22UPH105C/22UPH205C	PHYSICS FOR ELECTRICAL SCIENCES (EE & EC branches) (Integrated)	Credits-04
Hours/Week:(3:0:2)		CIE Marks: 50
Total Hours: 60 Hrs(40 L+20 P)		SEE Marks: 50

Course Objectives :

1. **To study the principles of quantum mechanics**
2. **To study the basics of lasers and optical fibers for engineering applications**
3. **To study the fundamentals of electromagnetism and dielectrics for engineering applications**
4. **To study the properties of conductors, semiconductors and superconductors**

UNIT-I	10 Hrs.

Quantum mechanics: Introduction, quantization of energy levels, Franck-Hertz experiment, Wave particle dualism, de-Broglie hypothesis and matter waves, de-Broglie wavelength and derivation of expression by analogy. Phase velocity, wave packet, group velocity and derivation of group velocity(superposition), Relation between group velocity and particle velocity. Heisenberg's uncertainty principle and its physical significance (no derivation), Application of uncertainty principle – nonexistence of electron in the nucleus, Principle of complementarity, Wave function, properties and physical significance of a wave function and Born interpretation, Expectation value, Normalization of a wave function. Derivation of one dimensional time independent Schrodinger's wave equation. Eigen functions and eigen values. Applications of Schrodinger's wave equation- eigen functions and energy eigen values of a particle in a one dimensional potential well of infinite height. Finite potential well(qualitative) and quantum tunneling(qualitative), Numerical problems.

Pre-requisite: Wave particle dualism

Self learning: Franck-Hertz experiment and Davission and Germer experiment

UNIT–II	10 Hrs.

Laser: Introduction, interaction of radiation with matter (absorption, spontaneous emission and stimulated emission), Einstein's coefficients (expression for energy density), Conditions for laser action, requisites of a laser system, working mechanism, characteristics of a laser, classification of lasers. Construction and working of Nd:YAG, carbon dioxide and semiconductor diode lasers. Applications of lasers- industry, medical and defense (laser range finder) and laser printing, Numerical problems.

Optical fibers: Introduction, Total internal reflection, propagation mechanism in optical fibers, angle of acceptance, numerical aperture and its derivation, fractional index change, Modes of propagation (qualitative), V number and number of modes, types of optical fibers, attenuation and mention of expression for attenuation coefficient, attenuation spectrum of an optical fiber with optical windows. Applications-optical fiber communication system, merits and demerits, intensity based fiber optic displacement sensor. Numerical problems.

Pre-requisite: Properties of light

Self learning: Ruby laser, He-Ne laser and Total internal reflection in optical fiber

UNIT–III	10 Hrs.

Electromagnetism :

Fundamentals of vector calculus, Orthogonal co-ordinate systems: Cartesian, Spherical and Cylindrical, divergence and curl of electric and magnetic field, Gauss divergence theorem and stokes theorem, displacement current with derivation, Maxwell's equations in vacuum(qualitative). Numerical problems.

Dielectric materials: Polar and non-polar dielectrics. Dielectric constant, Dielectric polarization, polarization mechanisms (qualitative). Relation between dielectric constant and polarization. Internal field and derivation of internal field in solids and liquids (one dimensional). Clausius - Mossotti relation. Dielectric loss and its derivation, solid, liquid and gaseous dielectrics. Applications of dielectric in transformers, capacitors and electrical insulations. Numerical problems.

Pre-requisite : Electricity and magnetism, difference between insulator and dielectrics

Self learning : Electromagnetic spectrum, Coulomb's law, Biot Savarts law and dielectrics basics

UNIT–IV	10 Hrs.

Electrical properties of materials :

Quantum free electron theory-assumptions, Bose-Einstein and Fermi-Dirac distribution(qualitatively), Fermi energy, density of states (no derivation). Fermi factor and variation of Fermi factor with energy for different temperatures. Derivation of Fermi energy for 0K. Numerical problems.

Semiconductors: Concentration of electrons and holes in intrinsic and extrinsic semiconductors (qualitative). Law of mass action. Fermi level in intrinsic and extrinsic semiconductors (qualitative). Direct and indirect band gap semiconductors. Derivation of electrical conductivity for semiconductors. Hall effect, derivation of Hall voltage and Hall coefficient, experimental measurement of Hall voltage and Hall coefficient. Applications of Hall effect. Numerical problems.

