Course Title	**Applied Physics for Computer Science Stream**	Semester	I/II
Course Code	**BPHYS102/ BPHYS202**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	2:2:2:0	Exam Hours	03
Total Hours of Pedagogy	40 hours Theory + 10 to12 Lab slots	Credits	04

Course Learning Objectives

CLO 1. To study the essentials of photonics and its application in computer science.

CLO 2. To study the principles of quantum mechanics and its application in quantum computing.

CLO 3. To study the electrical properties of materials

CLO 4. To study the essentials of physics for computational aspects like design and data analysis.

CLO 5. To conduct experiments in physics and measure the precise quantities.

Teaching-Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. Flipped Class

2. Chalk and Talk

3. Blended Mode of Teaching and Learning

4. Simulations, Interactive Simulations and Animations

5. NPTEL and Other Videos for theory topics

6. Smart Class Room

7. Lab Experiment Videos

8.Self-study motivation

9.Group Discussion

10.Seminars

Module-1: LASER AND OPTICAL FIBERS (8 hours)

Self-study: Interaction of Radiation with Matter

LASER: Characteristic properties of a LASER beam, Interaction of Radiation with Matter, Einstein's A and B Coefficients and Expression for Energy Density (Derivation), Population Inversion, Requisites of a laser system, Homojunction and Heterojunction (Qualitative), Semiconductor Diode Laser, Applications: Bar code scanner and Laser Printer (Qualitative), Numerical Problems.
Optical Fiber: Principle and structure, Acceptance angle and Numerical Aperture (NA) and derivation of Expression for NA, Classification of Optical Fibers, Attenuation and Fiber Losses, Applications: Fiber Optic Communication. Numerical Problems.

Applications: Communication, LIDAR
(RBT Levels: L1, L2 and L3)

Module-2: QUANTUM MECHANICS (8 hours)

Self-study: de Broglie hypothesis

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 application (Nonexistence of electron inside the nucleus-Non Relativistic). Wave Function, Time independent Schrodinger wave equation, Physical Significance of a wave function and Expectation value, Eigen functions and Eigen Values, Motion of a particle in a one dimensional potential well of infinite depth , Waveforms and Probabilities. Numerical Problems

Applications: Scanning electron microscope
(RBT Levels: L1, L2 and L3)

Module-3: QUANTUM COMPUTING (8 HOURS)

Self-study: Moore's law

Quantum Computing: 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 and Two qubits. Extension to N qubits.
Dirac representation and matrix operations: Matrix representation of 0 and 1 States, Identity Operator I, Applying I to|0⟩and |1⟩ states, Pauli Matrices and its operations on |0⟩and |1⟩states, Explanation of i) Conjugate of a matrix and ii) Transpose of a matrix. Unitary matrix U, Examples: Row and Column Matrices and their multiplication (Inner Product), Probability, and Quantum Superposition, normalization rule. Orthogonality, Orthonormality. Numerical Problems **Quantum Gates:** Single Qubit Gates: Quantum Not Gate, Pauli – X, Y and Z Gates, Hadamard Gate, Phase Gate (or S Gate), T Gate Multiple Qubit Gates: Controlled gate, CNOT Gate, (Discussion for 4 different input states). Representation of Swap gate, Controlled -Z gate, Toffoli gate

Applications: Quantum computers

(RBT Levels: L1, L2 and L3)

Module-4: ELECTRICAL PROPERTIES OF MATERIALS AND APPLICATIONS (8 hours)

Self-study: Basics of electrical conductivity

Conductors: Electrical conductivity in metals, Resistivity, Mobility. Concept of phonon, Assumptions of Quantum Free Electron Theory, Fermi Energy, Density of States, Fermi Factor, Variation of Fermi Factor with Temperature and Energy. Numerical Problems.

Semiconductors: Expression for electrical conductivity for intrinsic and extrinsic semiconductor (derivation). Photodiode and Power responsivity. Hall Effect in semiconductor, Expression for Hall coefficient and Hall voltage, Applications of Hall effect, Numerical problems.

Superconductors: Introduction to Super Conductors, Temperature dependence of resistivity, Meissner's Effect, Critical Field, Temperature dependence of Critical field, Types of Super Conductors, BCS theory (Qualitative), Quantum Tunnelling, High Temperature superconductivity, Josephson Junctions (Qualitative), DC and RF SQUIDs (Qualitative), Applications in Quantum Computing: Charge, Phase and Flux qubits, Numerical Problems.

Applications: Electronics industry, Maglev Vehicles
(RBT Levels: L1, L2 and L3)

Module-5: APPLICATIONS OF PHYSICS IN COMPUTING (8 hours)

Self-study: Frames, Frames per second

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, 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.

