Basaveshwar Engineering College, Bagalkote
Department of Artificial Intelligence and Machine Learning Engineering
Scheme of Teaching and Evaluation
(Academic Year 2020 – 2021 admitted)

III Semester BE

Sl. No	SUBJECT CODE	SUBJECT	CREDITS	HOURS/ WEEK			EXAMINATION MARKS		
				L	T	P	CIE	SEE	TOTAL
1.	UMA391C	Numerical Techniques and Integral Transforms	3	3	--	--	50	50	100
2.	UAI302C	Data Structures and Applications	4	4	--	--	50	50	100
3.	UAI303C	Embedded Systems	4	4	--	--	50	50	100
4.	UAI304C	Computer Organization	4	4	--	--	50	50	100
5.	UAI305C	AI and its Applications	3	3	--	--	50	50	100
6.	UAI306L	Problem Solving with Python Lab.	2	--	2	4	50	50	100
7.	UAI307L	Data Structures Lab.	1	--	--	2	50	50	100
8.	UAI308L	Embedded Systems Lab.	1	--	--	2	50	50	100
9.	UBT133M	Environmental Studies *	0	2	--	0	50	50	100
10.	UMA330M	Bridge course Mathematics – I *	0	3	--	0	50	50	100
		Total	**22**	**23**	**2**	**8**	**500**	**500**	**1000**

***Mandatory Subjects (For lateral entry (Diploma quota) students only)**

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IV Semester BE

Sl. No	SUBJECT CODE	SUBJECT	CREDITS	HOURS/ WEEK			EXAMINATION MARKS		
				L	T	P	CIE	SEE	TOTAL
1.	UMA491C	Statistics and Probability Distributions	3	3	--	--	50	50	100
2.	UAI402C	Design and Analysis of Algorithms	4	3	2	--	50	50	100
3.	UAI403C	Operating Systems	4	4	--	--	50	50	100
4.	UAI404C	Introduction to Data Science	3	3	--	--	50	50	100
5.	UAI405C	OOPS with Java Programming	3	3	--	--	50	50	100
6.	UHS001N	Fundamentals of Quantitative Aptitude And Soft Skills	1	1	--	--	50	50	100
7.	UAI406L	Design and Analysis of Algorithms Lab	1	--	--	2	50	50	100
8.	UAI407L	Data Science Lab	1	--	--	2	50	50	100
9.	UHS004M	Universal Human Values - II	--	3	--	--	--	--	--
10.	UMA430M	Bridge Course Maths - II*	--	3	--	--	50	50	100
11.	UHS226M	Constitution of India*	--	2	--	--	50	50	100
12.	UHS488C	Samskruthika Kannada**	1	2	--	--	50	50	100
	UHS489C	Balake Kannada***							
Total			**21**	**27**	**2**	**4**	550	550	1100

***For lateral entry (Diploma) students only**
****Students who have studied Kannada at primary level**
***** Students who have not studied Kannada at primary level**

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V Semester BE

Sl. No	SUBJECT CODE	SUBJECT	CREDITS	HOURS/ WEEK			EXAMINATION MARKS		
				L	T	P	CIE	SEE	TOTAL
1.	UAI501C	Principles of AI	3	3	--	--	50	50	50
2.	UAI502C	Machine Learning Algorithms	3	3	--	--	50	50	50
3.	UAI503C	Database Management Systems	3	3	--	--	50	50	50
4.	UAI504E	Computer Graphics with OpenGL	3	3	--	--	50	50	50
5.	UAI505X	Open Elective-I	3	3	--	--	50	50	50
6.	UHS002N	Fundamentals of Quantitative Aptitude And Soft Skills	1	2	--	--	50	50	50
7.	UAI506L	AI and Machine Learning Lab	1	--	--	3	50	50	50
8.	UAI507L	Database Lab	1	--	--	3	50	50	50
9.	UAI508L	Robotics Lab	2	--	2	2	50	50	50
Total			**21**	**17**	**2**	**8**	**450**	**450**	**900**

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VI Semester BE

Sl. No	SUBJECT CODE	SUBJECT	CREDITS	HOURS/ WEEK			EXAMINATION MARKS		
				L	T	P	CIE	SEE	TOTAL
1.	UAI601C	Advanced AI and ML	3	3	--	--	50	50	100
2.	UAI602C	Cloud Computing	3	3	--	--	50	50	100
3.	UAI603C	Computer Networks	3	3	--	--	50	50	100
4.	UAI604E	Natural Language Processing	3	3	--	--	50	50	100
5.	UAI605E	Cyber Security	3	3	--	--	50	50	100
6.	UAI606X	Open Elective – B	3	3	--	--	50	50	100
7.	UAI607L	Advanced AI and ML Lab	1	--	--	3	50	50	100
8.	UAI608L	Web Programming Lab	2	--	2	2	50	50	100
9.	UHS003N	Career Planning & Professional skills	1	2	--	--	50	50	100
10.	UAI610P	Mini Project	2	--	--	3	50	50	100
		Total	**24**	**20**	**2**	**8**	**500**	**500**	**1000**

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UMA391C	Numerical Techniques and Integral Transforms	Credits:03
Hrs/Week : 03		CIE Marks:50
Total Hours:40		SEE Marks:50

UNIT - I	10 Hrs
Numerical analysis - I: Introduction to root finding problems, Bisection Method, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof).	
UNIT – II	**10 Hrs**
Numerical analysis - II: Numerical differentiation using Newton's forward and backward formulae problems. Trapezoidal rule, Simpson's one third rule, Simpson's three eighth rule and Weddle's rule (no derivation of any formulae) problems. Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method.	
UNIT - III	**10 Hrs**
Fourier series: Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.	
UNIT - IV	**10 Hrs**
Fourier transforms and z-transforms: Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms. Z-transforms-definition, standard forms, linearity property, damping rule, shifting rule-problems.	
Text Books: 1) Steven C. Chapra & Raymond P Canale, Numerical Methods for Engineers. 2) Dr. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi. 3) H. K. Das, Advanced Engineering Mathematics, S. Chand & company Ltd. Ram Nagar, New Delhi. 4) E Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.	

UAI302C	Data Structures and Applications	Credits: 04
Hrs/Week : 04		CIE Marks:50
Total Hrs: 52		SEE Marks:50

UNIT - I	13 Hrs

Introduction to Data Structures: Basic Concepts: Abstract data type: Atomic and composite data, Data type, Data structure, Abstract data type, Model for an abstract data type: ADT operations, ADT data structures, Pointer to void. **Pointer to Function**: Defining pointers to functions, Using pointers to functions.

Stacks: **Basic stack operations**: Push, Pop, Stack top. **Stack linked list**: Implementation, Data structure, Stack head, Stack data node, Stack algorithms, Create Stack, Push Stack, Stack top, Empty Stack, Full Stack, Stack count, Destroy Stack, **C language implementation**: Insert data, Push Stack, Print Stack, Pop character. **Stack ADT**: Data structure, ADT implementations, Stack structure, Create stack, Push stack, Pop stack, Stack top, Empty stack, Stack count, Destroy stack. **Stack applications**: Reversing data, Reverse a list, Convert decimal to binary, Infix to postfix transformation, Evaluating postfix expressions, Stack implementation using array.

UNIT – II	13 Hrs

Queues: **Queue Operations**: Enqueue, Dequeue, Queue front, Queue rear, Queue example. **Queue Linked list design**: Data structure, Queue head, Queue data node, Queue algorithms, Create queue, Enqueue, Dequeue, Retrieving queue data, Empty queue, Full queue, Queue count, Destroy queue. **Queue ADT**: Queue structure, Queue ADT algorithms, Queue Implementation using array, Queue Applications. **Sorting:** Selection, Insertion, exchange and quick sorts. **Searching**: Sequential, binary search, hashed list searches.

UNIT - III	13 Hrs

General Linear lists: Basic operations, Insertion, Deletion, Retrieval, Traversal. **Implementation:** Data structure, Head node, Data node, Algorithms, Create list, Insert node, Delete node, List search, Retrieve node, Empty list, Full list, List count, Traverse list, Destroy list. **List ADT**: ADT functions, Create list, Add node, Internal insertion function, Remove node, Internal delete function, Search list, Internal search function, Retrieve node, Empty list, Full list, List count, Traverse, Destroy list. **Circular linked lists and Doubly linked lists**: Create list, add node, delete node, retrieve node, search list.

UNIT - IV	13 Hrs

Non-Linear lists: Trees: Basic tree concepts: Terminology, User representation, **Binary trees**: Properties, Height of binary trees, Balance, Complete and Nearly complete binary trees, **Binary tree traversals:** Depth-first traversals, Breadth-first traversals, **Expression Trees**: Infix traversal, Postfix traversal, Prefix traversal, **Huffman code, General trees, Binary search trees**: Basic concepts, **BST operations**: Traversals, Searches, Insertion Find the smallest and largest node, BST search, Insertion, Deletion, **Binary search tree ADT**, Data structure, Head and node structure, Algorithms, Create a BST, Insert a BST, Internal insert function, Delete a BST, Internal delete function, Retrieve a BST, Internal retrieve function, Traverse a BST, Internal traverse function, Empty a BST, Full BST, BST count, Destroy a BST, Internal destroy function.

Graphs: Basic concepts, **Operations**: Insert vertex, Delete vertex, Add edge, Delete edge, Find vertex, **Graph storage structures**: Adjacency matrix, Adjacency list.

Text Book:

1) Behrouz A. Forouzan and Richard F. Gilberg, 2nd Edition, Cengage Learning Publisher, 2005. **Data Structure A Pseudocode Approach with C**, (Chapter 1(1.2,1.3,1.5), 2,3,4 (4.1-4.4), 5, 6(6.1-6.3), 7(7.1-7.3), 11(11.1-11.3),12(12.2-12.4) 13(13.1-13.3) Appendix F.

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Reference Books:

1) Data Structures Using C, Aaron M. Tenanbaum, Yedidyah Langsam, Moshe J Augenstein Pearson Education.
2) Data Structures and Program Design in C, Robert Kruse, Bruce Leung, C. L. Tondo, Shashi Mogalla, 2nd Edition, Pearson Education.
3) Data Structures with C, Seymour Lipschutz, Schaum's outlines, MGH Education.
4) Data Structures Through C,Yeshwant Kanetkar , BPB publications.

Course outcomes:

1. Summarize linear and nonlinear data structures concepts, searching and sorting techniques.
2. Analyze and implement different data structures, searching and sorting techniques.
3. Compare and contrast different types of data structures and searching and sorting methods.
4. Develop solutions for the given problem by using relevant data structure

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UAI303C	Embedded Systems	Credits: 04
Hrs/Week: 04		CIE Marks:50
Total Hrs: 52		SEE Marks:50

UNIT - I	13 Hrs
Boolean Algebra: Definition of Boolean algebra, Boolean algebra theorems, A two-valued Boolean algebra, Boolean formulas and functions, Canonical Formulas, Manipulations of Boolean formulas. Gates and Combinational networks: Incomplete Boolean functions and Don't care conditions, Additional Boolean operations and Gates. Simplification of Boolean Expressions: K-maps and The Quine-McCluskey method. **Logic Design with MSI Components, Flip- Flops, Counters:** Binary adders and subtractors, Decimal adders, Comparators, Decoders, Multiplexers. The basic Bi-stable element, Latches, Master-Slave flip-flops (Pulse-Triggered flip-flops), Edge triggered flip-flops, Characteristic equations, Registers, Counters, Design of synchronous counters.	
UNIT – II	**13 Hrs**
The 8051 Microcontrollers, Assembly Language Programming: Microcontrollers and Embedded systems, Overview of the 8051 family, Inside the 8051, Introduction to 8051 Assembly programming, Assembling and running an 8051 program, the program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and PSW register, 8051 register banks and stack, pin description of the 8051. **Jump, Loop and Call Instructions, I/O Port Programming**: Loop and Jump instructions, Call instructions, Time delay for various 8051 chips, 8051 I/O programming, I/O bit manipulation programming.	
UNIT - III	**13 Hrs**
8051 Addressing Modes, Arithmetic, Logic Instructions and Programs: Immediate and register addressing modes, Accessing memory using various addressing modes, Bit addresses for I/O and RAM, Extra 128-byte-on-chip RAM in 8052. Arithmetic instructions, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction and data serialization, BCD, ASCII, and other application programs.	
UNIT - IV	**13 Hrs**
8051 Programming in C, Pin description of 8051: Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in 8051 C, Data conversion programs in 8051 C, Accessing code ROM space in 8051 C, Data serialization using 8051 C. **8051 Timer Programming in Assembly and C**: Programming 8051 timers, counter programming, Programming timer 0 and 1 in 8051 C. **Interrupts Programming in Assembly and C**: 8051 interrupts, Programming timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, Interrupt priority in the 8051/52, Interrupt programming in C. **MOTOR Control:** DC and Stepper Motors.	
Text Books: 1) Donald D. Givone, Digital Principles and Design, McGraw Hill Edition 2002. 2) Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson 2nd Edition, 2011.	

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Reference Books:

1) Leach and Malvino, Digital Principles and Applications, TMH, New Delhi, 2002.
2) Yarbrough J. M, Digital logic- Applications and Design, Thomson Learning, New Delhi, 2001.
3) Kenneth J. Ayala, The 8051 Microcontroller Architecture, Programming and Applications, 2nd Edition, Penram International, 1996.
4) Uma Rao and Andhe Pallavi, The 8051 Microcontroller Architecture, Programming and Applications, Pearson Education Sanguine.
5) V. Udayshankar, M. S. Mallikarjunaswamy, 8051 Microcontroller: Hardware, Software and Applications, McGrawHill, New Delhi.

Course outcomes:

1. Comprehend the difference between microprocessor and microcontroller architectures.
2. Simulate, analyze and develop basic programs using assembly and C language.
3. Demonstrate the use of Timers, Counters, Interrupts through programs.
4. Demonstrate the use of serial ports through programs for developing basic communication systems.
5. Analyze a problem and formulate appropriate computing solution for microcontroller based embedded applications.

UAI304C	Computer Organization	Credits: 04
Hrs/Week:04		CIE Marks: 50
Total Hrs:52		SEE Marks:50

UNIT - I	10 Hrs
Basic structure of computers: Computer types, Functional Units, Basic operational concepts, Bus structures. **Machine instructions and programs:** Numbers, Arithmetic operations and characters, Memory locations and addresses, Memory operations, Instructions and instruction sequencing, Addressing modes, Assembly language, assembler directives, number notation, Stacks and Queues, Subroutines, Encoding of machine instructions.	
UNIT – II	**10 Hrs**
Input/output organization: Accessing I/O devices, Interrupts-Interrupt hardware, Enabling and Disabling Interrupts, Handling multiple devices, controlling device requests, Exceptions, Direct memory access-bus Arbitrations, Buses-Asynchronous bus and Synchronous bus, Interface Circuits-Parallel port and serial port, Standard I/O Interfaces-Peripheral component interconnect Bus, SCSI bus, USB.	
UNIT - III	**10 Hrs**
The memory system: Some Basic concepts, Semiconductor RAM memories, Read only memories, speed, size, and cost, cache memories. **Arithmetic Unit:** Addition and subtraction of signed numbers, Design of fast adders, Multiplication of positive numbers, Signed operand multiplication, Fast multiplication. Integer Division, Floating point numbers and operations- IEEE standard for Floating point numbers, Arithmetic operations on Floating point numbers. Implementing Floating point operations.	
UNIT - IV	**10 Hrs**
Basic Processing Unit: Some fundamental concepts, Execution of complete instruction, Hardwired Control, Micro programmed control, Micro instructions. **Pipelining:** basic concepts, role of cache memory, pipeline performance. **Large computer systems**: forms of parallel processing, array processor, the structure of general purpose and multiprocessors. **Performance:** Processor Clock, Basic performance equation, pipelining and superscalar operations, Clock rate, Instruction set, compiler, performance measurement.	
Text Books: 1) Hamacher, Zvonko Vranesic, Safwat Zaky, 2002, Computer Organization, 5th Edition, MGH. (1.1-1.4, 2.1-2.5, 2.6.1, 2.6.3, 2.8-2.9, 2.12, 4.1, 4.2, 4.2.1-4.2.5, 4.4, 4.4.1, 4.5, 4.5.1-4.5.2, 4.6, 4.7, 5.1-5.5, 5.5.1, 6.1-6.7, 7.1-7.5, 7.5.1, 8.1, 8.1.1, 8.1.2, 12.1-12.3, 1.6)	
Reference Book: 1) J.P. Hayes, 1998, Computer Architecture and Organization, 3rd Edition, MGH. 2) William Stallings, 2007, Computer Organization and Architecture, 7th Edition, PHI.	

Course outcomes:

1. Describe the fundamental organization of a digital computer.
2. Explain the functional units and components of a computer.
3. Explain various addressing modes, instruction formats and program control statements and write assembly-level programs using simple machine instructions.
4. Distinguish the organization of various parts of a system memory hierarchy.
5. Describe fundamental concepts of pipelining and parallel processing.

UAI305C	AI and its Applications	Credits: 03
Hrs/Week:03		CIE Marks:50
Total Hrs: 40		SEE Marks:50

UNIT - I	10 Hrs

Introducing AI: Defining the Term AI, Discerning intelligence, Discovering four ways to define AI, Understanding the history of AI, Starting with symbolic logic at Dartmouth, Continuing with expert systems, Overcoming the AI winters, Considering AI uses, Avoiding AI Hype, Connecting AI to the underlying computer.

Defining the role of data: Finding data ubiquitous in this age, Understanding Moore's implications, Using data everywhere, Putting algorithms into action.

Considering the use of algorithms: Understanding the role of algorithms, Understanding what algorithm means, starting from planning and branching, Playing adversarial games, Using local search and heuristics, Discovering the learning machine, Leveraging expert systems, Introducing machine learning, Touching new heights.

Pioneering specialized hardware: Relying on standard hardware, Understanding the standard hardware, Describing standard hardware deficiencies, Using GPUs, Considering the Von Neumann bottleneck, Defining the GPU, Considering why GPUs work well, Creating a specialized processing environment, Increasing hardware capabilities, Adding specialized sensors, Devising methods to interact with the environment.

UNIT – II	10 Hrs

Seeing AI uses in computer applications: Introducing common application types, Using AI in typical applications, Realizing AI's wide range of fields, Considering the Chinese Room argument, Seeing how AI makes applications friendlier, Performing corrections automatically, Considering the kinds of corrections, Seeing the benefits of automatic corrections, Understanding why automated corrections don't work, Making suggestions, Getting suggestions based on past actions, Getting suggestions based on groups, Obtaining the wrong suggestions, Considering AI-based errors.

Using AI to address medical needs: Implementing portable patient monitoring, Wearing helpful monitors, Relying on critical wearable monitors, Using movable monitors, Making humans more capable, Using games for therapy, Considering the use of exoskeletons, Addressing special needs, Considering the software-based solutions, Relying on hardware augmentation, Seeing AI in prosthetics, Completing analysis in new ways, Devising new surgical techniques, Making surgical suggestions, Assisting a surgeon, Replacing the surgeon with monitoring, Performing tasks using automation, Working with medical records, Predicting the future, Making procedures safer, Creating better medications, Combining robots and medical professionals.

Relying on AI to improve human interaction: Developing new ways to communicate, Creating new alphabets, Automating language translation, Incorporating body language, Exchanging ideas, Creating connections, Augmenting communication, Defining trends, Using multimedia, Embellishing human sensory perception, Shifting data spectrum, Augmenting human senses.

UNIT - III	10 Hrs

Performing data analysis for AI: Defining data analysis, Understanding why analysis is important, Reconsidering the value of data, Defining machine learning, Understanding how machine learning works. Understanding the benefits of machine learning, Being useful; being mundane, Specifying the limits of machine learning, Considering how to learn from data, supervised learning, Unsupervised learning, Reinforcement learning.

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Employing machine learning in AI: Taking many different roads to learning, Discovering five main approaches to AI learning, Delving into the three most promising AI learning, approaches, Awaiting the next breakthrough, Exploring the truth in probabilities, Determining what probabilities can do, Considering prior knowledge, Envisioning the world as a graph, Growing trees that can classify, Predicting outcomes by splitting data, Making decisions based on trees, Pruning overgrown trees.

Developing robots and flying with drones: Defining robot roles, Overcoming the sci-fi view of robots, Knowing why it's hard to be a humanoid, Working with robots, Assembling a basic robot, Considering the components, Sensing the world, Controlling a robot, Acknowledging the state of the art, Flying unmanned to missions, Meeting the quad-copter, Defining uses for drones, Seeing drones in non-military roles, Powering up drones using AI, Understanding regulatory issues.

UNIT - IV	10 Hrs

Understanding the Non starter Application: Using AI where it won't work, Defining the limits of AI, Applying AI incorrectly, Entering a world of unrealistic expectations, Considering the effects of AI winters, Understanding the AI winter, Defining the causes of the AI winter, Rebuilding expectations with new goals, Creating solutions in search of a problem, Defining a gizmo, Avoiding the infomercial, Understanding when humans do it better, Looking for the simple solution.

Seeing AI in space: Observing the universe, Seeing clearly for the first time, Finding new places to go, Considering the evolution of the universe, Creating new scientific principles, Performing space mining, Harvesting water, Obtaining rare earths and other metals, Finding new elements, Enhancing communication, Exploring new places, Starting with the probe, Relying on robotic missions, Adding the human element, Building structures in space, Taking your first space vacation, Performing scientific investigation, Industrializing space, Using space for storage.

Adding new human occupations: Living and working in space, Creating cities in hostile environments, Building cities in the ocean, Creating space-based habitats, Constructing moon-based resources, Making humans more efficient, Fixing problems on a planetary scale, Contemplating how the world works, Locating potential sources of problems, Defining potential solutions, Seeing the effects of the solutions, Trying again.

Text Books:

1) John Paul Mueller and Luca Massaron, Artificial Intelligence for Dummies, John Wiley and Sons, 2018.

Reference Books:

1) Utpal Chakraborthy, Artificial Intelligence for all, BPB Publications, Feb. 2020.
2) Praphat Kumar, Artificial Intelligence, BPB Publications, Jan. 2019.
3) Nils J. Nilsson, The Quest for Artificial Intelligence: A History of Idea and Achievements, Stanford University, Camridge University Press, 2010.
4) Bernard Marr, Artificial Intelligence: How 50 Successful Companies used Artificial Intelligence to solve Problems, Wiley Publications, 2019.

Course outcomes:

1. Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
2. Demonstrate proficiency in usage of hardware and software platforms for AI based applications.
3. Demonstrate awareness and understanding of various applications of AI techniques.
4. Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implication

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UAI402C	DESIGN AND ANALYSIS OF ALGORITHMS	Credits: 04
L:T:P:3:2:0		CIE Marks:50
Total Hours/Week : 40/5		SEE Marks:50

UNIT - I **(10+6 hours)**

Introduction: Notion of Algorithm, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental Data Structures.
Fundamentals of the Analysis of Algorithm Efficiency: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms, Example – Fibonacci Numbers.
Brute Force: Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search.

UNIT – II **(10+6 hours)**

Divide and Conquer: Merge sort, Quick sort, Binary Search, Binary Tree Traversals and Related Properties, Multiplication of Large Integers and Strassen's Matrix Multiplication.
Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting, Algorithms for Generating Combinatorial Objects.

UNIT - III **(10+6 hours)**

Transform and Conquer: Presorting, Balanced Search Trees, Heaps and Heapsort, Problem Reduction.
Space and Time Tradeoffs: Sorting by Counting, Input Enhancement in String Matching, Hashing, B-Trees.
Dynamic Programming: Computing a Binomial Coefficient, Warshall's and Floyd's Algorithms, Optimal Binary Search Trees. The Knapsack Problem and Memory Functions.

UNIT - IV **(10+6 hours)**

Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees.
Limitations of Algorithm Power: Lower-Bound Arguments, Decision Trees, Problems Coping with the Limitations of Algorithm Power: Backtracking, Branch-and-Bound.

Text Books:

1) "Introduction to The Design & Analysis of Algorithms", Anany Levitin, Pearson Education, 3rd Edition, 2017

Reference books:

1) "Introduction to Algorithms", Stein, PHI, 2nd Edition,
2) "Computer Algorithms", Horowitz E., Sahni S., Rajasekaran S., Galgotia Publications, 2001

Course Outcomes:

1. Explain the notion of algorithm, asymptotic notations.
2. Design and analyze recursive and non-recursive algorithms.
3. Design and analyze algorithms using divide and conquer.
4. Design and analyze algorithms using dynamic programming and greedy approaches.
5. Design and analyze algorithms using backtracking, branch and bound.

UAI403C	**OPERATING SYSTEMS**	**Credits: 04**
L:T:P:4:0:0		CIE Marks:50
Total Hours/Week :52/4		SEE Marks:50

UNIT - I	**13 Hrs**
Introduction to operating systems, types and services: **Role of Operating systems:** user view, system view: Types of OS, Batch Systems; Multiprogramming; Time Sharing; Distributed & Real time OS, Operating System structure; Operating System operations; Operating System Services; User - Operating System interface; System calls; Types of system calls; System programs; Operating System design and implementation; Operating System structure; Virtual machines. **Process management:** Process concept; Concepts of process: Process status, Process description, Process model, Operations on processes	
UNIT – II	**13 Hrs**
Process management, threads and process synchronization **Process Scheduling:** Basic concepts; scheduling criteria; Scheduling algorithms; Multiple-Processor scheduling, Interprocess communication. **Threads**: concepts, Multi-Threaded Programming: Overview; Multithreading models; Thread Libraries; Threading issues. Thread scheduling. **Synchronization:** The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors.	
UNIT - III	**13 Hrs**
Deadlocks and memory management **Deadlocks:** Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock. **Memory Management Strategies:** Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Page replacement; Allocation of frames.	
UNIT - IV	**13 Hrs**
File system: concepts and implementation, secondary storage structures **File system:** File System: File concept; Access methods; Directory structure; File system mounting; File sharing; Protection. Implementing File System: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management. Protection: Goals, principles and domain of protection, Access Matrix, Disk management and other issues**:** Disk management: Disk Structure and Scheduling.	
Text Books: 1) Abraham Silberschatz, Peter Baer Galvin , Greg Gagne: Operating System 7th edition, Addison Wesley	
Reference books: 1. D.M Dhamdhere: Operating systems - A concept based Approach, 2nd Edition, Tata McGraw- Hill, 2002.	

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Course Outcomes: At the end of the course the student should be able to

1. Explain the core structure and different services provided by Operating System at different levels
2. Apply the concepts of process scheduling algorithms and synchronization techniques in solving real time problems
3. Exhibit the knowledge of memory management techniques
4. Exhibit the knowledge of secondary storage management techniques and security solutions

UAI404C	Introduction to Data Science	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week : 40/3		SEE Marks:50

UNIT - I	10 Hrs
Introduction: Data Science. Applications of data science. Data science related to other field. Relationship between data science and Information science. Computational thinking. Skills for data science. Tools for data science. Issues of Ethics, Bias, and Privacy in Data Science. **Data**: Introduction, Data types: Structured Data, Unstructured Data, Challenges with Unstructured Data. Data Collections: Open Data, Social Media Data, Multimodal Data, Data Storage and Presentation. **Data Pre-processing**: Data Cleaning, Data Integration, Data Transformation, Data Reduction, Data Discretization.	
UNIT – II	**10 Hrs**
Techniques: Introduction, Data Analysis and Data Analytics, Descriptive Analysis**:** Variables, frequency Distribution, Measures of Centrality, Dispersion of a Distribution Diagnostic Analytics**:** Correlations, Predictive Analytics, Prescriptive Analytics, Exploratory Analysis, Mechanistic Analysis, Regression. **Tools for data science:** Introduction, Getting Access to R, Getting Started with R**:** Basics, Control Structures, Functions, Importing Data, Graphics and Data Visualization: Installing ggplot2, Loading the Data, Plotting the Data, Statistics and Machine Learning**:** Basic Statistics, Regression, Classification, Clustering.	
UNIT - III	**10 Hrs**
Machine learning for data science: Machine Learning Introduction and Regression: Introduction, Machine Learning, Regression, Gradient Descent. Unsupervised learning**:** Introduction, Agglomerative Clustering, Introduction to Reinforcement Learning.	
UNIT - IV	**10 Hrs**
Applications, Evaluation, and Methods: Hands-On with Solving Data Problems: Introduction, Collecting and Analyzing Twitter Data, Collecting and Analyzing YouTube Data , Analyzing Yelp Reviews and Ratings. **Data Collection, Experimentation, and Evaluation: Data Collection Methods**: Surveys, Survey Question Types, Survey Audience, Survey Services, Analyzing Survey Data, Pros and Cons of Surveys, Interviews and Focus Groups, Why Do an Interview? Why Focus Groups? Interview or Focus Group Procedure, Analyzing Interview Data , Pros and Cons of Interviews and Focus Groups, Log and Diary Data, User Studies in Lab and Field, Picking Data Collection and Analysis Methods**:** Introduction to Quantitative Methods, Introduction to Qualitative Methods, Mixed Method Studies. Evaluation: Comparing Models, Training–Testing and A/B Testing, Cross-Validation.	

Text Books:

1) A hands on introduction to Data Science, Chirag Shah, Cambridge University Press, 2020.

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Reference books:

1) **"**Data Science from Scratch", Joel Grus, O'Rielly Publications, 2015.
2) **"** Introduction to Data Science", Laura Igual and Santi Segui, Springer International Publications, 2017

Course Outcomes:

1. Identify and asses the needs of an organization for data science task
2. Collect, manage and use data to examine, analyze and interpret data
3. Apply statistical and ML algorithms to effectively generate useful information from structural and un structured data
4. Design, build and evaluate models that can be used to make predictions in real world phenomena
5. Communicate data science related information effectively in various formats to appropriate audience

UAI405C	OOPS with Java Programming	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/3		SEE Marks:50

UNIT - I	10 Hrs
Java Programming Fundamentals: Object Oriented programming features. **History and evolution of Java**: Java's lineage, byte code, Java Buzzwords**,** An overview of Java, Data Types, Variables and Arrays, Operators, Control Statements. **Introducing Classes:** Class Fundamentals, Declaring Objects, Introducing Methods, Constructors, this keyword, garbage collection, method overloading.	
UNIT – II	**10 Hrs**
Inheritance: Inheritance Basics, Using Super, Creating a Multilevel Hierarchy, Method overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance. **String Handling : **The string constructors, string length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying a String. **Packages and Interfaces:** Packages, Access Protection.	
UNIT - III	**10 Hrs**
Importing packages and Interfaces. **Exception Handling:** Exception-Handling Fundamentals-Eception Classes, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch clauses, Nsted try Statements, throw and finally statements. **Multithreaded Programming:** The Java Thread Moel, The Main Thread , Creating a thread Creating Multiple Threads, Using is Alive( ) and join() , Thread Priorities , Synchronization , Suspending, Resuming and Stopping Threads.	
UNIT - IV	**10 Hrs**
Files: The Stream Classes, Byte streams, Character Streams, Serialization and Console Class. **Co** Collections Overview, The Collection Interfaces: The collection Interface, The List Interface, The Interface, The Queue Interface and The De queue Interface. The Collection Classes (Array List, List).	

Text Books:

1) 1. Java The Complete Reference,- Herbert Schildt 9th Edition, MGH Education

Reference books:

1) Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill.
2) Core Java Volume 1- Fundamentals, Cay S Horstmann ,Gary Cornell, 8th Edition Pearson Education.
3) Programming with Java, E Balagurusamy,6th Edition, MGH.

Course Outcomes:

1. Explain the syntax and semantics of java programming language and basic concepts of Object Oriented Programming (OOP).
2. Identify classes, objects, members of a class and relationships among them needed for a specific problem.
3. Develop reusable programs using the concepts of inheritance, polymorphism, string and packages.
4. Apply the concepts of importing packages and interface, multithreading and exception handling to develop efficient and error free codes.

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5. Develop interactive programs using file and collections.

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Course Outcomes	Programme Outcomes												PSO	PSO	PSO
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1										3		
CO2	3	3	3										3		
CO3	3	3	3										3		
CO4	3	3	3										3		
CO5	3	3	3										3		

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UAI501C	Principles of AI	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT - I	10 Hrs
Introduction: What is AI? Foundations and History of AI. **Intelligent Agents:** Agents and environment, Concept of Rationality, The nature of environment, The structure of agents.	
UNIT – II	**10 Hrs**
Problem solving: Problem solving agents, Example problems, Searching for Solutions, Uninformed Search. **Strategies:** Breadth First search, Depth First Search, Iterative deepening depth first search.	
UNIT - III	**10 Hrs**
Informed Search Strategies: Heuristic functions, Greedy best first search, A*search. Heuristic Functions. **Logical Agents:** Knowledge–based agents, The Wumpus world, Logic, Propositional logic, Reasoning patterns in Propositional Logic. **First Order Logic:** Representation Revisited, Syntax and Semantics of First Order logic, Using First Order logic.	
UNIT - IV	**10 Hrs**
Inference in First Order Logic: Propositional Versus First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution. **Uncertain Knowledge and Reasoning:** Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference using Full Joint Distributions, Independence, Baye's Rule and its use. Wumpus World Revisited.	

Text Books:

1) 1. Stuart J. Russell and Peter Norvig , Artificial Intelligence, 3rd Edition, Pearson, 2015.

Reference Books:

1) Elaine Rich, Kevin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2013.
2) George F Lugar, Artificial Intelligence Structure and strategies for complex, Pearson Education, 5th Edition, 2011.

Course Outcomes:

1. Apply knowledge of agent architecture, searching and reasoning techniques for different applications.
2. Analyze Searching and Inferencing Techniques.
3. Develop knowledge base sentences using propositional logic and first order logic
4. Demonstrating agents, searching and inferencing

Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	2	2	2										2	3	
CO2		3											2	3	
CO3			3										2	3	
CO4			2	2	2								2	3	

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UAI502C	Machine Learning Algorithms	Credits:03
L:T:P:3:0:0		CIE Marks: 50
Total Hours/Week: 40/03		SEE Marks: 50

UNIT - I	10 Hrs
Introduction: Introduction to Machine Learning, Examples of Machine Learning Applications. Well posed learning problems, Designing Learning System, Perspectives and issues in Machine Learning. **Decision Tree Learning**: Introduction, Decision tree representation, Appropriate problems for decision tree learning, the basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive Bias in decision tree learning, Issues in decision tree learning	
UNIT – II	**10 Hrs**
Artificial Neural Networks (ANN): Introduction, Neural Network Representations, Appropriate Problems For Neural Network Learning, Perceptron, Multilayer Networks And The Back propagation Algorithm, Remarks On The Back propagation Algorithm, An Illustrative Example: Face Recognition. **Hypothesis and Performance Evaluation**: Basic Performance Criterion, Precision and recall, Other ways to measure Performance, Estimating Hypothesis Accuracy, Basics of Sampling Theory, General approach for deriving confidence intervals, difference in error of two hypothesis, comparing learning algorithms.	
UNIT - III	**10 Hrs**
Bayesian learning: Introduction, Bay's theorem, Maximum likelihood and least squared hypothesis, Maximum likelihood hypothesis for predicting probabilities, Minimum Description length principle, Bay's optimal classifier, Gibbs algorithm, Naive Bay's Classifier. An Example: Classify Text. **Instance Based Learning**: Introduction, k-Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis function, and case based reasoning.	
UNIT - IV	**10 Hrs**
Dimensionality Reduction: Introduction, Subset Selection, Principal Components Analysis, Factor Analysis, Multi dimensional scaling, Linear discriminant analysis, isomap, Locally Linear Embedding. **Clustering**: Introduction, Mixture Densities, K-means Clustering, Expectation Maximization Algorithm, Mixture Latent Variable models, Supervised learning after clustering, Hierarchical clustering, Choosing the number of clusters	

Text Books:

1) Tom Mitchell, Machine Learning, McGraw- Hill Publications, 2nd Edition, 2013.
2) Ethem Alpaydin, Introduction to Machine Learning, MIT press, Cambridge, Massachusetts, London, 2nd Edition, 2010.

Reference Books:

1) Trevor Hastie. Robert Tipeshirani, Jerome Fredman, Elements of Statistical Learning, Springer, 2nd Edition, 2010.
2) Luis Pedro Coelho and Willi Richart, Building Machine Learning Systems with Python, PACKT Publication, 2nd Edition, 2013.

Course Outcomes:

1. Define machine learning and types of learning algorithms
2. Explain various machine learning algorithms.
3. Apply machine learning algorithm to solve problems of moderate complexity.
4. Analyze performance of algorithms by varying some parameters.
5. To formulate machine learning model for the simple problem.

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Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
CO1	3												2	2	
CO2	2												3	3	
CO3		2	3		2								3	3	
CO4			2		2								2	3	
CO5					3								2	2	2

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UAI503C	Database Management Systems L:T:P:3:0:0	03-Credits
Hrs/Week: 03		CIE Marks:50
Total Hours:40		SEE Marks:50

UNIT - I	10 Hrs
Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications. **Overview of Database Languages and Architectures:** Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment. Conceptual Data Modelling using Entities and Relationships: Entity types, Entity sets, attributes, roles, and structural constraints, Weak entity types, ER diagrams, examples, Specialization and Generalization.	
UNIT – II	**10 Hrs**
Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations. **Relational Algebra:** Unary and Binary relational operations, additional relational operations (aggregate, grouping, etc.) Examples of Queries in relational algebra. Mapping Conceptual Design into a Logical Design: Relational Database Design using ER-to-Relational mapping. SQL: SQL data definition and data types, specifying constraints in SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL.	
UNIT - III	**10 Hrs**
SQL: Advances Queries: More complex SQL retrieval queries, Specifying constraints as assertions and action triggers, Views in SQL, Schema change statements in SQL.Normalization: Database Design Theory-Introduction to Normalization using Functional and Multivalued **Dependencies:** Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form. Normalization Algorithms: Inference Rules, Equivalence, and Minimal Cover, Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Nulls, Dangling tuples, and alternate Relational Designs, Further discussion of Multivalued dependencies and 4NF, Other dependencies and Normal Forms.	
UNIT - IV	**10 Hrs**
Transaction Processing: Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions, Characterizing schedules based on recoverability, Characterizing schedules based on Serializability, Transaction support in SQL. **Concurrency Control in Databases:** Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering, Multiversion Concurrency control techniques, Validation Concurrency control techniques, Granularity of Data items and Multiple Granularity Locking.	
Text Books: **1)** Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 7th Edition, 2017, Pearson.	

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Reference books: 1) Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill 2) SilberschatzKorth and Sudharshan, Database System Concepts, 6th Edition, Mc-GrawHill, 2013. 3) Coronel, Morris, and Rob, Database Principles Fundamentals of Design, Implementation and Management, Cengage Learning 2012.
Course Outcomes:

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1) Provide a strong foundation in database concepts, technology, and practice.
2) Practice SQL programming through a variety of database problems.
3) Demonstrate the use of concurrency and transactions in database.
4) Design and build database applications for real world problems.

Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	2	3	1										3		
CO2	2	3	3										3		
CO3	2	2	3										3		
CO4	3	3	3										3		

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UAI504E	Computer Graphics with Open GL	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT - I	10 Hrs
Overview of Graphics Systems: Video Display Devices, Raster-Scan Displays, Graphics Workstations and Viewing Systems, Introduction to OpenGL, **Graphics Output Primitives:** Coordinate Reference Frames, Specifying A Two-Dimensional World-Coordinate Reference Frame in OpenGL, OpenGL Point Functions, OpenGL Line Functions, Line Drawing Algorithms: DDA, Bresenham's Line-Drawing Algorithm, OpenGL Curve Functions, Circle Generating Algorithms: Midpoint Circle Algorithm. **Attributes of Graphics Primitives**: OpenGL State Variables, Color and Grayscale, OpenGL Color Functions, OpenGL Point-Attribute Functions, OpenGL Line-Attribute Functions.	
UNIT – II	**10 Hrs**
Fill-Area primitives, OpenGL Polygon Fill-Area Functions, OpenGL Vertex Arrays, Pixel-Array Primitives, OpenGL Pixel-Array Functions, Character Primitives, OpenGL Character Functions, OpenGL Display Lists, OpenGL Display-Window Reshape Function. **Interactive Input Methods and Graphical User Interfaces:** Graphical Input Data, Logical Classification of Input Devices, Input Functions for Graphical Data, Interactive Picture-Construction Techniques, OpenGL Interactive Input-Device Functions, OpenGL Menu Functions, Designing a Graphical User Interface.	
UNIT - III	**10 Hrs**
Geometric Transformations-1: Basic Two-Dimensional Geometric Transformations, Matrix Representations and Homogeneous Coordinates, Inverse Transformations, Two-Dimensional Composite Transformations, Other Two-Dimensional Transformations, Raster Methods for Geometric Transformations, OpenGL Raster Transformations, Transformations between Two-Dimensional Coordinate Systems. **Geometric Transformations-2:** Geometric Transformations in Three-Dimensional Space, Three-Dimensional Translation, Three-Dimensional Rotation, Three-Dimensional Scaling, Composite Three Dimensional Transformations, Other Three Dimensional Transformations, Transformations between Three Dimensional Coordinate Systems, Affine Transformations, OpenGL Geometric Transformations Functions.	
UNIT - IV	**10 Hrs**
Two-Dimensional Viewing: The Two-Dimensional Viewing Pipeline, The clipping Window, Normalization and Viewport Transformations, OpenGL Two-Dimensional Viewing Functions, Clipping Algorithms, Two-Dimensional Point Clipping, Two-Dimensional Line Clipping: Cohen-Sutherland line Clipping, Polygon Fill-Area Clipping: Sutherlan-Hodgman Polygon Clipping, Curve Clipping, Text Clipping. **Viewing:** Classical and Computer Viewing, Viewing with a Computer, Positioning of the Camera, Simple Projections, Projections in OpenGL, Hidden-Surface Removal, Interactive Mesh Displays, Parallel-Projection Matrices, Perspective-Projection Matrices, Projections and Shadows.	

Text Books:

1) Computer Graphics with OpenGL, Donald Hearn and Pauline Baker, Pearson Education, 3rd Edition, 2004.

2) 2. Interactive Computer Graphics A Top-Down Approach using OpenGL, Edward Angel Addison-Wesley, 5th Edition, 2008.

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Reference books:

1. Computer Graphics using OpenGL, F.S.Hill Jr. Pearson Education, 2nd Edition, 2001.
2. Computer Graphics, James D. Foley, Andries Van Dam, Steven K Feiner, John F. Hughes, Addison-Wesley, 1997.

Course Outcomes:

1. Explain the fundamental concepts of computer graphics.
2. Implement the graphics algorithms to draw geometric primitives using OpenGL.
3. Develop an interactive 2D and 3D graphics applications.
4. Demonstrate 2D viewing and clipping algorithms.
5. Construct the graphical model with lighting and shading patterns.

Course Outcomes	**Programme Outcomes**												**PSO 1**	**PSO 2**	**PSO 3**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
CO1	3	3	1	3			2						1		
CO2	3	3	1	3			2						1		
CO3	3	3		3			2						1		
CO4	3	3		3			2						1		
CO5	3	3		3			2						1		

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UAI601C	Advanced AI and ML	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

UNIT - I	10 Hrs
Support Vector Machine (SVM): Basic terms, how does SVM works? Types of SVM, mathematical intuition behind support vector machine, SVM kernel functions, applications of SVM, advantages and disadvantages of SVMs, differences between logistic regression and SVM, v-SVM. **Advanced clustering techniques:** Introduction to clustering, applications of clustering, density based clustering algorithms, density reachability and density connectivity. *DBSCAN clustering:* types of points after the DBSCAN clustering is completed, algorithmic steps for DBSCAN clustering, the complexity of DBSCAN. *BIRCH algorithm:* stages of BIRCH algorithm, algorithm and cluster features, parameters of BIRCH, advantages of BIRCH. Differences between: DBSCAN and K-means, BIRTH and K-means. **Implementation of:** SVM, DBSCAN, BIRCH algorithms using python.	
e-Resources: • https://www.analyticsvidhya.com/blog/2021/10/support-vector-machinessvm-a-complete-guide-for-beginners/ • https://stackabuse.com/implementing-svm-and-kernel-svm-with-pythons-scikit-learn/ • Radial Basis Function (RBF) Kernel: The Go-To Kernel | by Sushanth Sreenivasa | Towards Data Science • https://www.kdnuggets.com/2020/04/dbscan-clustering-algorithm-machine-learning.html#:~:text=low%20point%20density.-,Density%2DBased%20Spatial%20Clustering%20of%20Applications%20with%20Noise%20(DBSCAN),is%20containing%20noise%20and%20outliers. • https://www.freecodecamp.org/news/8-clustering-algorithms-in-machine-learning-that-all-data-scientists-should-know/ • https://www.javatpoint.com/birch-in-data-mining	
UNIT – II	**10 Hrs**
Ensemble techniques: Definition, ensemble learning approaches. *Bagging techniques:* Random forest, differences between decision tree and random forest, example for random forest, features of random forest. *Boosting techniques:* Working processes of boosting, Gradient boosting-elements, algorithm. AdaBoosting, XGBoost, differences between bagging and boosting techniques. **Recommendation system:** *Content based technique:* working processes, advantages and disadvantages. *Collaborative based technique:* working process, advantages and disadvantages. *Hybrid based techniques:* working process and advantages and disadvantages. Applications of recommendation system. **Implementation of:** Random Forest, Content based and Collaborative based techniques using python.	

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e-Resources:

- https://www.pluralsight.com/guides/ensemble-methods:-bagging-versus-boosting
- https://www.wallstreetmojo.com/gradient-boosting/
- https://www.mygreatlearning.com/blog/random-forest-algorithm/
- Ensemble Learning Methods: Bagging, Boosting and Stacking (analyticsvidhya.com)
- https://www.geeksforgeeks.org/recommendation-system-in-python/
- https://www.nvidia.com/en-us/glossary/data-science/recommendation-

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system/#:~:text=A%20recommendation%20system%20is%20an,demographic%20information%2C%20and%20other%20factors.

- https://towardsdatascience.com/introduction-to-recommender-systems-6c66cf15ada
- https://www.analyticsvidhya.com/blog/2021/07/recommendation-system-understanding-the-basic-concepts/
- https://www.iteratorshq.com/blog/an-introduction-recommender-systems-9-easy-examples/

UNIT - III	10 Hrs

Introducing Neural Networks: Deep Learning at a glance: How deep learning works, differences between Machine Learning (ML) and Deep Learning (DL), Convolution Neural Network (CNN) architecture, illustration of different operations in CNN model(convolution, padding, flattening),advantages and disadvantage of CNN model, building an CNN, types of pre-defined CNN models:- VGG, AlexNet, LeNet, ResNet and GoogleNet.

A brief introduction to TensorFlow and Keras: Differences between Keras and TensorFlow, advantages and disadvantage of Keras and TensorFlow.

Implementation of CNN: using keras and TensorFlow.

e-Resources:

- https://www.tensorflow.org/tutorials/images/cnn
- https://medium.com/analytics-vidhya/cnns-architectures-lenet-alexnet-vgg-googlenet-resnet-and-more-666091488df5
- https://www.javatpoint.com/machine-learning-vs-deep-learning
- https://www.geeksforgeeks.org/cnn-introduction-to-pooling-layer/
- https://www.ibm.com/in-en/topics/convolutional-neural-networks#:~:text=The%20convolutional%20layer%20is%20the%20core%20building%20block%20of%20a,matrix%20of%20pixels%20in%203D.
- https://www.analyticsvidhya.com/blog/2021/06/building-a-convolutional-neural-network-using-tensorflow-keras/

UNIT - IV	10 Hrs

Knowledge Representation: Techniques of knowledge representation, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning systems for categories, the internet shopping world.

Quantifying Uncertainty: Probabilistic reasoning in Artificial intelligence, Bayes' theorem in Artificial intelligence, Application of Bayes' theorem in Artificial intelligence, Bayesian Belief Network in artificial intelligence

e-Resources:

- https://www.javatpoint.com/ai-techniques-of-knowledge-representation
- https://mitu.co.in/wp-content/uploads/2022/01/5.-Knowledge-Representation-in-AI.pdf
- https://www.uio.no/studier/emner/matnat/ifi/nedlagte-emner/INF5390/v14/forelesninger/inf5390-07-knowledge-representation.pdf
- https://pages.mtu.edu/~nilufer/classes/cs5811/2016-fall/lecture-slides/cs5811-ch13-quantifying-uncertainty.pdf
- Valen, J., Balki, I., Mendez, M. et al. Quantifying uncertainty in machine learning classifiers for medical imaging. Int J CARS 17, 711–718 (2022). https://doi.org/10.1007/s11548-022-02578-3

Text Books:

1. Giuseppe Bonaccorso, “Machine Learning Algorithms”, Second Edition, ISBN:978-1- 78934-799-9, Packet Publishing Ltd., Birmingham,UK.
2. Peter Norvig and Stuart J. Russell, “Artificial Intelligence: A Modern Approach”, third edition, ISBN:978-93-325-4351-5, pearson , 2021.(Chapter 12 and Chapter 13)

Reference books:

1. Tom Mitchel, "Machine Learning ", International Edition 1997, McGraw Hill Education.

e-Resources and other Digital Material:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
2. https://onlinecourses.nptel.ac.in/noc20_cs62/preview

Course Outcomes:

1. **Apply** and **Analyze** various algorithms for SVM, and Clustering techniques.
2. **Analyze** and **Apply** basic concepts of ensemble, and recommendation systems.
3. **Understand** and **Apply** the basic concepts of CNN using Tensor Flow and Keras
4. **Understand** and **Contrast** the concept of Knowledge Representation and Quantifying Uncertainty.
5. **Apply** and **Analyze** machine learning algorithms on given data and interpret the results obtained.

Course Outcomes	Programme Outcomes												PSO	PSO	PSO
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	3	1							1	2	3	1
CO2	1	2	3	2	1							1	2	3	1
CO3	1	2	3	2	1							1	2	3	1
CO4	2	2	3	2	1							1	2	3	1
CO5	2	2	3	3	2							1	2	3	1

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UAI602C	Cloud Computing	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

UNIT - I	10 Hrs
System Models and Enabling Technologies: Scalable Computing towards Massive Parallelism; System Models for Distributed and Cloud Computing - Clusters of Cooperative Computers, Grid Computing Infrastructures, Peer-to-Peer Network Families, Cloud Computing over the Internet; Parallel and Distributed Programming Models. **Computer Clusters**: Clustering for massive parallelism – Trend, Design objectives, Issues; Clusters and MPP architectures; Design Principles – SSI features.	
UNIT – II	**10 Hrs**
Cloud platform architecture over virtualized data centers: Cloud computing and service models; data center design and interconnection networks; architecture design of compute and storage clouds; Public cloud platforms (GAE, AWS and Azure); inter cloud resource management.	
UNIT - III	**10 Hrs**
Cloud security and trust management: Cloud Programming and Software Environments: Features of Cloud and Grid Platforms; Parallel and Distributed Programming Paradigms - Parallel Computing and Programming Paradigms., MapReduce, Twister, and Iterative MapReduce, Hadoop Library from Apache.	
UNIT - IV	**10 Hrs**
Programming Support of Google App Engine, Programming Amazon AWS and Microsoft Azure: G Emerging cloud software environments, Enabling technologies for Internet of Things	

Reference books:

1) Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed & Cloud Computing, Morgan Kaufmann / ELSEVIER Publishers, 2012
2) Dinakar Sitaram, Geeta Manjunath, Moving to the cloud, SYNGRESS/ ELSEVIER, 2012

Course Outcomes:

1. To explain various computing paradigms and system models for massive computing.
2. To describe service models, design of data centres and various cloud platforms.
3. To analyze data flow in parallel and distributed programming models and apply them to solve problems on distributed systems.
4. To describe public cloud platforms, emerging cloud software environments and enabling technologies for internet of things.

CO id	Course Outcomes	IS –PO -1	IS –PO-2	IS –PO-3	IS -PO-4	IS -PO-5	IS -PO-6	IS -PO-7	IS -PO-8	IS -PO-9	IS -PO_10	IS -PO_11	IS -PO_12
1	To explain various computing paradigms and system models for massive computing			2	2	3							
2	To describe service models, design of data centres and various cloud platforms			2	2	3							

3	To analyze data flow in parallel and distributed programming models and apply them to solve problems on distributed systems			3	3	3	1	1	2				

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4	To describe public cloud platforms, emerging cloud software environments and enabling technologies for internet of things.			2	2	3							

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UAI603C	Computer Networks	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

UNIT - I	10 Hrs
Introduction to Network and Communication: Definition, **Network topology:** Mesh (advantages and disadvantages), Star (advantages and disadvantages), Ring (advantages and disadvantages). **Types of Networks based on size:** LAN, WAN, MAN. **Classes of transmission media:** Guided (wired)-Twisted pair cable, Coaxial cable, Fiber-optic cable. Unguided (wireless)-Free space. **Propagation modes:** *Switching (switched networks)*- Circuit switched networks, Packed switched network-datagram circuit network, virtual circuit network, message switched network. **OSI (Open System Interconnection):** Seven layers, how data is referred to in the OSI model? Interaction between layers in the OSI model, advantages of OSI model, differences between OSI and TCP/IP models. Port number, port range groups. **IP address:** Types of IP addresses- IPv4, IPv6, IP address format, classes of IP address. **Protocols and Standards:** The key elements of a protocol, Standard Creation committees.	
e-Resources: • https://datacommandnet.blogspot.com/p/protocols-and-standards.html • https://www.javatpoint.com/ip-address-format-and-table • https://data-flair.training/blogs/osi-model-in-computer-network/ • https://www.geeksforgeeks.org/how-communication-happens-using-osi-model/ • https://www.geeksforgeeks.org/difference-between-ip-address-and-port-number/ • https://www.studytonight.com/computer-networks/protocols-and-standards • https://www.geeksforgeeks.org/difference-between-ip-address-and-port-number/ • https://www.javatpoint.com/ip-address-format-and-table	
UNIT – II	**10 Hrs**
Data link layer: Data link layer services and flow control techniques. Design issues. *Framing:* Character count, Flag bytes with byte stuffing, Starting and ending flags, with bit stuffing. *Elementary data link protocols:* Utopian simplex protocol-, a simplex stop and wait protocol for an error-free channel. *Noisy channel*: *Sliding Window protocols:* Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request. *Controlled Access Protocols:* Reservation, Polling, Token Passing. *Error Detection:* Simple Parity check, Two-dimensional Parity check, Checksum, Cyclic redundancy check.	
e-Resources: • https://www.tutorialspoint.com/what-is-byte-stuffing-in-computer-networks • https://www.geeksforgeeks.org/stop-and-wait-arq/ • https://www.javatpoint.com/go-back-n-arq	
UNIT - III	**10 Hrs**
Network Layer: Services, *Routing algorithms*- The Optimality Principal, Shortest Path Algorithm, Flooding, Distance Vector Routing, Link State Routing, Hierarchical routing, Congestion Control Algorithms. **Transport layer:** Services, advantage and disadvantages, responsibility of transport layer, Elements of Transport Protocols, Congestion control. The Internet Transport Protocols (TCP) and User Datagram Protocol (UDP), differences between TCP and UDP and features of network layer.	

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e-Resources:

- https://citizenchoice.in/course/computer-networks-theory/Chapter%204/2-process-to-process-delivery
- https://www.geeksforgeeks.org/transport-layer-responsibilities/
- https://www.tutorialspoint.com/what-are-the-elements-of-transport-protocol
- https://www.geeksforgeeks.org/differences-between-tcp-and-udp/

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UNIT - IV	10 Hrs

The application Layer: Functions of application layer, Application layer services, protocols. *DNS (Domain Name System):* Domain Name Space, Distribution of Name Space, DNS in the internet, resolution, applications of DNS. *Electronic mail:* Components of Email System. E-Mail Protocol-SMTP (Simple Mail Transfer Protocol), POP (Post Office Protocol), IMAP (Internet Mail Access Protocol). Architecture of WWW, *Web Documents:* static, dynamic, and active Static. **Network Security:** Goals of Network Security, Security Services, Types of Network Security and classification of Security Attacks.

e-Resources:

- https://www.geeksforgeeks.org/computer-security-and-its-challenges/
- https://www.tutorialspoint.com/internet_technologies/e_mail_protocols.htm
- https://www.javatpoint.com/computer-network-application-layer

Text Books:

1) 1. Andrew S Tanenbaum, David. J. Wetherall, "Computer Networks", Pearson Education, 5th Edition,

Reference books:

1) Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw-Hill, Fourth Edition
2) Kurose and Ross, Computer Networking- A Top-Down approach,
3) Pearson, 5th edition

e-Resources and other Digital Material:

1. https://www.digimat.in/nptel/courses/video/106105183/L01.html

Course Outcomes:

1. **Understand** and **Contrast** the concept of computer network concepts with it types, topologies, transmission media, layered protocols and standards, network models, port and IP address and **discuss** the functionalities of each layer in these models.
2. **Discuss** and **Analyze** flow control and error control mechanisms and apply them using standard data link layer protocols.
3. **Analyze** and **apply** various routing algorithms to find shortest paths for packet delivery. **Explain** the details of Transport Layer Protocols (UDP, TCP) and suggest appropriate pro able/unreliable communication.
4. **Analyze** the features and operations of various application layer protocols such as HTTP, DNS, SMTP, need of network security.

Course Outcomes	Programme Outcomes												PSO	PSO	PSO
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				1							1	2		1
CO2	2				1							1	2		1
CO3	2				1							1	2		1
CO4	2				1							1	2		1

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UAI604E	Natural Language Processing	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT - I	10 Hrs
Introduction to NLP, Empirical Laws, Text Processing, Spelling Correction: Edit Distance, Weighted Edit Distance, Other Variations, Noisy Channel Model for Spelling Correction, N-Gram Language Models, Evaluation of Language Models, Basic Smoothing, Computational Morphology, Finite - State Methods for Morphology.	
UNIT – II	**10 Hrs**
Introduction to POS Tagging, Hidden Markov Models for POS Tagging, Viterbi Decoding for HMM, Parameter Learning, Syntax – Introduction, Syntax – Parsing, Syntax - CKY, PCFGs, Introduction to PCFGs - Inside-Outside Probabilities, Dependency Grammars and Parsing – Introduction, Transition Based Parsing : Formulation and learning.	
UNIT - III	**10 Hrs**
Distributional Semantics – Introduction, Distributional Models of Semantics, Distributional Semantics : Applications, Structured Models, Word Embeddings Lexical Semantics ,Lexical Semantics – Word net Word Sense Disambiguation ,Novel Word Sense detection, Topic Models : Introduction, Latent Dirichlet Allocation : Formulation, Gibbs Sampling for LDA, Applications.	
UNIT - IV	**10 Hrs**
Entity Linking, Information Extraction – Introduction, Relation Extraction, Distant Supervision, Text Summarization – LEXRANK, Optimization Based Approaches for Summarization, Summarization Evaluation, Text Classification, Sentiment Analysis – Introduction, Sentiment Analysis - Affective Lexicons, Learning Affective Lexicons, Computing with Affective Lexicons, Aspect – Based Sentiment Analysis.	

Text Books:

1) Dan Jurafsky and James Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Prentice Hall, Second Edition, 2009. Some draft chapters of the third edition are available online: https://web.stanford.edu/~jurafsky/slp3/
2) Chris Manning and Hinrich Schütze. Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA: May 1999

Course Outcomes:

1. Extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing
2. Analyze the syntax, and semantic using computational methods
3. Apply statistical and machine learning algorithms to natural language processing
4. Design NLP-based applications using NLP tools

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UAI605E	Cyber Security	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

UNIT - I	10 Hrs
Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals? Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000. **Cyber offenses:** How Criminals Plan Them: Introduction, How Criminals Plan the Attacks,	
UNIT – II	**10 Hrs**
Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Bot nets: The Fuel for Cybercrime, Attack Vector. Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares.	
UNIT - III	**10 Hrs**
Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, Attacks on Wireless Networks. **Understanding the people on the scene:** Introduction, understanding cyber criminals, understanding cyber victims, understanding cyber investigators.	
UNIT - IV	**10 Hrs**
Understanding Cybercrime Prevention: Understanding Network Security Concepts, Understanding Basic Cryptography Concepts, Making the Most of Hardware and Software Security. **Cybercrime Detection Techniques:** Security Auditing and Log: Auditing for Windows platform, Firewall Logs, Reports, Alarms, and Alerts, Commercial Intrusion Detection Systems	

Text Books:

1) Sunit Belapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81- 265-21791, 2013.
2) Debra Little John Shinder and Michael Cross, "Scene of the cybercrime", 2nd edition, Syngress publishing Inc, Elsevier Inc, 2008

Reference books:

1) Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", 1 st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058
2) Charles Dierbach, "Introduction to Computer Science Using Python", 1 st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014
3) Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365

Course Outcomes:

1. Describe the cyber crime terminologies.
2. Analyze cybercrime in mobiles and wireless devices along with the tools for Cybercrime and prevention
3. Analyze the motive and causes for cybercrime, cybercriminals, and investigators.
4. Apply the methods for understanding criminal case and evidence, detection standing criminal case and evidence.

No	Programme Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	Familiarize the cyber crime terminologies and Acts	1							2					1		
2	Illustrate tools and methods used for cybercrime.		2		3	3								1		
3	Analyze the motive and causes for cybercrime, cybercriminals, and investigators					2								2		
4	Apply the methods for detection and prevention of cyber crimes.					3							2	3		

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Department of Artificial Intelligence and Machine Learning Engineering
Scheme of Teaching and Evaluation
(Academic Year 2021 – 2022 Admitted NEP)

III Semester BE

Sl. No	SUBJECT CODE	SUBJECT	CRE DITS	HOURS/ WEEK			EXAMINATION MARKS		
				L	T	P	CIE	SEE	TOTAL
1.	21UMA301C	Numerical Techniques and Integral Transforms	03	03	-	-	50	50	100
2.	21UAI312C	Data Structures and Applications	03	03	-	-	50	50	100
3.	21UAI316C	Computer Organization	03	03	-	-	50	50	100
4.	21UAI304C	AI and its Applications	03	03	-	-	50	50	100
5.	21UAI305C	Problem Solving with Python	03	03	-	-	50	50	100
6.	21UAI313L	Data Structures Lab	01	-	-	02	50	50	100
7.	21UAI314L	Python Programming Lab	01			02	50	50	100
8.	21UAI315L	Working with Office	01	01	-	-	50	50	100
9.	21UHS324C	Universal Human Values – II	01	01	-	-	50	50	100
10.	21UHS321C	Constitution of India	01	01	-	-	50	50	100
		Total	**20**	**18**	**00**	**04**	**500**	**500**	**1000**

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Department of Artificial Intelligence and Machine Learning Engineering
Scheme of Teaching and Evaluation
(Academic Year 2021 – 2022 Admitted NEP)

IV Semester BE

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UMA401C	Statistics and Probability Distribution	03	03	-	-	50	50	100
2.	PCC	21UAI402C	Analysis & Design of Algorithms (I)	04	03	-	02	50	50	100
3.	PCC	21UAI403C	Operating Systems	03	03	-	-	50	50	100
4.	PCC	21UAI404C	Introduction to Data Science	03	03	-	-	50	50	100
5.	PCC	21UAI417C	Embedded Systems (I)	03	02	-	02	50	50	100
6.	PCC	21UAI416L	Data Science Lab	01	-	-	02	50	50	100
7.	INT	21UAI409I	Internship	02	-	-	-	50	50	100
8.	HSSM	21UHS422C 21UHS423C	Sanskrutika Kannada **/Balake Kannada***	01	01	-	-	50	50	100
9.		21UMA401M	Bridge Course Mathematics – II *	00	03	-	-	50	50	100
			Total	**20**	**18**	**-**	**06**	**450**	**450**	**900**

***For lateral entry (Diploma) students only**
****Students who have studied Kannada at primary level**
***** Students who have not studied Kannada at primary level**

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21UAI312C	Data Structures and Applications	Credits: 03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT - I	10 Hrs
The stack: Definition and Examples: Primitive operations, An Example, The stack as an Abstract data type. Representing Stacks in C: Implementing pop operation, Testing for exceptional conditions, Implementing the push operations. , An Example- Infix, Postfix and Prefix: Basic Definitions and Examples, Evaluating a postfix expression, Program to evaluate a postfix expression, Limitations of the program, Converting an expression from Infix to Postfix, Program to convert an expression from Infix to Postfix.	
UNIT – II	**10 Hrs**
Recursion: Recursive definition and processes: The factorial function, Properties of recursive definitions or Algorithms. , Recursion in C: Factorial in C., writing recursive programs: The Towers of Hanoi Problem. **Queues: The queue and its sequential representation**: The queue as an abstract data type, C implementation of queues, The insert operation, The priority queue, Array implementation of a priority queue. **Lists: Linked lists**: Inserting and removing nodes from a list, Linked implementation of stacks, The getnode and freenode operations, Linked implementation of queues, The linked list as a data structure, Examples of list operations, List implementation of priority queues, Header Nodes.	
UNIT - III	**10 Hrs**
Lists in C: Array implementation of lists, Limitations of the array implementation, Allocating and freeing dynamic variables, Linked lists using dynamic variables, Queues as lists in C, Examples of list operations in C, Non integer and non homogeneous lists, Comparing the dynamic and array implementation of lists, Implementing Header Nodes. An example: simulation using linked lists. **Other list structures**: Circular lists, The stack as a circular list, The queue as a circular list, Primitive operations on circular lists, The Josephus problem, Header nodes, Addition of long positive integers using circular lists.	
UNIT - IV	**10 Hrs**
Trees: Binary trees: Basics, Operation on Binary trees, Applications of Binary trees. Binary tree representations: Node representations of Binary trees, Node Representation of binary trees, Internal & external nodes, Implicit array representation of Binary trees, Choosing a Binary tree representation, Binary tree traversal in C, traversal using a father field, heterogeneous binary trees. **Trees and their applications**: C representation of trees, Tree traversals, General expressions as trees, Evaluating an expression tree, Constructing tree.	

Text Books:

1. Data structure using C", Aaron M. Tennenbaum, Yedidyah Langsam and Moshe J. Augenstein, Pearson Education/PHI 2006.
2.

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Reference books:

1. Behrouz A. Forouzan and Richard F. Gilberg, Thomson, “Computer Science A structured Programming Approach using C”, II edition, 2003.
2. Richard F. Gilberg and Behrouz, “Data structures A pseudo code approach with c “, Thomson, 2005.
3. Robert Kruse and Breuse Leung, ”Data structures and program Design in C”, PEARSON Education, 2007.
4. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures in C, 2nd Ed, Universities Press,
   2014.
5. Seymour Lipschutz, Data Structures Schaum's Outlines, Revised 1st Ed, McGraw Hill, 2014.
6. Reema Thareja, Data Structures using C, 3rd Ed, Oxford press, 2012.

Course Outcomes:

CO 1. Identify different data structures and their applications

CO 2. Apply stack and queues in solving problems.

CO 3. Demonstrate applications of linked list.

CO 4. Explore the applications of trees to model and solve the real-world problem.

Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	2	2	2										1		
CO2		3	3	2	1								1		
CO3		3	3	2	1								1		
CO4		3	3	2	1								1		

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21UAI316C	Computer Organization	Credits:03
L:T:P:3:0:0		CIE Marks:50
Hours/Week:40/03		SEE Marks:50

UNIT - I	10 Hrs
Simplification of Boolean Expressions: K-maps and The Quine-McCluskey method. Logic Design with MSI Components, Flip- Flops, **Counters:** Binary adders and subtractors, Decimal adders, Comparators, Decoders, Multiplexers. The basic Bi-stable element, Latches, Master-Slave flip-flops (Pulse-Triggered flip-flops), Edge triggered flipflops, Characteristic equations, Registers, Counters, Design of synchronous counters.	
UNIT – II	**10 Hrs**
Basic structure of Computers: Computer types, Functional Units, Basic operational concepts, Bus structures. **Machine instructions and programs:** Numbers, Arithmetic operations and characters, Memory locations and addresses, Memory operations, Instructions and instruction sequencing, Addressing modes.	
UNIT - III	**10 Hrs**
Input/output organization: Accessing I/O devices, Interrupts - Interrupt hardware, Enabling and Disabling interrupts, Handling multiple devices, Controlling device requests, Exceptions, Direct memory access - Bus arbitrations, Buses - Asynchronous bus and Synchronous bus, Interface circuits - Parallel port and serial port, Standard I/O Interfaces - Peripheral component interconnect Bus, SCSI bus, USB. **The memory system:** Some basic concepts, Semiconductor RAM memories - Internal organization of memory chips, Static memories, Syncronous DRAMs, Syncronous DRAMs, Read only memories, speed, size, and cost, cache memories.	
UNIT - IV	**10 Hrs**
Arithmetic Unit: Addition and subtraction of signed numbers, Design of fast adders, Multiplication of positive numbers, Signed operand multiplication, Fast multiplication, Integer Division. **Basic Processing Unit:** Some fundamental concepts, Execution of complete instruction, Hardwired control, Micro programmed control, Micro instructions.	
Text Books: 1. Donald D. Givone, Digital Principles and Design, McGraw Hill Edition 2002 2. Hamacher, Zvonko Vranesic, Safwat Zaky, 2002, "Computer Organization", Fifth Edition, MGH.	
Reference books: 1. J. P. Hayes,1998, "Computer Architecture and Organization", 3th Edition, MGH. 2. William Stallings, 2007, "Computer Organization and Architecture", 7th Edition, PHI.	
Course Outcomes: **CO1:** Understand the basic concepts of Boolean algebra and digital logic design. **CO2:** Explain the functional units, addressing modes, instruction formats and assembly programming. **CO3:** Demonstrate the organization of various I/O devices and system memory hierarchy. **CO4:** Design of arithmetic and basic processing units	

Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
CO1	3	1	3	2			1						1		
CO2	3	2	3	1			2								
CO3	3	1	3	1			1						1		
CO4	3	2	3	3			1						1		

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21UAI304C	AI and Its Applications L:T:P:3:0:0	03-Credits
Hrs/Week:03		CIE Marks:50
Total Hours:40		SEE Marks:50

UNIT - I	10 Hrs

Introducing AI: Defining the Term AI, Discerning intelligence, Discovering four ways to define AI, Understanding the History of AI, Starting with symbolic logic at Dartmouth, Continuing with expert systems, Overcoming the AI winters, Considering AIUses, Avoiding AI Hype, Connecting AI to the Underlying Computer.

Defining the Role of Data: Finding Data Ubiquitous in This Age, Understanding Moore's implications, Using data everywhere, Putting algorithms into action.

Considering the Use of Algorithms: Understanding the Role of Algorithms, Understanding what *algorithm* means, Starting from planning and branching, Playing adversarial games, Using local search and heuristics, Discovering the Learning Machine, Leveraging expert systems, Introducing machine learning, Touching new heights.

Pioneering Specialized Hardware: Relying on Standard Hardware, Understanding the standard hardware, Describing standard hardware deficiencies, Using GPUs, Considering the Von Neumann bottleneck, Defining the GPU, Considering why GPUs work well, Creating a Specialized Processing Environment, Increasing Hardware Capabilities, Adding Specialized Sensors, Devising Methods to Interact with the Environment.

UNIT – II	10 Hrs

Seeing AI Uses in Computer Applications: Introducing Common Application Types, Using AI in typical applications , Realizing AI's wide range of fields, Considering the Chinese Room argument, Seeing How AI Makes Applications Friendlier, Performing Corrections Automatically, Considering the kinds of corrections, Seeing the benefits of automatic corrections, Understanding why automated corrections don't work, Making Suggestions,Gettingsuggestionsbasedonpastactions,Gettingsuggestionsbasedongroups, Obtaining the wrong suggestions, Considering AI-based Errors.

Using AI to Address Medical Needs: Implementing Portable Patient Monitoring, Wearing helpful monitors , Relying on critical wearable monitors, Using movable monitors, Making Humans More Capable, Using games for therapy ,Considering the use of exoskeletons, Addressing Special Needs , Considering the software-based solutions , Relying on hardware augmentation, Seeing AI in prosthetics , Completing Analysis in New Ways, Devising New Surgical Techniques, Making surgical suggestions , Assisting a surgeon, Replacing the surgeon with monitoring, Performing Tasks Using Automation, Working with medical records, Predicting the future, Making procedures safer, Creating better medications, Combining Robots and Medical Professionals.

Relying on AI to Improve Human Interaction: Developing New Ways to Communicate, Creating new alphabets, Automating language translation, Incorporating body language, Exchanging Ideas, Creating connections, Augmenting communication, Defining trends , Using Multimedia , Embellishing Human Sensory Perception, Shifting data spectrum, Augmenting human senses

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UNIT - III	10 Hrs
Performing Data Analysis for AI: Defining Data Analysis, Understanding why analysis is important, Reconsidering the value of data, Defining Machine Learning, Understanding how machine learning works. Understanding the benefits of machine learning, Being useful; being mundane, Specifying the limits of machine learning, Considering How to Learn from Data, Supervised learning, Unsupervised learning, Reinforcement learning. **Employing Machine Learning in AI:** Taking Many Different Roads to Learning, Discovering five main approaches to AI learning, Delving into the three most promising AI learning, approaches, Awaiting the next breakthrough, Exploring the Truth in Probabilities, Determining what probabilities can do, Considering prior knowledge, Envisioning the world as a graph, Growing Trees that Can Classify, Predicting outcomes by splitting data, Making decisions based on trees, Pruning overgrown trees. **Developing Robots and flying with drones:** Defining Robot Roles, Overcoming the sci-fi view of robots , Knowing why it's hard to be a humanoid, Working with robots, Assembling a Basic Robot , Considering the components, Sensing the world , Controllingarobot,AcknowledgingtheStateoftheArt,Flyingunmannedtomissions,Meeting the quadcopter, Defining Uses for Drones, Seeing drones in non military roles, Powering up drones using AI, Understanding regulatoryissues.	
UNIT - IV	**10 Hrs**
Understanding the Non starter Application: Using AI Where It Won't Work, Defining the limits of AI, Applying AI incorrectly, Entering a world of unrealistic expectations, Considering the Effects of AI Winters, Understanding the AI winter, Defining the causes of the AI winter, Rebuilding expectations with new goals, Creating Solutions in Search of a Problem, Defining a gizmo, Avoiding the infomercial, Understanding when humans do it better, Looking for the simple solution. **Seeing AI in Space:** Observing the Universe, Seeing clearly for the first time, Finding new places to go, Considering the evolution of the universe, Creating new scientific principles, Performing Space Mining, Harvesting water, Obtaining rare earths and other metals, Finding new elements, Enhancing communication, Exploring New Places, Starting with the probe, Relying on robotic missions, Adding the human element, Building Structures in Space , Taking your first space vacation, Performing scientific investigation, Industrializing space, Using space for storage. **Adding New Human Occupations:** Living and Working in Space, Creating Cities in Hostile Environments, Building cities in the ocean, Creating space-based habitats , Constructing moon-based resources, Making Humans More Efficient, Fixing Problems on a Planetary Scale, Contemplating how the world works, Locating potential sources of problems, Defining potential solutions, Seeing the effects of the solutions, Trying again.	
Text Books: 1. "Artificial Intelligence for Dummies" by John Paul Mueller and Luca Massaron, Published by: John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030-5774, www.wiley.com**,** Copyright © 2018 by John Wiley & Sons, Inc., Hoboken, New Jersey, Published simultaneously in Canada.	

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Reference books:

1. **“**Artificial Intelligence for all”, Utpal Chakraborthy, BPB Publications, Feb2020
2. “Artificial Intelligence”, Dr. Praphat Kumar, BPB Publications, Jan2019
3. “The Quest for Artificial Intelligence:A History of Idea and Achievements”, Nils J.Nilsson, Stanford University , Cambridge University Press,2010.
4. “Artificial Intelligence: How 50 Sucessful Companies used Artificial Intelligence tosolve problems, Bernard Marr, Wiley Publications,2019.

Course Outcomes:

CO 1. Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations

CO2. Demonstrate proficiency in usage of hardware and software platforms for AI based applications

CO 3. Demonstrate awareness and a fundamental understanding of various applications of AI techniques

CO 4. Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

Course Outcomes	Programme Outcomes												PSO 1	PSO 2	PSO 3
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
CO1	2	1	1										1	3	
CO2	1	3	3		3								1	3	3
CO3	1	2	2										1	3	1
CO4	1	1	1			1		1					1	3	2

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21UAI305C	Problem Solving with Python	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT - I	10 Hrs
Python Basics, Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, Flow control, Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), Functions, def Statements with Parameters, Return Values and return Statements	
UNIT – II	**10 Hrs**
The List Data Type: Getting Individual Values in a List with Indexes, Negative Indexes, Getting Sublists with Slices, Getting a List's Length with len(),Changing Values in a List with Indexes, List Concatenation and List Replication, Removing Values from Lists with del Statements. Working with Lists: Using for Loops with Lists, The in and not in Operators. Operations on tuples: indexing, slicing, concatenation, repeating. Functions on tuple: len(), count(), index(), sorted(),min(), max(), and sum(). Functions on set: add(), clear(),copy(),difference(),difference_update(),discard(),intersection(),intersection_update(),isdisjoint(),issubset(),issuperset(),pop(),remove(),update(),union(). The Dictionary Data Type: Dictionaries vs. Lists, The keys(), values(), and items() Methods, Checking Whether a Key or Value Exists in a Dictionary, The get() Method, The setdefault() Method.	
UNIT - III	**10 Hrs**
Operations on string. Useful String Methods: The upper(), lower(), isupper(), and islower() Methods , The isX() Methods ,The startswith() and endswith() Methods, The join() and split() Methods, Splitting Strings with the partition() Method, Justifying Text with the rjust(), ljust(), and center() Methods, Removing Whitespace with the strip(), rstrip(), and lstrip() Methods. Oops concepts: Object, Class, Method, Inheritance, Polymorphism, Data abstraction Encapsulation. Exception Handling.	
UNIT - IV	**10 Hrs**
Reading and Writing Files: Files and File Paths , Backslash on Windows and Forward Slash on macOS and Linux, Using the / Operator to Join Paths, ,The Current Working Directory, The Home Directory, Absolute vs. Relative Paths, Creating New Folders Using the os.makedirs() Function, Handling Absolute and Relative Paths, Getting the Parts of a File Path, Finding File Sizes and Folder Contents, Modifying a List of Files Using Glob Patterns, Checking Path Validity, The File Reading/Writing Process, Opening Files with the open() Function, Reading the Contents of Files, Writing to Files. Working with CSV Files: The csv Module, reader Objects, Reading Data from reader Objects in a for Loop, writer Objects, The delimiter and lineterminator Keyword Arguments, DictReader and DictWriter CSV Objects.	