Superconductivity: Introduction to superconductors, Temperature dependence of resistivity in conductors, semiconductors and superconductors, Meissner's effect, critical magnetic field, Silsbee effect, Type-I and Type-II superconductors, BCS theory (qualitative). Josephson junction, high temperature superconductors. Applications of superconductors- Maglev vehicle and SQUID. Numerical problems.

Pre-requisite: Classical free electron theory, basics of semiconductors

Self learning : Band theory of solids, superconducting magnets and loss less power transmission

Reference Books

1. M. N. Avadhanulu, P. G. Kshirsagar and T. V. S. Arun Murthy, 2019, "A Textbook of Engineering Physics" (11th edition), S. Chand, New Delhi,
2. Arthur Beiser, 2006, "Concepts of Modern Physics" (6th edition), TMH, New Delhi.
3. Kenneth Krane, 2006, "Modern physics" (2nd edition), John Wiely, New Delhi.
4. B.B. Laud, 2002, "Lasers and Non-Linear Optics" (2nd edition), New Age International Publishers, New Delhi,
5. K.R. Nambiar, 2006, "LASERS Principles, Types and Applications", New Age International Publishers, New Delhi,
6. B. P. Pal, 2015, "Fundamentals of Fibre Optics in Telecommunications and sensor systems" (2nd edition), New age international publishers, New Delhi.
7. David J. Griffiths, 2020, "Introduction to electrodynamics" (4th edition), Cambridge university press, New Delhi.
8. W. H. Hayt and J. A. Buck,2006, "Engineering Electromagnetics" (7th edition), TMH, New Delhi.
9. S. O. Piliai, 2010, "Solid State Physics" (6th edition), New Age International Publishers, New Delhi
10. R. K. Gaur and S. L. Gupta, 2018, "Engineering Physics" (8th edition), Dhanpat Rai Publications, New Delhi.

Web links and Video Lectures (e-Resources):

Laser: https://www.britannica.com/technology/laser,k

Laser: https://nptel.ac.in/courses/115/102/115102124/

Quantum mechanics :https://nptel.ac.in/courses/115/104/115104096/

Physics :http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Numerical Aperture of fiber :https://bop-iitk.vlabs.ac.in/exp/numerical-aperture-measurement

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning

http://nptel.ac.in

https://swayam.gov.in

https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

https://vlab.amrita.edu/index.php?sub=1&brch=189~=343&cnt=1

https://virtuallabs.merlot.org/vl_physics.html

https://phet.colorado.edu

https://www.myphysicslab.com

Laboratory Component:

Any Ten experiments have to be completed from the list of experiments

LIST OF EXPERIMENTS

1. Verification of Stefan's law
2. Determination of Planck's constant using LEDs
3. The study of characteristics of a laser
4. Determination of acceptance angle and numerical aperture of a given optical fiber
5. Determination of dielectric constant of a material in a capacitor by charging and discharging method
6. Determination of velocity of ultrasonic waves in a given liquid using ultrasonic interferometer
7. Determination of Fermi energy for a conductor
8. Determination of energy gap of a given semiconductor
9. The study of characteristics of a photodiode
10. The study of I-V characteristics of a given bipolar junction transistor
11. Determination of energy gap of a semiconductor by four probe method
12. The study of frequency response in series and parallel LCR circuits
13. Identification of passive components and estimation of their values in a given black box
14. Determination of magnetic flux density at any point along the axis of a circular coil
15. Step Interactive Physical Simulations
16. Study of motion using spread sheets
17. Study of application of statistics using spread sheets
18. PHET Interactive Simulations (https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

Course Outcomes:

At the end the course the student should be able to:

1. **Apply Schrodinger's wave equation for computing probability density and energy for one dimensional system.**
2. **Select appropriate properties of laser and type of optical fibers for engineering applications**
3. **Apply concepts of electromagnetism and appropriate properties of dielectrics for engineering applications**
4. **Select appropriate properties of conductors, semiconductors and superconductors for engineering applications**

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

22UPH106C/22UPH206C	PHYSICS FOR CIVIL SCIENCES (CV Branch) (Integrated)	Credits- 04
Hours/Week: (3:0:2)		CIE Marks:50
Total Hours: 60 Hrs (40L+20 P)		SEE Marks:50

Course Objectives:

1. **To study the properties, generation and engineering applications of types of oscillations and shockwaves**
2. **To study the basics of Laser and optical fiber and their engineering applications**
3. **To identify the importance of acoustics, radiometry and photometry for engineering applications**
4. **To study the elastic properties of materials and failures of engineering materials**
5. **To understand the various natural disaster and safety**

UNIT-I	10 Hrs.

