M.Sc. PHYSICS

CHOICE BASED CREDIT SYSTEM (CBCS)

Syllabus

Students admitted from 2018 onwards

Enable | Enlighten | Enrich

KARPAGAM

ACADEMY OF HIGHER EDUCATION

(Deemed to be University)

(Established Under Section 3 of UGC Act, 1956)

DEPARTMENT OF PHYSICS
KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University Established Under Section 3 of UGC Act, 1956)
Eachanari Post, Coimbatore – 641 021, INDIA.
Phone: 0422-6453777, 6471113-5, 2980011-2980018;
Fax No: 0422 – 2980022, 2980023
Email: info@karpagam.com
Web: www.kahedu.edu.in

SEMESTER – I

18PHP101 **CONDENSED MATTER PHYSICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- This course provide the study of properties of materials is very important at all times, to choose the correct material for the correct use.
- With the development of nanotechnology, it is important to give an idea about the preparation methods and characterization of different materials.
- This paper is intended to give the students an idea about importance of crystals and their properties.
- This course will teach you the fundamental physics behind different materials we commonly see in the world around us.
- The course will demonstrate the link between microscopic structure and bulk properties in a variety of systems in hard and soft condensed matter
- To study some of the basic properties of the **condensed** phase of **matter** especially solids.

Course Outcomes (COs)

After completing the course students will/can able to

1. Analyze the electronic, magnetic and thermal properties of materials.
2. classify condensed matter upon its degree of order, with emphasis on scattering experiments.
3. Differentiate materials in a variety of applications.
4. Explain various types of magnetic phenomenon, physics behind them, their properties and applications.
5. Explain superconductivity, its properties, important parameters related to possible applications.
6. Develop the superconducting materials and understand the materials property the basic concept of superconductor

UNIT I- INTER PLANAR SPACING

Inter planar spacing for SC, FCC, BCC lattices - diamond cubic structure - NaCl structure - The reciprocal lattice and their properties - Bragg condition in terms of reciprocal lattice.

Crystal defects: Classification of defects - Points defect - The Schottky defect - The Frenkel defect -colour centers - F center - other colour centers- Dislocations - Slip and plastic deformation - Shear strength of single crystals - Edge dislocation - Screw dislocation - Stress field around an edge dislocation.

UNIT II - THEORY OF SEMICONDUCTORS

Intrinsic and extrinsic semiconductors - Free carrier concentration in semiconductors – Fermi level and carrier concentration in semiconductors – Mobility of charge carriers – Effect of temperature on mobility – electrical conductivity of semiconductors – Hall Effect in semiconductors – Junction properties.

Ultrasonics: Non destructive testing and applications.

UNIT III - DIELECTRICS, PIEZOELECTRICS AND FERROELECTRICS

Dipole moment – Polarization – the electric field of a dipole – local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – dipolar polarizability – Ferro electricity – Dipole theory of ferroelectricity – Piezoelectricity.

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UNIT IV - HEAT CAPACITY OF THE ELECTRON GAS

Experimental electrical resistivity of metals – Free electron theory of metals – Debye's equation - superconductivity - Electron phonon interaction - Cooper pairs – BCS theory - Energy gap and its temperature dependence - London equation – Josephson effect and its applications.

Langevin theory of Para magnetism: Quantum theory of Para Magnetism - Curie law- Ferro Magnetism - Weiss molecular field theory - Domain theory - Anti Ferro magnetism -Neel theory - Ferri Magnetism – Ferrites – spin – waves - Experimental techniques to study the magnetic properties.

UNIT V- SUPERCONDUCTIVITY

Sources of superconductivity – The Meissner effect – Thermodynamics of superconducting transitions – Origin of energy gap – London equations –London Penteration depth – Type I and Type II Sueprconductors - Coherence length – BCS theory – Flux quantization – Theory of DC and AC Josephesen effect – Potential applications of superconductivity.

SUGGESTED READINGS

1. Kittel. C. 2005, Introduction to Solid State Physics, 8th Edition, Willey Eastern Ltd., New Delhi.
2. Saxena. B.S., R.C.Gupta and P.N.Saxena, 2012, Fundamentals of Solid State Physics, 15th edition, Pragati Prakashan, Meerut.
3. Dekkar. A.J., revised edition, 2000, Solid State Physics, Macmillan India Ltd., New Delhi.

4. Keer. H.V. 1st edition , 2002, Principles of Solid State, New age international., New Delhi.
5. Pillai S.O., 2005, Solid State Physics, 4th Edition, New Age International Publishers Ltd.
6. https://nptel.ac.in/courses/115106061/
7. https://nptel.ac.in/courses/115101009/

SEMESTER – I

18PHP102 ELECTRONIC DEVICES AND CIRCUITS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- This paper contains details of basic electronic components, their characteristics and applications in the construction of different electronic instruments.
- Other than ordinary transistors and diodes special devices are also explained.
- To give an idea about the basics of electronics and electronic devices, which is very important for knowing the basics of any modern instrument.
- To study basic electronic componenets
- To observe characteristics of electronic devices
- To understand the high frequency application of diodes.

Course Outcomes (Cos)

After completing the course students will/can able to

1. Build, design and analyze analog to digital converter.
2. Design digital and analog systems.
3. Understand the basic operation and working of different diodes like FET, MOSFET, CMOS, etc.
4. Understand the high frequency application of diodes.
5. Analyze PN junctions in semiconductor devices under various conditions.
6. Design and analyze simple rectifiers and voltage regulators using diodes.

UNIT I- ELECTRONIC DEVICES

Transistor Biasing and Stabilization with design problems, h-parameters and their applications in transistor circuit analysis for CE, CB and CC configurations; FET and MOSFETs: Characteristics and Biasing, Design of biasing circuits, Design and analysis of amplifiers, SCR, UJT, DIAC, TRIAC (construction & working).

UNIT II- ANALOG DEVICES

Base-Biased Amplifier, Emitter-Biased Amplifier, Small-Signal operation, AC Beta, AC Resistance of the Emitter Diode, Two Transistor models, Analyzing an Amplifier, AC Quantities on the data sheet, Frequency response of amplifiers General concepts; bode plot; low frequency response: BJT and FET amplifiers; miller effect capacitance; high frequency response of BIT amplifiers; hybrid pie model: short circuit current gain, cut off frequency, and current gain with resistive load.

UNITIII - ANALOG CIRCUITS

Analysis of compound configurations Cascade connection; Cascade connection; Darlington connection; The Depletion Mode MOSFET,D- MOSFET Curves, Depletion Mode MOSFET Amplifier, The Enhancement Mode MOSFET. The Basic concepts of Feedback, Effect Of Negative Feedback, Types of Negative Feedback Connections, Method of Identifying Feedback Topology and Feedback Factor, Stability of Feedback Amplifier.

UNIT IV- POWER AMPLIFIERS

Introduction, Series-fed Class A amplifier, Transformer coupled class A amplifier, Class B amplifier operation, Class B amplifier distortion, Power transistor heat sinking, Class C and Class D amplifiers, Numerical problems.