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Text Books:

1. Al Sweigart, "Automate the Boring Stuff with Python", 2 nd Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/) (Chapters 1 to 18)
2. Core Python Programming, R. Nageswara Rao, 2018, Dreamtech press

Reference books:

1. Programming with python, T R Padmanabhan, 2017, Springer.
2. Python for Data Analysis, Wes McKinney, 2012, O.Reilly.

e-Resources and other Digital Material:

1. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
2. https://zhanxw.com/blog/wp-content/uploads/2013/03/BeautifulCode_2.pdf
3. https://www.w3schools.com/python/
4. Python Tutorial (tutorialspoint.com)

Course Outcomes:

1. Learn the syntax and semantics of Python programming language.
2. Illustrate the process of structuring the data using lists, tuples, sets, dictionaries and strings.
3. Implement the object oriented programming concepts in python
4. Demonstrate the use of built-in functions to navigate the file system.
5. Implement basic operations on PDF, JSON and other file formats

21UA313L	Data Structures Lab	Credits:01
L:T:P:0:0:2		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

S. No.	Assignment
1.	Program on implementation of Stack using ADT
2.	Program on applications of stack using ADT
3.	Program on recursion
4.	Program on implementation of different types queues using ADT
5.	Program on developing stack and queue using linked list using ADT
6.	Program on implementing different operations on linked list using ADT
7.	Program on applications of linked lists using ADT
8.	Program on creation of BT and BST using ADT

Course Outcomes:

1. Design generic and reusable C code to implement ADT's for linear data structures like stack, queue, linked list and non linear data structures BT and BST and use the same to solve real time applications.
2. Compile, debug and execute the above C codes and analyze the output for different test cases.

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21UAI314L	**Python Programming Lab**	**Credits01**
L:T:P:0:0:2		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

Sl. No.	Assignment
1.	Implementation of Python fundamentals, data types, operators, flow control and exception handling in Python
2.	Demonstrating creation of functions, passing parameters and return values
3.	Demonstration of manipulation of strings using string methods
4.	Discuss different collections like list, tuple and dictionary
5.	Demonstration of pattern recognition with and without using regular expressions
6.	Demonstration of reading, writing and organizing files.
7.	Demonstration of the concepts of classes, methods, objects and inheritance
8.	Demonstration of classes and methods with polymorphism and overriding
9.	Demonstration of working with excel spreadsheets.
10.	Demonstration of working with PDF, word and JSON files

Course Outcomes:

CO 1. Demonstrate proficiency in handling of loops and creation of functions.

CO 2. Identify the methods to create and manipulate lists, tuples and dictionaries.

CO 3. Discover the commonly used operations involving regular expressions and file system.

CO 4. Interpret the concepts of Object-Oriented Programming as used in Python.

CO 5. Determine the need for scraping websites and working with PDF, JSON and other file formats.

21UAI315L	Working with Office	Credits:01
L:T:P:1:0:0		CIE Marks:50
Total Hours/Week:40/03		SEE Marks:50

List of Laboratory Assignments

Sl.No.	Assignment
1	Prepare an MS word document with the following specifications. **MS-WORD** Microsoft Word is a word processor developed by Microsoft. It was first released in 1983 under the name Multi-Tool Word for Xenix systems. MS Word is a popular word-processing program used primarily for creating documents such as letters, brochures, learning activities, tests, quizzes and students' homework assignments. There are many simple but useful features available in Microsoft Word to make it easier for study and work. That's why so many people would prefer to convert the read-only PDF to editable Word and edit PDF in Word. i Type the paragraph above as it is using “Calibri font”, font size 12. ii Use margins as, top:1.5, bottom:2, left:2, right:1 inches, set paper size:A4. iii Use heading “MS-WORD”, font size: 16, font color: Magenta, font face: Arial Black. Underline the “MS-WORD” using underline option. iv With first letter “dropped” (use drop cap option) set paragraph spacing 1.5. Insert a text box and move the whole paragraph into the text box. Align paragraph content justify. Apply background color. v Insert an image beside the paragraph side-by-side. vi Use three columns from the second paragraph onwards till the 2/3rd of the page. Add contents related to MS word with relevant headings. vii In the remaining part of the document, create a table using table menu with, a) At least 4 columns and 6 rows. b) Perform cell merging in row and columns. c) Use proper table border and color. d) Insert proper content into the table with proper text formatting. viii Make the word “MS-WORD” as the watermark of the document ix View your document in portrait and landscape view using orientation option in page layout menu. x Insert page number at the bottom of the page using page number option. xi Insert header &footer using the header and footer option. xii Insert file location in the footer. xiii Change the border of the page using page border option. xiv Inserting a Document's File Location xv Add hyperlink to access other documents
2	Prepare an MS Word document to demonstrate inserting mathematical equations such as follows. **PART-A** **ENGINEERING MATHEMATICS**

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	1	With usual notation, prove that for the curve $r = f(\theta)$, $\frac{1}{p^2}$ =
	2	Using Maclaurin's series, prove that $\sqrt{1+\sin 2x} = 1 + x - x^2/2! - x^3/3! + x^4/4!$
	3	Evaluate: i) $\lim_{x \to 0}\left(\frac{\tan x}{x}\right)^{1/x}$ ii) $\lim_{x \to 0}\left(\frac{a^x + b^x}{2}\right)^{1/x}$
	4	Evaluate $\int_{-c}^{c}\int_{-b}^{b}\int_{-a}^{a}(x^2+y^2+z^2)\,dz\,dy\,dx$
	5	Show that $\beta(m,n) = \frac{\Gamma m \, \Gamma n}{\Gamma(m+n)}$
	6	Prove that $\int_0^{\pi/2}\sqrt{\sin\theta}\,d\theta \cdot \int_0^{\pi/2}\frac{d\theta}{\sqrt{\sin\theta}} = \pi$
	7	Find the rank of the matrix $\begin{bmatrix} 2 & -1 & -3 & -1 \\ 1 & 2 & 3 & -1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & -1 \end{bmatrix}$ by applying elementa
	8	If $u = \operatorname{cosec}^{-1}\left(\frac{x^{1/2}+y^{1/2}}{x^{1/3}+y^{1/3}}\right)$, show that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = -\frac{1}{6}\tan$
	9	Prove that $\operatorname{div}(\phi\,\vec{A}) = \phi\,(\operatorname{div}\vec{A}) + \operatorname{grad}\phi . \vec{A}$.

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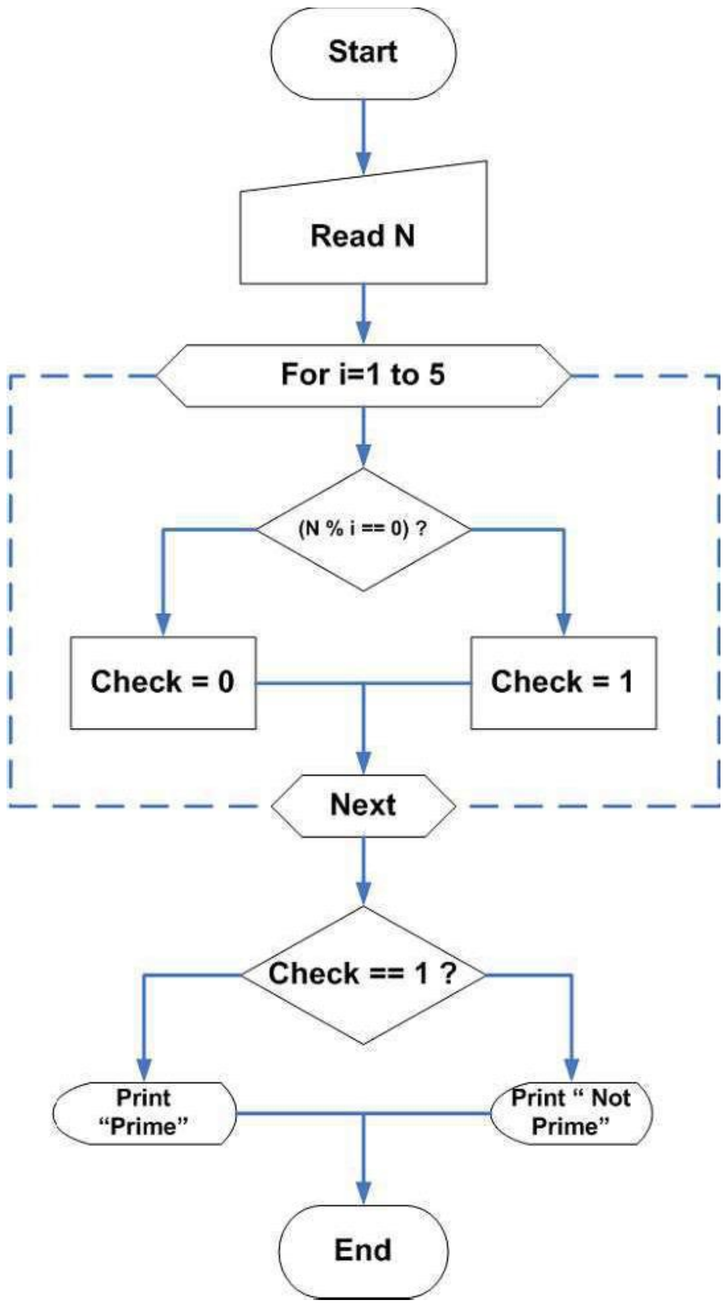
10

Express $f(t) = \begin{cases} \sin t, & 0 < t \le \pi/2 \\ \cos t, & \pi/2 < t \le \pi \\ 1, & \pi < t \end{cases}$ in terms of unit step functions and he

transform.

PART-B

Draw the flow chart to check the given number is prime or not.



3 a) Prepare an invitation letter to invite employees of other companies to attend the

workshop. Use mail.
merge option of MS word to select the names and other information of HR managers.
b) Prepare a macro to create letter template of the problem defined in (a).

4 Prepare an excel sheet to compute the correlation coefficient **‘r’**between two variables for the following dataset. Also compare the results with the builtin function =**CORREL()**and **=PEARSON()**available in MS Excel. Also draw the line chart **Number of Hours versus CGPA**demonstrating the correlation.

5 Prepare a payroll for the following list of faculty using MS Excel.

1.1 <u>List of Faculty</u>

Sl. No	**Faculty Name**	**Designation**
1	Ram Mohan Reddy	Professor
2	Anand Kumar M	Professor
3	Pijush M	Professor
4	Bhavana Kiran	Associate Professor
5	Dinesh Naik	Associate Professor
6	Soumaya Kamath S	Associate Professor
7	H S Nagendra Swami	Assistant Professor
8	Hamsaveni B N	Assistant Professor
9	Vijaykumar S	Assistant Professor
10	Praveenkumar C	Assistant Professor

1.2 Basic salary rate details

- The slab on the excel payroll calculation will contain the employee’s salary details.
- First column includes cell of Pay days in that month.
- Second column must have the Basic Salary details of the employee.
- (**Assistant Professor**: Rs. 57700-68900 with AGP of Rs.6000 or Rs. 7000,
- **Associate Professor**: Rs.79800-144200, with AGP of Rs.9000,
- **Professor**: Rs. 144200 -182200, with AGP of Rs.10000)
- Calculate Dearness Allowance (DA) with 38%.
- Calculate House Rent Allowance (HRA) 16%.
- Total Salary calculation.
- Gross earned salary details
- Deduction details
- Net salary details

6 Perform Data analysis with pivot table for the following case study.

Case Scenario: Headquartered in Memphis, TN, Grenadier Super Store (GSS) specializes in office supplies and furniture. The company's customers range from individual consumers and small businesses (retail), to corporate organizations (wholesale) located in the United States and Canada.

Project Requirements:

1. Use the data file (Excel Format) **sales_data.xlsx** given to you.

a. Using data from the starting data file, please create PivotTables and PivotCharts that can be used to answer the following questions.

b. What are the Regional Sales by Product Category and Product Sub-Category?

Please create ONE PivotTable showing Total Sales breakdown by Region, Product Category, and Product Sub-Category. Use information from the PivotTable to answer the following questions:

i. What was the Total Sales figure included in this data set?
ii. Which Product Category had the highest sales?
iii. Which Region had the lowest sales?
iv. What was the Total Sales of Appliances in Ontario?

c. Who are the most valuable customers?

Please create ONE PivotTable showing the Customer Names who placed orders with GSS during 1-6-2014 to 30-6-2015. For each customer, please also show the total number of orders, Total Sales, and Total Profit. Add a Slicer or a Filter that can be used to show the information specifically for each Customer Segment. Use information from the PivotTable to answer the following questions (Hint: Filter and sort the data in the PivotTable to locate the answer):

i. Which Small Business customer had the highest sales?
ii. Which Corporate customer placed the most number of orders in 2015-2016? How many orders were placed by the Corporate customer?
iii. Which Consumer customer was the most profitable one?
iv. What is the sales figure of the least profitable Home Office customer?

7 **Creating and Querying Databases using MSAccess.**

This lab requires the following Access techniques:

1. Creating a new databases, tables, and relationships
2. Add data to tables
3. Build simple queries using Query Builder

8 Prepare an MS Access file to create and query the database using forms.

Inthis exercise,youwill create a databasethat includes a table,form,report, andqueries.

Assignment Instructions:

1. Create a New blank database
2. Name the Access file as your last name in all lowercase letters. (For example, can would save your file as “learner.accdb”)
3. In Design View, create a table using the structure shown below:
   1. Name the table: Student List
   xv.2 Set the “USN” field as the Primary Key
   xv.3 AdmQuota= K for KEA, C for ComedK, M for Management

FieldName	DataType	FieldSize	Otherfieldpropert
USN (PrimaryKey)	ShortText	10	
First Name	ShortText	Default	

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Last Name	ShortText	Default		
Branch	ShortText	Default		
Year	Date/Time	Default		
Address	ShortText	Default		
City	ShortText	Default		
State	ShortText	Default		
ZipCode	ShortText	6		
AdmQuota	ShortText	1		
FeesBalance	Currency	Default		

1. In Datasheet View, add the data below to the “StudentList” table.
2. Create a form using the Form Wizard based on the “StudentList” table
   - Use All Fields
   - Layout: Columnar
   - Form Name: StudentForm

6. In Design View, change the Theme to “Executive”

7. Addthe followingrecordsusingtheForm:

8. Whenyouhavefinishedaddingthe records, save theformas“StudentForm”

9. Using the Report Wizard, create a report based on the “StudentList” table, according to the following specifications:

a. Use All Fields
b. Group by: First Term Attended
c. Layout: Stepped
d. Orientation: Landscape
e. Title the report: Student Report
f. Adjust column widths in Design View as necessary

10. Create Queries

Query 1: Create a query from the “StudentList” table using the Simple Query Wizard. The query is as follows:

i. Generate a report with the USN and names of the students who taken admission under KEA

ii. Select the appropriate fields and the appropriate criteria. Run this query.

Query 2: Create a query from the “StudentList” table using the Simple Query Wizard. The query is as follows:

i. Generate a report with the USN and names of the students whose FeeBalance is more than 50,000 Rs.

ii. Select the appropriate fields and the appropriate criteria. Run this query.

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9 Prepare an MS Access file to create and query the database using advanc d queries.
Create database with following tables:
1) bktblPublishers
2) bktblAuthors
3) bktblTitles

bktblPublishers attributes

Answer the following queries:

Exercise 3

Create a new query that shows all the information in the bktblAuthors and bktblTitles tables.

Exercise 4

Create a new query that displays title ID, title name, the publisher's name, and the author's first and names.

Exercise 5

Modify the query that you created in Exercise 4 so that it only shows records corresponding to Ab Publishers. Only show Abatis Publishers records with royalty rates less than 0.08 or with advances t are less than 30000. Do not show the advance and royalty rates fields in the query.

Exercise 1

The expression we created for profit is too simplified. Modify it so that the profit is calculate ((sales*price)-advance) * (1-royalty rate).

Exercise 2

In Query 3, remove the au_fname and au_lname fields from the query. Create a new field called Name that combines both names (with a space between them). Use the & operator.

10	1. Prepare the MS Powerpoint slides (Minimum 6 slides) which demonstrates use of hyperlinks, Inserting images, clip art, audio video, Tables and charts. 2. Create master layouts (slide, template and notes), inserting: background, textures, design templates, Hidden slides. 3. Use auto content wizard, slide transition, custom animation, rehearsing.

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21UAI402C	Analysis & Design of Algorithms (I)	Credits:04
L:T:P:3:0:2		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT-I	10 + 6 Hrs
Introduction: Notion of Algorithm, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental Data Structures. **Fundamentals of the Analysis of Algorithm Efficiency:** Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms, Example – Fibonacci Numbers. **Brute Force:** Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search.	
UNIT–II	**10 + 6 Hrs**
Divide and Conquer: Mergesort, Quicksort, Binary Search, Binary Tree Traversals and Related Properties, Multiplication of Large Integers and Strassen's Matrix Multiplication. **Decrease and Conquer:** Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting, Algorithms for Generating Combinatorial Objects.	
UNIT–III	**10 + 6 Hrs**
Transform and Conquer: Presorting, Balanced Search Trees, Heaps and Heapsort, Problem Reduction. **Space and Time Tradeoffs:** Sorting by Counting, Input Enhancement in String Matching, Hashing, B-Trees. **Dynamic Programming:** Computing a Binomial Coefficient, Warshall's and Floyd's Algorithms, Optimal Binary Search Trees. The Knapsack Problem and Memory Functions.	
UNIT–IV	**10 + 6 Hrs**
Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees. **Limitations of Algorithm Power:** Lower-Bound Arguments, Decision Trees, Problems Coping with the Limitations of Algorithm Power: Backtracking, Branch-and-Bound.	

Reference Books

Reference books:

1. "Introduction to Algorithms", Stein, PHI, 2nd Edition,
2. "Computer Algorithms", Horowitz E., Sahni S., Rajasekaran S., Galgotia Publications, 2001

Text Books:

1. "Introduction to The Design & Analysis of Algorithms", Anany Levitin, Pearson Education, 3rd Edition, 2017

Course Outcomes

After completion of the course student will be able to

1) Understand the notion of an algorithm, asymptotic notations and different problem types.
2) Analyze the recursive and non-recursive algorithms.
3) Understand the algorithm design techniques using divide and conquer approach.
4) Understand the algorithm design techniques using dynamic programming and greedy approaches.
5) Explain the algorithm design techniques using backtracking, branch & bound, NP-complete and NP-hard problems.

ANALYSIS AND DESIGN OF ALGORITHMS LAB ASSIGNMENTS

1) a) Write a C program to search a given element using binary search method and determine its time complexity.

b) Write a C program to sort a given set of numbers using the quick sort method and determine its time complexity.

2) Write a C program to sort a given set of numbers using the merge sort method and determine its time complexity.

3) Write a C program to check whether a given graph is connected or not using DFS method and determine its time complexity.

4) Write a C program to print all the nodes reachable from a given starting node in a digraph using BFS method and determine its time complexity.

5) Write a C program to sort a given set of numbers using the heap sort method and determine its time complexity.

6) a) Write a C program to find the Transitive Closure of a graph using Warshall's algorithm.

b) Write a C program to find all pair shortest path of a graph using Floyd's algorithm.

7) Write a C program to implement 0/1 Knapsack problem using Dynamic Programming and determine its time complexity.

8) Write a C program to find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm and determine its time complexity.

9) Write a C program to find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm and determine its time complexity.

10) Write a C program to find the shortest path from a given vertex to other vertices in a weighted connected graph using Dijkstra's algorithm and determine its time complexity

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21UAI403C	Operating Systems	Credits:03
L:T:P:3:0:2		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT-I	10 Hrs
Introduction to operating systems, types and services. **Role of Operating systems:** user view, system view; Operating System structure; Operating System operations; Operating System Services; User - Operating System interface; System calls; Types of system calls; System programs; Operating System design and implementation; Operating System structure; Virtual machines. Process management: Process concept; Concepts of process: Process status, Process description, Process model, Operations on processes.	
UNIT–II	**10 Hrs**
Process management, threads and process synchronization. **Process Scheduling:** Basic concepts; scheduling criteria; Scheduling algorithms; Multiple-Processor scheduling, Inter-process communication (Intd.), Threads: concepts, Multi-Threaded Programming: Overview; Multithreading models; **Synchronization:** The Critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors.	
UNIT–III	**10 Hrs**
Deadlocks and memory management: Deadlocks: Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation.	
UNIT–IV	**10 Hrs**
Virtual Memory Management: Background; Demand paging; Page replacement; Allocation of frames.**File system: concepts and implementation, secondary storage structures.** **File System:** File concept; Access methods; Directory structure; File system mounting; File sharing; Implementing File System: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management.	
Reference Books	
1) D.M Dhamdhere: Operating systems - A concept based Approach, 2^{nd} Edition, Tata McGraw- Hill, 2002.	
Text Books:	
1) Abraham Silberschatz, Peter Baer Galvin , Greg Gagne: Operating System 7^{th} edition, Addison Wesley	
Course Outcomes	
After completion of the course student will be able to 1. Explain the core structure and different services provided by Operating System at different levels 2. Apply the concepts of process scheduling algorithms and synchronization techniques in solving real time problems 3. Exhibit the knowledge of memory management techniques 4. Exhibit the knowledge of secondary storage management techniques and security solutions	

21UAI404C	Introduction to Data Science	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

UNIT-I	10 Hrs
Introduction: Data Science. Applications of data science. Data science related to other field. Relationship between data science and Information science. Computational thinking. Skills for data science. Tools for data science. Issues of Ethics, Bias, and Privacy in Data Science. **Data:** Introduction, **Data types**: Structured Data, Unstructured Data, Challenges with Unstructured Data. **Data Collections**: Open Data, Social Media Data, Multimodal Data, Data Storage and Presentation. **Data Pre-processing**: Data Cleaning, Data Integration, Data Transformation, Data Reduction, Data Discretization.	
UNIT–II	**10 Hrs**
Techniques: Introduction, **Data Analysis and Data Analytics**, **Descriptive Analysis:** Variables, frequency Distribution, Measures of Centrality, Dispersion of a Distribution **Diagnostic Analytics:** Correlations, Predictive Analytics, Prescriptive Analytics, Exploratory Analysis, **Mechanistic Analysis**: Regression **Tools for data science:** Introduction, Getting Access to R, Getting Started with R**:** Basics, Control Structures, Functions, Importing Data **Graphics and Data Visualization:** Installing ggplot2, Loading the Data, Plotting the Data. Statistics and Machine Learning: Basic Statistics, Regression.	
UNIT–III	**10 Hrs**
Machine learning for data science: Machine Learning Introduction and Regression: Introduction, Machine Learning, Regression, Gradient Descent. **Supervised Learning**: KNN classification **Unsupervised learning:** K means Clustering, Introduction to Reinforcement Learning.	
UNIT–IV	**10 Hrs**
Applications, Evaluation, and Methods: Hands-On with Solving Data Problems: Introduction, Collecting and Analyzing Twitter Data, Collecting and Analyzing YouTube Data , Analyzing Yelp Reviews and Ratings. **Data Collection, Experimentation, and Evaluation: Data Collection Methods**: Surveys, Survey Question Types, Survey Audience, Survey Services, Analyzing Survey Data, Pros and Cons of Surveys, Interviews and Focus Groups, Why Do an Interview? Why Focus Groups? Interview or Focus Group Procedure, Analyzing Interview Data , Pros and Cons of Interviews and Focus Groups, Log and Diary Data, User Studies in Lab and Field, **Picking Data Collection and Analysis Methods:** Introduction to Quantitative Methods, Introduction to Qualitative Methods, Mixed Method Studies. **Evaluation:** Comparing Models, Training– Testing and A/B Testing, Cross-Validation.	
Reference Books	
1) "Data Science from Scratch", Joel Grus, O'Rielly Publications, 2015. 2) " Introduction to Data Science", Laura Igual and Santi Segui, Springer International Publications, 2017.	
Text Books: 1) "A hands on introduction to Data Science", Chirag Shah, Cambridge University Press, 2020.	

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Course Outcomes: At the end of the course the students should be able to:
1. Identify and asses the needs of an organization for data science task 2. Collect, manage and use data to examine, analyse and interpret data 3. Apply statistical and ML algorithms to effectively generate useful information from structural and un structured data 4. Design, build and evaluate models that can be used to make predictions in real world phenomena 5. Communicate data science related information effectively in various formats to appropriate audience

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21UAI416L	Data Science Lab	Credits:03
L:T:P:3:0:0		CIE Marks:50
Total Hours/Week: 40/03		SEE Marks:50

A. NO.	Assignment
1	Programs on data collection and reading data
2	Programs on data pre processing methods (EDA)
3	Programs on descriptive, diagnostic and predictive analysis.(EDA)
4	Programs on visualization tools (EDA)
5	Program on LR with GD (ML model and its evaluation)
6	Program on KNN classification (ML model and its evaluation)
7	Program on Kmeans clustering (ML model and its evaluation)
8	Program on end to end data science life cycle (case study) on real time data sets

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
(Academic Year 2020 - 2021)

III Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UMA333C	Computational Methods for Mechanical Science	3	3	0	0	50	50	100
2	UAU312C	Thermodynamics	4	3	2	0	50	50	100
3	UAU313C	Production Technology	3	3	0	0	50	50	100
4	UAU314C	Mechanics of Materials	4	3	2	0	50	50	100
5	UAU325C	Automotive Chassis	3	3	0	0	50	50	100
6	UAU306C	Material Science and Metallurgy	3	3	0	0	50	50	100
7	UAU317L	Computer Aided Machine Drawing	1	0	0	2	50	50	100
8	UAU328L	Machine Shop Practice	1	0	0	2	50	50	100
9	UHS388C	Samskruthika Kannada#	1	2	0	0	50	50	100
	OR								
	UHS389C	Balake Kannada$							
10	UMA330M	Bridge Course Mathematics - I*	--	3	0	0	50	50	100
11	UBT133M	Environmental Studies*	--	2	0	0	50	50	100
Total			23	20/ 25*	04	04	450/ 550*	450/ 550*	900/ 1100*

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
(Academic Year 2020 - 2021)

IV Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1.	UMA433C	Statistical Methods for Mechanical Science	3	3	0	0	50	50	100
2.	UAU412C	Fluid Mechanics	3	3	0	0	50	50	100
3.	UAU433C	Theory of Machines	4	3	2	0	50	50	100
4.	UAU424C	Design of Machine Elements – I	4	3	2	0	50	50	100
5.	UAU415C	Theory of Automotive Engines	3	3	0	0	50	50	100
6.	UAU416C	Automotive Transmission Systems	3	3	0	0	50	50	100
7.	UHS001N	Fundamentals of Quantitative Aptitude and Soft Skills	1	1	0	0	50	50	100
8.	UAU437L	Foundry and Forging Practice	1	0	0	2	50	50	100
9.	UAU438L	IC Engine and Fuels Laboratory	1	0	0	2	50	50	100
10.	UAU439L	Material Testing and Measurement Laboratory	1	0	0	2	50	50	100
11.	UMA430M	Bridge course Mathematics – II*	--	3	0	0	50	50	100
12.	UHS226M	Constitution of India*	--	2	0	0	50	50	100
Total			24	19/ 24*	04	06	500/ 600*	500/ 600*	1000/ 1200*

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UMA333C	COMPUTATIONAL METHODS FOR MECHANICAL SCIENCE	**Credits:** 3
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Numerical analysis – I:
Introduction to find root finding problems, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae (without proof).Lagrange's and Newton's divided difference interpolation formulae (without proof) Numerical differentiation using Newton's forward and backward formulae-problems.

UNIT–II	10 Hrs.

Numerical analysis-II:
Numerical Integration: Simpson's one third rule, Simpson's three eighth rule (no derivation of any formulae)-problems. Numerical solution of ODE and PDE: Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method, Numerical solutions of one-dimensional heat and wave equations by explicit method, Laplace equation by using five point formula.

UNIT–III	10Hrs.

Fourier series:
Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.

UNIT–IV	10Hrs.

Fourier transforms:
Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms.

Calculus of Variations:
Variation of a function and a functional, external of a functional, variational problems, Euler's equation, standard variational problems including geodesics, minimal surface of revolution, hanging chain and Brachistochrone problems.

Reference Books *

1. **Numerical Methods for Engineers** by Steven C Chapra & Raymond P Canale.
2. **Higher Engineering Mathematics** by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. **Advanced Engineering Mathematics** By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi.
4. **Advanced Engineering Mathematics** by E Kreyszig (John Wiley & Sons)

Course Outcomes**

After completion of the course student will be able to

CO1: To know how root finding techniques can be used to solve practical engineering problems.
CO2: To apply the concept of finding approximate value of the derivative & definite integral for a given data using numerical techniques.
CO3: To apply numerical techniques to solve the first order first degree ordinary differential equations.
CO4: To apply partial differential techniques to solve the physical engineering problems.
CO5: To implement integration technique to determine the extreme values of a functional.

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UAU306C	MATERIAL SCIENCE AND METALLURGY	Credits: 03
L:T:P - N_L :3 N_T:0 N_P :0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

CRYSTAL STRUCTURE: Fundamental concepts of unit cell space lattice, Bravais space lattices, unit cells for cubic structure and HCP, crystallographic planes and directions, Miller indices, calculations of radius, coordination number and atomic packing factor for different cubic structures. Crystal imperfections; point, line, surface and volume defects. Diffusion; diffusion mechanism, Fick's laws of diffusion.

MECHANICAL BEHAVIOR: Stress-strain diagram to show ductile and brittle behavior of materials, mechanism of elastic action, linear and nonlinear elastic properties, true stress and strain. Plastic deformation, dislocation, slips and twinning, fracture-types, stages in cup and cone, Griffith's criterion

UNIT–II	10 Hrs.

FATIGUE: Stress cycles, effects of stress concentration, size effect, surface texture on fatigue, S-N curves, factors affecting fatigue life and protection methods.

CREEP: Creep curves, mechanisms of creep. Creep-resistant materials.

SOLIDIFICATION AND PHASE DIAGRAMS: Mechanism of solidification, homogeneous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions – types, rules governing the formation of solids solutions. Phase diagrams: basic terms, Gibb's phase rule, construction of phase diagrams, interpretation of equilibrium diagrams, types of phase diagrams. Lever rule.

UNIT–III	10 Hrs.

IRON CARBON EQUILIBRIUM DIAGRAM: Phases in the Fe-C system, invariant reactions, critical temperatures, microstructure of slowly cooled steels, effect of alloying elements on the Fe-C diagram, ferrite and austenite stabilizers. TTT diagram, drawing of TTT diagram, TTT diagram for hypo and hyper-eutectoid steels, effect of alloying elements on TTT diagram.

HEAT TREATMENT OF STEEL: Definition and aims of heat treatment, annealing and its types, normalizing, hardening, tempering, martempering, austempering, surface hardening like case hardening, carburizing, cyaniding, nitriding, induction hardening, hardenability, Jominy end-quench test.

UNIT–IV	10 Hrs.

ENGINEERING ALLOYS: Properties, composition and uses of low, medium and high carbon steels. Steel designation and AISI – SAE designation. Cast irons, gray CI, white CI, malleable CI, SC iron. Microstructures of cast iron. Light alloys, Al, Mg and Titanium alloys. Copper and its alloys. Brasses and bronzes.

COMPOSITE MATERIALS: Definition, classification, types of matrix materials and reinforcements, fundamentals of production of FRP's, production of MMC's, advantages and applications of composites.

Reference Books *

Text books:
1. Smith, **Foundations of material science and engineering-5th** edition,McGraw Hill,2009 ISBN-10:0073529249 ISBN-13:978-0073529240
2. Murthy, **Structure and properties of engineering materials**, TATA McGraw Hill,2003, ISBN-007048287X9780070482876

Reference Books:
1. William D.Callister Jr. **"**Materials Science & Engineering- An Introduction" Wiley India Pvt. Ltd, New Delhi,2010 ISBN:9788126521432,8126521430
2. Donald R. Askland, Pradeep P.Phule Thomson, Essentials of Materials For Science And Engineering", Engineering, 2007

James F. Shackel Ford, “Introduction to Material Science for Engineering”, 8th edition Pearson,Prentice Hall, New Jersey, 2015

Course Outcomes**

1. Discuss the concept of crystal structure, crystal imperfections, and laws governing the diffusion phenomena and apply the knowledge to solve simple problems
2. Analyze the mechanical behavior of materials for various loads(steady and dynamic), fatigue tests and mechanism of creep and various modes of failure and apply the knowledge to solve problems
3. Explain the basic terminologies involved in metallurgy, Construct and interpret different types of phase diagrams, Iron-carbon equilibrium diagram, TTT diagram and apply the knowledge to solve problems
4. Apply the heat treatment process knowledge for improving physical and mechanical properties of different types of engineering materials
5. Discuss composite manufacturing processes and list advantages and applications of engineering and composite materials.
6. Discuss the concept of crystal structure, crystal imperfections, and laws governing the diffusion phenomena and apply the knowledge to solve simple problems

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	1								1	2	2	3
CO2	3	3	3	2		1	1					3	2	2	3
CO3	3	1	1	3								1	1	2	3
CO4	3	2	1	1								1	2	2	3
CO5	3	2	1	1		1						1	2	2	3
CO6	3	3	1	1								1	2	2	3

UAU312C	THERMODYNAMICS	Credits: 04
L:T:P - N_L:3 N_T:2 N_P :0		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	14 Hrs.

FUNDAMENTAL CONCEPTS AND DEFINITIONS: Thermodynamics; definition and scope. Microscopic and macroscopic approaches, some practical applications of engineering thermodynamic. Types of system, control volume and characteristics of system boundary and examples. Thermodynamic properties; Types of properties, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes; thermodynamic equilibrium; definition, mechanical equilibrium, thermal equilibrium, chemical equilibrium, dithermic wall, Zeroth's law of thermodynamics, temperature; concepts, scales, measurement.

WORK AND HEAT: Mechanics definition of work and its limitations. Thermo dynamic definition of work with examples and sign convention. Displacement work; expressions for displacement work in various processes through PV diagrams. Shaft work; electrical work. Other types of work. Heat; definition, units and sign convention and 4numerical.

UNIT–II	18 Hrs.

FIRST LAW OF THERMODYNAMICS: Joule's experiments, equivalence of heat and work. Statement of the first law of thermodynamics, extension of the first law to non – cyclic processes, energy, energy as a property, modes of energy, specific heat at constant volume, enthalpy, specific heat at constant pressure. Steady flow energy equation with 4numerical.

SECOND LAW OF THERMODYNAMICS: Heat reservoir, heat source and sink, heat engines, heat pump, refrigerator and COP. Kelvin – Planck and Clausius's statement of second law of thermodynamics; equivalence of the two statements and 4numerical. PMM – I and PMM – II. Reversible and irreversible processes; factors that make a process irreversible and Carnot cycle.

UNIT–III	18 Hrs.

ENTROPY: Entropy – Clasius's inequality, statement, proof, application to a reversible cycle. QR/T as independent path. Entropy; definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations.

GAS POWER CYCLES: Air-standard cycles; Carnot, Otto, Diesel, dual and Stirling cycles, P-V and T-S diagrams, definition, efficiencies and mean effective pressure. Comparison of Otto and Diesel cycle.

UNIT–IV	16 Hrs.

VAPOR POWER CYCLES: Carnot vapor power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T – S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapor power cycles. Basic air conditioning system; air conditioning principles, air-conditioning types, temperature and pressure fundamentals, types of compressors and refrigerants.

Reference Books *

Text books

1."**Basic and Applied Thermodynamics**" by P .K. Nag, Tata McGraw Hill, 5th Edi. 2012

2. "**Thermodynamics an engineering approach**", by Yunus A. Cenegal

Reference Books:

1. Spalding and Cole, Engineering Thermodynamics, ELBS Edition Longmans,1997.
2. Engineering Thermodynamics by J.B. Jones and G.A.Hawkins, John Wiley and Sons.
3. Arora C.P. Thermodynamics, TMH, 1998.

4. Gordan J. Van Wylen and Richard E.Sountag, Fundamentals of Classical Thermodynamics, 4th Edition, Wiley, 1994.
Course Outcomes**
1. Define, state, classifications, and concepts of fundamentals of thermodynamic nomenclature.
2. Apply the knowledge to analyze and derive the thermodynamics equations.
3. Discuss and analyze laws of thermodynamics and to solve the problems.
4. Evaluate the various thermodynamics gas cycles and to solve the problems
5. Analyze the various thermodynamics vapour cycles and to solve the problems
6. Builds the foundation for preparing students to work in the area of thermal systems

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	2								1	1	2	2
CO2	3	3	1	3					1			1	1	2	2
CO3	3	3	2	1		2						1	1	1	2
CO4	3	3	2	3					2			1	1	2	2
CO5	3	2	1	2					2			1	1	1	2
CO6	3	3	1	2	1	2	2		2	2	1	1	1	2	2

UAU313C	PRODUCTION TECHNOLOGY	Credits: 03
L:T:P - N_L:3 N_T:0 $N_{P:}$ 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Concept of manufacturing process, its importance. Classification of manufacturing processes. Advantages and limitations.
CUTTING TOOL MATERIALS: Desired properties, types of cutting tool materials – HSS carbides coated carbides and ceramics, cutting fluids, types and selection. Machinability, factors affecting machinability.
THEORY OF METAL CUTTING: Single point cutting tool nomenclature, geometry, orthogonal and oblique cutting, mechanism of chip formation, types of chips.
TURNING: Classification, constructional features of Turret and Capstan lathe, tool layout. Machining time.

UNIT–II	10 Hrs.

SHAPING AND PLANNING MACHINES: Classification, constructional features, driving mechanisms, shaping and planning operations. Machining time.
DRILLING AND MILLING MACHINES: Classification, constructional features, drilling and related operations, types of drilling tools, drill bit nomenclature. Milling Machines**:** classification, constructional features, milling cutters, nomenclature, milling operations, up milling and down milling, indexing: Simple and compound indexing. Machining time.

UNIT–III	10 Hrs.

GRINDING MACHINES: Types of abrasives, bonding process, grade and structure of grinding wheels and types. Classification, constructional features. Selection of grinding wheel.
BROACHING PROCESS: Types of broaching machines – constructional details, applications.
NON-TRADITIONAL MACHINING PROCESSES: Need for non-traditional machining, operation and applications of Abrasive Jet Machining, Electric Discharge Machining, Electro Chemical Machining. Laser Beam Machining and Electron Beam Machining.

UNIT–IV	10 Hrs.

PATTERNS: Definition, functions, materials used for pattern, various pattern allowances. Classification of patterns.
SAND MOULDING: Types of base sand, requirement of base sand. Types of sand moulds, ingredients for different sand mixtures. Method used for sand moulding. Cores: Definition, need and types.
WELDING PROCESS: Definition, classification, application, arc welding, gas welding, TIG and MIG.
PRINCIPLES OF SOLDERING AND BRAZING: Different types of soldering and brazing methods, plastic welding techniques.

Reference Books *

Text Books:

1. **HMT Hand book,** McGraw-Hill, Edition 38, 2016
2. **Production Technology,** R. K. Jain, Khanna Publication, New Delhi, 17 Edition – 2009
3. **Fundamentals of metal machining and machine tools**", G. Boothroyd, McGraw-Hill Publication. Edition 2007.

Reference Books:

1. Manufacturing Process-I, Dr. K. Radhakrishna, Sapna Book House, 2nd Edition 2007.
2. Process and Materials of Manufacturing**,** Roy A Lindberg, 4th Ed Pearson Edu. 2006
3. Manufacturing Technology Vol-I , P.Radhakrishnan, Sceitch Publications,Chennai

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Course Outcomes**
1.Classify manufacturing processes & enumerate the process
2.Illustrate the fundamental principles of metal cutting processes and specify suitable machine tools
3.Suggest a suitable machining process for a given job
4.Recommend a suitable moulding /casting method (sand/special) & a melting furnace to cast given Auto components.
5.Enumerate the process steps involved in a sand casting process and their applications.
6. Suggest a suitable welding Brazing/Soldering process for a given precision job.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1										1	1	2	2
CO2	3	2	2		2				2			3	1	2	2
CO3	3	2	2		3							2	1	1	2
CO4	3	2	2		3							2	1	2	2
CO5	3	1	3		2		1		2			1	1	1	2
CO6	3	2	2		2		1					3	1	2	2

UAU314C	MECHANICS OF MATERIALS	**Credits: 04**
L:T:P - N_L :3 N_T:2 N_P 0		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10+6 Hrs.

SIMPLE STRESS AND STRAIN: Introduction, stress, strain, mechanical properties of materials, linear elasticity, Hooke's law and Poisson's ratio, stress – strain relation – behavior in tension for mild steel and non ferrous metals. Extension shortening of a bar, bars with cross sections varying in steps, bars with continuously varying (circular and rectangular), elongation due to self weight, principle of super position.

STRESS IN COMPOSITE SECTION: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars).

UNIT–II	10+6 Hrs.

COMPOUND STRESSES: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.

THICK AND THIN CYLINDERS: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), thick cylinders subjected to internal and external pressures (Lame's equation).

UNIT–III	10+8 Hrs.

BENDING MOMENT AND SHEAR FORCE IN BEAMS: Introduction, types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniform distributed load (UDL) and couple for different types of beams.

BENDING AND SHEAR STRESSES IN BEAMS: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, moment carrying capacity of a section, shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. Frames and over hanging beams.

UNIT–IV	10+6 Hrs.

DEFLECTION OF BEAMS: Introduction, differential equation for deflection, equations for deflections, slope and moments, double integration method for cantilever and simply supported beams for point load, UDL, UVL and couple, Macaulay's method.

TORSION OF CIRCULAR SHAFTS AND ELASTIC STABILITY OF COLUMNS: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts. Introduction to columns, Euler's theory for axially loaded elastic long columns, derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula.

Reference Books *

TEXT BOOKS:

1. **Mechanics of Materials,** SI Edition, Barry J. Goodno, James M. Gere Cengage Learning, 2017
2. **A TEXTBOOK OF STRENGTH OF MATERIALS,** Dr. R. K. BansalISBN :9788131808146 6th Edition, 2019

REFERENCE BOOKS:

1. Strength of Materials, 4th edition, S S Bhavikatti, Vikas Publishing, 2013

2. Mechanics of Materials, Beer , Johnston, Dewolf, Mazurek, Sanghi, Jul 2017

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Course Outcomes**
1. To define the fundamental terms of mechanics of materials
2. To derive equations for the stresses, strains and deformations in structural elements subjected to different types of loads
3. To solve numerical problems using the analytical and graphical methods
4. To compute the bending / shear stresses and deflection of beams
5. The students are able to apply the concepts of solid mechanics in the design of simple machine elements.
6. Simulate the mechanical elements receiving axial compressive loads under different end conditions and determine their columnar stability

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2									2	2	2	2
CO2	3	2	2									2	2	2	2
CO3	3	3	3									2	1	2	2
CO4	3	3	3									2	1	2	2
CO5	3	3	3									2	1	2	2
CO6	3	3	3						2			2	1	2	3

UAU325C	AUTOMOTIVE CHASSIS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P :0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

LAYOUTS AND FRAMES: Types of automobiles, different automobile layouts; front wheel drive, rear wheel drive, four wheel drive, rear engine layout. Types of frames, materials, different loads on frame, cross members, channel sections, sub frames, passenger car frames, x member type frame, truck frames, box section type frame, testing of frames, bending and torsion test, body construction and repairs, frame alignment and frame defects.

SUSPENSION: Objects, basic considerations, types of suspension springs; construction, rigid axle suspension, operation, materials of leaf springs, coil springs, torsion bar, rubber springs, helper springs, air suspension, shock absorbers, independent suspension; front and rear, stabilizer bars, active suspension systems, suspension systems for commercial vehicles trouble shooting. Numerical problems.

UNIT–II	10 Hrs.

STEERING SYSTEMS: Two wheeled steering system, four wheeled steering system, steering systems for multi axle vehicles and long wheeled chassis vehicles, steering mechanisms, correct steering angle, cornering force, self- righting torque, under steer and over steer, steering linkages, types of steering gear boxes: rack and pinion, recirculating ball type, etc. Steering ratio, turning radius, steering adjustment, steering columns, power steering; hydraulic and electronic, advanced steering systems, trouble shooting of steering systems. Numerical problems.

UNIT–III	10 Hrs.

BRAKES: Function, stopping distance, brake efficiency, weight transfer, determination of braking torque, classification of brakes, types, construction, operation of braking systems; mechanical, hydraulic, disc, drum. Details of hydraulic systems: master and wheel cylinder, diagonal split systems, bleeding of brakes, factors affecting brake fluid, pressure differential valve, proportioning valve, metering valve, brake adjustment. Brake compensation, parking brakes, hill holders, servo brakes, power brakes. Vacuum servo brakes, air brakes, vacuum – boosted hydraulic brakes. Auxiliary braking systems; retarders, exhaust brake, jake brakes.

UNIT–IV	10 Hrs.

WHEELS AND TYRES: Types of wheels, construction, wheel dimensions, structure and function, desirable tyre properties, types, materials, manufacture, designation, factors affecting tyre life, rotation and trouble shooting. Heat dissipation, wheel alignment and wheel balancing.

FRONT AXLE: Types of front axle, stub axle, materials, loads and stresses, drive line, construction working of drive shaft, types of drive shaft.

REAR AXLE: Types of drive, torque reaction, driving thrust, construction of rear axle supporting; fully floating, semi floating, three quarter floating arrangements, trouble shooting. Numerical problems.

Reference Books *

TEXT BOOKS:

1. **Automobile Engineering Vol. 1** (Chassis, Body), Dr. Kirpal Singh, 14th Edition/Reprint 2019 ISBN:9788180142420, Standard publications, New Delhi
2. **Automotive Chassis Engineering**, David C Barton, John D Fieldhouse, Springer, 2018

REFERENCE BOOKS:

1.The Automotive Chassis: Engineering Principles, Jornsen Reimpell, Helmut Stoll, Jurgen Betzler, Butterworth-Heinemann, Elsevier.

1. **Automotive Mechanics –** SIE Paperback , William Crouse, Donald Anglin, McGraw Hill, Jul 2017

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Course Outcomes**
1. Classify automotive layouts and enumerate the merits and demerits and their applications.
2. Illustrate the construction and working of suspension systems and specify suitable suspension systems for vehicles
3. Enumerate the classification and working of brakes and select suitable system for vehicles
4. Classify steering systems and working and diagnose its trouble shooting
5. Recommend tires and wheels for different vehicles
6. Suggest a suitable front and rear axles for various types of vehicles

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1											2	1	2	2
CO2	1											2	1	2	2
CO3	2	3	2	1								2	2	2	2
CO4	3	3	2	2								2	1	2	2
CO5	1											2	1	2	2
CO6	1		3	3								2	1	2	2

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UAU317	COMPUTER AIDED MACHINE DRAWING	**Credits: 01**
L:T:P - N_L :0 N_T:0 N_P 2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

1. Review of graphic interface of the software

Review of basic sketching commands and navigational commands. Standard sheet templates, and creating new templates, different line types and their applications.

1) **Section of solids:** sections of square pyramids, hexagonal prism, cones and cylinders**.**

2) **Orthographic views:** Conventions used in machine drawings. Sectional planes, Conversion of pictorial views into orthographic projections of simple machine parts with or without section (Bureau of Indian Standards conventions are to be followed for the drawings). Dimensioning and annotations.

2. **Thread forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme, Sellers thread, American Standard thread.

3. Fasteners :

Hexagonal head bolt, nut and washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

4. Keys & Joints

Parallel key, taper key, feather key, Gib head key and Woodruff key joint (socket and spigot), knuckle joint (pin joint) for two rods.

5. Couplings

Split Muff coupling, protected type flanged coupling, pin (bush) .type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint) GT&D, symbols.

Assembly Drawings (Part drawings should be given)

1) Plummer block (Pedestal Bearing)
2) Screw jack (Bottle type)
3) Petrol Engine piston
4) I.C. Engine connecting rod.

Laboratory Assessment:

1. This subject is to be evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   - Performance and preparation of drawings :
     10 sheets manually drawn shall be submitted and each sheet shall be evaluated for 3 marks.
   - One practical test for 20 marks. (5 mark for conversion from isometric to orthographic, 15 marks assembly and printing).
3. The SEE practical is conducted for 50 marks of three hours duration. The distribution of marks as 30% from orthographic view, 70 % for part modeling, assembling and creating 2 D views from assembly using CAD Software. No viva voce.
4. Question paper shall have two parts, questions for first part shall be asked from conversion of isometric to orthographic views and second part shall be asked from assembly.

5. Student should answer two questions choosing one question from each part. At least one question shall be asked from first 3 assemblies

Course Outcomes**

1. Able to utilize CAD software to generate 2D and 3D models.
2. Utilize CAD software commands and develop sections of solids.
3. Able to convert orthographic views to isometric views using CAD software.
4. Utilize advanced commands to generate assembly drawings of mechanical components.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1			3							2	1	2	2
CO2	3	2			3							2	1	2	2
CO3	3	2			3							2	2	2	2
CO4	3	2			3							2	2	2	2

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UAU328L	MACHINE SHOP PRACTICE	Credits: 01
L:T:P - N_L :0 N_T:0 N_P 2		CIE Marks: 50
Total Hours/Week:02		SEE Marks: 50

PART – A

1) Minimum four jobs using lathe of following machining operations:
2) Plain turning, taper turning, step turning, thread cutting, facing, knurling, eccentric turning.

PART – B

3) Cutting of gear teeth using milling machine.
4) Cutting of V – groove / Dovetail / Rectangular groove using shaping machine.
5) Demonstration of surface grinding.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   a. Performance and journal write-up: Marks for each experiment = 30 marks/No. of proposed experiments.
   b. One practical test for 20 marks. (5 write-ups, 10 conduction, calculation, results etc., 5 viva-voce).

Allocation of 50 marks for SEE :

Lathe work	: 30 Marks
Shaping or Milling	: 10 Marks
Viva-Voce	: 10 Marks

Course Outcomes**

After completion of the course student will be able to

1. Develop skills to operate lathe for turning, Facing, tapering, knurling, step turning, forming and threading operation
2. Apply skills to develop jobs on shaper and slotting machine.
3. Apply skills to develop jobs using milling machine.
4. Apply skills to finish turned or milled jobs using surface grinder.
5. Calculate machining time for different operations.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		2				2			2	2	1	2
CO2	3	2	2		2				2			2	2	1	2
CO3	3	2	2		2				2			2	2	1	2
CO4	3	2	2		2				2			2	2	1	2
CO5	3	2			2				2			2	1	1	2

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UMA433C	MATHEMATICAL METHODS FOR MECHANICAL SCIENCE	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Complex Variables:

Analytic function, Cauchy-Reimann equations in Cartesian and polar forms. Construction of analytic function (Cartesian and polar forms)

Complex Integration:

Line integral, Cauchy's theorem – corollaries (without Proof), Cauchy's integral formula. Taylor's and Laurent's series (statements only), singularities, poles, calculation of residues, Cauchy's residue theorem (without proof) – problems.

UNIT–II	10 Hrs.

Special Function:

Series solution of Bessel's differential equation, recurrence formulae, generating function, orthogonal property, Bessel's integral formula.

UNIT–III	10 Hrs.

Statistics and Probability

Statistics: Curve fitting by the method of least squares: $y = a + bx$ $y = ab^x$, and $y = a + bx + cx^2$

Correlation and regression.

Probability: addition rule, conditional probability, multiplication rule, Baye's rule.

UNIT–IV	10 Hrs.

Probability distributions:

Binomial distributions Poisson distributions and Normal distributions (No drivations). Concept of joint probability, Joint distributions - discrete random variables, Independent random variables, Problems on expectation and variance.

Markov chains:

Markov chains: Introduction, Probability vectors, Stochastic Matrices, Fixed Points and Regular stochastic Matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states.

Reference Books *

1. **Higher Engineering Mathematics** by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
2. **Theory and problems of probability** by Seymour Lipschutz (Schaum's Series).
3. **Advanced Engineering Mathematics** by H. K. Dass
4. **Advanced Engineering Mathematics** by E Kreyszig (John Wiley & Sons)
5. **Probability and stochastic processes** by Roy D. Yates and David J. Goodman, wiley India pvt.ltd 2nd edition 2012.
6. **Advanced Engineering Mathematics** by Peter V. O'Neil.

Course Outcomes**

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After completion of the course student will be able to
CO1: To apply the least square sense method to construct the specific relation for the given group of data.
CO2: To apply the concept of probability to find the physical significance of various distribution

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phenomena.

CO3: To apply the concept of probability to perform engineering duties in planning and designing, engines, machines and other mechanically functioning.

CO4: To apply the concept of probability to study the performance of Mechanical systems.

CO5: To apply the concept of Markov Chain for commercial and industry purpose.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

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UAU412C	FLUID MECHANICS	Credits: 03
L:T:P - N_L :3 N_T: 0N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
PROPERTIES OF FLUIDS: Introduction, properties of fluids, classification of fluids, thermodynamic properties of fluids. **FLUID STATICS - PRESSURE AND ITS MEASUREMENT:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressure, simple manometers, differential manometers.	
UNIT–II	**10 Hrs.**
FLUID STATICS- HYDROSTATIC FORCES ON SURFACES: Total pressure and center of pressure, vertical plane surface submerged in liquid, horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid, curved surface submerged in liquid. **BUOYANCY AND FLOATATION:** Buoyancy, center of buoyancy, metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies.	
UNIT–III	**10 Hrs.**
FLUID KINEMATICS: Types of fluid flow, flow net, continuity equation, continuity equation in three dimensions (Cartesian co-ordinate system only), velocity and acceleration, velocity potential function and stream function for 2D flow and types of motion. **FLUID DYNAMICS:** Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Bernoulli's equation for real fluids. **FLUID FLOW MEASUREMENTS:** Introduction, venturimeter, orifice meter, Pitot tube.	
UNIT–IV	**10 Hrs.**
LAMINAR FLOW AND VISCOUS EFFECTS: Reynolds's number, critical Reynolds's number, laminar flow through circular pipe - Hagen Poiseulle's equation, laminar flow between parallel and stationary plates. **FLOW THROUGH PIPES:** Frictional loss in pipe flow, major energy losses and minor energy losses in pipe flow, Darcy- equation for loss of head due to friction in pipes, Chezy's equation for loss of head due to friction in pipes, hydraulic gradient and total energy line. **DIMENSIONAL ANALYSIS:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Buckingham's- π theorem, Raleigh's method, dimensionless numbers, similitude, types of similitude.	
Reference Books *	

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Text books:

1. Kumar.D.S, **"Fluid Mechanics and Fluid power Engineering"** Kataria and sons-2010
2. Dr.Bansal.R.K, **"Fluid Mechanics"** by Lakshmi Publications, 2010.
3. OijushK.Kundu, **IRAM COCHEN,** EL SEVIER 3 rd Ed. 2005.

Reference Books:

1. Yunus A, Cenegel, John M, Cimbala, Fluid Mechanics, Fundamentals and Applications Tata by TATA McGraw Hill, 2013.
2. John F.Douglas, Janul and M.Gasiosek and john A.Swaffield, Fluid Mechanics published by Prentice hall 2007.

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Course Outcomes**
1. Demonstrate the basic concepts of fluid mechanics, properties and fluid statics
2. Compute force of buoyancy and floatation and analyze its conditions
3. Formulate equations of motion of fluid and apply to fluid flow measurements
4. Apply principles of dimensional analysis, similitude and use dimensionless parameters to solve the problems
5. Identify and optimize the fluid flow to analyze the problems
6. Evaluate the characteristics of laminar flow and viscous effects to solve problems

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1		1		1						1	2	1	2
CO2	3	3	1	1		1						1	3	1	2
CO3	3	1		1		1							3	1	2
CO4	3	3	1	1		1						1	3	1	2
CO5	3	3	1	1		1	1					3	3	1	2
CO6	3	3	1	1		1	1					2	3	1	2

UAU415C	THEORY OF AUTOMOTIVE ENGINES	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION: Historical development of automobiles. Types of power plant, Classification of engines; V - engines, stratified charge engines, variable compression ratio engine. Principle of engine operation - S and CI two stroke and four stroke engines. Scavenging systems**:** Theoretical processes, parameters, relative merits and demerits, valve and port timing diagrams. **AIR STANDARD CYCLES**: Otto, Diesel and dual cycle - efficiency and mean effective pressure. Fuel ai cycles: Introduction and mixture strength variations.	
UNIT–II	**10 Hrs.**
COMBUSTION IN S.I. ENGINES: Ignition limits, stages of combustion, ignition lag, effect of engine variable on ignition lag, flame propagation, effect of var iables, abnormal combustion, detonation, theory c detonation, effect of engine variables on detonation, control of detonation, surface ignition. Knock rating c SI engine fuels. HUCR engine. Combustion chamber: requirements, types, advantages and limitations.	
UNIT–III	**10 Hrs.**
COMBUSTION IN CI ENGINES: Stages of combustion, air fuel ratio in CI engines, delay period, variables affecting delay period, diesel knock, methods of controlling diesel knock. CI engine combustion chambers; open and divided. Swir l; induction, turbulent and combustion swirl chambers. M - Combustion chamber. **ENGINE PERFORMANCE**: Performance parameters; BHP, FHP, IHP, specific fuel consumption, volumetric efficiency, thermal efficiency, specific weight, heat balance sheet and testing of engines.	
UNIT–IV	**10 Hrs.**
LIQUID FUELS: Properties: specific gravity, viscosity, flash and fire points, calorific value, rating of fuels. **PETROL FUEL**: Octane number, chemical energy of fuels, reaction equation, volatility properties of A/ mixture, combustion temperature. **DIESEL FUELS**: Cet ane number, vapor pressure, cloud and pour point, annealing point, diesel index, carbon residue. Chemical energy of fuels, reaction equation, properties of A/ F mixture, combustion temperature, rating of fuels. **DUAL FUEL AND MULTI-FUEL ENGINES**: Combustion in dual fuel engines, factors affecting combustion. Main types of gaseous fuels, supercharge knock control and performance of diesel fuel engines. Char acteristics of multi fuel engines, modification of fuel system, suitability of various engines as multi fuel unit, performance of multi fuel engines.	
Reference Books *	

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Text books:

1. **I.C. Engines** By Mathur & Sharma, Dhanpat Rai & Sons, New Delhi, 1994
2. **Fuels & Combustion** by S.P. Sharma & Chandramohan, Tata McGrawHill, New Delhi ,1987

Reference books:

1. **I.C. Engines & Air pollution** by Obert, Harper & Row Roni publishers, New york, 1973 Fuels & Combustion by Smith & Stinson,
2. **I.C. Engines** by Lichty
3. **I.C. Engines** by Maleev, CBS Pub.
4. **Combustion fundamentals** by Roger A Strehlow

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Course Outcomes**
1. Compare and correlate between principle of engine operation, theoretical and actual cycle diagrams
2. Recommend the suitability of fuels for various applications and evaluate the performance of engine using key parameters
3. Correlate between power plants with valve timing diagrams of CI and SI Engines.
4. Evaluate abnormal combustion and its impact on engine performance
5. Illustrate the dual and multi fuel engines and its applications
6. Analyze the phases of combustion and their significance in Engine performance

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1	1	1			2		1	1	2	2	2
CO2	3	3	2	1	1	1			2		1	1	2	2	2
CO3	3	3	2	1	1	1			2		1	1	2	2	2
CO4	3	3	2	1	1	1			2		1	1	1	2	2
CO5	3	3	2	1	1	1			2		1	1	2	2	2
CO6	3	3	2	1	1	1			2		1	1	2	2	2

UAU416C	AUTOMOTIVE TRANSMISSION SYSTEMS	Credits: 03
L:T:P - N_L : 3 N_T: 0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

POWER REQUIRED FOR PROPULSION: Resistances: wind, gradient and rolling resistances of an automobile. Traction, tractive effort, road performance curves; acceleration, gradability, drawbar pull, numerical problems.

CLUTCH: Need of clutch, requirements, materials, different types of clutches, principle of friction clutches, single plate, multi-plate, diaphragm, cone, centrifugal clutch, semi- centrifugal clutch. Method of actuation; mechanical, electromagnetic, hydraulic and vacuum, adjustment of clutch, wet and dry friction clutches, clutch trouble shooting diagnosis and numerical problems.

UNIT–II	10 Hrs.

FLUID COUPLING AND ONE WAY CLUTCHES: Necessity, constructional details, types, field of application, percentage slip, one way clutch, working fluid requirements, fluid coupling characteristics.

HYDRODYNAMIC TORQUE CONVERTERS: Introduction, comparison between fluid coupling and torque converter, performance characteristics, slip, principle of torque multiplication, 3 and 4 phase torque converter, typical hydrodynamic transmission.

DRIVE LINE: Front universal joint, CV joint-inner and outer, slip joint.

FINAL DRIVE GEARS: Axle ratio**,** gear tooth nomenclature. Differential, limited slip differential. Transfer case; inter axle differential, locking differential, electronic control of transfer cases and drive trains, all wheel drive. Trouble shooting diagnosis of final drive.

UNIT–III	10 Hrs.

GEAR BOX: Functions of transmissions, necessity of gear box, gears, gear ratio and torque, types of transmission; manual and automatic transmission, sliding-mesh gear box, constant-mesh gear box, synchromesh gear box. Transfer box. Transaxle; construction and operation, dual range transaxle. Selector mechanism and its types and interlock devices, gearbox lubrication. Calculation of gear ratios for vehicles, performance characteristics in different gears. Switches and sensors - Transmission Controlled Spark (TCS), trouble shooting diagnosis and servicing and maintenance of manual transmission and transaxle. Trouble shooting diagnosis of gear box. Numerical problems.

EPICYCLIC TRANSMISSION: Principle of operation, types of planetary transmission, calculation of gear ratio in different speeds, over drives, numerical problems.

HYDROSTATIC DRIVES: Principle of hydrostatic drives, different systems of hydrostatic drives, types of pumps, advantages and limitations, typical hydrostatic drives.

UNIT–IV	10 Hrs.

AUTOMATIC TRANSMISSION: Hydraulic system, automatic transmission fluid, transmission fluid coolers, basic hydraulic control circuits, accumulator, shift timing, governor pressure, throttle pressure, controlling shift timing and quality, hydraulic valves and valve bodies, starting controls and shift interlocks, electronic shift control, shift solenoid, automatic shift counter shaft transmission. Principle, general description of Borg-Warner automatic transmission, Continuous Variable Transmission(CVT).

ELECTRIC TRANSMISSION: General arrangement and description of electric transmission, their working principle and control mechanisms and limitations.

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TEXT BOOKS:

1. **Automobile Engineering – I & II –** Kirpal Singh

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2. **Automobile Engineering** – G. B. S. Narang
3. **Automotive Mechanics** – William Crouse

Course Outcomes**

1. Illustrate the fundamentals related to various resistances offered to the motion of vehicle and tractive effort.
2. Recommend a suitable clutch for a given vehicle and their construction and working with details about trouble shooting
3. Assess the importance of torque converters and analyze the functioning of final drive
4. Analyze, interpret and compare various types of gear box and its operation.
5. Analyze the principle of hydrostatic drives and its applications.
6. Assess the potential, utility, features and mechanism of Automatic transmission.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1					1	1	1	1	2	2	2
CO2	3	1	1	1					1	1	1	1	2	2	2
CO3	3	2	1	1					1	1	1	1	1	2	2
CO4	3	1	1	1					1	1	1	1	2	2	2
CO5	3	2	1	1					1	1	1	1	2	2	2
CO6	3	2	1	1					1	1	1	1	2	2	2

UAU424C	DESIGN OF MACHINE ELEMENTS - I	Credits: 04
L:T:P - N_L : $3N_T$: $2N_P$ 0		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10+8 Hrs.
INTRODUCTION: Classification of design, design procedure, standardization, preferred numbers. Selection of materials, manufacturing consideration in design. **STRESSES IN ELEMENTARY MACHINE PARTS:** Definitions derived from stress; strain diagram, loads, stress, strain, stress strain diagrams. Factor of safety, combined stresses, eccentric loading, theories of failure, stress concentration, stress concentration factor, variable stresses, endurance limit, fatigue stress concentration factor, notch sensitivity, impact loading, design criteria.	
UNIT–II	**10+8 Hrs.**
SHAFTS: Introduction, material used for shafting, stresses in shafts, design of shafts, shafts subjected to twisting moment, bending moment. Combined bending and twisting moment, axial load in addition to bending and torsion, fluctuating loads, design of shaft on the basis of rigidity, ASME and ISI codes for design of transmission shafting. **KEYS, COUPLINGS, COTTER AND KNUCKLE JOINTS:** Types of keys, design of keys, shafts couplings; types, design of muff coupling, flange coupling, pin type flexible coupling. Oldham's coupling, universal coupling, socket and spigot type cotter joint, knuckle joint.	
UNIT–III	**10+6 Hrs.**
THREADED FASTENERS AND POWER SCREWS: Uses of screw threads, design of screw threads, design of screw threads, threaded fasteners, effect of initial tension, effect of applied loads; bolt stress, bolt spacing, effect of dynamic loads, bolts subjected to shear and eccentric loading, bolts subjected to shear eccentric loading, power screws; efficiency of screw threads, differential screws stress in power screws.	
UNIT–IV	**10+6 Hrs.**
RIVETED JOINTS: Types of joints, design stresses, design of typical joints, boiler joint, tank and structural joints. **WELDED JOINTS:** Types of joint deign stresses, design of typical joints, eccentrically loaded welded joints.	
Reference Books *	

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TEXT BOOKS:

1. **Theory and problems of Machine Design** by Hall (Schaum's 'Outline)
2. **Design of Machine Members** by Vallance and doughtIe
3. **Machine design** by Maleev and Hartman.

REFERENCES:

1. A Text book of Machine Design by R.S.Khurmi and J.K.Gupta.
2. Elements of Machine Design by Pandya and Shah. Machine Design by Black
3. Mechanical Engineering Design by Shigley. Machine Design Elements by M.P. Sports.

DATA HANDBOOKS:

1. Machine design data hand book by Lingiah.
2. Machine design data hand book by Balaveera Reddy.

Course Outcomes**
1. Classify the design approaches, design procedure and consideration
2. Analyze the stress and strain of mechanical components, and identify, quantify failure modes for mechanical parts.
3. Design and analysis of shafts and other mechanical component subjected to twisting and bending moment.
4. Design and analyze keys, coupling, and knuckle joints for various load condition.
5. Ability to design and analyze screw threaded fastener for various load condition.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	2									1	2	2	2
CO2	3	2	2	2								2	2	3	2
CO3	3	3	3	3								2	3	2	2
CO4	3	3	3	3								2	3	3	2
CO5	3	3	3	3								2	3	3	2

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UAU433C	THEORY OF MACHINES	Credits: 04
L:T:P - N_L :3 N_T:2 N_P 0		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10+6 Hrs.
INTRODUCTION: Definitions: link or element, kinematics pairs, degrees of freedom, Grubler's criterion, Kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine. **KINEMATIC CHAINS AND INVERSIONS**: Inversions of four bar chain; single slider crank chain and double slider crank chain. **MECHANISMS:** Quick return motion mechanisms - drag link mechanism, Whitworth mechanism and crank and slotted lever mechanism. **VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD**: Definition, Kennedy's theorem, determination of linear and angular velocity using instantaneous center method. Klein's construction: Analysis of velocity and acceleration of single slider crank mechanism.	
UNIT–II	**10+8 Hrs.**
STATIC FORCE ANALYSIS: Static force analysis: introduction: Static equilibrium, equilibrium of two and three force members. Members with two forces and torque, free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. **DYNAMIC FORCE ANALYSIS**: De Alembert's principle, inertia force, inertia torque, dynamic force analysis of four - bar mechanism and slider crank mechanism. Dynamically equivalent systems. Turning moment diagrams of flywheel, fluctuation of energy. Determination of flywheel size. **BALANCING OF ROTATING MASSES:** Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.	
UNIT–III	**10+8 Hrs.**
BALANCING OF RECIPROCATING MASSES: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder inline engine , primary and secondary forces, V - engine and radial engine. **GOVERNORS:** Types of governors, controlling force, stability, sensitiveness, isochronism, effort and power. Force analysis of Porter and Hartnell governors. **GEAR TRAINS:** Simple gear trains, compound gear trains for large speed reduction, epicyclic gear trains, algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear train.	
UNIT–IV	**10+6 Hrs.**
GYROSCOPE: Vectorial representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on ship,plane disc, aeroplane, stability of two wheelers and four wheelers. **CAMS:** Types of cams, types of followers, displacement, velocity and acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife - edge, roller and flat - faced follower, follower motions including SHM, uniform velocity, uniform acceleration and retardation and cycloidal motion.	
Reference Books *	

Text Books:

1. "**Theory of Machines**", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 2nd edition -2005.
2. "**Theory of Machines**", Sadhu Singh,Pearson Edn (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 2nd Edi. 2006.

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Reference books:

1. "Theory of Machines & Mechanisms", Shigley. J. V. and Uickers, J.J., OXFORD University press.2004.

2."Theory of Machines -I", by A.S.Ravindra, Sudha Publications Revised 5th Edi. 2004.

Course Outcomes**

1. Analyze the given machine/ mechanism for their type and mobility
2. Determine the velocity and acceleration of links in the mechanism using graphical and analytical methods
3. Carry out the static and dynamic force analysis for a given mechanism.
4. Formulate the equations for kinematic and dynamic analysis of gear and gear trains
5. Analyze the dynamic forces and couples on rotating and reciprocating components of machines to compute the magnitude and direction of balancing mass.
6. Develop a cam profile for a given follower motions and ascertain the gyroscopic and centrifugal couple for a given application

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	1	1	1			2		1	1	2	2	2
CO2	3	3	2	1	1	1			2		1	1	2	2	2
CO3	3	3	2	1	1	1			2		1	1	2	2	2
CO4	3	3	2	1	1	1			2		1	1	1	2	2
CO5	3	3	2	1	1	1			2		1	1	2	2	2
CO6	3	3	2	1	1	1			2		1	1	2	2	2

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UAU437	FOUNDRY AND FORGING PRACTICE	**Credits: 01**
L:T:P - N_L :0 N_T:0 N_P 2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

UNIT-I	xx Hrs.

Part - A

1. TESTING OF MOLDING SAND AND CORE SAND

Preparation of sand specimens and conduction of the following tests:

a. Compression, shear and tensile tests on universal sand testing machine.
b. Permeability test
c. Core hardness & mould hardness tests
d. Grain fineness number test (Sieve analysis test)
e. Clay content test
f. Moisture content test.

Part - B

2. FOUNDRY PRACTICE

a. Use of foundry tools and other equipments.
b. Preparation of moulds using molding boxes using patterns or without patterns.
c. Preparation of one casting (Aluminum or cast iron - Demonstration only)

Part - C

3. FORGING OPERATIONS

a. Preparing minimum three forged models involving upsetting, drawing and bending operations.
b. Out of these three models, at least one model is to be prepared by using power hammer.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
3. Performance and journal write-up: Marks for each experiment = 30 marks/No. of proposed experiments.

3. One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc.5 (viva voce).

Allocation of 50 marks for SEE:

Part-A	: 20 Marks
Part-B or Part-C	: 20 Marks
Viva-Voce	: 10 Marks

Course Outcomes**

1. To have understood various processes carried out in Foundry.
2. Ability to prepare different types of mold cavities and different sand testing methods.

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3. Demonstrate various skills of sand preparation and different molding methods.

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4. Able to know manufacturing process that in turn provide the student with the capacity to better understand and realization of engineering products and system.

5. Aware of importance of manufacturing process in an industry and the applications.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2							2			1	1	2	2
CO2	3	2	2						1				1	2	2
CO3	3	2	2		2		1		2				1	2	2
CO4	3	2	2		2							1	1	2	2
CO5	3	2	2		2				2			1	2	2	3

UAU438	I. C. ENGINE AND FUELS LABORATORY.	Credits: 01
L:T:P - N_L :0 N_T: 0 N_P 2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

Part - A

FUELS LAB:

1. Determination of flash point and fire point of lubricating oil using Ables'apparatus.
2. Determination of flash point and fire point of lubricating oil using Pensky Martin apparatus.
3. Determination of viscosity of lubricating oil using Redwood viscometer.
4. Determination of viscosity of lubricating oil using Saybolt viscometer.

Part - B

TESTS ON IC ENGINES:

1. Performance tests on I.C engines, calculations of IP, BP, FP, Thermal, volumetric and mechanical efficiency, SFC and heat balance sheet for:

   a) Four stroke single cylinder petrol engine.
   b) Four stroke single cylinder diesel engine.
   c) Four stroke twin cylinder diesel engine.
   d) Multi cylinder petrol engine for Morse test.
   e) Computerized single cylinder four stroke diesel engine.
2. Valve timing opening diagram of four stroke diesel / petrol engine.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. **Allocation of 50 marks for CIE**
   - Performance and journal write-up :
     Marks for each experiment = 30 marks/No. of proposed experiments.
   - One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

Allocation of 50 marks for SEE

Part-A	: 10 Marks
Part-B	: 30 Marks
Viva-Voce	: 10 Marks

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Course Outcomes**
1. Able to know and analyze the various properties of fuels
2. Able to know and analyze the valve timing diagram for different engines
3. Able to know and analyze and to perform experiments on various engines
4. To conduct performance study against malfunctioning and emission tests

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2							2			1	1	2	2
CO2	3	2							1				1	2	2
CO3	3	2							2				1	2	2
CO4	3	2										1	2	2	2

UAU439L	MATERIAL TESTING AND MEASUREMENT LABORATORY	Credits: 01
L:T:P - N_L :0 N_T: 0 N_P 2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

PART - A

a. Tensile and compression test of metallic and non - metallic specimens using a universal testing machine.
b. Shear test of metallic and non - metallic specimens using a universal testing machine
c. Bending test on metallic and non - metallic specimen.
d. Impact test: Izode and Charpy tests on M.S. Specimen.
e. Hardness test: Brinell, Rockwell and Vickers's test.

PART - B

a. Calibration of pressure gauge.
b. Calibration of micrometer using slip gauges.
c. Measurement of angle using sine bar/sine centre.
d. Measurement of screw thread parameters by two wire method.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. **Allocation of 50 marks for CIE**
    - Performance and journal write-up :
      Marks for each experiment = 30 marks/No. of proposed experiments.
    - One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

Allocation of 50 marks for SEE

Part-A	: 20 Marks
Part-B	: 20 Marks
Viva-Voce	: 10 Marks

Course Outcomes**
1. To conduct impact tests and find impact value of specimens.
2. To conduct hardness tests and find hardness number for different specimens.
3. To utilize UTM for tensile, compression and bending tests on mild steel and wooden specimens.
4. Demonstrate calibration techniques to various measuring devices to standardize the instruments.
5. Acquire knowledge about Measurements and Measuring procedures.

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1										2	1	2	2
CO2	3	2										2	1	2	2
CO3	3	2										2	1	2	2
CO4	3	1										2	2	2	2
CO5	3	2										2	1	2	2

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
(Academic Year 2021 - 2022)

V Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1.	UAU541C	Heat Transfer	3	3	0	0	50	50	100
2.	UAU532C	Design of Power Train and Suspension Systems	3	2	2	0	50	50	100
3.	UAU523H	Entrepreneurship and Industrial Management	3	2	0	0	50	50	100
4.	UAU524C	Auxiliary System for Automotive Engines	3	3	0	0	50	50	100
5.	UAUXXXE	Dept. Elective - I	3	3	0	0	50	50	100
6.	UCS559L	Advanced C Programming Lab	2	0	0	4	50	50	100
7.	UHS002N	Advanced Quantitative Aptitude and Soft Skills.	1	1	0	0	50	50	100
8.	UAU527L	Automotive Engine Servicing Laboratory	1.5	0	0	3	50	50	100
9.	UAU538L	Automotive Scanning Laboratory	1.5	0	0	3	50	50	100
		Total	21	14	2	10	450	450	900

Department Electives – I

Sl. No	Code	Subjects
1	UAU571E	Automotive Emissions and Control
2	UAU572E	Product Design and Development
3	UAU575E	Computer Graphics
4	UAU576E	Vehicle Transport Management

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
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VI Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1.	UAU621C	Automotive Engine Component Design	4	4	0	0	50	50	100
2.	UAU622H	Engineering Economics	3	3	0	0	50	50	100
3.	UAU623C	Automotive Electrical Systems	3	3	0	0	50	50	100
4.	UAUXXXE	Dept. Elective - II	3	3	0	0	50	50	100
5.	UAUXXXN	Open Elective - I	3	3	0	0	50	50	100
6.	UAU627L	Automotive CAD Laboratory	1.5	0	0	3	50	50	100
7.	UAU638L	Automotive Power Train and Electrical Servicing Lab	1.5	0	0	3	50	50	100
8.	UHS003N	Career Planning and Professional Skills	1	0	0	3	50	50	100
9.	UAU610P	Mini Project	2	0	0	2	50	50	100
		Total	22	16	0	11	450	450	900

Department Electives – II

Sl. No	Code	Subjects
1	UAU651E	CAD/CAM
2	UAU653E	Automotive Air Conditioning
3	UAU654E	Advanced Automotive Materials
4	UAU655E	Diesel Engine Management System and Components

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UAU523H	Entrepreneurship and Industrial Management	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

MANAGEMENT: Introduction - Meaning - nature and characteristics of Management, Scope and functional areas of management - Management as an art or science, art or profession Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches - Modern management approaches.