Oscillations: Simple Harmonic motion (SHM), the differential equation for SHM(no derivation), Sprigs: Stiffness factor and its physical significance, series and parallel combination of springs(derivation), Types of spring and their applications. Theory of damped oscillations (Qualitative), Types of damping (Graphical approach). Engineering applications of damped oscillations, Theory of forced oscillations(Qualitative), resonance, sharpness of resonance. Numerical problems.

Laser: Introduction, absorption, spontaneous emission and stimulated emission, Einstein's coefficients (expression for energy density). Conditions for laser action, requisites of a laser system, working mechanism. Characteristics of a laser. Classification of lasers, Semiconductor laser, Laser range finder, LIDAR, Road profiling, Bridge deflection, Speed checker. Numerical Problems.

Pre-requisites: Basics of oscillations, properties of light
Self-learning: Simple harmonic motion, differential equation for SHM

UNIT–II	10 Hrs.

Optical fibers: Principle and construction of optical fibers, Acceptance angle and numerical aperture (NA), Expression for NA, Modes of propagation, Attenuation and Fiber losses, Fiber optic displacement sensor, Fiber optic temperature sensor, Numerical problems.

Acoustics: Introduction to acoustics, Types of acoustics, reverberation and reverberation time, absorption power and absorption coefficient, Requisites for acoustics in auditorium, Sabine’s formula (derivation), measurement of absorption coefficient, factors affecting the acoustics and remedial measures, Noise and its measurements, Sound insulation and its measurements. Impact of noise in Multi-storied buildings. Numerical problems.

Pre-requisites: Basics of Sound,
Self-learning: Introduction to acoustics, Propagation mechanism and TIR in optical fiber

UNIT–III	10 Hrs.

Elasticity: Stress-Strain Curve, Stress hardening and softening. Elastic moduli, Poisson's ratio, Relation between Y, n and σ (with derivation), mention relation between K, Y and σ, limiting values of Poisson's ratio., Single cantilever (derivation) and their Engineering Applications, Elastic materials (qualitative). Failures of engineering materials - Ductile fracture, Brittle fracture, Stress concentration, Fatigue and factors affecting fatigue (only qualitative explanation), Numerical problems.

Radiometry and Photometry: Radiation quantities, Spectral quantities, Relation between luminance and Radiant quantities, Reflectance and Transmittance, Photometry (cosine law and inverse square law).

Pre-requisites: Elasticity, Stress and strain
Self-learning: Stress-Strain curve

UNIT–IV	10 Hrs.

Shock waves: Mach number and Mach Angle, Mach Regimes, definition and characteristics of shock waves, Construction and working of Reddy shock tube, Applications of shock Waves, Numerical problems.

Natural hazards and Safety: Introduction, Earthquake, (general characteristics, Physics of earthquake, Richter scale of measurement and earthquake resistant measures), Tsunami (causes for tsunami, characteristics, adverse effects, risk reduction measures, engineering structures to withstand tsunami), Landslide (causes such as excess rainfall, geological structure, human excavation etc, types of landslide, adverse effects, engineering solution for landslides). Forest Fires and detection using remote sensing. Fire hazards and fire protection, fire-proofing materials, fire safety regulations and firefighting equipment - Prevention and safety measures.