UNIT V- NETWORK THEORY

mesh and node analysis Kirchhoff's voltage and current law, Network Theorems- Thevein's theorem, Norton's theorem, Superposition Theorem, Maximum power transfer theorem, Problems based on network theorems

SUGGESTED READINGS:

1. Boyle L. stad and Louis Nashelsky, 10th edition, 2013, Electronic devices and circuit theory, Prentice-Hall of India,Delhi.
2. Millman and Halkias, 48th reprint, 2008, Integrated electronics, Tata McGraw-Hill, New Delhi.
3. Malvino A.P., Electronics Principles, 10th edition, 2013, Tata McGraw Hill, New Delhi.
4. Mottershed, 1st edition, 2002, Electronic devices and circuits : An introduction, Prentice-Halloflndia, New Delhi.
5. M. S. Ghausi1st edition, 2013, Electronic devices and circuits, CBS.
6. Donald L. Schilling, Charles Belove, 3rd edition, 2009, Electronic circuits discrete and integrated, Tata McGraw-Hill, New Delhi.
7. Millman and Grabel, 2nd edition, 2001, Microelectronics; Tata McGraw-Hill, New Delhi.
8. T.F. Bogart and J.S. beasely and G. Rico, 5th edition, 2000, Electronic devices and circuits, Prentice hall; New Delhi.Hall of India .
9. A.Nagoor Kani, 1st edition, 2014, Circuit theory, RBA publications.
10. https://nptel.ac.in/courses/122106025/
11. https://nptel.ac.in/courses/108108112/

SEMESTER – I

18PHP103 CLASSICAL MECHANICS AND RELATIVITY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course objective

- Study of Classical Mechanics gives an idea about how classical physics deal with matter and energy.
- It cannot explain many observed phenomena in the case of microparticles and relativistic velocities, it is still valid in the case of macro objects at non-relativistic velocities.
- To give an insight into the classical methods of physics.
- To understand the basic principles of classical mechanics.
- This course will demonstrate the ability to apply basic methods of classical mechanics towards solutions of variousproblems, including the problems of 1) complicated oscillatory systems, 2) the motion of rigid bodies, 3)mechanics of continuous media.
- Is to demonstrate the equations of motion for complicated many body mechanical systems and their solutions.

Course Outcomes (Cos)

After completing the course the students will/ can able to

1. Understand the classical laws of motion.
2. Compete in using the essential mathematical skills needed for describing mechanics and special relativity
3. Develop problem solving skills.
4. An appreciation of the influence of classical mechanics and relativity on modern scientific development.
5. Use the general theory of relativity to explain the motion of physical system in space co-ordinates
6. Able to solve central potential problems in n-dimensional space.

UNIT I

Conservation laws: Mechanics of a system of particles – Conservation laws: linear momentum, angular momentum, energy – Constraints, Degrees of freedom – Generalised co-ordinates – Generalized notations – Brachistocrone problems – Atwood's machine.

Hamilton's variational principle – Lagrange's equation of motion from Hamilton's principle, D'Alembert's principle – Applications of Lagrange's equation of motion – particle moving under a central force – particle moving on the surface of earth– Superiority of Langrange's approach over Newtonian's approach.

UNIT II

Phase space (concepts) - Hamiltonian – Hamilton's canonical equations of motion – Physical significance of H – Advantage of Hamiltonian approach – Hamilton's canonical equation of motion in different coordinate systems – Hamilton-Jacobi method – Kepler's problem solution by Hamilton-Jacobi method – Action and angle variables – Solution of Harmonic oscillator by action angle variable method – canonical or contact transformation – Condition for a transformation to be canonical.

UNIT III

General features of central force motion : General features of orbits – Centre of mass and laboratory coordinates – Virial theorem – Stable and unstable equilibrium – Properties of T, V and ω for small oscillations .

Generalized coordinates for rigid body motion : Euler's angles – Angular velocity, momentum of rigid body – moment and products of inertia – Principal axis transformation – rotational kinetic energy of a rigid body – Moment of inertia of a rigid body – motion of a symmetric top under action of gravity.

UNIT IV

General theory of Relativity: Introduction – Limitation of special theory of relativity and need for a relativity theory in non-inertial frames of reference. Concept of gravitational and inertial mass and the basic postulate of GTR, gravitation & acceleration and their relation to non-inertial frames of reference – principle of equivalence of principle of general co-variance – Minkowski space and Lorentz transformation.

UNIT V

Special Theory of Relativity: Introduction – Galilean transformation and invariance of Newton's laws of motion – Non variance of Maxwell's equations – Michelson Morley experiment and explanation of the null result.

Concept of inertial frame – Postulates of special theory – simultaneity – Lorentz transformation along one of the axes – length contraction – time dilatation and velocity addition theorem – Fizeau's experiment – Four vectors – Relativistic dynamics – Variation of mass with velocity – Energy momentum relationship.

SUGGESTED READINGS:

1. Gupta. S. L., V.Kumar and H.V.Sharma, 2008, Classical Mechanics, 19^{th} Edition, Pragati Prakashan, Meerut.

2. Banerji Sriranjan and Asit Banerjee, 2nd Edition 2013, The Special Theory of Relativity, Printice-Hall of India, New Delhi
3. Aruldhas G.,1st edition, 2008, Classical Mechanics, Printice Hall of India, New Delhi
4. Sardesai D.L., 1st edition, 2004, A Primer of Special Relativity, New Age International Publishers, New Delhi
5. Hartle B. James, 1st edition ,2009, Gravity, An Introduction to Einstein's General Relativity, Dorling Kindersley (India) Pvt. Ltd., Delhi.
6. Goldstein.H.A. 2000, Classical Mechanics, 2nd Edition, Wesley Publishing Company, London.
7. https://nptel.ac.in/courses/115105098/
8. https://nptel.ac.in/courses/115106059/

SEMESTER – I

18PHP104 MATHEMATICAL PHYSICS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- It is necessary for a physics student to be familiar with different methods in mathematics.
- Give a basic idea about different methods of mathematics, used in Physics.
- The purpose of the course is to introduce students to methods of mathematical physics
- To develop required mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of theoretical physics.
- This course provides the basic concepts in higher level mathematics application to physics
- To impart knowledge about various mathematical tools employed to study physics problems

Course Outcomes (COs)

After completing the course the students will / can able to

1. Apply integral transform (Fourier and Laplace) to solve mathematical problems of Fourier transforms as an aid for analyzing experimental data.
2. Students can formulate and express a physical law in terms of tensors, and simplify it by use the coordinate transforms (example: principal axes of inertia).
3. Students will be able to solve some simple classical variation problems.
4. Intuition of the physical meaning of the various vector calculus operators (div, grad, curl)
5. Students can formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms (example: principal axes of inertia).
6. Solve some simple classical variation problems.

UNIT I - VECTOR SPACE

Definition of vector space – Linear dependence – Linear independence – Basis – Dimension of a vector space – Representation of Vectors and linear operators with respect to basis – Schmidt orthogonalization process – Inner product.

Tensors : Transformation of coordinates – Summation convention – Contravariant Tensor – Covariant Tensor – Mixed Tensor – Rank of a Tensor – Kronecker delta symbol – symmetric and antisymmetric tensors – Invariant tensors.

UNIT II- COMPLEX VARIABLE

Functions of a complex variable – single and multivalued functions – Cauchy-Riemann differential equation – analytical – line integrals of complex function – Cauchy's integral theorem and integral formula – derivatives of an analytic function – Liouville's theorem - Taylor's series – Laurent's series - Residues and their evaluation - Cauchy's residue theorem – application to the evaluation of definite integrals.

