Semester: I/II			
Course Title	Applied Physics for Computer Science & Engineering Stream	**CIE Marks**	50
Course Code	BCSPHY102/202	**SEE Marks**	50
Course Type	Integrated	**Total Marks**	100
Course Category	ASC	**SEE Duration**	03 hrs
Hours Per Week	2L:2T:2P	**SEE Type**	Written
Total Hours	40 hrs of theory + 18-20 hrs of practical sessions	**Credits**	04

Course Learning Objectives
This course will enable the students to
• Understand the concepts of photonics, quantum mechanics, quantum computing and electrical properties.
• Study the concepts of Physics of Animation, Statistical Physics for Computing
• Study the various relevant applications of quantum computing and statistical analysis
• Understand the Practical importance, precise measurements and analysis of the experimental results.
Pre-Requisites
• Properties of light, Wave–Particle dualism, Matrices, Basics of Electrical conductivity, Motion in one dimension, and Concept of Probability

Module-1: Laser and Optical Fibers	**(8 hrs)**
Laser: Interaction of Radiation with Matter, Characteristic properties of a LASER beam, Einstein's Coefficients and Expression for Energy Density of Radiation (Derivation), Population Inversion, Metastable State, Requisites of a laser system and Laser Action. Construction and working of Semiconductor Diode Laser, Applications: Barcode scanner and Laser printer. Numerical Problems. **Optical Fiber:** Principle and Structure, Propagation of Light, Acceptance angle and Numerical Aperture (Derivation), V-number, Modes of Propagation, Classification of Optical Fibers, Attenuation and its mechanisms. Applications: Point to Point communication - merits and demerits, Numerical Problems. **Self-learning:** Total Internal Reflection	
Module-2: Quantum Mechanics	**(8 hrs)**
de Broglie hypothesis, Matter waves and their properties, de Broglie wavelength and derivation of expression by analogy. Heisenberg's Uncertainty Principle and its application (Non-existence of electron inside the nucleus: non-relativistic case). Wave Function and its properties. Time independent Schrodinger wave equation (Derivation), Physical Significance of a wave function- Born Interpretation. Eigen functions and Eigen Values, Particle in one dimensional infinite potential well, quantization of energy States, waveforms and probabilities. Numerical Problems. **Self-learning:** de Broglie Hypothesis	
Module-3: Quantum Computing	**(8 hrs)**
Principles of Quantum Information & Quantum Computing: Introduction to Quantum Computing, Moore's law & its end, Differences between Classical & Quantum computing. Concept of qubit and its properties. Representation of qubit by Bloch sphere. Single qubit, two qubit and extension to N qubits. **Dirac representation and matrix operations**: Matrix representation of 0 and 1 States, Identity Operator I, Applying I to $\|0\rangle$ and $\|1\rangle$ states, Pauli Matrices and its operations on $\|0\rangle$ and $\|1\rangle$ states. Conjugate of a matrix, Transpose of a matrix. Hermitian and Unitary matrix, Inner Product and examples. Probability,	

Quantum Superposition and Normalization rule. Orthogonality and Orthonormality. Numerical Problems.

Quantum Gates: Single Qubit Gates: Quantum Not Gate, Pauli – X, Y and Z Gates, Hadamard Gate. Multiple Qubit Gates: Controlled gate, CNOT Gate, (Discussion for 4 different input states). Representation of Swap gate, Controlled -Z gate, Toffoli gate.

Self-learning: Moore's law

Module-4: Electrical Properties of Materials and Applications	**(8 hrs)**

Electrical conductivity in metals: Concept of Phonon, Assumptions of Quantum Free Electron Theory (QFT), Success of QFT (Dependence of temperature and electron concentrations on conductivity). Fermi Energy and Density of States (Qualitative), Fermi Factor and its Temperature dependence. Numerical Problems.