Pre-requisite: Oscillations
Self-learning: Richter scale

Reference Books

1. R. Balasubramaniam, 2020, "Materials Science and Engineering", 9th edition, Wiley India Pvt. Ltd. Ansari Road, Daryaganj, New Delhi
2. M. N. Avadhanulu, P. G. Kshirsagar and T. V. S. Arun Murthy, 2019, "A Textbook of Engineering Physics" 11th edition, S Chand and Company Ltd. NewDelhi-110055.
3. R. K. Gaur and S. L. Gupta, 2010, "Engineering Physics", 8th edition, Dhanpat Rai publications Ltd., New Delhi
4. B. B. Laud, 2002, "Lasers and Non-Linear Optics", 2nd edition, New Age International
5. K.R. Nambiar, 2006, "Lasers Principles, Types and Applications", New Age International Publishers
6. Tor Eric Vigran, Taylor and Francis, 2019, "Building Acoustics", 1st Edition CRC Press
7. Micheal Bukshtab, 2012 "Photometry Radiometry and Measurements of Optical Losses", 2nd edition Springer
8. Chintoo S Kumar, K Takayama and K. P. J Reddy, 2014, "Shock waves made simple", Willey India Pvt. Ltd, Delhi
9. Edward Bryant, 2001 "Natural Hazards", 2nd Edition. Cambridge University Press
10. Ramesh P. Singh and Darius Bartlett, 2018, "Natural hazards, Earthquakes, Volcanoes, and landslides", 1st edition, CRC Press, Taylor and Francis group

Web links and Video Lectures (e-Resources):

Web links:

Simple Harmonic motion:https://www.youtube.com/watch?v=k2FvSzWeVxQ

Shock waves:https://physics.info/shock/

Shock waves and its applications:https://www.youtube.com/watch?v=tz_3M3v3kxk

Stress-strain curves:https://web.mit.edu/course/3/3.11/www/modules/ss.pdf

Stress curves:https://www.youtube.com/watch?v=f08Y39UiC-o

Oscillations and waves :https://openstax.org › books › college-physics-2e

Earthquakes:www.asc-india.org

Earthquakes and Hazards:http://quake.usgs.gov/tsunami

Landslide hazards:http://landslides.usgs.gov

Acoustics:https://www.youtube.com/watch?v=fHBPvMDFyO8

Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning

http://nptel.ac.in

https://swayam.gov.in

https://virtuallabs.merlot.org/vl_physics.html

https://phet.colorado.edu

https://www.myphysicslab.com

Laboratory Component:

Any Ten experiments have to be completed from the list of experiments

LIST OF EXPERIMENTS

1. Determination of effective spring constant of the given springs in series and parallel combination
2. Study of forced mechanical oscillations and resonance
3. The study of frequency response in series and parallel LCR circuits
4. Identification of passive components and estimation of their values in a given black Box
5. Characteristics of a Laser using diffraction grating
6. Determination of acceptance angle and numerical aperture of the given optical fiber
7. Determination of rigidity modulus of a wire by torsional pendulum method
8. Determination of Young's modulus of a metal strip by single cantilever method
9. Determination of Young's modulus of a material of the given bar by uniform bending
10. Determination of Fermi energy for a conductor

11. Determination of resistivity by four probe method
12. Determination of Planck's constant using LEDs
13. Determination of dielectric constant by RC charging and discharging method
14. Measurement of velocity of ultrasonic waves in a liquid using ultrasonic interferometer
15. Determination of viscosity of castor oil by Stokes method
16. Determination of radius of curvature of the given plano convex lens by setting Newton's Rings
17. Step interactive physics simulations
18. Study of motion using spread Sheets
19. Application of Statistics using Spread Sheet
20. PHET Interactive Simulations (https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

Course outcomes:

At the end of the course the student will be able to :

1. **Apply concepts of oscillations and select appropriate properties of lasers for engineering applications**
2. **Select the appropriate type of optical fiber and apply concepts of acoustics for engineering applications**
3. **Apply the concepts of elasticity, radiometry and photometry for engineering applications**
4. **Apply concepts of shockwaves, natural hazards and safety precautions for engineering applications**

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

22UPH107C/22UPH207C	PHYSICS FOR COMPUTER SCIENCES (CS, IS, AIML & BT branches) (Integrated)	Credits : 04
Hours/Week : (3:0:2)		CIE Marks : 50
Total Hours : 60 Hrs (40L+20 P)		SEE Marks : 50

Course objectives:

1. **To study the principles of quantum mechanics and its applications in quantum computing**
2. **To study the properties of conductors and superconductors for engineering applications**
3. **To study the basics of lasers and optical fibers for engineering applications**
4. **To study the essentials of physics for computational aspects like design and data analysis**

UNIT-I	10Hrs

Quantum mechanics: Introduction, de-Broglie hypothesis and matter waves, de-Broglie wavelength and derivation of expression by analogy. Phase velocity and Group velocity. Heisenberg's uncertainty principle and its physical significance (no derivation), Application of uncertainty principle (non-existence of electron in the nucleus), Principle of complementarity, Wave function, properties and physical significance of a wave function and Born interpretation, Expectation value, Normalization of a wave function. Derivation of one dimensional time independent Schrodinger's wave equation. Eigen functions and eigen values. Applications of Schrodinger's wave equation- eigen functions and energy eigen values of a particle in a one dimensional potential well of infinite height. Numerical problems.

