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

Course Title	Quantum Physics And Electronic Sensors						
Course Code	1BPHU202D (ECE stream)						
Category	Applied Science Course (ASC) (Integrated Course)						
Scheme and Credits	No. of Hours / Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	02	02	02	00	06	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, Photonics, Semiconductor devices and Sensors 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	**Photonics** Interaction of radiation with matter– Einstein's A and B coefficients, prerequisites for lasing actions, types of LASER–semiconductor diode LASER, applications laser in detecting pollutants. use of attenuators for single photon sources, optical modulators Pockel's effect, Kerr effect, photo detectors – single photon Avalanche diode, Superconducting Nanowire single photon detector, optical fiber, derivation of numerical aperture, V-number, Number of modes, losses in optical fiber (Scattering, absorption and bending), Numerical problems.	**8**
5	**Semiconductor devices and Sensors** Direct and indirect band gap, Band gap engineering, Zener Diode, LED, Photo Diode, Photo Transistor, Light dependent resistor, Resistance temperature detectors (high, medium, low), Sensing mechanisms, Piezo electric Sensors, Metal Oxide Semiconductor (MOS) sensors, Hall sensor, Superconducting Nanowire Single Photon Detector, Numerical Problems	**8**

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. Engineering Physics, S L Kakani, Shubra Kakani, 3rd Edition, 2020, CBS Publishers and Distributers.
3. Solid State Physics, S. O. Pillai, New Age International
4. Basic Electronics, B L Theraja, Multi-color Edition, S Chand, 2006
5. Quantum Physics and Applications, Dr. Geethanjali H. S., Dr. Nagaraja D., Jeevith Publications

Reference books / Manuals:

1. Engineering Physics, S Mani Naidu, Pearson, Fourteenth Impression, 2024.
2. Beiser, A. (2002). Concepts of Modern Physics (6th ed.). McGraw-Hill Education.
3. Griffiths, D. J. (2018). Introduction to Quantum Mechanics (2nd or 3rd ed.). Pearson.
4. Tinkham, M. (2004). Introduction to Superconductivity (2nd ed.). Dover Publications.

5. Mishra, P. K. (2009). Superconductivity – Basics and Applications. Ane Books.
6. Ghatak, A., & Thyagarajan, K. (2005). Optical Electronics. Oxford University Press.
7. Saleh, B. E. A., & Teich, M. C. (2019). Fundamentals of Photonics (3rd ed.). Wiley
8. Nielsen, M. A., & Chuang, I. L. (2010). Quantum Computation and Quantum Information (10th Anniversary ed.). Cambridge University Press.
9. Solid State Physics, A J Dekker (2000), Indian Ed., Macmillan Publishers India, New Delhi.
10. Principles of Electronics, V K Mehta & Rohit Mehta, S Chand and Company, 7th Edition 2008.

Course outcome (Course Skill Set)

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

1. Apply fundamental principles of quantum mechanics to analyze microscopic physical systems and predict quantized energy states and tunneling phenomena.
2. Analyze electrical conduction mechanisms in metals and semiconductors using classical and quantum models, and interpret carrier concentration and Fermi energy calculations.
3. Evaluate superconductivity phenomena including Meissner effect, Cooper pair formation, and Josephson junction behavior for advanced material applications. Describe light-matter interaction, laser operations, optical modulators, and photonic devices to illustrate the principles of photonics in sensor technologies.
4. Demonstrate the principles, characteristics, and applications of semiconductor and optical devices, sensors, and transducers used in electronic and photonic systems.
5. Practice working in groups to conduct basic Physics experiments, record, observations and arrive at appropriate conclusions

Suggested Learning Resources:

1. Detailed Text Book of Engineering Physics by S. P. Basavaraju, 2018 edition, Publisher - Subhas Stores.

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.

7. LASERS Principles, Types and Applications by K.R.Nambiar New Age International Publishers

8. 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. NPTEL Superconductivity: https://archive.nptel.ac.in/courses/115/103/115103108/

Activity-BasedLearning(SuggestedActivitiesinClass)/Practical-BasedLearning

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

SCHEMEFOREXAMINATIONS

1. Two full questions to be set from each unit with internal choice
   - Minimum number of sub-questions:2
   - Maximum number of sub-question: 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