PLANNING: Nature, importance and purpose of planning process - Objectives - Types of plans (Meaning only) - Decision making – Importance of planning - steps in planning & planning premises - Hierarchy of plans.

UNIT–II	10 Hrs.

ORGANISING AND STAFFING: Nature and purpose of organization -Principles of organization - Types of organization - Departmentation -Committees – Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of Staffing - Process of Selection & Recruitment (in brief).

DIRECTING & CONTROLLING: Meaning and nature of directing - Leadership styles, Motivation Theories, Communication - Meaning and importance – Coordination, meaning and importance and Techniques of Co - ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief)

UNIT–III	10 Hrs.

ENTREPRENEUR: Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur – an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Barriers to entrepreneurship.

SMALL SCALE INDUSTRY: Definition; Characteristics; Need and rationale: Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start an SSI – Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans, Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT, Supporting Agencies of Government for S.S.I., Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only)

UNIT–IV	10 Hrs.

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC.

PREPARATION OF PROJECT: Meaning of Project**;** Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

Reference Books *

TEXT BOOKS:
1. **Principles of Management -** P.C. Tripathi, P.N. Reddy; Tata McGraw Hill,
2. **Dynamics of Entrepreneurial Development & Management -** Vasant Desai Himalaya Publishing House
3. **Small Business Enterprises -** Poornima M Charantimath – Pearson Education - 2006 (2 & 4)

REFERENCE BOOKS:
1**. Management Fundamentals -** Concepts, Application, Skill Development Robert Lusier - Thomson

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2. **Entrepreneurship Development -** S S Khanka **-** S Chand & Co
3. **Management -** Stephen Robbins **-** Pearson Education /PHI **-**17th Edition, 2003

Course Outcomes**

1. Assess the scope and significance of management and its principles
2. Illustrate the importance of planning and decision making
3. Demonstrate the communication skills to various Industrial fields
4. Develop entrepreneurial qualities to establish small scale Industry
5. Identify and develop the criterions for formulating project report
6. Evaluate the schemes to build business enterprise

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	2	1	1	2		2	2	2	2	1	1	2	2
CO2	2	3	2	1	1	2		2	2	2	2	1	1	2	2
CO3	2	3	2	1	1	2		2	2	2	2	1	2	2	2
CO4	1	3	2	1	1			2	2	2	2	1	1	2	2
CO5	1	3	2	1	1			2	2	2	2	1	1	2	2
CO6	2	3	2	1	1	2		2	2	2	2	1	1	2	2

UAU524C	AUXILIARY SYSTEMS FOR AUTOMOTIVE ENGINE	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

CARBURETION: Carburetor principle, properties of air-petrol mixtures, mixture requirements for steady state and transient operation, mixture formation studies of volatile fuels, design of elementary carburetor, chokes, automatic chokes, effects of altitude on carburetion, carburetor for 2 - stroke and 4 - stroke engines, carburetor systems for emission control. Fuel flow systems for SI engines.

GASOLINE INJECTION: Petrol injection; advantages, disadvantages, Lucas petrol injection system, mechanical, pneumatic and electronic fuel injection systems, types. Performance and exhaust emissions of Gasoline Direct Injection (GDI) engine. Mixture and operation modes, fuel supply and engine management of GDI.

AIRCRAFT FUEL SYSTEMS: Basic fuel systems characteristics and functions, fuel properties and environment.

UNIT–II	10 Hrs.

DIESEL FUEL INJECTION: Cleaning systems, transfer pumps, injection pumps, injectors and nozzles - types, functions and necessities, fuel injection pump principle, ratio of piston displacement to fuel charge volume, delivery characteristics, injection lag, pressure waves in fuel lines, fuel pump and governors - types, constructional features and operation, factors influencing fuel spray atomization, penetration and dispersion of diesel and heavy oils and their properties, rate and duration of injection, fuel line hydraulics.

CRDI injection: Operating concept, design, control and regulation for cars and CVs.

Diesel spray characteristics: Macroscopic; front penetration, cone angle, liquid length.

Microscopic characteristics; droplet size and distribution.

UNIT–III	10 Hrs.

MANIFOLDS AND MIXTURE DISTRIBUTION: Intake system components: Air filter, intake manifold with mixture distribution, discharge coefficient, pressure drop, exhaust system components: exhaust manifold and exhaust pipe, spark arresters, waste heat recovery, exhaust mufflers, type of mufflers, exhaust manifold expansion.

COOLING SYSTEM: Necessity, variation of gas temperature, areas of heat flow, heat transfer, piston and cylinder temperature, heat rejected to coolant, quantity of water required. Cooling system: air cooling, water cooling, thermodynamics of forced circulation, water pumps, thermostats, pressurized water cooling, regenerative cooling. Comparison of air and water cooling. Radiators - types, cooling fan - power requirement, anti-freeze solution.

UNIT–IV	10 Hrs.

LUBRICATION SYSTEM: Lubricants, lubricating systems - types, lubrication of piston rings, bearings, oil consumption, oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, concept of adiabatic engines, oil filters, pumps, crankcase ventilation - types.

SUPERCHARGERS: Introduction, purpose, thermodynamic cycle, effect on the performance, limits of supercharging for petrol and diesel engines, modifications of an engine for super charging; methods of super charging, compressor design, performance measures and mapping, engine matching.

TURBOCHARGERS: Introduction, merits of turbochargers in diesel and gasoline engines, basic structure and functionality, turbocharger performance, engine/turbochargers matching basics, advanced engine requirements and turbo technologies.

Reference Books *

TEXT BOOKS:

1. **A Course in Internal Combustion Engines -** Mathur, M.L., and Sharma, R.P., Dhanpat Rai Publications (P) Ltd., 1998.
2. **Automobile Engineering Vol I & II -** Kirpal singh, Standard Pub,New Delhi, 2004

3. **Internal Combustion Engine -** Ramalingam, K.K, ScitechPublication (India) Pvt.Ltd.2000.

REFERENCES BOOKS:

1. **A Course in Internal Combustion Engines -** Domkundwar, V.M, Dhanpat Rai and Co., 1999.
2. **Internal Combustion Engines -** Ganesan, V., Tata McGraw-Hill Book Co., 2002.

Course Outcomes**

1. Demonstrate the working of carburetors and petrol injections systems with its utility
2. Illustrate the types and characteristics of diesel injection systems
3. Elucidate the necessity and types of cooling systems
4. Enumerate manifolds and mixture distribution for intake and exhaust systems
5. Suggest lubricants and types of lubrication systems adopted in vehicles
6. Evaluate the scope and significance of turbo charging and its patterns

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	1	1						3	2	1	2
CO2	3	3	3	3	1	1						3	2	1	2
CO3	3	3	3	3	1							3	2	1	2
CO4	3	3	3	3	1							3	2	1	2
CO5	3	3	3	3	1							3	2	1	2
CO6	3	3	3	3	1	1						3	2	1	2

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UAU532C	Design of Power Train and Suspension System	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

CRITERIA FOR VEHICULAR SYSTEM DESIGN: Vehicle load, Road, Wind and Gradient Resistance, Expectancy curves and Performance curves. Power and torque of propulsion, Driving Power and torque, Output Power and torque of the Propeller shaft, Output power and torque at fly wheels, Graphical representations of expectancy curves, Starting torque, Load-speed characteristics and performance curves (No derivation only problems).

DESIGN AND DEVELPOMENT OF CLUTCH ASSEMBLY FOR DIFFERENT TYPES OF VEHICLE POWER TRAINS:-Design and Development of clutch assembly using the vehicular design data calculation methods for the different types of vehicles, Calculations of required torque and BHP to be transmitted, types of clutches: - single plate, multi plate and cone clutches, selection criteria for the clutches. Analyses of various stresses, forces acting on clutch assembly and components (No derivation only problems).

Clutch assembly: clutch plates, pressure plates, springs, input and output shafts, rivets nuts and bolts, clutch plates, frictional materials and their selection criteria, materials used for various components.

UNIT–II	10 Hrs.

DESIGN AND DEVELPOMENT OF GEAR TRAINS AND GEAR BOXES FOR DIFFERENT TYPES OF VEHICLE POWER TRAINS:-Design and Development of gear trains using the vehicular design data calculation methods for the different types of vehicles, Calculations of required torque and BHP to be transmitted, types of gear boxes, gear trains and gears, selection criteria, transmission efficiency, criteria for selection of different gear ratios in gear boxes, calculations of gear train dimensions, gear ratios, diameter of the gear shafts and gears etc (No derivation only problems).

LUBRICATION AND BEARINGS: Lubricants and their properties, mechanisms of lubrication bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, heat dissipated, bearing materials design of journal bearing and thrust bearing (No derivation only problems).

TYPES OF BRAKES: Single block and simple band brakes.

UNIT–III	10 Hrs.

DESIGN AND DEVELPOMENT OF CONVENTIONAL TRANSMISSION SYSTEMS FO R DIFFERENT TYPES OF TWO WHEELER AND THREE WHEELERS:-Design and Development of gea trains using the vehicular design data calculation methods for the different types of vehicles, Calculations o required torque and BHP to be transmitted, types of conventional transmission systems:-belts ropes and chains force and stress analyses, calculations of dimensions for wire ropes. Belts:- types, Flat belts: length and cross section, selection of v-belts,wire ropes and chains for automotive and other applications (No derivation only problems).

DESIGN AND DEVELPOMENT OF PROPELLER SHAFTS FOR DIFFERENT TYPES OF VEHICLE POWER TRAINS:-Design and Development of propeller shaft using the vehicular design data calculation methods for the different types of vehicles, Calculations of required torque and BHP to be transmitted, Types of propeller shaft, selection criteria, types of joints used (No derivation only problems).

UNIT–IV	10 Hrs.

SPRINGS: Types of springs, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, leaf Springs: stresses in leaf springs. Equalized stresses, energy stored in springs, torsion, Belleville and rubber springs.

DESIGN AND DEVELPOMENT OF REAR AXEL GEAR TRAINS FOR DIFFERENT TYPES OF VEHICLE POWER TRAINS:-Design and Development of rear axle gear trains using the vehicular design data calculation methods for the different types of vehicles, Calculations of required torque and BHP to be transmitted, Types of gear trains, axle shaft design, gear train selection criteria, rear axle gear ratio calculations and selection criteria

Reference Books *

DESIGN DATA HAND BOOKS:

1. **Design Data Hand Book** – K. Lingaiah, McGraw Hill, 2nd Ed.2003.
2. **Design Data Hand Book -** K. Mahadevan and K.Balaveera Reddy CBS Publication
3. **Machine Design Data Hand Book -** H.G. Patil, ShriShashiPrakashan, Belgaum.

TEXT BOOKS:

1. **Mechanical Engineering Design -** Joseph E Shigley and Charles R.Mischke. McGraw Hill International edition.
2. **Introduction engineering system design method –** V. Gupta and P. Murthy
3. **Automotive Mechanics** – N. K. Giri
4. **Machine Design –** Trika

Course Outcomes**

1. Analyze the concept of engineering system design and formulate design aspects of curved beams
2. Recommend a suitable spring for various applications
3. Analyze the gear mechanisms and its applications to automobiles.
4. Evaluate the design criterion for clutches and brakes its applications
5. Formulate the materials to design and analyze the various types of bearings
6. Design and develop the belts, ropes and chains.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	1		1				1	1	1	1	2	2
CO2	3	2	3	2		1				1	1	1	1	2	2
CO3	3	2	3	2		1				1	1	1	1	2	2
CO4	3	2	3	2		1				1	1	1	2	2	2
CO5	3	2	3	2		1				1	1	1	1	2	2
CO6	3	2	3	2		1				1	1	1	2	2	2

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UAU541C	HEAT TRANSFER	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTORY CONCEPTS AND DEFINITIONS: Modes of heat transfer; basic laws governing conduction, convection, and radiation heat transfer; thermal conductivity; convective heat transfer coefficient; radiation heat transfer coefficient; combined heat transfer mechanism.

CONDUCTION: Basic equations, general form of one dimensional heat conduction equation in rectangular, cylindrical and spherical coordinates. Boundary conditions of first, second and third kinds; illustrative problems on mathematical formulation of conduction problems.

ONE-DIMENSIONAL STEADY STATE CONDUCTION : Steady state conduction in a slab, in a cylinder and in a sphere without heat generation; overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation.

UNIT–II	10 Hrs.

FINS: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency; conduction in solids with variable thermal conductivity.

ONE-DIMENSIONAL TRANSIENT CONDUCTION: Conduction in solids with negligible internal temperature gradients (lumped system analysis); use of transient temperature charts (Heisler 's charts) for transient conduction in slab, long cylinder and sphere.

UNIT–III	10 Hrs.

CONCEPTS AND BASIC RELATIONS IN BOUNDARY LAYERS: Flow over a body - velocity boundary layer; laminar and turbulent layers, critical Reynolds number; general expressions for drag coefficient and drag force, thermal boundary layer.

FORCED AND FREE CONVECTION: Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydrodynamically and thermally developed flows; use of correlations for flow over a flat plate, over a cylinder and numericals. Application of dimensional analysis for free convection-physical significance of Grashoff number.

UNIT–IV	10 Hrs.

HEAT EXCHANGERS: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD and NTU methods of analysis of heat exchangers.

RADIATION HEAT TRANSFER: Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan - Boltzman law, Kirchoff's law, Planck's Law and Wein's displacement law, Lambert's Law; radiation heat exchange between two parallel infinite black surfaces.

Reference Books *

TEXTBOOKS:

I) **Heat Transfer** by P.K. Nag Tata Mc Graw Hill 2002

2) **Heat Transfer-** A Basic approach by M Necats Osisik Mc Graw Hill International ed 1988

REFERENCE BOOKS:

1) **Heat transfer** a practical approaches by Yunus A Cengel Tata Mc Graw Hill 2002.

2) **Principles of Heat Transfer** by Kreith Thomas learning 200 1.

3)**Fundamentals of Heat and Mass Transfer** by Frank. P. Incropera and David. P. Dewitt John Wiley and Sons 4th ed 1995.

4) **Heat Transfer**: Sucec Jaieo Book house 2002.

5) **Heat transfer:** Jojo Jaico Book house 2003

Course Outcomes**
1. Categorize the modes of heat transfer, boundary conditions, laws governing heat conduction and analyze conduction phenomenon.
2. Illustrate the solution to conductive heat transfer problems.
3. Analyze unsteady state heat conduction phenomenon and apply to solve numerical problems
4. Formulate the convective heat transfer phenomenon and its applications
5. Evaluate the utility of heat exchangers and its analysis to solve numerical problems
6. Describe radiation heat exchange phenomenon and its analysis

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1									2	1	2	2
CO2	3	2	2									2	1	2	2
CO3	3	2	2									2	1	2	2
CO4	3	2	2									2	2	2	2
CO5	3	2	2									2	1	2	2
CO6	3	2	2									2	2	2	2

UAU571E	AUTOMOTIVE EMISSIONS AND CONTROL (ELECTIVE)	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION: Historical background, Euro norms, air quality standards. Effect of air pollution: effect on humans, animals and plants. Smog formation and its effects. **GENESIS AND FORMATION OF POLLUTANTS**: Vehicle emissions; sources- evaporative, blow-by and exhaust pipe. Unburnt hydrocarbons, carbon monoxide, oxides of nitrogen, particulate emission of both SI and CI engines. Diesel smoke; types and reasons of smoke, mechanism of smoke formation. Thermodynamics state of burned gases, flame quenching combustion chamber deposits, soot and particulate formation, characteristics and composition of particulates. Effect of engine design and operating variables. Emission test procedures and standards: test cycles for light and medium duty vehicles, USEPA emission test cycles, European emission test procedure, types of emission driving cycle, motor cycle emission standards.	
UNIT–II	**10 Hrs.**
INFLUENCE OF GASOLINE AND DIESEL PROPERTIES ON EMISSION: Properties like density, olefin and aromatic content, volatility, octane number, additives, viscosity, distillation interval, cetane number, sulphur content on emissions. Emission control methods: Evaporative emission control; charcoal canister. Positive Crankcase Ventilation (PCV). **EXHAUST EMISSION CONTROL**: Design modifications: lean burn strategies, compression ratio, cylinder size and combustion chamber shape, variable valve timing and lift, variable swept volume, downsizing and pressure charging, faster warm-up, heated air systems. Exhaust Gas Recirculation(EGR); control and related systems.	
UNIT–III	**10 Hrs.**
ADD-ON SYSTEMS FOR TREATMENT OF EMISSION WITHIN ENGINE: Air injection, thermal reactor, catalytic converter. Catalytic converter: catalysts, substrate, converter housing, oxidation and reduction catalyst, two and three way converter. Catalyst technology for control of cold start, catalyst and poisoning. Gasoline direct injection stratified charge engines; air motion and mixture formation in the cylinder, fuel injection and air fuel ratio control, emissions of gasoline direct injection engines. OBD systems.	
UNIT–IV	**10 Hrs.**
INSTRUMENTATION FOR POLLUTION MEASUREMENT: NDIR analyzers, gas chromatograph, Orsat apparatus, flame ionization detectors, chemilumiscence, smoke measurement; principle, Hartridge and Bosch smoke meter. **CI ENGINE EMISSION CONTROL TECHNOLOGY**: Fuel injection variables, high injection pressures, high pressure distributor pumps, electronic unit injectors, common rail fuel injection systems, EGR, turbo charging, catalytic treatment, Diesel Particulate Filters (DPF); material, substrates, diesel exhaust after treatment with metal substrates.	
Reference Books *	
TEXTBOOKS: 1. Theory of IC engines: Mathur and Sharma. 2. Automotive Mechanics: William H Crouse. 3. Engine Emissions: P.B.Pundir	
Course Outcomes**	
1. Assess the effect and conduct risk analysis of air pollution.	

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2. Analyze, interpret and compare the sources and formation of various emissions in gasoline engines.
3. Discuss and differentiate the influence of fuel properties on emissions.
4. Carry out the emission control measures for SI engines.
5. Evaluate the formation and controlling of emissions in CI engines.
6. Analyze and interpret the instrumentation utilized in measurement of emissions.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	2		2	3	1		2		1			
CO2	3	2	1	2		2	3	1		2		1			
CO3	3	2	1	2		2	3	1		2		1			
CO4	3	2	1	2		2	3	1		2		1			
Co5	3	2	1	2		2	2	1		2		1			
Co6	3	2	1	1	2	2	1	1		2		1			

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UAU572E	PRODUCT DESIGN AND DEVELOPMENT	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Characteristics of successful product development, design and development of products, duration and cost of product development, the challenges of product development.
DEVELOPMENT PROCESSES AND ORGANIZATIONS: Generic development process, concept development: the front-end process, adopting the generic product development process, AMF development process, product development organizations, the AMF organization.
PRODUCT PLANNING: Product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

UNIT–II	10 Hrs.

IDENTIFYING CUSTOMER NEEDS: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.
PRODUCT SPECIFICATIONS: What are specifications, when are specifications established, establishing target specifications, setting the final specifications**.**
CONCEPT GENERATION: Activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.

UNIT–III	10 Hrs.

CONCEPT SELECTION: Overview of methodology, concept screening, and concept scoring.
CONCEPT TESTING: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect the results and the process.
PRODUCT ARCHITECTURE: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.
INDUSTRIAL DESIGN: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.

UNIT–IV	10 Hrs.

DESIGN FOR MANUFACTURING: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors**.**
PROTOTYPING: Prototyping basics, principles of prototyping, technologies, planning for prototypes.
PRODUCT DEVELOPMENT ECONOMICS: Elements of economic analysis, base case financial mode. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.
MANAGING PROJECTS: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Reference Books *

TEXT BOOK:
1.Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.

REFERENCE BOOKS:
1. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3 rd Edition, 2003.
2. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997
3. Product Design for Manufacture and Assembly - Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002

Course Outcomes**
1. Understand the necessity of new product development and problems encountered in Developing new products.
2. Know the role of aesthetic in products.
3. Able to use different types of models designed by industrial engineer.
4. Able to select the different materials based on the functions of the product.
5. The ergonomic factors influencing the success of the product.
6. Know how to add value to the products.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	1	1	1	1	2	1	1	2	1			
CO2	3	2	3	1	1	1	1	1		1	2	1			
CO3	3	2	2	1	1	1	1	2		1	2	1			
CO4	3	2	2	1	1	1	1	1		1	2	1			
CO5	3	2	3	1	1	1	1	1	1	1	2	1			
CO6	3	2	3	1	1	1	1	1	1	1	2	1			

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UAU575E	COMPUTER GRAPHICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
SCAN CONVERSION AND CLIPPING REPRESENTATION: Scan conversion and clipping representation of points, lines, line drawing algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, mid point line and circle, polygon filling algorithms: scan conversion, seed filling, scan line algorithm. Viewing transformation, clipping points, lines, text, polygon, Cohen-Sutherland line clipping, Sutherland - Hodgmen algorithm.	
UNIT–II	**10 Hrs.**
TWO DIMENSIONAL TRANSFORMATIONS: Representation of points, transformations: rotation, reflection, scaling, combined transformations, translations and homogeneous coordinates, geometric interpretation of homogeneous coordinates, over all scaling, points at infinity, rotation about an arbitrary point, reflection through an arbitrary line.	
UNIT–III	**10 Hrs.**
THREE DIMENSIONAL TRANSFORMATIONS: Three dimensional transformations and projections 3D transformation matrix: general matrix, translation, scaling, shearing, rotation, reflection, multiple transformations, rotation about an axis parallel to coordinate axis, rotation about an arbitrary axis in space, reflection through an arbitrary plane, orthographic, parallel projection transformations, one, perspective projections - one point, two point and three point.	
UNIT–IV	**10 Hrs.**
PLANE AND SPACE CURVES CURVE: Plane and space curves curve representation, non-parametric curves, parametric curves, parametric representation and generation of line, circle, ellipse, parabola, hyperbola, generation of circle, ellipse, parabola, hyperbola, cubic spline, normalized cubic splines, Bezier curves: blending function, properties, generation, B-spline curves- Cox-de Boor recursive formula, properties, open uniform basis functions, non-uniform basis functions, periodic B-spline curve.	

Reference Books *

TEXT BOOKS:

1. Ibraham Zeid, "CAD/CAM-Theory and Practice" McGraw Hill, 2006

2. Rogoer's Adams, "Mathematical Elements for Computer Graphics", McGraw Hill. 1990 **Reference**

Reference Books:

1. Xiang Z, Plastock, R. A, Computer Graphics, Schaums outlines, McGraw Hill. 2007.

2. Foley, Van- Damn, Finner and Hughes, "Computer Graphics", principles and practice, Addison Wesley. 2000

3. Sinha AN., Udai A D., Computer Graphics, Tata McGraw Hill, 2008.

Course Outcomes**

1. To understand the fundamental concepts of graphics with suitable commands
2. To apply comprehensive transformation techniques of computer graphics
3. To know and draw the creation of two and three dimensional transformations
4. To know and analyze plane and space curves

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	2	2					1		1	1	2	1
CO2	3	3	2	2	2					1		1	1	2	1
CO3	3	3	2	2	2					1		1	1	2	1
CO4	3	2	3	2	2					1		1	1	2	1

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UAU576E	VEHICLE TRANSPORT MANAGEMENT	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION: Historical background, the growth of a network, trams, trolley buses, buses, private cars, subsidies. Motor vehicle act 1988. Maintenance - preventive, breakdown, overhauling - major, minor, repair schedules and workshop, facilities, documentation, analysis and corrective maintenance schedules. **ORGANIZATION AND MANAGEMENT:** Forms of ownership, municipal undertaking, company undertaking, traffic, secretarial and engineering deportments, management, principle of transport, - internal organization-centralized control, de-centralized control, staff administration: industrial relation, administration, recruitment and training, drivers and conductors duties, training of drivers and conductors, factors affecting punctuality, welfare, health and safety.	
UNIT–II	**10 Hrs.**
ROUTE PLANNING: Source of traffic, town planning, turning points, stopping places, shelters, survey of route, preliminary schedule test runs, elimination of hazards, factors affecting frequency, direction of traffic flow, community of interest, estimating, traffic volume, probable weekday travelers, passengers during various periods of the day, estimated number of passengers, estimated traffic, possibility of single verses double deck and frequency. **TIMING, BUS WORKING AND SCHEDULES**: Time table layout, uses of flat graph method of presentation, preparation of vehicle and crew schedule preparation of the duty roster, co-operation with employers, use of the vehicle running numbering determination of vehicle efficiency checking efficiency of crew, duty arrangements.	
UNIT–III	**10 Hrs.**
COLLECTIONS: Need, principles of collection, tickets, the way bill, stage by stage, bell punch system, bell graphic system, reduced ticket stocks will brew system, mechanical ticket machines, T.I.M and straight machines, Vero meter, one-man operation, two stream boarding, pre paid tickets, lenson parason coach tickets exchanges, the fare box, electronic ticket machines, box system personal and common stock flat fare platform control. **FARE STRUCTURE**: Basis of fares, historical background, effects of competition and control, calculating average zone system, concession fares, straight and tapered scale elastic and inelastic demand co-ordination of fares concessions fares changes for workman, standard layout of fare table, anomalies double booking inter availability through booking and summation, private hire charges.	
UNIT–IV	**10 Hrs.**
OPERATING COST AND TYPES OF VEHICLES: Classification of costs, average speed, running costs, supplementary costs, depreciation obsolescence, life of vehicles, sinking fund, factor affecting cost per vehicles mile incidence of wages and overheads, 100 seats miles basis, average seating capacity, vehicles size and spread overs, types of vehicle economic considerations authorization of trolley, bus services, statuary procedure taxes and hire car. **PUBLIC RELATIONS DIVISIONS:** Dissemination of information, maintaining goodwill handling complaints, traffic advisory committees, local contractors co-operation with the press news and articles - facilities for visitors- forms of publicity - importance of quality - inter departmental liaison advertisements, sings, notice and directions general appearance of premises, specialized publicity. prevention of accidents: Emphasis of safe driving, annual awards, bonus encouragement, vehicle design, platform layout, location of stops, scheduled speed, route hazards, records, elimination of accident prone drivers.	
Reference Books *	
TEXT BOOKS: 1. Bus operation - L.D.Kitchen, Iliffe & Sons , London	

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2. Bus & coach operation - Rex W. Faulks, Butterworth Version Of 1987, London

REFERENCE BOOKS:

1. Compendium of transport terms - Cirt,Pune
2. M.V. Act 1988 - Central Law Agency, Allahabad
3. The elements of transportation - R.J. Eaton
4. Goods vehicle operation - C.S. Dubbar

Course Outcomes**

1. Analyze public transport in India and different forms of ownership.
2. Define and analyze the vehicle maintenance and its types and selection and roles of crew.
3. Define route planning process and application bus scheduling methods of bus scheduling and implementation.
4. Analyze fare structure and collection systems, their principles and compare various fare collection systems.
5. Define different operating cost and analyze for optimized transport and functions of PRO in public transport.
6. Analyze the prevention of accidents and future of road transport.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1		1					1	1	1		2	2	2	2
CO2	1	1						1	1	1		2	2	3	2
CO3	1	2						1	1	1		2	2	2	3
CO4	1	1	1					1	1	1		2	2	2	3
CO5	1	1	1					1	1	1		2	2	2	
CO6	1	1	1					1	1	1		2	2	2	3

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UAU527L	AUTOMOBIE ENGINE SERVICING LAB	Credits: 01
L:T:P - N_L :0 N_T:0 N_P 3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

1. Study of hand tools- sketching, materials used and their applications
2. Technical specifications of all types of automobile engines
3. Trouble shooting charts of all engine components
4. Note the specifications of given engines and component standard dimensions. Dismantle, inspect, clean and assemble of engine components of SI and CI engines(two and four stroke) of any commercial vehicles. Note procedure of dismantling and assembly; identify the major components, noting their functions and materials used. Measurement & comparison of major components dimension with standard specifications. Inspection for wear and tear, crack and brake down, identify the service requirements of engines such as decarbonoizing, degreasing, spark plug cleaning and adjusting, fuel injector cleaning etc.
5. Compression and vacuum test on diesel and petrol and diesel engines.
6. Study(Dismantling and assembly): Carburetors, fuel injection pumps, fuel filters, fuel pumps, turbochargers, cooling systems and components, lubrication system and components. Identify the location of above components in a vehicle and note their functions

Laboratory Assessment:

1.Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)

2.Allocation of 50 marks for CIE

- Performance and journal write-up :
  Marks for each experiment = 30 marks/No. of proposed experiments.
- One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

3. Allocation of 50 marks for SEE

Course Outcomes**

1. Analyze the engine trouble shooting aspects and specifications of various vehicles
2. Able to demonstrate the dismantling and assembly of multi-cylinder of different engines with respective auxiliary systems.
3. Able to demonstrate the dismantling and assembly of two wheeler engines.
4. Conduct the testing of vacuum and compression test in engines and draw the inference.
5. Dismantle, assemble and analyze working and fault diagnosis of fuel system elements like carburetor and fuel injection pump.

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1							1	1	1	2	1	2	1
CO2	3	1							1	1	1	2	1	2	1
CO3	3	1							1	1	1	2	1	2	1
CO4	3	1		1	1				1	1	1	2	1	2	1
CO5	3	1							1	1	1	2	1	2	1

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UAU538L	AUTOMOTIVE SCANNING LABORATORY	Credits: 1.5
L:T:P - N_L :0 N_T: 0 N_P 3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

1. Maintenance/service charts for different parts of chassis, suspension and transmission.
2. Study of head light beam testing for two and four wheeler.
3. Braking distance test for four wheeler.
4. Study of tyre retreading, tubeless tyre puncture repairs, painting of vehicles.
5. Sketch the layout of a service station and bus depot mentioning the various equipments required including the space needed.
6. Study and practice on computerized wheel balancing machine, computerized wheel alignment machine, computerized engine analyzer.
7. Study of two wheeler performance on two wheeler chassis dynamometer.

1. 8.Study of electrical components like battery, alternator, regulator on electrical test bench

8. Study and demo of wind tunnel testing I) testing for pressure distribution ii) testing for lift ,yaw ,drag

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   - Performance and journal write-up :
     Marks for each experiment = 30 marks/No. of proposed experiments.
   - One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).
3. Allocation of 50 marks for SEE

Course Outcomes**

1. To study the head light beam testing for two and four wheeler and braking distance
2. To know the process of tyre retreading, painting of vehicles and able to draw the layout of a service station and bus depot
3. To study and practice on computerized wheel balancing machine, computerized wheel alignment machine, computerized engine analyzer.
4. Study and demo of wind tunnel testing and know the various aspects

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1		1	1	1			1	1	1	1	1	2	1
CO2	2	1		1	1	2			1	1	1	1	1	2	2
CO3	2	1		1	1	2			1	1	1	1	1	2	1
CO4	2	1		1	1	1	1		1	1	1	1	2	2	1

UAU621C	AUTOMOTIVE ENGINE COMPONENT DESIGN	Credits: 04
L:T:P - N_L :4 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	13 Hrs.

ENGINE SELECTION CRITERIA: Road, wind and gradient resistance, starting torque, load-speed characteristics, expectancy curves and performance curves.
CARBURETION: Air-fuel ratio, throat diameter, air and fuel flow rate, change in air-fuel ratio at altitude, velocity of air at venture throat, pressure drop, mass flow of fuel.
INJECTION: Injection in CI engines; volume of fuel injected, velocity and duration of injection, orifice area of injector, pressure difference.
DESIGN OF CYLINDER BLOCK, CRANK CASE AND CYLINDER HEADS: Cylinder heads, gaskets, cylinder wear, water jacket, cylinder liners, crank case, oil sumps and cooling features.
Engine mountings, front and rear mountings, type of engine blocks, manifolds; types, inlet and exhaust manifolds, dual manifolds, design of manifolds, mufflers; types, design.

UNIT–II	13 Hrs.

DESIGN OF CYLINDER BLOCK, CRANK CASE AND CYLINDER HEADS: Cylinder heads, gaskets, cylinder wear, water jacket, cylinder liners, valve seats. Crank case **-** general form of crank case, oil sumps and cooling features, flywheel mountings, engine mountings, front and rear mountings. Production of engine blocks, manifolds and mufflers **-** inlet and exhaust manifolds, mixture distribution, heating by exhaust gas, dual manifolds, general design of manifolds, effect of firing order, mufflers, general design.
DESIGN OF PISTON, PISTON RINGS, PISTON PIN: Piston temperatures, piston slap, compensation of thermal expansion in pistons. Piston rings, forms of gap, stresses in piston rings, ring collapse, heat treatment, piston ring selection, shape. Piston pin, locking of piston pins, length of piston.

UNIT–III	13 Hrs.

DESIGN OF CONNECTING ROD: Length of rod, cross section, buckling, drilled connecting rods, piston pin bearing, offset connecting rods, effects of whipping, bearing materials, lubrication.
DESIGN OF CRANK SHAFT: Balance weights, local balance, crankshaft proportions, oil holes drilled in crank shafts, balancing and torsional vibration analysis, vibration dampers, firing order, bearings, lubrication.

UNIT–IV	13 Hrs.

DESIGN OF FLYWHEEL: Necessity, capacity, mounting of flywheels, coefficient of fluctuation of speed, fluctuation of energy, maximum fluctuation of energy, energy stored in a flywheel, stresses, construction.
DESIGN OF VALVE AND VALVE MECHANISM: Angle of seat, operating conditions, operating temperatures, valve cooling, sodium cooled valves, valve rotators, valve seats, valve guides, valve springs, valve clearance, valve timing, OHV, OHC, dual valves, types of valve operating mechanisms. Valve train component details, camshaft, drives of cams, cam types, tappets, automatic zero clearance tappets, push rods, rocker arms and rocker shaft.

Reference Books *

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Text Books:

1. High Speed Engines - P.M.Heldt, Oxford & IBH, 1965
2. Auto Design – R.B Gupta, Satya Prakashan, New Delhi 2002
3. Automotive mechanics- N.K. Giri

Reference Books:

1. A course in I.C. Engine - Mathur & Sharma, Dhanput Rai & Sons, Delhi, 1994
2. Internal Combustion Engines-V Ganesan, Tata McGraw Hill,Delhi, 2002
3. Automobile Engineering Vol. II - Kirpal Singh, Standard publications, New Delhi, 2004

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4. Modern Petrol Engine - A.W.Judge, B.I. Publications. 1983
Course Outcomes**
1. Correlate, analyze, and solve the vehicle design related problems.
2. Formulate, analyze and estimate the expectancy curves and compare with performance curves.
3. Analyze and solve the design problems of cylinder head, block and valves with live time approach.
4. Analyze and solve the design problems of piston assembly, connecting rod, crank shaft and flywheel with live time approach.
5. Design engine and their components used in automobiles, aeronautical, locomotive and marine engines.
6. Correlate, analyze, and solve the vehicle design related problems.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	1	1	1			2	1	1	1	2	3	2
CO2	3	3	3	1	1	1			1	1	1	1	2	2	2
CO3	3	3	3	1	1	1			2	1	1	1	2	3	2
CO4	3	3	3	1	1	1			1	1	1	1	2	3	2
CO5	3	3	3	1	1	1			2	1	1	1	2	2	2
CO6	3	3	3	1	1	1			2	1	1	1	2	2	2

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UAU622H	ENGINEERING ECONOMICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Definition of various economic terms such as economic goods, utility, value, price, wealth, wants capital, rent and profit, laws of returns.
DEMAND AND SUPPLY: Law of diminishing utility and total utility. Demand schedule. Law of demand. Elasticity of demand, law of substitution, law of supply, supply schedule, elasticity of supply.
WAGES: Nominal and real wages, factors affecting real wages, theory of wages, difference in wages, methods of wage payment.

UNIT–II	10 Hrs.

MONEY AND EXCHANGE: Theory of exchange, barter, stock exchange, speculation money qualities of a good money, function of a money, classification of money, value of money, index number, appreciation and depreciation of money value, Gresham's law and its limitations.
TAXATION AND INSURANCE: Principle of taxation, characteristics of a good taxation system, kinds of taxes, and their merits and demerits, vehicle insurance, loss assessment.
INTEREST AND DEPRECIATION: Introduction, theory of interest, interest rate, interest from lender's and borrower's view point, simple and compound interest. Nominal and effective interest rates, interest formulae. Annual compounding, annual payments and continuous compounding annual payment, simple numerical problems. Need for depreciation causes of depreciation life and salvage value methods of depreciation, simple numerical problems.

UNIT–III	10 Hrs.

COSTS: Standard costs estimated cost, first cost, fixed cost, variable costs, incremental cost, differential cost, sunk and marginal cost, breakeven and minimum cost analysis, simple numerical problems.
COST ACCOUNTING: Introduction, objectives of cost accounting, elements of cost material cost, labour cost, and expenses, allocation of overheads by different methods, simple numerical problems.

UNIT–IV	10 Hrs.

BASIS FOR COMPARISON OF ALTERNATIVES: Present worth methods, capital recovery methods, and rate of return method, simple numerical problems.
BOOK KEEPING AND ACCOUNTS: Introduction, necessity for book keeping, single entry and double entry, ledger, trial balance, final accounts, trading accounts, profit and loss accounts, balance sheet, simple problems.

Reference Books *

TEXT BOOKS:

1. Engineering Economy - TARACHAND, 2000
2. Engineering Economy - RIGGS J.L., McGraw Hill, 2002
3. Engineering Economy - THUWSEN H.G., PHI, 2002

REFERENCE BOOKS:

1. Industrial Engineering and Management - O.P KHANNA, Dhanpat Rai & Sons.
2. Financial Management -I.M PANDAY, Vikas Publishing House
3. Engineering Economy - Paul Deoarmo, Macmillan Pub, Co., 2001
4. Mechanical Estimation and Costing - D. Kannappan.

Course Outcomes**
1. Define various economic terms and analyze the basic concepts of price, product and market and correlate them.
2. Know how of banking, stock exchange, insurance, wages, their role in economics of business.
3. Classify taxes and depreciation and monetary system their role in economics and methods to evaluate them.
4. Define various costs, cost accounting procedure and its implementation in business enterprises for assessment.
5. Concept of interest its significance, analysis of cash flow methods and apply them to evaluate investment options.
6. Define book keeping approaches, their role and implementation in assessments.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	1	1	2		1		2	2	2	1	1	2
CO2	2	2	1	1	1	2		1		2	2	2	1	1	2
CO3	2	2	1	1	1	2		1		1	2	2	1	1	2
CO4	2	2	1	1	1	2		1		1	2	2	1	2	2
CO5	2	2	1	1	1	2		1		1	2	2	1	2	2
CO6	2	2	1	1	1	2		1		2	2	2	1	2	2

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UAU623C	AUTOMOTIVE ELECTRICAL SYSTEMS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
STORAGE BATTERY: Introduction, principle of lead acid cells, construction and elements, electrolyte and their preparation, specific gravity, capacity and efficiency, battery tests, battery ratings, chemical action in cell, direction of current flow, recharging batteries, temperature effect on battery characteristics, methods of charging. Working principles of Alkaline, Nickel - Cadmium, silver - zinc battery, Lithium batteries. Battery trouble shooting. Networks and multiplexing. Other electric and electronic devices. Vehicle security systems: seat belts, air bags. **INDICATING AND WARNING DEVICES AND DASH BOARD INSTRUMENTS**: Fuel gauge, oil-pressure gauge; balancing coil, thermostatic, electronic and digital gauges, water temperature gauge, speedometers; mechanical, electrical, digital. Warning lights; oil pressure, water temperature, horn, windscreen-wipers, signaling devices. Trouble shooting.	
UNIT–II	**10 Hrs.**
GENERATOR / ALTERNATOR: Principle of generation of direct current, generator constructional details; commentators, principle of commutation, armature, field magnets, windings, brushes, wiring circuit of generators, types of generators, generator drives, cutout relay, ammeter. Construction of alternator, rectification, voltage regulation, testing of alternator. Alternator terminals, cooling, instrument panel. Charge indicators, charging system test, charging system service and fault diagnosis. **STARTER MOTOR AND DRIVES**: Introduction**,** starting motor principle, torque and power requirements, starting motors and its characteristics. Starting motor drives. Starting system tests. Servicing starting motors. Starting motor trouble shooting.	
UNIT–III	**10 Hrs.**
IGNITION SYSTEM: Ignition fundamentals, types of ignition systems and related components. Spark plugs; general considerations, characteristics, materials. Ignition timing; advance mechanism; centrifugal and vacuum. Ignition system tests, oscilloscope pattern. Setting ignition timing; types. **ELECTRONIC IGNITION**: Pickup coil voltage pulse, high energy ignition system, electronic spark advance, optical photo diode distributor, distributors less ignition system, multiple coil ignitions, direct capacitor charge ignition. Distributor less ignition system, C.D.I, systems. Artificial intelligence. Ignition system trouble shooting and trouble codes.	
UNIT–IV	**10 Hrs.**
LIGHTING AND ELECTRICAL ACCESSORIES: Introduction, principle of automobile illumination, lightings, control of head light beam, head light dazzle, fog lamps, side and taillight, brake warning light, instrument and indicator lights, ignition warning light, direction indicators, parking light, fluorescent lighting. Automatic head lamp controls, fiber optic lighting, computer control lighting, distributed lighting, head lamp aiming. Lighting system trouble shooting and recent developments; L.E.D. **VENTILATION, HEATING AND AIR CONDITIONING:** Passenger compartment heater, heater controls, heated air distribution, basic refrigeration cycle: refrigerant flow control valves, refrigerants, refrigerant oil. Types of air conditioner: manually controlled, automatically controlled and electronic automatic temperature control.	
Reference Books *	

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TEXT BOOKS: 1. Automobile Engineering: Kirpal Singh

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2. Automobile Mechanics : William H Crouse 3. Automotive Electrical equipments: P.L.Kohli
Course Outcomes**
1. Elucidate the construction, working and elements of different batteries, electrical accessories and dash board instruments.
2. To know and analyze the construction and working of starting motors with different types of drives and its trouble shooting.
3. Expound the theory of the working of various ignition systems and their components, its trouble shooting with update of latest systems.
4. Able to illustrate the construction and working of charging system and its fault diagnosing methods and remedial techniques.
5. Analyze the principle of automobile illumination and different types lighting systems and allied electrical systems.
6. Able to construe the utility, scope and significance of automobile ventilating, safety and air condition systems.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	1	2	1				1	1	1	1	2	2
CO2	3	2	1	1	2	1				1	1	1	1	2	2
CO3	3	2	2	2	2	1				1	1	1	2	2	2
CO4	3	2	1	1	2	1				1	1	1	1	2	2
CO5	3	2	1	2	2	1				1	1	1	1	2	2
CO6	3	2	1	1	2	1				1	1	1	2	2	2

UAU651E	CAD/CAM	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment. Introduction to CAD, Introduction to CAM. Advantages and disadvantages of CAD and CAM.

HARDWARE FOR CAD: Basic hardware structure, working principles, usage and types of hardware for CAD **-** Input devices, output devices, memory, CPU, hardcopy and storage devices.

UNIT–II	10 Hrs.

COMPUTER GRAPHICS: Software configuration of a graphic system, function of graphics package, construction of geometry, wire frame and solid modeling, geometry transformation - two dimensional and three dimensional transformation, translation, scaling, reflection, rotation, CAD/CAM integration. Desirable modeling facilities. Introduction to exchange of modeling data - basic features of IGES, STEP, DXF, DMIS

INTRODUCTION TO ROBOTICS: Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, robot sensor, robot applications.

UNIT–III	10 Hrs.

NC, CNC, DNC TECHNOLOGIES: NC, CNC, DNC, modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC.

CNC TOOLING: Turning tool geometry, milling tooling system, tool presetting, ATC, work holding.

CAM PROGRAMMING: Overview of different CNC machining centers, CNC turning centers, high speed machine tools.

UNIT–IV	10 Hrs.

CNC PROGRAMMING: Part program fundamentals, steps involved in development of a part program. Manual part programming, milling, turning, turning center programming.

INTRODUCTION TO FINITE ELEMENT ANALYSIS: Introduction, basic concepts, discretization, element types, nodes and degrees of freedom mesh generation, constraints, loads, preprocessing, application to static analysis.

Reference Books *

TEXT BOOKS:

1. CAD/CAM Principles and Application **-** by P.N. Rao, Tata McGraw Hill.
2. CAD/CAM **-** by Groover, Tata McGraw Hill.

REFERENCE BOOKS:

1. Introduction to the Design and Analysis of Algorithms – S.E. Goodman, S.T. Headetmiemi, McGraw Hill Book Company – 1988.
2. Principles of Interactive Computer Graphics **-** by Newman and Sproull, Tata McGraw Hill, 1995.
3. NC Machine Programming and Software Design – Chno- Hwachang, Michel. A. Melkanoff, Prentice Hall, 1989.
4. Numetical Control and CAM - Pressman RS and Williams JE, Johnwiley.
5. Computer Graphics by Steven Harrington, McGraw Hill Book Co.
6. CAD-CAM **-** by Chris McMahon & Jimmie Browne – Pearson education Asia 2001.
7. CAD/CAM – Ibrahim Zeid, Tat McGraw Hill, 1999.
8. Computer Aided Manufacturing **-** by P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999.
9. Introduction to FEM - T Chandra patta Ashok D Bebgundu.

Course Outcomes**

1. List role of computers in design and manufacturing area and realize their significance.

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2. Define various devices used in CAD/CAM, their role in CAD/CAM activities.
3. Classify cad model and know-how of developing models using different approaches.
4. Develop programs to generate the drawings on computers and manufacture products on NC machines.
5. Classify the different types of robots and manufacturing systems, their features and application.
6. Define the stages in Finite Element Analysis and their need and significance.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	1	2	1				1	2	1	2	1	1
CO2	3	2	3	1	2	1				1	2	1	2	1	1
CO3	3	2	3	1	2	1				1	2	1	2	1	1
CO4	3	2	3	1	2	1				1	2	1	3	2	1
CO5	3	2	3	1	2	1				1	2	1	2	2	1
CO6	3	2	3	1	2	1				1	2	1	2	1	1

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UAU653E	AUTOMOTIVE AIR CONDITIONING	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
AIR CONDITIONING FUNDAMENTALS: History of automotive air conditioning systems. Introduction to heating and ventilation. Basic theory of cooling, vapour compression refrigeration, alternative cycles, expansion valve system, fixed office valve system, dual air-conditioning. Refrigeration and cooling; refrigeration, evaporation, condensation, heat transfer, refrigeration cycle, refrigerant and flow control valves.	
UNIT–II	**10 Hrs.**
AIR CONDITIONING COMPONENTS: Compressor, compressor clutch, types of air conditioning compressors, cycling and non cycling compressor, electrically driven compressor, condenser, receiver-drier/accumulator, expansion valve, fixed orifice valve, evaporator, anti-frosting devices, basic control switches.	
UNIT–III	**10 Hrs.**
AIR CONDITIONING CONTROLS: Electrical and electronic control, electrical principles, sensors and actuators, testing of sensors and actuators, oscilloscope waveform sampling, multiplex wiring systems, OBD and EOBD, ready wiring diagrams, automotive A/C manual control systems - case studies. Diagnostics and troubleshooting: initial vehicle inspection, temperature measurement, pressure gauge, cycle testing, A/C system leak testing.	
UNIT–IV	**10 Hrs.**
SERVICE AND REPAIR: Precaution, refrigerant, recovery, recycle and charging, system oil, system flushing, odour removal, retrofitting, replacement and adjustment of components, fixed orifice valve replace. **ENVIRONMENT AND LEGISLATION**: Global warming, ozone layer, legislation. Ventilating the passenger compartment, heater controls, heated air distribution, heated wind shield. Solar powered ventilation, electronic automatic temperature control.	
Reference Books *	
TEXTBOOKS: 1. Automotive air conditioning and climate control: **Steven Daley** (Butterworth Heinmann, Elsevier) 2. Automotive mechanics – **William Crouse**.	
Course Outcomes**	
1. To understand the basic concepts of refrigeration and air - conditioning.	
2. Know-how on components vehicle air- conditioning system.	
3. To study the control systems in air - conditioning and trouble shooting.	
4. To study refrigerants, their environmental impact and legislation.	

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	1	1	1	1			1		1			
CO2	2	1	1	1	1	1	1			1		1			
CO3	2	1	1	1	1	1	1			1		1			
CO4	2	1	1	1	1	1	1			1		1			

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UAU654E	ADVANCED AUTOMOTIVE MATERIALS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION TO ADVANCED MATERIALS: Composites and hybrids Sandwich materials, Metal matrix composites: automotive applications. Ceramic and glasses; automotive glazing, sustainable materials. Advanced composites.	
UNIT–II	**10 Hrs.**
POLYMERS: Processing of polymers, components for noise and vibration isolation and control on automotive industry. Recycling of polymers and biopolymers and steel processing: formability of steel sheets and tailor welded blanks for automotive application. Thermoplastics, thermosets.	
UNIT–III	**10 Hrs.**
CARBON FIBERS: Carbon-fibers-reinforced silicon carbide. Magnesium: Properties and automotive application for magnesium. New brake disc material - Elements of ceramic brake disc, material behaviour, material properties, advantages. Titanium and Nickel: Properties and their automotive applications	
UNIT–IV	**10 Hrs.**
BODY MATERIALS: Future trends in body materials; objectives and contents. Mechanical and physical properties of materials. Material selection for automotive body components. Trimming of plastics. Insulating materials and sealing compounds. Factors influencing material change in future, emission control and fuel systems.	

Reference Books *

BOOKS: 1. Encyclopedia of automobile engineering (vol. 6)

1. Materials for automotive bodies – Geoff Davis (B/H)
2. Encyclopedia of automobile engineering (vol. 4)
3. Automotive Hand book(9th Edition) – Bosch(Wiley)

Course Outcomes**

1. To understand the basic knowledge and use of advanced materials and composites in automotive engineering.
2. Know-how on polymers and its application in automotives.
3. To study the use and significance of carbon polymers.
4. To understand the future trends in body materials.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	2	1	1	1			1		1			
CO2	2	1	1	1	1	1	1			1		1			
CO3	2	1	2	1	1	1	1			1		1			
CO4	2	1	1	1	1	1	1			1		1			

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UAU627L	AUTOMOTIVE CAD LABORATORY	Credits: 1.5
L:T:P - N_L :0 N_T:0 N_P 3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

1. Modeling – Introduction. Development of 2D and 3D geometric modeling using anyone parametric software. Exercises on automotive components - 3D modeling (1 – 4 components) Softwares – Pro-E, CATIA, UNIGRPHICS etc.
2. Analysis – FEA (Preprocessor, solver, post processor)
   a) Exercise involving simple structures.
   b) Validation of result with analytical solution.
3. Introduction to CNC programming(G codes & M codes) a)Turning b) Milling Simple Exercises (2 – 4 Nos.) using CNC Simulator.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   a. Performance and journal write-up :
      Marks for each experiment = 30 marks/No. of proposed experiments.
   b. One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

Allocation of 50 marks for SEE

Course Outcomes**

1. Utilize the CATIA software commands to generate geometrical primitives and sketcher
2. Utilize the CATIA software commands to generate 2D and 3D models.
3. Able to convert, modify and develop solid and surface models for FEM solutions.
4. Develop program for generating component profile using NC programming for milling and turning jobs.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1	1	3				1	1	1	2	1	2	1
CO2	3	1	1	1	3				1	1	1	2	1	2	1
CO3	3	1	1	1	3				1	1	1	2	1	2	1
CO4	3	1	1	1	3				1	1	1	2	1	2	1

UAU638L	AUTOMOTIVE POWER TRAIN AND ELECTRICAL SERVICING LAB	Credits: 1.5
L:T:P - N_L :0 N_T:0 N_P 3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

1. Writing technical specifications and description of all types of chassis and transmission components of automobiles, including body and interiors (two wheeler, four wheeler and heavy vehicle – one each)
2. Trouble shooting charts for major parts like clutch, gear box, differential, brakes, wheels with tyres, steering system and suspension.
3. Testing and servicing of electrical components like battery, starting system, ignition system, central locking system, lighting system, and alternator. Experiments on microprocessors related to automobiles
4. Dismantle and assemble of major systems (clutch system, Gear boxes, Propeller shaft, Differential, Front and Rear axles, brake system, steering system and suspension system) and identifying remedies (like backlash adjustment, brakes adjustment, bleeding of brakes) for the possible problems based on trouble shooting charts.
5. Draw sketch of seating arrangements, seats for commercial vehicle and study the comfort levels provided for driver and passengers.
6. Draw sketches of different mechanisms of door, seat adjustments mechanisms.

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   c. Performance and journal write-up :
      Marks for each experiment = 30 marks/No. of proposed experiments.
   d. One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

Allocation of 50 marks for SEE

Course Outcomes**

1. To know the electrical and power train trouble shooting aspects and specifications of various vehicles
2. Able to demonstrate the dismantling of various transmission elements like clutch, gear box etc. and study its details
3. Able to demonstrate the dismantling of electrical elements and study its details
4. To be able to know the seat adjustments and door mechanisms

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1			1			2	1	1	1	1	2	1
CO2	2	1	1			1			2	1	1	1	1	2	1
CO3	2	1	1			1			2	1	1	1	1	2	1
CO4	2	1	1			1			2	1	1	1	2	2	1

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
(Academic Year 2021 - 2022)

VII Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1.	UAU721C	Vehicle Body Engineering	3	3	0	0	50	50	100
2.	UAU712C	Vehicle Dynamics	3	3	0	0	50	50	100
3.	UAU723C	Autotronics	3	3	0	0	50	50	100
4.	UAU XXXE	Dept. Elective - III	3	3	0	0	50	50	100
5.	UAUXXXN	Open Elective - II	3	3	0	0	50	50	100
6.	UAU716L	Automotive Reconditioning Laboratory	1	0	0	3	50	50	100
7.	UAU717P	Project Phase - I	5	0	0	8*	50	50	100
8.	UAU718I	Internship	2	0	0	0	0	0	0
		Total	23	15	0	11	400	400	800

Department Electives - III

Sl. No	Code	Subjects
1	UAU761E	Modern Machining Processes
2	UAU762E	Rocket and Jet Propulsive Systems
3	UAU763E	On and Off Board Vehicle Diagnostics
4	UAU764E	Electrical Vehicles

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Department of Automobile Engineering

Scheme of Teaching and Evaluation
(Academic Year 2021 - 2022)

VIII Semester BE

Sl. No	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1.	UAUXXXE	Dept. Elective - IV	3	3	0	0	50	50	100
2.	UAUXXXE	Dept. Elective - V	3	3	0	0	50	50	100
3.	UAUXXXE	Dept. Elective - VI	3	3	0	0	50	50	100
4.	UAU804P	Project Phase - II	12	0	0	24	50	50	100
5.	UAU805S	Technical Seminar	1	0	0	0	50	50	100
		Total	22	9	0	24	250	250	500

Department Electives - IV

Sl. No	Code	Subjects
1	UAU821E	Alternative Energy Sources
2	UAU822E	Computational Fluid Dynamics
3	UAU823E	Intelligent Transport Systems and Future trends
4	UAU824E	Robotics and Automation

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UAU712C	VEHICLE DYNAMICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

UNDAMPED FREE VIBRATION: Introduction, sinusoidal motion, single degree of freedom system, Newton's method, energy method and De'Alembert's principle, undamped free vibration - natural frequency of free vibration, problems.

DAMPED FREE VIBRATION: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, response study of viscous damped systems for cases of under damping and over damping, logarithmic decrement, problems.

UNIT–II	10 Hrs.

FORCED VIBRATION: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force solution by complex algebra, vibration isolation - transmissibility ratio, energy dissipated by damping equivalent viscous damping, structural damping, sharpness of resonance, base excitation, problems.

SYSTEMS WITH TWO DEGREE OF FREEDOM: Introduction, principle modes and normal modes, co-ordinate coupling, generalised and principle co-ordinate, free vibrations in terms of initial conditions, Lagrange's equation, semi-definite systems, applications: Vehicle suspension, dynamic vibration absorber, dynamics of reciprocating engines, problems.

UNIT–III	10 Hrs.

NUMERICAL METHODS FOR MULTI DEGREE OF FREEDOM SYSTEMS: Introduction, influence coefficients, Maxwell's reciprocal theorem, Dunkerley's method, orthogonality principle, method of matrix iteration- method of determination of all the natural frequencies using sweeping matrix and orthogonality principle, Holzer's method for systems with free, fixed free and fixed ends, Stodola method, Rayleigh Ritz method for beam vibration.

UNIT–IV	10 Hrs.

VEHICULAR VIBRATION: Vibration due to road roughness, vibration due to engine unbalance, reciprocating and rotating unbalance, transmissibility of engine mounting vibration with two degree of freedom, compensated suspension systems forced vibration.

TYRE MECHANICS: Vehicle control - low speed cornering and static steering, steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slip angle steer, steady state handling - lateral acceleration gain, characteristic speed, yaw velocity gain, critical speeds.

Reference Books *

TEXT BOOKS:

1. Mechanical Vibration - G.K.Grover, Nemchand & Brothers,1989
2. Mechanical Vibration – V.P.Singh, Dhanpat Rai & Company Pvt. Ltd., 3rd Edition, 2006.
3. Fundamentals of vehicle dynamics - Thomas D. Gillespie, SAE USA 1992

REFERENCE BOOKS:

1. Vibration Theory Mechanical Vibrations- S.S.Rao, Pearson Edu.Inc., 4th Edition, 2003
2. Theory & Problems of Mechanical Vibration - William W. Seto, McGrawHill (schaum's

outline series)

3. Problems in Automobile Mechanics - N.K.Giri, Khanna Pub.2004
4. Mechanics of Pneumatic Tyre - S.K.Clark, Prentice Hall
5. Mechanical Vibration Analysis- P.Srinivasan, TMH

Course Outcomes**

1. Classify and determine first and second order vibratory systems and formulate using basic approach.
2. Analyze the response of damped systems for varying degree of damping and compute the natural frequency of damped free vibration of mechanical systems.
3. Evaluate on numerical methods and their significance in multi degree freedom systems.
4. Illustrate the natural frequencies and mode shapes for multi-degree of freedom vibrating systems.
5. Investigate the response of vibrating systems due to engine unbalance
6. Asses the tire mechanics and analyze the vehicle control parameters

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	2							1	2	3	3	2
CO2	3	3	2	2							1	2	3	3	2
CO3	3	3	1	2							1	2	3	3	3
CO4	3	3	1	2							1	2	3	3	2
CO5	3	3	3	2							1	2	3	3	2
CO6	3	3	2	2							1	2	3	3	2

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UAU 721C	VEHICLE BODY ENGINEERING	**Credits: 03**
L:T:P - N_L :4 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Classification of coachwork type: styling forms, coach and bus body style, layout of cars, buses and coach with different seating and loading capacity, commercial vehicle types, vans and pick-ups. Terms used in body building construction, angle of approach, angle of departure, ground clearance, cross bearers, floor longitudes, posts, seat rail, waist rail, cant rail, roof stick, roof longitude, rub rail, skirt rail, truss panel, wheel arch structure, wheel arch, post diagonals, gussets.

VEHICLE BODY MATERIALS: Properties, manufacturing methods and suitability for vehicle body construction Aluminum alloys, steel, alloy steels, plastics and composite materials, semi rigid PUR foams and sandwich panel construction. Paints and adhesives.

UNIT–II	10 Hrs.

AERODYNAMICS: Basics, various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, study of wind tunnels, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles.

LOAD DISTRIBUTION: Type of body structures, vehicle body stress analysis, vehicle weight distribution, calculation of loading for static loading, symmetrical, longitudinal loads, side loads, stress analysis of bus body structure under bending and torsion.

UNIT–III	10 Hrs.

INTERIOR ERGONOMICS: Introduction, seating dimensions, interior ergonomics, seat comfort, driver seat design, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, driver's visibility, methods of improving visibility, window winding mechanisms.

VEHICLE STABILITY: Introduction, longitudinal, lateral stability, vehicle on a curvilinear path, critical speed for toppling and skidding. Effect of operating factors on lateral stability, steering geometry and stabilization of steerable wheels, mass distribution and engine location on stability.

UNIT–IV	10 Hrs.

NOISE AND VIBRATION: Noise characteristics, sources of noise, noise level measurement techniques, body structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression.

SAFETY: Impact protection basics, physics of impact between deformable bodies, design for crash worthiness, occupant and cargo restraint, passive restraint systems, side impact analysis, bumper system, energy absorbent foams, laws of mechanisms applied to safety.

Reference Books *

TEXT BOOKS:

1. Sydney F page, “Body Engineering”’ Chapman & Hall Ltd, London, 1956
2. “Giles J Pawlowski”, Vehicle body engineering Business books limited, 1989
3. John Fenton, “Vehicle body layout and analysis”, Mechanical Engg. Publication ltd, London.

REFERENCE BOOKS:

1. Hand book on vehicle body design – SAE publication
2. Automotive chassis by P.M. Heldt, Chilton & Co, 1970
3. Vehicle Safety 2002, Cornwell press, Townbridge, UK, ISBN 1356 -1448.
4. Redesign of bus bodies – part I & part II – CIRT pune (Report), 1983

Ed W.H. Hucho, Aerodynamics of Road Vehicles, 4th Edition, Butter worth’s 1987

Course Outcomes**
1. To know and analyze classification, vehicle body construction, design and development of various types of vehicles and their layouts body design nomenclatures.
2. To know and analyze fixed and free control systems, aerodynamic styling, trimming, materials and paintings used in vehicle body design and development of various vehicles.
3. Analyze the forces and couples acting on vehicle during various running conditions.
4. Develop templates / prototypes and analyze the various aerodynamic forces and couples acting on the vehicle, pressure distribution analysis and flow visualization techniques while testing in wind tunnel.
5. To analyze and develop SFD and BMD for load distribution and stress analysis in vehicle body design.
6. To analyze space optimization techniques, visibility, body development skills, luxury, ergonomics for both driver and passengers. NVH analysis and safety.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	3	3	1							3	2	2	2
CO2	3	2	3	3	2							3	2	2	2
CO3	3	2	3	3	2							3	2	2	2
CO4	3	2	3	3	2							3	1	2	2
CO5	3	2	3	3	2							3	1	2	2
CO6	3	2	3	3	2							3	2	2	2

UAU723C	AUTOTRONICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Need for electronics in automotive control systems, structure of vehicle electronics systems, common features of vehicle systems, measurement system, sensors and actuators.

INTRODUCTION TO ELECTRONICS: Electronic components, diodes, transistors, electronic circuits, analog circuits, digital circuits, integrated circuits, microprocessor systems, systems approach to control and instrumentation.

UNIT–II	10 Hrs.

ELECTRONIC IGNITION SYSTEMS: Types of ignition systems, conventional ignition system, CDI, programmed ignition system, distributor-less ignition system, direct ignition.

ELECTRONIC FUEL CONTROL: Electronic control of carburetion, petrol injection system, single and multi point injection system, components, flow diagram, diesel fuel injection.

UNIT–III	10 Hrs.

ENGINE MANAGEMENT SYSTEM: Combined ignition and fuel management system, exhaust emission control, digital control techniques, complete vehicle control systems, artificial intelligence and engine management.

CHASSIS ELECTRICAL SYSTEMS: Anti-lock brakes, active suspension, traction control, electronic control of automatic transmission.

UNIT–IV	10 Hrs.

ELECTRONICS FOR COMFORT, SAFETY AND SECURITY: Electric seats, mirrors and sun-roof operation, central looking and electric windows, cruise control, In Car Entertainment (ICE) and communications, adaptive noise control, airbags and seatbelt tensioners, obstacle avoidance radar, security systems **-** engine immobilizer, ICAT.

Reference Books *

TEXT BOOK:

1. Automotive electrical and electronic systems: Tom Denton, 3rd edition, SAE International.

REFERENCE BOOKS:

1. Automotive electronics: Eric Chowanietz, Newnes, 1995.

2. Understanding automotive electronics, William B Ribbens, Butterworth-Heinemann.

3. Automotive Electrics Automotive Electronics, Robert Bosch.

Course Outcomes**

1. To justify the need of Autotronic systems and explain the construction of various electronically controlled chassis and vehicle safety systems.
2. The student will be able to analyze the working of electronic control systems used in modern automobiles
3. To apply the knowledge of working of various sensors in the control of vehicular systems
4. To compare the working of programmed control systems with conventional vehicular control systems

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5. To evaluate the performance of vehicle embedded with engine management systems
6. To justify the need of Autotronic systems and explain the construction of various electronically controlled chassis and vehicle safety systems.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2	3	1	1			1	1	1		1	
CO2	3	2	2	2	2	1	1			1	1	1	1	3	2
CO3	3	2	2	2	2	1	1			1	1	1	1	3	3
CO4	3	2	2	2	3	1	1			1	1	1	1	2	2
CO5	3	2	2	2	3	1	1			1	1	1	1	2	2
CO6	3	2	2	2	3	1	1			1	1	1	1	2	1

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UAU761E	MODERN MACHINING PROCESSES	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: History, classification, comparison between conventional and non-conventional machining process selection.

ULTRA SONIC MACHINE(USM): Introduction, equipment, tool materials and tool size, abrasive slurry, cutting tool system design: effect of parameter: effect of amplitude and frequency and vibration, effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool and work material.

UNIT–II	10 Hrs.

ABRASIVE JET MACHINING(AJM): Introduction, equipment, variables in AJM: carrier gas, type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number. abrasive particles per unit volume of the carrier gas, work material, Stand Off Distance(SOD), nozzle design, shape of cut. Advantages and disadvantages of AJM. Water Jet Machining: principle, operation, application, advantages and limitations of water jet machinery.

ELECTROCHEMICAL MACHINING(ECM): Introduction, study of ECM machine, elements of ECM process: Cathode tool, anode work piece, source of DC power, electrolyte, chemistry of the process, ECM process characteristics - material removal rate, accuracy, surface finish, ECM tooling: ECM tooling technique and example, tool and insulation materials, tool size electrolyte flow arrangement, handling of slug, economics of ECM, advantages, limitations.

UNIT–III	10 Hrs.

CHEMICAL MACHINING(CHM): Introduction, elements of process, chemical blanking process: Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps -masking, etching, process characteristics of CHM: material removal rate accuracy, surface finish.

ELECTRICAL DISCHARGE MACHINING(EDM): Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) electrode feed control, electrode manufacture, electrode wear , EDM tool design choice of machining operation electrode material selection, under sizing and length of electrode, machining time. Flushing; pressure flushing, suction flushing, side flushing, pulsed flushing synchronized with electrode movement.

UNIT–IV	10 Hrs.

PLASMA ARC MACHINING(PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, applications, advantages and limitations.

LASER BEAM MACHINING(LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, process characteristics, applications, advantages and limitations.

ELECTRON BEAM MACHINING(EBM): Principle, equipment, operations, applications, advantages and limitation of EBM.

Reference Books *

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TEXT BOOKS:

1. **Modern Machining Process -** by Pandey and Shah, TATA McGraw Hill 2000
2. **New Technology -** by Bhattacharya, 2000

REFERENCE BOOKS:

1. **Production Technology –**HMT, TATA McGraw Hill. 2001
2. **Modern Machining Process** – Aditya, 2002
3. **Non-Conventional Machining -** P.K.Mishra, The Institution of Engineers (India) Test book series,

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Narosa Publishing House – 2005. 4. **Metals Handbook -** Machining volume 16 Joseph R. Davis (Editor), American Society of Metals (ASM)
Course Outcomes**
1. Define and Classify different non - traditional machining techniques and their working principle.
2. Classify the NTM systems based on applications and limitation.
3. Ability to analyze the working parameters for optimize productivity.
4. Compare two or more NTM methods on the basis of merits and demerits.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1	1								2	2	2	1
CO2	3	2	1	1								2	2	2	1
CO3	3	2	1	1								2	2	2	1
CO4	3	3	1	1								2	2	2	1

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UAU762E	ROCKET AND JET PROPULSION SYSTEM	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Review of thermodynamic principles, principles of aircraft propulsion, types of power plants, basics of heat transfer; conduction, convection, radiation, diffusion mass transfer basic concepts and governing equations.

FUNDAMENTALS OF GAS TURBINE ENGINES ILLUSTRATION OF WORKING OF GAS TURBINE ENGINE: Thrust equation - factors affecting thrust - effect of pressure, velocity and temperature changes of air entering compressor - methods of thrust augmentation - characteristics of turboprop, turbofan and turbojet - performance characteristics.

UNIT–II	10 Hrs.

SUBSONIC AND SUPERSONIC INLETS FOR JET: Engines internal flow and stall in subsonic inlets - boundary layer separation - major features of external flow near a subsonic inlet - relation between minimum area ratio and eternal deceleration ratio - diffuser performance - supersonic inlets - starting problem on supersonic inlets - shock swallowing by area variation - external declaration - models of inlet operation.

COMBUSTION CHAMBERS AND NOZZLES: Classification of combustion chambers - important factors affecting combustion chamber design - combustion process - combustion chamber performance - effect of operating variables on performance - flame tube cooling - flame stabilization - use of flame holders - theory of flow in isentropic nozzles - convergent nozzles and nozzle choking - nozzle throat conditions - nozzle efficiency - losses in nozzles - over expanded and under - expanded nozzles - ejector and variable area nozzles - interaction of nozzle flow with adjacent surfaces - thrust reversal.

UNIT–III	10 Hrs.

COMPRESSORS PRINCIPLE OF OPERATION OF CENTRIFUGAL COMPRESSOR: Work done and pressure rise - velocity diagrams - diffuser vane design considerations – Concept of pre whirl - rotation stall - elementary theory of axial flow compressor - velocity triangles - degree of reaction - three dimensional - air angle distributions for free vortex and constant reaction designs - compressor blade design - centrifugal and axial compressor performance characteristics**.**

INTODUCTION TO TURBINES: Types of turbines - operating principle - design consideration - velocity triangles - degree of reaction - performance parameters - basics of blade design principle.

UNIT–IV	10 Hrs.

RAMJET PROPULSION: Operating principle - sub critical, critical and supercritical operation - combustion in ramjet engine - ramjet performance - sample ramjet design calculations - introduction to scramjet - preliminary concepts in supersonic combustion - integral ram- rocket.

FUNDAMENTALS OF ROCKET PROPULSION: Types and classification of rockets operating principle - specific impulse of a rocket - rocket nozzle classification - rocket performance considerations.

Reference Books *

Text Books

1. V. Ganesan, “ Gas Turbine”, Tata McGraw Hill Pub. Co. Ltd., 1996 2. Hill, P.G. & Peterson,
2. C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999. 43

References

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Longman,
2. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York 1985
3. “Rolls Royce Jet Engine” – Third Edition – 1983. 5. Mathur, M.L. and Sharma, R.P., “Gas Turbine,

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Course Outcomes**
1. Able to know the principles of aircraft propulsion, types of power plants
2. Able to know the fundamentals of gas turbine engines illustration
3. To study the subsonic and supersonic inlets
4. To study the compressors principle and types of compressor used in jets
5. Able to know the ram jet propulsion and operating principle
6. Able to know the principles of aircraft propulsion, types of power plants

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	1	1	1		1	1	1	1	2	1	2
CO2	2	2	2	1	1	1	1		1	1	1	1	2	2	2
CO3	2	1	1	1	1	1	1		1	1	1	1	3	2	3
CO4	2	1	2	1	1	1	1		1	1	1	1	2	2	3
CO5	2	2	2	1	1	1	1		1	1	1	1	1	2	2
CO6	2	2	2	1	1	1	1		1	1	1	1	1	2	2

UAU763E	ON AND OFF BOARD DIAGNOSTICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION: DEFINITION OF DIAGNOSTICS: System structure, on-board diagnostics, off-board diagnostics, model based approach to diagnosis, VMBD (vehicle model based diagnosis) project, common rail demonstrator, DTI (distributor type injection) demonstrator. Prospects for failure diagnostics of automotive electronic control system. History of diagnostics tools, present state and changes in diagnostics techniques, OBD-II diagnostic logic, future trends of diagnostics technique. Further improvement of diagnostic function.	
UNIT–II	**10 Hrs.**
A new object oriented diagnostic system management for power train control units with OBD. Impact of legal regulation (OBD-II), challenges for OBD software. Description of the problem domain; basic objects and relations, integration with real time system. In-cylinder diagnosis by laser tomography; measurement methods. Portable on-board diagnostic OBD-II /CAN scan tool. An on-board diagnosis method for three way catalyst deterioration Engine knock detection. OBD-II Performance of three way catalysts. Product, tools and emerging research.	
UNIT–III	**10 Hrs.**
Evolution knock detection products, stages of knock detector development and tool requirements, next generation of knock systems. Virtual sensing**:** A neural network based intelligent performance and emissions prediction system for on-based diagnostics and engine control. Operation of virtual sensing system, virtual sensor architecture virtual sensors prediction and training, applications to diesel and petrol engine, applications of virtual sensing, engine diagnostics, engine control and engine modeling.	
UNIT–IV	**10 Hrs.**
High temperature measurements for on-board diagnostics of LEV/ULEV systems. Emissions after cold start, catalyst heating systems, temperature measurement systems. Heavy duty approach to on board diagnostics. An advanced electronic control and diagnostics systems for automatic transmission: Function, structure, software, sensors, actuators, operation, diagnosis. Fuzzy system for automotive fault diagnosis. OBD-II system in the Hyundai Accent (case study).	
Reference Books *	
BOOKS: Ronald Jurgen	
Course Outcomes**	
1. To study the introduction of diagnostics; System structure, on-board diagnostics, off-board diagnostics	
2. To study the risks and challenges of OBD software and description of the problem domain; basic objects and relations, integration with real time system.	
3. To study and analyse the neural network based intelligent performance and emissions prediction system for on-based diagnostics	
4. To study and analyse the fuzzy system for automotive fault diagnosis.	

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Course Outcomes	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	2	1	1			1			1	1	1
CO2	2	2	1	1			1			1	1	1
CO3	2	2	1	1			1			1	1	1
CO4	2	1	1	1			1			1	1	1

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UAU764E	ELECTRIC VEHICLES	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION: Electric vehicles; early systems, charging techniques for lead acid batteries, charging techniques for nickel based batteries, charging techniques for non aqueous batteries, Battery state of charge measurement, battery management, connection methods, battery exchange, infrastructure implications, recharging/refueling of other power storage devices. Economic and environmental comparison of alternative vehicle options. Electric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.	
UNIT–II	**10 Hrs.**
BATTERIES: Storage batteries; advanced lead acid, metal foil lead acid, nickel - iron, nickel - zinc, nickel - cadmium, sodium - sulphur, sodium - nickel chloride, lithium - iron sulphide, lithium - solid polymer, lithium - ion, aluminum - air and zinc - air. Formation of GHG emissions from EV fuel cycle. **CONVERSION**: Conversion overview, summary of EV conversion process. Controller; overview, solid state controller, manual switch versus solid state component.	
UNIT–III	**10 Hrs.**
PROPULSION METHODS: DC Motors; series wound motors, shunt wound motors, compound wound motors, separately excited motors. AC Motors; induction motors, synchronous motors, brushless DC motors, switched reluctance motors, motor cooling, power train options for electric vehicles. **ELECTRIC PROPULSION SYSTEMS:** DC motor drives, chopper control of DC motors. Drive train configuration and design objectives, control strategies.	
UNIT–IV	**10 Hrs.**
VEHICLE DESIGN AND SAFETY: Effect of battery weight and volume, designing for minimum weight, safety of batteries, safety of alternative energy generating and storage systems, safety of other electrical systems, general design and safety issues, heating and air conditioning, auxiliary power subsystem, braking, suspension and wheel systems, rolling resistance. Prototype and experimental electric cars. **CONTEMPORARY VEHICLE TECHNOLOGY**: GM; EV1, Zafure, Ford; Think City, Ka Litmus, Nissan Hypermini, Toyota RAV 4 EV, Honda EV.	

Reference Books *

TEXT BOOKS:

1. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
2. Electronic Engine Controls – Steve V Hatch(Cengage learning)
3. Electric and Hybrid vehicles – Pistoia (Elsevier)
4. Fuel cells principles and applications - B.Vishwanath, M. Aulice Scibion (University Press)
5. Electrical vehicle machine and drives – K.T.Chau (Wiley)

Course Outcomes**

1. Able to know the principles of aircraft propulsion, types of power plants
2. Able to know the fundamentals of gas turbine engines illustration
3. To study the subsonic and supersonic inlets

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4. To study the compressors principle and types of compressor used in jets
5. Able to know the ram jet propulsion and operating principle
6. Able to know the principles of aircraft propulsion, types of power plants

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	1	1	1	1	1	1	1	1	2	1	2
CO2	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2
CO3	2	1	1	1	1	1	1	1	1	1	1	1	3	2	3
CO4	2	1	2	1	1	1	1	1	1	1	1	1	2	2	3
CO5	2	2	2	1	1	1	1	1	1	1	1	1	1	2	2
CO6	2	2	2	1	1	1	1	1	1	1	1	1	1	2	2

UAU 716L	Automotive Reconditioning Lab	Credits: 1
L:T:P - N_L :0 N_T:0 N_P 2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

1. Study and Practice of Line reboring machine
2. Study and Practice of calibration FIP
3. Study and Practice of vertical cylinder reboring machine
4. Study and Practice of reboring small and big end of connecting rod ‘
5. Study and Practice on body repairs tinkering and painting
6. Study and Practice of refacing of given valve
7. Study and Practice of surface grinding machine
8. Study and Practice of crank shaft grinding machine

Laboratory Assessment:

1. Each Laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)
2. Allocation of 50 marks for CIE
   - Performance and journal write-up :
     Marks for each experiment = 30 marks/No. of proposed experiments.
   - One practical test for 20 marks. (5 write-up, 10 conduction, calculation, results etc., 5 viva-voce).