Electrical properties of materials:

Quantum free electron theory – assumptions, Bose-Einstein and Fermi-Dirac distribution (qualitative), Fermi energy, Density of states(qualitative), Fermi factor and variation of Fermi factor with energy for different temperatures, Numerical problems.

Pre-requisite : Wave particle dualism, Basics of electrical conductivity

Self learning: Franck-Hertz experiment, CFET

UNIT-II	10Hrs

Quantum Computation:

Principles of quantum computation: Introduction to quantum computing, bit and qubits, Bloch sphere, multi-qubits

Dirac notation: Vector space, Bra-ket notation, inner and outer products, Hilbert space, Basis and linear dependence, orthonormal vectors, exploratory problems

Quantum operators: Projectors, operators, trace and tensor product, measurement, density operator, partial trace and partial transpose

Non-locality: Bells inequality and entanglement, entanglement measures

Quantum gates: Single, two, three qubit gates, quantum circuits, quantitative measures of quality of quantum circuits – gate count, garbage bit, quantum cost, depth and width of circuits, total cost, optimization rules

Quantum algorithms – Deutsch-Jozsa algorithms, Grover's algorithms

Statistical Physics for Computing: Descriptive statistics and inferential statistics, Poisson distribution and modelling the probability of proton decay, Normal Distributions (Bell Curves), Monte Carlo method, Determination of value of **π.** Numerical problems.

Pre-requisites: Matrices and probability

Self-learning: Moore's law

UNIT-III	10Hrs

Superconductivity: Introduction to superconductors, Temperature dependence of resistivity in conductors, semiconductor and superconductors, Meissner's effect, Critical magnetic filed, Temperature dependence of critical magnetic field, Silsbee effect, Type-I and Type-II superconductors, BCS theory (qualitative), High temperature superconductors, Quantum tunnelling, Josephson junction, DC and AC SQUIDs(qualitative), Applications of superconductors in quantum computing: Charge, Phase and Flux qubits. Numerical problems.

Laser: Introduction, interaction of radiation with matter (absorption, spontaneous emission and stimulated emission), Einstein's coefficients (expression for energy density), Conditions for laser action, requisites of a laser system, working mechanism, Characteristics of a laser, Classification of lasers. Construction and working of semiconductor diode laser. Applications of lasers- Bar code scanner, laser printer and laser cooling, Numerical problems.

Pre-requisite: Properties of light

Self learning: Maglev vehicles, superconducting magnets, Nd: YAG and Carbon dioxide lasers

UNIT-IV	10Hrs

Optical fibers: Introduction, Principle and structure, propagation mechanism in optical fibers, angle of acceptance, numerical aperture and its derivation. Modes of propagation (qualitative), types of optical fibers, attenuation and fiber losses, Applications-optical fiber communication and fiber optic networking, Numerical problems.

Physics of Animation: Taxonomy of physics based animation methods, Frames, Frames per second, Size and Scale, weight and strength, Motion and timing in animations, Constant force and Acceleration, The Odd rule, Odd – rule scenarios, Motion graphs, Examples of character animation: Jumping, Parts of Jump, Jump magnification, Stop time, Walking: Strides and Steps, Walk timing. Numerical problems.

