Dr. Ambedkar Institute of Technology, Bengaluru-56
Department of Physics
Scheme and Syllabus-2025-2026

Course Title	**Physics Of Electrical And Electronic Materials**						
Course Code	**1BPHU202E (EEE)**						
Category	Applied Science Course (ASC) (Integrated Course)						
Scheme and Credits	No. of Hours / Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	00	02	00	05	40 + 10 – 12 labs	04
CIE Marks: 50	**SEE Marks: 50**		**Total Max. Marks =100**		**Duration of SEE: 03 Hours**		

Course Objective: To introduce the Engineering students to the basics of Quantum Mechanics, Electrical Properties of Metals and Semiconductors, Superconductivity, Dielectric and Magnetic Materials, Thermoelectric materials and devices, with an emphasis on inculcating strong analytical skills among them so that they can understand and analyze complex engineering problems with relative ease**.**

Unit No.	Syllabus Content	No. of Teaching Hours
1	**Quantum Mechanics:** de Broglie hypothesis, Heisenberg's uncertainty principle and its application (Broadening of Spectral Lines), principle of complementarity, wave function, time independent Schrödinger wave equation (Derivation), physical significances of a wave function and Born Interpretation, expectation value and its physical significance, Eigen functions and Eigen values, Particle inside one dimensional infinite potential well, role of higher dimensions (Qualitative), Wave function and probability densities for n=1, 2 and 3. Quantum tunneling, Numerical Problems.	**8**
2	**Electrical Properties of Metals and Semiconductors:** Assumptions and failures of classical free electron theory, mechanisms of electron scattering in solids, Matheissen's rule, assumptions of Quantum free electron theory, density of states (Qualitative), Fermi	**8**

	Dirac statistics, Fermi Energy (no derivation), variation of Fermi factor with temperature and energy, expression for carrier concentration: derivation of electron and hole concentrations in an intrinsic semiconductor, Fermi level for intrinsic (derivation) and extrinsic semiconductor (no derivation), Hall effect (derivation), Numerical Problems.	
3	**Superconductivity** Zero resistance state, persistent current, Meissner effect, critical temperature, critical current (Silsbee Effect). Formation of Cooper pairs - BCS Theory (Qualitative) Limitations of BCS theory, high temperature superconductors, Type-I and Type-II superconductors, Formation of Vortices, Explanation for upper critical field, Cooper pair Tunneling (Andreev reflection), Josephson junction (AC and DC), Flux quantization, SQUID (DC), Numerical Problems.	**8**
4	**Dielectric and Magnetic Materials:** **Dielectrics:** Introduction, Electrical Polarization Mechanisms, Internal fields in solids (qualitative), Clausius-Mossotti relation (Derivation) and its implications, Properties and Frequency dependence of Dielectric constant, Dielectric loss, Solid, Liquid and Gaseous dielectrics. Application of dielectrics in Capacitors, Transformers (Oils). Numerical Problems. **Magnetic material:** Classification of magnetic materials, Weiss Molecular field theory of ferromagnetism (Qualitative), Importance of Curie Temperature, Ferromagnetic Hysteresis and Explanation using Domain theory, Energy loss, Hard and soft ferromagnetic materials and Applications, Numerical Problems	**8**
5	**Thermoelectric materials and devices:** Thermo emf and thermo current, Seebeck effect, Peltier effect, Seebeck 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	**8**

	Thermoelectric generators (TEG) and Thermoelectric coolers (TEC), low, mid and high temperature thermo electric materials, Applications: Exhaust of Automobiles, Refrigerator, Space Program (Radioisotope Thermoelectric Generator), Numerical Problems	

Experimental Components:

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

1. Series & Parallel LCR Circuits
2. Determination of Fermi energy of a copper.
3. Wavelength of LASER using Grating
4. Numerical Aperture using optical fiber
5. Charging and Discharging of a Capacitor
6. Energy Gap of the given Semiconductor
7. Planck's constant using LEDs.
8. Transistor Characteristics
9. Zener Diode Characteristics
10. Radius of curvature of Plano convex lens using Newton's rings
11. GNU Step Interactive Simulations
12. Study of Electrical quantities using spreadsheet
13. OnlineCircuitSimulatorOnlineCircuitSimulator(https://www.partsim.com/simulator)
14. PHET Interactive Simulations (https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype)

Teaching and Learning Process: Chalk and Talk, Power Point presentation and Lab Experiment Videos.