UNIT III- FOURIER TRANSFORM

Properties of Fourier transform – Fourier transform of derivatives – Fourier sine and cosine transforms of derivatives – Fourier transform of functions of two or three variables – Finite Fourier transforms – Simple Applications of FT

Laplace transform – Properties of Laplace transforms – Laplace Transform of derivative of a function – Laplace transform of integral – Laplace transform of periodic functions - Inverse Laplace Transform – Fourier Mellin Theorem - Properties of inverse Laplace Transform – Convolution theorem – Evaluation of Laplace Transform using Convolution theorem.

UNIT IV- FOURIER SERIES

Dirichlet's theorem – change of interval – complex form – Fourier series in the interval (0, T) – Uses of Fourier series - Legendre's polynomials and functions – Differential equations and solutions – Rodrigues formula – Orthogonality – relation between Legendre polynomial and their derivatives – recurrence relations – Lagurae Polynomials – recurrence relations

UNIT V- BESSEL'S FUNCTIONS

differential equation and solution – generating functions – recurrence relations – Bessel function of second order – Spherical Bessel function -

Hermite differential equation and Hermite polynomials: Generating function of Hermite polynomials – Recurrence formulae for Hermite polynomials – Rodrigue's formula for Hermite Polynomials – Orthogonality of Hermite Polynomials – Dirac's Delta Function.

SUGGESTED READINGS:

1. Satya Prakash.,2002. Mathematical Physics , 4th edition, S.Chand & Co, New Delhi.
2. Gupta.B.D., 2002, .Mathematical Physics, 2nd edition, Vikas publishing company, New Delhi.
3. Singaravelu.V., 2008. Numerical methods, 2nd edition, Meenakshi publications, Sirkali.
4. Rajput.B.S., 2003. Mathematical Physics, 16th edition, Pragati Prakashan, Meerut.
5. Gupta. P.P., Yadav., and Malik.,2012. Mathematical Physics, Kedar Nath & Ram Nath, Meerut.

6. Venkataraman.M.K., 2003. Numerical methods in Science & Engineering, 5th edition, The National Publishing Company, Chennai.
7. Butkov, 2007, Mathematical Physics, Addison Wesley, New York
8. A.W. Joshi, 2008, Tensors and Matrices, reprint, Wiley Interscience, New York.
9. https://nptel.ac.in/courses/115103036/
10. https://nptel.ac.in/courses/115105097/

SEMESTER – I

18PHP105A **MATERIAL CHARACTERIZATION** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To Study materials is always important, for any application, including fabrication of satellites.
- To introduce various methods available for characterizing the materials. The characterization of materials specifically addresses that portfolio with which researchers and educators must have working familiarity.
- To provide an introduction to materials characterization and its importance
- To discuss different types of characterization techniques and their uses.
- To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques Introduction:
- To understand the materials characterization and available techniques

Course Outcomes (COs)

After completing the course the students will / can able to

1. Handle with X-ray, thermal, microscopic, and electrical methods of characterization.
2. Understand and describe the fundamental principles behind the methods of characterization which are included in the curriculum
3. Analyze, interpret and present observations from the different methods.
4. Evaluate the uncertainty of observations and results from the different methods.
5. Understand the history of materials science with basic understanding of metals, binary alloys, magnetic materials, dielectric materials and polymers
6. Understand nucleation, growth and phase transformation kinetics

UNIT I- X-RAY TECHNIQUES

Introduction, X-Ray Powder Diffraction - Rotatory crystal method of X ray diffraction -Neutron diffraction – experiment- Particle size - strain determination, Single Crystal X-Ray Structure Determination, GIXRD and its applications, X-Ray Photoelectron Spectroscopy, Surface X-Ray Diffraction.

Neutron Techniques

Introduction, Neutron Powder Diffraction, Single Crystal Neutron Diffraction.

UNIT II- THERMAL ANALYSIS

Introduction - Definitions, Codes of Practice and Nomenclature - thermogravimetric analysis (TGA) - instrumentation - determination of weight loss and decomposition products - differential thermal analysis (DTA) - cooling curves - differential scanning calorimetry (DSC) - instrumentation - specific heat capacity measurements - determination of thermomechanical parameters .

UNIT III- MAGNETIC ANALYSIS AND OPTICAL MICROSCOPY

Vibrating sample magnetometer - SQUID : Introduction - construction and working principle.
Optical microscopy techniques - Bright field - Dark field optical microscopy - phase contrast microscopy -differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - Metallurgical microscope.

UNIT IV - ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

Electron diffraction technique – High energy electron diffraction – Low energy electron diffraction - Electron microscopy – Scanning electron microscopy (SEM) - FESEM - EDAX - TEM - HRTEM: working principle and Instrumentation - sample preparation - Advantages/disadvantages.

Scanning probe microscopy - STM - AFM - EPMA - working principle and Instrumentation - Advantages/disadvantages.

UNIT V - ELECTRICAL AND OPTICAL METHODS OF CHARACTERIZATION

Two probe and four probe methods - van der Pauw method - Hall probe and measurement - scattering mechanism - C-V, I-V characteristics - Schottky barrier capacitance - impurity concentration - electrochemical C-V profiling - limitations - Introduction to Photoluminescence and Electroluminescence - Applications. Dielectrics - working principle and Instrumentation - Applications.

SUGGESTED READINGS

1. Elton N. Kaufmann, Characterization of Materials volumes 1 and 2, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.
2. R.A.Stradling and P.C.Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
3. Cullity B D., Stock S R “Elements of X-ray Diffraction”, Prentice Hall, Inc 2001.
4. J.A.Belk. Electron Microscopy and Microanalysis of Crystalline Materials. Applied Science Publishers, London, 1979.
5. L. E.Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991.

6. D.Kealey & P.J.Haines, Analytical Chemistry, Viva Books Private Limited, New Delhi, 2002. 5. Banwell, Fundamentals of Molecular Spectroscopy, McGraw-Hill Education, Pvt. Ltd., 2013.
7. https://nptel.ac.in/courses/115103030/
8. https://nptel.ac.in/courses/113106034/

SEMESTER – I

18PHP105B ASTRONOMY AND ASTROPHYSICS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Astronomy and Astrophysics is a very fundamental subject in Physics.
- Includes study of the solar system, evolution of stars, different physical processes going on stellar bodies, life cycle of stars etc.
- Is to apply basic physical principles from a broad range of topics in physics to astronomical situations
- Be able to formulate scientific problems in mathematical terms and apply analytical and numerical methods towards its solution
- Develop skills to design observing projects with research telescopes and projects drawing upon data in the literature and in archives
- Establish competence in focused areas of astrophysical theory and experiment
- Generate fluency in the scientific enterprise and awareness of possible career paths available to the undergraduate astronomy and astrophysics major

Course Outcomes (COs)

After completing the course the students will / can able to

1. Plan and engage in an independent and sustained critical investigation of a chosen research topic to generate new knowledge in an area of astronomy and astrophysics.
2. Systematically evaluate relevant theory and concepts in astronomy and astrophysics,
3. Relate these to appropriate methodologies and evidence and draw appropriate conclusions.
4. Demonstrate capacity for astronomy and astrophysics reasoning through analyzing, proving and explaining concepts from the chosen research area.
5. Identify important constellations – orient in space.
   Describe the planets of the solar system and their properties.

UNIT I- ASTROPHYSICS

Introduction - Astrophysics and Astronomy - Celestial coordinate systems (Sun-Earth system, Galactic Coordinate system)

UNIT II- STELLAR STRUCTURE AND EVOLUTION

Star formation - Stellar Magnitudes - Classification of stars - H-D classification - Saha Equation of ionization - Hertzsprung-Russel (H-R) diagram - Gravitational energy - Virial theorem - Equations of stellar structure and evolution - Pre-main sequence evolution - Jeans criteria for star formation - fragmentation and adiabatic contraction - Evolution on the main sequence - Post main sequence evolution

UNIT III - NUCLEAR ASTROPHYSICS

Thermonuclear reactions in stars - pp chains and CNO cycle - Solar Neutrino problem - subsequent thermonuclear reactions - Helium burning and onwards - nucleosynthesis beyond iron - r- and s- processes

Stellar Objects & Stellar Explosions: Qualitative discussions on: Galaxies – Nabulae – Quasars - Brown dwarfs - Red Giant Stars – Nova - Supernova.

UNIT IV- GRAVITATIONAL COLLAPSE AND RELATIVISTIC ASTROPHYSICS

Newtonian theory of stellar equilibrium - White Dwarfs - Electron degeneracy and equation of States - Chandrasekhar Limit - Mass-Radius relation of WD - Neutron Stars - Spherically symmetric distribution of perfect fluid in equilibrium - Tolman-Oppenheimer-Volkoff (TOF) equation – Mass - Radius relations of NS – Pulsars - Magnetars - Gamma ray bursts - Black holes - Collapse to a black hole (Oppenheimer and Snyder) - event horizon - singularity.

UNIT V - ACCRETION DISKS

Formation of Accretion Disks - Differentially rotation systems in Astrophysics - Disk dynamics - Steady Disks - Disk formation in close binary systems through mass transfer - Accretion onto compact objects.

SUGGESTED READINGS:

1. V.B.Bhatia, , 1st edition, 2001; Textbook of astronomy and astrophysics with elements of cosmology,Alpha science international.
2. K. D. Abhyankar, , 1st edition Astrophysics – Stars and Galaxies,University Press, 2001.
3. S.L.Shapiro and S.A.Teukolsky, , 1st edition Black Holes, White Dwarfs and Neutron Stars (John Wiley, 2002)
4. E.W.Kolb and M.S.Turner, , 1st edition, 2007, The Early Universe Sarth book house and distributers
5. J.V.Narlikar, , 3rd edition 2012 Introduction to Cosmology, Cambridge University Press.
6. A.K.Raychaudhuri, S.Banerji and A.Banerjee, General Relativity, Astrophysics and Cosmology – , 1st edition (Springer-Verla, 2001)
7. S. Banerji and A. Banerjee , General Relativity and Cosmology – , 1st edition (Elsevier, 2007)
8. https://nptel.ac.in/courses/115105046/

9. http://www.nptelvideos.in/2012/12/astrophysics-cosmology.html

SEMESTER – I

18PHP105C **CRYSTAL GROWTH TECHNIQUES** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To strengthen the students with crystallographic and **crystal growth techniques**
- To provide the general characteristics of crystals, methods of preparation etc.
- Various thin films deposition techniques and thin film characterization techniques are also covered in the course.
- To give an idea about historical importance of crystals, methods of preparation and characterization of crystals etc.
- To explore the knowledge in fundamentals of materials syntheses, crystal growth techniques, zone refining, properties etc.,
- To provide the basic knowledge on crystal structure.

Course Outcomes (COs)

After completing the course the students will / can able to

1. The student will learn about the crystal growth mechanisms and techniques.
2. Understand different crystals having a lot applications in electronics, energetics etc.
3. Acquire the theoretical concept behind electrical and thermal properties of metals
4. Understand the fundamental theories to describe the energy bands in metals
5. Gain the knowledge about Semiconductor Crystals and their properties
6. Gain the knowledge about phonons and its importance in thermal physics

UNIT I- CRYSTAL GROWTH PHENOMENA

The historical development of crystal growth – significance of single crystals - crystal growth techniques - the chemical physics of crystal growth - Theories of nucleation - Gibb's Thompson equation for vapour, melt and solution- energy of formation of spherical nucleus- heterogeneous nucleation - kinetics of crystal growth, singular and rough faces, KSV theory, BCF theory - periodic bond chain theory- The Muller- Krumbhaar model.

UNIT II- CRYSTAL GROWTH FROM MELT AND SOLUTION GROWTH

Growth from the melt - the Bridgmann technique – crystal pulling - Czochralski method-experimental set up - controlling parameters advantages and disadvantages.- convection in melts – liquid solid interface shape - crystal growth by zone melting - Verneuil flame fusion technique.

UNIT III- LOW TEMPERATURE CRYSTAL GROWTH

Low temperature solution growth - methods of crystallization - slow cooling - solvent evaporation, temperature gradient methods - crystal growth system - growth of KDP, ADP and KTP crystals - high temperature solution growth - gel growth.

UNIT IV- VAPOUR GROWTH AND EPITAXIAL GROWTH

Physical vapour deposition - chemical vapour transport – definition - fundamentals, criteria for transport, Specifications, STP, LTVTP & OTP - advantages and limitations of the technique, hydrothermal growth – design aspect of autoclave – growth of quartz, sapphire and garnet.
Advantages of epitaxial growth - epitaxial techniques - liquid phase epitaxy - vapour phase epitaxy - molecular beam epitaxy - chemical beam epitaxy and atomic layer epitaxy

UNIT V- MATERIALS FOR SEMICONDUCTOR DEVICES

Semiconductor optoelectronic properties - band structure - absorption and recombination, semiconductor alloys - group III-V materials selection - binary compounds, ternary alloys - lattice mismatch - lattice mismatched ternary alloy structures - compositional grading, heteroepitaxial ternary alloy structure - Quaternary alloys - Semiconductor Devices - Laser diodes, light emitting diodes (LED) – photocathodes - microwave Field-Effect Transistors (FET).

SUGGESTED READINGS:

1. R.A. Laudise, 2006, illustrated edition, The Growth of Single Crystal, Prentice Hall, NJ.
2. A.W. Vere,2012 edition, Crystal Growth: Principles and Progres, Springer press.
3. P.S. Raghavan and P.Ramasamy, 2000 Hard cover edition. Crystal Growth Processes and methods, KRU Publications.
4. F.C. Auluck, A Short course in Solid State Physics, Vol. I, Thomson Press India Ltd.
5. B.R. Pamplin, 2nd edition Crystal Growth, Pergamon, (2012)
6. Heinz K Henish, , 1st edition 2005, Crystal Growth in Gel, Dover Publication.
7. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/113105025/lec12.pdf
8. http://mgcl.iitr.ac.in/49200-nptel-video-lecture-topics.pdf

SEMESTER – I

18PHP111 GENERAL PHYSICS PRACTICAL - I 4H – 2C

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objective

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.
- To enable the students to understand the **basic** concepts of mechanics
- To enable the students to get the better understanding of thermodynamical laws using simple experiments
- To develop the practical knowledge of characteristic nature of monochromatic light source

Course Outcomes (COs)

After completing the practical course students will/can able to

1. Apply the analytical techniques and graphical analysis to the experimental data.
2. Verify laws studied in the different theory course.
3. Measure different properties of materials.
4. classify the materials with the properties
5. overcome the fear of experimental skill
6. Capable to built his own equipments for measuring the properties of materials

ANY TEN EXPERIMENTS

1. Young's Modulus – Elliptical Fringes (Cornu's method).
2. Viscosity of liquid – Mayer's oscillating disc method.
3. Michelson Interferometer – Determination of λ and $d\lambda$.
4. 'e/m' by Thomson's method and Magnetron method.
5. Young's Modulus – Hyperbolic Fringes (Cornu's method).
6. Fresnel's biprism - Determination of Wavelength of monochromatic source.

