BPHS102C/ BPHS202C	APPLIED PHYSICS FOR COMPUTER SCIENCE AND ENGINEERING STREAM (CS, IS, AIML & BT Branches) (Integrated)	Credits - 04
Hours/Week:(3:0:2)		CIE Marks: 50
Total Hours:60Hrs(40L+20P)		SEE Marks: 50

Course Objectives:

1. To study the basics of laser, optical fibers and their applications
2. To study the principles of quantum mechanics and its applications
3. To study the principles of quantum computation and its applications
4. To study the electrical properties and applications of conductors and superconductors
5. To study the essentials of physics for computational aspects like design and data analysis

MODULE – I	8 Hrs

Laser and Optical Fibers:

Laser: Introduction, interaction of radiation with matter (absorption, spontaneous emission and stimulated emission), Einstein's coefficients (derivation 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- laser bar code scanner, laser printer and laser cooling. Numerical problems.

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 system and fiber optic networking. Numerical problems.

Pre requisite: Properties of light

Self-learning: Ruby laser and Snell's law

MODULE – II	8 Hrs

Quantum Mechanics:

Introduction, de-Broglie hypothesis, matter waves and its properties, de-Broglie wavelength and its derivation, phase velocity, group velocity and wave packet, relation between group velocity and particle 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's interpretation. Derivation of one dimensional time independent Schrodinger's wave equation. Expectation value, normalization of a wave function. 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, wave forms and probability densities. Numerical problems.

Pre requisite: Wave–Particle dualism

Self-learning: Franck-Hertz experiment and Davisson and Germer experiment.

MODULE – III	8 Hrs

Quantum Computing:

Principles of quantum information and quantum computing: Introduction to quantum computing, Moore's law and its violation, differences between classical and quantum computing. Concept of qubit and its properties. Representation of qubit on Bloch sphere. single and two qubits. Extension to N qubits.

Dirac representation and matrix operations:

Dirac's bra- ket representation of quantum states $|0\rangle$ and $|1\rangle$, their matrix forms.

Inner product- Proof of orthonormality of quantum states using matrix notation and basis.

Outer product- Density matrix representation of two dimensional quantum states. Unitary matrices- Pauli matrices and their operation on quantum $|0\rangle$ and $|1\rangle$. Numerical problems.

Quantum gates:

Single qubit gates: quantum NOT gate, Pauli –X,Y and Z gates, Hadamard gate, phase gate - S and T gates.

Multiqubit gates: control and target qubit, CNOT gate (discussion for 4 different input states), Swap gate, controlled Pauli –X,Y and Z gates, Toffoli gate.

Pre requisites: Matrices

Self-learning: Vector notion of quantum states

MODULE – IV	08 Hrs
Electrical properties of materials and applications: **Electrical conductivity in metals:** Introduction, resistivity and mobility, Matheissen's rule, failures of classical free electron theory. Assumptions of quantum free electron theory, Fermi energy, density of states (qualitative), Fermi factor, variation of Fermi factor with temperature and energy. Numerical problems. **Superconductivity:** Introduction to superconductors, temperature dependence of resistivity in conductors and superconductors, Meissner's effect, critical magnetic field, 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(RF) SQUIDs (qualitative). Applications of superconductors in quantum computing: charge, phase and flux qubits. Numerical problems. **Pre requisites: Basics of electrical conductivity** **Self-learning: Bose-Einstein and Fermi-Dirac statistics**	
MODULE – V	**08 Hrs**
Applications of physics in computing: **Physics of Animation:** Introduction, 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. **Statistical physics for computing**: Descriptive statistics and inferential statistics, Poisson distribution and modeling the probability of proton decay, normal distributions (Bell curves), Monte Carlo method: Determination of value of π. Numerical problems. **Pre requisites: Motion in one dimension, probability** **Self-learning: Basics of statistics.**	

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(2nd edition), 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 Vedio Lecturers (e-Rosources)

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/plinko-probability/latest/plinko-probability_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=1
Activity based learning (suggested activities in class)/ practical based learning
http://nptel.ac.in,https://swayam.gov.i
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 wavelength of laser using diffraction grating
2. Determination of acceptance angle and numerical aperture of the given optical fiber
3. Verification of Stefan's law
4. Determination of Planck's constant using LEDs
5. Determination of Fermi energy of copper
6. Determination of resistivity of a semiconductor by four probe method
7. Determination of energy gap of the given semiconductor
8. Study the characteristics of a photodiode and to determine the power responsivity.
9. Study the frequency response of series and parallel LCR circuits
10. Identification of passive components and estimation of their values in a given black box
11. Determination of dielectric constant of the material of capacitor by charging and discharging method
12. Determination of magnetic flux density at any point along the axis of a circular coil
13. Step interactive physical simulations
14. Study of motion using spread sheets
15. Study of application of statistics using spread sheets
16. 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:

CO1: Select appropriate properties of laser and type of optical fiber for engineering applications

CO2: Apply Schrödinger's wave equation for computing probability density and energy for one dimensional system

CO3: Apply basic principles of quantum computing for engineering applications

CO4: Select appropriate properties of conductors and superconductors for engineering applications

CO5: Apply basic principles of animation and statistical computing 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	-	-	1
CO4	3	2	-	-	1	-	-	-	1	-	-	1
CO5	3	2	-	-	1	-	-	-	1	-	-	1