Course Title:	**Applied Physics for EEE Stream**	Semester	**I/II**
Course Code:	**BPHYE102/BPHYE202**	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 principles of Photonic devices
CLO 2. To study the principles of quantum mechanics
CLO 3. To understand fundamentals of vector calculus and EM waves.
CLO 4. To understand the properties of conductors, dielectrics and superconductors.
CLO 5. To study the knowledge about semiconductors and devices.
CLO 6. To conduct experiments in physics and measure precise quantities.

Teaching-Learning Process

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. Quiz

11. 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: MAXWELL'S EQUATIONS AND EM WAVES (8 hours)

Self-study: Fundamentals of vector calculus

Maxwell's Equations: Fundamentals of Vector Calculus. Divergence and Curl of Electric field and Magnetic field (static), Gauss' divergence theorem and Stoke's theorem. Description of laws of Electrostatics, Magnetism, Faraday's laws of EMI, Current Density, Equation of Continuity, Displacement Current (with derivation), Maxwell's equations in vacuum, Numerical Problems **EM Waves:** The wave equation in differential form in free space (Derivation of the equation using Maxwell's equations), Plane Electromagnetic Waves in vacuum, their transverse nature.

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

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

Self-study: Quantum free electron theory

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.
Dielectric Properties: Polar and non-polar dielectrics, Electrical Polarization Mechanisms, internal fields in solids, Clausius-Mossotti equation (Derivation), Solid, Liquid and Gaseous dielectrics.

Application of dielectrics in transformers, Capacitors, Electrical Insulation. 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 Applications Maglev and SQUID. Numerical Problems.

Applications: Maglev Vehicles, Tunnel Diodes
(RBT Levels: L1, L2 and L3)

Module-5: SEMICONDUCTORS AND DEVICES (8 hours)

Self-study: Fermi level in intrinsic and extrinsic semiconductor

Fermi level in Intrinsic & Extrinsic Semiconductor, Expression for concentration of electrons in conduction band & holes concentration in valance band (only mention the expression), Relation between Fermi energy & Energy gap in intrinsic semiconductors(derivation), Law of mass action, Electrical conductivity of a semiconductor (derivation), Hall effect, Expression for Hall coefficient (derivation) and its application. Photo-diode and Power responsivity, Four probe method to determine resistivity, Phototransistor, Numerical problems.

Applications: Optoelectronics device
(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 outcomes

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

1. For a given specifications of laser **determine** population ratio, wavelength, and power, 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. **Employ** Ampere's Law, Gauss Laws and Faraday's law to **deduce** Maxwell's equations and **analyze** the solution.
4. For given specification, **compute** fermi factor for conductor, polarization for dielectrics and critical field for superconductor
5. **Determine** electrical conductivity, Hall coefficient and **demonstrate** semiconductor devices - photodiode, phototransistor, four probe setup
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 circuits using Pspice and study frequency response curve
2. Understand Instrumentation techniques using virtual lab
3. Conduct Study of Transistor Characteristics using virtual lab
4. Seminars on semiconductor devices- Photo-diode and Power responsivity, Four probe method to determine resistivity, Phototransistor
5. Problem solving exercises
6. Quiz
7. Reports on Guest lectures/ industry visit

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

Suggested Learning Resources:

Text Books

1. A Textbook of Engineering Physics- M.N. Avadhanulu and P.G. Kshirsagar, 10th revised Ed, S. Chand. & Company Ltd, New Delhi 2010
2. Engineering Physics-Gaur and Gupta-Dhanpat Rai Publications-2017.
3. Engineering Physics, S P Basavaraj, 2005 Edition, Subhash Stores.

Reference Books

1. An Introduction to Lasers theory and applications by M.N.Avadhanulu and P.S. Hemne revised Edition 2012. S. Chand and Company Ltd -New Delhi.
2. Concepts of Modern Physics-Arthur Beiser: 6th Ed;Tata McGraw Hill Edu Pvt Ltd- New Delhi 2006.
3. Fundamentals of Fibre Optics in Telecommunication & Sensor Systems, B.P. Pal, New Age International Publishers. 2015
4. Introduction to Electrodynamics, David Griffith, 4th Edition, Cambridge University Press 2017.
5. Lasers and Non Linear Optics – B.B. Laud, 3rd Ed, New Age International Publishers 2011.

6. LASERS Principles, Types and Applications by K.R. Nambiar-New Age International Publishers. 2014
7. Solid State Physics-S O Pillai, 8th Ed- New Age International Publishers-2018.

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
- NPTEL Supercoductivityc:https://archive.nptel.ac.in/courses/115/103/115103108/
- 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 mappings 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