7. Determination of Plank's constant using Photo cell.
8. Forbe's method – Thermal conductivity.
9. 'e' by Millikan's method.
10. Ferguson's method - Specific heat of a liquid.
11. Faraday effect – Determination of Verdet constant using He-Ne laser.
12. Young's Double slit – Determination of Wavelength of monochromatic source.

SUGGESTED READINGS:

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12th Edition, Pragathi Prakashan, Meerut
4. Gupta S.L. and V.Kumar, 2002, Practical Physics, 25th Edition, Pragathi Prakashan, Meerut
5. B.L Worsnop & H T Flint,1951,Advanced Practical Physics For Students ,9th revised Edition ,Littlehampton Book Services Ltd
6. https://nptel.ac.in/courses/115105110/

SEMESTER – I

18PHP112 ELECTRONICS PRACTICAL – I 4H – 2C

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- To apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific
- concepts in a group. Know and follow the proper procedures and regulations for safely working in a lab.
- To communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

Course Outcomes (COs)

After completing the practical course students will/can able to

1. Design and handle various instruments.
2. Verify laws studied in the different theory course.
3. Measure different properties of materials.
4. Gain the knowledge in quantization of electromagnetic fields.
5. Analyze the characteristics of oscillators and wave shaping circuits
6. Understand the basic concepts of amplifiers and operational amplifier

ANY TEN EXPERIMENTS

1. Construct and verify the output of IC regulated power supply.
2. Find the Hysterisis of IC 555 - Schmitt Trigger and plot the response.
3. Construct and verify the output of Instrumentation Amplifier using four IC 741
4. Design and construct high pass and low pass , filter using IC 741 and plot the frequency response curve.
5. Design and construct RC coupled amplifier and plot the frequency response curve.
6. Hartley and Colpitt's oscillators using discrete components.

7. Wave form generators (Square wave and Triangular wave) – Op amp.
8. Phase shift oscillator and Wein's bridge oscillator – Op amp.
9. Design and construct band pass and band rejecter filter using IC 741 and plot the frequency response curve
10. Astable, monostable and bistable multi-vibrators, using discrete components.
11. Analog computer setup – Solving simultaneous equations.
12. Design and construct Differential amplifiers and plot the frequency response curve
13. Construct D to A converter and verify the output- Binary weighted method - R/2R ladder method..
14. FET characteristics and Source follower.

SUGGESTED READINGS:

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13^{th} Edition, Pragathi Prakashan, Meerut
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12^{th} Edition, Pragathi Prakashan, Meerut
4. Ramakant A. Gayakwad, 2002, Op-amp and Linear Integrated Circuits ,4^{th} Edition, Prentice Hall.
5. https://nptel.ac.in/courses/122106025/

SEMESTER – II

18PHP201 THERMODYNAMICS AND STATISTICAL MECHANICS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course objectives

- Thermodynamics is an important branch of physics, which helps us to understand the different phenomena in the evolution of the universe.
- To introduce the students to the concepts of statistical Thermodynamics. The statistical treatment permits to define the concepts of temperature, heat and entropy strictly from first principles without making use of empirical or axiomatic approach
- This paper gives a basic idea about the laws of thermodynamics and statistical processes.
- To Consolidate the understanding of the laws of thermodynamics and a systematic definition of thermodynamic potentials as the general formalism of thermodynamics.
- To know the foundations of equilibrium statistical physics as the microscopic theory of matter and fields.
- To apply the concepts and principles of black-body radiation to analyze radiation phenomena in thermodynamic systems

Outcomes (Cos)

After completing the course students will/can able to

1. Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.
2. Describe the laws of thermodynamics from both a macroscopic and microscopic point of view.
3. Use the statistical physics methods, such as Boltzmann distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in physical systems.
4. Apply the laws of thermodynamics to real physical systems and processes.
5. Describe the properties of ideal gases using Boltzmann statistics.
6. Describe the differences between systems of bosons and fermions and how these arise from microscopic consideration

UNITI- LAWS OF THERMODYNAMICS

Some consequences of the laws of thermodynamics − Entropy − Calculation of entropy changes in reversible processes. The principle of increase of entropy − Thermodynamic potentials −

Ehthalpy, Helmholtz and the Gibbs functions − Phase transitions − The Clausius-Clayperon equation − Van der Waals equation of state.

UNIT II- KINETIC THEORY
Distribution function and its evolution − Boltzmann transport equation and its validity − Boltzmann's H-theorem − Maxwell-Boltzmann distribution − Transport phenomena − Mean free path- Conservation laws − Hydrodynamics (No derivation).

UNIT III- CLASSICAL STATISTICAL MECHANICS
Maxwell Boltzmann distribution law: Evaluation of constants - Maxwell's law of distribution of velocities - Most probable speed, Average speed, Root mean square speed - Principle of equipartition of energy - Partition function - Condition for applicability of M.B statistics - Non degenerate and degenerate systems - Maxwell velocity distribution in a given direction - Total internal energy of an ideal gas - Molar heat capacity of a gas at constant volume – Entropy - Helmholtz free energy - Pressure and equation of state of an ideal gas - Limitation of M.B method.

UNIT IV- QUANTUM STATISTICAL MECHANICS
B.E energy distribution for energies in the range E to E + dE – Condition for B.E distribution to approach classical M.B distribution - Bose temperature - Bose Einstein condensation - Planck's law from B.E law - Fermi Dirac distribution law (no derivation) - FD law for the energies in the range E to E+dE – Fermi energy - Effect of temperature - Energy distribution curve - Free electron in a metal - Fermi temperature and Thermionic emission - Richardson Dushmann Equation - Comparison of MB,BE and FD statistics.

UNIT V- APPLICATIONS OF QUANTUM STATISTICAL MECHANICS
Ideal Bose gas : Photons − Black body and Planck radiation − Photons − Specific heat of solids − Liquid Helium.
Ideal Fermi gas : Properties − Degeneracy − Electron gas − Pauli paramagnetism
Ferromagnetism : Ising and Heisenberg models.

SUGGESTED READINGS:

1. Agarwal B.K. and M. Eisner, 3rd edition, 2013, Statistical Mechanics, New age international Limited, New Delhi.
2. Reif F., 2008, Fundamentals of Statistical and Thermal Physics, (Reprint), McGraw Hill International Edition, Singapore.
3. Gupta and Kumar, reprint, 2014, Elements of Statistical Mechanics, Pragati Prakashan, Meerut.
4. Huang K., 2nd edition, 2014, Statistical Mechanics, Wiley Eastern Limited, New Delhi

5. Sears N. and L. Salinger, 2013, Thermodynamics, 3rd Ed., Narosa Publishing House, New Delhi.
6. Greiner W., L. Neise and H. Stocker, 1st edition, 2007, Thermodynamics and Statistical Mechanics, Springer Verlag, New York.
7. Singh. K. and S.P. Singh reprint 2016, Elements of Statistical Mechanics, S. Chand & Company Ltd., New Delhi.
8. https://nptel.ac.in/courses/115103113/
9. https://nptel.ac.in/courses/115/103/115103028/

SEMESTER – II

18PHP202 **QUANTUM MECHANICS - I** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- This course is aimed to introduce basic concepts and ideas on **Quantum Mechanics**
- To acquire working knowledge of the Quantum Mechanics postulate on the physical systems.
- To impart knowledge of advanced quantum mechanics for solving relevant physical problems
- It has revolutionized the whole science, important for any physics student to know the
- basics of quantum mechanics.
- This paper gives an idea about the development of quantum mechanics.