Superconductivity: Introduction, Matthiessen's rule, Temperature dependence of resistivity. BCS theory (Qualitative), Properties of Superconductors: Meissner's Effect, Critical Field, Temperature dependence of Critical field. Types of Superconductors, High Temperature superconductivity (Qualitative). Quantum Tunnelling, Josephson Junctions (Qualitative), Application of superconductors: Superconducting Quantum Interference device (SQUID), Numerical Problems.

Self-learning: Resistivity and Mobility

Module-5: Applications of Physics in Computing	**(8 hrs)**

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

Statistical Physics for Computing: Descriptive statistics and inferential statistics, Poisson distribution. Normal Distributions (Bell Curves), Monte Carlo Method: Determination of Value of π. Numerical Problems.

Self-learning: Frames, Frames per Second

Practical Components

Experiments are categorized into 1. Exercise 2. Open ended 3. Demonstration.

Any ***Ten*** Experiments to be conducted by selecting ***six*** experiments from ***Exercise***, ***two*** from ***Open ended*** & ***two*** from ***Demonstration***

Sl. No.	**Experiments for Conduction/ Exercise**
1.	Determination of wavelength of LASER using Diffraction Grating.
2.	Determination of acceptance angle and numerical aperture of the given Optical Fiber.
3.	Determination of Magnetic Flux Density at any point along the axis of a circular coil.
4.	Determination of Fermi Energy of Copper.
5.	Determination of dielectric constant of the material of capacitor by Charging and Discharging method.
6.	Study the Characteristics of a Photo-Diode and to determine the power responsivity / Verification of Inverse Square Law of Intensity of Light
7.	Determination of Energy gap of the given Semiconductor.
8.	Determination of Planck's constant
Open ended Experiments	
1.	Identification of circuit elements in a Black Box and determination of values of the components.

2.	Study of motion using spread Sheets
3.	Study the I-V Characteristics of the Given Bipolar Junction Transistor.
4.	Step Interactive Physical Simulations
Experiments for Demonstration	
1.	Study the frequency response of Series & Parallel LCR circuits
2.	Study of Application of Statistics using spread sheets
3.	Determination of resistivity of a semiconductor by Four Probe Method
4.	PHET Interactive

Text Books:	
1.	"A textbook of Engineering Physics" by M. N. Avadhanulu, P. G. Kshirsagar and T V S Arun Murthy S, Chand and Company Ltd,11th Edition, New Delhi
2.	"Engineering Physics" by R. K. Gaur and S. L. Gupta Dhanpath Rai and Sons, New Delhi
3.	"Quantum Computing" by Vishal Sahani McGraw Hill Education
4.	"Physics for Animators" by Michele Bousquet with Alejandro Garcia, CRC Press, Taylor & Francis
5.	"Concepts of Modern Physics" by Aurthur Beiser McGraw-Hill, 6th Edition
Reference Books:	
1.	"Solid State Physics" by S O Pillai, New Age International Private Limited
2.	"Engineering Physics" by S P Basavaraju, Subhash Publication
3.	"Quantum Computation and Quantum Information" by Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press
4.	"Lasers and Non-Linear Optics" by B B Laud, New age international

Course Outcome Statements: After the successful completion of the course, the student will be able to	
CO1	Describe the concepts of Laser, Optical Fibers, Quantum & statistical Mechanics, quantum computing, Electrical Properties of materials and physics of animation.
CO2	Apply the concepts of Laser, Optical Fibers, Quantum & statistical Mechanics, quantum computing, Electrical Properties of materials and physics of animation to tackle engineering problems.
CO3	Analyze the optical, electrical properties of materials, quantum computing and statistical approaches in computing by Solving Numerical.
CO4	Determine and interpret the physical properties of the materials and devices by conducting the experiments.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	-	2	-	-	-	-	-	-	-	-	-	1
CO3	-	2	-	-	-	-	-	-	-	-	-	1
CO4	-	2	1	-	1	-	-	1	1	-	-	1
Avg.	3	2	1	-	1	-	-	1	1	-	-	1

3: High, 2: Medium, 1: Low