3. Allocation of 50 marks for SEE

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	2	1	2	2	2	2	3	1	2	1
CO2	3	3	2	2	2	2	1	2	2	2	2	3	1	2	1
CO3	3	3	3	2	2	2	1	2	2	2	2	3	1	2	1
CO4	3	3	3	2	2	2	1	2	2	2	2	3	2	2	1

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UAU 777P	PROJECT PHASE – I	Credits: 05
L:T:P - N_L :0 N_T: 0 N_P 10		CIE Marks: 50
Total Hours/Week: 10		SEE Marks: 50

- Project Batch may consist of maximum of Four Students however under exceptional conditions it may be extended up to 5 students.
- Guide/s may be identified by the students or it may be allotted by the department.
- The students along with the respective guides have to decide the project work and submit the title and synopsis of the project work to the Departmental committee (DC) consisting of 1) HOD or HOD Nominee 2) Project Coordinator and 3) Respective Project Guide/s
- Each student in the batch is directed to maintain the project progress record book to enter the progress of project work during the contact hours with the respective guides.
- The contact hour schedule may be defined by the guides in consent with their batches as per convenience
- The CIE evaluation is to be conducted for 50marks by the guide by reviewing the progress of the project work, attendance through the record books conducting at least one demo/seminar presentation for the same project work before SEE examination.
- Students have to submit the synopsis in 2 copies containing objectives, methodology, literature review, etc as a project report-I for VII Semester SEE Examination purpose. (one report to the Guide and one report to DC)
- The SEE examinations will be conducted by DC separately for each project batch for 50marks.

In case of the change of the title/synopsis/project work, may be done in consent with the respective guides before SEE examination and the same should be brought to the notice of DC.

Project- I

Examination	**CIE**	**SEE**
Marks	**50**	**50**

Course Outcomes**

1. Applying knowledge of basic science, core and elective engineering subjects to identify and execute the problems.
2. Conduct and analyze the literature survey in the identified fields and define the objectives, proposed action plan and methodology.
3. Able to interact, analyze and create the directions and dimensions for problem solving.
4. Skill developments in project report preparation, presentation, communication and justification.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	2	1	2	2	2	2	3	3	3	3
CO2	3	3	2	2	2	2	1	2	2	2	2	3	3	3	3
CO3	3	3	3	2	2	2	1	2	2	2	2	3	3	3	3
CO4	3	3	3	2	2	2	1	2	2	2	2	3	3	3	3

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UAU718I	INTERNSHIP	**Credits: 02**
L:T:P - N_L : N_T: N_P		CIE Marks: 50
Total Hours/Week: 0		SEE Marks: 50

Students have to submit a report of the training undergone. Evaluation will be done at the end of the semester by evaluation committee set by the department.

Scheme of Evaluation for Internship (Mandatory)

- Students should complete 4 weeks
- Scheme of evaluation consists of both CIE and SEE.

➢ **CIE consists of 3 phases**

A report about the industry / institute and objectives after **1** weeks of internship

A report on study/ methodology of internship after **2** weeks

➢ A presentation on internship after completion of **4** weeks

Total: 50 Marks

- SEE to be conducted along with 7th semester examination, which includes viva-voce and report submission (both internal examiners)

Viva Voce	25 marks
Report	**25 marks**
Total	**50 marks**

The report should be in the format prescribed by department.

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UAU821E	ALTERNATIVE ENERGY SOURCES	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
ALTERNATIVE ENERGY RESOURCES: Types of energy sources need for energy sources, availability, merits and demerits. Green house gases and climate change. Renewal energy sources: definition, classification and comparison with conventional fuels. **SOLAR ENERGY**: Solar radiation, geometry, radiation measurement devices; pyranometer and pyreliometer, solar energy collectors and their types, performance characteristics of collectors, applications of solar energy, solar energy storage system, photovoltaic conversion, solar cell characteristics.	
UNIT–II	**10 Hrs.**
BIOMASS ENERGY: Introduction, definition of biomass, types of biomass, biomass conversion techniques, bio gas, composition, bio gas generation process, factors affecting bio gas generation, selection of biogas plant, types of bio gas plants, construction and their working, problems involved in production and transportation, application of bio gas for IC engines, dual fuel approach, modifications required. Producer gas: Production through pyrolysis, composition, performance modifications needed.	
UNIT–III	**10 Hrs.**
ALCOHOL FUELS: Introduction, suitability, production of methanol and ethanol; through municipal solid wastes, grains and sugarcane. Properties; comparison of alcohols and gasoline as engine fuels, exhaust emission study, performance of IC engines using pure ethanol and methanol, ethanol and methanol blends, change in properties of alcohol - gasoline blends, alcohols as diesel fuels; performance and limitations. General implications; crop pattern, food shortages through grain and sugarcane based alcohols. **BIODIESEL**: Introduction, feed stock for biodiesel production, non edible oils, raw materials for sustainable biodiesel. Vegetable oils, types, properties. Animal fat wastes for bio diesel production. Thermodynamic characteristics. Biodiesel esterification. Biodiesel emissions.	
UNIT–IV	**10 Hrs.**
HYDROGEN ENERGY: Scope and scale of hydrogen as fuel, issues and challenges of hydrogen as fuel, properties; comparison with gasoline, production methods; electrolysis, thermochemical, coal gasification, solar photolysis, storage; gas, liquid and metal hydrides, transportation; pipe line, liquid and solid, combustion, utility, safety and management, emission and performance characteristics of hydrogen engine, engine modifications required. Natural gas, Liquefied Petroleum Gas (LPG), composition, properties, LPG kits, modification, natural gas engines, performance and pollution study. Fuel cell; utility and methods.	
Reference Books *	
TEXT BOOKS: 1. Theory of IC engines: Mathur and Sharma 2. Non-conventional energy sources: G.D. Rai. 3. Solar energy: S.P.Sukatme	
Course Outcomes**	
1. Able to know the need, availability, classification of renewable energy sources and its environmental impact	
2. Able to know the solar energy and its applications with collectors and their types.	
3. To know and analyze of bio mass and its utility with its derived products and their application in IC 3engines and subsequent modification	

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4. Ability to study and the use of alcohol fuels, its properties and its comparison with conventional fuels.
5. To study and analyze the use of biodiesel, LPG and natural gas properties and its performance
6. Analyze the issue and challenges associated with hydrogen as an energy carrier, properties, production, storage and transportation and utilization with modifications involved.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	2		2	3	1		2		2	2	1	2
CO2	2	1		2		2	3	1		2		2	2	2	2
CO3	2	2	1	2		2	3	1		2		2	2	2	2
CO4	2	2	1	2		2	3	1		2		2	2	2	2
CO5	2	1	1	2		2	3	1		2		2	2	2	2
CO6	2	2	1	2		2	3	1		2		2	2	2	2

UAU 823E	INTELLIGENT TRANSPORT SYSTEM AND FUTURE TRENDS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTELLIGENT TRANSPORT SYSTEM (ITS): Overview and structure, history, application and architecture. Emergence and characteristics of ITS. Structure of ITS, technology and user services. ITS standards. Benefits and constraints of ITS deployment. Advanced driver assistance system; Overview, research. Infrastructure based automated driving vehicles, cyber cars. Future of driver assistances. Long -term goal-autonomous driving. BVS Systems: requirements, (special and general), advantages, components of bus, access methods, network topology.	
UNIT–II	**10 Hrs.**
EVOLUTION AND FUTURE TRENDS; safety and energy efficiency, navigation/telematic services; comfort and safety benefits, traffic information services, client feed back. Traffic management. Lane assistance. **DATA ACQUISITION:** Introduction, data types, vehicle dynamic sensors, inertial sensors, acceleration sensors, rotation rate sensors, steering angle sensors. Human machine interface design in modern vehicles.	
UNIT–III	**10 Hrs.**
STEER- BY- WIRE: System architecture, potential and challenges. Concept sketching, full size tape drawing, clay modeling, ergonomics in the automotive industries. Control system in automobiles: Open loop, feed forward, closed loop or feedback control, sequential control. Vehicle navigation : Functions of navigation, digital map near vision system; application, far – infrared system (FIR), near infrared (NIR) ; operating principles. **AUTOMATED DRIVING**: Requirements, sensor technology, actuator technology, legal aspects. Sports car engines characteristics.	
UNIT–IV	**10 Hrs.**
BODY DESIGN: Styling process, studios; working environment and structure. Mechanical design, design possibilities, advances in manufacture methods, material advances, energy conversation, power system, vehicle sales. Automotive embedded systems, infotainment and navigation systems, automotive antennas, urban and extra urban vehicles, rethinking the vehicle design. **ELECTRICAL AND ELECTRONIC POSSIBILITIES:** electronic advances in power train design, electronically controlled valve actuation, electronic transmission control, electronic developments in chassis system.	
Reference Books *	
BOOKS: Encyclopedia of automobile engineering (vol. 4, 5 and 6) New trends and developments in automotive system engg –Maxcello Chiaberge (INTECH)	
Course Outcomes**	
1. Able to know the overview and structure, history, application and architecture of intelligent Transport Systems(ITS)	
2. To study the evolution and future trends of ITS and data acquisition systems	
3. To study the steer- by- wire system architecture, potential and challenges	
4. Able to know the details and dynamics of automated driving	
5. To study the body design and electrical and electronic possibilities of ITS	

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	2	2	2	1		1	1	2			
CO2	2	1	1	1	2	2	2	1		1	1	2			
CO3	2	2	1	1	2	2	2	1		1	1	2			
CO4	2	2	2	1	2	2	2	1		1	1	2			

UAU824E	ROBOTICS AND AUTOMATION	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION AND MATHEMATICAL REPRESENTATION OF ROBOTS:
Types of robots, notation, position and orientation of a rigid body, successive rotations, Euler angles for fixed frames X-Y-Z and moving frame ZYZ. Transformation between coordinate system, homogeneous coordinates, types of joints: rotary, prismatic joint, cylindrical joint, spherical joint, representation of links using Denvit-Hartenberg parameters: link parameters for intermediate, first and last links, link transformation matrices, transformation matrices of SCARA manipulator.

UNIT–II	10 Hrs.

KINEMATICS OF SERIAL MANIPULATORS:
Direct kinematics of 2R, 3R, RRP, RPR manipulator Stanford arm, inverse kinematics of 2R, 3R manipulator. Velocity and statics of manipulators: 7 hours differential relationships, Jacobian, differential motions of a frame (translation and rotation), linear and angular velocity of a rigid body, linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, velocity ellipse of 2R manipulator, singularities of 2R manipulators, statics of serial manipulators, static force and torque analysis of 3R manipulator, singularity in force domain.

UNIT–III	10 Hrs.

DYNAMICS OF MANIPULATORS:
Kinetic energy, potential energy, equation of motion using Lagrangian, equation of motions of one and two degree freedom spring mass damper systems using Lagrangian formulation, inertia of a link, recursive formulation of dynamics using Newton Euler equation, equation of motion of 2R manipulator using Lagrangian, Newton-Euler formulation. Trajectory planning: joint space schemes, cubic trajectory, joint space schemes with via points, cubic trajectory with a via point, third order polynomial trajectory planning, linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning.

UNIT–IV	10 Hrs.

CONTROL:
Feedback control of a single link manipulator **-** first order, second order system, PID control, PID control ofmulti link manipulator, force control of manipulator, force control of single mass, partitioning a task for force and position control lever, peg in hole hybrid force and position controller, actuators and sensors in industrial robots.

Reference Books *

TEXT BOOKS:
1. Fundamental Concepts and Analysis, Ghosal A., Robotics, Oxford,2006
2. Introduction to Robotics Analysis, Systems, Applications, Niku, S. B., Pearso Education, 2008

REFERENCE BOOKS:
1. Introduction to Robotics: Mechanical and Control, Craig, J. J., 2nd Edition, Addison-Welsey, 1989.
2. Fundamentals of Robotics, Analysis and Control, Schilling R. J., PHI, 2006.

Course Outcomes**

1. To understand features of various robot.

2. To understand the features robot drives and controls.

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3. To know how the sensor technology used in robotics.
4. To use the programs for simple robot tasks.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	2	2	2	1	1	1	1	2	1	1	1	1
CO2	3	3	3	2	2	2	1	1	1	1	2	1	2	2	2
CO3	3	3	3	2	2	2	1	1	1	1	2	1	2	2	2
CO4	3	3	3	2	2	2	1	1	1	1	2	1	3	2	2

UAU832E	COMPOSITE MATERIALS	Credits: 03
L:T:P - N_L : 3N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION TO COMPOSITE MATERIALS:
Definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites.

FIBER REINFORCED PLASTIC PROCESSING: Lay up and curing, fabricating process, open and closed mould process, hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pull forming, thermo-forming, injection molding, blow molding.

UNIT–II	10 Hrs.

CHARACTERISTICS OF FIBER-REINFORCED LAMINA:
Fundamentals, Elastic properties of a lamina, unidirectional, continuous fiber zero degree and angle-ply lamina. Lamina to laminate, lamination theory, lamina strains and stresses due to applied loads. Inter-laminar stresses. A, B, D matrices, simple problems.

UNIT–III	10 Hrs.

METAL MATRIX COMPOSITES:
Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC‟s and its application, mechanical properties, isostress, iso strain for fiber reinforced MMC‟s applications and mechanics of fiber reinforced plastics: automobile, aircraft missiles. Space hardware, electrical and electronics, marine, recreational and sports equipment

UNIT–IV	10 Hrs.

FABRICATION PROCESS FOR MMC'S:
Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

STUDY PROPERTIES OF MMC'S: Physical , mechanical, wear, machinability and other properties. Effect of size, shape and distribution of particulate on properties.

Reference Books *

TEXT BOOKS:
1. Composite Science and Engineering by K. K. Chawla Springer Verlag 1998.
2. Introduction to composite materials by Hull and Clyne, Cambridge University.

'REFERENCE BOOKS:
1. Fiber Reinforced Composites by P. K. Mallick, Marcel Dekker,Inc 2
2. Mechanics of Composite Materials, Robert M. Jones, McGraw Hill Kogakusha Ltd.1998

Composite materials hand book, Meing Schwaitz," McGraw Hill book company.1984

Course Outcomes**

1. To understand the concepts of composite materials and their processing
2. To laminates for various automotive applications
3. Know of mechanical properties of metal matrix composite
4. To approaches for fabrication of MMC and applications

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	2	1	1			1	2	1	1			
CO2	2	2	2	1	1	1			1	2	1	1			
CO3	3	2	1	2	1	1			1	2	1	1			
CO4	2	2	2	1	1	1			1	2	1	1			

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UAU833E	ENGINE TROUBLE DIAGNOSIS AND REBUILDING	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
DIAGNOSIS: Introduction, risk assessment and reduction, terminology. Fault code readers, systems, data sources. **TOOLS AND EQUIPMENT**: Basic equipment, scanners.	
UNIT–II	**10 Hrs.**
DIAGNOSTIC TECHNIQUES: Introduction, diagnostic process, mechanical and electrical diagnostic techniques, fault codes and systems. Sensors, actuators and oscilloscope diagnostics; Introduction, sensors, actuators, engine waveforms, communications networks. **ON-BOARD DIAGNOSTICS**: Gasoline OBD monitors, misfire detection, future developments in diagnostic systems.	
UNIT–III	**10 Hrs.**
ENGINE SYSTEMS DIAGNOSTICS: Engines, fuel system, ignition system, emission, fuel injection system, diesel injection system, engine management, exhaust and air supply, cooling and lubrication. **ENGINE TESTING INSTRUMENTS**; Tachometer, dwell meter, cylinder compression tester, vacuum gauge, exhaust gas analyzer, engine analyzer, oscilloscope, chassis dynamometer. **ENGINE TUNE-UP**: Meaning, significance and procedure.	
UNIT–IV	**10 Hrs.**
PRACTICAL APPROACH AND TROUBLE DIAGNOSIS: Engine trouble diagnosis; engine not cranking, engine runs but misses, engine lacks power, engine overheating, engine idles rough, engine backfires, engine carbonizing, engine run-on or dieseling, engine stalling, engine backfires, excessive fuel , excessive oil consumption, engine noises, low compression. **DIESEL ENGINE TROUBLE DIAGNOSIS.**	
Reference Books *	
BOOKS: Advanced automotive fault diagnosis - Tom Denton (third edition Rantledge) Automotive Mechanics - William Crouse	
Course Outcomes**	
1. To study the diagnosis of vehicle introduction, risk assessment and reduction, terminology. fault code readers, systems, data sources.	
2. To know the scope and utility of tools and equipment , basic equipment, scanners	
3. To study and analyze OBD monitors, misfire detection, future developments in diagnostic systems	
4. To study various engine testing instruments and tune-up techniques	
5. To study the diesel engine trouble diagnosis	

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	1	2	1				1	1	1	1	2	2
CO2	2	2	1	1	2	1				1	1	1	1	2	2
CO3	2	2	1	1	2	1				1	1	1	1	2	2
CO4	2	2	1	1	2	1				1	1	1	1	2	2
CO5	2	2	1	1		1				1	1	1	1	2	2

UAU834E	HYBRID VEHICLES	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
HYBRID DRIVES: Introduction, features , functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, optimization of hybrid configurations. Changing modes for conductive charging. Super capacitor, fuels cells, solar cells, the flywheel, the hydraulic accumulator, compressed air storage, thermal energy storage, non battery energy sources.	
UNIT–II	**10 Hrs.**
HYBRID ELECTRIC VEHICLES(HEVS) AND DRIVE STRUCTURES: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive(electrical coupling), parallel hybrid electrical drive train(mechanical coupling), parallel hybrid drive train with torque coupling, power split hybrid drive, speed coupling, hybrid drive train with torque and speed coupling. Control of hybrid vehicles.	
UNIT–III	**10 Hrs.**
Road performance simulation of battery, hydrogen and hybrid cars, simulation of efficient IC Engine. Flywheel technologies, hybridization of energy storage, regenerative braking; braking energy versus vehicle speed, braking power, vehicle speed, vehicle deceleration rate. Electric motor drive design. Brake system of HEVs and FCV. Power train options for hybrid vehicles.	
UNIT–IV	**10 Hrs.**
FUEL CELLS: Fundamentals, operating principles of fuel cells, fuel cell system characteristics, fuel cell technologies, non-hydrogen fuel cells, fuel cell hybrid electric drive train design, configuration, control strategy, parametric design. Inductive charging. Factors affecting plug-in hybrid fuel consumption. Relative fuel economy potential of intelligent, hybrid and intelligent-hybrid passenger vehicle. Vehicle models for simulation studies, hybrid vehicles with telematics. Hybrid system configuration of BMW, Volkswagan, Fiat, Volvo, Toyota. All-electric hybrid vehicles, electromechanical hybrid vehicles, heat engine electric hybrid vehicles, production.	
Reference Books *	
BOOKS: Electric and hybrid vehicles - Gianfranco pistoia (elsevies)	
Course Outcomes**	
1. Able to classify drives in hybrid vehicles their principles and merits.	
2. Able to classify and analyze different electronic control system and their application.	
3. List different batteries their merits, demerits and specification.	
4. List different power sources used in hybrid vehicles and compare with analyze.	
5. To define vehicle safety system and working principles and applications.	
6. Able justify working principles of hybrid vehicles and carry out performance analysis.	

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1				2					2	2	2	1
CO2	3	1	1				1					2	2	2	2
CO3	3	1	1				1					2	2	2	1
CO4	3	1	1				3					2	2	2	2
CO5	2	1	1				2	1				2	2	2	1
CO6	2	1	1				1	1				2	2	2	1

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UAU852E	HYDRAULICS AND PNEUMATICS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
INTRODUCTION TO HYDRAULIC POWER: Pascal's law and problems on Pascal's law, continuity equations, introduction to conversion of units. Structure of hydraulic control system. **SOURCE OF HYDRAULIC POWER**: Pumps; pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps. **HYDRAULIC ACTUATORS AND MOTORS**: Linear hydraulic actuators [cylinders], mechanics of hydraulic cylinder loading, hydraulic rotary actuators, gear motors, vane motors, piston motors, hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.	
UNIT–II	**10 Hrs.**
CONTROL COMPONENTS IN HYDRAULIC SYSTEMS: Directional control valves - symbolic representation, constructional features, pressure control valves - direct and pilot operated types, flow control valves. **HYDRAULIC CIRCUIT DESIGN AND ANALYSIS**: Control of single and double - acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.	
UNIT–III	**10 Hrs.**
MAINTENANCE OF HYDRAULIC SYSTEMS: Hydraulic oils - desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting. **INTRODUCTION TO PNEUMATIC CONTROL**: Choice of working medium, characteristics of compressed air. Structure of pneumatic control system. **PNEUMATIC ACTUATORS**: Linear cylinders - types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. Rod - less cylinders - types, working advantages. Rotary cylinder types construction and application. Design parameters - selection.	
UNIT–IV	**10 Hrs.**
DIRECTIONAL CONTROL VALVES: Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Signal processing elements: Use of logic gates - OR and AND gates pneumatic applications. Practical examples involving the use of logic gates. **MULTI - CYLINDER APPLICATIONS**: Coordinated and sequential motion control. Motion and control diagrams - signal elimination methods. Electro-pneumatic control: principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Compressed air: production of compressed air compressors, preparation of compressed air driers, filters, regulators, lubricators, distribution of compressed air piping layout.	
Reference Books *	

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TEXT BOOKS:

1. Fluid Power with applications: Anthony Esposito, Fifth edition pearson education, Inc. 2000.
2. Pneumatics and Hydraulics: Andrew Parr. Jaico Publishing Co. 2000.

REFERENCE BOOKS:

1. Oil Hydraulic Systems – Principles and Maintenance: S.R. 2002 Majumdar, Tata Mc Graw Hill publishing

company Ltd. 2001.

Course Outcomes**

1. To draw block diagram and explain working principles of fluid power systems
2. To analyze given hydraulic and pneumatic circuits
3. To compute dimensions of various hydraulic and pneumatic components using analytical equations
4. To design basic hydraulic and pneumatic circuits for a given application
5. To design electro-hydraulic and electro-pneumatic circuits for a given application

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2		1								1	2	1	1	1
CO2	2	2	1	2							1	2	2	2	2
CO3	3	3	2	2							1	2	2	3	2
CO4	2	2	2	1							1	2	3	3	2
CO5	1	2	2								1	2	3	3	2

UAU 841E	AUTOMOTIVE VEHICLE SAFETY	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: xx03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to vehicle safety: Objectives, general implications. Basic concepts of vehicle safety: Underlying principles, public health analogy, prioritization of effort, triology, cause and effect, immediate objectives. Driving forces for increased vehicle safety, safety legislation, accident data.	
UNIT–II	**10 Hrs.**
Accident avoidance: Human factors, comfort, ergonomics, acceleration and braking; adaptive cruise control, brake-by-wire, vehicle dynamics. Design requirement of frontal collision, rear end collision and roll over. Occupant protection: Restraint systems, seat belts, air bags for frontal impacts, side protection by air bags, additional air bag applications, sensors for systems.	
UNIT–III	**10 Hrs.**
Risk Evaluation, human error control, risk communication, universal design, occupant injury prevent; bio-kinetics. Human simulation application, crash testing, accident reconstruction. Development criteria and standards for vehicle. Compatibility, accident analysis, impact analysis; frontal impact, side impact, computer simulation.	
UNIT–IV	**10 Hrs.**
Body structure of small car in frontal vehicle to vehicle crash; introduction, safety improvement for small cars, new design concept, structure and crash performance. Compatibility requirement for cars in frontal and side impact: Introduction, collision type, geometry, mass and structure stiffness, car to car side impact, finite element modeling.	
Reference Books *	
Books: Automotive vehicle safety – George A Peters, Barbara j Peters (SAE) Automotive vehicle safety – Ulrich Seiffest, Lothar Wech Vehicle compatibility in automotive crashes – Stanley H Backaities(SAE)	
Course Outcomes**	
1. Able to know the vehicle safety objectives, general implications. basic concepts of vehicle safety	
2. To study the brake-by-wire, vehicle dynamics human factors, comfort, ergonomics.	
3. To study and analyze the risk evaluation, human error control and bio-kinetics	
4. To study the compatibility requirement for cars in frontal and side impact collision type; geometry, mass and structure	

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	2		1		1	1	1	1	1			
CO2	2	2	1	2		1		1	1	1	1	1			
CO3	2	1	2	2		1		1	1	1	1	1			

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CO4	2	2	2	2		1		1	1	1	1	1			

UAU 842E	ADVANCED I.C. ENGINES	Credits: 03
L:T:P - N_L :3 N_T: 0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
COMBUSTION IN SPARK IGNITION ENGINES: Thermodynamic analysis of SI engine combustion: burned and unburned mixture states. Analysis of cylinder pressure data, combustion process characterization, flame structure and speed; laminar burning speeds, partial burning and misfire: definitions, causes of cycle - by - cycle and cylinder to cylinder variations, partial burning, misfire and engine stability. Abnormal combustion: knock and surface ignition, knock fundamentals, fuel factors.	
UNIT–II	**10 Hrs.**
COMBUSTION IN COMPRESSION IGNITION ENGINES: Types of diesel combustion systems: Direct injection systems, indirect injection systems, comparison of different combustion systems, analysis cylinder pressure data; combustion efficiency, DI engines, IDI engines, ignition delay: definitions and discussion, fuel ignition quality, auto ignition fundamentals.	
UNIT–III	**10 Hrs.**
MODERN DEVELOPMENTS IN I.C.ENGINES: Lean burn engines, ceramic and adiabatic engines, multi-valves, tuned manifolds, cam less valve gearing, variable valve timing, turbo and supercharging - waste gating, EGR, part-load charge stratification in GDI systems. Sports vehicle engines, Stirling engines, MPFI engines - operation and performance.	
UNIT–IV	**10 Hrs.**
SPECIAL TYPES OF ENGINES: Introduction to working of stratified charged engines, Wankel engine, variable compression engine, surface ignition engines, free piston engines, current engines and future trends (e.g. convergence of SI and CI engine technology, control developments, fuel quality), effect of air cleaners and silencers on engine performance.	

Reference Books *

TEXT BOOKS:

1. Internal Combustion Engines Fundamentals - John B. Heywood, McGraw Hill International Edition,
2. A course in I.C. Engines - Mathur & Sharma, Dhanpat Rai & sons, New Delhi,1994

REFERENCE BOOKS:

1. I.C.Engines by Taylor, MIT Press England 1989
2. I.C.Engines By Lichty., McGraw Hill
3. Fuels & Combustion By Smith & Stinson., McGrawHill
4. Motor Vehicle Engines by M.Khovakh., Mir Publishers
5. I.C. Engines by V.Ganesan, Tata Mc Graw Hill,1994

Course Outcomes**

1. Analyze the thermodynamic analysis and pressure variations in single and multiple cylinders of SI and CI engines and variation of mixture strength and emissions .
2. Analyze the combustion analysis, its phases and heat release patterns and their variations, air cleaners and silencers in SI and CI engines.
3. Analyze cycle – by – cycle fluctuations in single cylinder and cylinder to cylinder and problems of power /energy imbalance, misfiring in the SI engines and types of combustion chambers in both engines.

4. To know and analyze the causes of knocking and its impacts on engine performance and their controlling methods.

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5. Analyze the various construction, working and applications of V- type, stratified charge, multi valve, lean burn, MPFI and VCR engines.
6. Analyze the principle and feature of supercharging, free piston, Stirling and Wankel engine.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	1									2	2	2	1
CO2	3	1	1									2	2	2	2
CO3	3	1	1									2	2	2	1
CO4	3	1	1									2	2	2	2
CO5	3	1	1									2	2	2	1
CO6	3	1	1									2	2	2	1

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UAU843E	FINITE ELEMENT METHODS	Credits: 03
L:T:P - N_L : 3N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION: Equilibrium equations in elasticity subjected to body force, traction forces, stress strain relations for plane stress and plane strain, Boundary conditions, Initial conditions, Euler's Lagrange's equations of bar, beams, principle of a minimum potential energy, principle of virtual work, Rayleigh-Ritz method Galerkins method and matrix techniques. Basic procedure: General description of Finite Element Method, discretization process; types of elements 1D, 2D and 3D elements, size of the elements, location of nodes, node numbering scheme, half bandwidth, stiffness matrix of bar element by direct method, properties of stiffness matrix, preprocessing, post processing. Engineering applications of finite element method. Advantages and disadvantages of FEM.

UNIT–II	10 Hrs.

INTERPOLATION MODELS: Polynomial form of interpolation functions - linear, quadratic and cubic, simplex, complex, multiplex elements, selection of the order of the interpolation polynomial, convergence requirements, static condensation. Penalty approach and elimination method. One dimensional bar element: Recall of 1D linear bar element. Lagrangian interpolation, higher order one dimensional elements- quadratic, cubic element and their shape functions, properties of shape functions, effect of temperature on 1D elements and stress calculation.

UNIT–III	10 Hrs.

TWO DIMENSIONAL ELEMENTS: Shape functions and stiffness matrix of 2D elements four - node quadrilateral, nine - node quadrilateral eight - node quadrilateral, serendipity and Lagrange comparison with 2D Pascals triangle. CST and LST shape functions , Jacobian matrix, stiffness matrix, force terms, stress calculation and numerical integration. Introduction to 3-D elements shape function of tetrahedron element.

UNIT–IV	10 Hrs.

TRUSSES AND BEAM ELEMENTS: Analysis of trusses and beam elements its shape functions, stiffness matrix and stress calculation heat transfer problems: steady state heat transfer, 1D heat conduction governing equation, boundary conditions, one dimensional element, functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1D heat transfer in thin fins.

Reference Books *

Text Books:

1. Finite Elements in engineering, Chandrupatla T.R., 3rd Pearson Edition.
2. Finite Element Analysis, C.S.Krishnamurthy,–Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995.
3. "Fundamental Finite Element Analysis and Application" by "Asghar Bhatti" by PageTurner 2013.
4. "Advanced Topics in Finite Element Analysis of Structures with Mathematica and MATLAB Computations" by M. Asghar Bhatti by PageTurner 2013.

Reference Books:

1. The FEM its basics and fundamentals: O.C.Zienkiewicz, Elsevier, 6e.
2. Finite Element Method, J.N.Reddy, McGraw –Hill International Edition.
3. Finite Element Methods, by Daryl. L. Logon, Thomson Learning 3rd edition, 2001.

Course Outcomes**

1. Exposure to the fundamentals of continuum mechanics
2. Able to analyze the various interpolation models in FEM

3. To apply finite element procedures for simple 2D structural elements
4. To be able to compute the Jacobian matrix, stiffness matrix and force terms
5. Apply FEA method to analyze the various heat transfer problems

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	1	1					1	1	1			
CO2	2	2	1	2	2					1	1	1			
CO3	2	2	1	2	2					1	1	1			
CO4	2	2	1	2	1					1	1	1			
CO5	2	2	1	2	2					1	1	1			

UAU844E	EARTHMOVING EQUIPMENTS AND HEAVY DUTY TRUCKS	Credits: 03
L:T:P - N_L :3 N_T:0 N_P 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
EQUIPMENTS AND OPERATION: Different types of earth moving equipments and their applications. Dozers, loaders, shovels, excavators, scrapers, motor graders, rollers, compactors, tractors and attachments. Types of soil.	
UNIT–II	**10 Hrs.**
CARRIAGE AND SUSPENSION: Tyre and tracked vehicles, advantages and disadvantages, under carriage components like tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. **SUSPENSION:** Rubber spring suspension and air spring suspension. **TRANSMISSIONS AND FINAL DRIVES:** Basic types of transmissions, auxiliary transmission, compound transmission, planetary transmission, constructional and working principles, hydroshift automatic transmission and retarders. Final drives; types of reductions like, single reduction, double reduction final drives and planetary final drives, PTO shaft	
UNIT–III	**10 Hrs.**
HYDRAULICS: Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders. Depth and draft control systems. **STEERING AND BRAKES:** Power steering types like, linkage type power steering, semi integral power steering and integral power steering. Steering of tracked vehicles: articulated steering, clutch /brake steering system. Brakes: types of brakes like, disc brake, engine brakes etc.	
UNIT–IV	**10 Hrs.**
ODS OF SELECTION OF EQUIPMENTS: Selection of machines, basic rules of equipments including the nature of operation, selection based on type of soil, selection based on haul distance, selection based on weather condition. **CALCULATION OF OPERATING CAPACITY:** Methods of calculating operating capacity, calculation of productivity of EMEs.	

Reference Books *

TEXT BOOKS:

1. Diesel equipment: volume I and II by Erich J.schulz
2. Construction equipment and its management By S.C. Sharma

REFERENCE BOOKS:

1.Farm machinery and mechanism by Donald R. hunt and L. W.garner
2.Theory of ground vehicles by J.Y.Wong john wiley and sons
3.Moving the earth by Herbert Nicholas
4.On and with the earth by Jagman Singh, W.Newman and Co. culkatta

Course Outcomes**

1. List various types of earthmovers and explain their working principles and applications
2. Describe and differentiate the systems used in earth movers with conventional vehicles

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3. Prepare maintenance schedules for earthmovers and tractors

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4. To identify the hydraulic components and analyze hydraulic circuits used in earthmovers
5. Apply analytical methods to calculate productivity of earthmovers.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3											2	2	2	2
CO2	3	2										2	2	2	2
CO3	3	2	2	1								3	2	2	2
CO4	3	2										3	2	2	2
CO5	3	3	3	1								3	2	2	2

UAU 804P	PROJECT PHASE – II	Credits: 12
L:T:P - N_L :0 N_T:0 N_P 12		CIE Marks: 50
Total Hours/Week: 12		SEE Marks: 50

- The project work defined in project -I has to be continued for the project work – II.
- The guides have to review the progress of the project work continuously during the contact hours.
- The contact hour schedule may be defined by the guides in consent with their batches as per convenience
- CIE evaluation has to be done by DC based on the progress of the project work by conducting minimum of two demos/ seminar presentation for 25 marks each.
- The students of the project batches are supposed to submit the final project report earlier to SEE examination with the consent of the guide to the DC.
- The SEE examinations will be conducted by PEC consisting of 1) HOD/His Nominee, 2)Internal Examiner/Project Coordinator, 3)External Examiner separately for each project batch for 50marks

Project-II

Examination	**CIE I**	**CIE II**	**SEE**
Marks	**25**	**25**	**50**

Course Outcomes**

1. Applying knowledge of basic science, core and elective engineering subjects to analyze, design, develop and solve the problems.
2. Develop, fabricate and test the models, further analyze and compare performance results/ outcomes the projects.
3. Able to articulate and analyze the results and conclude with scope for future works and cost analysis.
4. Skill developments in presentation, communication and project report preparation

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	2	2	2	1	2	2	2	2	3	3	3	3
CO2	3	3	3	2	2	2	1	2	2	2	2	3	3	3	3
CO3	3	3										3	3	3	3
CO4	3	3							3	2	3	3	2	2	2

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UAU805S	TECHNICAL SEMINAR	Credits: 01
L:T:P - N_L : N_T: N_P		CIE Marks: 50
Total Hours/Week: 00		SEE Marks: 50

Each student has to submit the synopsis of the seminar topic and gets approval from the department committee (DC) consisting of HoD, BoE and respective seminar guide. The department committee allots the guide for the student. Students are required to present the seminar on said topic in consultation with the guide.

Mode of Evaluation:

Sl. No	Particulars	Marks
1	Selection of seminar topic	4
2	Collection of information	12
3	Preparation of PPT	12
4	Presentation of seminar	12
5	Queries and discussion	10
	Total	50

Scheme:

Examination	CIE	SEE
Marks	50	50

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	Title of the Subject: **Auto electrical and electronic systems**	Sem:**5** Code**: UAU551N** Credits: **3**												PSO		
														1	**2**	**3**
	Programme Outcomes / **Course Outcomes**	**Engineering knowledge**	**Problem analysis:**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage:**	**The engineer and society:**	**Environment and sustainability:**	**Ethics:**	**Individual and team work**	**Communication:**	**Project management and finance:**	**Life-long learning:**	**Apply engineering basic knowledge with modern computing tools in solving problems of design, production and servicing domains**	**Mould and develop engineers to serve in industries as professionals or entrepreneur**	**Prepare engineers to undertake research and higher learning**
1	Elucidate the construction, working and elements of different batteries, electrical accessories and dash board instruments.	3	2	2	1	2	1				1	1	1	1	2	2
2	To comprehend and apply automotive advancements and analyze for performance	3	2	1	1	2	1				1	1	1	1	2	2
3	Able to illustrate the construction and working of different ignition system and their fault diagnosing methods and remedial techniques.	3	2	2	2	2	1				1	1	1	2	2	2
4	To realize the construction and working of starter motors and alternators	3	2	1	1	2	1				1	1	1	1	2	2
5	Analyze the working of vehicle safety systems and auxiliary systems	3	2	1	2	2	1				1	1	1	1	2	2

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Common to All Branches

UAU551N: AUTO ELECTRICAL AND ELECTRONIC SYSTEMS
3 Credits (L T P: 3 - 0 - 0)

UNIT - I **10 HOURS**

STORAGE BATTERY: Introduction, principle, construction and working of lead acid battery, battery tests, battery ratings, methods of charging. Alkaline, Nickel - Cadmium battery, Lithium batteries. Battery trouble shooting.

INDICATING AND WARNING DEVICES AND DASH BOARD INSTRUMENTS: Fuel gauge, oil-pressure gauge, water temperature gauge, speedometers, horn, windscreen-wipers, signaling devices, brake warning light.

UNIT - II **10 HOURS**

AUTOELECTRONICS: Introduction to Electronic systems in Automotives - Sensors, ECU and actuators for body electronics, power train and chassis systems.

Transmission control, ABS, ESP, Traction Control, Active Suspension, passive safety, Adaptive Cruise Control. On-Board Diagnostics (OBD). Electronic suspension system.

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UNIT - III **10 HOURS**

IGNITION SYSTEM: Ignition fundamentals, types of ignition systems and related components. Spark plugs; general considerations, characteristics, materials. Ignition timing; advance mechanism; centrifugal and vacuum. Ignition system trouble shooting.

ELECTRONIC IGNITION SYSTEMS: Advantages, types, distributors less ignition system, multiple coil ignitions, direct capacitor charge ignition. Electronic spark advance.

UNIT - IV **10 HOURS**

OTHER SYSTEMS: Introduction to starter motor and drives, alternator and types, lighting systems. Electronic fuel injection systems. Types of air conditioners: manually controlled, automatically controlled. Oscilloscope. Networks and multiplexing, vehicle safety systems: seat belts, air bags. Trouble shooting diagnosis of starting motors and alternators.

TEXT BOOKS:

1. Automobile Engineering: Kirpal Singh
2. Automobile Mechanics: William H Crouse
3. Automotive Electrical equipments: P. L. Kohli

	Title of the Subject: Vehicular Systems	Sem:6				Code: UAU641N					Credits: 3		
	Programme Outcomes / **Course Outcomes**	**Engineering knowledge**	**Problem analysis:**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage:**	**The engineer and society:**	**Environment and sustainability:**	**Ethics:**	**Individual and team work**	**Communication:**	**Project management and finance:**	**Life-long learning:**
1	To classify the different types of automotive layouts and engines and their applications	1	2	1			1						2
2	To classify brakes and steering systems, construction and operational features	1	2	1									2
3	Ability to illustrate construction and working of various transmission systems	2	3	2	1								2
4	To be able to describe construction and working of different types of suspension systems and tyres	1		3	3								2

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3	3	3	3	Apply engineering basic knowledge with modern computing tools in solving problems of design, production and servicing domains	1	PSO
2	2	2	2	Mould and develop engineers to serve in industries as professionals or entrepreneur	2	
2	2	2	2	Prepare engineers to undertake research and higher learning	3	

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(All Branches)

OPEN ELECTIVE
UAU641N: VEHICULAR SYSTEMS
3 Credits (L-T-P: 3-0-0)

UNIT – I **10 HOURS**

GENERAL: Introduction, electric vehicles, hybrid vehicles, electronics in automobiles; sensors, ECU. Automotive emissions.
VEHICLE LAYOUTS: Introduction, different types of layouts, front engine front wheel drive, front engine rear wheel drive, rear engine rear wheel drive, four-wheel drive, all-wheel drive.
ENGINES: Combustion in SI Engines; ignition limits, stages of combustion, detonation, combustion chambers.
Combustion in CI Engines; stages of combustion, delay period, diesel knock, combustion chambers. Turbo-charging and dual fuel engines.

UNIT – II **10 HOURS**

CONTROL SYSTEMS:

BRAKES: classification, hydraulic brakes, mechanical brakes, disc brakes, drum brakes, brake fluids, requirements, bleeding of brakes, air brakes, vacuum servo brakes, parking brakes, trouble shooting diagnosis. ABS and EBD.
STEERING SYSTEMS: Types of steering systems, correct steering angle, cornering force, under steer and over steer. Types of steering gear; rack and pinion, recirculating type etc. Power steering.

UNIT – III **10 HOURS**

TRANSMISSION SYSTEMS:
CLUTCH: Purpose, requirements, materials, types of clutches; single plate, multi-plate, diaphragm, centrifugal, semi-centrifugal, vacuum, hydraulic clutch. Trouble shooting diagnosis.
GEAR BOX: Purpose, types of gear box; sliding mesh, constant mesh, synchromesh and epicyclic gear box. Gear box lubrication, gear ox troubles. Automatic transmission; significance and types.

UNIT – IV **10 HOURS**

SUSPENSION SYSTEMS:
Purpose, types of springs; coil springs, leaf springs, torsion bar, helper springs, rubber springs. Independent suspension; advantages and types. Shock absorbers. Stabilizer bars. Active suspension. Trouble shooting.
WHEELS AND TYRES: Wheels; types and materials. Tyres; Tubed and tubeless tyres; advantages. Tyre materials, desirable tyre properties, aspect ratio, nomenclature, factors affecting tyre life and tyre rotation.

TOTAL: 40 HOURS

Text books:

1. Automobile Engineering By Kirpal singh Vol. I & II
2. Automobile Engineering By GBS Narang
3. I C Engines, M L Mathur, R P Sharma, Dhanpat Rai Publications
4. Automotive Mechanics, W H Crouse, Anglin, Tata Mcgraw Hil

	Title of the Subject: Electric Vehicles	Sem:6			Code: UAU642N					Credits: 3				PSO		
														1	2	3
	Programme Outcomes / **Course Outcomes**	Engineering knowledge	Problem analysis:	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage:	The engineer and society:	Environment and sustainability:	Ethics:	Individual and team work	Communication:	Project management and finance:	Life-long learning:	Apply engineering basic knowledge with modern computing tools in solving problems of design, production and servicing domains	Mould and develop engineers to serve in industries as professionals or entrepreneur	Prepare engineers to undertake research and higher learning
1	Ability to classify EVs through understanding the operational and control features.	3	2	1	1	1	1	1					1	2	2	2
2	Ability to classify the automotive batteries, understand the working principles and applications.	3	2	1	1	1	1	1					1	2	2	2
3	Ability to classify the drives for EVs by realising the working and control principles, speed-torque characteristics and applications.	3	2	1	1	1	1	1					1	2	2	2
4	Ability to classify HEVs through understanding the power trains and compare the operating conditions.	3	2	1	2	2	1	1					1	2	2	2
5	Understand the force dynamics for an automobile and apply the same for selection of EV components	3	2	1	2	2	1	1					1	2	2	2

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Common to All Branches

Open Elective
Electric Vehicles (UAU642N)
3 Credits (L-T-P: 3-0-0)

UNIT-I

Electric Vehicles History: Basics of Electric Vehicles, components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs), Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EVs, National Policy for adoption of EVs, Batteries: Types, working, merits and demerits **10 Hours**

UNIT-II

Drives and controls: Drive classification: Principle and working of PMDC motor, BLDC motor and PMSM motors. Characteristics (Speed torque characteristics) and control features of PMDC motor, BLDC motor and PMSM motors. Comparison and advantages. Converters: AC-DC, DC-AC, DC-DC and AC-AC. Four quadrant operation. **10 Hours**

UNIT-III

Hybrid Powertrains: Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs). Compare and contrast the performance of ICE vehicles, HEVs and BEVs.

10 Hours

UNIT-IV

Vehicle dynamics: Vehicle resistance, Types: Rolling Resistance, Grading resistance, Aerodynamic drag, Vehicle performance, Calculating the Acceleration Force, Maximum speed, Total Tractive Effort and Torque Required On The Drive Wheel. Transmission: Differential, clutch & gear box, Braking performance and regenerative braking.

10 Hours

Text books:

1. **Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, CRC Press 2005**
2. **Electric and Hybrid Vehicles- Design Fundamentals by Iqbal Husain, CRC Press, 2005**
3. **Electrical Vehicle Technology by Sunil R Pawar, Notion Press Publications, Second edition, 2021**
4. **Automobile Mechanics by N.K.Giri, Khanna Publishers, 2008**

	Title of the Subject: Emerging Technology in Automobile	Sem:7			Code: UAU731N					Credits: 3			
	Programme Outcomes / **Course Outcomes**	**Engineering knowledge**	**Problem analysis:**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Modern tool usage:**	**The engineer and society:**	**Environment and sustainability:**	**Ethics:**	**Individual and team work**	**Communication:**	**Project management and finance:**	**Life-long learning:**
1	Apply the basics of Automotives to emerging technology	2	2	1	1		1						1
2	Ability to analyze and apply concepts of advancements in Brakes, steering and MPFI etc	2	2	1	1		1						1
3	Analyze and demonstrate contemporary technology related to emission control	2	2	1	1		1						1
4	Evaluate and apply vehicle safety techniques and impact	2	2	1	1		1						2

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2	2	2	2	**Apply engineering basic knowledge with modern computing tools in solving problems of design, production and servicing domains**	**1**	PSO
2	2	2	2	**Mould and develop engineers to serve in industries as professionals or entrepreneur**	**2**	
2	2	2	2	**Prepare engineers to undertake research and higher learning**	**3**	

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(All branches)

OPEN ELECTIVE
UAU731N: Emerging Technology in Automobiles
3 Credits (L-T-P: 3-0-0)

UNIT – I 10 HOURS

HYBRID / ELECTRICAL VEHICLES: Fundamentals, need for EVs, types of drives, batteries used for EVs, different electrical motors used for EVs. Charging systems, performance of EVs. Electrical vehicles in India and their specifications. Architecture of electric drive train. Comparison with respect to conventional power train.
FUEL CELLS: Operating principles, types and characteristics.

UNIT – II 10 HOURS

ENGINE MANAGEMENT SYSTEMS: Introduction, automotive fuel flow systems, electronic petrol and diesel injection systems. MPFI engines; construction, working and applications.
TURBO CHARGING SYSTEMS: Need, utility, application types of turbo charging systems merits limits Introduction alternative fuels for power plant for automobiles.

UNIT – III 10 HOURS

ADVANCEMENTS IN AUTOMOBILES: Variable compression ratio engine, multi valve engines, electronic power steering, anti-roll bars and OBD. Vehicle safety systems; air bags, ABS,EBD, TCS and ESP.
AERODYNAMICS: Necessity, significance and applications to surface, ambient and aero-transportation systems.
Introduction to guided vehicles, autonomous vehicles and computer aided vehicle navigational system.

UNIT – IV 10 HOURS

AUTOMOTIVE EMISSIONS AND CONTROL: Automotive emissions; petrol and diesel engine emissions; pollutants, reasons, effects of emissions. Emission norms.
Emission control measures: Catalytic converter; need, working and types. PCV systems, EGR systems, diesel particulate filters.
ALTERNATIVE FUELS: Need, availability, merits and demerits. Alcohol fuels, natural gas, biomass and hydrogen energy.

TOTAL: 40 HOURS

Text books:

1. Electric And Hybrid Vehicles, Gianfranco, Elsevier
2. Engine Emissions Fundamentals And Advances In Control, B P Pundir, Narosa Books
3. I C Engines, M L Mathur, R P Sharma, Dhanpat Rai Publications
4. Automotive Mechanics, W H Crouse, Anglin, Tata Mcgraw Hill

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DEPARTMENT OF BIOTECHNOLOGY

SCHEME OF TEACHING AND EXAMINATION

B. E. III SEMESTER

2023-24

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA301C	Partial definition equation and integral transforms	03	3	0	0	50	50	100
2.	IPCC	22UBT302C	Microbiology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT303C	Unit Operations + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT304C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT305C	Bioprocess Principles and Calculations	03	2	2	0	50	50	100
6.	BSC	22UBT340C	Biology for Engineers	02	2	0	0	50	50	100
7.	PCCL	22UBT306L	Biochemistry Lab	01	0	0	2	50	50	100
8.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	100	-	-
			Total	**20**	**16**	**2**	**8**	**450**	**350**	**700**

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22UMA301C	PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs.

Partial Differential Equations_I : Introduction to PDE, Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives with respect to one independent variable only. Solution of Lagrange's linear PDE.

(RBT Levels: L1, L2 and L3)

UNIT – II	10 Hrs.

Partial Differential Equations_II : Solutions of PDE by the method of separation of variable. Derivation of one-dimensional heat and wave equations and their solutions by explicit method, solution of Laplace equation by using five point formulas.

(RBT Levels: L1, L2 and L3)

UNIT – III	10 Hrs.

Fourier series :Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.

(RBT Levels: L1, L2 and L3)

UNIT – IV	10 Hrs.

Fourier transforms and z-transforms : Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms. Z-transforms-definition, standard forms, linearity property, damping rule, shifting rule-problems. Inverse Z-transforms.

(RBT Levels: L1, L2 and L3)

References:

1. Numerical Methods for Engineers by Steven C Chapra &Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi
4. Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons.

Course Objectives:

1. PDE’s provides a powerful tool for quantifying rates of change optimizing functions, and modeling complex systems.
2. To provide a way, to represent periodic functions in terms of simple trigonometric functions.
3. To transform a function from the time domain to the frequency domain.
4. Provides a powerful mathematical tool for analyzing, designing, and manipulating

discrete time signals and systems.
Course Outcomes: After completion of the course the students shall be able to, 1. Identify different types of PDEs including linear vs nonlinear, first order vs higher-order, and partial derivatives of different variables. 2. Learn various analytical techniques to solve to specific types of PDEs, such as variable separable and explicit method. 3. Grasp the concept of representing periodic functions as an infinite sum sinusoidal (sine and cosine) with different frequencies. 4. Grasp the concept of the Fourier transform as a mathematical tool that converts a function from the time domain into the frequency domain.

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	40	20
CIE-II	40	20
Assignments/ Quizzes/Case Study/ Course Project/Term Paper/Field Work	10	10
SEE	100	50
Total	**190**	**100**

Question paper pattern for CIE-I and CIE-II:

Question paper consists Part-A and Part-B. Part A is compulsory, it consists of short answer questions of 1 or 2 marks, covering Unit-I and Unit-II (no multiple choice questions and No true or false questions).

1. In Part-B, four questions are to be set as per the following table.

CIE	Number of questions / Maximum marks	Sub divisions	Covering entire unit
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-I

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I	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-II
II	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-III
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-IV

Question paper pattern for SEE:

1. Question paper consists Part-A and Part-B. Question number 1 is compulsory, it consists of short answer questions of 1 or 2 marks, covering entire syllabus (no multiple choice questions and No true or false questions, 50% of questions must be L3 and L4 level).
2. In Part-B total of eight questions with two from each unit; with internal choice to be set uniformly covering the entire syllabus.
3. Each question carries 20 marks and should not have more than four subdivisions.
4. In Part-B, any FOUR full questions are to be answered choosing at least one from each unit.
5. Sketches, figures and tables if any should be clearly drawn, as the same is scanned for printing.
6. The question paper should contain all the data / figures / marks allocated, with clarity.

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22UBT302C	MICROBIOLOGY	Credits: 04
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction: Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).	
UNIT–II	**10Hrs.**
Microorganisms: Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth pattern (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid & alcohol).	
UNIT–III	**10 Hrs.**
Control of Microorganisms: Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. Medical Microbiology: Normal microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention.	
UNIT–IV	**10 Hrs.**
Agricultural and Environmental Microbiology: Microbiology of soil, Air and Aquatic Microbiology, Bio-fertilizer, Plant endophytes, Microbes in bioremediation and bio-control agents. Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).	

REFERENCE BOOKS *

1. Pelczar, Chan and Noel Kreig, "Microbiology"- 5th Edition Tata Macgraw Hill, 2010.
2. Tortora, Funke and Case, "Microbiology an Introduction" -8th Edition, Pearson Education, 2006.
3. Stainer R.Y., Ingraham J.L., "General Microbiology"- 5th Edition Mc.Millan Press, 2010.
4. Madigan, Martinko, Parker, Brock's, "Biology of Microorganisms" - 10th Edition, Prentice Hall, Pearson Education, 2003.
5. Prescot and Dunn, "Industrial Microbiology"-Agribios India, 2002.
6. J. Salle, "Fundamental Principles of Bacteriology" – 7th Edition, Tata Macgraw Hill, 2007.

7. E Alcamo I "Fundamentals of Microbiology"6th Ed, Jones &Bartlet, Pub. 2001.
8. Prescott, Harley & Klein, "Microbiology" -7th Edition, WCB/McGraw Hill, Int. Edition, 2008.

COURSE OUTCOMES**

- Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
- Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
- Ability to discuss the causative organisms of the disease and their effect on society
- Ability to analyse the applied techniques in the environment and create awareness to society

LIST OF EXPERIMENTS

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Enumeration of microorganisms using colony counter
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria & Observation of motility by hanging drop technique.

COURSE OUTCOMES**

1. Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Ability to discuss the causative organisms of the disease and their effect on society
4. Ability to analyse the applied techniques in the environment and create awareness to society

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2			2		2					1	1	1
CO 2	2	2	2		2	3		1					2	1	2
CO 3	3	3	2		2	2		1				1	1	1	2
CO 4	3	3	3		2	3		2				1	2	1	3

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22UBT303C	UNIT OPERATIONS	Credits: 04
L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 Hrs.

Fundamentals of Fluid Mechanics:

Units and Dimensions- Basic and Derived units, Dimensional homogeneity, Dimensional Analysis, Fluid definition and classification of fluids, Properties and Rheological behaviour of fluids, Newton's Law of viscosity, Newtonian and Non-Newtonian types of Fluids, Hydrostatic equilibrium, Barometric equation and Pressure measurement using manometers, Conceptual numericals, Types of Fluid flow- Laminar and Turbulent, Reynolds number and its Importance.

UNIT–II	10 Hrs.

Fluid Flow and Measurement:

Basic equations of fluid flow - Continuity equation and Bernoulli theorem and equation; Derivation of Bernoulli's equation, Correction for Bernoulli's equation, Flow through circular and non-circular conduits, Flow Measurement, Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter), Pumps- Classification of Pumps (Centrifugal & Reciprocating pumps), Construction and working of Centrifugal pump, characteristics of pumps and Characteristic Curves.

UNIT–III	10 Hrs.

Filtration and Sedimentation:

Theory of Filtration, Types of Filtration, Distribution of overall pressure drop (Resistances), Filter medium, Characteristics of filter medium, Filter aids, Factors Affecting Rate of Filtration, Filtration equipment's - Plate and Frame Filter Press, Rotary Drum Filter. Theory of Settling and Sedimentation, Types of Settling - Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Equipment (cyclones, thickeners), Conceptual numericals

UNIT–IV	10 Hrs.

Size Separation and Mixing:

Size Separation: Concept and Importance of screening operation, Type of Screen Analysis, Effectiveness of a Screen, Factors affecting performance of screens. Concept Of Mixing, Homogeneous and Heterogeneous Mixtures, Importance of Mixing and Agitation, Mixing liquids with liquids, Construction and Flow Patterns of Impellers, Mixing Of Gases With Liquids

List of Experiments in Unit Operations Laboratory

1. **Verification of Bernoulli's theorem**
2. **Study of packed bed characteristics**
3. **Orifice meter**

4. **Venturimeter**
5. **Rotameter**
6. **Batch sedimentation test**
7. **Screen effectiveness and Sieve analysis**
8. **Filtration**
9. **Settling**
10. **Mixing**

Text Books and Reference Books *

1. McCabe W. L, Smith J. C and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2014) Unit Operations I, Fluid Flow and Mechanical operations, 24nd Edition. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA. Edited by R. P. Chhabra V. Shankar (2017)

. Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA. Edited by R. P. Chhabra and Basavaraj Gurappa (2019)

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of dimensional analysis and can state and describe the nature and properties of the fluids.
2. Apply the knowledge of fluid mechanics and determine the flow rate, discharge of transportation fluids
3. Apply the knowledge of filtration and sedimentation in Engineering applications
4. Apply the knowledge of Size Separation and Agitation techniques in Engineering applications

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	1	-	-	-	-	-	-	-	3		
CO2	3	2	3	2	1	-	-	-	-	-	-	-	3		
CO3	2	3	3	1	1	-	-	-	-	-	-	-	2		
CO4	2	3	3	1	1	-	-	-	-	-	-	-	2		

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22UBT304C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT – 1	12 Hrs.
Carbohydrate Metabolism: Glycolysis, TCA cycle, Glyoxylate cycle, Gluconeogenesis and regulation of gluconeogenesis, pentose phosphate pathwayand Electron transport chain, oxidative phosphorylation, bioenergetics, Structure and properties of ATP. Disorders of carbohydrate metabolism.	
UNIT – 2	**10 Hrs.**
Lipid Metabolism: Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids. Regulation of fatty acid biosynthesis, biodegradation of fatty acid. Ketone bodies production during starving and diabetes. Disorders of lipid metabolism.	
UNIT – 3	**10 Hrs.**
Nucleic acid Metabolism: Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP. De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines & pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Disorders of nucleic acid metabolism.	
UNIT – 4	**10 Hrs.**
Amino Acid Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family) - Aspartate, Asparagine, Methionine, Lysine, Threonine. Biodegradation of amino acids- deamination, transamination and urea cycle. Disorders of amino acid metabolism.	

REFERENCES*

1. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" **7th** edition W.H Freeman & Co., Pub.
2. Lubert Stryer (2010)., "Biochemistry" **-**5th edition Freeman & Co., Pub.
3. Voet&Voet (2011). "Biochemistry"**-** 4th edition, John Wiley,New York Pub.
4. Thomas M. Davlins (2010). " Biochemistry with clinical correlations" 7th edition Wiley-Liss;.
5. Mathews, Vanholde & Arhen (2010). "Biochemistry" -3rd edition, Pearson Education Pub
6. Elliot & William H (2011). "Biochemistry & Molecular Biology"3rd edition, John Wiley.
7. U. Sathyanarayana (2022). "Biochemistry" -5th edition, Books and Allied Pub.

COURSE OUTCOMES**

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After completion of the course student will have the ability

1. To understand the metabolic pathways in the carbohydrates along with its energetic and interpret the metabolic disorders.
2. To understand lipid metabolism and comprehend the regulation of along with the in born errors of metabolism.
3. To understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism and also its disorders
4. To understand pathways involved in amino acid metabolism and its disorders.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	
CO 2	2	3	3	3		3	2	3				3	2	1	2
CO 3	2	2	3	3		3	2	2				3	3	2	
CO 4	2	2	2	2		2	2	2				2	2	2	

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22UBT305C	BIOPROCESS PRINCIPLES AND CALCULATIONS	03 - Credits (2 : 2 : 0)
Hours / Week : 04		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	7 + 3 Hrs.

Introduction to Engineering Calculations

Dimensions and System of Units:

Introduction, Fundamental and Derived Units, Fundamental and Derived Quantities; System of Units (FPS, CGS, MKS, SI); Conversion of Units, Inter-conversion; Conceptual Numericals

Basic Chemical Engineering Calculations:

Atomic, Molecular and Equivalent weights, molar concept, Gram atom, Gram mole; Equivalent Weight; Concept of Normality, Molarity and Molality. Method of Expressing the Composition of Mixtures and solutions, weight fraction, mole fraction, Percentage by weight, mole percent and volume percent; Concept of PPM (Parts Per Million); Conceptual Numericals;

Gases, Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Gaseous Mixtures, Relationship between Partial Pressure and Mole Fraction of Component Gas; Average Molecular Weight of Gas Mixture; Density of Gas Mixture; Conceptual Numericals

UNIT – 2	7 + 3 Hrs.

Introduction to Bioprocesses:

Bioprocess Engineering, Role of a bioprocess engineer in the biotechnology industry, unit operations involved in bioprocesses

Material Balance without Chemical Reactions

General material balance equation for steady and unsteady states.

Generalized Block Diagram of process showing input and output; Material balance equations for Unit Operations like Distillation, Evaporation, Crystallization, Mixing, Drying, Extraction; Material balances and calculations on Distillation, Evaporation, Crystallization and Mixing Unit Operations- Conceptual Numericals

UNIT – 3	7 + 3 Hrs.

Material Balance Involving Chemical Reactions

Generalized material balance equations, stoichiometry, Principles of stoichiometry, stoichiometric ratio, proportion, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity, Material Balance and Conceptual Numericals on different Unit processes

UNIT – 4	7 + 3 Hrs.

Stoichiometry of Microbial growth and Product formation

Stoichiometry of cell Growth and Product Formation- elemental balances, degrees of reduction of substrate and biomass; available-electron balances; yield coefficients of biomass and product formation

REFERENCES
Chemical Process Calculations by D. C. Sikdar, PHI Learning Private Limited, Delhi, 2013 Introduction to Process Calculation by K A Gavane, Nirali Publications,2016 Stoichiometry by B. I. Bhatt and S. M. Vora, Tata McGraw Hill Publishing, 4th Edition, 2004 Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI Learning Private Limited, 2005 Bioprocess Engineering Principles by Pauline M. Doran, Academic Press, 2012 Biochemical Engineering Fundamentals: by J. E. Bailey & D. F. Ollis, McGraw Hill, 2005 Bioprocess Engineering by Shule and Kargi, Prentice Hall, 2010
COURSE OUTCOMES
After completion of the course student will be able to 1. Describe and Perform Basic Biochemical Calculations involving compositions of Mixtures and solutions 2. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Operations 3. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Processes 4. Solve the Bioprocess Engineering problems applying Stoichiometry knowledge of Microbial cells

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

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22UBT340C/22UBT440C	BIOLOGY FOR ENGINEERS	02 - Credits (2: 0 : 0)
Hours / Week : 02		CIE Marks : 50
Total Hours : 26		SEE Marks : 50

UNIT-I	06 Hrs.

Nature Bioinspired Materials And Mechanisms

Bio inspiration - Introduction, Alliance between Engineering and Biology, Biomimicry - Science mimicking nature. Human Blood substitutes-hemoglobin based oxygen carriers (HBOCs) and perflourocarbons (PFCs). Artificial Intelligence for disease diagnosis. Bioichips & their applications.
Biosensors & their applications. Nanobiomolecules in medical science. Biofilms in dental treatment

UNIT–II	06 Hrs.

Bio Inspiration Models Used In Engineering:

BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs), Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Gecko Feet, Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Fire fly LED.

UNIT–III	07 Hrs.

Human Organ Systems And Bio Designs

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).

Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators).

Lungs as purification system gas exchange mechanisms, spirometry, Ventilators, Heart-lung machine).

Eye as a Camera system, bionic eye. **Kidney** as a filtration system - dialysis systems. **Muscular and Skeletal Systems** as scaffolds, bioengineering solutions for muscular dystrophy and osteoporosis.

UNIT–IV	07 Hrs.

Trends In Bioengineering

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods, electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Self-healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic). Bio-bleaching.

Reference Books *

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012
3. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011
5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2020.
6. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, CRC Press, 2012
7. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008
8. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019
9. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016
10. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources)

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Course Outcomes**

After completion of the course student will be able to

1. Corroborate the concepts of biomimetics for specific requirements.
2. Elucidate the basic biological concepts via relevant industrial applications and case studies.

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3. Evaluate the principles of design and development, for exploring novel bioengineering projects.
4. Think critically towards exploring innovative biobased solutions for ecofriendly and socially relevant problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3		2	1		3						1			
CO 2	3	2	1	1		3						1			
CO 3	3		3	1		3						1			
CO 4	3		1	2		3	3					1			

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22UBT306L	BIOCHEMISTRY LAB	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS **12 Hrs.**

1. pH measurements, concentration of solutions and units, conversion factors, accuracy.
2. Preparation of buffers of constant strength.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of sugar by Folin Wu and O-toluene method.
6. Estimation of amino acid by ninhydrin method
7. Estimation of protein by Lowry's method.
8. Estimation of nitrogen by Kjeldahl method.
9. Estimation of urea by diacetylmonooxime method.
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acid value of a lipid.

REFERENCE BOOKS*

1. Plummer D. T (2017)"Practical Biochemistry" – 3rd edition McGraw Hill Education pub.
2. T N. Pattabhiraman, (2017) "Laboratory Manual & Practical Biochemistry" 4th Edition, All India Publishers & Distributors
3. Sadasivam, S. and Manickam (2017) A Biochemical Method. 3rd Edition, New Age International Publishers, New Delhi.
4. Rodney Boyer, "Modern Experimental Biochemistry" 3rd edition, Pearson Education Pub, (2000).
5. Keith Wilson(2003). "Practical Biochemistry" 3rd edition Cambridge University Pub.
6. Beedu SashidharRao and Vijay Deshpande (2005) "Experimental Biochemistry"I.K International Pvt. Ltd.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To understand the importance of pH & learn the different strength of solution & buffer preparations.
2. To identify various biomolecules by means of qualitative analysis.
3. To quantify the concentrations of the biomolecules in the given sample.
4. To apply knowledge of acid & iodine value to determine the quality of lipids.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3

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CO 1	1	2	3	2			3	3				1	2	3	
CO 2	2	3	2	2			2	3					1	3	
CO 3	2	3	3	3		3	2	2					2	1	
CO 4	2	3	3	2		2	2	2					3	1	

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B. E. IV SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UBT401C	Biostatistics & Biomodeling	03	2	2	0	50	50	100
2.	IPCC	22UBT402C	Immunotechnology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT403C	Heat & Mass Transfer + Lab	04	3	0	2	50	50	100
4.	IPCC	22UBT404C	Molecular Biology	03	3	0	0	50	50	100
5.	PCC	22UBT405C	Cell culture techniques	02	2	0	0	50	50	100
6.	AEC		Advance programming lab / IoT/AI & ML/ Robotics/	01	0	0	2	50	50	100
7.	PCCL	22UBT406L	Cell culture & Molecular Biology Lab	01	0	0	2	50	50	100
8.	HSMC	22UHS424C	UHV-II	01	1	0	0	50	50	100
9.	PCCL	22UBT407L	Biostatistics lab	01	0	0	2	50	50	100
10.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	100	-	-
			Total	**20**	**14**	**2**	**12**	**550**	**450**	**900**

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22UBT401C	BIOSTATISTICS & BIO-MODELING	Credits: 03
L: T: P - 2: 2: 0		CIE Marks: 50
Total Hours/Week: 4		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction and Descriptive Statistics: Scope of biostatistics, presentation of data, Diagrammatic and graphical represent,(simple, multiple, component bar diagrams, pie chart, histogram, frequency polygon, frequency curve, ogive curve). Measure of central tendency (meaning of central tendency, arithmetic mean, median, Quartiles, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, quartile deviation, mean deviation and standard deviation, coefficient of variation, skewness and kurtosis. Correlation and linear regression analysis, curve fitting straight line).	
UNIT–II	**10Hrs.**
Probability and Probability Distributions: Definition of probability, Event, Mutual Exclusive, Independent, Complimentary Events Addition and Multiplication theorem of probability and examples. Discrete probability distributions: Bernoulli's , Binomial and Poisson distribution. Continuous probability distribution – normal, Standard normal variate, properties of normal curve, T, F and $\chi 2$ (Chi square -goodness of fit test) distributions and their applications in Biology.	
UNIT–III	**10 Hrs.**
Statistical Inference , ANOVA and Design of Experiments: Estimation theory and testing of hypothesis point estimation, interval estimation. Sample, population, sample size determination. Methods of Sampling techniques- random (simple, stratified and systematic) non random sampling - (Judgement and convenience). Definition of analysis of variance(one way and two way classifications), Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burmann design, Response surface methodology(RSM).	
UNIT–IV	**10 Hrs.**
Bio-modeling: Microbial Growth in a Chemo-stat, Growth Equations of Microbial Populations, product formation models, Models of Commensalisms, Batch culture model, Mutualism, Predation and Mutation. Simple Prey predator model, Volterra's Model for n Interacting Species. Basic Models for Inheritance, Applications of probability in genetics, Hardy - Weinberg law. Selection and Mutation Models, Genetic Inbreeding Models. Dose response studies.	

REFERENCE BOOKS *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N. (2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.

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3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

COURSE OUTCOMES**

After completion of the course student will be able to

1. Interpretation of the data using different statistical methods.
2. Investigate the probability distributions of the data.
3. Design and analyze the experimentation using statistical tools.
4. Apply the biomodelling concepts in various biological studies.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	-	3	2	-	-	-	-	3	-	2	3	2	-
CO2	2	2	-	3	1	-	-	-	-	2	-	-	3	1	-
CO3	1	3	3		3	-	-	-	-	2	-	2	3	-	-
CO4	3	2	-	2	2	-	-	-	-	1	-	2	2	2	-

22UBT402C	IMMUNOTECHNOLOGY	Credits: 04
L: T: P - 3 : 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10Hrs.
The immune system: Introduction, Cells and Organs of the immune system: Lymphoid cells and myeloid cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT). Innate and adaptive immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants. Antibodies: their structure and function, Immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and subclasses (isotypic, allotypes, idiotypes and anti-idiotytopic antibodies). Cytokines and their role in immune response.	
UNIT–II	**10 Hrs.**
Humoral and cell mediated immunity: Introduction to humoral and cell mediated immunity. B-lymphocytes maturation and mechanism of activation. Thymus derived lymphocytes (T cells) and types, T-cell maturation and mechanism of activation. Major Histocompatibility Complex: MHC I and MHC II structure and functions. Antigen processing and presentation process.	
UNIT–III	**10 Hrs.**
Immunological disorders: Complement system and its pathways (classical, alternative and lectin pathway) regulation and biological consequences of compliment activation. Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune disorders, types and treatment of autoimmune disease. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: immunological basis of graft rejection, Types of transplantations. **Vaccines:** Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines. Inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.	
UNIT–IV	**10Hrs.**

Immunodiagnosis:

Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, Immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, flow cytometry, fluorescence activated cell sorting (FACS) analysis. Production of monoclonal antibodies.

Laboratories:

1. Agglutination Technique: Blood group identification and Rh factor
2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL
3. Ouchterlony Double Diffusion (ODD)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA/ DOT Blot.

REFERENCE BOOKS *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

COURSE OUTCOMES**

After completion of the course student will be able to

1. Interpret the properties and functions of immune system.
2. Asses the functions of humoral and cell mediated immune system.
3. Develop the vaccines by analyzing the immunological disorders
4. Identify the diseases using different immunodiagnostic tools.

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	-	3	1	2	-	-	-	-	-	-	-	1	-	2	-
CO 2	-	2	-	3	-	-	-	-	-	1	-	1	-	3	-
CO 3	-	-	3	-	3	2	-	-	-	-	2	2	-	3	1
CO 4	-	2	-	2	3	-	-	-	-	2	-	2	2	3	-

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<table>
<tr><td>22UBT403C</td><td rowspan="3">HEAT AND MASS TRANSFER</td><td>04- Credits (3 : 0 : 2)</td></tr>
<tr><td>Hours / Week : 05</td><td>CIE Marks : 50</td></tr>
<tr><td>Total Hours : 40</td><td>SEE Marks : 50</td></tr>
</table>

UNIT-I	**10 Hrs.**

Fundamentals of Heat Transfer:

Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall, sphere and cylinder, Conceptual numericals on conduction; Forced and Natural convection, Conceptual Numericals on convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer to fluids without phase change; heat transfer in laminar and turbulent flow inside closed conducts.

UNIT–II	**10 Hrs.**

Heat Transfer concept in Heat Exchangers:

Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling; Flow arrangements in Heat transfer equipment's - co current and counter current flow; LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger; Concepts of Heat transfer coefficients- Individual and overall; Fouling factor and Resistance for heat transfer; Conceptual numericals

UNIT–III	**10 Hrs.**

Mass transfer concepts

Diffusion - Fick's law of diffusion; Measurement of diffusivity, Two film theory of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas mass transfer. Principles, mass transfer considerations in unit operations like Extraction, Absorption, Adsorption, Crystallization and Evaporation

UNIT–IV	**10 Hrs.**

Mass transfer Operations

Methods of distillation –Simple, Flash, and Fractional distillation of binary mixtures, Continuous Distillation with reflux, relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, Drying, Principle of Drying, Drying rate, drying curve.

LIST OF EXPERIMENTS (ANY 10)

1. **Thermal conductivity of material (solid or liquid)**
2. **Heat transfer in a composite wall by conduction**
3. **Heat transfer by Natural Convection**
4. **Heat transfer by Forced convection**
5. **LMTD and Effectiveness in Heat Exchanger – Co-current**
6. **LMTD and Effectiveness in Heat Exchanger – Counter-current**
7. **Distillation**
8. **Extraction**

9. **Drying**
10. **Leaching**

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA
2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA.
3. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
4. Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth-Heinemann
5. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press
6. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn. John Wiley & Sons, USA.
7. Kern (2001). Process Heat Transfer, 2nd Edn. McGraw-Hill Publications, USA.
8. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw- Hill Publications.

Course Outcomes**

After completion of the course student will be able to

1. State the different modes of heat transfer and solve basic heat transfer problems
2. Apply the knowledge of Heat Exchangers in Biochemical Engineering applications
3. Apply the knowledge of Mass Transfer in Unit Operations to solve Biochemical Engineering problems
4. Apply the knowledge of Distillation and Drying Unit Operations in Bioprocess Industries

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1							1	2		
CO 2	3	2	3	3	2							2	2		
CO 3	2	3	2	2	1							1	2		
CO 4	3	2	1	1	1							1	2		

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22UBT404C	MOLECULAR BIOLOGY	Credits-3
L: T: P - 3 : 0: 0		CIE Marks : 50
Total Hours/week : 03		SEE Marks : 50

UNIT – 1	12 Hrs.

Introduction

Genes and their location. Information flow in biological systems: central dogma, updated central dogma. Signalling (signal transduction)-molecular mechanism. Reverse genetics, Genetic code-its features, codon and anticodon.

Replication:

Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).

UNIT – 2	10 Hrs.

Transcription

Mechanism of transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing, Si RNA, Antisense RNA technology.

Translation:

Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation, Structure and function of prokaryotic and eukaryotic ribosomes, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.

UNIT – 3	10 Hrs.

Gene Expression in Prokaryotes

Regulation of gene expression in prokaryotes: Operon model-structure and function, galactose and lactose operon, tryptophan Operon-regulation by attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.

Gene Expression in Eukaryotes:

Regulation of eukaryotic gene expression, hormonal regulation- peptide and steroid hormones, transcriptional control, super secondary structures-Helix turns Helix. Zinc fingers and Leucine Zippers. Gene silencing- methylation, chromatin modification.

UNIT – 4	10 Hrs.

Transposons and Oncogenes

Transposons-replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (Mc Clintock's work), Cut and paste transposition, Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle.

Genetic Recombination and Molecular markers:

Genetic recombination in bacteria- transformation, transduction and recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.

REFERENCES*
1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6^{th} Edition), W.H. Freeman 2. James Watson (2008), Molecular Biology of the Gene (5^{th} Edition) Pearson Education 3. David Freifelder, (2008), Essentials of Molecular Biology (2^{nd} Edition), Narosa Publishing House
COURSE OUTCOMES**
1. Apply the knowledge of the basic aspects of molecular biology and classify the mechanism of DNA repair processes along with replication. 2. Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research. 3. Use research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology. **4.** Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	2	1	3	2	1	-	-	-	-	-	2	1	1
CO2	1	-	1	3	3	2	2	-	-	-	-	-	2	2	1
CO3	1	-	1	3	2s	1	1	-	-	-	-	-	1	1	1
CO4	1	-	3	3	3	2	3	-	-	-	-	-	2	2	1

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22UBT405C	CELL CULTURE TECHNIQUES	Credits: 02
L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

UNIT – 1	8 Hrs.
Plant cell culture: History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture.Cellular totipotency, cytodifferentition, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichometry of cell growth and product formation.	
UNIT – 2	**6 Hrs.**
Culture techniques and applications: Protoplast culture, somatic hybridization, haploid production, micro propagation,somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.	
UNIT – 3	**6 Hrs.**
Animal cell culture Techniques History and development of mammalian cell culture. lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.	
UNIT – 4	**6 Hrs.**
Cell line Characterization and Maintenance Measurement of Cell viability and Cytotoxicity assay –MTT, LDH dehydrogenase, . Dye exclusion and inclusion tests, clonogenic assay. Characterization. Cell line contaminations, detection and control. Stem cells & their applications	

REFERENCES BOOKS*

1. Culture of Animal cells-3rdEdition-R.IanFreshney.Wiley Less, 2010
2. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010
3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers,2010.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers,2002

COURSE OUTCOMES**

1. To use the plant cells to produce in vitro cultures
2. To comprehend the applications of plant tissue culture techniques in various fields
3. To acquire working knowledge of culture of animal cells in *in vitro* conditions.
4. To identify, and classify the cell culture techniques

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Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3												1	1	1
CO 2	1				3									2	2
CO 3	1				3			1			1		3	3	
CO 4	3				3									3	

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22UHS424C	UNIVERSAL HUMAN VALUES-II	Credit: 01
L:T:P - 1 : 0: 0		CIE Marks: 50
Total Hours/Week:01		SEE Marks: 50

UNIT-I	04 Hrs.
Introduction to Value Education: Right Understanding; Relationship and Physical Facility; Understanding Value Education; Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity -the Basic Human Aspiration-Current Scenario and Method to Fulfill the Basic Human Aspirations.	
UNIT–II	**04 Hrs.**
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.	
UNIT–III	**04Hrs.**
Harmony in the Family and Society and Nature: Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; 'Respect' **–** as the Right Evaluation: Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature.	
UNIT–IV	**03 Hrs.**
Implications of the Holistic Understanding – a Look at Professional Ethics Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics; Holistic Technologies, Production Systems and Management Models; Strategies for Transition towards Value-based Life and Profession	

Reference Books

1. R R Gaur, R Sangal, G P Bagaria, 'Human Values and Professional Ethics', , Excel Books, New Delhi, 2010
2. A. Nagaraj, Jeevan VidyaEkParichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
4. Annie Leonard,The Story of Stuff (Book), Simon & Schuster, 2011.
5. Mohandas Karamchand Gandhi,The Story of My Experiments with Truth, Public Affairs Press of Washington, DC. 1948
6. E. F Schumacher, Small is Beautiful,. Blond & Briggs, 1973

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7. Cecile Andrews, Slow is Beautiful, New Society Publishers, 2006.
8. J C Kumarappa, Economy of Permanence, Akhil Bharat Sarva-Seva-Sangh, Rajghat, Kashi, 1958.
9. Pandit Sunderlal, Bharat Mein Angreji Raj,Publications Division, M/O Information & Broadcasting, Govt. of India, 2016
10. Dharampal,Rediscovering India, Society for Integrated Development of Himalayas, 2003
11. Gandhi, Mohandas K. Hind Swaraj or Indian Home Rule Ahmedabad, Nava jivan Pub. House, 1946.
12. India Wins Freedom, Maulana Abdul Kalam Azad, Orient Black Swan, 1988.
13. Romain Rolland, Gandhi, Romain Rolland (English), Srishti, 2000.