Course Outcomes (COs)

After completing the course the students can/will able to

1. Interpret the wave function and apply operators to it, to obtain information about a particle's physical properties such as position, momentum and energy
2. To solve the Schroedinger equation to obtain wave functions for some basic, physically important types of potential in one dimension, and estimate the shape of the wavefunction based on the shape of the potential
3. Understand the role of uncertainty in quantum physics, and use the commutation relations of operators to determine whether or not two physical properties can be simultaneously measured
4. They will be able to apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms.
5. Apply special functions as the solutions of differential equation as the wave function/state functions and understanding the physical situations where these can be applied.
6. Calculating states of electrons in hydrogen atom and harmonic oscillators and the interpretation of quantum states.

UNIT I - QUANTUM THEORY AND WAVE MECHANICS

Introduction – Limitation of classical physics – Origin of quantum theory – Planck’s quantum hypothesis – Einstein’s theory of Photoelectric effect –Bohr model of hydrogen atom – Inadequacy of quantum theory.

Matter waves – Uncertainty principle –Wave packet – Group and phase velocity – Time-dependent and Time-independent Schrodinger equations for a free particle and particle in a potential .

UNIT II - ONE DIMENSIONAL POTENTIAL WELL

Square-well potential with rigid walls – Square-well potential with finite walls – Square-well potential barrier – Alpha emission – Bloch waves in a periodic potential – Linear harmonic oscillator (Schrodinger method and operator method) – Free particle.

UNIT III - THREE DIMENSIONAL POTENTIAL WELL AND MATRIX MECHANICS

Particle moving in a spherically symmetric potential – System of two interacting particles – Rigid rotator – Hydrogen atom –– Three-dimensional square-well potential - Deutron

Properties of matrix elements – Schroedinger equation in matrix form –Unitary Transformations – Linear harmonic oscillator.

UNIT IV-TIME-INDEPENDENT PERTURBATION THEORY

Basic concepts – Non-degenerate energy levels – First and Second order corrections for energy and wave functions – Ground state of Helium atom – Effect of electric field on the ground state of hydrogen atom (Stark effect) – Degenerate energy levels – Effect of electric field on the n=2 state of hydrogen atom

UNIT V- WKB APPROXIMATION AND TIME DEPENDENT PERTURBATION THEORY

Variational method, Variational principle – Variation method for excited states – Application of variation method to ground state of helium – The WKB method

Introduction – First-order perturbation – Harmonic perturbation – Transition to continuum states (Fermi's Golden rule) – Absorption and emission of radiation – Transition probability – Selection rules

SUGGESTED READINGS:

1. Aruldhas. G, 2009, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, New Delhi.
2. Leonard I. Schiff, 2000, Quantum Mechanics, 3rd Edition, McGraw Hill International, Auckland
3. Satya Prakash, New Edition, 2003, Quantum Mechanics, Kedar Nath & Ram Nath & Co, Meerut.
4. Gupta, Kumar and Sharma, 2002 – 2003, Quantum Mechanics, 22nd Edition, Jai Prakash Nath & Co, Meerut.
5. Eugen Merzbacher,2013, Quantum Mechanics, 3rd Edition, Wiley, Weinheim

6. Mathews. P.M. and K. Venkatesan, 2nd Edition, 2013, Textbooks of Quantum Mechanics, McGraw Hill International, Weinheim.
7. Chatwal R.G. and Sk. Anand, 4th edition, 2004, Quantum Mechanics, Himalaya Publishing House, New Delhi
8. Thangappan. V. K., 2nd Edition,2013, Quantum Mechanics, Tata McGraw Hill, New Delhi.
9. https://nptel.ac.in/courses/115101107/
10. https://nptel.ac.in/courses/122106034/

SEMESTER –II

18PHP203 **NUCLEAR PHYSICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Nuclear physics is one of the fundamental subjects of physics. It is important to know about the physics of nuclei and the different energies involved in the nuclear processes.
- Nuclear energy is one of the major sources of energy, which, with proper careful usage, can solve the energy crisis to a large extent.
- To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics
- to introduce students to the fundamental concepts of nuclear and sub-nuclear physics
- This paper is intended to give an insight into the different nuclear processes and the fundamental particles, which are the real building blocks of the universe.
- To introduce students to the fundamental concepts of nuclear and sub-nuclear physics

Course Outcomes (COs)

After completing the course the students will / can able to

1. Explain central concepts, laws and models in nuclear and particle physics.
2. Interpret basic experiments using basic laws and relations to solve simple problems.
3. Students understand the basic principle, type of accelerators, working and operation of accelerators.
4. Learn the basic of ion sources, beam transport and application of accelerator in different branches of science.
5. Get trained in research institute and academic Universities to handle such complicated machine such as reactors.
6. Explore their knowledge in reactors to the atomic agency

UNIT I - NUCLEAR MASS AND CHARGE

Distribution of nuclear charge - Nuclear mass and binding energy of a nucleus – semi-empirical mass formula – Nature of nuclear force – form of nucleon-nucleon potential – charge independence and charge symmetry of nuclear forces - Bound states of two nucleons-Ground state of Deuterium - Wave mechanics of ground state of Deuterium-Spin states –Pauli's exclusion principle -Tensor force - Exchange force - Low energy Nucleon - Nucleon scattering

UNIT II - NUCLEAR MODELS

Liquid drop model - Bhor Wheeler theory of fission - Condition for spontaneous fission - Activation energy-Seaborg's expression - Shell model: Explanation for magic numbers - Prediction of shell model -Prediction of spin and parity - Nuclear statistics - Magnetic moment of nuclei - Schmidt lines-Nuclear isomerism - Collective model: Explanation of Quadrupole moments - Prediction of sign of electric quadrupole moments. Optical model: Nilsson model - Elementary ideas

UNIT III- RADIOACTIVITY

Alpha decay: Properties of α particles - Velocity and energy of α particles - Gamow's theory of α particles- Geiger - Nuttall law- α ray energies and fine structure of α rays - α disintegration energy-Low range α particles

Beta decay: Properties of β particles - General features of β ray spectrum – Pauli's hypothesis - Fermi's theory of β particles - Forms of interaction and selection rules - Fermi's and Gamow teller transition

Gamma decay: The absorption of γ rays by matter - Interaction of γ rays with matter - Measurement of γ ray energies - Dumont bent crystal spectrometer method-internal conversion – Applications.

UNIT IV - NUCLEAR REACTIONS

Nuclear fission and fusion - Kinds of reaction and conservation laws - energetics of nuclear reaction – Applications of Nuclear Energy – Nuclear Reactors - Isospin - Reaction cross section-Continuum theory of nuclear reaction - Resonance - Briet Wigner Dispersion formula - Stages of nuclear reaction - Statistical theory of nuclear reaction - Evaporation probability and cross section – Kinematics of stopping and pickup reaction - Surface reaction

UNIT V - ELEMENTARY PARTICLES

Introduction to antiparticles, Interactions and Feynman diagrams and particle exchange, Lepton and the weak interaction, Muon Decay, Neutron Decay, Pion and Kaon Decay, Dirac Equation and its Solution, Quarks and Hadrons; Space time symmetries, Quark theory, The Quark Model, QCD, Jets and Gluons.