Pre-requisites: Motion in one dimension

Self-learning: TIR, Frames, Frames per second

Reference Books

1. M. N. Avadhanulu, P. G. Kshirsagar and T. V. S. Arun Murthy, 2019, "A Textbook of Engineering Physics" (11th edition), S. Chand, New Delhi
2. Arthur Beiser, 2006, "Concepts of Modern Physics"(6th edition), TMH, New Delhi.
3. Kenneth Krane, 2006, "Modern physics"(2nd edition), John Wiely, New Delhi
4. A. Pathak, 2016, "Elements of Quantum Computation and Quantum Communication", CRC Press
5. M. A. Nielsen & I. L. Chuang, 2011, "Quantum Computation and Quantum Information"(10th edition), Cambridge university press, NY, USA
6. Preskill's lecture notes on "Quantum Information and Quantum Computation", http://theory.caltech.edu/~preskill/ph229/1998
7. P. Kaye, R. Laflamme and M. Mosca, 2010, "An introduction to Quantum Computing", Oxford University Press
8. N. D. Mermin, 2007, "Qunatum Computer Science An introduction", Cambridge university press, NY, USA
9. G. Benenti, G. Casati, and G. Strini, 2004, "Principles of Quantum Computation and Information"(Vol-1), World Scientific

10. W. H. Steeb and Y. Hardy, 2012, "Problems and Solutions in Quantum Computing and Quantum Information", World Scientific
11. Vishal Sahani, 2007, "Quantum Computing", McGraw Hill Education
12. F. Reif, 2007, "Statistical Physics: Berkely Physics Course", Volume 5, McGraw Hill
13. B.B. Laud, 2002, "Lasers and Non-Linear Optics"(2nd edition), New Age International Publishers, New Delhi
14. Michael Tinkham, 2010, "Introduction to Superconductivity"(2ndedition), McGraw Hill, INC
15. Michele Bousquet with Alejandro Garcia, 2016, "Physics for Animators", CRC Press, Taylor & Francis
16. S. O. Piliai,2010,"Solid State Physics"(6th edition), New Age International Publishers, New Delhi

Web links and Video Lectures (e-Resources):
LASER: https://www.youtube.com/watch?v=WgzynezPiyc

Superconductivity: https://www.youtube.com/watch?v=MT5Xl5ppn48

Optical Fiber: https://www.youtube.com/watch?v=N_kA8EpCUQo

Quantum Mechanics:https://www.youtube.com/watch?v=p7bzE1E5PMY&t=136s

Quantum Computing:https://www.youtube.com/watch?v=jHoEjvuPoB8

Quantum Computing:https://www.youtube.com/watch?v=ZuvCUU2jD30

Physics of Animation: https://www.youtube.com/watch?v=kj1kaA_8Fu4

Statistical Physics simulation:

https://phet.colorado.edu/sims/html/plinkoprobability/latest/plinkoprobability_en.html

NPTEL Supercoductivity:https://archive.nptel.ac.in/courses/115/103/115103108/

NPTEL Quantum Computing :https://archive.nptel.ac.in/courses/115/101/115101092

Virtual LAB:https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

Virtual LAB: https://vlab.amrita.edu/index.php?sub=1&brch=189&sim=343&cnt=

Activity-Based Learning (Suggested Activities in Class)/Practical-Based Learning
http://nptel.ac.in
https://swayam.gov.in
https://virtuallabs.merlot.org/vl_physics.html
https://phet.colorado.edu

Laboratory component:

Any Ten Experiments have to be completed from the list of experiments

List of Experiments

1. Verification of Stefan's law
2. Determination of Planck's constant using LEDs
3. Determination of Fermi energy for a conductor
4. The study of characteristics of a laser
5. Determination of acceptance angle and numerical aperture of a given optical fiber
6. Determination of energy gap of a given semiconductor
7. Determination of resistivity of a semiconductor by four probe method.
8. The study of characteristics of a photodiode
9. The study of I-V characteristics of a given bipolar junction transistor
10. Identification of passive components and estimation of their values in a given black box
11. The study of frequency response in series and parallel LCR circuits
12. Determination of dielectric constant of a material in a capacitor by charging and discharging method
13. Determination of magnetic flux density at any point along the axis of a circular coil
14. Determination of velocity of ultrasonic waves in a given liquid using ultrasonic interferometer
15. Step Interactive physical simulations
16. Study of motion using spread sheets
17. Study of application of statistics using spread sheets
18. PHET Interactive simulations. (https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

Course Outcomes:

At the end the course the student should be able to:

1. **Apply principles of quantum mechanics and properties of conductors for engineering applications**
2. **Apply basic principles of quantum and statistical computing for engineering applications**
3. **Select the appropriate properties of lasers and superconductors for engineering applications**
4. **Select appropriate type of optical fiber and apply physics of animation for engineering applications**