Course Outcomes

Upon successful completion of the course, students will be able to:

CO1: Explore holistic vision of life - themselves and their surroundings.

CO2: Develop competence and capabilities for maintaining Health and Hygiene.

CO3: Analyse various problems in life, family,Society and in handling problems with Sustainable Solutions.

CO4: Apply values to their own self in different day-to-day settings in real life and in handling problems with sustainable solutions.

CO5: Adopt the value of appreciation and aspiration for excellence and gratitude for all.

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
No	Programme Outcomes Course Outcomes															
Upon successful completion of course the Students will																

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be able to:																
1	Explore holistic vision of life - themselves and their surroundings.							3	2	3			1			
2	Develop competence and capabilities for maintaining Health and Hygiene.						3	3	1	1			1			
3	Analyse various problems in life, family,Society and in handling problems with Sustainable Solutions.						3	3	2	1			1			
4	Apply values to their own self in different day-to-day settings in real life and in handling						2	2	3	2			1			

	problems with sustainable solutions.															
5	Adopt the value of appreciation and aspiration for excellence and gratitude for all.								3				1			

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22UBT406L	CELL CULTURE AND MOLECULAR BIOLOGY LAB	Credits: 01
0:0:2 - N_L : N_T: N_P		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Animal cell culture techniques
5. Study of absorption spectra of nucleic acids.
6. UV Vis survival curve of bacteria.
7. Agarose gel electrophoresis.
8. Isolation of genomic DNA from plant sources.
9. Isolation of plasmid DNA from E. coli.
10. Estimation of DNA by diphenyl method.
11. Estimation of RNA by orcinol method.
12. Purity of nucleic acids by UV-Vis Spectrophotometer.
13. Standard Operating Procedure for Centrifuge and Gel Documentation Unit.

Reference Books *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2nd Edition), W.H. Freeman
2. R.A. Dixon & Gonzales, (1995), Plant Cell Culture: A Practical Approach by IRL Press. (2nd Edition),
3. Sambrook& Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

Course Outcomes**

After completion of the course student will be able to

1. Conduct and analyze the growth of plant and animal cells by plant and animal tissue culture techniques.
2. Apply absorption spectra and analyze SOP for various lab equipments.
3. Conduct and analyze the concentration and purity of DNA.
4. Conduct observations and experiments including Genomic DNA/plasmid DNA /RNA/protein.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO2	1	2	2	1	3	2	-	-	-	-	-	1	1	3	1
CO3	1	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO4	2	2	3	2	3	2	-	-	-	-	-	1	1	3	1

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22UBT407L	BIOSTATISTICS LAB	Credits: 1
L: T: P - 0:0:2		CIEMarks:50
Total Hours/Week: 02		SEEMarks:50

LIST OF EXPERIMENTSIN BIOSTATISTICS LABORATORY

1. Procedure for creating Data file, Diagram and Graphs.
2. Procedure and calculation of Mean, Median, Mode, Standard Deviation and Variance.
3. Procedure and calculation of t test.
4. Calculation of Chi-square test.
5. ANOVA- one-way analysis
6. ANOVA- two-way analysis.
7. Experimental Research Design – CRD- Analysis.
8. Experimental Research design – RBD- Analysis.
9. Experimental Research design – Latin square Design- Analysis.
10. Placket-Burman Design for media optimization.
11. Response Surface Methodology for media optimization.

REFERENCE BOOKS *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.
3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

COURSE OUTCOMES**

After completion of the course student will be able to

1. Create data file, draw graphs, charts using statistical software tools.
2. Calculate measures of dispersion and central tendency.
3. Analyse the data using ANOVA.
4. Design experimental set up using statistical software tools.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	3	-	-	-	-	-	-	1	2	2	1	1
CO 2	3	3	2	3	3	-	-	-	-	-	2	2	2	1	-
CO 3	2	3	3	2	2	2	-	-	-	-	-	3	2	1	-
CO 4	3	3	1	3	3	2	-	-	-	-	-	3	2	1	2

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DEPARTMENT OF BIOTECHNOLOGY

B. E. V SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	21UBT501C	Bioinformatics	03	3	0	0	50	50	100
2.	IPCC	21UBT502C	Genetic Engineering & Applications + lab	04	3	0	2	50	50	100
3.	PEC	21UBT5XXE	Elective –I	03	3	0	0	50	50	100
4.	OEC	21UXX5XXN	Open Elective-I	03	3	0	0	50	50	100
5.	PCCL	21UBT503L	Bioinformatics Lab	01	0	0	2	50	50	100
6.	AEC	21UHS521C	Quantitative Aptitude and Professional Skills	02	2	0	0	50	50	100
7.	INT	21UBT504I	Summer Internship – II	03	0	0	4	100	-	100
8.	HSMC	21UBT523C	Environmental Studies	01	1	0	0	50	50	100
			Total	**20**	**15**	**0**	**08**	**450**	**350**	**800**

Elective-I

21UBT511E: Environmental BT
21UBT512E: Nutraceuticals
21UBT513E: Computational Biology
21UBT514E: Protein Engineering and Drug Design
21UBT515E: Environmental BT

Open Elective-I

21UBT532N: Biofuels Technology

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21UBT501C	BIOINFORMATICS	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Introduction to Bioinformatics and Biological Database Introduction to bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG;ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases	
UNIT–II	**10 Hrs.**
Sequence alignment and database searches: Introduction, Types of sequence alignment, Comparison between global and local alignment, Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions;Word/k-tuple method- BLAST, FASTA. Multiple Sequence Alignment:Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles. Tutorials: Solving problems on pairwise sequence alignment	
UNIT–III	**10 Hrs.**
Phylogenetic analysis and predictive methods using sequences Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees,Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares. Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan).Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling. Tutorials: Practices on prediction of phylogenetic trees	

UNIT–IV	10 Hrs.

Plasmid mapping and primer designing &molecular modelling techniques

Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties,Dockingsoftwares (AUTODOCK, HEX)

Tutorials: Solving problems related to Restriction mapping and Primer designing

REFERENCE BOOKS *

1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition,2006.
2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000.
3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
4. Computational methods for macromolecular sequence analysis – R F Doolittle. Academic Press, 1996.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Importance of databases involved in bioinformatics along with their file formats
2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences
3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis
4. Explain various statistical tools involved in predicting the structure of genes and proteins
5. The principle behind restriction mapping and primer designing
6. Different approaches involved in silico drug design

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

21UBT502C	GENETIC ENGINEERING & APPLICATIONS	Credits: (4: 0: 0)
L: T: P – 3-0-2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambda vectors.

Enzymes in genetic engineering:

Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase

UNIT–II	10Hrs.

Nucleic acid hybridization and amplification

Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.

Construction of cDNA libraries:

Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.

UNIT–III	10 Hrs.

Gene transfer techniques

Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.

Transgenic science and genetic improvement:

Transgenic science in plant improvement, Antisense RNA technology (Flavr savr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes(*Bacillus thuringiensis* and its mode of action), Cry proteins – mechanism of action.

UNIT–IV	10 Hrs.

Gene therapy

Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.

Applications:

Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.

REFERENCE BOOKS

1. Molecular Biotechnology, Principles and applications of Recombinant DNA by Bernard R Glick and Jack J Pasternak, second edition, CBS Publishers, 2012.
2. Recombinant DNA by Watson, et al., second edition, Freeman Publishers 2010.
3. Principles of gene manipulation, Primrose S.B., Blackwell Scientific Publications, 2010.
4. From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers, 2010.
5. Biotechnology Expanding Horizon, B.D.Singh, 3rd revised edition, Kalyani Publishers,2010
6. https://onlinecourses.swayam2.ac.in/cec19_bt02/preview

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1. Transformation
2. Blue white colony screening
3. Thermal denaturation of DNA
4. Restriction Digestion
5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblotting and analysis
8. Lyophilization of biologic samples (fluids, microbial samples)
9. SOP for UV-Spectrophotometer
10. SOP for PCR
    PCR (Amplification with specific primers)

COURSE OUTCOMES

1. Apply the knowledge of various tools used in genetic engineering experiments.
2. Select and apply the knowledge of methods of nucleic acid detection, hybridization and amplification and library construction in research.
3. Identify different methods of various gene transfer techniques in plants, animals and microbes
4. Use knowledge of various strategies of Gene therapy in therapeutics and engineer microbes for the production of biopharmaceuticals

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	-	1	-	2	3	-	2	-	-	-	-	2	1	3	1
CO 2	-	1	-	-	3	-	1	-	-	-	-	2	2	3	1
CO 3	-	1	-	2	3	1	1	-	-	-	-	2	3	3	1
CO 4	-	1	-	2	3	2	1	-	-	-	-	2	3	3	1

22UBT511E	ENVIRONMENTAL BT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
Microorganisms Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms. **Bioaccumulation of Toxicants** Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.	
UNIT–II	**12Hrs.**
Biological Treatment of Wastewater Waste water characteristics BOD, COD, Primary & Secondary treatment, nano-filtration, ulta-filration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries. **Solid Waste Management** Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules	
UNIT–III	**10 Hrs.**
Bioleaching & Biomining Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum. **Bioremediation** Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.	
UNIT–IV	**10 Hrs.**
Biotechnology in Biodiversity Conservation Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.	
REFERENCE BOOKS*	

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1. Environmental Biotechnology by Pradipta Kumar Mahopatra.
2. Text book of microbiology by R C Dubey and D K Maheshwari
3. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited,1987.
4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT,.
5. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young (Eds.), Pergamon Press.
6. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
7. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987.
8. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge

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Univ. Press, Cambridge.

COURSE OUTCOMES**

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove environmental contaminants.
5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	2	2				2		3		1	2	3	1
CO 2	2	3	2	1				1	2				3	3	1
CO 3	2	3	2	1				1	2				3	3	1
CO 4	1	3	2	3				2	2	3			2	3	
CO 5								2		3		3			
CO 6	1	3	2	2					2	2			1	3	

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22UBT512E	NUTRACEUTICALS	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to Nutraceutical and dietetics Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.	
UNIT–II	**10Hrs.**
Nutrition related diseases and disorders Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management.Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress.Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.	
UNIT–III	**10 Hrs.**
Nutraceuticals of microbial, plant and animal origin Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health.Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides	
UNIT–IV	**10 Hrs.**
Biotechnology in Phytonutraceuticals Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties.Golden rice, GM Tomatoes	
REFERENCE BOOKS*	

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1. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA.
2. L. Rapport and B. Lockwood,Nutraceuticals, Pharmaceutical Press.,2nd Edition,2002.
3. M. Maffei ,Dietary Supplements of Plant Origin, Taylor & Francis,1 st Edition,2003.
4. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society,1 st Edition, 2004.
5. Richard Neeser& J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
6. TimothtS. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

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COURSE OUTCOMES**
1. To be aware of basic concepts of nutraceuticals and nutrition. 2. To have a general idea of scope of nutraceuticals and functional foods. 3. To have brief idea about nutrition related health disorders and the role of Nutraceuticals. 4. To classify nutraceuticals and the role of nutraceuticals among different age groups. 5. To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin. 6. To know about the role of biotechnology in production of plant secondary metabolites

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

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21UBT513E	COMPUTATIONAL BIOLOGY	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	12 Hrs
Nature and scope of Computational Biology: Basic algorithms in Computational Biology, Biological and Computer algorithm, Fibonacci problem, Dynamic Programming, Time and space complexity of algorithms, Laplace's Rule. Search Algorithms: Random walk, Hill climbing, simulated annealing. Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – 2	**8 Hrs**
Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – 3	**10 Hrs**
Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:- Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.	
UNIT – 4	**10 Hrs**
Insilico Drug Design and Biopython applications in Computational Biology Insilico Drug Design: Basic Concepts, importance and application, Molecular force fields and energy minimization, Molecular Dynamics Simulation methods, Methods of Insilico Drug Design: structure and ligand based drug design approach, structure based drug design: Molecular docking. Biopython: Introduction, important features and application of biopython in computational biology, Create a simple sequence in Biopython for DNA, RNA and Protein Alphabets, Sequence Alignment Tools in Biopython, PDB Module of Biopython,	
REFERENCE BOOKS	

- Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith,1999,Pearson Education.
- Arthur M.Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
- Higgins and W.Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000
- An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004 2.
- Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998

Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 20014.

1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., 1998, John Wiley & Sons, UK.
2. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999,Pearson Education.
3. Arthur M.Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
4. D.Higgins and W.Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000.
5. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001 2.
6. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona,Tucson

COURSE OUTCOMES

After completion of the course student will be able to

1) Understand the nature, scope of computational biology and biological and computer algorithms.
2) Know about the Combinatorial Pattern Matching, Genetic algorithms and their applications.
3) Analyze various Markov processes and Markov Models.
4) **Learn about the Insilico Drug Design and Biopython applications in Computational Biology**

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

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21UBT514E	PROTEIN ENGINEERING AND DRUG DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Structure of proteins
Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.

Protein structure prediction
Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.

Protein engineering and design
Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

UNIT–II	10 Hrs.

Molecular modeling
Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.

UNIT–III	10 Hrs.

Insilico drug design
Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.

Computer assisted new lead design
Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.

UNIT–IV	10 Hrs.

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Docking methods
Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.
Computer - assisted drug discovery
The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of

CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

REFERENCE BOOKS *

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI,4th Edition, 2013
2. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition,2010.
3. Creighton T.E. Proteins, Freeman W.H. Second Edn,1993.
4. Branden C. and Tooze R. Introduction of protein structure, Garland,1993.
5. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.

COURSE OUTCOMES**

1. Ability to study protein structure prediction and protein engineering and design
2. Able to understand molecular modeling
3. Able to know computer assisted new lead design
4. Able to study docking methods and computer - assisted drug discovery

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-

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21UBT532N	BIOFUELS TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Biochemistry of biofuels and energy resources Basic principle of light energy conversion to chemical energy &carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources. **Biofuels** Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.	
UNIT–II	**12Hrs.**
Biofuel feed stocks Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks. **Types of biofuels** First generation biofuels-vegetable oil biodisel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels and third generation biofuels.	
UNIT–III	**10 Hrs.**
Technologies for biofuels Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Thermochemical platforms - biodiesel production, standardization, properties and emissions of biodiesel. BtL fuels -production, properties and emissions. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Biomethanation, Microbial fuel cells. Blending of biofuels	
UNIT–IV	**10 Hrs.**
Biofuels in perspective Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodisel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels.. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.	

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REFERENCE BOOKS*

1. Foster C. F., John ware D.A.Environmental Biotechnology by, Ellis Horwood Limited, 1987.
2. Larry Anderson and David A Fuels from Waste by Tillman. Academic Press, 1977.
3. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 2000
4. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Ability to understand the basic principle involved in bioconversion process in energy and to differentiate the conventional fuels with biofuels .
2. Able to diagnose the types of feed stocks used for biofuels.
3. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current technologies and innovations involved
4. Able to understand and recall current issues related with production and use of biofuels, Research opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-

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21UBT503L	BIOINFORMATICS LAB	Credits: 1
L: T: P – 0-0- 2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures.

REFEENCE BOOKS*

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologists guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
6. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 2006.

COURSE OUTCOMES**

1. Ability to Search literature and sequence databases
2. Ability to retrieve and search sequences from databases
3. Ability to align pair wise and multiple sequences
4. Ability to identify evolutionary and relationships and functional sites in genomes
5. Ability to evaluate primer designing and restriction mapping
6. Ability to docking and superimpose the structures

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	3	1	-	3				3	3	3	1
CO 2	3	3	3	-	3	1	-	-				3	2	3	1
CO 3	3	3	2	2	3	1	1	-				3	3	3	1
CO 4	3	3	2	-	3	-	1	-				3	2	3	2
CO 5	3	3	2	1	3	1	-	2				3	3	3	2
CO 6	3	3	3	2	3	1	-	1				3	2	3	1

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21UBT523C/21UBT623C	**ENVIRONMENTAL STUDIES**	**01 - Credits (1: 0 : 0)**
Hours / Week : 01		CIE Marks : 50
Total Hours : 15		SEE Marks : 50

UNIT – 1	**04 Hrs.**

Natural Resources:

Human activities and their impacts. EIA, **Renewable Energy**: Solar energy, Wind energy, Hydropower, Tidal energy, Ocean thermal energy, Geo thermal energy, Biomass energy, Biogas, Biodiesel, Bioethanol, Hydrogen as fuel.

Non renewable Energy: Coal, Petroleum, Natural gas, Nuclear energy.

UNIT – 2	**04 Hrs.**

Environmental Pollution:

Water pollution, water quality standards, water borne diseases, Fluoride problem, Air pollution, Noise pollution. Effect of electromagnetic waves.

Sustainable future: Concept of sustainable development, threats to sustainability, strategies for sustainable development. Environment economics – concept of green building, Circular Economy.

UNIT – 3	**03 Hrs.**

Current Environmental Issues of concern:

Greenhouse Effect- Greenhouse gases and Global Warming, Climate change, ozone layer depletion, Acid rain, Eutrophication

Environmental policy legislation rules & regulations

UNIT – 4	**04Hrs.**

Fundamentals of Waste management:

Solid waste management: Sources, classification, characteristics, collection & transportation, disposal, and processing methods. Hazardous waste management and handling.

Concept of waste water treatment, Bioremediation.

Industrial waste management (Case studies: Cement, plastic, chemical, E–waste, food & construction industry waste management).

REFERENCES

1. Benny Joseph "Environmental Studies" Tata McGraw Hill, 2005
2. Dr. D. L. Manjunath, "Environmental Studies" Pearson Education, 2006
3. Koushik and Koushik "Environmental Science & Engineering" New Age International Publishers, New Delhi, 2006
4. Meenakshi "Environmental Science & Engineering" Pranticce Hall of India, 2006

COURSE OUTCOMES

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After completion of the course the students shall be able to,

- Ability to recognize natural resources and its uses.
- Able to understand pollution and its effects on environment and to implement sustainable future in the work place.
- Ability to understand current environmental issues.
- Able to apply the waste management techniques in various fields

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Course Outcomes	Program Outcomes												Program Specified Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO 2	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO 3	**-**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO 4	**-**	**-**	**-**	**1**	**-**	**2**	**2**	**1**	**-**		**-**	**3**	**1**	**-**	**1**

Question Paper Pattern for SEE:

Question is of Objective type
Duration of exam is 1 hour 30 mins
50 questions covering all the four units. Each question carries one mark

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B. E. VI SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UBT601C	Bioprocess and Bioreaction Engineering	03	3	0	0	50	50	100
2.	PCC	21UBT602C	Upstream Processing Technology	03	3	0	0	50	50	100
3.	PCC	21UBT603C	Biotransformation and Enzyme Technology	03	3	0	0	50	50	100
4.	PEC	21UBT6XXE	Elective-II	03	3	0	0	50	50	100
5.	OEC	21UXX6XXN	Open Elective –II	03	3	0	0	50	50	100
6.	OEC	21UXX6XXN	Open Elective –III	03	3	0	0	50	50	100
7.	PCCL	21UBT604L	Biokinetics & Enzyme Technology Lab	01	0	0	2	50	50	100
8.	MP	21UBT605P	Mini Project	02	0	0	4	50	50	100
Total				**21**	**18**	**0**	**6**	**400**	**400**	**800**

Elective-II

21UBT621E: Biofuels Technology
21UBT622E: Food Biotechnology
21UBT623E: Biopython
21UBT624E: Genomics & Proteomics
21UBT625E: Bioreactor Design

Open Electives –II

21UBT632N: Environmental Technology

Open Electives –III

21UBT633N: Industrial Safety

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21UBT601C	BIOPROCESS AND BIOREACTION ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Kinetics of Homogeneous reactions:

Basic Concepts of Bioreaction and bioprocess engineering, Concentration dependent term of a rate equation, Rate Constant. Representation of elementary reaction and non-elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.

UNIT–II	10 Hrs.

Interpretation of Batch Bioreactor Data:

Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalysed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data.

UNIT–III	10 Hrs.

Ideal Bioreactor and bioprocess models:

Ideal Batch Reactor, General features of reactors, Basic design equation, relation between Concentration and conversion, Batch cycle time, Space-Time and Space-Velocity, Mixed flow reactor, Plug flow Reactor, Holding time and space time for flow reactors

Design for Single Reactions: Size comparison of single reactors. Growth kinetics quantification Unstructured models for microbial growth- Substrate limited growth-models with growth inhibitors, product formation kinetics. Monod kinetics

UNIT–IV	10 Hrs.

Analysis of Bioreactors:

Various types of reactors for immobilised cell and enzyme systems, Multiple reactors like CSTR in series /CSTR in Parallel; MFR in series/ MFR in Parallel, PFR in series/ PFR in parallel, Reactors of different types in series, Challenges and issues in bioprocess industries- mixing, interphase mass and heat transfer, Bioreactor instrumentation and control, bioreactor considerations for animal cell cultures and plant cell cultures.

Reference Books *

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3nd edn., Prentice Hall PTR.

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4. Bailey J E and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
5. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
6. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
7. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
8. Indian Standards Institution, Code for Unfired Pressure Vessels, IS – 2825.
9. Bhattacharya, B.C, Introduction to Chemical Equipment Design, CBS Publications, 1985.
10. Perry's Chemical Engineers Handbook. 7th Edition Mc Graw Hill Publications

Course Outcomes**

After completion of the course student will be able to

1. Understand the basic concept of reaction engineering to solve bioprocess problems
2. Predict the order and rate of the different reactions.
3. Analyze the batch bioreactor data for different reactions.
4. Apply the suitable bioreactor for different biochemical reactions.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3	2	2							2	2		
CO2	2	3	2	3	1							2	2		
CO3	2	3	3	2	2							2	2		
CO4	2	3	3	3	1							2	2		

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21UBT602C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Fermentation process Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications, Types of Fermentors. **Scale Up:** Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.	
UNIT–II	**10Hrs.**
Raw materials and media Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization. Different methods for optimization (Plackett-Burman Design, RSM) of industrial media, microbio	
UNIT–III	**10 Hrs.**
Microbial system Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculum from laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination). **Secondary metabolite production:** secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.	
UNIT–IV	**10 Hrs.**
Plant Cell system Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics). **Animal Cell system :** Scale up in suspension (stirred and static), monolayer (roller bottles, nunc cell factory microcarriers culture) and Perfusion culture (fixed and fluidized bed reactors). Factors affecting cell culture, Growth monitoring. Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass transfer and others. Large scale production of insulin by mammalian cell culture. Cellbank preparation & cell reviving techniques **Monoclonal antibody production**: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).	

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REFERENCE BOOKS
1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Aditya books (P) Ltd. New Delhi 1997. **2.** Bioprocess Engineering by Michael L. Shuler, 2nd Edition Shuler & Kargi, Fikret Kargi, Academic Internet Publishers, 2006 **3.** Introduction to plant Biotechnology by H.S. Chawla, Second edition, Oxford & IBH Publisher **4.** Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996). Elsevier **5.** Culture of animal cells by Ian Freshney IVth Edition. John Willey & Sons Publ. **6.** Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, Oxford
COURSE OUTCOMES
1. Understand and identify the component parts of fermentor and fermentation system 2. Select the raw material , prepare and sterilize the media and also to optimize the industrial media using Design of experiments 3. Develop/design the industrially important microbes for industrial scale processes 4. Operate the reactors for Plant, Animal and GMOs

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	1											1	3	
CO 2	-	3												3	3
CO 3	2	2	3	1	1					2		1	3	3	
CO 4	2									3		1		3	

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21UBT603C	BIOTRANSFORMATION AND ENZYME TECHNOLOGY	Credits: 3
L:T:P - **3-0-0**		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.

Enzyme action:
Mechanism of enzyme action. Derivations of Km value (Michaelis-Menton constant), Lineweaver-Burk plot., Enzyme inhibition and kinetics
Multi-Substrate Reactions:
Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry

UNIT–II	10 Hrs.

Enzymatic Techniques:
Strategies of purification of enzymes: choice of source, methods of homogenization, Criteria of purity: tests for purity, tests for catalytic activity, active site titrations, Molecular weight determination and characterization of enzymes.
Immobilization of enzymes:
Techniques of enzyme immobilization; design and configuration of immobilized enzyme reactions,Kinetics of immobilized enzymes**,** immobilized enzymes in bioconversion processes(uses). The design and construction of novel enzymes

UNIT–III	10 Hrs.

Enzymes of biological importance:
Enzyme pattern in diseases like in Myocardial infarctions (SGOT, SGPT, & LDH) Acetylcholinesterase, angiotensin converting enzyme (ACE), 5'- nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD). Use of isozymes as markers in cancer.

UNIT–IV	10 Hrs.

Industrial uses of enzymes:
Enzymes used in detergents, use of proteases, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes).Uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Uses of proteases in food industries.

Reference Books *

1. Trevor Palmer (2008). Enzymes: Biochemistry , Biotechnology, Clinical Chemistry. Horwood Publishing Ltd, East-West Press,5th Edition.
2. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" –7th Edition.
3. Nicholas C. Price and Lewis Stevens (2009).Fundamentals of Enzymology, Oxford university Press, 3rd edition.
4. James R Hanson (2017). "An Introduction to Biotransformation in Organic Chemistry" 5th edition , Oxford university Press,
5. Daniel L. Purich, Melvin I. Simon, John N. Abelson (2009). Contemporary Enzyme Kinetics and Mechanism" Academic press, 3rd edition.
6. K. Faber (2018). Biotransformations in Organic: Springer- Verlag.4th Edition,.
7. Bailey and Ollis (2017). "Biochemical Engineering Fundamentals", Mcgraw Hill 2nd Ed.

Course Outcomes**

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After completion of the course student will have the ability
1. To understand mechanism of enzyme and its reactions.

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2. To know enzymatic techniques to characterize the enzymes and apply the techniques of immobilization of enzymes.
3. To understand the importance of enzymes in diagnostics.
4. To apply knowledge of using enzymes in detergent, wool, leather and food industries.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-

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21UBT621E	BIOFUELS TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Biochemistry of biofuels and energy resources

Basic principle of light energy conversion to chemical energy &carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources.

Biofuels

Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.

UNIT–II	12Hrs.

Biofuel feed stocks

Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks.

Types of biofuels

First generation biofuels-vegetable oil biodisel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels and third generation biofuels.

UNIT–III	10 Hrs.

Technologies for biofuels

Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Thermochemical platforms - biodiesel production, standardization, properties and emissions of biodiesel. BtL fuels -production, properties and emissions. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Biomethanation, Microbial fuel cells. Blending of biofuels

UNIT–IV	10 Hrs.

Biofuels in perspective

Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodisel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels.. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.

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REFERENCE BOOKS*
1. Foster C. F., John ware D.A.Environmental Biotechnology by, Ellis Horwood Limited, 1987. 2. Larry Anderson and David A Fuels from Waste by Tillman. Academic Press, 1977. 3. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 2000 4. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.
COURSE OUTCOMES**
After completion of the course student will be able to 1. Ability to understand the basic principle involved in bioconversion process in energy and to differentiate the conventional fuels with biofuels . 2. Able to diagnose the types of feed stocks used for biofuels. 3. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current technologies and innovations involved 4. Able to understand and recall current issues related with production and use of biofuels, Research opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-

21UBT622E	FOOD BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.

Novel bioprocessing

Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.

Nutrigenomics

Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.

UNIT–II	10 Hrs.

Microbial biotechnology of food

Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of neutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.

UNIT–III	10 Hrs.

Plant food applications

Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for neutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.

UNIT–IV	10 Hrs.

Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study.

Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends.

Food safety: international aspects of the quality and safety, genetically modified food controversies. Regulation of the release of genetic modified organisms,patenting inventions in food biotechnology.

REFERENCE BOOKS *

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1. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- " Food Biotechnology"- second edition, CRC press, 2006
2. Gustavo F.G and Gustavo V.B,-" Food Science and Food Biotechnology"- CRC press, 2003
3. Mahesh S.-" Plant Molecular Biotechnology"- first edition, New age international publishers, , 2008

4. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007

COURSE OUTCOMES**

1. Students will be able to know the importance and current status of food biotechnology
2. Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
3. Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
4. Will be able to learn about plant food biotechnology and transplastomic technology
5. Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation
6. Able to have an overview recent trends in GMOs and food biotechnology

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

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21UBT623E	Biopython	Credits: 03
L:T:P - 3 : 0: 0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	16 Hrs.
Introduction and brief history of Biopython, Biopython modules, Tools and GNU/Linux, Nucleic Acid Bioinformatics, Sequences, Strings, and the Genetic Code, Sequences File Formats, Introduction to Biological Sequence Database, Sequence Motifs, Introduction to Motifs, String Matching, Consensus Sequences, Motif Finding, Promoters, De novo Motif Finding.	
UNIT–II	**12 Hrs.**
Sequence Alignments, Alignment Algorithms and Dynamic Programming, Alignment Software, Alignment Statistics, Short Read Mapping Multiple Sequence Alignments, Molecular Evolution, and Phylogenetics, Multiple Sequence Alignment, Phylogenetic Trees, Models of mutations, Practices Lab 4: Using BLAST on the command line, Lab 5: Phylogenetics	
UNIT–III	**12 Hrs.**
Genomics, The Three Fundamental "Gotchas" of Genomics, Genomic Data and File Formats, Genome Browsers, Transcriptomics, High-throughout Sequencing (HTS), RNA Deep Sequencing, Small RNA sequencing, Long RNA sequencing, Single-Cell Transcriptomics, Transcription Initiation, Transcription, Elongation, RNA Seq, Noncoding RNAs, Small Noncoding RNAs (srcRNAs), Long Noncoding RNAs, RNA Structure Prediction, Destabilizing energies. Practices: Lab 6: Genome Annotation Data, Lab 7: RNA-seq, Lab 8: RNA Structure, Lab 9: Proteins.	
UNIT–IV	**12 Hrs.**
Protein Alignment, Functional Annotation of Proteins, Secondary Structure prediction, Gene Ontology, Gene Regulation, Transcription Factors and ChIP-seq, MicroRNA regulation and Small RNA-seq, Regulatory Networks. Practices: Lab 8: RNA Structure, Lab 9: Proteins, Lab 10: ChIP-seq	
Reference Books *	
Reference Books: 1) Prof. David A. Hendrix 2) Deep Learning with Python, Francois Chollet Reference Books/Protocols: Tutorials Point (Simply easy learning).	
Course Outcomes**	

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After completion of the course student will be able to
1,Obtain knowledge on the biopython-GNU/Linux, modules, tools, commands and Motifs.

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2.Acquire the skills of Sequence Alignments using the Softwares, Statistics, Short Read Mapping, Multiple Sequence Alignments, Molecular Evolution,
3.Understand and Analyze the Phylogenetics, Phylogenetic Trees, and Models of mutations.
4.Utilize the biopython in analysis of the Genomic and transcriptomics data.
5. Conduct the Protein Alignment, Functional Annotation, Secondary Structure prediction, Gene Ontology, Gene Regulation.

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21UBT624E	GENOMICS AND PROTEOMICS	Credits: 3
L:T:P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases. c) prediction of new genes and their function by databases, d) potential revenue in the area diagnostic and biomedical applications, e) biosimilars market and implications. Sequencing & genome projects: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on *E.coli.*, Arabidopsis and rice; Human genome project.	
UNIT–II	**10 Hrs.**
Functional Genomics Gene variation and Single Nucleotide Polymorphisms (SNPs) genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans. Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics-definition & concept. C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking Methods of molecular mapping, Marker assisted selection, map based cloning, Bioinformatics analysis- clustering methods. Approaches to physical mapping	
UNIT 3	**10 Hrs.**
Structure of Proteins Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, Vanderwaal's force , salt bridges hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions (Examples of bio-molecular interactions), fibrous proteins (structure of collagen, keratin) and Quaternary structures.	
UNIT–IV	**10 Hrs.**
Proteomics Introduction to proteomics, Sample preparation, protein extraction Denovo protein synthesis, LCMS/MS, M/Z ratio, sequencing and identification, Predictive Methods using Protein sequences: Protein Identity based on composition, Related web based software (JPRED, PROSEC, NNPREDICT and SOPMA) Proteome analysis "Protein Chip" - interactions and detection techniques, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas. Challenges in proteomics.	
REFERENCE BOOKS *	

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1. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science, 1st Edition,1994.
2. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics –, Pearson Education, 2nd Edition, 2006.
3. Albala J S & I Humprey-Smith Protein Arrays, Biochips and Proteomics, CRC Press,1st Edition, 2003.
4. Sabesan, Genomics & Proteomics –Ane Books, 2007. 5. Pennington S. R. and M J Dunn Proteomics.

COURSE OUTCOMES**

After completion of the course student will be able to

1. To know about genes, brief history, polymorphism, prediction methods, Biosimilars, business opportunities in diagnostic and medicine
2. Understand about the Human genome project, tools in DNA sequencing methods and other advanced techniques, Comparative genomics using model organisms, functional genomics of different organisms and molecular markers, gene and physical mapping techniques
3. To know about Protein structure analysis and molecular interactions
4. Analysis of proteins, quantification, sequencing, identification, protein predictive methods and proteomics in medicine

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	**3**	**3**	**2**	**-**	**-**	**2**	**2**	**-**				**1**	-	**2**	**3**
CO 2	**3**	**3**	**1**	**-**	**-**	**2**		**-**				**2**	1	-	3
CO 3	**3**	**2**	**2**	**1**	**2**	**-**		**-**				**1**	**1**	**2**	2
CO 4	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**				**1**	**1**	**2**	**2**

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21UBT625E	BIOREACTOR DESIGN	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT-I	10 Hrs.

BASICS OF BIOREACTORS

Overview of bioreactions, Elements in bioreactor design, Rate expression in biological systems, Basic concept of material and energy balances, Development and significance of bioreactors, Bioreactor configurations, Classification of bioreactors, Bioreactors for solid-state fermentation, plant and animal cell cultures

UNIT–II	10 Hrs.

BIOREACTOR OPERATION

Common operations of bioreactor, Identification of common factors for smooth operation of bioreactors, Spectrum of basic bioreactor operations, Bioreactor operation for immobilized systems, plant and animal cell cultures

UNIT–III	10 Hrs.

BATCH, SEMICONTINUOUS AND CONTINUOUS BIOREACTORS DESIGN

Overview of bioreactor design, Batch and semi continuous bioreactors for submerged fermentation of microbes, Continuous flow stirred tank and plug flow tubular bioreactors for submerged fermentation of microbes, Recycle bioreactors, Multistage bioreactors, Bioreactors for enzyme reactions and immobilized systems

UNIT–IV	10 Hrs.

CASE STUDIES AND SCALE-UP

Design of packed bed, fluidized bed, airlift, hollow fibre, plant cell, mammalian cell bioreactors for various applications, Scale=up – Criteria, Similarity criteria, Methods, Generalized approaches.

Reference Books *

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
2. Atkinson, B., Biological Reactors, pion Ltd., London,1974.
3. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon
4. Alba S., Humphrey E and Milli N.R., “Bio Chemical Engineering” Academic Press, 1973.
5. Scragg. A.H “Bioreactors in Biotechnology”- A Practical approach
6. Tapobrata Panda. “Bioreactors: Analysis and Design”, Latest Edition, New Delhi: Tata McGraw Hill Education Private Limited. 2011
7. Moser, Anton. “Bioprocess Technology: Kinetics and Reactors”, Latest Edition, New York: Springer Verlag. 1988
8. Lydersen, D’ Elia, Nelson, Bioprocess engineering: Systems and equipment.
9. Rawlings, J. B. and Ekerdt, J. G. “Chemical Reactor Analysis and Design Fundamentals”, Latest Edition, San Francisco: Nob Hill Publisher. 2002

Course Outcomes**

After completion of the course student will be able to

1. State and Describe basic concepts of bioreactors
2. Apply the knowledge and Execute bioreactor operations for various applications
3. Design bioreactors for various biochemical applications

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4. Apply the knowledge of scale up process to design bioreactors from Research to Industrial level

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1							1	2		
CO 2	3	2	3	3	2							2	2		
CO 3	2	3	2	2	1							1	2		
CO 4	3	2	1	1	1							1	2		

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21UBT632N	ENVIRONMENTAL TECHNOLOGY	Credits: 3
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction: Current Environmental Issues and scope of Environmental science and technology biogeochemical role of soil microorganisms, Bioconcrete, Environment Impact Assessment **Bioaccumulation of toxicants** Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation **Sustainable future**: Green building concept, Carbon foot print, crediting, trading and its calculation, Water foot print Rain water harvesting .	
UNIT–II	**10 Hrs.**
Waste water treatment: Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration. ultrafiltration and microfiltration Microbial removal of phosphorous and Nitrogen Wastewater treatment of industries like sugar factories, food industries, beverages industries, and distilleries. **Solid waste management** Basic aspects, general composition of municipal solid wastes, aerobic treatment, anaerobic treatment biogas generation Solid waste management. Hazardous wastes, Biomedical Wastes E waste management, MoEF rules.	
UNIT–III	**10 Hrs.**
Bioleaching & Biomining: Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of phosphate, petroleum. **Bioremediation:** Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation	
UNIT–IV	**10Hrs.**
Biofuels: Definition, Renewable and nonrenewable resources Advantages and disadvantages of biofuels Biofuel feed stocks-sugar starch, cellulose, lipid Types of biofuel- first, second and third generation Technologies for bio-fuel production-transesterification, gasification 2G technology, Biomethanation, Issues of biofuel production and its use. Microbial fuel cells. **Biodiversity**: Value of biodiversity, threats to biodiversity approaches of biodiversity conservation.	

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REFERENCE BOOKS *

1. Pradipta Kum Mahopatra, 2006, Text Book of Environmental Biotechnology, I K Publishers.
2. R C Dubey and D K Maheshwari,2013 Text book of Microbiology,
3. M Y Young ,2004 ,Comprehensive Biotechnology Vol 1-4 (Eds). Pergamon Press
4. EJ Dasilva, C Ratledge & A Sasson, 2003, Biotechnology, Economic & Social Aspects Cambridge Univ Press.
5. Indu Shekhar Thakur,2012,Environmental Biotechnology Basic concepts and applications, Second Edition, I K international Publishing House, Pvt, Ltd.

COURSE OUTCOMES**

1. Able to analyse the current environmental issues, scope of environmental Technology and understand the various sustainable future concepts.
2. Able to analyse the methods used in treatment of waste water and solid waste.
3. Able to understand the concept of bioleaching process and biomining activity
4. Able to analyse the types and methods used in cleaning of the environment by bioremediation.
5. Able to define the sources of biofuels and produce various biofuels
6. Able to analyse the need of conservation of biodiversity

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2				2	1								1	1
CO2	2	3	1		1								2	2	2
CO3	3	2			1								2	3	2
CO4	2	2	1				1						2	3	1
CO5	2	1					3					2	2	2	2
CO6	2		1		2		1					2	2	3	2

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21UBT633N	INDUSTRIAL SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Industrial safety Need for safety, importance of occupational health and safety, Health and safety programs, unsafe conditions, factors contributing to unsafe conditions, Good Lab Practices (GLP). Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention- Engineering, Education, Enthusiasm, Enforcement and Evaluation. Hierarchy of Controls, Safety policy. Chemical Hazards: Types of hazards, Classification of chemicals based on their nature, routes to exposure of chemicals, Health effects of harmful chemicals in the work environment, Control of chemical hazards.	
UNIT–II	10 Hrs.
Electrical Hazards and Control measures Electrical hazards, protection against voltage fluctuations, effects of shock on human body. Fire- Fire formation, Fire extinguishing agents. Evacuation procedures for workers during emergency conditions. Physical Hazards and Control measures: Noise, noise exposure regulation, properties of sound, Workers exposure to electromagnetic field, Ionizing radiation and non-ionizing radiations, effects of radiations, Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines.	
UNIT–III	10 Hrs.
Biological and Construction Hazards and their control measures Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases –Hazardous material used in labs, Instructions followed for hazardous waste disposal, Biohazard control program, Biological safety cabinets. Construction Hazards: Hazards in construction and safety measures, Good Manufacturing Practices (GMP).	
UNIT–IV	10 Hrs.
Occupational Health and Toxicology Classification of Occupational hazards, occupational related diseases- silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene. Various types of Company policies.	
REFERENCE BOOKS *	
1. Mark Friend and James Kohn, (2007), Fundamentals of Occupational Safety and Health The Scarecrow Press, Inc. 2. Phil Hughes and Ed Ferret, (2011), Introduction to Health and Safety at work, (5th edition), Elsevier Ltd.	
COURSE OUTCOMES**	

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After completion of the course student will be able to

1. Apply the basic knowledge of Industrial hazards and safety.
2. Interpret & analyze the various types of accidents and chemical hazards.

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3. Identify physical hazards and apply control measures in work place.
4. Acquire knowledge of electrical hazards and apply control measures in work place.
5. Identify various types of biological hazards and apply control measures.
6. Identify control measures and apply the knowledge in industrial toxicology and hygiene, occupational diseases in work place.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	1	1	1	1	1	1	-	-	-	-	-	3	2	1
CO2	-	1	1	3	1	1	1	-	-	-	-	-	3	2	1
CO3	-	1	3	3	3	2	1	-	-	-	-	-	3	2	1
CO4	-	1	3	2	3	2	1	-	-	-	-	-	3	2	1
CO5	-	1	3	3	3	2	1	-	-	-	-	-	3	2	3
CO6	-	1	3	3	3	3	1	-	-	-	-	-	3	2	3

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21UBT604L	BIOKINETICS & ENZYME TECHNOLOGY LAB	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. Isolation of alpha-amylase from sweet potato or saliva
2. Maltose calibration curve by DNS method
3. Determination of activity of Salivary alpha-amylase
4. Determination of Specific activity of an enzyme
5. Effect of pH and temperature on enzyme activity
6. Determination of Kinetics constants (Km & Vmax)
7. Urea calibration curve
8. Determine the activity of enzyme Urease
9. Effect of inhibitors on enzyme activity
10. Immobilization of enzyme and determination of immobilized enzyme activity
11. Prediction of % error, standard deviation need to be calculated from expt. no 5 and 6)

12 Hrs.

REFERENCE BOOKS*

1. Pattabiraman 2017. Laboratory manual of Biochemistry, 4th Edition, International Book Publishers, India,.
2. Sadasivam and Manickam, 2017, Biochemical methods, 2nd Edition, New age International Publishers.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To to isolate enzymes and plot calibration curves for estimation the enzyme activity and specific activity.
2. To evaluate the optimum pH and temperature required for enzyme activity and analyze the effect of inhibitors for enzyme activity.
3. To apply knowledge of Km & Vmax for enzyme activity.
4. To immobilize enzymes and find the activity of enzymes.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	1
CO 2	2	3	3	2			2	3				3	2	3	1
CO 3	2	3	3	3		3	2	2				2	2	1	2
CO 4	3	3	3	2		2	2	2				2	3	1	1

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
Scheme and Syllabus
B. E. VII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2.	PCC	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3.	PEC	UBT7XXE	Elective-4	3	3	0	0	50	50	100
4.	PEC	UBT7XXE	Elective-5	3	3	0	0	50	50	100
5.	HSMS	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6.	OEC	UBT733N	Industrial Safety (Open Elective)	3	3	0	0	50	50	100
7.	INT	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8.	PCCL	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
Total				**21**	**18**	**0**	**06**	**400**	**400**	**800**

Elective-4 & Elective-5

UBT722E: Biopython
UBT723E: Industrial BT
UBT724E: Food Processing Technology
UBT725E: Protein Engineering and Drug Design
UBT731E: Nanobiotechnology & Biomaterials
UBT732E: Computational Biology
UBT733E: Bioconjugative Technology
UBT734E: Food Biotechnology

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UBT704C	ECONOMICS & PLANT DESIGN	Credits: 3:
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week:03		SEE Marks: 50

UNIT-I	10 Hrs.
Process design development Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design and equipment design and specialization, safety factors specifications, and materials of construction. **General design considerations:** Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, storage, materials handling, materials and fabrication selection,. Waste disposal community factors. Safety and hazard control measures.	
UNIT–II	**12Hrs.**
Capital investments Fixed capital investments including land, building, equipment and utilities, installation costs,(including equipment, instrumentation, piping, electrical installation and other utilities),working capital investments. **Manufacturing costs and plant overheads:** Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges Plant Overheads: Administration, safety and other auxiliary services, Conceptual numerical.	
UNIT–III	**10 Hrs.**
Cost analysis Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital Depreciation: different type of depreciation methods of and calculations, Conceptual numerical.	
UNIT–IV	**10 Hrs.**
Profitability analysis Methods for the evaluation of profitability. Return on original investment, interest rate of return, Cash flow diagrams. Break-even analysis. Conceptual numericals.	
REFERENCE BOOKS*	
• Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn.McGraw Hill. • Rudd and Watson (1987) Strategy of Process Engineering, Wiley. • Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises", Pearson education. • Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management",H imalaya Publishing House. • Khanka SS (2004) Entrepreneurship Development, S Chand & Co. Thomas W. Zimmer, Norman M. Scarborough.(2007), Essentials of Entrepreneurship and small Business Management	
COURSE OUTCOMES**	

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At the end of the course the student should be able to:

1. Acquire knowledge in the design of a plant.
2. Conduct preliminary feasibility study of the plant design assigned.
3. Estimate the cost analysis involved in the design of a chemical plant.
4. Analyze the project profitability and alternative investments for the selection of good investment projects
5. Develop entrepreneurs with substantial knowledge in engineering concepts.
6. Apply the knowledge of plant design and cost estimation in actual engineering problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	1	1			1	1	1		2		2		
CO 2	2	1	2	1			1	1	1		3		2		
CO 3	1	2	1	2			1	1	1		2		1		
CO 4	2	1	2	2			1	1	1		3		2		
CO 5	1	1	2	1			1	1	1		2		1		
CO 6	2	2	2	1			1	1	1		2		2		

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UBT715C	DOWNSTREAM PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Role and importance of downstream processing in biotechnological processes. Range and characteristics of bioproducts. Purification process of bio-product. Cell disruption methods for intracellular products; physical, chemical and mechanical methods. Basic principles of distillation,crystallization, centrifugation, ultracentrifugation (preparative and analytical).Types of centrifuges and rotors,centrifugation-differential,density gradient (zonal and isopycnic).	
UNIT–II	**12Hrs.**
Primary Recovery Operations Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.	
UNIT–III	**10 Hrs.**
Chromatography Principles of chromatographic seperations, Classification of chromatography- plain and column chromatography, Paper chromatography - Single dimensional (Ascending and Descending, radial and two dimensional) chromatography, partition coefficient, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.	
UNIT–IV	**10 Hrs.**
Electrophoresis Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis,Cellulose Acetate, Starch Gel , Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry. **Downstream Processes** Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.	

REFERENCE BOOKS*
1. BioseparationsPrinciples and techniques, by B.Sivasankar, Kindle edition,PHI Publishers, 2010 2. Biophysical chemistry principles and Techniques by Upadhay and Nath,Himalaya Publishing House, 3rd edition, 2010 3. NPTEL Source material. 4. Bioseparations - Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub, 1988 5. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993. 6. Product Recovery in Bioprocess Technology – BIOTOL Series, VCH, 1990 7. Rate controlled separations by Wankat P.c., Elsevier, 1990 8. Fermentation & Enzyme Technology by D.I.C. Wang, Wiley Eastern 1979
COURSE OUTCOMES**
1. Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques. 2. Interpret and analyze the industrial fermentation processes. 3. Apply the knowledge in identifying various pharma and R&D sections. 4. Analyse the details of experimentation pertaining to chromatography and electrophoresis. 5. Understand analyse and apply the techniques in various tests involved in finding out purity of biological components. 6. Apply the knowledge in identifying various biochemicals using advanced purifications like HPLC and to demonstrate DSP flowsheets.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	1
CO 2			2			3	2	3				1	2	1	1
CO 3			1			3	2	2				1	2	1	1
CO 4			2			3	2	2				1	2	1	1
CO 5			1			3	3	3				1	2	1	1
CO 6			1			3	2	2				2	2	1	1

UBT716H	INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Development of management thoughts and its functions Concept & definition of Management, Social Responsibilities of Management, and Pioneers in Management: Contributions of Taylor, Henry Taylor, Gilberth& Mayo, Schools of Management thought: Management process school, Empirical School, Human Behavior School, Social system school, Systems approach school and decision theory school. Selection of site for the plant and plant layout, plant operation and control, utilities, structural design, storage, material handling, Sources of capital. Definition and functions of administration. Planning, organizing, staffing, directing and controlling. Concept of authority and responsibility.	
UNIT–II	**10 Hrs.**
Quantitative techniques in managerial decisions Concept of productivity, measuring productivity, concept of budget, effective budgetary control, ABC analysis, break even analysis, product life cycle, promotion of sales, pricing, "EOQ"model. Production costs (including raw materials, and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges (including depreciation, taxes, insurance, rental costs etc.).	
UNIT–III	**10 Hrs.**
Production And Material Management Types of production, types of planning, manufacturing planning, factory planning, production planning, method study, systems of wage payments, bonus, automation, organization of production, planning. Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management.	
UNIT–IV	**10 Hrs.**
Entrepreneurship& personnel management Meaning of entrepreneur, evaluation of the concept, function of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship- its barriers. Recruitment and selection. Training of personnel. Employer - Employee relationship. Settlement of disputes.	
Reference Books *	
1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons, 1992. 2. T. R. Banga & S. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003. 3. C.B.Mamoria and S.V.Gankar- Personnel Management, Himalaya Pub, 21 st edn,2010 4. Veerabhadra Havinal -Management and Entrepreneurship- New Age International, 2009 5. Ramesh Burbure – Management &Entrepreneurship- Rohan Pub. 2008 6. Poornima M. Charanthimath – Entrepreneurship Development, Pearson Education-2005	
COURSE OUTCOMES**	
After completion of the course student will be able to 1. Recall and recollect the history theories and definition of management and its importance in society	

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2. Analyze and apply the basic concepts of Quantitative techniques of management
3. Know the difference between production and productivity, measurement and cost analysis
4. Explore the knowledge of production costs, planning and material management
5. Make basic economic analysis of project
6. Understand the role and importance of entrepreneurship in economic development

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-	-	-	-	1	-	-	-	3	1	-	-	2
CO2	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO3	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO4	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO5	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO6	-	1	-	-	-	-	-	-	2	-	3	1	-	-	2

UBT710L	BIOSEPARATION TECHNIQUES LAB	Credits: 1
L: T: P – 0-0-2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

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1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration (Cross flow)
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Membrane dialysis
6. Product enrichment operations: Precipitation – (NH4)2 SO4 fractionation of a protein.
7. Product enrichment operations: Two – phase aqueous extraction.
8. Product drying techniques.
9. Estimation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

REFERENCE BOOKS**

1. Protein Purification by Scopes R.K., IRL Press,1993.
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri.
5. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990
6. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993

COURSE OUTCOMES**

1. Able to prepare/reproduce the protocols for the experiments.
2. Able to extract the intracellular product using different cell disruption techniques.
3. Able to concentrate, purify the desired product using different chromatography/ filtration techniques.
4. Able to analyze the product both quantitative/qualitatively.
5. Able to record/observe the experimental data and interpret them in the graph/table.
6. Able to calculate the result and to write the conclusion at the end of the experiment.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3												3		1
CO 2		2												3	1
CO 3			3										2	2	1
CO 4				3	3								2	2	1
CO 5		3										2	2	3	1
CO 6		3										2	3	2	1

UBT722E	Biopython	Credits: 03
L:T:P - 3 : 0: 0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	16 Hrs.
Introduction and brief history of Biopython, Biopython modules, Tools and GNU/Linux, Nucleic Acid Bioinformatics, Sequences, Strings, and the Genetic Code, Sequences File Formats, Introduction to Biological Sequence Database, Sequence Motifs, Introduction to Motifs, String Matching, Consensus Sequences, Motif Finding, Promoters, De novo Motif Finding.	
UNIT–II	**12 Hrs.**

Sequence Alignments, Alignment Algorithms and Dynamic Programming, Alignment Software, Alignment Statistics, Short Read Mapping Multiple Sequence Alignments, Molecular Evolution, and Phylogenetics, Multiple Sequence Alignment, Phylogenetic Trees, Models of mutations, Practices Lab 4: Using BLAST on the command line, Lab 5: Phylogenetics	
UNIT–III	**12 Hrs.**
Genomics, The Three Fundamental "Gotchas" of Genomics, Genomic Data and File Formats, Genome Browsers, Transcriptomics, High-throughout Sequencing (HTS), RNA Deep Sequencing, Small RNA sequencing, Long RNA sequencing, Single-Cell Transcriptomics, Transcription Initiation, Transcription, Elongation, RNA Seq, Noncoding RNAs, Small Noncoding RNAs (srcRNAs), Long Noncoding RNAs, RNA Structure Prediction, Destabilizing energies. Practices: Lab 6: Genome Annotation Data, Lab 7: RNA-seq, Lab 8: RNA Structure, Lab 9: Proteins.	
UNIT–IV	**12 Hrs.**
Protein Alignment, Functional Annotation of Proteins, Secondary Structure prediction, Gene Ontology, Gene Regulation, Transcription Factors and ChIP-seq, MicroRNA regulation and Small RNA-seq, Regulatory Networks. Practices: Lab 8: RNA Structure, Lab 9: Proteins, Lab 10: ChIP-seq	
Reference Books *	
Reference Books: 1) Prof. David A. Hendrix 2) Deep Learning with Python, Francois Chollet Reference Books/Protocols: Tutorials Point (Simply easy learning).	
Course Outcomes**	
After completion of the course student will be able to 1,Obtain knowledge on the biopython-GNU/Linux, modules, tools, commands and Motifs. 2.Acquire the skills of Sequence Alignments using the Softwares, Statistics, Short Read Mapping, Multiple Sequence Alignments, Molecular Evolution, 3.Understand and Analyze the Phylogenetics, Phylogenetic Trees, and Models of mutations. 4.Utilize the biopython in analysis of the Genomic and transcriptomics data. 5. Conduct the Protein Alignment, Functional Annotation, Secondary Structure prediction, Gene Ontology, Gene Regulation.	

UBT724E	**FOOD PROCESSING TECHNOLOGY**	**Credits: 3**
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	**10 Hrs.**
Introduction Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavours, Browning reactions and its effects . Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods .Food additives, Vitamins, amino acids, Sweeteners, Food colours. Toxic-trace elements in food.	

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UNIT–II	12Hrs.
Detection of Microorganisms Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dyereduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice, squash, wine, pickles and sauerkraut	
UNIT–III	**10 Hrs.**
Food Spoilage & Preservation The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry.:, nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing, and promotional strategies, risks and benefits of food industry.	
UNIT–IV	**10 Hrs.**
Food Engineering Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management.	

REFERENCE BOOKS*

1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press,2007.
2. Food microbiology by William Frazier and Westhoff D.C, 4thEdn,TATA McGraw Hill Pub(2005)
3. Modern Food Micro-Biology by James M.Jay, CBS Publishers.2005.
4. Food Microbiology by K.Vijay RameshMJP Publishers, 2007.
5. Plant biotechnology In Agriculture by K. Lindsey and M.G.K. Jones, Prentice Hall, USA. 1990.
6. Food Science By Potter N.N. and Joseph Hotchkiss, 5thEdn, CBSPub,1996.

COURSE OUTCOMES**

1. Able to know about basic constituents of food
2. Able to know the techniques involved in detection of microbes in food industry
3. To have idea about Dairy , fruits and vegetable processed products and production
4. To be aware of different food spoilage and preservation techniques
5. To know the Characteristics of food industry and scope
6. Able to understand Basic concepts in food Engineering for preservation

Course Outcomes	Programme Outcomes	Programme Specific Outcomes

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	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	
CO 2			2			3	2	3				1	2	1	
CO 3			1			3	2	2				1	2	1	
CO 4			2			3	2	2				1	2	1	
CO 5			1			3	3	3				1	2	1	
CO 6			1			3	2	2				2	2	1	

UBT725E	PROTEIN ENGINEERING AND DRUG DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Structure of proteins

Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.

Protein structure prediction

Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.

Protein engineering and design

Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

UNIT–II	10 Hrs.

Molecular modeling

Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.

UNIT–III	10 Hrs.

Insilico drug design

Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.

Computer assisted new lead design

Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.

UNIT–IV	10 Hrs.

Docking methods

Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.

Computer - assisted drug discovery

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

REFERENCE BOOKS *

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI,4th Edition, 2013
2. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition,2010.
3. Creighton T.E. Proteins, Freeman W.H. Second Edn,1993.
4. Branden C. and Tooze R. Introduction of protein structure, Garland,1993.

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5. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.
COURSE OUTCOMES**
1. Ability to study protein structure prediction and protein engineering and design 2. Able to understand molecular modeling 3. Able to know computer assisted new lead design 4. Able to study docking methods and computer - assisted drug discovery

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-

UBT731E	NANOBIOTECHNOLOGY AND BIOMATERIALS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to nanotechnology:

A Brief History of the Nano particles : Bottom-Up versus Top-Down; What Is Nanobiotechnology.Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy(SEM,STM & AFM), biomolecule-surface interactions, quantum dots,

Applications of nanotechnology in the life sciences:

Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.

UNIT–II	10 Hrs.

Biopolymers:

Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli,sterilization and disinfections of polymeric materials. Biocompatibility of

polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.	
UNIT–III	**10 Hrs.**
Synthetic polymers: Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.	
UNIT–IV	**10 Hrs.**
Biocompatibility: Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods. **Medical devices:** Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.	

REFERENCE BOOKS *

1. B.Vishwanath (2011). " Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delh.
2. Mark Ratner and Daniel Ratner (2003). "Nanotechnology:A Gentle Introduction to Next Gig Idea" Pearson Ecducation Ltd.
3. K Eric Drexler (1993). "Unbounding the future" Quill.
4. Stephen Lee and Lynn M Savage (2010). "Biological molecules in Nanotechnology".

COURSE OUTCOMES**

After completion of the course student will have the

1. Ability to explain the characterization techniques of nanotechnology.
2. Ability to understand the importance of nano-particles in drug delivery system.
3. Ability to understand the importance of biopolymers.
4. Ability to differentiate biopolymer and synthetic polymer.
5. Ability to understand the importance of biocompatibility.
6. Ability to apply the methods to test the implants and use in medical devices.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	3	-	-	1	2	-	-	-	-	-	2	2	1
CO2	1	2	3	-	-	1	-	-	-	-	-	-	3	-	-
CO3	2	2	3	-	-	2	-	-	-	-	-	-	2	2	1
CO4	3	3	3	-	-	2	-	-	-	-	-	-	2	1	1
CO5	3	3	3	-	-	1	-	-	-	-	-	1	2	-	-
CO6	2	3	3	-		3	3	-	-	-		-	3	1	-

UBT732E	**COMPUTATIONAL BIOLOGY**	**03 - Credits (3 : 0 : 0)**
Hours / Week : 03		CIE Marks : 50

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Total Hours : 40		SEE Marks : 50

UNIT – 1	12 Hrs
Nature and scope of Computational Biology: Basic algorithms in Computational Biology, Biological and Computer algorithm, Fibonacci problem, Dynamic Programming, Time and space complexity of algorithms, Laplace's Rule. Search Algorithms: Random walk, Hill climbing, simulated annealing. Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – 2	**8 Hrs**
Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – 3	**10 Hrs**
Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.	
UNIT – 4	**10 Hrs**
Insilico Drug Design and Biopython applications in Computational Biology Insilico Drug Design: Basic Concepts, importance and application, Molecular force fields and energy minimization, Molecular Dynamics Simulation methods, Methods of Insilico Drug Design: structure and ligand based drug design approach, structure based drug design: Molecular docking. Biopython: Introduction, important features and application of biopython in computational biology, Create a simple sequence in Biopython for DNA, RNA and Protein Alphabets, Sequence Alignment Tools in Biopython, PDB Module of Biopython,	
REFERENCE BOOKS	

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- Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith,1999,Pearson Education.
- Arthur M.Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
- Higgins and W.Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000
- An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004 2.
- Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998

Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 20014.

1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., 1998, John Wiley & Sons, UK.
2. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999,Pearson Education.
3. Arthur M.Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
4. D.Higgins and W.Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000.
5. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001 2.
6. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona,Tucson

COURSE OUTCOMES

After completion of the course student will be able to

1) Understand the nature, scope of computational biology and biological and computer algorithms.
2) Know about the Combinatorial Pattern Matching, Genetic algorithms and their applications.
3) Analyze various Markov processes and Markov Models.
4) **Learn about the Insilico Drug Design and Biopython applications in Computational Biology**

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

UBT733E	BIOCONJUGATIVE TECHNOLOGY	Credits: 03

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L:T:P – 3:0:0		CIE Marks: 50
Total Hours:40		SEE Marks: 50

UNIT-I	10 Hours
Bioconjugative technology Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides.	
UNIT–II	**10 Hrs.**
Chemistry of active groups Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions. **Bioconjugate reagents** Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes.	
UNIT–III	**10 Hrs.**
Enzyme and nucleic acid modification and conjugation Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.	
UNIT–IV	**10 Hrs.**
Bioconjugate applications Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives-Colloidal – gold-labeled proteins – modification with synthetic polymers.	

REFERENCE BOOKS *

1. Bioconjugate Techniques, G.T. Hermanson, Academic Press, 2 nd edition 2008
2. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2016
3. A Text book of biophysics by Dr R.N. Roy,UBS publishers, 2001
4. Bioconjugative Chemistry by Vincent M Rotello, American Chemical society, 2016
5. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2017

COURSE OUTCOMES**

1. Able to understand modification of nucleic acids and oligonucleotides.
2. Ability to know the chemistry of active groups.
3. To analyse the bioconjugate reactants.
4. To analyze bioconjugate applications .
5. Ability to know the conjugate derivatives.
6. Ability tostudy the conjugation process.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

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CO1	1	-	2	-	1	1	2	1	-	-	-	1	2	1	1
CO2	**1**	**-**	**2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**2**
CO3	**-**	**-**	**1**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO4	**2**	**-**	**2**	**-**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO5	**-**	**-**	**1**	**2**	**2**	**-**	**3**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO6	**1**	**-**	**1**	**-**	**-**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**2**	**1**	**-**

UBT734E	**FOOD BIOTECHNOLOGY**	**Credits: 03**
L:T:P – 3:0:0		**CIE Marks: 50**
Total Hours/Week: 03		**SEE Marks: 50**

UNIT-I	**10 Hours**

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Introduction
Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.
Novel bioprocessing
Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.
Nutrigenomics
Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.

UNIT–II	10 Hrs.

Microbial biotechnology of food
Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of neutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.

UNIT–III	10 Hrs.

Plant food applications
Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for neutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.

UNIT–IV	10 Hrs.

Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study.
Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends.
Food safety: international aspects of the quality and safety, genetically modified food controversies. Regulation of the release of genetic modified organisms,patenting inventions in food biotechnology.

REFERENCE BOOKS *

1. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- " Food Biotechnology"- second edition, CRC press, 2006
2. Gustavo F.G and Gustavo V.B,-" Food Science and Food Biotechnology"- CRC press, 2003
3. Mahesh S.-" Plant Molecular Biotechnology"- first edition, New age international publishers, , 2008

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4. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007

COURSE OUTCOMES**

1. Students will be able to know the importance and current status of food biotechnology
2. Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
3. Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
4. Will be able to learn about plant food biotechnology and transplastomic technology
5. Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation
6. Able to have an overview recent trends in GMOs and food biotechnology

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

UBT733N	INDUSTRIAL SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

Industrial safety

Need for safety, importance of occupational health and safety, Health and safety programs, unsafe conditions, factors contributing to unsafe conditions, Good Lab Practices (GLP).

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Accidents:
Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention- Engineering, Education, Enthusiasm, Enforcement and Evaluation. Hierarchy of Controls, Safety policy.
Chemical Hazards:
Types of hazards, Classification of chemicals based on their nature, routes to exposure of chemicals, Health effects of harmful chemicals in the work environment, Control of chemical hazards.

UNIT–II	10 Hrs.

Electrical Hazards and Control measures
Electrical hazards, protection against voltage fluctuations, effects of shock on human body. Fire- Fire formation, Fire extinguishing agents. Evacuation procedures for workers during emergency conditions.
Physical Hazards and Control measures:
Noise, noise exposure regulation, properties of sound, Workers exposure to electromagnetic field, Ionizing radiation and non-ionizing radiations, effects of radiations, Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines.

UNIT–III	10 Hrs.

Biological and Construction Hazards and their control measures
Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases –Hazardous material used in labs, Instructions followed for hazardous waste disposal, Biohazard control program, Biological safety cabinets.
Construction Hazards:
Hazards in construction and safety measures, Good Manufacturing Practices (GMP).

UNIT–IV	10 Hrs.

Occupational Health and Toxicology
Classification of Occupational hazards, occupational related diseases- silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene. Various types of Company policies.

REFERENCE BOOKS *

1. Mark Friend and James Kohn, (2007), Fundamentals of Occupational Safety and Health The Scarecrow Press, Inc.
2. Phil Hughes and Ed Ferret, (2011), Introduction to Health and Safety at work, (5th edition), Elsevier Ltd.

COURSE OUTCOMES**

After completion of the course student will be able to
1. Analyze the effects of hazards in workplace and select appropriate measures of safety for preventing industrial accidents and chemical hazards.
2. Identify physical and electrical hazards and apply control measures in work place for the prevention of fires and explosions.
3. Identify various types of biological hazards and understand the methods of hazard identification and preventive measures.

4. Assess the risks in the occupation, identify control measures and apply hygiene in the work place.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO2	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO3	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO4	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1

B. E. VIII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PEC	UBT82XE	Elective-6	03	3	0	0	50	50	100
2.	PEC	UBT83XE	Elective-7	03	3	0	0	50	50	100
3.	PP	UBT805P	Project	15	0	0	30	50	50	100
Total				**21**	**6**	**0**	**30**	**150**	**150**	**300**

Elective-6
UBT823E: Biosimulations
UBT824E: Metabolic engineering

UBT825E: Bionanalytical techniques
UBT827E: Pharmaceutical BT

Elective-7
UBT830E: Clinical research UBT832E:
Health diagnostics UBT833E:
Validation & quality control UBT834E:
Product development
UBT835E: Validation & quality assurance

UBT823E	BIOSIMULATIONS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	08 Hours
Modelling Principles: Basic modeling principles, uses of mathematical modeling classification of modeling techniques Fundamental laws, energy equations, continuity equation, equations of motion, transport equations, equations of state, equilibrium states and chemical kinetics-examples.	
UNIT–II	**08 Hrs.**
Mathematical Models for Biochemical Engineering Systems: Mathematical models for Biochemical engineering systems, Mathematical models in batch and continuous process, continuous flow tanks, reversible reaction.	
UNIT–III	**16 Hrs.**
Simulation Softwares in Bioprocess: Introduction to SuperPro Designer for Material balance, Software for mass and energy balance; Energy Balance with and without reaction. **Metabolic Flux** Balance Analysis: Introduction, Principle of steady state metabolic flux balance analysis, COPASI, COBRA.	
UNIT–IV	**08Hrs.**

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Matlab and Simulink: MATLAB for data analysis Basics, Data analysis, curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Simulation of gravity flow tank, SIMULINK for dynamic systems.
REFERENCE BOOKS *
1. Luben W.L. "Process Modelling Simulation and Control for Chemical Engineers", McGrawHill, International New York, 1990. 2. Franks RGE. "Mathematical Modeling in Chemical Engineering", John Wiley and Sons, Inc., New York, 2004. 3. Biquette W.B. "Process Dynamics- Modeling analysis with simulation", Prentice Hall; 1 edition January 15, 1998. 4. William J. Palm. "Introduction to Matlab 7 for Engineers", III, McGraw Hill 2005. 5. Kenneth J. Beers. "Numerical Methods for Chemical Engineering Applications in MATLAB", Massachusetts Institute of Technology, Cambridge University press 2007 edition. 6. http://www.mathworks.com
COURSE OUTCOMES**
Course Outcomes: After the completion of this course, students will be 1) Analyse the biological and bioprocess data and make suitable interpretation of them. 2) Handle mathematical models 3) Understand simulation software's for bioprocess development. 4) Analyze using Matlab and Simulink

UBT824E	**METABOLIC ENGINEERING**	**Credits: 03**
L:T:P – 3:0:0		**CIE Marks: 50**
Total Hours/Week: 03		**SEE Marks: 50**

UNIT-I	**10 Hours**
Introduction Basic Concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies. **Metabolic regulation** An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Glycolysis, ermentative Pathways, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, atabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, iosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids, and Other Building Blocks, Polymerization, Growth Energetics	
UNIT–II	**10 Hrs.**
Metabolic flux Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method. **Applications of metabolic flux analysis** Amino Acid Production by Glutamic Acid Bacteria, Biochemistry and Regulation of Glutamic Acid Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine Biosynthetic Network in C. glutamicum, Metabolic Flux Analysis of Specific Deletion Mutants of C. Glutamicum, Metabolic Fluxes in Mammalian Cell Cultures, Determentation	

of Intracellular Fluxes., Computational Networks and Systems Biology

UNIT–III	10 Hrs.

Regulation of metabolic pathways

Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites.

UNIT–IV	10 Hrs.

Metabolic engineering in practice

Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Alteration of Nitrogen Metabolism, Enhanced Oxygen Utilization, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX).

REFERENCE BOOKS *

1. P.F. Stanbury and A. Whitkar. 2008,Principle of Fermentation Technology pergaman press,
2. Wang D I C Cooney C I Demain, A L ,2008, “Fermentation and enzyme Technology” John Willey,
3. Roberts, 2007 “Metabolism of Agrochemicals in Plants” Willey Int,.
4. David L. Nelson and Michael Cox, 2016, “Lehninger Principles of Biochemistry” –6th Edition
5. Lubert Stryer, 2010 “Biochemistry” -Freeman & Co., Pub.

COURSE OUTCOMES**

1. Recall the concepts of cellular metabolism.
2. Explain the Basic concepts of metabolic engineering.
3. Explain Fundamentals of Metabolic flux analysis.
4. Apply the knowledge of metabolic flux analysis.
5. Apply the knowledge of regulatory mechanism for altering the metabolic pathways.
6. Design the metabolic pathways for desired product.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2			2							1	1	1
CO2	2	2	2		2	3							2	1	2
CO3	3	3	2		2	2						1	1	1	2
CO4	3	3	3		2	3						1	2	1	3

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CO5	2	1		2		2		2					1	3	1
CO6	1	2	3	2		3		1					1	3	1

UBT825E	BIOANALYTICAL TECHNIQUES	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	10 Hrs.

Centrifugation

Introduction: Basic, Types of centrifuges: Desktop, High Speed and Ultracentrifuge (Preparatory and Analytical), Design and their working principle, Types of Rotors, Wall-effect

Spectroscopy :

(i) Absorption Spectroscopy

Simple theory of absorption of light by molecules, Chromophore and terminologies associated with absorption of molecules

The Beer-Lambert Law and its deviations

Single and double beam spectrophotometers for measuring Visible and Ultraviolet light: Instrumentation and Parameters measured in absorption Spectroscopy **(UV-Vis spectrophotometer)**

Empirical rule for the absorption spectra of biological macromolecules

Chemical Analysis by absorption spectroscopy using Visible and Ultraviolet light

(ii) Fluorescence Spectroscopy

Simple theory of Fluorescence

Instrumentation and Technology of Fluorescence Spectroscopy **(Fluorescence spectrometer)**

Intrinsic Fluorescence measurements for information about the conformation and binding sites of proteins

Extrinsic fluorescence measurements for information about the conformation and binding sites of proteins

UNIT – 2	10 Hrs.

(iii) Infrared Spectroscopy

Infrared Spectroscopy: Basic Principle Instrumentation and Technology of Infrared Spectroscopy (Fourier-transform infrared spectroscopy (FTIR))

Information in Infrared Spectra and Applications of Infrared spectroscopy

(iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)

Theory of Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)

Relative values of ORD and CD measurements, Advantages of CD over ORD

Instrumentation for measuring ORD and CD, Applications of ORD and CD

(v) Nuclear Magnetic Resonance (NMR) Spectroscopy

Nuclear Magnetic Resonance (NMR) Spectroscopy : Principle Basic Instrumentation of NMR Spectrometer

Applications of NMR Spectroscopy

(vi) Mass spectrometry

Mass spectrometry: Basic Principle Instrumentation and main components of mass spectrometers Ionization source, Mass analyzers, and Detectors **(LC-MS and GC-MS)**

Applications of Mass Spectrometry

UNIT – 3	10 Hrs.

Chromatography

Adsorption Chromatography: Simple Theory & Types

Operations of columns : Terminologies and concept

Elution : Types of elution methods

Supports : Concept of mesh size and mesh screen

Gas Chromatography: Principle, Basic set up of Gas chromatography system, Detectors and Uses of Gas chromatography

Gel Chromatography (molecular-sieve chromatography): Simple Theory, Materials (dextran, agarose and polyacrylamide gels), Advantages of gel chromatography, Estimation of molecular

weight and applications of gel chromatography

Ion-Exchange Chromatography: Principle, Properties of Ion Exchangers, Choice of Ion Exchangers, Technique and application of Ion Exchange chromatography.

High-Performance of Liquid Chromatography (HPLC): Principle, Application of pressure in HPLC, Advantages and uses of HPLC.

Affinity Chromatography: Principle, Methods of Ligand immobilization (Cyanogen-bromide-activated agarose, Aminoethyl- and hydrazide-activated polyacrylamide), uses of affinity chromatography

UNIT – 4	10 Hrs.

Electrophoresis

Iso-electric focusing (IEF): Principle, Technique and application, 2-D PAGE: Steps involved in 2-D PAGE, application in proteomics

Pulse-field gel electrophoresis: Principle, Technique and Application

Capillary electrophoresis: Principle, Technique and Application

X-ray crystallography

Interaction of X-ray with matter: Absorption, Scattering and diffraction (Bragg' s Law)

Preparation of crystals : Hanging and sitting drop vapor diffusion methods

X-ray diffraction methods

Application of X-ray Diffraction in Crystal structure

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REFERENCES

1. Fundamentals of Bioanalytical Techniques And Instrumentation, Ghosal, Sabari, Avasthi, Anupama Sharma, Second Edition, Phi Learning Pvt. Ltd., 2018.
2. Bioanalytical Techniques, Abhilasha Shourie, Shilpa S. Chapadgaonkar, The Energy and Resources Institute, 2015
3. Biomolecular and Bioanalytical Techniques: Theory, Methodology and Applications, Vasudevan Ramesh, John Wiley & Sons Ltd, 2019
4. Handbook of Analytical Techniques, Helmut Günzler, Alex Williams, WILEY, 2001
5. Analytical Techniques in Biotechnology, Suzy Hill, Syrawood Publishing House, 2016
6. Analytical Techniques In Biotechnology, Goutam Bhowmik, Tata McGraw Hill Education Private Limited, 2010
7. Instrumental Methods of Chemical Analysis, G. R. Chatwal and A. K. Sham, 5th edition Himalaya Publishing House, 2005.
8. Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, 11th edition, Brooks/Cole, a part of Cengage Learning, 2012.

COURSE OUTCOMES

After completion of the course student will be able to

1. Understand the basic concepts and principles of the major analytical techniques including instrumentation, sample preparation and standardization.
2. Evaluate the proper application of various analytical techniques for problem solving in biological sciences.
3. Demonstrate the ability to plan and execute experiments, and analyze and interpret the outcomes.
4. Design an analytical regimen to obtain data relevant to their research problem

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

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UBT827E	PHARMACEUTICAL BT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction: Introduction to pharmaceutical biotechnology, Pharmaceutical Industry. Drug design, development and Economics, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescription and Non-prescription drugs. Regulations & guidelines for pharma ,CDSCO, fda, ichq7, usfdA21 cfr part11. **Drug metabolism:** Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) . Pharmacodynamics and Pharmacokinetics of drugs.	
UNIT–II	**10 Hrs.**
Toxicology: Basic concepts in toxicology, the mechanism of toxin action, biotransformation of toxins, their inactivation and removal from the body, Reactive intermediates. **Manufacturing principles and formulations:** Definitions, applications, composition, preparation, physicochemical considerations,. Preformulation Testing, Tablets, compressed tablets, tablet granulation, Coatings, Pills, Parental preparations, herbal extracts, Oral liquids, Ointments, short study of current biotech products, herbal medicines. Quality control, storage and stability of biotech products.	
UNIT–III	**10 Hrs.**
Stem cells in health care: Introduction to Stem Cell Biology, Fate Mapping of Stem Cells, Mesenchymal Stem Cells, Stem Cells and Neurogenesis and its application , Epidermal Stem Cells, Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon. Application of epidermal stem cell in Tissue engineering, Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.	