SUGGESTED READINGS:

1. Pandya. M.L. and R. P. S. Yadav, 2004, Elements of Nuclear Physics, 1st edition Kedar Nath Ram Nath, Meerut.
2. D.C Tayal , 4th edition 2011, Nuclear Physics, Himalaya Publishing House, New Delhi.
3. Introduction to Nuclear Physics- Harald, Enge, The Perseus Books Group.

4. Nuclear Physics: Theory and Experiment- R. R. Roy, B.P. Nigam, New Age International Pvt Ltd.
5. Kenneth S.Karne, , 1st edition, 2008, Introducing Nuclear Physics, John Wiley and Sons, New York.
6. Sharma. D.C 2004, Nuclear Physics, - K. Nath & Co, Meerut.
7. Bernard L. Cohen, , 1st edition, 2011, Concept of Nuclear Physics, Tata Mc Graw Hill, New Delhi.
8. Devanathan V.,2nd edition, 2008, Nuclear Physics, Narosa Book Distributers Pvt. Ltd., New Delhi.
9. Kaplan Irving, 2002, Nuclear Physics, 2nd Edition, Narosa Book Distributers Pvt. Ltd., New Delhi.
10. https://nptel.ac.in/courses/115103101/
11. https://nptel.ac.in/courses/115104043/

SEMESTER – II

18PHP204 **SPECTROSCOPY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- This paper gives an insight into the theoretical and practical aspects of spectroscopy. it is used as a tool for non-destructive testing of samples. It is important to know the physical aspects of spectroscopy.
- The major objectives of this course are to integrate theory and practice and to bring together different branches of both Academic studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy.
- The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine.
- To give an understanding of wide range of techniques including optical Nearfield spectroscopy, X-ray, Raman, and FTIR spectroscopy.
- To introduce optical **spectroscopy** methods that are widely used in physics, chemistry and biological sciences
- To teach the basic aspects of nuclear magnetic resonance (NMR) **spectroscopy**.

Course Outcomes (COs)

After completing the course the students will / can able to

1. Understand the basic physical chemistry law that govern molecular spectroscopy
2. Student will know basic information on molecular methods (IR, Raman, UV-VIS, NMR, EPR)
3. Select molecular spectroscopy methods suitable for solving given scientific problem
4. Analyze results of measurements using molecular spectroscopy
5. Give a view of the modern experimental tools of Atomic- and Molecular Physics.
6. Gain knowledge of the most common atomic and molecular spectroscopic methods and the atomic and molecular properties derived from those.

UNIT I - IR SPECTROSCOPY AND RAMAN SPECTROSCOPY

Practical aspects – Theory of I.R rotation vibration spectra of gaseous diatomic molecules – applications of I.R spectroscopy – Basic principles of F.T.I.R spectroscopy
Classical and Quantum theory of Raman effect - Rotation vibration Raman spectra of diatomic and polyatomic molecules – Applications - Laser Raman spectroscopy .

UNIT II- ATOMIC SPECTRA AND MICROWAVE SPECTRA

Hydrogen spectra – Angular momentum – Larmor precession – Spin-orbit interactions - Spectra of alkali metals – Energy level and spectral transitions of Helium - Normal Zeeman effect – Anomalous Zeeman effect – Paschen back effect – Inference of nuclear spin - Hyperfine structure of spectral lines – Stark effect – Characteristic X-ray spectra

Classification of molecules – Interaction of radiation with rotating molecule – Rotational spectra of rigid diatomic molecule – Isotopic effect – Non-rigid rotator – Linear, symmetric and asymmetric top molecules – Microwave spectrometer

UNIT III - VIBRATIONAL SPECTROSCOPY

Electronic excitation of diatomic species - Vibrational analysis of diatomic molecules - Deslandre's table - Intensity distribution Frank Condon principle - Rotational structure of electronic bands - Resonance and Normal Fluorescence – Intensities of transitions - Phosphorescence population of triplet state and intensity- Experimental methods - Applications of Fluorescence and phosphorescence.

UNIT IV - NMR SPECTROSCOPY AND NQR SPECTROSCOPY

Quantum mechanical and Classical description - The Bloch equation - Relaxation process - the experimental technique - Principle and working of high resolution NMR Spectrometer - Chemical shift – Applications of NMR

Fundamental requirements - General principle - Experimental detection of NQR frequencies – Interpretation and chemical explanation of NQR spectroscopy – Applications of NQR

UNIT V- ESR SPECTROSCOPY AND MOSSBAUER SPECTROSCOPY

Basic principles of ESR - Experiments – ESR spectrometer reflection cavity and microwave bridge – ESR spectrum hyperfine structure - Study of free radicals – Applications of ESR

The Mossbauer effect- the recoilless emission and absorption of - Mossbauer spectrum – Experimental methods- Hyperfine interaction - Chemical Isomer Shift – Magnetic hyperfine and electric quadrupole interaction.

SUGGESTED READINGS:

1. Fundamentals of Molecular Spectroscopy 4th Edition, Colin N. Banwell and Elaine M. McCash, Mcgraw Higher Ed
2. Aruldhas. G., 2008, Molecular Structure and Spectroscopy, 2nd Edition, Prentice Hall of India, New Delhi
3. Straughan.B.P. and S. Walker, 2000, Spectroscopy: Volume 1, Chapman and Hall Ltd, London. (for Unit I)
4. Straughan.B.P. and S. Walker, 2012, Spectroscopy: Volumes 2 & 3, Chapman and Hall Ltd, London.

5. Chatwall and Anand, 2004, Atomic and Molecular Spectroscopy, 5th Edition, Himalaya Publishing House, New Delhi.
6. Gordon M Barrow,1962, Introduction to Molecular Spectroscopy, McGraw-Hill Inc.,USA.
7. https://nptel.ac.in/courses/104101099/
8. https://nptel.ac.in/courses/104102113/

SEMESTER – II

18PHP205A **DIGITAL SIGNAL PROCESSING** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Digital processing of signals has an extensive range of applications, from the military to the medical, from entertainment to mass production.
- The primary objective of this course is to provide a thorough understanding and working knowledge of design, implementation and analysis DSP systems.
- This course provides areas of application the advent of these specially designed DSP devices has started a revolution in engineering which will pervade most areas of modern life.
- To make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.
- To make students aware about the meaning and implications of the properties of systems and signals.
- To give idea about different classifications of signals, different methods of recording and processing.