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

22UPH108C/22UPH208C	PHYSICS FOR MECHANICAL SCIENCES (ME & IP branches) (Integrated)	Credits -04
Hours/Week:(3:0:2)		CIE Marks:50
Total Hours: 60 Hrs (40L+20 P)		SEE Marks:50

Course Objectives:

1. **To study the properties, generation and engineering applications of types of oscillations and shock waves**
2. **To study the basics of lasers and their engineering applications**
3. **To study the elastic properties of materials and failures of engineering materials**
4. **To study the concepts of low temperature phenomena and generation of low temperature**
5. **To study the fundamentals of thermoelectric materials, devices and their applications**
6. **To study the various material characterization techniques**

UNIT – I	10 Hrs

Oscillations :

Oscillations: Simple Harmonic motion (SHM), differential equation for SHM (no derivation), Springs: Stiffness factor and its physical significance, series and parallel combination of springs (derivation), types of springs and their applications. Theory of damped oscillations (qualitative), types of damping (graphical approach). Engineering applications of damped oscillations. Theory of forced oscillations (qualitative), resonance, sharpness of resonance. Numerical problems.

Laser: Introduction, interaction of radiation with matter (absorption, spontaneous emission and stimulated emission), Einstein's coefficients (expression for energy density). Conditions for laser action, requisites of a laser system, working mechanism. Characteristics of a laser. Construction and working of carbon dioxide laser. Applications of lasers- industry (cutting, drilling and welding). Numerical problems.

Pre-requisite: Basics of oscillations, Waves and properties of light

Self learning: Simple harmonic motion, differential equation for SHM, Nd:YAG and semiconductor diode lasers

UNIT – II	10Hrs

Elasticity:

Stress-Strain Curve, Stress hardening and softening. Elastic Moduli, Poisson's ratio, relation between Y, n and σ (with derivation), relation between K, Y and σ, limiting values of Poisson's ratio, single cantilever(qualitative). Elastic materials (qualitative). Failures of engineering materials - ductile fracture, brittle fracture, stress concentration, fatigue and factors affecting fatigue (only qualitative explanation). Numerical problems.

Cryogenics :

Production of low temperature – Joule Thomson effect(qualitative), liquefaction of gases, liquefaction of Helium and its properties. Low temperature thermometry. Applications of cryogenics-superconducting magnets, aerospace and food preservation. Numerical problems.

Pre-requisites: Elasticity, stress and strain, basics of thermodynamics

Self learning: Stress-strain curve, laws of thermodynamics, Joule Thomson effect

UNIT – III	10 Hrs

Shock waves: Mach number and Mach angle, Mach regimes, definition and characteristics of shock waves. Construction and working of Reddy shock tube, applications of shock waves. Numerical problems.

Thermoelectric materials and devices:
Thermo emf and thermo current, Seeback effect, Peltier effect, Seeback and Peltier coefficients, figure of merit (mention expression), laws of thermoelectricity. Expression for thermo emf in terms of T1 and T2, thermo couples, thermopile. Construction and working of Thermoelectric generators (TEG) and Thermoelectric coolers (TEC), low, mid and high temperature thermoelectric materials. Applications: Exhaust of automobiles, Refrigerator, Space program (RTG). Numerical problems.
Pre-requisites: Basics of electrical conductivity
Self-learning: Thermo emf and thermo current

UNIT – IV	10Hrs

Material Characterization and Instrumentation Techniques:
Introduction to nanomaterials: Nanomaterials and nanocomposites. Principle, construction and working of X-ray diffractometer, crystallite size determination by Scherrer equation. Principle, construction, working and applications of Atomic Force Microscopy(AFM), X-ray Photo electron Spectroscopy(XPS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscopy(STM), Raman Spectrometer. Lithography technique and applications. Numerical problems.
Pre-requisites: Principle and working of optical microscope
Self-learning: X-ray diffractometer

Reference Books :