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Drug delivery system: Advanced Sustained Release Drug Delivery System, Advanced drug Delivery Systems, Liposomes and Nanoparticles Drug Delivery System, Biodegradable Drug Delivery System, Hydrogel based Drug Delivery System.	
UNIT–IV	**10 Hrs.**
Analysis of biologicals & pharmaceuticals: Vitamins Cold remedies Laxatives Analgesics, NSAIO, External antiseptics, Antacids, Antibiotics, Biologicals, Herbal products. Packaging techniques – Glass containers, plastic containers, film wrapper, bottle seals. **Advanced pharmacology:** Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.	

REFERENCE BOOKS *

1. Gary Walsh, (2013),Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers.
2. Bartram Katzung, (2009),Basic & Clinical Pharmacology(9th Edition), McGrawHill.
3. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of Industrial Pharmacy, (3 rd Edition) Publishing House Bombay.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Apply and classify various biological sources of pharmaceutical products to retrieve the basic concept of pharmacology, drug metabolism .and their importance in biotechnology
2. Select and apply the toxicological studies of pharmaceutical products
3. Use knowledge of the techniques used in the manufacture of pharmaceutical products and apply in the field of Biopharmaceuticals.
4. Ability to discuss the concepts used in production of stem cells and analyse the applications and ethical issues of stem cells in the society.
5. Select and apply appropriate techniques advanced techniques in drug delivery system.
6. Demonstrate an ability to apply principles various other applications to protect the global community from various dreadful diseases.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	2	2	2	3	3	1	-	-	-	-	-	3	2	1
CO2	-	3	3	3	3	2	3	-	-	-	-	-	2	2	1
CO3	-	2	3	2	3	1	-	-	-	-	-	-	3	2	-
CO4	-	2	3	2	3	1	-	-	-	-	-	-	2	2	-
CO5	-	3	3	2	3	1	-	-	-	-	-	-	2	3	-
CO6	-	3	3	3	3	2	2	-	-	-	-	-	2	2	3

UBT830E	CLINICAL RESEARCH	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology. **Clinical pharmacology** Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development -formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.	
UNIT–II	**10 Hrs.**
Therapeutics Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors. **Management of drugs** Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.	
UNIT–III	**10 Hrs.**
Healthcare marketplace National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing. **Social, ethical issues** patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.	

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UNIT–IV	10 Hrs.
Clinical research Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data **Management in Clinical Research:** General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.	

REFERENCE BOOKS *

1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd.
2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication. ,
3. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology,
4. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.

COURSE OUTCOMES**

1. Exploit the knowledge to know the clinical importance of different therapeutic products
2. An integrated understanding of the formulations, manufacturing and supply of materials
3. Ability to study the philosophy behind organization of research Ability to understand control measures uised in drug and its control
4. Ability to elucidate the marketing strategies of pharma products
5. Ability to compare the social and ethical issues
6. Ability to inculcate the epidemiology study designs, case reports and case series

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	3	-	2	-	2	1	-	-	-	2	2	2	1
CO2	1	2	3	-	1	-	2	1	-	-	-	3	3	1	1
CO3	1	2	3	-	2	-	2		-	-	-	3	2	2	1
CO4	1	3	3	-	1	-	1	1	-	-	-	2	2	1	1
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

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UBT832E	HEALTH DIAGNOSTICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
INTRODUCTION: Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders chromosomal disorders, single cell disorders and complex traits. Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis. **DNA BASED DIAGNOSTICS** G-banding, in *situ* hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH). Cancer cytogenetics: spectral karyotyping. DNA diagnostics: PCR based diagnostics; ligation chain reaction, Southern blot diagnostics, array-based diagnostics, Genome sequencing and Metagenomics, DNA sequencing, genetic profiling, single nucleotide polymorphism. Haemoglobinopathies. Neuro developmental disorders. Neuro degenerative disorders. Dynamic mutations. G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (translocation, deletion, Down's syndrome, Klumefelter syndrome, Turner's syndrome, etc.) FISH for detections of: translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation).	
UNIT–II	**10 Hrs.**
Biochemical diagnostics Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis Cell based diagnostics Antibody markers, CD Markers, FACS, HLA typing, Bioassays	
UNIT–III	**10 Hrs.**
Immunodiagnostics Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs.	
UNIT–IV	**10 Hrs.**
Imaging diagnostics Imaging Techniques (Basic Concepts), Invasive and Non-Invasive, Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT, Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization of Imaging Services in Hospital, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.	
REFERENCE BOOKS *	

1. Lisa Anne Shimeld.,2000 Essentials of Diagnostic Microbiology
2. Balley & Scott's. 1998 Diagnostic Microbiology, 2ND edition,
3. Burtis & Ashwood,.Tietz ,2005,Text book of Clinical Biochemistry.

COURSE OUTCOMES**

1. Ability to study Biochemical disorders, chromosomal disorders.
2. Able to study DNA based diagnostics.
3. Analyse Biochemical diagnostics.
4. Understand cell based diagnostics.
5. Analyse Immunodiagnostics
6. Understand imaging diagnostics

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

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UBT833E	VALIDATION & QUALITY CONTROL	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation . Validation of Water, Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non- Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). FDA and ICH guidelines .	
UNIT–II	**10Hrs.**
Medical Device, In-Vitro Diagnostics & Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11. **Standards** Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems.	
UNIT–III	**10 Hrs.**
Implementation The Influence of Good Automated Manufacturing Practice (GAMP); The FDA's Approach to GMP Inspections of Pharmaceutical Companies. Quality System, Contract Review, Design Control, Document and Data Control, Purchasing,Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Control of Inspection, Measuring and Test Equipment, Inspection and Test Status, Control of Nonconforming Product, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques. Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement	
UNIT–IV	**10 Hrs.**
Quality Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Regrade, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation, Information, Document, Specification, Quality Manual, Quality Plan, Record; Terms Relating of	

Examination, Objective Evidence, Inspection, Test. Metrological Confirmation.

REFERENCE BOOKS*

1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp.,
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998.
4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance
5. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. . Cloud,Interpharm Press, 1998.
6. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001.

COURSE OUTCOMES**

1. Ability to comprehend the validation techniques, process, concepts.
2. Ability to analyse the good practices in lab, clinical and manufacturing practices
3. Ability to retrieve the regulations , fundamentals of validations and its procedures
4. Capable of understanding the ISO standards and environmental management systems
5. An ability to analyse the analytical methods of validation, issues and automated system and standards
6. Ability to interpret guidelines and discuss the case studies
7. Ability to discuss the quality control measures used in industries
8. Ability to analyse the Quality Management System

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2					2	3	1						1	3
CO 2	2			2		3	3	3					2	2	3
CO 3	3					3	2	2				3	2	3	2
CO 4	2					3	1	3				3	2	3	3
CO 5	2					2	3	3				2	2	2	3
CO 6	2			2		2	1	2				2	2	3	2
CO 7	2			1		3	1	2				1	2	3	2
CO8	2			2		3	1	2				3	3	2	2

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UBT834E	PRODUCT DEVELOPMENT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

Essentials of product development

The product development process, privacy policies and Knowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies. Stability studies – Stability Testing of new Drug Substances and Products –types and stages of testing, Stress Testing, storage conditions. Manufacturing Process for Recombinant pharma Products. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Approved Biotech Drugs.

UNIT–II	12Hrs.

Interpersonal Skills

Understand work output requirements, company policies, delivery of quality work on time and report any anticipated reasons for the delay, effective interpersonal communication, conflict-resolution techniques, importance of collaborative working, multi-tasking, training the team members, knowledge of project management.

UNIT–III	10 Hrs.

Reporting and formulations

Reporting – power point presentations, technical writing, Principal investigator, communication with upstream and downstream teams.Problem Solving and Decision Making. Types of adverse drug reactions (ADR) and their treatment. Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, geriatric products, veterinary products, immune boosters

UNIT–IV	10 Hrs.

Safety and Security at workplace

Different types of occupational health hazards, knowledge of chemical substances -characteristics & safety measures. Use of safety gears, masks, gloves and accessories, evacuation procedures for workers and visitors. Health, safety and security issues – types (illness, fire accidents). Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances.

REFERENCE BOOKS*

1. Endrenyi, L., Declerck, D. and Chow, S. (2017). Biosimilar Drug Product Development. Boca Raton: CRC Press.
2. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers

COURSE OUTCOMES**

1. Understand analyze and apply the techniques and essentials of product development.
2. Ability to understand the various techniques in Pharma industries.
3. Demonstrate the different interpersonal skills.
4. Demonstrate the methodologies and applications of Project development and management.
5. Ability to comprehend various techniques involved in Reporting.
6. Describe the different formulations of various energy drinks

7. Analyse and list the various health hazards in industry.
8. Ability to understand importance of safety and implement in various Industries.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1		2	2	3	1			3	1		2	2	2	1	1
CO 2		2	2	3	3		2					3	2	1	
CO 3					2	3		2	3	3	3	3	2	1	1
CO 4		3	3	3	3	3	2	3	3	3	3	3	2	1	2
CO 5			3	3	3		2			2	2	3	2	1	
CO 6					2							3	2	1	
CO 7				2	3	3		3					2	1	
CO 8					2	3	3	3				2			

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UBT835E	VALIDATION & QUALITY ASSURANCE	Credits: 2
L: T: P – 2-0-0		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

UNIT-I	7 Hrs.
Introduction Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, Validation life cycle, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation . FDA and ICH guidelines.	
UNIT–II	**6 Hrs.**
Types of Validation Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation of Active Pharmaceutical Ingredients (APIs) Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11. **Standards** Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems	
UNIT–III	**7 Hrs.**
Quality Assurance The Influence of Good Automated Manufacturing Practice (GAMP),Quality System, Contract Review, Design Document and Data Control, Purchasing, Control of Customer Supplied Product, Process Control, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement.	
UNIT–IV	**6 Hrs.**
Quality Control Efficiency; Relating to Process and Product, Process characteristics, Quality Characteristics, Documentation, Information, Specification, Quality Manual, Quality Plan, Record of Examination, Objective, Inspection.Quality Requirement, Customer Satisfaction, Capability; Management System, Quality Management System, Quality Policy, Continual Improvement.	

REFERENCE BOOKS*
1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003 2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp. 3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998. 4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance 5. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998. 6. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001.
COURSE OUTCOMES**
1. Ability to comprehend the validation techniques, process, concepts. 2. Ability to analyse the good practices in lab, clinical and manufacturing practices 3. Capable of understanding the ISO standards and environmental management systems 4. Ability to analyse the analytical methods of validation, issues and automated system and standards 5. Ability to discuss the quality control measures used in industries 6. Ability to analyse the Quality Management System

Course Outcomes	**Programme Outcomes**												**Programme Specific Outcomes**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2				2	2								1	3
CO 2	2	3	1	2	3	3							2	2	3
CO 3	3	2			3	3						3	2	3	2
CO 4	2	2	1		3	3	1					3	2	3	3
CO 5	2	1			2	2	3					2	2	2	3
CO 6	2		1	2	2	2	1					2	2	3	2

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION

2021-2022

B.E. IV SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT418C	Molecular Biology	3	3	0	0	50	50	100
2	UBT406C	Immunotechnology	3	3	0	0	50	50	100
3	UBT412C	Heat and Mass Transfer	3	3	0	0	50	50	100
4	UBT415C	Biostatistics & Bio-modeling	3	2	2	0	50	50	100
5	UBT419C	Thermodynamics	3	3	0	0	50	50	100
6	UBT408L	Molecular Biology Lab	1.5	0	0	3	50	50	100
7	UBT410L	Immunotechnology Lab	1	0	0	2	50	50	100
8	UBT412L	Biostatistics Lab	1.5	0	0	3	50	50	100
9	UHS001N	Fundamentals of Quantitative Aptitude & Soft skills	1.0	1	0	0	50	50	100
10	UHS004M	Universal Human Values-II	0	3	0	0	50	50	100
		Total	**20**	**18**	**02**	**8**	**500**	**500**	**1000**

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UBT418C	MOLECULAR BIOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Introduction: Genes and their location. Information flow in biological systems: central dogma, updated central dogma. Signalling (signal transduction)-molecular mechanism. Reverse genetics, Genetic code-its features, codon and anticodon. **Replication:** Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).	
UNIT–II	**10 Hrs.**
Transcription: Mechanism of transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing, Si RNA, Antisense RNA technology. Translation: Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation, Structure and function of prokaryotic and eukaryotic ribosomes, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.	
UNIT–III	**10 Hrs.**
Gene Expression in Prokaryotes: Regulation of gene expression in prokaryotes: Operon model-structure and function, galactose and lactose operon, tryptophan Operon-regulation by attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression. **Gene Expression in Eukaryotes:** Regulation of eukaryotic gene expression, hormonal regulation- peptide and steroid hormones, transcriptional control, super secondary structures-Helix turns Helix. Zinc fingers and Leucine Zippers. Gene silencing- methylation, chromatin modification.	
UNIT–IV	**10 Hrs.**
Transposons and Oncogenes: Transposons-replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (McClintock's work), Cut and paste transposition, Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle. **Genetic Recombination:** Genetic recombination in bacteria- transformation, transduction and recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.	
Reference Books *	

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1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6th Edition), W.H. Freeman
2. James Watson (2008), Molecular Biology of the Gene (5th Edition) Pearson Education
3. David Freifelder, (2008), Essentials of Molecular Biology (2nd Edition), Narosa Publishing House

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Course Outcomes**

After completion of the course student will be able to

1. Emphasize on the basic aspects of molecular biology; the key areas and apply the knowledge in information flow in biological systems, reverse genetics and genetic code.
2. Classify and compare the mechanism of DNA repair processes, replication.
3. Acquire working knowledge on the mechanism of transcription, translation and post translational processes stepwise and their applications in the research.
4. Identify the various mechanism of gene regulation in prokaryotes and eukaryotes.
5. Identify the steps of transposition and concept of oncogenes.
6. Identify, describe and classify the molecular mechanism of genetic recombination.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	2	1	3	2	1	-	-	-	-	-	3	1	-
CO2	1	-	1	3	3	2	2	-	-	-	-	-	3	2	-
CO3	1	-	1	3	2	1	1	-	-	-	-	-	3	1	-
CO4	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-
CO5	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-
CO6	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-

UBT406C	IMMUNOTECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10Hrs.

The immune system:

Introduction, Cells and Organs of the immune system: Lymphoid cells, phagocytes, mast cells and dendritic cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT, CALT). Innate and adaptive immunity. Antigens, Antibodies, Complement system-complement activation, (classical, alternative and lectin pathway) regulation and biological consequences of compliment activation. Cytokines and their role in immune response. Monoclonal antibodies and applications.

UNIT–II	10 Hrs.

Humoral and cell mediated immunity:

Introduction to humoral and cell mediated immunity. B-lymphocytes and their activation; Basic structure of immuno globulins; immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and biological activity. Antigenic determinants on immunoglobulin's- Isotype, Allotype and Idiotype. Thymus derived lymphocytes (T cells) and types, T-cell maturation and activation, mechanisms of T cell activation. Cell death and T-cell populations. Major Histocompatibility Complex and antigen presentation. Antigen presenting cells, dendritic cells, macrophages, mechanism of phagocytosis.

UNIT–III	10 Hrs.

Immunological disorders:

Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune diseases, Animal models for autoimmune diseases and treatment of autoimmune disease. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: immunological basis of graft rejection, Types of transplantations.

Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines. Inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.

UNIT–IV	10Hrs.

Immunodiagnosis:

Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, immuno-electrophoresis, Non-isotopic methods of detection of antigens - Enhanced chemiluminescence assay. Purification and synthesis of antigens.

Reference Books *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

Course Outcomes**

After completion of the course student will be able to 1. Understand Immune system. 2. Analyze the humoral and cell mediated immune system. 3. Explain the immunological disorders. 4. Evaluate the Transplantation immunology.

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5. Understand the designing of Vaccines.
6. Understand Ag Ab reaction and applications of Electrophoresis in Immunology.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	-	-	2	-	-	-	3	-	1	3
CO 2	2	2	1	3	2	-	3	-	-	-	-	3	3	1	3
CO 3	3	1	1	-	2	2	3	1	-	-	-	3	1	1	2
CO 4	2	2	2	2	2	2	-	-	-	-	-	2	-	2	1
CO 5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO 6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

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UBT412C	HEAT AND MASS TRANSFER	Credits: 03
L:T:P –3:0:0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	10 Hrs.
Introduction to Heat Transfer: Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall sphere, cylinder; Insulation – types, critical radius, Optimum thickness of insulation. Forced and Natural convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer without phase change, heat transfer in laminar and turbulent flow inside closed conducts, concepts of film heat transfer coefficients.	
UNIT–II	**10 Hrs.**
Heat Transfer Equipment's: Equations and numerical problem for calculations of film heat transfer coefficients, Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling. Co current and counter current flow. Individual and overall Heat transfer coefficients, LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger.	
UNIT–III	**10 Hrs.**
Basics of Mass Transfer: Diffusion - Fick's law of diffusion. Measurement of diffusivity, Theories of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas Mass transfer. Principles, mass transfer considerations, design equations and equipments for leaching, extraction, absorption, adsorption, crystallization and evaporation	
UNIT–IV	**10 Hrs.**
Mass transfer Operations- Distillation: Methods of distillation –Simple, Flash distillation of binary mixtures – relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, numerical. Drying: Drying rate, drying curve and calculations, drying equipment.	

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA
2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA.
3. R.P.Chhabra V. Shankar (2018) Coulson and Richardson's Chemical Engineering Volume Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth- Heinemann
4. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press
5. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn. John Wiley & Sons, USA.
6. Kern (2001). Process Heat Transfer, 2nd Edn. McGraw-Hill Publications, USA.
7. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw- Hill Publications.

Course Outcomes**

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After completion of the course student will be able to

1. Define the different modes of heat transfer and solve the problems
2. Determine heat flux and temperature distribution in steady state one- dimensional problems using thermal resistance concept.
3. Estimate the heat transfer rate for different types of heat exchangers.
4. Predict mass transfer rates and mass transfer coefficients.
5. Estimate the number of theoretical plates required for effective separation of liquid mixtures.
6. Determine various parameters of mass transfer operations.

*Books to be listed as per the format with decreasing level of coverage of syllabus
** Each CO to be written with proper action word and should be assessable and quantifiable

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	2	1	-	-	-	-	-	-	1	2	-	-
CO2	3	2	3	3	2	-	-	-	-	-	-	2	2	-	-
CO3	2	3	2	2	1	-	-	-	-	-	-	1	2	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	1	2	-	-
CO5	2	3	3	2	1	-	-	-	-	-	-	1	2	-	-
CO6	2	2	2	1	1	-	-	-	-	-	-	1	2	-	-

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UBT415C	BIOSTATISTICS & BIO-MODELING	Credits: 03
L: T: P - 2:2:0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction and Descriptive Statistics:

Scope of biostatistics, presentation of data, Diagrammatic and graphical represent,(simple, multiple, component bar diagrams, pie chart, histogram, frequency polygon, frequency curve, ogive curve). Measure of central tendency (meaning of central tendency, arithmetic mean, median, Quartiles, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, quartile deviation, mean deviation and standard deviation, coefficient of variation, skewness and kurtosis. Correlation and linear regression analysis, curve fitting straight line).

UNIT–II	10Hrs.

Probability and Probability Distributions:

Definition of probability, Event, Mutual Exclusive, Independent, Complimentary Events Addition and Multiplication theorem of probability and examples. Discrete probability distributions: Bernoulli's, Binomial and Poisson distribution. Continuous probability distribution – normal, Standard normal variate, properties of normal curve, T, F and $\chi 2$ (Chi square -goodness of fit test) distributions and their applications in Biology.

UNIT–III	10 Hrs.

Statistical Inference , ANOVA and Design of Experiments:

Estimation theory and testing of hypothesis point estimation, interval estimation. Sample, population, sample size determination. Methods of Sampling techniques- random (simple, stratified and systematic) non random sampling -(Judgement and convenience). Definition of analysis of variance(one way and two way classifications), Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burmann design, Response surface methodology(RSM).

UNIT–IV	10 Hrs.

Bio-modeling:

Microbial Growth in a Chemo-stat, Growth Equations of Microbial Populations, product formation models, Models of Commensalisms, Batch culture model, Mutualism, Predation and Mutation. Simple Prey predator model, Volterra's Model for n Interacting Species. Basic Models for Inheritance, Applications of probability in genetics, Hardy - Weinberg law. Selection and Mutation Models, Genetic Inbreeding Models. Dose response studies.

Reference Books *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.
3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

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Course Outcomes**

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After completion of the course student will be able to

1. Demonstrate and understand the basic concepts of biostatistics, analysis of measure of central tendency and dispersion.
2. Ability to know the basic principles of probability and distributions in Biology and Genetics
3. Analyse and interpret data regarding various distributions (T-test, F-test, and chi square)
4. Basic principles and designs of experimentation and ANOVA
5. Perform experimental design (RSM, Plakett Burman, LSD, CRD, RCBD)
6. Ability to study the microbial growth in chemostat, product formation and biomodelling in various parameters

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	3	3	-	-	-	-	-	2	2	2	1	1
CO2	3	3	3	3	3	2	-	-	-	-	1	3	2	1	2
CO3	2	3	1	3	3	-	-	-	-	-	1	2	2	1	1
CO4	2	3	1	3	3	-	-	-	-	-	1	-	-	-	-
CO5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

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UBT419C	THERMODYNAMICS	Credits: 03
L: T: P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction System, surrounding & processes, closed and open systems, intensive & extensive properties, state and path functions, equilibrium state, reversible and irreversible processes. First Law of Thermodynamics: General statement of first law of thermodynamics, first law for cyclic process, Non-flow process, flow process.	
UNIT–II	**10Hrs.**
Second law of thermodynamics & P-V-T behaviour General statement of the second law, concept of entropy, the Carnot principle, calculation of entropy changes, Clausius inequality, entropy and irreversibility, third law of thermodynamics. P-V-T behaviour of pure fluids, equations of state and ideal gas law, processes involving ideal gas law: constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equations of real gases, principles of corresponding states, compressibility charts.	
UNIT–III	**10 Hrs.**
Thermodynamic Properties of Pure Fluids Derived properties, work function, Gibbs free energy, relationships among thermodynamic properties. Fundamental property relations, Maxwell's relations, Clapeyron equation, entropy-heat capacity relation, Effect of temperature on U, H & Entropy (S), relationships between Cp & Cv, Gibbs Helmholtz equation. Fugacity, fugacity coefficient, Determination of fugacity of pure gases, fugacity's of solids and liquids. Activity and activity coefficient, Thermodynamic diagrams. Properties of solutions.	
UNIT–IV	**10 Hrs.**
Thermodynamic Properties of Pure Fluids Partial molar properties, Chemical potential, Gibbs-Duhem equation & its applications, Henry's law & Raoult's law. Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour- Liquid Equilibria: VLE in ideal solutions, Consistency test for VLE data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams.	

Reference Books *

1. Smith JM and Van Ness HC (2004) Introduction to Chemical Engineering thermodynamics, 6th Edition, McGraw Hill Publications, USA.
2. Stanley I. Sandler (2006) Chemical and Engineering Thermodynamics, 4th Edn., John Wiley & Sons, USA.
3. Narayanan KV (2001) A Textbook of Chemical Engineering Thermodynamics, Prentice Hall Publication, India.
4. Bailey JE and Ollis DF (2010) Biochemical Engg. Fundamentals, 2nd Edition, McGraw Hill, New York, USA.
5. Rao YVC (1997) Chemical Engineering Thermodynamics, New Age International, India.
6. Segel IH (1993) Biochemical Calculations, 2nd Edn., John Wiley & Sons, USA.
7. Shuler ML and Kargi F (2001) Bioprocess Engineering, 2nd Edn., Prentice Hall International, USA. 5. Eruster L (2013) Bioenergetics, Academic Press, New York.

Course Outcomes**

After completion of the course student will be able to
1. Explain the fundamental concepts of the laws of thermodynamics and apply the first law of thermodynamics to solve engineering problems.

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2. Understand the second law of Thermodynamics and apply in engineering problems and solve the problems related to properties of fluids.
3. Estimate the thermodynamic properties, such as enthalpies, entropies, Gibbs energies, fugacity coefficients, and activity coefficients of pure fluids as well as fluid mixtures.
4. Analyze and find properties such as Pressure, Volume and Temperature for equations of states. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
5. Predict equilibrium compositions of mixtures under phase.
6. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**
** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	2	3	3	-	-	-	-	-	-	-	1	2	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO5	2	2	3	2	-	-	-	-	-	-	-	1	2	-	-
CO6	3	3	2	3	-	-	-	-	-	-	-	1	2	-	-

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UBT408L	MOLECULAR BIOLOGY LAB	Credits: 1.5
L: T: P – 0:0:3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

LIST OF EXPERIMENTS IN MOLECULAR BIOLOGY LABORATORY

1. Study of standard practices in Molecular Biology Lab
2. Standard Operating Procedure for Centrifuge.
3. Standard Operating Procedure for Gel Documentation Unit.
4. Study of absorption spectra of nucleic acids.
5. Agarose gel electrophoresis.
6. Isolation of genomic DNA (plant / animal / microbial sources).
7. Isolation of plasmid DNA from E. coli.
8. Estimation of DNA by diphenyl method.
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids, protein by UV-Vis Spectrophotometer.
11. PAGE (DEMO).

Reference Books *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2^{nd} Edition), W.H. Freeman
2. Sambrook& Russell, (2002), Molecular Cloning, (3^{rd} Edition), Cold Spring Harbor Lab.

Course Outcomes**

After completion of the course student will be able to

1. Analyze the concentration and purity of DNA.
2. Conduct and analyze Agarose gel electrophoresis.
3. Perform absorption spectra and understand SOP for various lab equipments.
4. Conduct observations and experiments including Genomic DNA/plasmid DNA /RNA/protein.
5. Demonstrate the knowledge of quantification and purity analysis of biomolecules.
6. Gain knowledge in demonstration of PAGE.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	3	1	-	-	-	-	-	1	2	1	-
CO2	1	2	2	1	3	2	-	-	-	-	-	1	2	2	-
CO3	1	2	2	1	3	1	-	-	-	-	-	1	1	1	-
CO4	2	2	3	2	3	2	-	-	-	-	-	1	2	2	-
CO5	1	2	3	1	3	1	-	-	-	-	-	1	3	3	-
CO6	1	1	3	2	3	1	-	-	-	-	-	1	3	3	-

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UBT410L	IMMUNOTECHNOLOGY LABORATORY	Credit: 01
L: T: P - 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN IMMUNOTECHNOLOGY LABORATORY

1. Agglutination Technique: Blood group identification and Rh factor
2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL
3. Ouchterlony Double Diffusion (ODD)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA**/** DOT Blot.
9. Quantitative precipitin assay (QPA).

Reference Books *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology (8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

Course Outcomes**

After completion of the course student will be able to

1. Understand Immune system.
2. Analyze the humoral and cell mediated immune system..
3. Explain the immunological disorders.
4. Evaluate the Transplantation immunology.
5. Understand the designing of Vaccines.
6. Understand Ag Ab reaction and applications of Electrophoresis in Immunology.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	-	-	2	-	-	-	3	-	1	3
CO 2	2	2	1	3	2	-	3	-	-	-	-	3	3	1	3
CO 3	3	1	1	-	2	2	3	1	-	-	-	3	1	1	2
CO 4	2	2	2	2	2	2	-	-	-	-	-	2	-	2	1
CO 5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO 6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

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UBT412L	BIOSTATISTICS LAB	Credits: 1.5
L: T: P - 0:0:3		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

LIST OF EXPERIMENTSIN BIOSTATISTICS LABORATORY
1. Procedure for creating Data file, Diagram and Graphs. 2. Procedure and calculation of Mean, Median, Mode, Standard Deviation and Variance. 3. Calculation of Regression and correlation 4. Procedure and calculation of t, Z and F test. 5. Calculation of Chi-square test. 6. ANOVA- one-way analysis 7. ANOVA- two-way analysis. 8. Experimental Research Design – CRD- Analysis. 9. Experimental Research design – RBD- Analysis. 10. Experimental Research design – Latin square Design- Analysis. 11. Placket-Burman Design for media optimization. 12. Response Surface Methodology for media optimization.
Reference Books *
1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication 2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd. 3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers 4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books
Course Outcomes**
After completion of the course student will be able to 1. Draw graphs, charts, enter the data using statistical software tools 2. Calculate measures of dispersion and central tendency 3. Analyse the t, z and f test 4. Solve and analyze ANOVA 5. Know the different types of experimental designs with case studies 6. Aware of media optimization techniques using statistical designs

***Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	3	-	-	-	-	-	-	1	2	2	1	1
CO 2	3	3	2	3	3	-	-	-	-	-	2	2	2	1	-
CO 3	2	3	3	2	2	2	-	-	-	-	-	3	2	1	-
CO 4	3	3	1	3	3	2	-	-	-	-	-	3	2	1	2
CO 5	2	3	1	3	3	-	-	-	-	-	1	2	2	1	1

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CO 6	**1**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

VI SEMESTER

Sl. No.	Subject Code	Subject Title	Hours/Week				Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT615C	Enzyme kinetics and Biotransformation	3	3	0	0	50	50	100
2	UBT616C	Upstream Processing Technology	3	2	2	0	50	50	100
3	UBT617C	Bioprocess Equipment Design	3	2	2	0	50	50	100
4	UHS003N	Career Planning and Professional Skills	1	1	0	0	50	50	100
5	UBT62XE	Elective-2	3	3	0	0	50	50	100
6	UBT62XE	Elective-3	3	3	0	0	50	50	100
7	UBT632N	Environmental Technology (OE)	3	3	0	0	50	50	100
8	UHS004M	Universal Human Values-II	0	3	0	0	50	50	100
9	UBT615L	Bio-kinetics & Enzyme Technology Lab	1	0	0	2	50	50	100
10	UBT614L	Upstream Processing Lab	1	0	0	2	50	50	100
11	UBT609P	Mini Project	3	0	0	3	50	50	100
		Total	**24**	**20**	**04**	**7**	**550**	**550**	**1100**

Elective- 2 & 3

UBT621E Microbial BT
UBT622E **Genomics & Proteomic**
UBT623E Plant BT
UBT624E Animal BT
UBT625E **Biofuels technology**
UBT626E Pearl programming
UBT627E Tissue engineering
UBT628E Transport phenomena

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UBT615C	ENZYME KINETICS AND BIOTRANSFORMATION	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Enzyme action: Mechanism of enzyme action. Derivations of Km value (Michaelis-Menton constant), Lineweaver-Burk plot., Enzyme inhibition and kinetics **Multi-Substrate Reactions:** Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry	
UNIT–II	**10 Hrs.**
Enzymatic Techniques: Strategies of purification of enzymes: choice of source, methods of homogenization, Criteria of purity: tests for purity, tests for catalytic activity, active site titrations, Molecular weight determination and characterization of enzymes. **Immobilization of enzymes:** Techniques of enzyme immobilization; design and configuration of immobilized enzyme reactions,Kinetics of immobilized enzymes, immobilized enzymes in bioconversion processes(uses). The design and construction of novel enzymes	
UNIT–III	**10 Hrs.**
Enzymes of biological importance Enzyme pattern in diseases like in Myocardial infarctions (SGOT, SGPT, & LDH) Acetylcholinesterase, angiotensin converting enzyme (ACE), 5'- nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD). Use of isozymes as markers in cancer.	
UNIT–IV	**10 Hrs.**
Industrial uses of enzymes: Enzymes used in detergents, use of proteases, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes).Uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Uses of proteases in food industries.	

Reference Books *

1. Trevor Palmer (2008). Enzymes: Biochemistry , Biotechnology, Clinical Chemistry. Horwood Publishing Ltd, East-West Press, 2nd Edition.
2. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" –7th Edition.
3. Nicholas C. Price and Lewis Stevens (2009).Fundamentals of Enzymology, Oxford university Press, 3rd edition.
4. James R Hanson (1997). "An Introduction to Biotransformation in Organic Chemistry" Oxford university Press,
5. Daniel L. Purich, Melvin I. Simon, John N. Abelson (2009). Contemporary Enzyme Kinetics and Mechanism" Academic press, 3rd edition.
6. K. Faber (1999). Biotransformations in Organic: Springer- Verlag.1st Edition,.
7. Bailey and Ollis (2017). "Biochemical Engineering Fundamentals", Mcgraw Hill 2nd Ed.

Course Outcomes**

After completion of the course student will have the

1. Ability to understand mechanism of enzyme reactions.
2. Ability to understand how to characterize the enzymes.

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3. Ability to apply the techniques of immobilization of enzymes and know its uses.
4. Ability to know the importance of enzymes in diagnostics.
5. Ability to know the application of enzymes in wool, leather and detergent industries.
6. Ability to apply knowledge of using enzymes in food industries.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-
CO5	2	3	-	1	-	-	-	-	-	-	-	-	3	2	-
CO6	2	3	3	2		3	2			-	-	1	3	-	-

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UBT616C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Fermentation process

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Types of Fermentors, Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT–II	10 Hrs.

Raw materials and media sterilization

Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization.Different methods for optimization (Plackett-Burman Design, RSM)

UNIT–III	12 Hrs.

Microbial system

Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculumfrom laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination). **Secondary metabolite production:** secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT–IV	10 Hrs.

Plant Cell system

Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).

Animal Cell system :

Scale up of animal cell culture, factors affecting cell culture, Batch reactors, continuous culture, and perfusion systems. Scale up of monolayer culture- roller bottles, nunc cell factory microcarriers culture. Growth monitoring.

Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass transfer and others.

Large scale production of insulin by mammalian cell culture. Cellbank preparation & cell reviving techniques

Monoclonal antibody production: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).

Reference Books *

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth-Heinemann; 3rd Edition,2016.
2. Bioprocess Engineering by Michael L. Shuler, Shuler & Kargi, Fikret Kargi, Pearson Publishers, 2nd Edition, 2012.
3. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995.

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4. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3nd Edition, 2018.
5. Introduction to Plant tissue Culture, M.K. Razdan, Oxford & IBH Publishers,3rd Edition,2019
6. Culture of animal cells by Ian Freshney , John Willey & Sons Publ. 7th Edition.2016

Course Outcomes**

After completion of the course student will be able to

1. Understand the fermenter and fermentation processes
2. Prepare and sterilize the industrial media
3. Design and optimize the media formulation using design of experiments
4. Develop the inoculum and improve the strain for industrially important microorganism
5. Distinguish the bioreactors for various cell systems
6. Develop plant & animal system for fermentation process and to use the Genetically modified cell into the fermentation process

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-		2	-	1	-	-	-	-	1	3	2	-
CO2	3	3	-	3	-	-	2	-	-	-	-	1	2	-	-
CO3	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-
CO5	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO6	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-

UBT617C	BIOPROCESS EQUIPMENT DESIGN	Credits: 03
L:T:P –2:2:0		CIEMarks:50
Total Hours/Week: 04		SEEMarks:50

UNIT-I	10 Hrs.

Process design of double pipe heat exchanger:

Introduction to heat exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside & overall), area, length, number of hair pins, diameter of tube. Pressure drop calculations. Detailed drawing of sectional front view of Heat exchanger.

UNIT–II	10 Hrs.

Process design of shell & tube heat exchanger:

Introduction to Heat Exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside and overall), area, length, number of tubes, tube sheet diameter, pitch type, diameter of tube sheet. Mechanical design – baffle, thickness of shell, thickness of tube sheet, thickness of head, pressure drop calculations – tube side and shell side. Detailed drawing of sectional front view of Heat exchanger (1-1, 1-2) with tube sheet layout.

UNIT–III	10 Hrs.

Process design of fermenter:

Functional design-Based on the type of bioreactor (batch reactor & MFR) and cell growth kinetics and performance equation, determines the volume of the reactor, according to H/D ratio determine height and diameter. Mechanical design- Thickness of the shell (cylindrical, spherical), thickness of top & bottom cover, flange calculations – width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter.

UNIT–IV	10 Hrs.

Process design of plate column distillation column:

Functional design- material balance, energy balance, height of the packed column using McCabe Thiele's method, Mass transfer coefficients, Diameter of columns (Top and bottom), top and bottom free space. Detailed drawing for the above design (showing clearly inlets, outlets liquid distributors, packing support)

Reference Books *

1. Joshi, M.V., Process Equipment Design, Macmillan India, 1991.
2. Brownell, L.E. and Young, E.H., Process Equipment Design - Vessel Design, John Wiley and Sons, Inc.1959.
3. Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2, 3rd Ed., Gulf Publishing Co. 1997.
4. Indian Standards Institution, Code for Unfired Pressure Vessels, IS – 2825.
5. Bhattacharya, B.C, Introduction to Chemical Equipment Design, CBS Publications, 1985.
6. Perry's Chemical Engineers Handbook. 7th Edition McGraw Hill Publications

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of heat exchangers in industries and can describe the types of industrial heat exchangers
2. Solve problems related to heat exchangers referring the data book

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3. Apply the knowledge of design concepts of double pipe heat exchanger and their parts in Engineering applications
4. Apply the knowledge of design concepts of shell & tube heat exchanger and their parts in Engineering applications
5. Apply the knowledge of different types of bioreactors and their design concepts in Industrial applications
6. Apply the knowledge of design concepts of distillation column and their parts in Industrial applications

*__Books to be listed as per the format with decreasing level of coverage of syllabus__

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3	2	2	-	-	-	-	-	-	2	2	-	-
CO2	2	3	2	3	1	-	-	-	-	-	-	2	2	-	-
CO3	2	3	3	2	2	-	-	-	-	-	-	2	2	-	-
CO4	2	3	3	3	1	-	-	-	-	-	-	2	2	-	-
CO5	2	2	3	2		-	-	-	-	-	-	2	2	-	-
CO6	2	3	2	2	1	-	-	-	-	-	-	2	2	-	-

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UBT621E	MICROBIAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Microbial biotechnology

a) In Bacteria: Genetic Transfer in bacteria, Transformation, Conjugation, Translation, cloning techniques, polymerase chain reaction, expression of cloned Genes, Recovery and purification of expressed proteins.

b) In Yeast: Introduction of DNA into yeast cells, yeast cloning vectors, expression of foreign genes in yeast, expression of foreign gene products in secreted form.

UNIT–II	10 Hrs.

Industrial microbiology

Vitamins as laxatives and analgesics; non steroidal contraceptives, external antiseptics, antacids and others. Antibiotics and hormones. Impact of Biotechnology on vaccine development; sub unit vaccines, fragments of antigen sub unit as synthetic peptide vaccines. Production of Microbial enzymes, strain -medium, fermentation processes. Large scale application of Microbial enzymes - starch processing, textile designing, detergents, cheese industry.

UNIT 3	10 Hrs.

Microbial by products

Bacillus thuringinesis, Sphaericus, Popilliae, Baculoviruses. Bacterial Polysaccharides - structure & role in nature xanthan Gum - structure, production & Biosynthesis polyesters. Saccherification & fermentation. Metabolites from microorganisms, Amino acids, antibiotics. Organic synthesis & Degradation, classification of enzymes, microbial transformation of steroids & sterols.

Environmental microbiology

Sewage & Waster water microbiology, Microbiological Degradation of xenobiotics microorganisms in mineral recovery microorganisms in the removal of heavy metals from aqueous effluents.

Food microbiology

Microbial spoilage of food and its control; food preservatives; fermented foods; single cell protein (SCP) and single cell oil (SCO); food borne infections and their control.

UNIT–IV	10 Hrs.

Bioremediation and bioleaching

Uses of Bacteria in Bioremediation – Biodegradation of hydrocarbons, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, Methanotrophs, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Studies of Pyrite Dissolution in Pachuca Tanks and Depression of Pyrite Flotation by Bacteria, Factors Effecting Microbial Coal Solubilization, Sulfur Leaching by Thermophilic Microbes of Coal Particles Varying in size, Microbiological Production of Ferric Ion for Heap and Dump Leaching, New Bacteriophage which infects Acidophilic, Heterotrophic Bacteria from Acidic Mining Environments, Treatment of Coal Mine Drainage with Constructed Wetlands

Reference Books *

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1. Fundamentals of Biotechnology. Edited by Paule Prave, Uwe Faust, Wolfgang Sitting and Dieter A Sukatsch. VCH Publishers.
2. Principles of fermentation Technology, P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.
3. Alexander N Glazer, Hiroshi Nikaido by Microbial Biotechnology, W H Freeman & Company New York,2005
4. Bernard Davis & Renato Dulbecco Microbiology by, Lippincott Company, Philadelphia. 2000
5. Prit S J Principle of Microbe & Cell Cultivation, Blackwell Scientific co).1975

Course Outcomes**

After completion of the course student will be able to

1. Able to study about Genetic Transfer in bacteria cloning techniques.
2. Able to study industrial microbiology.
3. Able to study production & Biosynthesis microbial by products.
4. Able to know Uses of Bacteria in Bioremediation
5. Able to analyse microbial products.
6. Able to understand phytoremediation.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	2	-	-	2	2	2	-	-	-	-	1	1	1
CO 2	2	2	2	-	-	3	2	1	-	-	-	-	2	1	-
CO 3	3	3	2	-	2	2	2	1	-	-	-	1	1	1	-
CO 4	3	3	3	-	2	3	3	2	-	-	-	1	2	1	3
CO 5	2	2	2	-	2	2	3	1	-	-	-	1	2	1	2
CO 6	2	2	2	3	2	2	1	1	-	-	-	1	1	1	2

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UBT623E	PLANT BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Plant genetic engineering

Induction of tumours by Agrobacterium, introduction of binary vectors into Agrobacterium by triparental mating, leaf disc transformation using Agrobacterium, GUS expression in transformed tissues, extraction of DNA from transformed plants, Southern hybridization to check plant
22 transformation, PCR amplification of T-DNA in transformed plant tissues. Agrobacterium mediated gene transfer and cloning. Types of plant vectors and their use in gene manipulation. Viruses as a tool to delivery foreign DNA.

Transformation technology

Plant transformation technology -Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of T-DNA transfer, role of virulence genes, use of Ti and Ri-plasmids as vectors, binary vectors. Vectorless or direct DNA transfer-particle bombardment, electroporation, microinjection, transformation of monoctos. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and mainteance of transgenic plants.

UNIT–II	10 Hrs.

Applications

Application of plant transformation for productivity and performance – Herbicide resistance - phosphoinothricin, glyphosate, atrazine, insect resistance -bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation of its impact in on insect control. Non-bt like protease inhibitors, alpha amylase inhibitor, virus resistance -coat protein mediated, nucleocapsid gene, disease resistance - chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, RS proteins, abiotic stress – drought and salinity, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems.

UNIT 3	10 Hrs.

Secondary metabolites & gene markers

Metabolic engineering and industrial products -Plant secondary metabolites. Industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Molecular marker-aided breeding - RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map-based cloning, molecular marker assisted selection.

UNIT–IV	10 Hrs.

Nitrogen fixation

Nitrogen fixation and biofertilizers -Diazotrophic microorganisms, nitrogen fixation genes. Two component regulatory mechanisms. Transfer of nif genes to non-diazotrophic microorganisms, nod genes structure function and role in nodulation, Hydrogenase -Hydrogen metabolism. Genetic engineering of hydrogenase genes.

Algae

Blue-green algae and Azolla -Identification of elite species and mass production for practical application. Mycorrhizae -importance in agriculture and forestry. Algae as a source of food, feed, single cell protein, biofertilizers; industrial uses of algae. Mass cultivation of commercially valuable marine macroalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation of microalgae as a source of protein and feed. 6 Hour

Reference Books *

1. Dixon R.A. & Gonzales Plant Cell Culture: A Practical Approach by, IRL Press.,2008
2. Plant biotechnology in Agriculture by K. Lindsey and M.G.K. Jones (1990), Prentice hall, New Jersey,2000
3. Plant Biotechnology 1994, Prakash and Perk, Oxford & IBH Publishers Co J Hammond, P
4. McGarvey and V Yusibov (Eds): Plant Biotechnology. Springer Verlag, 2000
5. Chawla HS: Biotechnology in Crop Improvement. Intl Book Distributing Company, 1998
6. Biodegradation and Detoxification of Environmental Pollutants – Chakrabarthy AM RJ Henry:
7. Practical Application of Plant Molecular Biology. Chapman and Hall 1997
8. Plant Tissue Culture: Applications and Limitations by S.S. Bhojwani (1990), Elsevier, Amsterdam. TJ Fu, G Singh and WR Curtis (Eds):
9. Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic Press, 1999 PK Gupta:

Course Outcomes**

After completion of the course student will be able to

1. Study plant genetic engineering and transformation technology.
2. Study Application of plant transformation for productivity and performance
3. Study Metabolic engineering and industrial products.
4. Study nitrogen fixation and Identification of elite species and mass production for practical application of algae.
5. Analyse the growth and cultivation of Blue green Algae.
6. Identify various methods of plant transgenics

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	2	-	-	-	-	-	-	-	3	1	-
CO 3	3	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 4	3	2	3	-	2	-	-	-	-	-	-	1	3	1	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 6	2	2	2	3	2	-	-	-	-	-	-	1	1	1	-

UBT627E	TISSUE ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to tissue engineering, Cell and Tissue Biology
Basic definition of tissue engineering;current scope of development; use in therapeutics. Introduction to cell – biology and biochemistry. Tissuedevelopment and organization. Stem cells (embryonic), Stem cells (adult). Introduction to cell adhesion,Adhesion Receptors in Tissue Structures, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion,Effect of Biomaterial on Physiological Behavior. Introduction to cell migration, Characteristics ofMammalian Cell Migration, Measurement of cell characteristics morphology, number viability, cell-fateprocesses, cell motility, cell function.

UNIT–II	10 Hrs.

Extracellular Matrix
Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signaling Complexes, ECM and Skeletal Tissues,Sources of ECM for Tissue Engineering Applications, Properties of ECM , Mining the ECM for Functional Motifs, Summary of Functions of ECM Molecules, Polymeric Materials and their Surface Modification,Formation of Gradient Structures.

UNIT 3	10 Hrs.

Biomaterials & Drug Delivery Systems
Introduction to synthetic polymers, Biodegradable materials vspermanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications.Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering.

UNIT–IV	10 Hrs.

Tissue Engineering Bioreactors - Design and Fabrication
Introduction, Most common Bioreactors inTissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, DesignConsiderations, Challenges in Bioreactor\ Technologies.

Clinical & Regulatory Aspects of Engineered Tissues
Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal, Tissue Engineering, Cardiovascular TissueEngineering, Musculoskeletal Tissue Engineering, (tendon/ligament/muscle).

Reference Books *

1. Channarayappa, Cell Biology, Universities Press, kindle Edition,2010.
2. Robert Lanza Robert Langer Joseph Vacanti Anthony Atala Principles of Tissue Engineering Academic Press 5th Edition 2020.
3. Patrick CW, Mikos AG, McIntire LV, Frontiers in Tissue Engineering, Pergamon Press, 1st Edition, 1998.
4. Bernhard O Palsson, Sangeeta N Bhatia, Tissue Engineering, Pearson Prentice Hall.1st Edition 2003.

Course Outcomes**

After completion of the course student will be able to

1. Identify and differentiate between various stages of tissue development & stem cells.
2. Differentiate between various stages of tissue development & stem cells.
3. Analyze the mechanism and organization of ECM and its functions.
4. Apply the knowledge of drug delivery mechanism in therapeutics.
5. To strengthen the concept of protein drug interactions.
6. Integrate the knowledge of clinical and regulatory aspects on different engineered tissues in medical human tissue products and pharmaceutical sector

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	2	-	-	-	-	-	-	-	3	1	-
CO 3	3	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 4	3	2	3	-	2	-	-	-	-	-	-	1	3	1	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 6	2	2	2	3	2	-	-	-	-	-	-	1	1	1	-

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UBT624E	ANIMAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Cell lines

Primary culture – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture -passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines -definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines. Contamination -bacterial, viral, fungal and mycoplasma contaminations, detection and control, cell transformation – normal vs. transformed cells, growth

Cell culture

Scale-up of animal cell culture – Factors to be considered. Scale-up of suspension cultures Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, microcarrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

UNIT–II	10 Hrs.

Invitro fertilization & cloning

Conventional methods of animal improvement, predominantly selective breeding and crossbreeding. Embryo biotechniques for augumentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation Oestrus synchronization. Embryo collection, evaluation and transfer. Invitro maturation of oocytes. Invitro fertilisation and embryo culture. Embryo preservation. Micro manipulation and cloning. Artificial insemination, preparation of foster mother, surgical and non-surgical methods of embryo transfer, donor and recipient aftercare. Cloning -concept of nuclear transfer, nuclear reprogramming and creation of Dolly. Stem cells -embryonic and adult stem cells, plasticity and concept of regenerative medicine.

UNIT 3	10 Hrs.

Human genome

Human genome complexicity of the genome, outlines of human genome project, human disease genes. Molecular biological techniques for rapid diagnosis of genetic diseases. Chemical carcinogenesis, transfection, oncogenes and antioncogenes. Cryo preservation and transport of animal germ plasm (i.e. semen, ovum and embryos). Genetherapy -ex vivo and in vivo gene therapy methods, applications.

Transgenics

Transgenic animals -retroviral, microinjection, and engineered embryonic stem cell method of transgenesis. Application of transgenic animals -biopharming, disease models, functional knockouts.

UNIT–IV	10 Hrs.

Other applications

Application of animal cell culture -Vaccine production, specialized cell types. Concepts of tissue engineering - skin, liver, kidney, bladder and heart. Principles and species suitable for aquaculture (Indian major carps and prawns). Genetic status of culture stocks. Chromosome manipulations -Production of all male and sterile populations, Hypophysation in fishes and prawns. Pearl culture -pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls. Probiotics and their significance in aquaculture. Molecular tools for the identification of diseases in aquatic species.

Reference Books *

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1. Ian Fredhney. Culture of Animal Cells, (3rd Edn) R Wiley-Liss Animal Cell Biotechnology, - Spier, RE and Griffith, JB Academic Press, London 1990
2. Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, 2000
3. Oxford Animal Cell Technology, Principles and practices, 1987, Butter, M Oxford press
4. Molecular Biotechnology by Primrose.
5. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press Fish and Fisheries India VG Jhingram
6. Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop (1990), cambridge University Press, cambridge.
7. Animal Cell Culture – Practical Approach, Ed. John RW. Masters, Oxford Animal
8. Cell Culture Techniques Ed Martin Clynes, Springer Cell Culture Lab Fax. Eds. M
9. Butler & MDawson, Bios Scientific Publications Ltd. Oxford

Course Outcomes**

After completion of the course student will be able to

1. Study cell lines and cell culture
2. Study Invitro fertilization & cloning.
3. Study human genome and Transgenic animals
4. Know Application of animal cell culture
5. Understand transgenic science
6. Understand and analyse cell culture applications.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	-	-	-	-	-	-	2	-	3	1	2
CO 3	3	2	2	-	-	-	-	-	-	-	2	1	3	1	-
CO 4	3	2	3	-	-	-	-	-	-	-	2	1	3	1	2
CO 5	2	2	2	-	-	-	-	-	-	-	-	1	3	1	1
CO 6	2	2	2	3	-	-	-	-	-	-	-	1	1	1	1

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UBT626E	PERL PROGRAMMING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

An overview of Perl: Getting started, interpreted vs compiled source code, documentation in perl, statement blocks, ASCII and Unicode, Escape sequences, whitespaces, numerical data type, strings in perl, alternative delimiters, conversion between numbers and strings, Arithmetical operators, bitwise operators, Boolean operators, string operators, string comparison, operator precedence, variables, modifying a variable, autoincrement and autodecrement operators, multiple assignments, scoping, special variables, regular expression variables, input/ output variables, filehandle / format variables, error variables and system variables variable interpolation .

Lists, Arrays and Hashes

Introduction to lists, simple lists, complex lists, accessing list values, list slices, ranges, combining ranges and slices, arrays, assigning arrays, scalar vs list context, adding elements to an array, accessing single and multiple elements from an array, running through arrays, array functions (pop, push, shift, unshift, and sort, Introduction to Hashes, creating a hash, working with hash values, adding, changing and taking values from a hash, accessing multiple values.

UNIT–II	10 Hrs.

Loops and Decisions

Introduction, Changing Array Size, Interacting Over an Array by Reference, Extracting Unique Elements from a List, Computing Union, Intersection, or Difference of Unique Lists, Appending One Array to Another, Reversing an Array, Processing Multiple Elements of an Array, Finding All Elements in an Array Matching Certain Criteria, Sorting an Array Numerically

Regular Expression

Introduction to regular expressions, patterns, interpolation, escaping special characters, anchors, character classes, word boundaries, posix and Unicode classes, detecting repeating words, well defined repetition, back reference variables, match operator, substitution operator and transliteration operator, binding operators, meta characters, changing delimiters, modifiers, usage of split and join keywords, inline comments and modifiers, grouping and alternation, grouping with back references.

UNIT 3	10 Hrs.

Files and References

Introduction to Filehandles, STDIN, STDOUT, STDERR file handles, reading lines, creating filters, line separator, reading paragraphs, reading entire files, writing to files, writing on a file handle, accessing filehandle, writing binary data, selecting a filehandle, buffering, file permissions, opening pipes, piping in, piping out, file tests, reading directories and globbing, introduction to references, lifecycle of a reference, anonymous reference, dereferencing, reference modification, array and hash referencing, reference counting and destruction.

Subroutines and Modules

Introduction to subroutines, difference between subroutines and modules, defining subroutines, order of declaration, subroutines for calculations, return values, caching, context, subroutine prototypes, scope, global variables, lexical variables, runtime scope, aliases, passing references, arrays, hashes and filehandles to a subroutine, modules, usage of keywords do, require and use, changing @INC, package hierarchies, exporters, standard modules in perl.

UNIT–IV	10 Hrs.

Running and Debugging Perl
Examining syntax errors, runaway strings, brackets around conditions, missing semicolons, braces, commas

and barewords. Diagnostic modules, use warnings, scope of warnings, use strict, strict on variables, references, subroutines, use diagnostics, perl command line switches, usage of–e, -n, -p, -c, -l, -M, -s, -I, @INC, -a, -F and –T switches, Debugging techniques, usage of print, comments, context, scope and precedence in debugging, Defensive programming.

Bioperl

Overview, Bioperl Objects, Brief descriptions (Seq, PrimarySeq, LocatableSeq, RelSegment, LiveSeq, LargeSeq, RichSeq, SeqWithQuality, SeqI), Location objects, Interface objects and implementation objects, Representing large sequences (LargeSeq), Representing changing sequences (LiveSeq), Using Bioperl: Accessing sequence data from local and remote databases, Accessing remote databases (Bio::DB::GenBank, etc), Indexing and accessing local databases Bio::Index::*, bp_index.pl, bp_fetch.pl, Bio::DB::*), Transforming sequence files (SeqIO), Transforming alignment files (AlignIO);

Reference Books *

1. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 1st Edition,2003.
3. D. Curtis Jamison, Perl Programming for Bioinformatics & Biologists, John Wiley & Sons, INC., 2004
4. Michael Moorhouse, Paul Barry, Bioinformatics Biocomputing and Perl, Wiley, 1st Edition 2007.

Course Outcomes**

After completion of the course student will be able to

1. Study the over view of perl
2. Study about loops and decisions.
3. Study of regular expression paterns.
4. Study of files and references.
5. Understand the subroutines and modules.
6. Understand the concept of running and debugging perl.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	-	-	-	-	-	-	2	-	3	1	2
CO 3	3	2	2	-	-	-	-	-	-	-	2	1	3	1	-
CO 4	3	2	3	-	-	-	-	-	-	-	2	1	3	1	2
CO 5	2	2	2	-	-	-	-	-	-	-	-	1	3	1	1
CO 6	2	2	2	3	-	-	-	-	-	-	-	1	1	1	1

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UBT628E	TRANSPORT PHENOMENA	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Momentum Transfer and Overall Balances

Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes.

Momentum transfer – Principles and Applications: Flow past immersed objects, packed beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion).

UNIT–II	10 Hrs.

Steady State Heat Transfer

Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, natural convection heat transfer, boiling and condensation, heat exchangers.

Unsteady State Heat Transfer: Derivation of basic equation, simplified case for systems with negligible internal resistance.

UNIT 3	10 Hrs.

Mass Transfer:

Mass transfer and diffusion, molecular diffusion in gases, liquids and solids. Mass transfer coefficients. Separation Processes - Evaporation, Drying, Humidification, and Absorption.

UNIT–IV	10 Hrs.

Separation Processes:

Distillation, Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes.

Reference Books *

1. Transport Processes and Separation Process Principles – C. J. Geankoplis, 4th Edition
2. Momentum, Heat and Mass Transfer – Bennett and Myers
3. Welty, Wicks and Wilson Fundamentals of momentum, heat and mass transfer,2000.
4. Sawhney Gs Fundamentals of Fluid Mechanics IK Publishers ,2008

Course Outcomes**

After completion of the course student will be able to

1. Define the units, dimensions and dimensional analysis
2. Analyze the dimensional analysis methods
3. Define the fluid, property and types of fluid
4. Apply the Hydrostatic and Bernoulli's theorem
5. Apply the applications of Bernoulli's theorem in venture meter, Orifice meter, etc
6. Evaluate the working of size reduction equipments and mixing equipments

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

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Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 2	3	3	3	-	-	-	1	-	-	-	-	-	3	1	-
CO 3	2	3	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 4	3	2	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 5	2	3	3	-	-	-	1	-	-	-	-	-	2	1	-
CO 6	3	2	2	-	-	-	1	-	-	-	-	-	2	1	-

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UBT622E	GENOMICS AND PROTEOMICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases, c) potential revenue in the area diagnostic and biomedical applications, d) biosimilars market and implications.

Sequencing & genome projects

Early sequencing efforts, Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on *E.coli*, Arabidopsis and rice; Human genome project .

UNIT–II	10 Hrs.

Genomics

Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans.

Genome management in eukaryotes

Cell differentiation and gene regulation. Inheritance pattern in eukaryotes, Mutations, organization of eukaryotic genome within the nucleus, translation and post-translational modification in eukaryotes. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics- definition & concept.

UNIT 3	10 Hrs.

Functional genomics

Hargobhind Khorana discovery the first artificial gene, C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking. Molecular markers – RFLP, RAPD and AFLP, Microsatellites and telomerase as a molecular markers. Methods of molecular mapping, Marker assisted selection, map based cloning, T-DNA tagging, Transposon tagging. Bioinformatics analysis- clustering methods. Approaches to physical mapping, FISH – DNA amplification markers.

UNIT–IV	10 Hrs.

Proteomics

Introduction to proteins, Methods of protein isolation, purification, quantification, Large scale preparation of proteins, use of peptides in biology, Proteomics databases and proteins as drugs.

Proteome analysis

Mass-spec based analysis of protein expression and post-translational modifications. "Protein Chip" - interactions and detection techniques. Methods of measurement of mRNA expression, DNA array hybridization Non-DNA array hybridization, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas.

Reference Books *

1. Introduction to Genomics – Arthur M Lesk, Oxford University Press, 2007.
2. Plant Genome Analysis – Peter M Gresshoff, CRC Press.
3. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science,1994.
4. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics–,Pearson Education, 2007.
5. Albala J S & I Humprey-Smith Protein Arrays, Biochips and Proteomics–CRC Press, 2003.
6. 3.Sabesan, Genomics & Proteomics – , Ane Books, 2007.
7. Pennington S. R. and M J Dunn Proteomics –, 2004.
8. Richard J Simpson Purifying Proteins for Proteomics, IK International, 2004.
9. Richar.d J Simpson Proteins and Proteomics –, IK International, 2003.

Course Outcomes**

After completion of the course student will be able to

1. Ability to describe how genomic DNA contains long stretches non-coding regions.
2. Ability to describe how a single gene can give rise to multiple proteins.
3. Ability to harness the emerging genomic, transcriptomics and proteomics.
4. Ability to understand bioinformatics information to build novel paradigms of biological importance.
5. Ability to understand how modern genomics tools are useful in functional genomics.
6. Ability to understand the importance of proteomics in modern biology.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	-	-	2	2	-	-	-	-	1	-	2	3
CO 2	3	3	1	-	-	2		-	-	-	-	2	1	-	3
CO 3	3	2	2	1	2	-		-	-	-	-	1	1	2	2
CO 4	2	2	2	2	2	2	2	2	-	-	-	1	1	2	2
CO 5	2	1	2	-	1	-	2	-	-	-	-	1	1	2	2
CO 6	3	1	2	2	2	1	-	-	-	-	-	1	1	2	2

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UBT625E	BIOFUELS TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Biochemistry of biofuels and energy resources

Basic principle of light energy conversion to chemical energy & carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources.

Biofuels

Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.

UNIT–II	10 Hrs.

Biofuel feed stocks

Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks.

Types of biofuels

First generation biofuels-vegetable oil biodisel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation and third generation biofuels

UNIT–III	12 Hrs.

Technologies for biofuels

Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Innovations in 2G technology. Thermochemical platforms - biodiesel production, Innovations in Biodiesel productions, standardization, properties and emissions of biodiesel. Biomethanation-AD technology and innovations in Biomethanation process. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Microbial fuel cells. Blending of biofuels.

UNIT–IV	10 Hrs.

Biofuels in perspective

Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodiesel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.

Reference Books *

1. Environmental Biotechnology by Foster C. F., John ware D.A., Ellis Horwood Limited, 1987.
2. Fuels from Waste by Larry Anderson and David A Tillman. Academic Press, 1977.
3. Biofuels by Ayhan Demirbas publ. Springer
4. Biofuels (Series - Energy For The Future And Global Warming)
5. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.
6. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.

Course Outcomes**

1. After completion of the course student will be able to
2. Ability to understand the basic principle involved in bioconversion process in energy and to

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differentiate the conventional fuels with biofuels .

3. Able to diagnose the types of feed stocks used for biofuels.
4. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current technologies and innovations involved
5. Able to understand and recall current issues related with production and use of biofuels, Research opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-
CO 5	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 6	3	3	-	3			2	-	-	-	-	3	-	1	-

UBT632N	ENVIRONMENTAL TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction:
Current Environmental Issues and scope of Environmental science and technology biogeochemical role of soil microorganisms, Bioconcrete, Environment Impact Assessment
Bioaccumulation of toxicants
Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation
Sustainable future: Green building concept, Carbon foot print, crediting, trading and its calculation, Water foot print Rain water harvesting .

UNIT–II	10 Hrs.

Waste water treatment: Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration. ultrafiltration and microfiltration Microbial removal of phosphorous and Nitrogen Wastewater treatment of industries like sugar factories, food industries, beverages industries, and distilleries.
Solid waste management
Basic aspects, general composition of municipal solid wastes, aerobic treatment, anaerobic treatment biogas generation Solid waste management. Hazardous wastes, Biomedical Wastes E waste management, MoEF rules.

UNIT–III	10 Hrs.

Bioleaching & Biomining:
Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of phosphate, petroleum.
Bioremediation:
Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation

UNIT–IV	10Hrs.

Biofuels:
Definition, Renewable and nonrenewable resources Advantages and disadvantages of biofuels Biofuel feed stocks-sugar starch, cellulose, lipid Types of biofuel- first, second and third generation Technologies for bio-fuel production-transesterification, gasification 2G technology, Biomethanation, Issues of biofuel production and its use. Microbial fuel cells.
Biodiversity: Value of biodiversity, threats to biodiversity approaches of biodiversity conservation.

Reference Books *

1. Pradipta Kum Mahopatra, 2006, Text Book of Environmental Biotechnology, I K Publishers.
2. R C Dubey and D K Maheshwari,2013 Text book of Microbiology,
3. M Y Young ,2004 ,Comprehensive Biotechnology Vol 1-4 (Eds). Pergamon Press
4. EJ Dasilva, C Ratledge & A Sasson, 2003, Biotechnology, Economic & Social Aspects Cambridge Univ Press.
5. Indu Shekhar Thakur,2012,Environmental Biotechnology Basic concepts and applications, Second Edition, I K international Publishing House, Pvt, Ltd.

Course Outcomes**

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1. Able to analyse the current environmental issues, scope of environmental Technology and understand the various sustainable future concepts.
2. Able to analyse the methods used in treatment of waste water and solid waste.
3. Able to understand the concept of bioleaching process and biomining activity
4. Able to analyse the types and methods used in cleaning of the environment by bioremediation.
5. Able to define the sources of biofuels and produce various biofuels
6. Able to analyse the need of conservation of biodiversity

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	**2**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**
CO2	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**
CO3	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**
CO4	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**1**
CO5	**2**	**1**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**
CO6	**2**	**-**	**1**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**2**

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UBT615L	BIOKINETICS & ENZYME TECHNOLOGY LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN BIOKINETICS & ENZYME TECHNOLOGY LABORATORY

1. Isolation of alpha-amylase from sweet potato or saliva
2. Maltose calibration curve by DNS method
3. Determination of activity of Salivary alpha-amylase
4. Determination of Specific activity of an enzyme
5. Effect of pH and temperature on enzyme activity
6. Determination of Kinetics constants (Km & Vmax)
7. Urea calibration curve
8. Determine the activity of enzyme Urease
9. Effect of inhibitors on enzyme activity
10. Immobilization of enzyme and determination of immobilized enzyme activity
11. (Prediction of error percentage, standard deviation need to be calculated from expt. no 5 and 6)

Reference Books *

1. Laboratory manual of Biochemistry by Pattabiraman, 4th Edition, International book publishers , India, 2017.
2. Sadasivam and Manickam, “Biochemical Methods”, 2nd Edition, New age international Publishers, 2017.

Course Outcomes**

After completion of the course student will be able to

1. Understand the preparation of enzymes.
2. Determine the activity of enzymes.
3. Estimate the effect of external condition on enzyme activity.
4. Evaluate the action of inhibitors on the enzyme activity.
5. Analyze the kinetic of enzymes.
6. Apply knowledge of immobilization of enzymes

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-
CO5	2	3	-	1	-	-	-	-	-	-	-	-	3	2	-
CO6	2	3	3	2		3	2	-	-	-	-	1	3	-	-

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UBT614L	UPSTREAM PROCESSING LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN UPSTREAM PROCESSING LABORATORY

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Animal cell culture techniques
5. Artificial seed production (Auxiliary buds)
6. Production of secondary metabolite by shake flask studies; Comparison of yield in various media
7. Fed batch culture – Assessment of yield
8. Development of inocula; lag time effect
9. Study of operational functions of the fermentor
10. Production of Ethanol in fermentor – Study of Growth, product formation
11. Kinetics and end substrate utilization
12. Single Cell Protein (SCP) production by continuous culture.

Reference Books *

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995
2. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3nd Edition, 2018.
3. Culture of Animal cells-3rd Edition-R. Ian Freshney. Wiley 2010.
4. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth- Heinemann; 3rd Edition, 2016.

Course Outcomes**

After completion of the course student will be able to

1. Prepare/reproduce the protocols for the experiments
2. Produce callus using plant tissue culture techniques
3. Prepare the industrial media and inoculum for the fermentation process
4. Operate lab fermenter and prepare the fermentation process to study growth kinetics, substrate utilization and product formation
5. Record/observe the experimental data and interpret them in the graph/table
6. Calculate the result and to write the conclusion at the end of the experiment

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-		2	-	1	-	-	-	-	1	3	2	-
CO2	3	3	-	3	-	-	2	-	-	-	-	1	2		-
CO3	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-
CO5	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO6	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-

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VIII SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT805P	Project	15	0	0	15	50	50	100
2	UBT8XXE	Elective-6	3	3	0	0	50	50	100
3	UBT8XXE	Elective-7	3	3	0	0	50	50	100
		Total	**21**	**6**	**0**	**15**	**150**	**150**	**300**

Elective-6
UBT823E: Chemical plant utilities & safety
UBT824E: Metabolic engineering
UBT825E: Industrial waste water treatment
UBT827E: Pharmaceutical BT

Elective-7
UBT830E: Clinical research
UBT832E: Health diagnostics
UBT833E: Validation & quality control
UBT834E: Product development

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UBT827E	PHARMACEUTICAL BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:
Introduction to pharmaceutical biotechnology, Pharmaceutical Industry. Drug design, development and Economics, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescription and Non-prescription drugs. Regulations & guidelines for pharma ,CDSCO, fda, ichq7, usfdA21 cfr part11.

Drug metabolism:
Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway). Pharmacodynamics and Pharmacokinetics of drugs.

UNIT–II	10 Hrs.

Toxicology:
Basic concepts in toxicology, the mechanism of toxin action, biotransformation of toxins, their inactivation and removal from the body, Reactive intermediates.

Manufacturing principles and formulations:
Definitions, applications, composition, preparation, physicochemical considerations, Preformulation Testing, Tablets, compressed tablets, tablet granulation, Coatings, Pills, Parental preparations, herbal extracts, Oral liquids, Ointments, short study of current biotech products, herbal medicines. Quality control, storage and stability of biotech products.

UNIT–III	10 Hrs.

Stem cells in health care:
Introduction to Stem Cell Biology, Fate Mapping of Stem Cells, Mesenchymal Stem Cells, Stem Cells and Neurogenesis and its application , Epidermal Stem Cells, Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon. Application of epidermal stem cell in Tissue engineering, Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.

Drug delivery system:
Advanced Sustained Release Drug Delivery System, Advanced drug Delivery Systems, Liposomes and Nanoparticles Drug Delivery System, Biodegradable Drug Delivery System, Hydrogel based Drug Delivery System.

UNIT–IV	10 Hrs.

Analysis of biologicals & pharmaceuticals:
Vitamins Cold remedies Laxatives Analgesics, NSAIO, External antiseptics, Antacids, Antibiotics, Biologicals, Herbal products. Packaging techniques – Glass containers, plastic containers, film wrapper, bottle seals.

Advanced pharmacology:
Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.

Reference Books *

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1. Gary Walsh, (2013),Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers.
2. Bartram Katzung, (2009),Basic & Clinical Pharmacology(9th Edition), McGraw Hill.
3. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of

Industrial Pharmacy, (3 rd Edition) Publishing House Bombay.
Course Outcomes**

After completion of the course student will be able to

1. Apply and classify various biological sources of pharmaceutical products to retrieve the basic concept of pharmacology, drug metabolism .and their importance in biotechnology
2. Select and apply the toxicological studies of pharmaceutical products
3. Use knowledge of the techniques used in the manufacture of pharmaceutical products and apply in the field of Biopharmaceuticals.
4. Ability to discuss the concepts used in production of stem cells and analyse the applications and ethical issues of stem cells in the society.
5. Select and apply appropriate techniques advanced techniques in drug delivery system.
6. Demonstrate an ability to apply principles various other applications to protect the global community from various dreadful diseases.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	2	2	2	3	3	1	-	-	-	-	-	3	2	1
CO2	-	3	3	3	3	2	3	-	-	-	-	-	2	2	1
CO3	-	2	3	2	3	1	-	-	-	-	-	-	3	2	-
CO4	-	2	3	2	3	1	-	-	-	-	-	-	2	2	-
CO5	-	3	3	2	3	1	-	-	-	-	-	-	2	3	-
CO6	-	3	3	3	3	2	2	-	-	-	-	-	2	2	3

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UBT833E	VALIDATION & QUALITY CONTROL	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	6 Hours

Introduction

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation &Revalidation . Validation of Water, Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non- Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). FDA and ICH guidelines.

UNIT–II	7 Hrs.

Medical Device, In-Vitro Diagnostics & Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11.

Standards

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems.

UNIT–III	6Hrs.

Implementation **10 Hours**

The Influence of Good Automated Manufacturing Practice (GAMP); The FDA's Approach to GMP Inspections of Pharmaceutical Companies.

Quality System, Contract Review, Design Control, Document and Data Control, Purchasing,Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Control of Inspection, Measuring and Test Equipment, Inspection and Test Status, Control of Nonconforming Product, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques.

Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement

UNIT–IV	7Hrs.

Quality

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Regrade, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation, Information, Document, Specification, Quality Manual, Quality Plan, Record; Terms Relating of Examination, Objective Evidence, Inspection, Test. Metrological Confirmation.

Reference Books *

1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From

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Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000.
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998.
4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance,2017
5. Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie,2017
6. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998.
7. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001

Course Outcomes**

1. Ability to comprehend the validation techniques, process, concepts.
2. Ability to analyse the good practices in lab, clinical and manufacturing practices
3. Capable of understanding the ISO standards and environmental management systems
4. Ability to analyse the analytical methods of validation, issues and automated system and standards
5. Ability to discuss the quality control measures used in industries
6. Ability to analyse the Quality Management System

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	2	3	1	-	-	-	-	-	1	3
CO2	2	-	-	2	-	3	3	3	-	-	-	-	2	2	3
CO3	3	-	-	-	-	3	2	2	-	-	-	3	2	3	2
CO4	2	-	-	-	-	3	1	3	-	-	-	3	2	3	3
CO5	2	-	-	-	-	2	3	3	-	-	-	2	2	2	3
CO6	2		-	2	-	2	1	2	-	-	-	2	2	3	2

UBT823E	CHEMICAL PLANT UTILITIES AND SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment, **Air** Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system-piping and accessories. Air-water vapour system: humidification/ dehumidification and evaporative cooling-related calculations.	
UNIT–II	**10 Hrs.**
Steam and power Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. **Refrigeration:** Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect-related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.	
UNIT–III	**10 Hrs.**
Insulation Insulation Materials & Selection-Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation. Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards-Toxicity, Flammability, Fire , Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.	
UNIT–IV	**10 Hrs.**
Safety devices Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. **Process safety analysis** HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.	
Reference Books *	

1. Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill, 8th Reprint, 1998.
2. Heat Engines, K.P. Roy, Media Promoters and Publishers, 1995.
3. Chemical Engineers Handbook, Perry, 8th Edition, 2007.
4. Chemical Engineering-Vol 6, R.K. Sinnot, Coulson and Richardson's, 3rd Edition, BH, Reprint, 2000.

Course Outcomes**
1. Ability to Storage and handling of water 2. Able to understand types of compressor 3. Able to analyze the economy of steam generation with different fuels 4. Able to study Hazard and risk assessment methods. 5. Ability to understand safety devices 6. Ability to compare HAZAN and HAZOP operations

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	2	1	-	2	-	2	-	2	-	-	-	-	1	3	1
CO6	1	2	3	2	-	3	-	1	-	-	-	-	1	3	1

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UBT824E	METABOLIC ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

Basic Concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies.

Metabolic regulation

An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Glycolysis, ermentative Pathways, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, atabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, iosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids, and Other Building Blocks, Polymerization, Growth Energetics

UNIT–II	10 Hrs.

Metabolic flux

Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method.

Applications of metabolic flux analysis

Amino Acid Production by Glutamic Acid Bacteria, Biochemistry and Regulation of Glutamic Acid Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine Biosynthetic Network in C. glutamicum, Metabolic Flux Analysis of Specific Deletion Mutants of C. Glutamicum, Metabolic Fluxes in Mammalian Cell Cultures, Determentation of Intracellular Fluxes., Computational Networks and Systems Biology

UNIT–III	10 Hrs.

Regulation of metabolic pathways

Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites.

UNIT–IV	10 Hrs.

Metabolic engineering in practice

Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Alteration of Nitrogen Metabolism, Enhanced Oxygen Utilization, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX).

Reference Books *

1. P.F. Stanbury and A. Whitkar. 2008,Principle of Fermentation Technology pergaman press,
2. Wang D I C Cooney C I Demain, A L ,2008, “Fermentation and enzyme Technology” John Willey,
3. Roberts, 2007 “Metabolism of Agrochemicals in Plants” Willey Int,.
4. David L. Nelson and Michael Cox, 2016, “Lehninger Principles of Biochemistry” **–**6th Edition
5. Lubert Stryer, 2010 “Biochemistry” **-**Freeman & Co., Pub.

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Course Outcomes**
1. Recall the concepts of cellular metabolism. 2. Explain the Basic concepts of metabolic engineering. 3. Explain Fundamentals of Metabolic flux analysis. 4. Apply the knowledge of metabolic flux analysis. 5. Apply the knowledge of regulatory mechanism for altering the metabolic pathways. **6.** Design the metabolic pathways for desired product.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2			2							1	1	1
CO2	2	2	2		2	3							2	1	2
CO3	3	3	2		2	2						1	1	1	2
CO4	3	3	3		2	3						1	2	1	3
CO5	2	1		2		2		2					1	3	1
CO6	1	2	3	2		3		1					1	3	1

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UBT825E	INDUSTRIAL WASTE WATER TREATMENT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Water and waste water engineering an overview Water quality, physical chemical and biological parameters of water, water quality standards,water quality indices. Waste water: terminology, impact of regulation on waste waterengineering, health and environmental concern in waste water management, waste water characteristics and treatment methods, current status and future trends, waste water reclamation and reuse, biosolids and residual management. Constituents of waste water, physical chemical and biological parameters of waste water, sampling methods, waste water effluent standards, sewage disposal methods.	
UNIT–II	**10 Hrs.**
Primary and secondary treatment of waste water Screens, oil traps, grit chambers, coagulation, clariflocculation, oxidation ponds and lagoons,Attached growth biological treatment : Activated sludge process and its modifications, trickling filter, biological nitrification and denitrification, anaerobic process, sludge disposal. **Advanced waste water treatment** Removal of dissolved organic, inorganic constituents and biological constituents, Filtration: modeling and backwashing for slow sand and rapid sand filters, adsorption principle and isotherms, gas stripping, ion exchange, advanced oxidation process. **Membrane filtration** RO, UF, MF, NF, electrodialysis. Disinfection: chlorine dioxide, chloramines, ozonation, UV radiation.	
UNIT–III	**10 Hrs.**
Waste water reclamation and reuse Waste water reuse application, need for water reuse, public health and environmental issues in water reuse, introduction to risk assessment for water reuse, different reuse options: Agriculture and landscape irrigation, industrial reuse, ground water recharge, non-potable uses with case studies.	
UNIT–IV	**10 Hrs.**
Issues related to treatment plant performance Need for upgrading treatment plant performance, treatment process reliability and selection of design values, odour management, introduction to automatic process control, energy efficiency, upgrading waste water treatment plant performance by process optimization, important design consideration for new waste water treatment plants: Liquid stream, solid processing, odour control.	