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Engineering Physics, Satyendra Sharma and Jyotsna Sharma, Pearson, 2018

2. Solid State Physics-S O Pillai, 8th Ed- New Age International Publishers-2018.

3. Engineering Physics, Satyendra Sharma and Jyotsna Sharma, Pearson, 2018.

4. A Text book of Engineering Physics by M.N. Avadhanulu, P G. Kshirsagar, S Chand, 2014, Revised Edition.

5. Quantum Physics and Applications, Dr. Geethanjali H. S., Dr. Nagaraja D., Jeevith Publications

Reference books / Manuals:

1. Beiser, A. (2002). Concepts of Modern Physics (6th ed.). McGraw-Hill Education.

2. Griffiths, D. J. (2018). Introduction to Quantum Mechanics (2nd or 3rd ed.). Pearson

3. Engineering Physics, S L Kakani, Shubra Kakani, 3rd Edition, 2020, CBS Publishers and Distributers Pvt Ltd., 2018

4. Tinkham,M. (2004). Introduction to Superconductivity (2nd ed.). Dover Publications.

5. Engineering Physics, Wiley Precise Text Books Series, Wiley,2014

6. Engineering Physics-Gaur and Gupta-Dhanpat Rai Publications-2017.

Course outcome (Course Skill Set)

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

1. Explain the core concepts of quantum mechanics such as matter waves, uncertainty principle, wave functions, and quantization of energy, with relevance to computational applications.

2. Evaluate electrical transport mechanisms in metals and semiconductors using classical and quantum models, and perform relevant calculations. Describe superconducting principles, distinguish between types of superconductors, and explain their physical properties and technological uses.

3. Explain dielectric and magnetic properties of materials and apply them in electrical components like transformers, capacitors, and magnetic switches.

4. Evaluate the principles of thermoelectric effects and assess the performance of thermoelectric materials and devices for energy conversion and thermal management.

5. Practice working in groups to conduct basic Physics experiments, record, observations and arrive at appropriate conclusions.

Suggested Learning Resources:

1. A Textbook of Engineering Physics- M. N. Avadhanulu and P. G. Kshirsagar, 10th revised Ed, S. Chand. &Company Ltd, New Delhi.

2. 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.

3. Engineering Physics-Gaur and Gupta Dhanpat Rai Publications-2017.

4. Concepts of Modern Physics-Arthur Beiser: 6th Ed; Tata Mc Graw Hill Edu Pvt Ltd-New Delhi 2006.

5. Fundamentals of Fibre Optics in Telecommunication & Sensor Systems, B.P.Pal, New Age International Publishers.

6. Lasers and Non-Linear Optics–B. B. Laud, 3rd Ed, New Age International Publishers 2011. LASERS Principles, Types and Applications by K. R. Nambiar New Age International Publishers

7. Solid State Physics- S O Pillai, 8th Ed-New Age International Publishers-2018

Web links and Video Lectures (e-Resources):

1. Laser: https://Laser:https://nptel.ac.in/courses/115/102115102124/
2. Quantum mechanics: https://nptel.ac.in/courses/115/104/115104096/
3. Physics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
4. Numerical Aperture of fiber: https://bop-iitk.vlabs.ac.in/exp/numerical-aperture-measurement
5. NPTELSuperconductivity:https://archive.nptel.ac.in/courses/115/103/115103108/

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

1. http://nptel.ac.in
2. https://swayam.gov.in
3. https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham
4. https://vlab.amrita.edu/index.php?sub=1&brch=189&sim=343&cnt=1
5. https://virtuallabs.merlot.org/vl_physics.html
6. https://phet.colorado.edu
7. https://www.myphysicslab.com

Scheme for Examinations:

1) Two full questions to be set from each unit with internal choice

- Minimum number of subquestions:2
- Maximum number of subquestions:3

2) Each full question shall be for a maximum of 20 marks

3) Answer any Five full questions choosing at least One full question from each unit

Note:1. Questions from Experiments shall be included in the SEE question paper
2. Questions from Self-study component will not be asked for CIE and SEE

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

Level-3: Highly Mapped, Level-2: Moderately Mapped, Level-1: Low Mapped