1 A. P. French, "Vibrations and Waves" (MIT introductory Physics Series),CBS, (2003 Edition)
2 Timoshenko, S. and Goodier J.N.2001 "Theory of Elasticity", (2nd Edition), McGraw Hill Book Co.
3 Sadhu Singh,1997, "Theory of Elasticity", Khanna Publishers
4 Wole Soboyejo, 2002, "Mechanical Properties of Engineered Materials" (1st edition), CRC Press.
5 Singhal, Agarwal & Satyaprakash,2006 "Heat & Thermodynamics and Statistical Physics" (18thEdition), Pragati Prakashan, Meerut
6 D. S. Mathur,1991 "Heat and Thermodynamics" (1st Edition) S.Chand & Company Ltd., New Delhi
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8 Bahman Zohuri, 2018, "Physics of Cryogenics", Elsevier
9 Sam Zhang, Lin Li, Ashok Kumar, 2008, "Materials Characterization Techniques" (1st edition), CRC Press.
10 Mitra P.K, 2014, "Characterization of Materials", Prentice Hall India Learning Private Limited .
11 M. S. Ramachandra Rao & Shubra Singh,2013, "Nanoscience and Nanotechnology Fundamentals to Frontiers", Wiley India Pvt Ltd.
12 Parameswaranpillai, N.Hameed, T.Kurian, Y. Yu, 2017, "Nano Composite Materials-Synthesis, Properties and Applications", CRC Press
13 Chintoo S Kumar, K Takayama and K P J Reddy, 2014, "Shock waves made simple", Willey India Pvt. Ltd, New Delhi.
14 M.N. Avadhanulu, P. G. Kshirsagar and T. V. S. Arun Murthy, 2019, "A Textbook of Engineering Physics" (11th edition), S. Chand, New Delhi.

Weblinks and Video Lectures (e-Resources):

Simple Harmonic Motion :https://www.youtube.com/watch?v=k2FvSzWeVxQ

Shock waves: https://physics.info/shock/

Shock waves and its applications: https://www.youtube.com/watch?v=tz_3M3v3kxk

Stress-strain curves: https://web.mit.edu/course/3/3.11/www/modules/ss.pdf

Stress curves: https://www.youtube.com/watch?v=f08Y39UiC-o

Fracture in materials : https://www.youtube.com/watch?v=x47nky4MbK8

Thermoelectricity :

https://www.youtube.com/watch?v=2w7NBuu5w9c&list=PLtkeUZItwHK5y6qy1GFxa4Z4RcmzU aaz6

Thermoelectric generator and coolers: https://www.youtube.com/watch? v=NruYdb31xk8

Cryogenics: https://cevgroup.org/cryogenics-basics-applications/

Liquefaction of gases: https://www.youtube.com/watch?v=aMelwOsGpIs

Virtual lab:https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

Material characterization:https://onlinecourses.nptel.ac.in/noc20_mm14/preview

https://www.encyclopedia.com/science-and-technology/physics/physics/cryogenics

https://www.usna.edu/NAOE/_files/documents/Courses/EN380/Course_Notes/Ch10_Deformation.pdf

Laboratory Component:

Any Ten experiments have to be completed from the list of experiments

LIST OF EXPERIMENTS
1. The study of forced mechanical oscillations and resonance 2. Determination of effective string constant of the given springs in series and parallel combinations 3. The study of characteristics of a laser 4. Determination of Young's modulus of metal strip by single cantilever method 5. Determination of rigidity modulus of a wire by torsional pendulum method 6. Determination of Young's modulus of a given metal strip by uniform bending method 7. Determination of specific heat of a solid by using calorimeter 8. Determination of viscosity of a given liquid by Stoke's method 9. The study of frequency response in series and parallel LCR circuits 10. Identification of passive components and estimation of their values in a given black box 11. Determination of velocity of ultrasonic waves in a given liquid using ultrasonic interferometer 12. Determination of dielectric constant of a material in a capacitor by charging and discharging method 13. Determination of Fermi energy for a conductor 14. Determination of energy gap of a semiconductor by four probe method

15. Determination of acceptance angle and numerical aperture of a given optical fiber
16. Determination of the radius of curvature of a given planoconvex lens by Newton rings method
17. Step Interactive physical simulations
18. Study of motion using spread sheets
19. Study of application of statistics using spread sheets
20. PHET Interactive simulations
(https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype)

Course outcomes:

At the end of the course the student will be able to:

1. **Apply concepts of oscillations and select appropriate properties of lasers for engineering applications**
2. **Apply concepts of elasticity and generation of low temperature for engineering applications**
3. **Select appropriate properties of thermoelectric materials and shock waves for engineering applications**
4. **Apply material characterization techniques for engineering materials**

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