Reference Books *

1. John C. Geyer and Daniel A Okun, Jhon Hutey,1996. Water and Waste water engineering-Vol 2, Gordon M Fair.
2. Mark J. Hammer Jr. ,1997 ,Water and waste water Technology,, 4th Edition, Prentice Hall.

Course Outcomes**

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1. Define water quality and explain methods to characterize water quality.
2. Describe water quality standards and their impact.
3. Explain primary and secondary treatment methods of waste water.
4. Apply membrane filtration techniques, and disinfection methods to purify waste water.
5. Analyze the importance of reclamation and reuse of waste water.

6.	Identify various issues related to the performance of treatment plants and problems

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

UBT830E	CLINICAL RESEARCH	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology. **Clinical pharmacology** Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development - formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.	
UNIT–II	**10 Hrs.**
Therapeutics Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors. **Management of drugs** Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.	
UNIT–III	**10 Hrs.**
Healthcare marketplace National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing. **Social, ethical issues** patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.	
UNIT–IV	**10 Hrs.**
Clinical research Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data **Management in Clinical Research:** General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.	
Reference Books *	

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1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd.
2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication. ,
3. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology,
4. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.

Course Outcomes**

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1. Exploit the knowledge to know the clinical importance of different therapeutic products
2. An integrated understanding of the formulations, manufacturing and supply of materials
3. Ability to study the philosophy behind organization of research Ability to understand control measures uised in drug and its control
4. Ability to elucidate the marketing strategies of pharma products
5. Ability to compare the social and ethical issues
6. Ability to inculcate the epidemiology study designs, case reports and case series

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	3	-	2	-	2	1	-	-	-	2	2	2	1
CO2	1	2	3	-	1	-	2	1	-	-	-	3	3	1	1
CO3	1	2	3	-	2	-	2		-	-	-	3	2	2	1
CO4	1	3	3	-	1	-	1	1	-	-	-	2	2	1	1
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

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UBT832E	HEALTH DIAGNOSTICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

INTRODUCTION:
Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders chromosomal disorders, single cell disorders and complex traits. Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis.

DNA BASED DIAGNOSTICS
G-banding, in *situ* hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH). Cancer cytogenetics: spectral karyotyping. DNA diagnostics: PCR based diagnostics; ligation chain reaction, Southern blot diagnostics, array-based diagnostics, Genome sequencing and Metagenomics, DNA sequencing, genetic profiling, single nucleotide polymorphism. Haemoglobinopathies. Neuro developmental disorders. Neuro degenerative disorders. Dynamic mutations. G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (translocation, deletion, Down's syndrome, Klumefelter syndrome, Turner's syndrome, etc.) FISH for detections of: translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation).

UNIT–II	10 Hrs.

Biochemical diagnostics
Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis
Cell based diagnostics
Antibody markers, CD Markers, FACS, HLA typing, Bioassays

UNIT–III	10 Hrs.

Immunodiagnostics
Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs.

UNIT–IV	10 Hrs.

Imaging diagnostics
Imaging Techniques (Basic Concepts), Invasive and Non-Invasive, Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT, Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization of Imaging Services in Hospital, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.

Reference Books *

1. Lisa Anne Shimeld.,2000 Essentials of Diagnostic Microbiology
2. Balley & Scott's. 1998 Diagnostic Microbiology, 2ND edition,
3. Burtis & Ashwood,.Tietz ,2005,Text book of Clinical Biochemistry.

Course Outcomes**

1. Ability to study Biochemical disorders, chromosomal disorders.
2. Able to study DNA based diagnostics.
3. Analyse Biochemical diagnostics.
4. Understand cell based diagnostics.
5. Analyse Immunodiagnostics
6. Understand imaging diagnostics

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

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UBT834E	PRODUCT DEVELOPMENT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hours

Essentials of product development

The product development process, privacy policies and Knowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies. Stability studies – Stability Testing of new Drug Substances and Products – types and stages of testing, Stress Testing, storage conditions. Manufacturing Process for Recombinant pharma Products. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Approved Biotech Drugs.

UNIT–II	10 Hrs.

Interpersonal Skills

Understand analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in Pharma industries.

Understand work output requirements, company policies, delivery of quality work on time and report any anticipated reasons for the delay, effective interpersonal communication, conflict-resolution techniques, importance of collaborative working, multi-tasking, training the team members, knowledge of project management.

UNIT–III	10 Hrs.

Reporting and formulations

Reporting – power point presentations, technical writing, Principal investigator, communication with upstream and downstream teams. Problem Solving and Decision Making. Types of adverse drug reactions (ADR) and their treatment. Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, geriatric products, veterinary products, immune boosters.

UNIT–IV	10 Hrs.

Safety and Security at workplace

Different types of occupational health hazards, knowledge of chemical substances -characteristics & safety measures. Use of safety gears, masks, gloves and accessories, evacuation procedures for workers and visitors. Health, safety and security issues – types (illness, fire accidents). Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances.

Reference Books *

1. Endrenyi, L., Declerck, D. and Chow, S. (2017).
2. Biosimilar Drug Product Development. Boca Raton: CRC Press.
3. Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd.
4. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp.,
5. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers.

Course Outcomes**

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1. Understand, analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in pharma industry
2. Demonstrate the different inter personnel skills and project management skills
3. Ability to comprehend various techniques involved in reporting, decision making process and understand adverse effects of drugs.
4. Describe the formulation of various energy drinks and demonstrate the role of Upstream and Downstream marketing.
5. Analyze and list the various health hazards in industry.
6. Ability to understand importance of safety and implement in various industries.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**
** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3	2	2	2	3	1	-	-	-	-	1	1	2	3
CO2	1	-	-	2	1	2	1	-	-	-	-	1	1	1	1
CO3	1	3	2	1	2	1	1	-	-	-	-	1	1	2	1
CO4	1	-	3	2	1	2	2	-	-	-	-	1	1	1	2
CO5	1	2	2	1	2	3	3	-	-	-	-	1	1	2	1
CO6	1	2	2	2	1	2	3	-	-	-	-	1	1	1	-

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION

2021-2022

B.E. III SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UMA392C	Numerical Techniques & Fourier Series	3	3	0	0	50	50	100
2	UBT305C	Biochemistry	3	3	0	0	50	50	100
3	UBT315C	Bioprocess Principles & Calculations	3	2	2	0	50	50	100
4	UBT312C	Unit Operations	3	3	0	0	50	50	100
5	UBT313C	Microbiology	3	3	0	0	50	50	100
6	UBT317C	Cytogenetics and Cell Culture Techniques	3	3	0	0	50	50	100
7	UBT307L	Biochemistry Lab	1.5	0	0	3	50	50	100
8	UBT308L	Microbiology Lab	1.5	0	0	3	50	50	100
9	UBT311L	Unit Operations Lab	1.0	0	0	2	50	50	100
10	UHS388C	Samskruthika Kannada	1	2	0	0	50	50	100
		Total	**23**	**19**	**02**	**8**	**500**	**500**	**1000**

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UMA392C	NUMERICAL TECHNIQUES AND FOURIER SERIES	Credits : 03
L:T:P - 3:0:0		CIE Marks : 50
Total Hours /Week: 03		SEE Marks : 50

UNIT – 1	10 Hrs.
Numerical Analysis-I: **10 Hours** Introduction to root finding problems, Bisection Method, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof).	
UNIT – 2	**10 Hrs.**
Numerical Analysis-II: **10 Hours** Numerical differentiation using Newton's forward and backward formulae-problems.Trapezoidal rule, Simpson's one third rule, Simpson's three eighth rule and Weddle's rule (no derivation of any formulae)-problems. Euler's and Modified Euler's method, Runge-Kutta 4th order method.	
UNIT – 3	**10 Hrs.**
Fourier series: **10 Hours** Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.	
UNIT – 4	**10 Hrs.**
Fourier transforms and z-transforms: **10 Hours** Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms. Z-transforms-definition, standard forms, linearity property, damping rule, shifting rule-problems.	

Reference Books *

1. Numerical Methods for Engineers by Steven C Chapra& Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics by H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi.
4. Advanced Engineering Mathematics by E Kreyszig (John Wiley & Sons)

Course Outcomes **

After completion of the course the students shall be able to,

1. Solve engineering problems using non-linear equations and interpolation techniques.
2. Solve problems using numerical differentiation and numerical integration.
3. Solve ordinary differential equations using numerical methods.
4. Solve Problems using the Fourier series.
5. Solve problems using the basic concept of Fourier transforms.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

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CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

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CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UBT305C	**BIOCHEMISTRY**	**Credits: 03**
L:T:P – 3:0:0		**CIE Marks: 50**
Total Hours/ Week: 03		**SEE Marks: 50**

UNIT-I	**12 Hrs.**

Principles of Bioenergetics:
Energy Flow cycle, energy conversion. Structure and properties of ATP, Bioenergetics of metabolic pathway
Carbohydrate Metabolism:
Glycolysis, TCA cycle, Electron transport chain and oxidative phosphorylation and respiration energetics. Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway, Gluconeogenesis and regulation of gluconeogenesis.
Disorders of carbohydrate metabolism- Galactosemia, Lactose intolerance, Glycogen storage disorder etc. (Defective enzyme lead to disorder during metabolism).
Osazone formation to identify the carbohydrates.

UNIT–II	**10 Hrs.**

Lipid Metabolism:
Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids, Regulation of fatty acid biosynthesis, biodegradation of fatty acid, ketone bodies production during starving and diabetes.
Disorders of lipid metabolism- Sphingolipidoses etc.

UNIT–III	**10 Hrs.**

Nucleic acid Metabolism:
Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP.De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines&pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways.Disorders of nucleic acid metabolism-Lesch-Nyhan Syndrome and Gout.

UNIT–IV	**10 Hrs.**

Amino Acid Metabolism:
Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family)-Aspartate, Asparagine, Methionine, Lysine, Threonine.Biodegradation of amino acids- deamination, transamination and urea cycle.Disorders of amino acid metabolism-Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia.

Reference Books *

1. David L. Nelson and Michael Cox (2011). “Lehninger Principles of Biochemistry” –6th Edition.
2. Lubert Stryer (2010)., “Biochemistry” -Freeman & Co., Pub.
3. Voet&Voet (2004). “Biochemistry”- 3rd Edition, John Wiley, New York Pub.
4. Thomas M. Davlins (2001). “Biochemistry with clinical correlations” Wiley-Liss; 5 edition.
5. Mathews, Vanholde & Arhen (2010). “Biochemistry” -3rd Edition, Pearson Education Pub., 3rd Edition.
6. K. Trehan (2003). “Biochemistry” -New Age International Pub, 2nd edition.
7. Elliot & William H (2005). “Biochemistry & Molecular Biology” Oxford Pub.
8. Helmreich JEM (2005). “Biochemistry of cell signaling” –Oxford Pub.
9. U. Sathyanarayana (2007). “Biochemistry” -Books and Allied Pub.
10. Berg J.M., Stryer, Tymoczko J.L (2010). “Biochemistry” Freeman & co.
11. Freifelder D (2003). “Molecular Biology” -Narosa Publications, 2nd Edition.

Course Outcomes**

After completion of the course student will have the

1. Ability to understand the principles of high energy compounds & interpret the metabolic pathways in the carbohydrates and their disorders
2. Ability to recognize the regulation of lipid metabolism along with the in born errors.
3. Ability to understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism disorders
4. Ability to comprehend pathways involved in amino acid metabolism and its disorders

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	2	-		-	-	-	-	-	1	2	2	-
CO2	2	3	3	3	-	3	-	-	-	-	-	1	2	1	1
CO3	2	2	3	3	-	3	-	-	-	-	-	3	2	2	-
CO4	2	2	2	2	-	2	-	-	-	-	-	2	2	2	-

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UBT315C	BIOPROCESS PRINCIPLES AND CALCULATIONS	Credits: 03
L:T:P – 2:2:0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT–I	10 Hrs.
Introduction & Basic Chemical Calculations: Development and overview of traditional and modern applications of biotechnological processes. Process flow sheet and unit operations in chemical and bioprocess industries. Fundamental and derived quantities, Inter-conversion of units from one system to another (FPS, CGS, MKS, SI).Concept of mole and molecule, Composition of mixtures and solutions- Percentage by weight, mole and volume; Normality, Molarity, Molality; average molecular weight; ppm, pH and pK Buffer calculations. Numerical problems	
UNIT–II	**10 Hrs.**
Material balance without chemical reactions: General material balance equation for steady and unsteady states. Material balances in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing, and Evaporation Operations. Numerical problems Numerical problems.	
UNIT–III	**10 Hrs.**
Material balance involving chemical reactions: Principles of Stoichiometry. Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity and related problems. Material balances involving bypass & recycle; Fuels and Combustion: calculations involving Excess air and Air-fuel ratio. Numerical problems.	
UNIT–IV	**10 Hrs.**
Energy Balance: General energy balance equation for steady state. Thermo physics and Thermo chemistry: Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of Δ (HR) at elevated temperature. Heat effects of biochemical reactions. Numerical problems.	

Reference Books *

1. Hougen OA, Wats (2018) Chemical Process Principles: Part I, 2nd Edn., John Wiley, USA.
2. P.M.Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Elsevier India Pvt Ltd.
3. Gavhane K A (2009) Process Calculations Stoichiometry, 2nd Edn, Nirali Prakashan, India.
4. M.L.Shuler and F.Kargi (2008) Bioprocess Engineering--basic Concepts, 2nd Edn. Prentice-hall of India Pvt Ltd.
5. Narayanan K V, Lakshmikutty B (2016) Stoichiometry and Process Calculations, 2nd Edition, PHI India.
6. D.M.Himmelblau (2014) Basic Principles and Calculations in Chemical Engineering, 8th Edn,
7. Phi Learning Pvt Ltd.
8. Segel IH (2010) Biochemical Calculations 2nd Edn., John Wiley & Sons, NewYork.
9. Bailey JE and Ollis DF (1993) Biochemical Engg. Fundamentals, McGraw Hill, Newyork, USA.

Course Outcomes**

1. Define the process operations and terms of calculations
2. Apply various types of unit systems and convert units from one system to another.
3. Develop strategy for solving problems involving gases, vapours etc.
4. Adopt the tools learned from the course to solve numerical problems which contain one or more unit operations.
5. Able to solve material balance problems involving reactions.
6. Develop mathematical relations for both mass and energy balances for different processes.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	2	2	2	1	1	-	-	-	-	-	-	-	3	-	-
CO 2	3	2	3	2	1	-	-	-	-	-	-	-	3	-	-
CO 3	2	3	2	2	1	-	-	-	-	-	-	-	3	-	-
CO 4	3	2	1	1	1	-	-	-	-	-	-	-	3	-	-
CO 5	2	3	3	1	1	-	-	-	-	-	-	-	2	-	-
CO 6	2	2	2	2	1	-	-	-	-	-	-	-	2	-	-

UBT312C	UNIT OPERATIONS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to Fluid Mechanics: Units and Dimensions, Basic and Derived units, Dimensional homogeneity, Dimensionless numbers, Rayleigh method, Buckingham's pi theorem, Similitude. Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); Rheological behaviour of fluids. Fluid statics and its applications Hydrostatic equilibrium, Pressure measurement - Manometers.	
UNIT–II	**10 Hrs.**
Flow past Immersed Bodies: Types of flow - laminar and Turbulent; Reynolds number; Basic equations of fluid flow - Continuity equation and Bernoulli equation; Correction for Bernoulli's equation, Pump work in Bernoulli's equation; Flow through circular and non-circular conduits – Friction factor relations for smooth and commercial pipes.	
UNIT–III	**10 Hrs.**
Flow measurements: Orifice meter, Venturimeter, Rota meter. Pumps, principle, construction numerical. Major and minor losses, Centrifugal & Reciprocating pumps, Characteristics of centrifugal pumps. Pipes, fittings and valves.	
UNIT–IV	**10 Hrs.**
Mechanical Operations: Types of filtration, Filter media and filter aids, calculation of resistances and rate of filtration, filtration equipment. Settling, Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Agitation: Theory of mixing, Power number calculations, mixing equipment. Flow patterns in agitated tanks, mechanism of mixing, scale up of mixing systems. Size Separation: Particle shape, size, screen analysis, screening equipment. Size Reduction: Characteristics of comminute products, crushing laws and work index; Size reduction equipment.	
Reference Books *	

1. McCabe WL, Smith JC and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2012) Unit Operations I & II, 22nd Edn. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
5. R.P. Chhabra Basavaraj Gurappa (2019) Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA.

Course Outcomes**

After completion of the course student will be able to

1. Understand the basic concept of fluid mechanics and flow measurements.
2. Predict the dimensional analysis and solution for fluid flow problems.
3. Predict the pressure drop in fluid flow and flow through packed beds.
4. Estimate the flow rate of fluids and design the pumps for transportation of fluids.
5. Analyse and solve the problems on filtration and settling.
6. Analyse the forces involved in flow through solids and its operations

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	2	1	1	-	-	-	-	-	-	-	3	-	-
CO 2	3	2	3	2	1	-	-	-	-	-	-	-	3	-	-
CO 3	2	3	2	2	1	-	-	-	-	-	-	-	3	-	-
CO 4	3	2	1	1	1	-	-	-	-	-	-	-	3	-	-
CO 5	2	3	3	1	1	-	-	-	-	-	-	-	2	-	-
CO 6	2	2	2	2	1	-	-	-	-	-	-	-	2	-	-

UBT313C	MICROBIOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction: Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. **Microscopy:** Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).	
UNIT–II	**10 Hrs.**
Microorganisms: Bacteria- Morphology and ultrastructure of Bacteria, Culturing of bacteria, Types of media reproduction and growth (continuous and batch). Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. **Microbial Techniques:** Culture techniques- Aerobic and Anaerobic culture techniques. Fermentation(acid & alcohol).	
UNIT–III	**10 Hrs.**
Control of Microorganisms: Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. **Medical Microbiology:** **Normal** microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention and control (Typhoid, Malaria,Polio, Sars, Dengue, hepatitis, Cholera)	
UNIT–IV	**12 Hrs.**
Agricultural and Environmental Microbiology: Microbiology of soil, Air and Aquatic Microbiology, Biofertilizer, Plant endophytes, Microbes in bioremediation and biocontrol agents. **Industrial Microbiology:** Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).	
Reference Books *	
1. Pelczar, Chan and Noel Kreig, 2010 “Microbiology”- 5th Edition Tata Macgraw Hill 2. Tortora, Funke and Case, 2006, “Microbiology an Introduction” -8th Edition, Pearson Education. 3. E Alcamo I 2001. “Fundamentals of Microbiology”6th Ed, Jones & Bartlet, Pub. 4. Prescott, Harley & Klein, 2008, “Microbiology” -7th Edition, WCB/McGraw Hill, Int. Edition. 5. Prescot and Dunn, 2002, “Industrial Microbiology”-Agribios India.	
Course Outcomes**	

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1. Ability to know the basic concepts of Microbiology, scope ,organization
2. Ability to analyze the techniques to study microorganisms through microscopy
3. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes

4. Ability to discuss the causative organisms of the disease and their effect on society
5. Ability to comprehend the applications in the industry and their use in society
6. Ability to analyse the applied techniques in the environment and create awareness to society

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-	-	2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	2	2	1	-	2	1	-	-	-	-	-	2	1	1	1
CO6	2	2	1	-	3	1	-	-	-	-	-	2	2	1	3

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UBT317C	CYTOGENETICS AND CELL CULTURE TECHNIQUES	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Cell cycle and its regulation:
Cell & cell organelles, chromosome structure and its organisation, Cell division-mitosis and meiosis & their significance, (gametogenesis) cell cycle: check points, cell cycle and Regulation, factors regulating M phase initiation, M phase kinase, activation and inactivation.

Introductory genetics:
Mendel's laws of inheritance, Gene interactions-complete, incomplete, supplementary, complimentary, epistasis-inhibitory. Multiple allelism, Linkage, recombination and chromosomal mapping. Sex linked inheritance and extra chromosomal inheritance.

UNIT–II	10 Hrs.

Plant cell culture
History and Introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture. Cellular totipotency, cytodifferentition, organogenic differentiation, embryogenesis. Plant growth factors and hormones - auxins, gibberlins, cytokines and others. Stoichometry of cell growth and product formation.
Culture techniques and applications, cell and organ culture, protoplast culture, somatic hybridization, haploid production ,micro propagation: somaclonal variation Regeneration of plantlets-shooting, rooting and hardening, synthetic seeds.

UNIT–III	10 Hrs.

Animal cell culture Techniques:
History and development of mammalian cell culture. Lab organization, Introduction to balanced salt solutions. Cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Cell lines – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines -definite and continuous cell lines. Measurement of cell number Haemocytometer and coulter counter.

UNIT–IV	12 Hrs.

Cell line Characterisation and Maintenance:
Measurement of Cell viability and Cytotoxicity. Dye exclusion and inclusion tests, clonogenic assay, and MTT, PDT. Characterization, maintenance and preservation of cell lines (cryopreservation). Cell line contaminations, detection and control, cell transformation – normal v/s. Transformed cells, growth characteristics of transformed cells. In Vitro Fertilization (IVF) and Embryo Transfer Technique (ETT). Embryo splitting. Diagnosis of genetic diseases.

Reference Books *

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS pub, 2002.
2. Culture of Animal cells-3rd Edition-R.Ian Freshney.Wiley Less 2010.
3. Rastogi S C "Cell Biology" - New Age International Pub. 2005.
4. Powar C.B., "Cell Biology", Himalaya Pub. 2006.
5. Channarayappa, Cell biology, Universities Press, 2010.
6. Gardener, Simmons and Snustad,"Principles of Genetics"John Willey Publisher,2003

7. Singh B.D, “Fundamentals of Genetics”, Kalyani Pub, 2010.
8. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers, 2010.
9. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010

Course Outcomes**

Student will be

1. Able to understand the chromosome structure, cell cycle regulation and Mendalian genetics.
2. Able to use the plant cells to produce in vitro cultures
3. Able to apply the tissue culture techniques in various applications
4. Able to acquire working knowledge of culture of animal cells in *in vitro* conditions.
5. Able to identify, describe and classify the contaminants of cell culture and cryopreservation techniques
6. Able to identify the various applications of cell culture techniques

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	3	1	-	-	-	-	-	-	1	2	-
CO 2	2	-	-	-	3	1	-	-	-	-	-	-	2	2	-
CO 3	2	-	-	-	3	1	-	-	-	-	-	-	1	2	-
CO 4	2	-	-	-	3	1	-	-	-	-	-	-	2	2	-
CO 5	2	-	-	-	3	1	-	-	-	-	-	-	1	2	-
CO 6	2	-	-	-	3	1	-	-	-	-	-	-	2	2	-

UBT307L	BIOCHEMISTRY LABORATORY	Credits: 1.5
L:T:P – 0:0:3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

LIST OF EXPERIMENTS IN BIOCHEMISTRY LABORATORY

1. pH measurements, volume / weight measurements, concentration units, Specificity, precision, Accuracy.
2. Classes of carbohydrates, lipids and proteins.
3. Reagent preparation and preparation of buffers of constant strength.
4. Qualitative tests for carbohydrate and lipids.
5. Qualitative tests for amino acids and proteins.
6. Estimation of sugar by Folin and O-toluene method.
7. Estimation of amino acid and protein by ninhydrin method
8. Determination of Saponification value of lipids.
9. Determination of Iodine value of lipid.
10. Determination of acetyl value of a lipid.
11. Estimation of urea by diacetyl monooxime method.

Reference Books *

1. Laboratory manual of Biochemistry by Pattabiraman , 4th Edition, International book publishers India, 2017.
2. Sadasivam and Manickam, "Biochemical Methods", 2nd Edition, New age international Publishers, 2017.

Course Outcomes**

1. Ability to understand the basic aspects of standard reagent & buffer preparations.
2. Ability to identify various biomolecules qualitatively.
3. Ability to estimate the concentration of carbohydrates in a given sample
4. Ability to evaluate the concentration of amino acid quantitatively.
5. Ability to analyze the types of lipids.
6. Ability to apply knowledge of acid & iodine value to determine the quality of lipids.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	2	-	-	3	3	-	-	-	3	2	3	1
CO2	2	3	3	2	-	-	2	3	-	-	-	3	2	3	1
CO3	2	3	3	3	-	3	2	2	-	-	-	2	2	1	2
CO4	3	3	3	2	-	2	2	2	-	-	-	2	3	1	1
CO5	2	2	2	2	-	1	2	2	-	-	-	3	3	2	1
CO6	2	2	3	3	-	3		3	-	-	-	2	3	2	1

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UBT308L	MICROBIOLOGY LABORATORY	Credits: 1.5
L:T:P – 0:0:3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

LIST OF EXPERIMENTS IN MICROBIOLOGY LABORATORY

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Fermentation of Carbohydrates (gas production)
8. Growth curve of bacteria and yeast.
9. Antibiotic susceptibility testing of bacteria
10. Observation of motility by hanging drop technique.

Reference Books *

1. Pelczar, Chan and Noel Kreig, 2010 , “Microbiology”- 5th Edition Tata Macgraw Hill,.
2. Tortora, Funke and Case, 2006. “Microbiology an Introduction” -8th Edition, Pearson Education,
3. K. R. Aneja, 2004. “Experiments in Microbiology, Plant Pathology and Biotechnology” ,4th Edition, New age International Pub.

Course Outcomes**

After completion of the course student will be able to

1. Analyze the principle and procedures of different experiments
2. Perform simple and differential staining techniques
3. Prepare the media for culturing microbes
4. Observe the motility of organisms
5. Interpret the instruments and different components used in lab interpret the subject orally.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	-	-	2	1	-	-	-	-	-	3	1	1	1
CO2	2	2	-	-	2	3	-	-	-	-	-	2	2	1	2
CO3	3	3	-	-	3	2	-	-	-	-	-	2	1	1	2
CO4	3	3	-	-	2	3	-	-	-	-	-	3	2	1	3
CO5	1	3	-	-	3	1	-	-	-	-	-	3	1	2	1
CO6	2	1	-	-	3	1	-	-	-	-	-	3	1	2	1

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UBT311L	UNIT OPERATIONS LABORATORY	Credits: 01
L:T:P -0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN UNIT OPERATIONS LABORATORY

1. Friction in circular and non-circular pipes
2. Flow rate measurement using Orifice meter
3. Flow rate measurement using Venture meter
4. Batch sedimentation test
5. Constant pressure /constant filtration using leaf filter
6. Verification of Stoke's law in Free / Hindered settling
7. Determination of screen effectiveness and sieve analysis
8. Verification of Bernoulli's theorem
9. Unsteady state flow
10. Study of pump characteristics
11. Study of packed bed characteristics
12. Distillation

Reference Books *

1. Mccabe W.L. And Smith J.C, "Unit Operations In Chemical Engineering" -7th Edition, Mcgraw-Hill, 2017.
2. Goenkloplis, "Principles of Unit Operations" -P H I Publication, 1993.
3. Badger, Banchero and Walter (1955). Introduction to Chemical Engineering, 3rd Edn, Mcgraw- Hill Publications, USA.
4. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008). Principles of Unit Operations. 2nd Edn., John Wiley & Sons, USA.
5. Coulson And Richardson's (2011); Chemical Engineering, Vols I & II., 6 Th Edn., Reed Educational And Professional Publishing Ltd., USA.

Course Outcomes**

On successful completion of this course students will be able to

1. Determine energy loss due to friction in flow systems
2. Measure flow rate of incompressible fluids
3. Perform particle size analysis
4. Evaluate performance of size reduction and filtration equipments
5. Understand the working principles of mass transfer equipments
6. Evaluate the performance of mass transfer equipments

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	-	-	2	1	-	-	-	-	-	3	1	1	1
CO2	2	2	-	-	2	3	-	-	-	-	-	2	2	1	2

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CO3	3	3	-	-	3	2	-	-	-	-	-	2	1	1	2
CO4	3	3	-	-	2	3	-	-	-	-	-	3	2	1	3

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CO5	1	3	-	-	3	1	-	-	-	-	-	3	1	2	1
CO6	2	1	-	-	3	1	-	-	-	-	-	3	1	2	1

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
2021-2022
V SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT516C	Bioprocess & Reaction Engineering	3	3	0	0	50	50	100
2	UBT519C	Genetic Engineering & Applications	3	3	0	0	50	50	100
3	UBT520C	Fundamentals of Bioinformatics	3	2	2	0	50	50	100
4	UBT52XE	Elective-1	3	3	0	0	50	50	100
5	UBT506H	Industrial Safety and Bioethics	3	3	0	0	50	50	100
6	UBT514L	Bioinformatics Lab	1	0	0	2	50	50	100
7	UBT515L	Genetic Engineering Lab	1	0	0	2	50	50	100
8	UCS559L	Advanced C Programming Lab	2	0	0	4	50	50	100
9	UHS002N	Advanced Quantitative Aptitude and Soft Skills	1.0	1	0	0	50	50	100
Total			**20**	**15**	**02**	**8**	**450**	**450**	**900**

Elective-1
UBT521E: Environmental BT
UBT522E: Biomedical Instrumentation
UBT525E: Stem cell technology
UBT527E: Nutraceuticals

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UBT516C	BIOPROCESS & REACTION ENGINEERING	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Kinetics of Homogeneous reactions Basic Concepts of Bioreactor and bioprocess engineering, Concentration dependent term of a rate equation. Rate Constant. Representation of elementary reaction and Non elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.	
UNIT–II	**10 Hrs.**
Interpretation of Batch Bioreactor Data Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalyzed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data and numerical	
UNIT–III	**10 Hrs.**
Introduction to Reaction Design Introduction. Factors to be consider for designing a reactor, Types of reactors, Basic design equation, relation between Concentration and conversion, Performance equation for ideal batch reactor, MFR/CSTR and PFR, space time and space velocity for flow reactors, design of flow reactors and numerical.	
UNIT–IV	**10 Hrs.**
Design for single reactions Introduction .Size comparison of single reactors, multiple reactors CSTR in series /MFR in series, CSTR in parallel .PFR in series, in parallel, Reactors of different types in series, and numerical.	

Reference Books *

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3nd edn., Prentice Hall PTR.
4. Bailey JE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
5. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
6. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
7. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

Course Outcomes**

After completion of the course student will be able to

1. Understand the basic concept of reaction engineering.
2. Predict the order and rate of the different reactions.
3. Analyse the batch bioreactor data for different reactions.
4. Design the suitable bioreactor for different biochemical reactions.
5. Predict the residence time distribution to determine the conversion in non ideal flow reactors
6. Analyse bioreactors for various cell cultures.

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	1	2	3	1	-	-	-	-	-	1	1	2	3
CO2	1	-	2	2	3	1	-	-	-	-	-	1	1	2	3
CO3	1	-	3	2	3	1	-	-	-	-	-	1	1	2	1
CO4	1	-	3	2	3	1	-	-	-	-	-	1	1	2	1
CO5	1	-	3	2	3	3	-	-	-	-	-	1	1	2	1
CO6	1	-	1	2	3	3	-	-	-	-	-	1	1	2	1

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UBT519C	GENETIC ENGINEERING & APPLICATIONS	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:
Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambda vectors.

Enzymes in genetic engineering:
Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, and terminal deoxy nucleotidyl transferase.

UNIT–II	10 Hrs.

Nucleic acid hybridization and amplification:
Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.

Construction of cDNA libraries:
Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries

UNIT–III	12 Hrs.

Gene transfer techniques:
Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.

Transgenic science and genetic improvement:
Transgenic science in plant improvement, Antisense RNA technology (Flavr savr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes (Bacillus thuringiensis and its mode of action), Cry proteins – mechanism of action.

UNIT–IV	10 Hrs.

Gene therapy:
Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.

Applications:
Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.

Reference Books *

1. Bernard Glick and J. Pasternak (2017). Molecular Biotechnology – Principles and applications of recombinant DNA, 2nd edition, ASM Press.
2. Watson (2010), Recombinant DNA, 2nd edition, Freeman Publishers.
3. Primrose S.B, Richard Twyman and Bob (2010), Principles of gene manipulation Blackwell 6th edition, Scientific Publications.
4. NPTEL Course material.

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Course Outcomes**

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After completion of the course student will be able to

1. Emphasize on the basic aspects of genetic engineering; the key areas and apply the knowledge in vectors used in genetic engineering experiments.
2. Apply the properties of various enzymes and vectors in gene and genome manipulation.
3. Acquire working knowledge on the mechanism of methods of nucleic acid detection, hybridization and amplification and their applications in the research.
4. Acquire working knowledge on the construction of genomic and cDNA libraries, their applications in the research and biology of Bacillus thuringiensis.
5. Identify the various gene transfer techniques in plants, animals and microbes that are essential for controlled protein production in the industry and acquire knowledge on various strategies of Gene therapy and its application in therapeutics.
6. Identify and apply the current applications and advances of biotechnology and describe the steps involved in the production of biopharmaceuticals in microbial systems and industrial utilization.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	1	2	3	1	-	-	-	-	-	1	1	2	3
CO2	1	-	2	2	3	1	-	-	-	-	-	1	1	2	3
CO3	1	-	3	2	3	1	-	-	-	-	-	1	1	2	1
CO4	1	-	3	2	3	1	-	-	-	-	-	1	1	2	1
CO5	1	-	3	2	3	3	-	-	-	-	-	1	1	2	1
CO6	1	-	1	2	3	3	-	-	-	-	-	1	1	2	1

UBT520C	FUNDAMENTALS OF BIOINFORMATICS	Credits: 03
L:T:P – 2:2:0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	12 Hrs.

Introduction to Bioinformatics and Biological Database

Introduction to bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG;ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases

UNIT–II	10 Hrs.

Sequence alignment and database searches:

Introduction, Types of sequence alignment, Comparison between global and local alignment, Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions;Word/k-tuple method- BLAST, FASTA.

Multiple Sequence Alignment:Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles.

Tutorials: Solving problems on pairwise sequence alignment

UNIT–III	10 Hrs.

Phylogenetic analysis and predictive methods using sequences

Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees,Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares.

Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan).Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling.

Tutorials: Practices on prediction of phylogenetic trees

UNIT–IV	10 Hrs.

Plasmid mapping and primer designing &molecular modelling techniques

Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties,Dockingsoftwares (AUTODOCK, HEX)

Tutorials: Solving problems related to Restriction mapping and Primer designing

Reference Books *

1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition,2006.
2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000.
3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
4. Computational methods for macromolecular sequence analysis – R F Doolittle. Academic Press, 1996.

Course Outcomes**

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After completion of the course student will be able to

1. Importance of databases involved in bioinformatics along with their file formats
2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences
3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis
4. Explain various statistical tools involved in predicting the structure of genes and proteins
5. The principle behind restriction mapping and primer designing
6. Different approaches involved in silico drug design

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2	-	-	-	3	2	2	3
CO 2	3	2	2	2	2	1	2	-	-	-	-	3	2	2	3
CO 3	3	2	-	1	-	-	2	-	-	-	-	3	2	2	3
CO 4	2	2	-	1	-	2	-	-	-	-	-	3	1	-	2
CO 5	2	2	2	1	-	2	-	2	-	-	-	1	2	-	2
CO 6	2	1	2	2	2	2	1	1	-	-	-	1	1	1	1

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UBT521E	ENVIRONMENTAL BT	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Microorganisms

Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms.

Bioaccumulation of toxicants

Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.

UNIT–II	12 Hrs.

Biological treatment of waste water

Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration, ultafilration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries.

Solid waste management

Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules.

UNIT–III	10 Hrs.

Bioleaching and Biomining

Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum.

Bioremediation

Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.

UNIT–IV	10 Hrs.

Biotechnology in biodiversity conservation

Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.

Reference Books *

1. Mahopatra P K (2006), Textbook of Environmental Biotechnology, I K International Publishing House Pvt. Ltd.
2. Dubey R C and Maheshwari D K (2022), Text book of microbiology (5th edition), S Chand and Company Ltd.
3. Forster C F, Wase D A J (1987), Environmental Biotechnology, United Kingdom: Ellis Horwood.

Course Outcomes**

After completion of the course student will be able to

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove

environmental contaminants.

5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	2	2	-	-	-	2	-	3	-	1	2	3	1
CO2	2	3	2	1	-	-	-	1	2	-	-	-	3	3	1
CO3	2	3	2	1	-	-	-	1	2	-	-	-	3	3	1
CO4	1	3	2	3	-	-	-	2	2	3	-	-	2	3	-
CO5	-	-	-	-	-	-	-	2	-	3	-	3	-	-	-
CO6	1	3	2	2	-	-	-	-	2	2	-	-	1	3	-

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UBT527E	NUTRACEUTICALS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to Nutraceutical and dietetics Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope and opportunities involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.	
UNIT–II	**10 Hrs.**
Nutrition related diseases and disorders: Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management. Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress. Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.	
UNIT–III	**10 Hrs.**
Nutraceuticals of microbial, plant and animal origin Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Symbiotics for maintaining good health. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides	
UNIT–IV	**10 Hrs.**
Biotechnology in Phytonutraceuticals Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties. Golden rice, GM Tomatoes.	

Reference Books *

1. M. Maffei ,Dietary Supplements of Plant Origin, Taylor & Francis,1 st Edition,2003.
2. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society,1 st Edition, 2004.
3. Richard Neeser& J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
4. TimothtS. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

Course Outcomes**

1. To be aware of basic concepts of nutraceuticals and nutrition.
2. To have a general idea of scope of nutraceuticals and functional foods.
3. To have brief idea about nutrition related health disorders and the role of Nutraceuticals.
4. To classify nutraceuticals and the role of nutraceuticals among different age groups.
5. To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin.

6. To know about the role of biotechnology in production of plant secondary metabolites.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

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UBT522E	BIOMEDICAL INSTRUMENTATION	Credits: 03
L:T:P - 3:0:0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	10 Hrs.

Introduction

Sources of Biomedical signals, Basic medical instrumentation system, Performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems.

Bioelectric Signals and Electrode

Origin of bioelectric signals, Recording electrodes, - Electrode-tissue interface, metal electrolyte interface, electrolyte -skin interface, Polarization, Skin contact impedance, Silver – silver chloride electrodes, Electrodes for ECG, EEG, EMG, Electrical conductivity of electrode jellies and creams, Microelectrode. Patient Safety: Electrode shock hazards, Leakage currents.

UNIT–II	12 Hrs.

ECG & EEG

Electrical activity of heart, Genesis & characteristics of Electrocardiogram (ECG), Block diagram description of an Electrocardiograph, ECG Lead Systems, and Multichannel ECG machine Genesis of Electroencephalogram (EEG), Block diagram description of an Electroencephalograph, 10-20 Electrode system, Computerized analysis of EEG.

Cardiac pacemakers and defibrillators

Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers, DC defibrillator, AC defibrillator and Implantable Defibrillator.

UNIT–III	10 Hrs.

Patient monitoring system

Bedside monitors, Central Monitoring System, Measurement of Heart rate -Average heart rate meter, Instantaneous heart rate meter, (Cardio tachometer), Measurement of Pulse Rate, Blood pressure measurement -direct and indirect method, Rheographic method, Oscillometric method, Ultrasonic Doppler shift method, Measurements of Respiration rate -Thermistor method, impedance puenmography, CO2 method, and Apnea detector. Blood flow meters: Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO2, pO2.

Physiological transducers

Introduction, classification, performance characteristics of transducers-static and dynamic transducers, Displacement, position and motion transducers, Pressure transducer, Transducers for body temperature measurement, Optical Fiber sensor and Biosensor

UNIT–IV	10 Hrs.

Recording systems

Basic recoding system, general considerations for signal conditioners, preamplifiers-instrumentation amplifier, isolation amplifier, and ink jet recorder, potentiometric recorder, thermal array recorder and electrostatic recorder.

Analysis of Cardiac output measurement: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of Continuous cardiac output derived from the aortic pressure waveform, Impedance technique. Pulmonary function analysis: Pulmonary function measurement, Spirometry, Puemotachometer, Measurement of Volume, Nitrogen washout technique.

Reference Books *

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1. Khandpur R S (2003), Hand book of Biomedical Instrumentation (2nd Edition), Tata McGraw-Hill Publishing Company Limited.

2. Enderle J, Blanchard S &Bronzino J (2005), Introduction to Biomedical Engineering, Elsevier.
3. Carr J J, Brown J M (2005), Introduction to Biomedical equipment technology(4^{th} Edition), Prentice hall.

Course Outcomes**

After completion of the course student will be able to

1. Able to understand basic concepts of biomedical signals.
2. Able to know ECG and EEG.
3. Able to understand the patient monitoring system and recording systems
4. Able to know characteristics of transducers
5. Able to understand various analysis techniques
6. Able to understand the recording systems.

***Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-	2	-	-	-	-	-	-	-	1	-	2	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO3	2	3	2	1	-	-	-	-	-	-	-	-	3	3	1
CO4	1	2	2	3	-	-	-	-	-	-	-	-	1	3	-
CO5	1	3	2	2	-	-	-	-	-	-	-	-	2	3	1
CO6	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-

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UBT525E	STEM CELL TECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIEMarks:50
Total Hours/Week: 40		SEEMarks:50

UNIT-I	10 Hrs.
Stem cells and cellular pedigrees Scope of stem cells – definition of stem cells – concepts of stem cells – differentiation , maturation , proliferation , pluripolericy, self – maintainance and self – renewal –problems in measuring stem cells – preservation protocols.	
UNIT–II	**12 Hrs.**
Stem cell concept in plants Stem cell and founder zones in plants – particularly their roots – stem cells of shoot meristems of higher plants.	
UNIT–III	**10 Hrs.**
Stem cell concept in animals Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –Tumour stem cells, Embryonic stem cell biology - factors influencing proliferation and differentiation of stem cells – hormone role in differentiation.	
UNIT–IV	**10 Hrs.**
Haemopoietic stem cell Biology – growth factors and the regulation of haemopoietic stem cells. **Potential uses of stem cells** Cellular therapies – vaccines – gene therapy – immunotherapy – tissue engineering –blood and bone marrow – Fc cells.	

Reference Books *

1. Mao J. J, Vunjak-NovakovicG (2008), Translational Approaches in Tissue Engineering & Regenerative Medicine, Artech House, INC Publications.
2. Lanza R et al.(2007), Principles of Tissue Engineering(3rd Edition), Academic Press.

Course Outcomes**

After completion of the course student will be able to

1. Isolate and Culture of Hematopoietic Stem cells
2. Isolate and Culture of Mesenchymal Stem cells
3. Analyse Differentiation of Pluripotent stem cells
4. Interpret Cell culture in Scaffolds
5. Anayse growth of haemopoietic stem cells
6. Apply the potential uses of stem cells

***Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-	-	-	-	-	-	-	-	1	1	2	2	2
CO2	2	3	2	-	-	-	-	-	-	-	1	1	2	3	1
CO3	2	3	2	1	-	-	-	-	-	-	-	1	3	3	1
CO4	1	2	2	-	-	-	-	-	-	-	1	2	1	3	-
CO5	1	3	2	2	-	-	-	-	-	-	-	1	2	3	1
CO6	-	-	-	-	-	-	-	-	-	-	1	3	2	2	2

UBT506H	INDUSTRIAL SAFETY AND BIOETHICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Bioethics & Biosafety

Definition and scopeof bioethics and biosafety, Ethical implications and need for biosafety, Legal and Socio-Economic impacts of Biotechnology. Convention on biological weapons. Bioterrorism-classification of biological agents with examples.

Biosafety regulation guidelines

Recombinant DNA Advisory Committee (RDAC) ,Institutional Biosafety committee(IBC),Review Committee on Genetic Modification (RCGM),Genetic Engineering Approval Committee(GEAC), Biosafety guidelines- national guidelines, Cartagena Protocol on Biosafety.

UNIT–II	10 Hrs.

Biosafety Regulation:

Genetically modified organisms and their release in environment, Laboratory associated infections and other hazards, Good Lab Practices and Good Manufacturing Process (GLP &GMP). Biosafety levels for microorganismBL1,BL2,BL3,BL4) plants (BL1-P,BL2-P,BL3-P,BL4-P) animals (BL1-N,BL2-N,BL3-N,BL4-N).

Risk assessment during laboratory research and risk groups. Recombinant organisms and transgenic crops. Guideline for labeling GM crops. Containments; Physical, Biological. Field trial methods using transgenic plants.

UNIT–III	10 Hrs.

Food and Pharma safety:

Biosafety assessment procedures for biotech foods and Pharma products. Procedure to apply patent, Copy right, Plant Breeder's Right, Environmental aspects of biotech applications. Special application of patent laws in biotechnology and case studies. FlavrSavr Tomato as model case, case studies of relevance (Eg. Bt cotton, Btbrinjal). Licensing and cross licensing.

UNIT–IV	10 Hrs.

Industrial safety

Need for safety, importance of occupational safety, Health and safety programs, Safe and unsafe conditions.

Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention Safety policy

Fire: Fire extinguishers and fire exits, extinguishing agents.

Importance of safety in food and Pharma industry. Food safety, Biological, chemical and Physical Hazards-HAACP system, Pharma safety. Food and safety act. Injuries by industrial sector.

Reference Books *

1. Sateesh M.K.(2012),Bioethics and Biosafety,I.K.International Publication
2. Singh B.D.(2010), Biotechnology Expanding Horizon(3rd revised edition), Kalyani Publishers.
1. Goel D and Parashar S (2010), IPR-Biosafety and Bioethics(2nd edition), Pearson Education India Publishers.

Course Outcomes**

After completion of the course student will be able to

1. Emphasize on the basic aspects of Biosafety and ethics; the key areas and apply the knowledge in the social, legal & ethical issues connected with BT, BWC and Bioterrorism
2. Interpret & describe biosafety regulation guidelines committees, Cartagena protocol & their relevant

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applications in BT

3. Identify biosafety levels as relevant to Biotechnology & apply this knowledge in maintenance of biosafety, GLP, GMP in research lab, field & industry.
4. Acquire working knowledge on the risk assessment, containment, GMO labeling and transgenic field trials in the research.
5. Identify the various forms of IPR and understand the importance of patents in modern scientific and industrial research and discuss special application of patent laws in biotechnology with case studies.
6. Identify & discuss the potential dangers in Biotechnology and gain knowledge on safety aspects in food and Pharma industry and apply precautionary measures to avoid /overcome it.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**1**	**-**	**1**	**1**	**1**	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**3**
CO2	**1**	**-**	**1**	**2**	**1**	**2**	**1**	**2**	**-**	**3**	**-**	**-**	**3**	**1**	**1**
CO3	**1**	**-**	**2**	**2**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	**1**
CO4	**1**	**-**	**1**	**2**	**3**	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**3**	**2**	**1**
CO5	**1**	**-**	**1**	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**-**	**2**	**2**	**1**
CO6	**1**	**-**	**2**	**2**	**1**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**1**

UBT514L	BIOINFORMATICS LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN BIOINFORMATICS LABORATORY	28 Hrs.

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures

Reference Books *

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologists guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
6. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 2006.

Course Outcomes**

After completion of the course student will be able to

1. Ability to Search literature and sequence databases
2. Ability to retrieve and search sequences from databases
3. Ability to align pair wise and multiple sequences
4. Ability to identify evolutionary and relationships and functional sites in genomes
5. Ability to evaluate primer designing and restriction mapping
6. Ability to docking and superimpose the structures

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

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Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	3	1	-	3				3	3	3	1
CO 2	3	3	3	-	3	1	-	-				3	2	3	1
CO 3	3	3	2	2	3	1	1	-				3	3	3	1
CO 4	3	3	2	-	3	-	1	-				3	2	3	2
CO 5	3	3	2	1	3	1	-	2				3	3	3	2
CO 6	3	3	3	2	3	1	-	1				3	2	3	1

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UBT515L	GENETIC ENGINEERING LABORATORY	Credits: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN GENETIC ENGINEERING LABORATORY

1. Transformation
2. Blue white colony screening
3. Thermal denaturation of DNA
4. Restriction Digestion
5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblotting and analysis
8. Lyophilization of biologic samples (fluids, microbial samples)
9. SOP for UV-Spectrophotometer
10. SOP for PCR
11. PCR (Amplification with specific primers)

Reference Books *

1. Sambrook & Russell, (2002), Molecular Cloning (3rd Edition), Cold Spring Harbor Lab.
2. Sadashiva and Manickam, (2017), Biochemical methods (2nd Edition), W.H. Freeman

Course Outcomes**

After completion of the course student will be able to

7. Demonstrate proficiency in Transformation and screening of transformants.
8. Apply the knowledge of thermal denaturation to calculate Tm value.
9. Use research-based knowledge of restriction digestion and Ligation in the field of Biotechnology.
10. Demonstrate proficiency in Electro-blotting and detection.
11. Demonstrate understanding of SOP and PCR.
12. Gain knowledge in common and advanced laboratory practices in Genetic engineering lab.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	3	3	-	3	1	1	3	-	-	-	3	3	3	1
CO2	-	3	3	-	3	1	1	-	-	-	-	3	2	3	1
CO3	-	3	2	2	3	1	1	-	-	-	-	3	3	3	1
CO4	-	3	2	-	3	-	1	-	-	-	-	3	2	3	2
CO5	-	3	2	1	3	1	1	2	-	-	-	3	3	3	2
CO6	-	3	3	2	3	1	1	1	-	-	-	3	2	3	1

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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
2021-2022
VII SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	**Lecture**	**Tutorial**	**Practical**	**CIE**	**SEE**	**Total**
1	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3	UBT72XE	Elective-4	3	3	0	0	50	50	100
4	UBT73XE	Elective-5	3	3	0	0	50	50	100
5	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6	UBT733N	Industrial Safety (Open Elective)	3	3	0	0	50	50	100
7	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
9	UBT717L	Food Analysis Techniques Lab	1	0	0	2	50	50	100
10	UBT701T	Technical Seminar	1	2	0	0	50	50	100
		Total	**23**	**19**	**02**	**8**	**500**	**500**	**1000**

Elective-4
UBT722E: Aquaculture & Marine Biotechnology
UBT723E: Dairy Biotechnology
UBT724E: Food Processing Technology
UBT725E: Protein Engineering and Drug Design
Elective-5
UBT731E: Nanobiotechnology& Biomaterials
UBT732E: Computational Biology
UBT733E: Bioconjugative Technology
UBT734E: Food Biotechnology

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UBT704C	ECONOMICS AND PLANT DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Process design development Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design and equipment design and specialization, safety factors specifications, and materials of construction. **General design considerations** Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, storage, materials handling, materials and fabrication selection,.Waste disposal community factors. Safety and hazard control measures.	
UNIT–II	**10 Hrs.**
Capital investments Fixed capital investments including land, building, equipment and utilities, installation costs,(including equipment, instrumentation, piping, electrical installation and other utilities),working capital investments. **Manufacturing costs And plant overheads** Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges Plant Overheads: Administration, safety and other auxiliary services, Conceptual numerical.	
UNIT–III	**10 Hrs.**
Cost analysis Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital and **Depreciation**: different type of depreciation methods of and calculations, Conceptual numerical.	
UNIT–IV	**10Hrs.**
Profitability Analysis Methods for the evaluation of profitability. Return on original investment, interest rate of return, Cash flow diagrams. Break-even analysis. Conceptual numerical.	
Reference Books *	
1. Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw Hill. 2017 2. Rudd and Watson (1987) Strategy of Process Engineering, Wiley. 3. Poornima M C, “Entrepreneurship Development and Small Business Enterprises”, Pearson education, 2006 4. Vasanth Desai,”Dynamics of Entrepreneurial Development & Management”, Himalaya Publishing House.4th Edition,2007. 5. Khanka SS ,” Entrepreneurship Development, S Chand & Co. Revised edition, 2007. 6. Thomas W. Zimmer, Norman M. Scarborough, Essentials of Entrepreneurship and small Business Management, Pearson education,5th Edition,2008.	
Course Outcomes**	

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1. Acquire knowledge in the design of a plant.
2. Conduct preliminary feasibility study of the plant design assigned.

3. Estimate the cost analysis involved in the design of a chemical plant.
4. Analyze the project profitability and alternative investments for the selection of good investment projects
5. Develop entrepreneurs with substantial knowledge in engineering concepts.
6. Apply the knowledge of plant design and cost estimation in actual engineering problems.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3
CO2	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3
CO3	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3
CO4	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3
CO5	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3
CO6	-	-	-	-	-	2	-	-	1	-	3	-	-	1	3

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UBT715C	DOWNSTREAM PROCESSING TECHNOLOGY	Credits: 03
L:T:P – 2:2:0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	10 Hours
Introduction Role and importance of downstream processing in biotechnological processes. Range and characteristics of bioproducts. Purification process of bio-product. Cell disruption methods for intracellular products; physical, chemical and mechanical methods. Basic principles of distillation, crystallization, centrifugation, ultracentrifugation (preparative and analytical).Types of centrifuges and rotors, centrifugation-differential,density gradient (zonal and isopycnic).	
UNIT–II	**10 Hrs.**
Primary Recovery Operations Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.	
UNIT–III	**10 Hrs.**
Chromatography Principles of chromatographic seperations, Classification of chromatography- plain and column chromatography, Paper chromatography - Single dimensional (Ascending and Descending, radial and two dimensional) chromatography, partition coefficient, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.	
UNIT–IV	**10Hrs.**
Electrophoresis Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis,Cellulose Acetate, Starch Gel , Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry. **Downstream Processes:** Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.	

Reference Books *

1. B.Sivasankar, Bioseparations-2010 Principles and techniques Kindle edition,PHI Publishers,
2. Upadhay and Nath, 2010,Biophysical chemistry principles and Technques, Himalaya Publishing House, 3rd edition.
3. P.A., Cussier E. and Wei ,Shan Hu. 2008. Bioseparations - Downstream processing for biotechnology by Belter, Wiley Interscience Pub,
4. NPTEL Source material
5. Palanivelu, 2005 Lab manual for separation Techniques.

Course Outcomes**

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1. Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.

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2. Interpret and analyze the industrial fermentation processes.
3. Apply the knowledge in identifying various pharma and R&D sections.
4. Analyse the details of experimentation pertaining to chromatography and electrophoresis.
5. Understand analyse and apply the techniques in various tests involved in finding out purity of biological.
6. Apply the knowledge in identifying various biochemicals using advanced purifications like HPLC and to demonstrate DSP flow sheets.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**1**	**1**	**2**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO2	**2**	**-**	**2**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO3	**1**	**1**	**1**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**2**
CO4	**2**	**-**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO5	**2**	**1**	**1**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**2**
CO6	**1**	**-**	**1**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

UBT724E	FOOD PROCESSING TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavours, Browning reactions and its effects. Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods. Food additives, Vitamins, amino acids, Sweeteners, Food colours. Toxic-trace elements in food.	
UNIT–II	**11 Hrs.**
Detection of Microorganisms Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dyereduction, Roll Tubes, Direct Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. **Dairy products** Composition of milk,Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice, squash, wine, pickles and sauerkraut.	
UNIT–III	**12 Hrs.**
Food Spoilage Preservation The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds; Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods. **Food Preservation** Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. **Food Industry** Characteristics of Food Industry. Nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing, and promotional strategies, risks and benefits of food industry.	
UNIT–IV	**9 Hrs.**
Food Engineering Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management.	

Reference Books *

1. Sunetra Roady, 2007, Food Science & Nutrition, Oxford University Press.
2. William Frazier and Westhoff D.C, 2005,Food microbiology 4th Edn, TATA McGraw Hill Pub
3. James M.Jay, 2005.Modern Food Micro-Biology, CBS Publishers.
4. K. Vijay Ramesh, 2007, Food Microbiology by MJP Publishers.
5. Potter N.N. and Joseph Hotchkiss, 1996,.Food Science, 5 th Edn, CBS Pub,

Course Outcomes**

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1. Ability to understand about basic constituents of food
2. Ability to analyse the techniques involved in detection of microbes in food industry
3. Ability to have idea about Dairy , fruits and vegetable processed products and production
4. Ability to be aware of different food spoilage and preservation techniques
5. Ability to analyse the Characteristics of food industry and scope
6. Ability to comprehend the concepts in food Engineering used in preservation.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

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UBT722E	AQUACULTURE & MARINE BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Aquatic environment

Major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes, fish and other animals. Production & Nutrient dynamics in lakes, rivers, estuaries and wetlands. Eutrophication and water pollution: monitoring and control conservation and management of lakes, rivers and wetlands. Importance of coastal aquaculture- Design and construction of aqua farms, Criteria for selecting cultivable species. Culture systems – extensive, semi intensive and intensive culture practices

Aqua culture

Classification and Characteristics of Arthropoda. Crustacean characteristic key to important species of Prawns and Shrimps, General biology, of – Shrimp and Prawn, Finfish, Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton, zooplankton cultures, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

UNIT–II	10 Hrs.

Aquaculture engineering and techniques

Principles and criteria for site selection; multi-design, layout plan for prawn, shrimp and fish hatchery; design, lay-out plan and pond construction for grow- out production, design and construction of feed mill and installation of machineries. Chromosome manipulation in aquaculture - hybridization, ploidy induction, gynogenesis, androgenesis and sex reversal in commercially important fishes. Application of microbial biotechnology in culture ponds, bioaugmentation, bioremediation, nutrient cycling, and biofertilization.Probiotics – imunostimulants. Tools for disease diagnosis in cultivable organisms Enzyme immuno assays - Dot immunobinding assay - Western blotting - Latex agglutination test - Monoclonal antibodies - DNA based diagnosis. Cryopreservation techniques.

UNIT–III	10 Hrs.

Marine environment

Biological Oceanography: The division of the marine environment – benthing, pelagic, batuyal, littoral. Ocean waters as biological environment. Distribution and population of plants and animals. Marine ecology and fisheries potential. Effects of pollution on marine life. Geological and geophysical Oceanography: geophysical and geological processes. Ocean basin rocks and sediments.

Marine microbiology

Biology of micro-organisms used in genetic engineering *(Escherichia coil, Rhizobium sp., Agrobacterium tumefaciens, Saccharomyces cerevisiae, phage lambda, Nostoc, Spirulina, Aspergillus, Pencillium and Streptomyces).* Methods of studying the marine micro-organisms collection, enumeration, isolation, culture & identification based on morphological, physiological and biochemical characteristics. Preservation of marine microbes, culture collection centre (ATCC, IMTECH, etc.). Microbial nutrition and nitrogen fixation.Seafood microbiology - fish & human pathogens. Indicator of Pollution - faecai coliforms - Prevention &control.

UNIT–IV	10 Hrs.

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Marine biotechnology and pharmacology

Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Green house gases (CO_2 and Methane). Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial). Biological indicators and accumulators: Protein as biomarkers, Biosensors and biochips. Biodegradation and Bioremediation. Separation, purification and bioremoval of pollutants. Biofouling - Biofilm formation, Antifouling and Anti boring treatments. Corrosion Process and control of marine structures.

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Biosafety – special characteristics of marine environment that bear on biosafety. Ethical and moral issues - food health, and environmental safety concerns. Medicinal compounds from marine flora and fauna - marine toxins –antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds.

Reference Books *

1. Kirchman, D.L,. Microbial ecology of the oceans. Wiley – liss, New York, 542 pp,2005
2. Kenneth, C. Hingham and Leonard Hill, 1969. The comparative endocrinology of the invertebrates. Edward Arnold Ltd.
3. Farming the edge of the sea. Fishing News Ltd. London.
4. Finger man, M.. Recent advances in Marine Biotechnology. Vol. 4,2000
5. Kenneth, B.D., 2000. Environmental impacts of Aquaculture. CRC. pp. 214 ,2000

Course Outcomes**

1. Ability to understand the importance of coastal aquaculture.
2. Ability to know the different Culture systems.
3. To analyse the cryopreservation techniques.
4. To understand the Seafood microbiology.
5. To understand the applications of marine biology.
6. Ability to extract crude drugs and find the bioactive compounds.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

UBT723E	DAIRY BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Dairy Industry and Microbiology Overview of dairy industry, Characteristics of dairy Industry. Manufacturing & processing of dairy products, effect of processing on constituents and methods of evaluation of dairy products. Morphological and biochemical characteristics of important groups of milk microbes and their classification i.e.psychrotrophs, mesophiles, thermodurics, and thermophiles. Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk, Direct and indirect rapid technique for assessment of microbial quality of milk. Food infection, intoxication and toxic infection caused by milk borne pathogens. Microbiological changes in bulk refrigerated raw milk; Mastitis milk: organisms causing mastitis, detection of somatic cell count (SCC). Role of microorganisms in spoilage of milk Significance of antimicrobial substances naturally present in milk (responsible for its nutraceutical properties): immunoglobulin, lactoferin, Lysozymes	
UNIT–II	**10 Hrs.**
Dairy biotechnology Genetic engineering of bacteria and animals intended for dairy-based products: DNA cloning. protoplast fusion & cell culture methods for trait improvement with instances cited. Enzymes in dairy industry & production by whole cell immobilization. Biotechnology of dairy effluent treatment. Ethical issues relating to genetic modification of dairy microbes & milk-yielding animals. **Dairy engineering** Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, Description, working and maintenance of can washers, bottle washers. CIP cleaning and designing of system. Homogenization, Pasteurization, sterilization septic packaging and equipment. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine maintenance.	
UNIT–III	**10 Hrs.**
Dairy process engineering Evaporation: Basic principles of evaporators, Different types of evaporators used in dairy industry, Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture. Fluidization Mechanization and equipment used in manufacture of indigenous dairy products, Butter and Ghee making machine, Ice-cream and Cheese making equipments. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis in dairy processing, membrane construction & maintenance for electro-dialysis & ultra-filtration, Ultra filtration of milk, Effect of milk constituents on operation. **Dairy plant design and layout** Introduction of Dairy Plant design and layout. Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, selection of site for location. Dairy building planning, Process schedule, basis of dairy layout, General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design.	
UNIT–IV	**10 Hrs.**

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Quality and safety monitoring in dairy industry

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentations commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system National and international food regulatory standards; their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP): Rapid assessment of dairy food for microbial and non-microbial contaminants Quality of water and Quality of air & personnel hygiene.

By products technology

Status, availability and utilization of dairy by-products in India and abroad, associated economic and pollution problems. Physico-chemical characteristics of whey, butter milk and ghee residue, by-products from skim milk such as Casein; Whey processing & utilization of products generated from whey.

Reference Books *

1. Diary Science & Technology Handbook (Vols. 1-3). Ed by Hui, Y.H, Wiley Publishers,2007
2. Handbook of Farm, Dairy & Food Machinery - Myer Kutz- Andrew Publishers,2005
3. Diary Microbiology Handbook (3rd Ed). Robinson, R.K., Wiley Publishers,2001
4. Comprehensive Biotechnology (Vol. 6) Ed N.C Gautam- Shree Pblns,2002.
5. General Microbiology (Vol. 2) – Powar & Daginawala- Himalaya Publishers,2005
6. Milk composition, production & biotechnology (Biotechnology in Agriculture Series). CABI Publishers,2005

Course Outcomes**

1. Able to manufacture & processing of dairy products.
2. Ability to know the ethical issues in dairy.
3. Ability to understand principles of evaporators.
4. Ability to plan the Plant design and layout.
5. will be aware of quality and safety of dairy foods.
6. Ability to know the regulatory standards.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

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UBT725E	PROTEIN ENGINEERING AND DRUG DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Structure of proteins

Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, and protein-ligand interactions.

Protein structure prediction

Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.

Protein engineering and design

Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

UNIT–II	10 Hrs.

Molecular modeling

Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.

UNIT–III	10 Hrs.

Insilico drug design

Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.

Computer assisted new lead design

Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.

UNIT–IV	10 Hrs.

Docking methods

Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.

Computer - assisted drug discovery

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery

Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

Reference Books *

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI,4th Edition, 2013
2. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition,2010.
3. Creighton T.E. Proteins, Freeman W.H. Second Edn,1993.
4. Branden C. and Tooze R. Introduction of protein structure, Garland,1993.
5. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.

Course Outcomes**

1. Ability to study protein structure prediction and protein engineering and design
2. Able to understand molecular modeling
3. Able to know computer assisted new lead design
4. Able to study docking methods and computer - assisted drug discovery

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-

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UBT731E	NANOBIOTECHNOLOGY AND BIOMATERIALS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to nanotechnology:
A Brief History of the Nano particles : Bottom-Up versus Top-Down; What Is Nanobiotechnology.Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy(SEM,STM & AFM), biomolecule-surface interactions, quantum dots,
Applications of nanotechnology in the life sciences:
Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.

UNIT–II	10 Hrs.

Biopolymers:
Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli,sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.

UNIT–III	10 Hrs.

Synthetic polymers:
Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.

UNIT–IV	10 Hrs.

Biocompatibility:
Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods.
Medical devices:
Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.

Reference Books *

1. B.Vishwanath (2011). " Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delh.
2. Mark Ratner and Daniel Ratner (2003). "Nanotechnology:A Gentle Introduction to Next Gig Idea" Pearson Ecducation Ltd.
3. K Eric Drexler (1993). "Unbounding the future" Quill.
4. Stephen Lee and Lynn M Savage (2010). "Biological molecules in Nanotechnology".

Course Outcomes**

After completion of the course student will have the

1. Ability to explain the characterization techniques of nanotechnology.
2. Ability to understand the importance of nano-particles in drug delivery system.
3. Ability to understand the importance of biopolymers.
4. Ability to differentiate biopolymer and synthetic polymer.
5. Ability to understand the importance of biocompatibility.
6. Ability to apply the methods to test the implants and use in medical devices.

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*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	3	-	-	1	2	-	-	-	-	-	2	2	1
CO2	1	2	3	-	-	1	-	-	-	-	-	-	3	-	-
CO3	2	2	3	-	-	2	-	-	-	-	-	-	2	2	1
CO4	3	3	3	-	-	2	-	-	-	-	-	-	2	1	1
CO5	3	3	3	-	-	1	-	-	-	-	-	1	2	-	-
CO6	2	3	3	-		3	3	-	-	-		-	3	1	-

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UBT732E	COMPUTATIONAL BIOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction to computational biology and sequence analysis

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT–II	10 Hrs.

Phylogenetics

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

Protein structure, modelling and simulations

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

UNIT–III	10 Hrs.

Machine learning, systems biology and other advanced topics

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction toSystems Biology and its applications in whole cell modeling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

UNIT–IV	10 Hrs.

Perl for bioinformatics

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Laboratory Demonstrations for

Biological Databases, Sequence alignment: BLAST family of programs, FASTA, Clustal W for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Auto Dock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.

Reference Books *

1. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
2. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
3. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
4. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
5. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic
6. Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.

Course Outcomes**

1. Ability to know the sequence analysis.

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2. Ability to understand and analyze the multiple sequence alignment and applications.
3. Ability to understand the phylogenetics.
4. Ability to analyze the molecular dynamics simulations.
5. Ability to understand perl bioinformatics.
6. Ability to differentiate prokaryote and eukaryote gene finding software.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	-	2	-	1	1	2	-	-	-	-	1	2	1	-
CO2	1	-	2	-	-	2	2	-	-	-	-	1	2	1	-
CO3	-	-	1	1	2	-	-	-	-	-	-	1	1	1	-
CO4	2	-	2	-	-	1	2	-	-	-	-	1	-	1	-
CO5	-	-	1	2	2	-	-	-	-	-	-	1		1	-
CO6	1	-	1	-	-	2	2	-	-	-	-	2	2	1	-

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UBT733E	BIOCONJUGATIVE TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Bioconjugative technology

Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides.

UNIT–II	10 Hrs.

Chemistry of active groups

Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

Bioconjugate reagents

Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes.

UNIT–III	10 Hrs.

Enzyme and nucleic acid modification and conjugation

Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.

UNIT–IV	10 Hrs.

Bioconjugate applications

Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives- Colloidal – gold-labeled proteins – modification with synthetic polymers.

Reference Books *

1. Bioconjugate Techniques, G.T. Hermanson, Academic Press, 2 nd edition 2008
2. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2016
3. A Text book of biophysics by Dr R.N. Roy,UBS publishers, 2001
4. Bioconjugative Chemistry by Vincent M Rotello, American Chemical society, 2016
5. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2017

Course Outcomes**

1. Able to understand modification of nucleic acids and oligonucleotides.
2. Ability to know the chemistry of active groups.
3. To analyse the bioconjugate reactants.
4. To analyze bioconjugate applications.
5. Ability to know the conjugate derivatives.
6. Ability tostudy the conjugation process.

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	1	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	-	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	-	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	1	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	1	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

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UBT734E	FOOD BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.

Novel bioprocessing

Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.

Nutrigenomics

Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.

UNIT–II	10 Hrs.

Microbial biotechnology of food

Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of neutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.

UNIT–III	10 Hrs.

Plant food applications

Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for neutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.

UNIT–IV	10 Hrs.

Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study.

Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends.

Food safety: international aspects of the quality and safety, genetically modified food controversies. Regulation of the release of genetic modified organisms,patenting inventions in food biotechnology.

Reference Books *

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1. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- “ Food Biotechnology”- second edition, CRC press, 2006
2. Gustavo F.G and Gustavo V.B,-“ Food Science and Food Biotechnology”- CRC press, 2003
3. Mahesh S.-“ Plant Molecular Biotechnology”- first edition, New age international publishers, , 2008
4. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007

Course Outcomes**

1. Students will be able to know the importance and current status of food biotechnology
2. Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
3. Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
4. Will be able to learn about plant food biotechnology and transplastomic technology
5. Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation
6. Able to have an overview recent trends in GMOs and food biotechnology

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

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UBT716H	INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

Development of management thoughts and its functions

Concept & definition of Management, Social Responsibilities of Management, and Pioneers in Management: Contributions of Taylor, Henry Taylor, Gilberth& Mayo, Schools of Management thought: Management process school, Empirical School, Human Behavior School, Social system school, Systems approach school and decision theory school. Selection of site for the plant and plant layout, plant operation and control, utilities, structural design, storage, material handling, Sources of capital. Definition and functions of administration. Planning, organizing, staffing, directing and controlling. Concept of authority and responsibility.

UNIT–II	10 Hrs.

Quantitative techniques in managerial decisions

Concept of productivity, measuring productivity, concept of budget, effective budgetary control, ABC analysis, break even analysis, product life cycle, promotion of sales, pricing, "EOQ"model. Production costs (including raw materials, and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges (including depreciation, taxes, insurance, rental costs etc.).

UNIT–III	10 Hrs.

Production And Material Management

Types of production, types of planning, manufacturing planning, factory planning, production planning, method study, systems of wage payments, bonus, automation, organization of production, planning. Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management.

UNIT–IV	10 Hrs.

Entrepreneurship& personnel management

Meaning of entrepreneur, evaluation of the concept, function of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship- its barriers. Recruitment and selection. Training of personnel. Employer - Employee relationship. Settlement of disputes.

Reference Books *

1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons, 1992.
2. T. R. Banga & S. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003.
3. C.B.Mamoria and S.V.Gankar- Personnel Management, Himalaya Pub, 21 st edn,2010
4. Veerabhadra Havinal -Management and Entrepreneurship- New Age International, 2009
5. Ramesh Burbure – Management &Entrepreneurship- Rohan Pub. 2008
6. Poornima M. Charanthimath – Entrepreneurship Development, Pearson Education-2005

Course Outcomes**

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After completion of the course student will be able to

1. Recall and recollect the history theories and definition of management and its importance in society
2. Analyze and apply the basic concepts of Quantitative techniques of management
3. Know the difference between production and productivity, measurement and cost analysis
4. Explore the knowledge of production costs, planning and material management
5. Make basic economic analysis of project
6. Understand the role and importance of entrepreneurship in economic development

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-	-	-	-	1	-	-	-	3	1	-	-	2
CO2	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO3	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO4	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO5	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO6	-	1	-	-	-	-	-	-	2	-	3	1	-	-	2

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UBT733N	INDUSTRIAL SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Industrial safety: Need for safety, importance of occupational health and safety, Health and safety programs, unsafe conditions, factors contributing to unsafe conditions, Good Lab Practices (GLP). **Accidents:** Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention- Engineering, Education, Enthusiasm, Enforcement and Evaluation. Hierarchy of Controls, Safety policy. **Chemical Hazards:** Types of hazards, Classification of chemicals based on their nature, routes to exposure of chemicals, Health effects of harmful chemicals in the work environment, Control of chemical hazards.	
UNIT–II	**10 Hrs.**
Electrical Hazards and Control measures: Electrical hazards, protection against voltage fluctuations, effects of shock on human body. Fire- Fire formation, Fire extinguishing agents. Evacuation procedures for workers during emergency conditions. **Physical Hazards and Control measures:** Noise, noise exposure regulation, properties of sound, Workers exposure to electromagnetic field, Ionizing radiation and non-ionizing radiations, effects of radiations, Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines.	
UNIT–III	**10 Hrs.**
Biological and Construction Hazards and their control measures: Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases –Hazardous material used in labs, Instructions followed for hazardous waste disposal, Biohazard control program, Biological safety cabinets. **Construction Hazards:** Hazards in construction and safety measures, Good Manufacturing Practices (GMP).	
UNIT–IV	**10 Hrs.**
Occupational Health and Toxicology: Classification of Occupational hazards, occupational related diseases- silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene. Various types of Company policies.	
Reference Books *	
1. Mark Friend and James Kohn, (2007), Fundamentals of Occupational Safety and Health The Scarecrow Press, Inc. 2. Phil Hughes and Ed Ferret, (2011), Introduction to Health and Safety at work, (5th edition), Elsevier Ltd.	
Course Outcomes**	

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After completion of the course student will be able to

1. Apply the basic knowledge of Industrial hazards and safety.
2. Interpret & analyze the various types of accidents and chemical hazards.
3. Identify physical hazards and apply control measures in work place.

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4. Acquire knowledge of electrical hazards and apply control measures in work place.
5. Identify various types of biological hazards and apply control measures.
6. Identify control measures and apply the knowledge in industrial toxicology and hygiene, occupational diseases in work place.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**
CO2	**-**	**1**	**1**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**
CO3	**-**	**1**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**
CO4	**-**	**1**	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**
CO5	**-**	**1**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**
CO6	**-**	**1**	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**

UBT710L	BIOSEPARATION TECHNIQUES LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN BIOSEPARATION TECHNIQUES LABORATORY

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration (Cross flow)
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Membrane dialysis
6. Product enrichment operations: Precipitation – (NH4)2 SO4 fractionation of a protein.
7. Product enrichment operations: Two – phase aqueous extraction.
8. Product drying techniques.
9. Estimation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

Reference Books *

1. Scopes R.K., 1993. Protein Purification IRL Press
2. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
3. Palanivelu. P, 2001, Analytical Biochemistry and Seperation Techniques, Kalaimani Publishers.

Course Outcomes**

After completion of the course student will be able to

1. Prepare/reproduce the protocols for the experiments.
2. Extract the intracellular product using different cell disruption techniques.
3. Concentrate, purify the desired product using different chromatography/filtration techniques.
4. Analyze the product both quantitative/qualitatively.
5. Record/observe the experimental data and interpret them in the graph/table.
6. Calculate the result and to write the conclusion at the end of the experiment.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1	-	3	-	-	-	-	-	-	1	1	1	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	1
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	3	1
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	2	1
CO5	-	-	-	3	3	-	-	-	-	-	-	-	2	2	1
CO6	-	3	-	-	-	-	-	-	-	-	-	2	2	3	1

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UBT717L	FOOD ANALYSIS TECHNIQUES LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN FOOD ANALYSIS TECHNIQUES LABORATORY

1. Proximate analysis of foods
2. Nutritional profiling of food samples for labeling (Carbohydrates, protein and fat)
3. Nutritional profiling of food samples for labeling (Vitamins and minerals)
4. Determination of calories in foods.
5. Determination of viscosity and texture of food sample
6. Detection of microbial load in processed food a sample
7. Extraction and detection of active ingredients in foods
8. Extraction of chitin, chitosan and glucosamine from prawn shells/mushrooms
9. Detection of Antioxidant property of Nutraceuticals
10. Sensory evaluation
11. Visit to NABL lab

Reference Books *

1. Food analyses by S Suzanne Nielsen, Fourth edition, Springer publisher, 2010
2. Food Regulation: Law, Science, Policy and Practice, N.D. Fortin, Wiley Publication, 2nd Edition, 2016
3. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury Professional India, 1st Edition, 2016.
4. Food Safety and Standards Act and Regulations, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2006

Course Outcomes**

After completion of the course student will be able to

1. Analyze different food samples for quality.
2. Evaluate food samples for quality.
3. Evaluate food samples for chemical and microbial safety.
4. Analyze the data for the acceptability of food sample

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	1	-	3	-	-	-	-	-	-	1	1	1	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	1
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	3	1
CO4	-	-	3	-	-	-	-	-	-	-	-	-	2	2	1

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SCHEME OF TEACHING AND EXAMINATION
III SEMESTER

2022-23 Batch

Sl. No	Category	Subject Code	Subject Title	Credits	HOURS/ WEEK			EXAMINATION MARKS		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA302C	Numerical Techniques and Fourier Series	03	3	0	0	50	50	100
2.	IPCC	22UBT301C	Microbiology	04	3	0	2	50	50	100
3.	IPCC	22UBT305C	Unit Operations	04	3	0	2	50	50	100
4.	PCC	22UBT303C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT307L	Biochemistry lab	01	0	0	2	50	50	100
6.	INT	22UBT308I	Internship	02	0	0	2	100	-	100
7.	UHV	22UHS324C	Universal Human Values –II	01	2	0	0	50	50	100
8.	HSMC	22UHS322C 22UHS323C	Samskruthika Kannada- Balake Kannada	01	2	0	0	50	50	100
9.	AEC	22UBT306C	Cell Culture Techniques	02	2	0	0	50	50	100
			Total	**21**	**17**	**2**	**8**	**500**	**400**	**900**

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22UMA302C	NUMERICAL TECHNIQUES AND FOURIER SERIES	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	10 Hrs.

Numerical Methods-I:

Introduction to root finding problems, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof) Numerical differentiation using Newton's forward and backward formulae-problems.

UNIT – 2	10 Hrs.

Numerical Methods -II:

Numerical Integration: Simpson's one third rule, Simpson's three eighth rule waddles' (no derivation of any formulae)-problems. Numerical solution of ODE: Taylors, Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method, miles Predictor corrector method.