Applications: Games, Animations
(RBT Levels: L1, L2 and L3)

List of Laboratory experiments (2 hours/week per batch/ batch strength 15)
10 lab sessions + 1 repetition class + 1 Lab Assessment

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 resistivity of a semiconductor by Four Probe Method
5. Study the I-V Characteristics of the Transistor.
6. Determination of dielectric constant of the material of capacitor by Charging and Discharging method.
7. Study the frequency response of Series & Parallel LCR circuits.
8. Determination of Fermi Energy of Copper.
9. Identification of circuit elements in a Black Box and determination of values of the components.
10. Study of motion using spread Sheets

Suggested software: PSPICE , Virtual lab

Course outcome

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

1. For a given specifications of laser **determine** population ratio, wavelength, power and for a given specifications classify optical fibers, **determine** numerical aperture, V-number and attenuation coefficient.

2. **Employ** de Broglie hypothesis to **deduce** Schrodinger wave equation and **Solve** Schrodinger wave equation for a particle in one dimensional infinite potential well.
3. **Apply** advanced quantum mechanics to **construct** quantum gates- Pauli Gates, Hadamard Gate, Phase Gate T Gate, Controlled gate, CNOT Gate, Swap gate, Controlled -Z gate, Toffoli gate and study **operation** of these quantum gates.
4. For given specification, **compute** fermi factor for conductor, electrical conductivity, Hall coefficient for semiconductor and critical field for superconductor.
5. **Employing** equations of motion d**etermine** number frames, base distance jump height, push acceleration and **employing** distribution, **model** proton decay and **determine** π value.
6. **Practice** working in groups to conduct experiments in physics and perform precise and honest measurements.

Course Assessment and Evaluation Details (both CIE and SEE)

Continuous Internal Evaluation: 50 marks		
Theory Assessment Tool	**Marks**	**Reduced marks**
IAT-1	25	15
IAT-2	25	
Assessment -1(activity based)	25	10
Assessment -2(activity based)	25	
Lab Assessment Tool	**Marks**	**Reduced marks**
Conducting Experiment and Laboratory Record(10 labs)	15(each lab)	15
Lab Test	10	10
Semester End Examination (SEE) : 50 marks		
SEE	**Marks**	**Reduced marks**
Course end examination (Answer any one question from each unit – Internal choice)	100	50

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

1. Circuit design of LCR circuit using Pspice and study frequency response curve
2. Circuit design of Transistor characteristics using Pspice and study I-V characteristics
3. Seminars on Animations
4. Problem solving exercises
5. Quiz
6. Reports on Guest lectures/ industry visit
7. Creating animation

http://nptel.ac.in
https://swayam.gov.in
https://virtuallabs.merlot.org/vl_physics.html
https://phet.colorado.edu
https://www.myphysicslab.com

Suggested Learning Resources

Text Books

1. Engineering Physics by Gupta and Gour, Dhanpat Rai Publications, 2016 (Reprint).

2. A Textbook of Engineering Physics by M.N. Avadhanulu, P G. Kshirsagar and T V S Arun Murthy revised edition 2019,S Chand and Company Ltd. New Delhi-110055.
3. Engineering Physics, S P Basavaraj, 2005 Edition & 2018 Edition Subhash Stores.

Reference Books

1. Solid State Physics, S O Pillai, New Age International Private Limited, 8th Edition, 2018.
2. Concepts of Modern Physics, Aurthur Beiser, McGrawhill, 6th Edition, 2009.
3. Lasers and Non Linear Optics, B B Loud, New age international, 2011 edition.
4. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press, 2010 Edition. 3 16-2-2023 4
5. Quantum Computing, Vishal Sahani, McGraw Hill Education, 2007 Edition.
6. Quantum Computing – A Beginner's Introduction, Parag K Lala, Indian Edition, Mc GrawHill, Reprint 2020.
7. Physics for Animators, Michele Bousquet with Alejandro Garcia, CRC Press, Taylor & Francis, 2016.
8. Quantum Computation and Logic: How Quantum Computers Have Inspired Logical Investigations,Maria Luisa Dalla Chiara, Roberto Giuntini, Roberto Leporini, Giuseppe Sergioli,TrendsinLogic, Volume 48, Springer, 2015
9. Statistical Physics: Berkely Physics Course, Volume 5, F. Reif, McGraw Hill. 14. Introduction to Superconductivity, Michael Tinkham, McGraw Hill, INC, 2010

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

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

Cos and POs Mapping (CO-PO mapping are only Indicative)

COs	POs											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3		3					2		2
CO2	3	3	3		3					2		2
CO3	3	3	3		3					2		2
CO4	3	3	3		3					2		2
CO5	3	3	3		3					2		2
CO6	3	3	3		3			2	2	2		2

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped