## SEMESTER-V

**PHY-H-C-511-T: QUANTUM MECHANICS AND APPLICATION (04 Credits, 60 Lectures)**

***Instruction to Question Setter for End Semester Examination (ESE):*** *There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.*

**Time dependent Schrodinger equation**: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities; Conditions for Physical Acceptability of Wave Functions. Normalization, eigenvalues and eigenfunctions. Expectation values of position and momentum. **(14 Lectures)**

**Time independent Schrodinger equation**- Time independent Schrodinger equation; General solution of the time independent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension. **(12 Lectures)**

**Operators:** Postulates of quantum mechanics, Position, momentum, Hamitonian, and Energy operators; eigenvalues and eigenfunctions, commutator of position and momentum operators **(8 Lectures)**

**General discussion in an arbitrary potential**- One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, one dimensional potential step, Quantum tunnelling & rectangular potential barrier. **(12 Lectures)**

**Atoms in Electric & Magnetic Fields**: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. **(14 Lectures)**

**Reference Books:**


1. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.
7. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.


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8. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
9. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
10. Quantum Physics, H. C. Verma, 2018, Surya Publications,.
11. Quantum Mechanics, S. N. Biswas, Books & Allied (P) Ltd.
12. Advanced Quantum Mechanics ,Satya Prakash, Kedar Nath Ram Nath Publisher.
13. Introduction To Quantum Mechanics, Nikhil Ranjan Roy, Vikas Publishing.

## PHY-H-C-512-T: SOLID STATE PHYSICS (04 Credits, 60 Lectures)

***Instruction to Question Setter for End Semester Examination (ESE):*** *There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.*

**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis, Unit Cell, Bravais lattice (2D &3D), Miller Indices. Reciprocal Lattice- properties and applications. Types of Lattices. Diffraction of X-rays by Crystals, Bragg's Law, Laue's equation. **(14 Lectures)**

**Lattice Vibrations and Phonons:** Phonons of monatomic one dimensional lattice. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids, $T^3$ law **(16 Lectures)**

**Magnetic Properties of Matter:** Dia-, Para-, and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic materials. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. **(12 Lectures)**

**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. **(8 Lectures)**

**Elementary band theory:** Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. **(10 Lectures)**

**Reference Books:**

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.

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5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India.
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
8. Solid State Physics, M.K. Mahan and P. Mahto, 2008, Bharti Bhawan.
9. Introduction to Solid State Physics , Arun Kumar, PHI Learning.

**PHY-H-C-511-P & 512-P (PRACTICAL) (04 Credits, 120 Lectures)**

***Instruction to Question Setter for End Semester Practical Examination (ESE):*** *The questions in practical examination will be of equal to 40 marks and will be of 3 hours duration. Distribution of marks in practical paper of an end-semester examination will be of 60% in performance of experiment, 20% in record/note book and 20% in viva-voce.*

1. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150°C) and to determine its band gap.
2. To determine the Hall coefficient of a semiconductor sample.
3. To study the V-I characteristics of a Zener diode
4. To study the use of Zener Diode as a voltage regulator.
5. To Study Zeeman effect with external magnetic field; Hyperfine splitting
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To measure the Dielectric Constant of a dielectric Materials with frequency
8. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
9. To determine the refractive index of a dielectric layer using SPR
10. To study the PE Hysteresis loop of a Ferroelectric Crystal.
11. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.

**Reference Books**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

**PHY- H-DSE-501A-T: PHYSICS OF DEVICES & INSTRUMENTS (04 Credits, 60 Lectures)**

***Instruction to Question Setter for End Semester Examination (ESE):*** *There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.*

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**Devices:** Characteristic and small signal equivalent circuits of UJT and JFET. Metal semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. $SiO_2$-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. **(22 Lectures)**

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.
**(12 Lectures)**

**Multivibrators:** Astable and Monostable Multivibrators using transistors. **(10 Lectures)**

**Digital Data Communication Standards:** Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave.
**(16 lectures)**

**Reference Books:**


1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons.
2. Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
3. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd.
4. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
5. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
6. Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
7. Basic Electronics: Arun Kumar, Bharti Bhawan 2007.


**PHY-H-DSE-502A-T: ADVANCED MATHEMATICAL PHYSICS (04 Credits, 60Lectures)**

***Instruction to Question Setter for End Semester Examination (ESE):*** *There will be two groups of questions. Five Questions to be answered out of Nine Questions. Group A is compulsory and will contain two questions. Question No.1 (A) will be MCQ of 1 mark each (six questions). Question No.1 (B) will be short answer type to be answered in about 50 words of 3 marks (2 Questions). Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to answer. Each question carries 12 marks.*

**Linear Algebra:** Vector Spaces: Vector Spaces over Fields of Real and Complex numbers. Examples. Vector space of functions. Linear independence of vectors. Basis and dimension of a vector space. Change of basis. Subspace. Isomorphisms. Inner product and Norm. Inner product of functions: the weight function. Triangle and Cauchy Schwartz Inequalities.
**(18 Lectures)**

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**Linear Transformations**: Introduction. Identity and inverse. Singular and non-singular transformations. Representation of linear transformations by matrices. Similarity transformation. Linear operators. Adjoint of a linear operator. Hermitian operators and their matrix representation. Examples. Eigenvalues and eigenvectors of linear operators. Properties of eigenvalues and eigenvectors of Hermitian and unitary operators. Functions of Hermitian operators

**(24 Lectures)**

**Tensors:** Symmetric and antisymmetric tensors. Change of basis: relation between coordinate basis vectors. Change of tensor components under change of coordinate system. Example: Inertial coordinates & bases in Minkowski space, Lorentz transformations as coordinate transformations, Elelctromagnetic tensor and change in its components under Lorentz transformations.

**(18 Lectures)**

**Reference Books:**


1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
3. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
4. Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
5. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
6. Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press


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