UNIT – 3	10 Hrs.

Fourier series:

Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.

UNIT – 4	10 Hrs.

Fourier transforms:

Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms. Inverse Fourier sine and cosine transforms.

REFERENCES

1. Numerical Methods for Engineers by Steven C Chapra &Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi
4. Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons.

LEARNING OBJECTIVES

1. To understand the numerical methods of solving algebraic and transcendental equations.
2. To acquire the knowledge of interpolation techniques.
3. To understand the basic concepts of numerical differentiation, numerical integration and numerical solution of ordinary differential equations.
4. To understand concepts of Fourier series, and Fourier transforms.

COURSE OUTCOMES
After completion of the course the students shall be able to, 1. Solve engineering problems using non-linear equations and interpolation techniques. 2. Solve problems using numerical differentiation and numerical integration. 3. Solve ordinary differential equations using numerical methods. 4. Solve Problems using the Fourier series. 5. Solve problems using the basic concept of Fourier transforms.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

No	Programme Outcomes / Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
The students will be able to:																
1	Solve engineering problems using non-linear equations and interpolation techniques.	✓	✓													
2	Solve problems using numerical differentiation and numerical integration.	✓	✓													
3	Solve ordinary differential equations using numerical methods.	✓	✓													
4	Solve Problems using the Fourier series.	✓	✓													

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5	Solve problems using the basic concept of Fourier transforms.	✓	✓													

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22UBT301C	MICROBIOLOGY	Credits: 04 (3: 0: 2)
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:

Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).

UNIT–II	10Hrs.

Microorganisms:

Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid & alcohol).

UNIT–III	10 Hrs.

Control of Microorganisms:

Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. Medical Microbiology: Normal microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention.

UNIT–IV	10 Hrs.

Agricultural and Environmental Microbiology:

Microbiology of soil, Air and Aquatic Microbiology, Bio-fertilizer, Plant endophytes, Microbes in bioremediation and bio-control agents.

Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).

REFERENCE BOOKS

1. Pelczar, Chan and Noel Kreig, “Microbiology”- 5th Edition Tata Macgraw Hill, 2010.
2. Tortora, Funke and Case, “Microbiology an Introduction” -8th Edition, Pearson Education, 2006.
3. Stainer R.Y., Ingraham J.L., “General Microbiology”- 5th Edition Mc.Millan Press, 2010.
4. Madigan, Martinko, Parker, Brock’s, “Biology of Microorganisms” - 10th Edition, Prentice Hall, Pearson Education, 2003.
5. Prescot and Dunn, “Industrial Microbiology”-Agribios India, 2002.
6. J. Salle, “Fundamental Principles of Bacteriology” – 7th Edition, Tata Macgraw Hill, 2007.
7. E Alcamo I “Fundamentals of Microbiology”6th Ed, Jones &Bartlet, Pub. 2001.
8. Prescott, Harley & Klein, “Microbiology” -7th Edition, WCB/McGraw Hill, Int. Edition, 2008.

LEARNING OBJECTIVES

- To know the basic concepts of Microbiology, scope and organization of organisms in the taxonomy.
- Ability to understand the techniques to study microorganisms through microscopy.
- Capable to analyse the structure of different microbes and their applications.
- To know the metabolic reactions within the organisms for fermentation process.

COURSE OUTCOMES**

- Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
- Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
- Ability to discuss the causative organisms of the disease and their effect on society
- Ability to analyse the applied techniques in the environment and create awareness to society

LIST OF EXPERIMENTS

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Enumeration of microorganisms using colony counter
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria & Observation of motility by hanging drop technique.

COURSE OUTCOMES

1. Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Ability to discuss the causative organisms of the disease and their effect on society
4. Ability to analyse the applied techniques in the environment and create awareness to society

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2			2		2					1	1	1
CO 2	2	2	2		2	3		1					2	1	2
CO 3	3	3	2		2	2		1				1	1	1	2
CO 4	3	3	3		2	3		2				1	2	1	3

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22UBT305C	UNIT OPERATIONS	Credits: 04
L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Fluid Mechanics:

Units and Dimensions, Basic and Derived units, Dimensional homogeneity, Dimensionless numbers, Rayleigh method, Buckingham's pi theorem, Similitude. Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); Rheological behaviour of fluids. Fluid statics and its applications Hydrostatic equilibrium, Pressure measurement - Manometers.

UNIT–II	10 Hrs.

Flow past Immersed Bodies:

Types of flow - laminar and Turbulent; Reynolds number; Basic equations of fluid flow - Continuity equation and Bernoulli equation; Correction for Bernoulli's equation, Pump work in Bernoulli's equation; Flow through circular and non-circular conduits – Friction factor relations for smooth and commercial pipes.

UNIT–III	10 Hrs.

Flow measurements:

Orifice meter, Venturimeter, Rota meter. Pumps, principle, construction numerical. Major and minor losses, Centrifugal & Reciprocating pumps, Characteristics of centrifugal pumps. Pipes, fittings and valves. Dimensional Analysis.

UNIT–IV	10 Hrs.

Mechanical Operations:

Types of filtration, Filter media and filter aids, calculation of resistances and rate of filtration, filtration equipment. Settling, Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Agitation: Theory of mixing, Power number calculations, mixing equipment. Flow patterns in agitated tanks, mechanism of mixing, scale up of mixing systems. Size Separation: Particle shape, size, screen analysis, screening equipment. Size Reduction: Characteristics of comminute products, crushing laws and work index; Size reduction equipment.

LIST OF EXPERIMENTS IN UNIT OPERATIONS LABORATORY

1. Friction in circular and non-circular pipes
2. Flow rate measurement using Orifice meter

3. Flow rate measurement using Venture meter
4. Batch sedimentation test
5. Constant pressure /constant filtration using leaf filter
6. Verification of Stoke's law in Free / Hindered settling
7. Determination of screen effectiveness and sieve analysis
8. Verification of Bernoulli's theorem
9. Unsteady state flow
10. Study of packed bed characteristics
11. Distillation

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2012) Unit Operations I & II, 22nd Edn. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
5. R.P. Chhabra Basavaraj Gurappa (2019) Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA.

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of dimensional analysis and can state and describe the nature and properties of the fluids.
2. Apply the knowledge of fluid mechanics in Engineering applications
3. Determine the flow rate, discharge of transportation fluids
4. Apply the knowledge of mechanical operations in Engineering applications

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

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Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	1	-	-	-	-	-	-	-	3		
CO2	3	2	3	2	1	-	-	-	-	-	-	-	3		
CO3	3	2	1	1	1	-	-	-	-	-	-	-	3		
CO4	2	3	3	1	1	-	-	-	-	-	-	-	2		

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22UBT303C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 42		SEE Marks: 50

UNIT – 1	12 Hrs.
Principles of Bioenergetics: Energy Flow cycle, energy conversion. Structure and properties of ATP, Bioenergetics of metabolic pathway **Carbohydrate Metabolism:** Glycolysis, TCA cycle, Electron transport chain and oxidative phosphorylation and respiration energetics. Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway, Gluconeogenesis and regulation of gluconeogenesis. Disorders of carbohydrate metabolism- Galactosemia, Lactose intolerance, Glycogen storage disorder etc. (Defective enzyme lead to disorder during metabolism). Osazone formation to identify the carbohydrates.	
UNIT – 2	**10 Hrs.**
Lipid Metabolism: Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids, Regulation of fatty acid biosynthesis, biodegradation of fatty acid, ketone bodies production during starving and diabetes. Disorders of lipid metabolism- Sphingolipidoses etc.	
UNIT – 3	**10 Hrs.**
Nucleic acid Metabolism: Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP.De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines&pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways.Disorders of nucleic acid metabolism-Lesch-Nyhan Syndrome and Gout	
UNIT – 4	**10 Hrs.**
Amino Acid Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family)-Aspartate, Asparagine, Methionine, Lysine, Threonine.Biodegradation of amino acids-deamination, transamination and urea cycle.Disorders of amino acid metabolism-Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia.	

REFERENCES
1. David L. Nelson and Michael Cox, “Lehninger Principles of Biochemistry” –6th Edition LubertStryer, “Biochemistry” -Freeman & Co., Pub, 2010. 2. Voet&Voet, “Biochemistry”- 3rd Edition, John Wiley,New York Pub., 2004. 3. Thomas M. Davlins“ Biochemistry with clinical correlations” Wiley-Liss; 5 edition, 2001. 4. Mathews, Vanholde&Arhen “Biochemistry” -3rd Edition, Pearson Education Pub., 3 edition 2010. 5. K. Trehan, “Biochemistry” -New Age International Pub, 2nd edition, 2003 6. Elliot & William H, “Biochemistry & Molecular Biology” Oxford Pub., 2005. 7. Helmreich JEM, “Biochemistry of cell signaling” –Oxford Pub. 2005. 8. U. Sathyanarayana, “Biochemistry” -Books and Allied Pub, 2007 9. Berg J.M., Stryer, Tymoczko J.L. “Biochemistry” Freeman & co 2010. 10. Freifelder D. “Molecular Biology” -Narosa Publications, 2nd Edition 2003.
LEARNING OBJECTIVES
• To understand the principles of bioenergetics. • To study metabolic pathway reactions and analysis of metabolic disorders. • To study the experimental identification of biomolecules.
LIST OF EXPERIMENTS
COURSE OUTCOMES
1. Ability to understand the principles of high energy compounds & interpret the metabolic pathways in the carbohydrates and their disorders 2. Ability to recognize the regulation of lipid metabolism along with the in born errors. 3. Ability to understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism disorders 4. Ability to comprehend pathways involved in amino acid metabolism and its disorders

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	
CO 2	2	3	3	3		3	2	3				3	2	1	2
CO 3	2	2	3	3		3	2	2				3	3	2	
CO 4	2	2	2	2		2	2	2				2	2	2	

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SUBJECT CODE:22UBT307L	BIOCHEMISTRY LABORATORY	Credits: 02
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 42		SEE Marks: 50

LIST OF EXPERIMENTS

12 Hrs.

1. pH measurements, volume / weight measurements, concentration units, Specificity, precision, Accuracy.
2. Classes of carbohydrates, lipids and proteins.
3. Reagent preparation and preparation of buffers of constant strength.
4. Qualitative tests for carbohydrate and lipids.
5. Qualitative tests for amino acids and proteins.
6. Estimation of sugar by Folin and O-toluene method.
7. Estimation of amino acid and protein by ninhydrin method
8. Determination of Saponification value of lipids.
9. Determination of Iodine value of lipid.
10. Determination of acetyl value of a lipid.
11. Estimation of urea by diacetylmonooxime method.

REFERENCES

1. Rodney Boyer, “Modern Experimental Biochemistry”-Pearson Education Pub, (2000).
2. Keith Wilson, “Practical Biochemistry” Cambridge University Pub, (2003).
3. Pattabhiraman, “Practical Biochemistry”
4. BeeduSashidharRao and Vijay Deshpande, “Experimental Biochemistry” -I.K.Intl
5. Plummer D. T “Practical Biochemistry” -TMH Pub., 1988

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to understand the basic aspects of standard reagent & buffer preparations.
2. Ability to identify various biomolecules qualitatively.
3. Ability to estimate the concentration of carbohydrates in a given sample
4. Ability to evaluate the concentration of amino acid quantitatively.
5. Ability to analyze the types of lipids.
6. Ability to apply knowledge of acid & iodine value to determine the quality of lipids.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	1
CO 2	2	3	3	2			2	3				3	2	3	1
CO 3	2	3	3	3		3	2	2				2	2	1	2
CO 4	3	3	3	2		2	2	2				2	3	1	1
CO 5	2	2	2	2		1	2	2				3	3	2	1
CO 6	2	2	3	3		3		3				2	3	2	1

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SUBJECT CODE:22UBT306C	CELL CULTURE TECHNIQUES	Credits: 02
L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 26		SEE Marks: 50

UNIT – 1	8 Hrs.

Plant cell culture:

History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture.Cellular totipotency, cytodifferentition, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichometry of cell growth and product formation.

UNIT – 2	6 Hrs.

Culture techniques and applications:

Protoplast culture, somatic hybridization, haploid production, micro propagation,somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.

UNIT – 3	6 Hrs.

Animal cell culture Techniques

History and development of mammalian cell culture. lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.

UNIT – 4	6 Hrs.

Cell line Characterization and Maintenance

Measurement of Cell viability and Cytotoxicity assay –MTT, LDH dehydrogenase, . Dye exclusion and inclusion tests, clonogenic assay. Characterization. Cell line contaminations, detection and control. Stem cells & their applications

REFERENCES

1. Culture of Animal cells-3rdEdition-R.IanFreshney.Wiley Less, 2010
2. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010
3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers,2010.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers,2002

LEARNING OBJECTIVES

1. To use the plant cells to produce in vitro cultures
2. To comprehend the applications of plant tissue culture techniques in various fields
3. To acquire working knowledge of culture of animal cells in *in vitro* conditions.
4. To identify, describe and classify the contaminants of cell culture and preservation techniques

COURSE OUTCOMES
1. To use the plant cells to produce in vitro cultures 2. To comprehend the applications of plant tissue culture techniques in various fields 3. To acquire working knowledge of culture of animal cells in *in vitro* conditions. 4. To identify, and classify the cell culture techniques

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3												1	1	1
CO 2	1				3									2	2
CO 3	1				3			1			1		3	3	
CO 4	3				3									3	

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V-Semester-2022-23

Sl No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	22UBT516C	Bioprocess & Reaction Engineering	3	3	0	0	50	50	100
2	22UBT519C	Genetic Engineering & Applications	3	3	0	0	50	50	100
3	22UBT520C	Fundamentals of Bioinformatics	3	2	2	0	50	50	100
4	22UBT52XE	Elective-I	3	3	0	0	50	50	100
5	22UBT506H	Industrial Safety and Bioethics	3	3	0	0	50	50	100
6	22UBT514L	Bioinformatics Lab	1	0	0	2	50	50	100
7	22UBT515L	Genetic Engineering Lab	1	0	0	2	50	50	100
8	22UCS559L	Advanced C Programming Lab	2	0	0	2	50	50	100
9	22UHS002N	Advance Quantitative Aptitude and Soft Skills	1	2	0	0	50	50	100
10	22UXX5XXN	Open Elective-I	3	3	0	0	50	50	100
		Total	**23**	**19**	**2**	**6**	**500**	**500**	**1000**

Elective-I

UBT521E: Environmental BT

UBT522E: Biomedical Instrumentation

UBT525E: Stem cell technology

UBT527E: Nutraceuticals

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Subject Code: 22UBT516C	BIOPROCESS & REACTION ENGINEERING	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Kinetics of Homogeneous reactions

Basic Concepts of Bioreactor and bioprocess engineering, Concentration dependent term of a rate equation. Rate Constant. Representation of elementary reaction and Non elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.

UNIT–II	10Hrs.

Interpretation of Batch Bioreactor Data

Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalyzed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data and numerical.

UNIT–III	10 Hrs.

Introduction to Reaction Design

Introduction. Factors to be consider for designing a reactor, Types of reactors, Basic design equation, relation between Concentration and conversion, Performance equation for ideal batch reactor, MFR/CSTR and PFR, space time and space velocity for flow reactors, design of flow reactors and numerical.

UNIT–IV	10 Hrs.

Design for single reactions

Introduction .Size comparison of single reactors, multiple reactors CSTR in series /MFR in series, CSTR in parallel .PFR in series, in parallel, Reactors of different types in series, and numerical.

REFERENCE BOOKS

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3nd edn., Prentice Hall PTR.
4. BaileyJE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
5. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
6. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
7. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

LEARNING OBJECTIVES

1	To Understand the basic concept of reaction engineering
2	To calculate the order and rate of reaction
3	To categorize the batch reactor data for different reactions
4	To decide the suitable bioreactor for different reactor
5	To Demonstrate the RTD to calculate the conversion
6	To Evaluate the bioreactor for various purposes

COURSE OUTCOMES

1. Understand the basic concept of reaction engineering.
2. Predict the order and rate of the different reactions.
3. Analyze the batch bioreactor data for different reactions.
4. Design the suitable bioreactor for different biochemical reactions.
5. Predict the residence time distribution to determine the conversion in non ideal flow reactors
6. Analyze bioreactors for various cell cultures.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	2							1	2		
CO 2	3	2	2	2	1							1	2		
CO 3	2	3	2	1	2							1	2		
CO 4	2	3	3	2	1							1	2		
CO 5	3	1	2	1	2							1	2		
CO 6	2	2	2	2	1							1	2		

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Subject Code:22UBT519C	GENETIC ENGINEERING & APPLICATIONS	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction
Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambda vectors.
Enzymes in genetic engineering:
Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase

UNIT–II	10Hrs.

Nucleic acid hybridization and amplification
Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.
Construction of cDNA libraries:
Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.

UNIT–III	10 Hrs.

Gene transfer techniques
Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.
Transgenic science and genetic improvement:
Transgenic science in plant improvement, Antisense RNA technology (Flavr savr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes(*Bacillus thuringiensis* and its mode of action), Cry proteins – mechanism of action.

UNIT–IV	10 Hrs.

Gene therapy
Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.
Applications:
Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.

REFERENCE BOOKS

1. Molecular Biotechnology, Principles and applications of Recombinant DNA by Bernard R Glick and Jack J Pasternak, second edition, CBS Publishers, 2012.
2. Recombinant DNA by Watson, et al., second edition, Freeman Publishers 2010.
3. Principles of gene manipulation, Primrose S.B., Blackwell Scientific Publications, 2010.

4. From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers, 2010.
5. Biotechnology Expanding Horizon, B.D.Singh, 3rd revised edition, Kalyani Publishers,2010
6. NPTEL Source material

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Emphasize on the basic aspects of genetic engineering; the key areas and apply the knowledge in vectors used in genetic engineering experiments.
2. Apply the properties of various enzymes and vectors in gene and genome manipulation.
3. Acquire working knowledge on the mechanism of methods of nucleic acid detection, hybridization and amplification and their applications in the research.
4. Acquire working knowledge on the construction of genomic and cDNA libraries their applications in the research and biology of *Bacillus thuringiensis*.
5. Identify the various gene transfer techniques in plants, animals and microbes that are essential for controlled protein production in the industry and acquire knowledge on various strategies of Gene therapy and its application in therapeutics.
6. Identify and apply the current applications and advances of biotechnology and describe the steps involved in the production of biopharmaceuticals in microbial systems and industrial utilization.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	1	1	2						1		2	1	2	3
CO 2	1			2	3							2	1	2	3
CO 3		1		2								2	1	2	1
CO 4		1		2								2	1	2	1
CO 5		1	1	2	3	3		3				2	1	2	1
CO 6		1	1	2	3	2	2	3				2	1	2	1

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Subject Code:22UBT520C	FUNDAMENTALS OF BIOINFORMATICS	Credits: (2: 2: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	12 Hrs.

Introduction to Bioinformatics and Biological Database

Introduction to bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG;ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases

UNIT–II	10 Hrs.

Sequence alignment and database searches:

Introduction, Types of sequence alignment, Comparison between global and local alignment, Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions;Word/k-tuple method- BLAST, FASTA.

Multiple Sequence Alignment:Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles.

Tutorials: Solving problems on pairwise sequence alignment

UNIT–III	10 Hrs.

Phylogenetic analysis and predictive methods using sequences

Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees,Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares.

Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan).Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling.

Tutorials: Practices on prediction of phylogenetic trees

UNIT–IV	10 Hrs.
Plasmid mapping and primer designing &molecular modelling techniques Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties,Dockingsoftwares (AUTODOCK, HEX) Tutorials: Solving problems related to Restriction mapping and Primer designing	
Reference Books *	
1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition,2006. 2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000. 3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006. 4. Computational methods for macromolecular sequence analysis – R F Doolittle. Academic Press, 1996.	
Course Outcomes**	
After completion of the course student will be able to 1. Importance of databases involved in bioinformatics along with their file formats 2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences 3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis 4. Explain various statistical tools involved in predicting the structure of genes and proteins 5. The principle behind restriction mapping and primer designing 6. Different approaches involved in silico drug design	

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2

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CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

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Subject Code:UBT527E	NUTRACEUTICALS	3 Credits: (3-0-0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Nutraceutical and dietetics

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

UNIT–II	10Hrs.

Nutrition related diseases and disorders

Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management.Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress.Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.

UNIT–III	10 Hrs.

Nutraceuticals of microbial, plant and animal origin

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health.Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides

UNIT–IV	10 Hrs.

Biotechnology in Phytonutraceuticals

Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties.Golden rice, GM Tomatoes

REFERENCE BOOKS

6. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA.
7. L. Rapport and B. Lockwood,Nutraceuticals, Pharmaceutical Press.,2nd Edition,2002.
8. M. Maffei ,Dietary Supplements of Plant Origin, Taylor & Francis,1 st Edition,2003.

9. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society,1 st Edition, 2004.
10. Richard Neeser& J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
11. TimothtS. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. To be aware of basic concepts of nutraceuticals and nutrition.
2. To have a general idea of scope of nutraceuticals and functional foods.
3. To have brief idea about nutrition related health disorders and the role of Nutraceuticals.
4. To classify nutraceuticals and the role of nutraceuticals among different age groups.
5. To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin.
6. To know about the role of biotechnology in production of plant secondary metabolites

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

Subject Code:22UBT506H	INDUSTRIAL SAFETY & BIOETHICS	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Bioethics & Biosafety:

Definition and scope of bioethics and biosafety, Ethical implications and need for biosafety, Legal and Socio-Economic impacts of Biotechnology. Convention on biological weapons. Bioterrorism-classification of biological agents with examples.

Biosafety regulation guidelines

Recombinant DNA Advisory Committee (RDAC) ,Institutional Biosafety committee(IBC),Review Committee on Genetic Modification (RCGM),Genetic Engineering Approval Committee(GEAC), Biosafety guidelines- national guidelines, Cartagena Protocol on Biosafety.

UNIT–II	10Hrs.

Biosafety Regulation:

Genetically modified organisms and their release in environment, Laboratory associated infections and other hazards, Good Lab Practices and Good Manufacturing Process (GLP &GMP). Biosafety levels for microorganismBL1,BL2,BL3,BL4) plants (BL1-P,BL2-P,BL3-P,BL4-P) animals (BL1-N,BL2-N,BL3-N,BL4-N).

Risk assessment during laboratory research and risk groups. Recombinant organisms and transgenic crops. Guideline for labeling GM crops. Containments; Physical, Biological. Field trial methods using transgenic plants.

UNIT–III	10 Hrs.

Food and Pharma safety:

Biosafety assessment procedures for biotech foods and Pharma products. Procedure to apply patent, Copy right, Plant Breeder's Right, Environmental aspects of biotech applications. Special application of patent laws in biotechnology and case studies. Flavr Savr Tomato as model case, case studies of relevance (Eg. Bt cotton, Bt brinjal). Licensing and cross licensing.

UNIT–IV	10 Hrs.

Industrial safety

Need for safety, importance of occupational safety, Health and safety programs, Safe and unsafe conditions.

Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention Safety policy

Fire: Fire extinguishers and fire exits, extinguishing agents.

Importance of safety in food and Pharma industry. Food safety, Biological, chemical and Physical Hazards-HAACP system, Pharma safety. Food and safety act. Injuries by industrial sector

REFERENCE BOOKS

1. Sateesh M.K.(2012),Bioethics and Biosafety, I.K.International Publication
2. Singh B.D.(2010), Biotechnology Expanding Horizon (3rd revised edition), Kalyani Publishers.
3. Goel D and Parashar S (2010), IPR-Biosafety and Bioethics (2nd edition), Pearson Education India

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LEARNING OBJECTIVES

COURSE OUTCOMES

1. Interpret ethical issues connected with BT and biosafety guidelines.
2. Use GLP and GMP at work place.
3. Identify biosafety assessment procedures and patent laws.
1. Use the safety measures at work place.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	2	1	-	-	3	-	3	-	-	-	-	-	-	3
CO2	-	-	-	1	2	3	-	-	-	-	-	1	-	2	-
CO3	1	-	2	-	-	3	-	-	-	-	-	1	-	2	3
CO4	-	1	-	2	-	3	-	-	1	-	-	-	-	-	2

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Subject Code:22UBT521E	ENVIRONMENTAL BT	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Microorganisms Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms. **Bioaccumulation of Toxicants** Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.	
UNIT–II	**12Hrs.**
Biological Treatment of Wastewater Waste water characteristics BOD, COD, Primary & Secondary treatment, nano-filtration, ulta-filration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries. **Solid Waste Management** Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules	
UNIT–III	**10 Hrs.**
Bioleaching & Biomining Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum. **Bioremediation** Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.	
UNIT–IV	**10 Hrs.**
Biotechnology in Biodiversity Conservation Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.	
REFERENCE BOOKS	

1. Environmental Biotechnology by Pradipta Kumar Mahopatra.
2. Text book of microbiology by R C Dubey and D K Maheshwari
3. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited,1987.
4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT,.
5. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young (Eds.), Pergamon Press.
6. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
7. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987.
8. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove environmental contaminants.
5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	2	2				2		3		1	2	3	1
CO 2	2	3	2	1				1	2				3	3	1
CO 3	2	3	2	1				1	2				3	3	1
CO 4	1	3	2	3				2	2	3			2	3	
CO 5								2		3		3			
CO 6	1	3	2	2					2	2			1	3	

22UBT514L	BIOINFORMATICS LABORATORY	**Credits: (0: 0: 2)**
L: T: P – 0-0- 1		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures.

REFERENCE BOOKS

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologists guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
6. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 2006.

COURSE OUTCOMES

1. Ability to Search literature and sequence databases
2. Ability to retrieve and search sequences from databases
3. Ability to align pair wise and multiple sequences
4. Ability to identify evolutionary and relationships and functional sites in genomes
5. Ability to evaluate primer designing and restriction mapping
6. Ability to docking and superimpose the structures

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	3	1	-	3				3	3	3	1
CO 2	3	3	3	-	3	1	-	-				3	2	3	1

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CO 3	**3**	**3**	**2**	**2**	**3**	**1**	**1**	**-**				**3**	**3**	**3**	1
CO 4	**3**	**3**	**2**	**-**	**3**	**-**	**1**	**-**				**3**	**2**	**3**	**2**
CO 5	**3**	**3**	**2**	**1**	**3**	**1**	**-**	**2**				**3**	**3**	**3**	**2**
CO 6	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**1**				**3**	**2**	**3**	**1**

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22UBT515L	GENETIC ENGINEERING LABORATORY	**Credits: (0: 0: 2)**
L: T: P – 0-0- 1		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Transformation.-
2. Blue white colony screening.
3. Thermal denaturation of DNA.
4. Restriction Digestion.
5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblotting and analysis.
8. SOP for PCR
9. SOP for Gel Documentation
10. SOP for UV-Spectrophotometer
11. SOP for Lyophilizer
12. PCR (Amplification with specific primers)

REFERENCE BOOKS

1. Sadashiva and Manickam, “Biochemical Methods”, 2nd Edition, New age international Publishers,2017.
2. Sambrook & Russell, “Molecular Cloning”, Cold Spring Harber Lab, 3rd Edition, 2002.
3. Current protocols in molecular biology-Greena Publishing Associates, NY, 1988

COURSE OUTCOMES

1. To demonstrate proficiency in Transformation and screening of transformants.
2. To apply the knowledge of thermal denaturation to calculate Tm value.
3. To evaluate the functions of restriction digestion and Ligation on DNA.
4. To demonstrate proficiency in Electro-blotting and detection.
5. To demonstrate understanding of SOP and PCR.
6. To gain knowledge in common and advanced laboratory practices in Genetic engineering lab.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	PSO1	PSO2	PSO3
CO 1	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**3**				**3**	3	**3**	**1**
CO 2	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**-**				**3**	2	3	1

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CO 3	**3**	**3**	**2**	**2**	**3**	**1**	**1**	**-**				**3**	**3**	**3**	1
CO 4	**3**	**3**	**2**	**-**	**3**	**-**	**1**	**-**				**3**	**2**	**3**	**2**
CO 5	**3**	**3**	**2**	**1**	**3**	**1**	**-**	**2**				**3**	**3**	**3**	**2**
CO 6	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**1**				**3**	**2**	**3**	**1**

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VII-Semester -2022-23

Sl. No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3	UBT72XE	Elective- 4	3	3	0	0	50	50	100
4	UBT73XE	Elective-5	3	3	0	0	50	50	100
5	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6	UXX7XXN	Open Elective-3	3	3	0	0	50	50	100
7	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
9	UBT701T	Technical Seminar	1	2	0	0	50	50	100
		Total	**22**	**19**	**2**	**6**	**450**	**450**	**900**

Elective- 4

UBT722E: Aquaculture & Marine biotechnology

UBT723E: Dairy Biotechnology

UBT724E: Food processing technology

UBT725E:Protein Engineering and Drug design

Elective- 5

UBT731E: Nanobiotechnology & biomaterials

UBT732E: Computational biology

UBT733E: Bioconjugative technology

UBT734E: Food Biotechnology

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Subject Code: 22 UBT704C	ECONOMICS & PLANT DESIGN	3 Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week:		SEE Marks: 50

UNIT-I	10 Hrs.
Process design development Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design and equipment design and specialization, safety factors specifications, and materials of construction. **General design considerations:** Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, storage, materials handling, materials and fabrication selection,. Waste disposal community factors. Safety and hazard control measures.	
UNIT–II	**12Hrs.**
Capital investments Fixed capital investments including land, building, equipment and utilities, installation costs,(including equipment, instrumentation, piping, electrical installation and other utilities),working capital investments. **Manufacturing costs and plant overheads:** Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges Plant Overheads: Administration, safety and other auxiliary services, Conceptual numerical.	
UNIT–III	**10 Hrs.**
Cost analysis Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital Depreciation: different type of depreciation methods of and calculations, Conceptual numerical.	
UNIT–IV	**10 Hrs.**
Profitability analysis Methods for the evaluation of profitability. Return on original investment, interest rate of return, Cash flow diagrams. Break-even analysis. Conceptual numericals.	
REFERENCE BOOKS	
1. Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn.McGraw Hill. 2. Rudd and Watson (1987) Strategy of Process Engineering, Wiley. 3. Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises”, Pearson education. 4. Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management”,H imalaya	

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Publishing House.

5. Khanka SS (2004) Entrepreneurship Development, S Chand & Co.

Thomas W. Zimmer, Norman M. Scarborough.(2007), Essentials of Entrepreneurship and small Business Management

LEARNING OBJECTIVES

COURSE OUTCOMES

At the end of the course the student should be able to:

1. Acquire knowledge in the design of a plant.
2. Conduct preliminary feasibility study of the plant design assigned.
3. Estimate the cost analysis involved in the design of a chemical plant.
4. Analyze the project profitability and alternative investments for the selection of good investment projects
5. Develop entrepreneurs with substantial knowledge in engineering concepts.
6. Apply the knowledge of plant design and cost estimation in actual engineering problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	1	1			1	1	1		2		2		
CO 2	2	1	2	1			1	1	1		3		2		
CO 3	1	2	1	2			1	1	1		2		1		
CO 4	2	1	2	2			1	1	1		3		2		
CO 5	1	1	2	1			1	1	1		2		1		
CO 6	2	2	2	1			1	1	1		2		2		

Subject Code: 22 UBT715C	DOWNSTREAM PROCESSING TECHNOLOGY	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Role and importance of downstream processing in biotechnological processes. Range and characteristics of bioproducts. Purification process of bio-product. Cell disruption methods for intracellular products; physical, chemical and mechanical methods. Basic principles of distillation,crystallization, centrifugation, ultracentrifugation (preparative and analytical).Types of centrifuges and rotors,centrifugation-differential,density gradient (zonal and isopycnic).	
UNIT–II	**12Hrs.**
Primary Recovery Operations Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.	
UNIT–III	**10 Hrs.**
Chromatography Principles of chromatographic seperations, Classification of chromatography- plain and column chromatography, Paper chromatography - Single dimensional (Ascending and Descending, radial and two dimensional) chromatography, partition coefficient, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.	
UNIT–IV	**10 Hrs.**
Electrophoresis Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis,Cellulose Acetate, Starch Gel , Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry. **Downstream Processes** Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.	

REFERENCE BOOKS

1. BioseparationsPrinciples and techniques, by B.Sivasankar, Kindle edition,PHI Publishers, 2010
2. Biophysical chemistry principles and Techniques by Upadhay and Nath,Himalaya Publishing House, 3rd edition, 2010
3. NPTEL Source material.
4. Bioseparations - Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub, 1988
5. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
6. Product Recovery in Bioprocess Technology – BIOTOL Series, VCH, 1990
7. Rate controlled separations by Wankat P.c., Elsevier, 1990
8. Fermentation & Enzyme Technology by D.I.C. Wang, Wiley Eastern 1979

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.
2. Interpret and analyze the industrial fermentation processes.
3. Apply the knowledge in identifying various pharma and R&D sections.
4. Analyse the details of experimentation pertaining to chromatography and electrophoresis.
5. Understand analyse and apply the techniques in various tests involved in finding out purity of biological components.
6. Apply the knowledge in identifying various biochemicals using advanced purifications like HPLC and to demonstrate DSP flowsheets.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	1
CO 2			2			3	2	3				1	2	1	1
CO 3			1			3	2	2				1	2	1	1
CO 4			2			3	2	2				1	2	1	1
CO 5			1			3	3	3				1	2	1	1
CO 6			1			3	2	2				2	2	1	1

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Subject Code: 22 UBT724E	FOOD PROCESSING TECHNOLOGY	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavours, Browning reactions and its effects . Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods .Food additives, Vitamins, amino acids, Sweeteners, Food colours. Toxic-trace elements in food.	
UNIT–II	**12Hrs.**
Detection of Microorganisms Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dyereduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice, squash, wine, pickles and sauerkraut	
UNIT–III	**10 Hrs.**
Food Spoilage & Preservation The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry.:, nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing, and promotional strategies, risks and benefits of food industry.	
UNIT–IV	**10 Hrs.**
Food Engineering Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management.	
REFERENCE BOOKS	
1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press,2007. 2. Food microbiology by William Frazier and Westhoff D.C, 4th Edn,TATA McGraw Hill	

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Pub(2005)

3. Modern Food Micro-Biology by James M.Jay, CBS Publishers.2005.
4. Food Microbiology by K.Vijay RameshMJP Publishers, 2007.
5. Plant biotechnology In Agriculture by K. Lindsey and M.G.K. Jones, Prentice Hall, USA. 1990.
6. Food Science By Potter N.N. and Joseph Hotchkiss, 5thEdn, CBSPub,1996.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Able to know about basic constituents of food
2. Able to know the techniques involved in detection of microbes in food industry
3. To have idea about Dairy , fruits and vegetable processed products and production
4. To be aware of different food spoilage and preservation techniques
5. To know the Characteristics of food industry and scope
6. Able to understand Basic concepts in food Engineering for preservation

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	
CO 2			2			3	2	3				1	2	1	
CO 3			1			3	2	2				1	2	1	
CO 4			2			3	2	2				1	2	1	
CO 5			1			3	3	3				1	2	1	
CO 6			1			3	2	2				2	2	1	

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Subject Code: 22 UBT731E	NANOBIOTECHNOLOGY AND BIOMATERIALS	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to nanotechnology **A Brief History of the Nano particles :** Bottom-Up versus Top-Down; What Is Nanobiotechnology.Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy(SEM,STM & AFM), biomolecule-surface interactions, quantum dots, **Applications of nanotechnology in the life sciences:** Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.	
UNIT–II	**12Hrs.**
Biopolymers Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli,sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.	
UNIT–III	**10 Hrs.**
Synthetic polymers Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.	
UNIT–IV	**10 Hrs.**
Biocompatibility Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods. **Medical devices** Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.	

REFERENCE BOOKS

TEXT BOOKS:

1. B.Vishwanath " Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delhi, 2011.
2. K Eric Drexler "Unbounding the future" Quill,1993.
3. Stephen Lee and Lynn M Savage "Biological molecules in Nanotechnology" 2010.
4. Mark Ratner and Daniel Ratner "Nanotechnology:A Gentle Introduction to Next Gig Idea" Pearson Ecducation Ltd, 2003.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to explain the characterization techniques of nanotechnology.
2. Ability to understand the importance of nano-particles in drug delivery system.
3. Ability to understand the importance of biopolymers.
4. Ability to differentiate biopolymer and synthetic polymer.
5. Ability to understand the importance of biocompatibility.
6. Ability to apply the methods to test the implants and use in medical devices.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	3			1	2					2	2	2	1
CO 2	1	2	3			1	2					3	3		
CO 3	2	2	3			2	2	3				3	2	2	1
CO 4	3	3	3			2	2	2				2	2	1	1
CO 5	3	3	3			1	2	3				1	2	3	
CO 6	2	3	3			3	3	3				3	3	3	3

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Subject Code: 22 UBT716H	INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP	3 Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
DEVELOPMENT OF MANAGEMENT THOUGHTS AND ITS FUNCTIONS Concept & definition of Management, Social Responsibilities of Management, and Pioneers in Management: Contributions of Taylor, Henry Taylor, Gilberth & Mayo, Schools of Management thought: Management process school, Empirical School, Human Behavior School, Social system school, Systems approach school and decision theory school. Selection of site for the plant and plant layout, plant operation and control, utilities, structural design, storage, material handling, Sources of capital. Definition and functions of administration. Planning, organizing, staffing, directing and controlling. Concept of authority and responsibility.	
UNIT–II	**12Hrs.**
QUANTITATIVE TECHNIQUES IN MANAGERIAL DECISIONS Concept of productivity, measuring productivity, concept of budget, effective budgetary control, ABC analysis, break even analysis, product life cycle, promotion of sales, pricing, "EOQ"model. Production costs (including raw materials, and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges (including depreciation, taxes, insurance, rental costs etc.).	
UNIT–III	**10 Hrs.**
PRODUCTION AND MATERIAL MANAGEMENT Types of production, types of planning, manufacturing planning, factory planning, production planning, method study, systems of wage payments, bonus, automation, organization of production, planning. Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management.	
UNIT–IV	**10 Hrs.**
ENTREPRENEURSHIP & PERSONNEL MANAGEMENT Meaning of entrepreneur, evaluation of the concept, function of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship- its barriers. Recruitment and selection. Training of personnel. Employer - Employee relationship. Settlement of disputes.	

REFERENCE BOOKS

1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons, 1992.
2. T. R. Banga & s. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003
3. C.B.Mamoria and S.V.Gankar- Personnel Management, Himalaya Pub, 21 st edn,2010
4. Veerabhadra Havinal -Management and Entrepreneurship- New Age International,2009
5. Ramesh Burbure – Management &Entrepreneurship- Rohan Pub.2008

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6. Poornima M. Charanthimath – Entrepreneurship Development, Pearson Education-2005

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to recall and recollect the history theories and definition of management and its importance in society
2. To analyze and apply the basic concepts of Quantitative techniques of management
3. Ability to know the difference between production and productivity, measurement and cost analysis
4. Explore the knowledge of production costs, planning and material management
5. Able to make basic economic analysis of project
6. To be aware of making business ideas and prepare project planning
7. Ability to understand the role and importance of entrepreneurship in economic development
8. Ability to know the importance of personnel management

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2		3	2		1					1	2	1	1
CO 2	2	1	2	3	2		1						2	1	2
CO 3	1	2	1	2	2		1					1	2	1	2
CO 4	2	1	2	3	1		1						2	1	3
CO 5	1	1	2		2		1					1	2	1	3
CO 6	2	3	2	1		2							2	1	3
CO 7	2	1	3	1								1	2	1	2
CO 8	1	2	1										2	1	2

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Subject Code: 22 UBT710L	BIOSEPARATION TECHNIQUES LAB	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration (Cross flow)
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Membrane dialysis
6. Product enrichment operations: Precipitation – $(NH_4)_2SO_4$ fractionation of a protein.
7. Product enrichment operations: Two – phase aqueous extraction.
8. Product drying techniques.
9. Estimation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

REFERENCE BOOKS

1. Protein Purification by Scopes R.K., IRL Press,1993.
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri.
5. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990
6. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Able to prepare/reproduce the protocols for the experiments.
2. Able to extract the intracellular product using different cell disruption techniques.
3. Able to concentrate, purify the desired product using different chromatography/ filtration techniques.
4. Able to analyze the product both quantitative/qualitatively.
5. Able to record/observe the experimental data and interpret them in the graph/table.
6. Able to calculate the result and to write the conclusion at the end of the experiment.

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Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3												3		1
CO 2		2												3	1
CO 3			3										2	2	1
CO 4				3	3								2	2	1
CO 5		3										2	2	3	1
CO 6		3										2	3	2	1

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22UCH111C/211C	CHEMISTRY FOR COMPUTER SCIENCE (CS) STREAM	Credits: 04
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	10 Hrs

Energy Systems

Electrode System: Introduction, types of electrodes. Reference electrode; Introduction, calomel electrode – construction, working and applications of calomel electrode. Ion selective electrodes; Introduction, construction, working and applications of glass electrode. Determination of pH using glass electrode. Concentration cell; Definition, construction and working. Numerical problems.

Battery Systems: Introduction to batteries, construction, working and applications of Lithium ion and Sodium ion batteries.

Green Fuels: Introduction, construction and working of solar photovoltaic cell, advantages, and disadvantages. Quantum Dot Sensitized Solar Cells (QDSSC's); Principle, Properties and Applications. Generation of energy (green hydrogen) by electrolysis of water and its advantages.

Self Study: Characteristics of batteries & Introduction to Fuel cell, MeOH – O_2 fuel cell, Applications.

UNIT – II	10 Hrs

Corrosion Science and Polymers

Corrosion: Introduction, electrochemical theory of corrosion, types of electro-chemical corrosion; differential metal corrosion and differential aeration corrosion (Waterline and Pitting). Factors affecting rate of corrosion. Penetration Rate (CPR); Introduction and numerical problems.

Corrosion control: Introduction, Metal coating; Galvanization, surface conversion coating; Anodization and cathodic protection; Sacrificial anodic method.

Polymers: Introduction, Monomer, polymer, polymerization, degree of polymerization. Glass transition temperature (Tg), factors affecting Tg. Molecular weight - Number average and Weight average molecular weight and numerical problems. Conducting polymers; Synthesis and conducting mechanism of polyacetyline (n & p type) and commercial applications. Preparation, properties and commercial applications of Silicon rubber.

Self Study: Stress corrosion and Biodegradable polymers.

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UNIT - III	10 Hrs

Nano materials and display systems

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example.

Liquid crystals (LC's); Introduction, classification, positional and orientational order, director, requirement of a substance to exhibit liquid crystal state. Chemical constitution and liquid crystalline behavior, molecular ordering in liquid crystal phase, liquid crystal behavior in homologous series; PAA and MBBA homologous series, electro-optic effect in liquid crystals, construction of liquid crystal display and applications of Liquid Crystal in Displays.

Light Emitting Diode (LED): Introduction, working principle of LED. Application of LED.

Organic Light Emitting Diode (OLED): Introduction, Anatomy of OLED, Types of OLED. Comparison between LED and OLED. Advantages and Disadvantages of OLED, Applications of OLED. Quantum Light Emitting Diodes (QLED's); Properties and applications.

Self Study: Light emitting electrochemical cells.

UNIT - IV	10 Hrs

Analytical Techniques & E-Waste Management

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid.

E-Waste: Introduction, sources of e-waste, Composition, Characteristics, and Need of e- waste management. Toxic materials used in manufacturing electronic and electrical products, health hazards due to exposure to e-waste. Recycling and Recovery; Different approaches of recycling (separation, thermal treatments, hydrometallurgical extraction, pyrometallurgical methods, direct recycling). Extraction of gold from E-waste. Role of stake holders in environmental management of e-waste (producers, consumers, recyclers, and statutory bodies).

Self Study: Impact of heavy metals on environment & human health and control measures.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

Reference books:

1. Wiley (2013), Engineering Chemistry (2nd edition), Wiley India Pvt. Ltd. New Delhi.
2. Satyaprakash & Manisha Agrawal (2012), Engineering Chemistry (1st edition), Khanna Book Publishing, Delhi.
3. Shashi Chawla (2003), A Text Book of Engineering Chemistry (3rd edition), Dhantpat Rai & Co. Pvt., Pub. Delhi.
4. Bahl.B.S., Arun Bahl &Tuli.G.D (2010), Essentials of Physical Chemistry (1st edition), S.Chand Publishing.
5. Sunita Rattan (2011), Applied Chemistry (3rd edition), S.K. Kataria & Sons.

6. Dr. Chinnappan Baskar, Dr.Shikha Baskar & Dr.Ranjit S.Dhillon (2012), Engineering Chemistry (1st edition), Wiley India Pvt. Ltd.
7. Gourkrishna Dasmohapatra (2017), Engineering Chemistry (4th edition), Vikas Publishing
8. Dhara.S.S. & Umare.S.S (2010), Engineering Chemistry (12th edition), S. Chand & Company Ltd., Delhi.
9. Gadag R.V. and Nityananda Shetty (2016), A Text Book of Engineering Chemistry (2nd edition), I. K. International Publishing house.
10. Billmeyer.F.W. (1999), Text Book of Polymer Science (4th edition), John Wiley & Sons.
11. Ozin.G.A. & Arsenault.A.C. (2005), Nanotechnology A Chemical Approach to Nanomaterials (2nd edition), RSC Publishing.
12. Fontana.M.G., Greene.N.D. (1996), Corrosion Engineering (3rd edition), McGraw Hill Publications, New York.
13. Kirby W. Beard (2019), Linden's Handbook of Batteries (5th edition), McGraw Hill.
14. Takatoshi Tsujimura (2012), OLED Display Fundamentals and Applications (2nd edition), Wiley–Blackwell
15. Dr. Panda H. (2017), "Handbook on Electroplating with Manufacture of Electrochemicals" (1st edition),, Asia Pacific Business Press Inc.
16. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782
17. Laboratory Manual, Department of Chemistry, BEC Bagalkot.
18. Dr. Sudha Rani (1998), Laboratory Manual on Engineering Chemistry (1st edition), DhanapathRai Publishing Co. Ltd.

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- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1bb3X- 9IbHrDMjHWWh

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Course Outcomes:

CO1: Analyse the properties of raw materials in desigining energy systems for industrial and social applications.

CO2: Assess properties of metallic and polymer materials for variety of engineering applications.

CO3: Choose appropriate materials for desing of display systems.

CO4: Identify and determine composition of various materials using sensors and develop e-waste management for electrical and electronic products.

Course Outcomes	**Programme Outcomes**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1	1				1					

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22UCH112C/212C	CHEMISTRY FOR MECHANICAL ENGINEERING (ME) STREAM	**Credits: 04**
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	10 Hrs

Analytical Techniques & Energy Sources

Analytical techniques: Introduction, principle, instrumentation of potentiometric sensors; its application in the estimation of iron, Optical sensors (colorimetry); its application in the estimation of the copper, pH-sensor (Glass electrode); its application in the determination of pH of beverages.

Fuels: Introduction, classification and characteristics of a good fuel, calorific value, Gross calorific value (GCV) and Net calorific value (NCV), determination of calorific value using bomb calorimeter, numerical problems on GCV and NCV.

Green fuels: Introduction, synthesis and applications of Bio gas, Bio ethanol and biodiesel.

High energy fuels: Production of hydrogen by electrolysis of water and its advantages and limitations.

Self Study: Types of electrodes - Reference electrode, Calomel electrode; Construction, working and applications.

UNIT – II	10 Hrs

Corrosion Science and Metal Finishing

Corrosion: Introduction, electrochemical theory of corrosion, types of electrochemical corrosion - differential metal, differential aeration (waterline and pitting), stress corrosion (caustic embrittlement). Factors affecting rate of corrosion. Corrosion testing by weight loss method. Corrosion penetration rate (CPR)-numerical problems.

Corrosion control: Introduction, Metal coating; Galvanization, surface conversion coating; Anodization and cathodic protection; Sacrificial anodic method.

Metal finishing: Introduction, technological importances. Electroplating: Process, Factors affecting quality of electrodeposit. Determination of throwing power by Haring-Blum cell. Numerical problems on throwing Power. Electroplating of chromium (hard and decorative). Electroless plating: Introduction, Comparision between electroplating and electroless plating, electroless plating of nickel.

Self Study: Use of corrosion inhibitors to control corrosion. Factors governing electroplating – Polarization, Decomposition potential and Over voltage.

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UNIT - III	10 Hrs
Macromolecules for Engineering Applications **Polymers:** Introduction, Monomer, polymer, polymerization degree of polymerization, Glass transition temperature- factors affecting Tg. Molecular weight; number average and weight average, numerical problems. Synthesis, properties and industrial applications of Acrylo-Butadiene Styrene (ABS) plastics and silicon rubber. **Fibers:** Introduction, synthesis, properties and industrial applications of Kevlar and Polyester. **Plastics:** Introduction, synthesis, properties and industrial applications of poly methyl methacrylate (PMMA) and Polyurethene (PU). **Composites:** Introduction, properties and industrial applications of carbon-based reinforced composites (grapheme/carbon nano-tubes as fillers) and metal matrix polymer composites. **Lubricants:** Introduction, classification, properties and applications of lubricants. **Self Study:** Biodegradable polymer: Introduction, synthesis, properties and applications of polylactic acid(PLA) and poly caprolactum (PCL).	
UNIT - IV	**10 Hrs**
Phase Rule and Materials for Engineering Applications **Phase rule:** Introduction, Definition of terms: phase, components, degree of freedom, phase rule equation. Phase diagram: Two component lead-silver system. **Alloys:** Introduction, classification, composition, properties and applications of Stainless Steel, Solders, Brass and Alnico. **Ceramics:** Introduction, classification based on chemical composition, properties and applications of perovskites ($CaTiO_3$). **Nanomaterials:** Introduction, size-dependent properties of nanomaterial (surface area, catalytical and thermal), synthesis of nanoparticles by sol-gel and co-precipitation method. Synthesis, Properties and engineering applications of carbon nanotubes and graphene. **Self Study:** Phase diagram of one component system; Water system and classification of nano particles.	

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

Reference books:

1. Wiley (2013), Engineering Chemistry (2nd edition), Wiley India Pvt. Ltd. New Delhi.
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15. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782.
16. Laboratory Manual, Department of Chemistry, BEC Bagalkot
17. Dr. Sudha Rani (1998), Laboratory Manual on Engineering Chemistry (1^{st} edition), DhanapathRai Publishing Co. Ltd.

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- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1b b3X- 9IbHrDMjHWWh

Course Outcomes: **CO1:** Identify suitable sensor for the estimation of elements and fuel for future generation. **CO2:** Assess and describe the forms, mechanisms, control of corrosion and surface modifications. **CO3:** Choose appropriate smart materials for design of display systems. **CO4:** Identify and determine composition of various materials using sensors and synthesis of polymers for specific engineering applications

Course Outcomes	**Programme Outcomes**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1

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22UCH110C/210C	CHEMISTRY FOR CIVIL SCIENCES (CVS) STREAM	Credits:04
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	10 Hrs

Chemistry of Water and Environment

Water technology: Introduction, water quality parameters, hardness of water, determination of total hardness by EDTA method, numerical problems. Determination of chlorides; Mohr's method. Softening of water by ion exchange method, desalination of water by electrodialysis, Reverse and Forward osmosis: Introduction, Process and applications.

Water pollution: Sources, water quality assessment, effect of oxygen demanding waste water, Sewage treatment; Primary, secondary and tertiary treatment. Determination of Biological Oxygen Demand (BOD), Chemical oxygen demand (COD) and Numerical problems.

Self Study: Determination of DO in water samples by Winkler's method. Impact of heavy metals on human health.

UNIT – II	10 Hrs

Analytical Techniques and Corrosion Science

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid. pH-sensors and its application in the determination of soil sample.

Corrosion: Introduction, electrochemical theory of corrosion, types of electrochemical corrosion; differential metal corrosion, differential aeration corrosion (waterline and pitting), stress corrosion (caustic embrittlement). Factors affecting rate of corrosion. Corrosion testing by weight loss method. Corrosion penetration rate (CPR)-numerical problems.

Corrosion control: Introduction, Metal coating; galvanization, Surface conversion coating; anodization and cathodic protection; sacrificial anodic method.

Self Study: Use of Corrosion inhibitors to control corrosion. Corrosion control by organic coatings.

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UNIT - III	10 Hrs

Structural Materials

Metals and Alloys: Introduction, Properties and application of Iron and its alloys, Aluminium and itsalloys.

Cement: Introduction, composition, properties, classification, manufacturing process of cement, process of setting and hardening of cement, additives for cement and testing of cement.

Refractories: Introduction, classification based on chemical composition, properties and application ofrefractory materials.

Glass: Introduction, Composition, Types, Preparation of Soda-lime glass, properties and applications ofglass.

Nano materials: Introduction, size dependent properties of nanomaterial (surface area and catalytic), Synthesis of nanomaterial by sol-gel method and co-precipitation method. Synthesis, properties and engineering applications of carbon nanotubes and graphene. Nanomaterials for water treatment, Introduction and example.

Self Study: Chemistry of reinforced concrete from various sources of water (seawater, groundwater,treated water).

UNIT - IV	10 Hrs

Polymers and Composites

Polymer: Introduction, monomer, polymer, polymerization, degree of polymerization. Molecular weight of polymers, Weight average and number average molecular weight of polymer. Numerical problems. Synthesis, properties and engineering applications of Acrylo Butadiene Styrene (ABS) plastics and Silicon rubber.

Fibers: Introduction, Synthesis, properties & applications of Rayon & Nylon fibers.

Polymer composites: Introduction, properties and applications of fiber reinforced polymers composites (FRPC).

Geo polymer concrete: Introduction, synthesis, constituents, properties & applications.

Adhesives: Introduction, properties and applications of epoxy resin

Biodegradable polymers: Introduction, Synthesis, properties and applications of polylactic acid (PLA)and poly hydroxy butyrate (PHB).

Self Study: Introduction, structural properties and applications of cellulose and lignin.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
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- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1b b3X- 9IbHrDMjHWWh

Course Outcomes:

CO1: Able to evaluate quality of water and its treatment methods for domestic and industrial applications..

CO2: Identify and evaluate composition of materials and mechanism involved in corrosion with controlling measures.

CO3: Outline the application of structural materials for engineering application.

CO4: Outline the various polymers and their properties with application in various engineering field.

Course Outcomes	**Programme Outcomes**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1

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22UCH109C/209C	**CHEMISTRY FOR ELECTRICAL SCIENCES (ES) STREAM**	**Credits : 04**
L:T:P : **3:0:1**		**CIE Marks:**50
Total Hours/week: 05 Hrs		**SEE Marks:**50

UNIT - I	**10 Hrs**

Energy Systems

Electrode System: Introduction, types of electrodes. Reference electrode; Introduction, calomel electrode – construction, working and applications of calomel electrode. Ion selective electrode; definition, construction, working and applications of glass electrode. Determination of pH using glass electrode. Concentration cell; Definition, construction and working. Numerical problems.

Batteries: Introduction, Components and classification of batteries. Construction, working and applications of modern batteries; Na-ion battery, solid state battery (Li-polymer battery) and flow battery (Vanadium redox flow battery).

Fuel Cells: Introduction, construction, working and applications of methanol–oxygen and polymer electrolyte membrane (PEM) fuel cell.

Solar Cell: Introduction, Semiconductors as solar cell materials. Arrangement of atoms in space, arrangement of electrons in atoms. Formation of bonds. Charge carriers and their motion in semiconductors. Construction and working of Solar Photo voltaic cell, advantages and disadvantages.

Self study: Characteristics of batteries. A note on Quantum dot sensitized solar cells (QDSSC) and applications.

UNIT – II	**10 Hrs**

Corrosion Science and E-waste management

Corrosion: Introduction, electrochemical theory of corrosion, types of corrosion-differential metal corrosion and differential aeration corrosion (Water line and pitting). Factors affecting rate of corrosion. Corrosion Penetration Rate (CPR); Introduction and numerical problems.

Corrosion control: Introduction, Metal coating; galvanization, Surface conversion coating; anodization and cathodic protection; sacrificial anodic method.

Electroless Plating: Introduction, Electroless plating of copper in the manufacture of double-sided printed circuit board (PCB).

E-waste Management: Introduction, sources, types, effects of e-waste on environment and human health, methods of disposal, advantages of recycling.

Extraction of copper and gold from e-waste. **Self study:** Recycling of printed circuit board (PCB) and battery components. Electroplating of Copper.

UNIT - III	10 Hrs

Nano materials and display systems

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example.

Display Systems

Liquid crystals (LC's); Introduction, classification, positional and orientational order, director, requirement of a substance to exhibit liquid crystal state. Chemical constitution and liquid crystalline behavior, molecular ordering in liquid crystal phase, liquid crystal behavior in homologous series; PAA and MBBA homologous series, electro-optic effect in liquid crystals, construction of liquid crystal display and applications of Liquid Crystal in Displays (LCD's).

Light Emitting Diode (LED): Introduction, working principle of LED. Application of LED.

Organic Light Emitting Diode (OLED): Introduction, Anatomy of OLED, Types of OLED. Comparison between LED and OLED. Advantages and Disadvantages of OLED, Applications of OLED. Quantum Light Emitting Diodes (QLED's); Properties and applications.

Self Study: Light emitting electrochemical cells.

UNIT - IV	10 Hrs

Analytical technique and Polymers

Analytical Techniques: Sensors, Introduction, basic principle of sensor, Types of sensors; Conductometric sensors, Electrochemical sensors, Thermometric sensors, and Optical sensors. Potentiometric sensors; Introduction, principle, working and application in the estimation of iron. Colorimetric sensors; Introduction, principle, working and application in the estimation of copper. Conductometric sensors; Introduction, principle, working and application in the estimation of weak acid.

Polymers: Introduction, Monomer, polymer, polymerization, degree of polymerization. Glass transition temperature, factors affecting glass transition temperature, Molecular weight; Number average and Weight average molecular weight. Numerical problems. Conducting polymers; synthesis and conducting mechanism of polyacetylene (n & p type). Preparation, properties and commercial applications of silicon rubber.

Self Study: Methods of polymerization. Polymer composites.

PRACTICAL CONTENT

List of Experiments

UNIT-I : Compulsorily conducting experiments

1. Estimation of total hardness of water by EDTA method
2. Potentiometric estimation of FAS using $K2Cr_2O_7$
3. Determination of pKa of vinegar using pH sensor (Glass electrode)
4. Estimation of Copper present in electroplating effluent by optical sensor (colorimetry)
5. Conductometric estimation of acid mixture
6. Estimation of iron in TMT bar by diphenyl amine/external indicator method
7. Determination of Alkalinity of given water sample by dual indicator method.
8. Determination of Viscosity coefficient of lubricant (Ostwald's viscometer)

UNIT-II: Virtual experiments (any one)

1. Electro-gravimetric estimation of metals
2. Preparation of urea formaldehyde resin
3. Synthesis of iron oxide nanoparticles
4. Electrolysis of water

UNIT-III: Open Ended Experiments (any one)

1. Measurements of IV characteristics of Photovoltaic Cell
2. Determination of percentage of copper in present the brass solution.
3. Determination of CaO in cement solution
4. Determination of manganese dioxide in pyrolusite ore

Reference books:

1. Wiley (2013), Engineering Chemistry (2nd edition), Wiley India Pvt. Ltd. New Delhi.
2. Satyaprakash & Manisha Agrawal (2012), Engineering Chemistry (1st edition), Khanna Book Publishing, Delhi.
3. Shashi Chawla (2003), A Text Book of Engineering Chemistry (3rd edition), Dhantpat Rai & Co. Pvt., Pub. Delhi.

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4. Bahl.B.S., Arun Bahl &Tuli.G.D (2010), Essentials of Physical Chemistry (1st edition), S.Chand Publishing.
5. Sunita Rattan (2011), Applied Chemistry (3rd edition), S.K. Kataria & Sons.
6. Dr. Chinnappan Baskar, Dr.Shikha Baskar & Dr.Ranjit S.Dhillon (2012), Engineering Chemistry (1st edition), Wiley India Pvt. Ltd.
7. Gourkrishna Dasmohapatra (2017), Engineering Chemistry (4th edition), Vikas Publishing
8. Dhara.S.S. & Umare.S.S (2010), Engineering Chemistry (12th edition), S. Chand & Company Ltd., Delhi.
9. Gadag R.V. and Nityananda Shetty (2016), A Text Book of Engineering Chemistry (2nd edition), I. K. International Publishing house.
10. Billmeyer.F.W. (1999), Text Book of Polymer Science (4th edition), John Wiley & Sons.
11. Ozin.G.A. & Arsenault.A.C. (2005), Nanotechnology A Chemical Approach to Nanomaterials (2nd edition), RSC Publishing.
12. Fontana.M.G., Greene.N.D. (1996), Corrosion Engineering (3rd edition), McGraw Hill Publications, New York.
13. Kirby W. Beard (2019), Linden's Handbook of Batteries (5th edition), McGraw Hill.
14. Takatoshi Tsujimura (2012), OLED Display Fundamentals and Applications (2nd edition), Wiley–Blackwell.
15. Dr. Panda H. (2017), "Handbook on Electroplating with Manufacture of Electrochemicals" (1st edition), Asia Pacific Business Press Inc.
16. Expanding the Vision of Sensor Materials. National Research Council 1995, Washington, DC: The National Academies Press. doi: 10.17226/4782.
17. Laboratory Manual, Department of Chemistry, BEC Bagalkot.
18. Dr. Sudha Rani (1998), Laboratory Manual on Engineering Chemistry (1st edition), DhanapathRai Publishing Co. Ltd.

Web links and Video Lectures (e-Resources):

- http://libgen.rs/
- https://nptel.ac.in/downloads/122101001/
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/

- https://www.youtube.com/watch?v=faESCxAWR9k
- https://www.youtube.com/watch?v=TBqXMWaxZYM&list=PLyhmwFtznRhuz8L1bb3X- 9IbHrDMjHWWh
- https://www.youtube.com/watch?v=j5Hml6KN4TI

Course Outcomes:

CO1: Analyse the properties of raw materials in designing energy system for industrial and social application.

CO2: Assess and evaluate the forms, mechanism, control of corrosion and develop e-waste management of electrical and electronic products.

CO3: Choose appropriate small material for design of display system.

CO4: Identify and determine composition of various material using sensors and synthesis of polymers for specific purpose.

Course Outcomes	Programme Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1					1					1
CO2	3	2										1
CO3	3	2										1
CO4	3	1					1					1

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SUBJECT CODE: **21UCH110C/UCH210C**	ENGINEERING CHEMISTRY	**Credits: 03**
L:T:P - 3 : 0 : 0		CIE Marks: 50
Total Hours/Week: **3**		SEE Marks: 50

UNIT-I	10 Hrs.

Water Technology:

Introduction, sources, impurities and specifications of water, Hardness of water, Basic terms, Determination of total hardness of water by EDTA method, Numerical problems. Boiler feed water - boiler problems, Scale and sludge formation, priming and foaming, boiler corrosion (due to dissolved O_2, CO_2 and $MgCl_2$).

Chemical analysis of water: Standard for portable water, Determination of; Dissolved oxygen, Chlorides. Water softening **-** Desalination of sea water by reverse osmosis.

Self Study: Softening of water by ion exchange process.

Electro Chemical Technology :

Introduction, Origin of electrode potential, Nernst equation, concentration cell, numerical problems on concentration cell, Reference electrode – Calomel electrode. Determination of single electrode potential using calomel electrode, Ion Selective Electrode – Glass electrode, Determination of pH of solution using glass electrode.

Energy storage devices: Introduction, Basic concept, Classification, Characteristics of batteries.

Construction and working of; 1) Nickel Metal hydride battery 2) Li-Cobalt oxide battery

Self Study: Different types of Reference electrodes and their working principle.

UNIT–II	10 Hrs.

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Corrosion Science:
Introduction, Corrosion – Definition, Types of corrosion, Chemical (Dry) and Electrochemical (Wet) corrosion. Theory of electrochemical corrosion by taking Iron as an example. Types of Electrochemical corrosion - Differential metal corrosion, Differential aeration corrosion. e.g. water line corrosion, Pitting corrosion. Stress corrosion e.g. Caustic embrittlement. Factors affecting the rate of corrosion; Related to metal & Related to environment. Numerical problems on Corrosion Penetration Rate (CPR) & Weight loss method.
Corrosion Control: Protective coatings: Inorganic coatings, Anodizing – meaning, Anodizing of Al and applications. Cathodic protection - i) Sacrificial anodic method ii) Impressed current method.
Self study: *Metallic coating methods.*
Metal Finishing :
Introduction, Technological importance of metal finishing. Factors governing

electroplating - Polarization, Decomposition potential and Over voltage.
Electroplating process: Theory of electroplating - Definition, Principle components of an electroplating bath. Effects of plating variables on the nature of electro deposit. Determination of throwing power of plating bath by Harring - Blum cell and Numerical problems. Surface preparation for electroplating. Electroplating of Chromium (Decorative & Hard) and its applications.
Electroless plating process: Meaning, Distinction between electroplating and electroless plating. Surface preparation, Electroless plating of Copper on PCB and its applications.
Self study: *Electroplating of Gold and Electroless plating of Ni on Al*

UNIT–III	10 Hrs.

Green Chemistry:
Introduction, definition, Major environmental pollutants, Basic principles of green chemistry (12 principles). Various green chemical approaches – Microwave synthesis, Bio catalysed reactions, Phase transfer catalysis. Super critical conditions for solvent free reactions. Synthesis of typical organic compounds by conventional and green route;
i) Adipic acid ii) Paracetamol
Atom economy – Atom economy calculations on synthesis of Ethylene oxide & Methyl Methacrylate. Numerical problems on Atom economy calculations. Industrial applications of green chemistry.
Self study: *Information on recent green technology in industry.*
Fuel Technology:
Non Renewable Energy Sources
Chemical Fuels: Introduction, Definition, classification, characteristics of fuel, Combustion, Calorific value - Definition, HCV, LCV, Determination of CV solid/liquid fuel by Bomb calorimeter, numerical problems.
Renewable Energy Sources
Biofuel - Introduction, Classification of biofuel. Biomass, Sources of biomass. Biodiesel-production of biodiesel by alkali catalyzed trans - esterification methods. Advantages and disadvantages of biodiesel.
Solar Energy – Photo Voltaic Cell; Introduction , Construction and Working of Typical P.V.Cell, Preparation of solar grade silicon by union carbide process, Advantages & Disadvantages of P.V.Cell.
Self study: *Fuel cell technology eg: $CH_3OH – O_2$ fuel cell.*

UNIT–IV	10 Hrs.

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Polymer materials:
Introduction, definitions, classification, types of polymerization. Ionic polymerization; Mechanism of polymerization – Cationic and Anionic polymerizations of styrene. Molecular weight of polymers- Number average and weight average methods, numerical

problems. Glass transition temperature and factors affecting Tg & its significance. Synthesis, properties and applications of; i) Epoxy resin ii) Silicon rubber iii) PLA iv) PET.

Conducting polymers : Introduction – Definition, Mechanism of conduction in poly acetylene and its applications.

Self study: *Polymer composites.*

Dyes: Introduction, definition, sensation of colour, classification based on chromophores. Theories of dyes- Witt theory & Electronic theory. Synthesis and applications of; i) Phenolphthalein ii) Methyl orange iii) Malachite green. Applications of Phenolphthalein & Methyl orange in chemical analysis.

Self study: *Information on food dyes with example and applications*

Reference Books

Text Books:

1. Dr. Suba Ramesh etal (2011), Engineering Chemistry (1^{st} edition), Wiley India Pvt. Ltd., Delhi.
2. Shashi Chawla (2003), A Text Book of Engineering Chemistry (3^{rd} edition), Dhantpat Rai & Co. Pvt., Pub. Delhi.

Reference Books:

1. Dr. Dhara.S.S. & Dr. Omare.S.S (2010), Engineering Chemistry (12^{th} edition), S. Chand & Company Ltd., Delhi.
2. Jain & Jain (2013), Engineering Chemistry (16^{th} edition), Dhanapath Rai pub. Co.
3. Dr. Timmanagoudar P. L. & Dr. Patil S. K. (2014), A Text Book of Engineering Chemistry (1^{st} edition), EBPB, Gadag.
3. Kenneth Doxsee & James Huchison (2004), Green Organic Chemistry (1^{st} edition), Thomson-Brooks/Cole.
4. David M. Mousdale (2017), Introduction to Bio fuels (3^{rd} edition), CRC Press.

Course Outcomes

After completion of the course student will be able to

1. apply and demonstrate quantitative chemical analysis and electrochemical analysis techniques & incorporate new methods to produce soft water for industrial & domestic use at cheaper cost.
2. analyze engineering problems related to corrosion and develop/practice suitable preventive measures. Utilize surface modification methods to improve various cost effective properties of materials.
3. apply the principles of green chemistry in design and development of alternative ecofriendly chemical synthesis methods to minimize hazardous substances and impart the knowledge of conventional and non-conventional energy sources and their effective

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management.

4. acquire the knowledge of different polymer materials and dyes for wide variety of engineering applications.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		1		1						1	1		
CO2	3	3		1		1						1	1	2	1
CO3	3	2				1						2	1	1	2
CO4	3	1											1	1	1

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<table>
<tr><td>SUBJECT CODE:
21UCH114L/UCH214L</td><td rowspan="3">ENGINEERING CHEMISTRY LABORATORY</td><td>Credits: 1.0</td></tr>
<tr><td>L:T:P - 0 – 0 – 2</td><td>CIE Marks: 50</td></tr>
<tr><td>Total Hours/Week: 02</td><td>SEE Marks: 50</td></tr>
</table>

Sl. No.	Name of the experiment

PART – A

1. Potentiometric estimation of Iron in the given solution using standard $K_2Cr_2O_7$ solution.
2. Determination of pKa of a weak acid by standard NaOH using pH meter.
3. Conductometric estimation of HCl & CH_3COOH in acid mixture by Standard NaOH.
4. Colorimetric estimation of copper in the given solution.

PART – B

1. Preparation standard solution and Standardization of a given solution.
2. Determination of total hardness of a given water sample by EDTA method.
3. Determination of alkalinity of water sample by duel indicator method.
4. Determination of amount of Fe in a given solution using standard $K_2Cr_2O_7$ solution.

Virtual lab

1. Gravimetric estimation of metals.
2. Determination of viscosity of liquid by Ostwald's Viscometer.

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Reference Books
Text Books: **Reference Books:** 1. Sudharani (2012), Laboratory manual in Engineering Chemistry (3^{rd} edition), Dhanapat Rai Publishing Company Private Limited, New Delhi. 2. Jeffery.G.H., Basett.J., Mendham.J & Denney R.C.(1989), Vogel's Test Book of quantitative Chemical Analysis (5^{th} edition), John Wiley & Sons. Inc., New York. 3. Sunita Rattan (2009), Practical Engineering Chemistry (2^{nd} edition). Publisher S.K.Kataria & Sons.

Course Outcomes
After completion of the course student will be able to 1. **Write systematic procedure for setting up & conduct of experiment.** 2. **Perform experiment on volumetric analysis individually along with interpretation of / results of analysis and calculation.** 3. **Perform experiments using instruments for trace of chemical analysis with high accuracy.** 4. **Incorporate the practical knowledge of chemistry for engineering applications.**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1	1	1		2						1	3	1	1
CO2	2	1	1	2	2	2		1	1			1	3	1	1
CO3	2	2		2	2	2	2	1	1			1	3	1	1
CO4	2	1		2	2	2			1			1	3	1	1

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SUBJECT CODE: UCH168C/UCH268C	ENGINEERING CHEMISTRY	Credits: 04
L:T:P - 3 : 2 : 0		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	16Hrs.

Water Technology:

Introduction, sources, impurities and specifications of water, Boiler feed water - boiler problems, Scale and sludge formation, priming and foaming, boiler corrosion (due to dissolved O_2, CO_2 and $MgCl_2$).

Chemical analysis of water: Standard for portable water, Determination of; Dissolved oxygen, Chlorides, Sulphates, TDS and numerical problems.

Water softening: Softening of water by ion exchange process. Desalination of sea water by reverse osmosis.

Self Study: BOD and its determination.

Electro Chemical Technology

Introduction, Origin of electrode potential, Nernst equation, concentration cell, numerical on Concentration cell, Reference electrode – Calomel electrode. Determination of single electrode potential using calomel electrode, Ion selective Selective Electrode – Glass electrode, Determination of pH of solution using glass electrode.

Energy storage devices: Introduction, Basic concept, Classification, Characteristics of batteries.

Construction and working of;

1) Nickel Metal hydride battery
2) Lithium ion batteries;
   i) Li-Air battery ii) Li-Cobalt oxide battery iii) Li-Sulphur battery

Self Study: Electrochemical Sensors & applications.

UNIT–II	18Hrs.

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Corrosion Science:

Introduction, Corrosion – Definition, Types of corrosion, Chemical (Dry) and Electrochemical (Wet) corrosion. Theory of electrochemical corrosion by taking Iron as an example. Types of Electrochemical corrosion - Differential metal corrosion, Differential aeration corrosion. e.g. water line corrosion, Pitting corrosion. Stress corrosion e.g. Caustic embrittlement. Factors affecting the rate of corrosion; Related to metal & Related to environment. Numerical problems on Corrosion Penetration Rate (CPR) & Weight loss method.

Corrosion Control: Protective coatings: Inorganic coatings – (i) Anodizing – meaning, Anodizing of Al and applications (ii) Phosphating – process and applications. Cathodic protection - i) Sacrificial anodic method ii) Impressed current method. ***Self study:*** Corrosion control by Metallic coating methods. **Metal Finishing :** Introduction, Technological importance of metal finishing. Factors governing electroplating - Polarization, Decomposition potential and Over voltage. ***Electroplating process***: Theory of electroplating - Definition, Principle components of an electroplating bath. Effects of plating variables on the nature of electro deposit. Determination of throwing power of plating bath by Harring-Blum cell and Numerical problems. Surface preparation for electroplating. Electroplating of Chromium and applications. ***Electroless plating process***: Meaning, Distinction between electroplating and electroless plating. Surface preparation, Electroless plating of Copper on PCB and applications. ***Self study:*** Information on Multifunctional Coating.	
UNIT–III	**16Hrs.**

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Green Chemistry:
Introduction, definition, Major environmental pollutants, Basic principles of green chemistry (12 principles). Various green chemical approaches – Microwave synthesis, Bio catalysed reactions, Phase transfer catalysis. Super critical conditions for solvent free reactions. Synthesis of typical organic compounds by conventional and green route; i) Adipic acid ii) Paracetamol

Atom economy – Synthesis of Ethylene oxide & Mehtyl Methacrylate. Industrial applications of green chemistry, Numerical problems on Atom economy.

Self study: Information on recent green technology, green chemical products and application

Fuel Technology :

Non Renewable Energy Sources: Introduction, Definition, classification, characteristics of fuel, Combustion, Calorific value- Definition, HCV, LCV, Determination of CV solid/liquid fuel by Bomb calorimeter, numerical problems.

Renewable Energy Sources:

Biofuel - Introduction, Classification of biofuels. Biomass, Sources of biomass. Biodiesel-production of biodiesel by trans-esterification, mechanism of acid catalyzed reaction and alkali catalyzed reactions. Advantages and disadvantages of biodiesel. Fuel cell technology eg: CH_3OH – O_2 fuel cell.

Solar Energy – P.V.Cell; Introduction , Construction and Working of Typical P.V.Cell, Preparation of solar grade silicon by union carbide process, Advantages & Disadvantages of P.V.Cell.

Self study: Information on Wind Energy.

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UNIT–IV	16Hrs.

Polymer materials:

Introduction, definitions, classification, polymerization types. Mechanism of polymerization- Cationic/Anionic polymerizations of styrene. Molecular weight of polymers- Number average and weight average methods, numerical problems. Glass transition temperature and factors affecting. Synthesis, properties and applications of; i) Epoxy resin ii) Silicon rubber iii) PLA iv) PET.

Conducting polymers – Definition, Mechanism of conduction in polyacetylene and applications, Graphene – introduction, Mechanism of conduction in graphene and applications.

Self study: Polymer membranes and their applications

Dyes: Introduction, definition, sensation of colour, classification based on applications of dyes. Theories of dyes- Wit theory, Electronic theory, Relationship of absorbed and visible colours. Synthesis, Properties and applications of; i) Azo dyes

Fluorescent dyes – Introduction, Classification, flurophores and their bio-Applications.

Self study: Information on food dyes with example and applications

Reference Books

Text Books:

1. Dr. Suba Ramesh etal (2011), Engineering Chemistry (1st edition), Wiley India Pvt. Ltd., Delhi.
2. Shashi Chawla (2003), A Text Book of Engineering Chemistry (3rd edition), Dhantpat Rai & Co. Pvt., Pub. Delhi.

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2. Jain & Jain (2013), Engineering Chemistry (16th edition), Dhanapath Rai pub. Co.
3. Kenneth Doxsee & James Huchison (2004), Green Organic Chemistry (1st edition), Thomson-Brooks/Cole.
4. David M. Mousdale (2017), Introduction to Bio fuels (3rd edition), CRC Press.

Course Outcomes**

After completion of the course student will be able to

1. **Apply and demonstrate quantitative chemical analysis and electrochemical analysis techniques and incorporate new methods to produce soft water for industrial and domestic use at cheaper cost.**
2. **Analyze engineering problems related to corrosion and develop/practice suitable preventive measures. Utilize surface modification methods to improve various cost effective properties of**

materials.

3. Apply the principles of green chemistry in design and development of alternative ecofriendly chemical synthesis methods to minimize hazardous substances and impart the knowledge of conventional and non-conventional energy sources and their effective management.
4. Acquire the knowledge of different polymer materials and dyes for wide variety of engineering applications.

* Books to be listed as per the format with decreasing level of coverage of syllabus
** Each CO to be written with proper action word and should be assessable and quantifiable

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1										**1**			
CO2	3	2	1									**1**			
CO3	3	2	1				**2**					**1**			
CO4	3	1	1									**1**			

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