Course Outcomes (COs)

After completing the course the students will/able to

1. Determine the spectral coefficients and the Fourier series components of discrete-time signals.
2. Determine the frequency response and the z-transform of discrete-time systems.
3. Determine the discrete Fourier transform of discrete-time signals.
4. Calculate the outputs of discrete-time systems in response to inputs.
5. Understand the characteristics field effect transistors
6. Analyze the characteristics of oscillators and wave shaping circuits

UNIT I- SIGNALS AND SYSTEMS

Introduction- Classification of signals - Concept of frequency in continuous time and discrete–time signals. Theory of A/D and D/A conversion - Sampling of analog signals -sampling theorem - Quantization of continuous amplitude signals - Quantization of sinusoidal signal - Coding of quantized – samples - Digital to analog conversion

UNIT II- DISCRETE- TIME SIGNALS AND SYSTEMS

Discrete - time linear time-invariant systems-Techniques of analysis of linear systems - Resolution of a discrete time signal into impulses - Response of LTI systems to arbitrary inputs : Convolution sum - Properties of convolution and the interconnection of LTI systems - Casual LTI systems Stability of LTI systems - Systems with finite duration and infinite duration impulse – response

UNIT III- THE Z-TRANSFORM

The Direct Z-Transform - The Inverse Z-Transform - Properties of Z-transform - Rational Z-transforms - Poles and zeros - Inversion of Z-transforms. The inverse Z-Transform by contour integration - Power series expansion - Partial fraction expansion – Decomposition of rational Z-transform – Analysis of linear time invariant systems in the Z-domain – one sided Z-Transform.

UNIT IV-FREQUENCY ANALYSIS OF SIGNALS AND SYSTEMS

Frequency analysis of continuous - time signals. The Fourier Series for continuous Time Periodic Signals - Power Density Spectrum of Periodic Signals - The Fourier Transform of Continuous - Time Aperiodic Signals - Energy Density Spectrum of Aperiodic Signals - Frequency analysis of discrete time signals – The Fourier Series for discrete time Periodic Signals - Power Density Spectrum of Periodic Signals – Fourier transform for discrete time Aperiodic signal - Convergence of the Fourier Transform - Energy Density Spectrum of Aperiodic signals - Relationship of the Fourier Transform to the Z Transform.

UNIT V- DISCRETE FOURIER TRANSFORM

Frequency domain sampling and reconstruction of discrete time signals – The Discrete Fourier transform – DFT as a linear transformation - Relationship of the DFT to the other transforms. Properties of DFT - Multiplication of two DFTs and Circular convolution - Linear filtering methods based on DFT - Frequency analysis of signals using the DFT – Discrete cosine transform - Computation of the Discrete Fourier Transform

SUGGESTED READINGS:

1. Oppenheim and Schafer, , 1st edition, Digital Signal Processing, Prentice Hall India – 1999
2. Paulo S.R. Piniz, Eduardo A.B. De Silva and Sergio Netto,2nd+ edition, 2010, Digital Signal Processing, Cambridge University Press
3. Rabiner and Gold, 1st edition ,Theory and Applications of Digital Signal Processing, Prentice Hall India -2011.
4. Digital Signal Processing Video Prof. T.K. Basu IIT Kharagpur, http://nptel.iitm.ac.in/video.php?subjectId=10810505520.

5. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
6. Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press, Digital Signal Processing Principles Algorithm & Applications, J.G. Proakis and D.G. Manolakis, 2007, 4th Edn., Prentice Hall.
7. Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2011, Cengage Learning, Digital Signal Processing , J.G. Proakis and D.G. Manolakis, 2013., Prentice.
8. https://nptel.ac.in/courses/104/106/104106122/
9. https://nptel.ac.in/courses/104101099/
10. http://nptel.iitm.ac.in/video.php?subjectId=10810505520.

SEMESTER – II

18PHP205B **COMPUTATIONAL PHYSICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Computational physics may be broadly defined as 'the science of using computers to assist in the solution of physical problems, and to further physics research.
- To equip the students of M.Sc. Physics with knowledge of programming in C, roots of equation, interpolation, curve fitting, numerical differentiation, numerical integration, solution of ordinary differential equations
- To introduce students to computational methods for simulating physical systems and solving problems arising in physics and astronomy, as well as in other related fields
- Computers now play a role in almost every branch of physics like large scale quantum mechanical calculations in nuclear, atomic, molecular and condensed matter physics, large scale calculations in such fields as hydrodynamics, astrophysics, plasma physics, meteorology and geophysics etc.
- The huge increase in the power of computers in recent years has made an impact on the role of computational physics.
- This paper gives idea about different types of computations involved in Physics, like curve fitting, interpolation, extrapolation, numerical calculations etc.

Course Outcomes (COs)

After completing the course the students will/able to

1. Programme numerical methods and their implementation like applying to problem in
2. physics, including modeling of classical physics to quantum system as well as data analysis (Linear and non linear).
3. Analysis techniques for propagating error, representing data graphically. Create, solve and interpret basic mathematical tool.
4. Program independently computers using leading-edge tools,
5. formulate and computationally solve a selection of problems in physics,
6. Use the tools, methodologies, language and conventions of physics to test and Communicate ideas and explanations.
7. Identify and describe the characteristics of various numerical methods

UNIT I - CURVE FITTING

The least squares method for fitting a straight line, parabola, power and exponential curves with the help of principle of least square fit.

UNIT II - INTERPOLATION

Introduction to finite difference operators - Newton's forward and backward difference interpolation formulae - Lagrange’s interpolation formula - Newton's divided difference formula with error term - interpolation in two dimensions - Cubic spline interpolation end conditions. Statistical tests - Ψ^2- test and T-test.

UNIT III- NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical differentiation - errors in numerical differentiation - cubic spline method - finding maxima and minima of a tabulated function - Integration of a function with Trapezoidal Rule - Simpson's 1/3 and 3/8 Rule and error 55 associated with each - Romberg's integration - Gaussian integration method - Monte Carlo evaluation of integrals - numerical double integration

UNIT IV- DIFFERENTIAL EQUATIONS

Numerical Solution of Ordinary Differential Equations:Euler method - modified Euler method and Runge - Kutta 4th order methods - adaptive step size R-K method - predictor - corrector methods - Milne's method - Adam-Mouton method.

Numerical Solution of System of Equations**:**Gauss-Jordan elimination Method - Gauss-Seidel iteration method – Gauss elimination method and Gauss-Jordan method to find inverse of a matrix - Power method and Jacobi's method to solve eigenvalue problems.

UNIT V- NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Elementary ideas and basic concepts in finite difference method – Schmidt Method - Crank - Nicholson method - Weighted average implicit method - Concept of stability.

SUGGESTED READINGS:

1. G. Shanker Rao, K. Keshava Reddy, Mathematical Methods, I.K. , 1st edition 2009, International Publishing House, Pvt. Ltd.
2. S.S. Sastry,5th edition 2013, Introductory Methods of Numerical Analysis, PHI Pvt. Ltd.
3. Singaravelu.A,Numerical Methods,2008,New Revised Edition, Meenakshi Agencies Pvt.Ltd
4. Tao Pang, 1st edition , 2006.An Introduction to Computational Physics, Cambridge University Press
5. James B Scarborough, Numerical Mathematical Analysis,6th Edition, Baltimore : Johns Hopkins Press.
6. https://nptel.ac.in/courses/115106118/
7. https://nptel.ac.in/courses/115104095/

SEMESTER – II

18PHP205C **THIN FILM PHYSICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- Introduce physical concepts and mathematical tools used to describe surfaces, interfaces and thin films.
- To develop an intuition for surface and thin film physical principles through plotting of functions using Maple
- To relate the mathematical results to practical applications and experiments in thin film techniques.
- Develop an appreciation of the mathematical basis for experimental techniques for deposition and analysis of thin films
- Understand physical phenomena that can be exploited for the deposition of thin films
- To demonstrate knowledge of different thin film deposition strategies

Course Outcomes (COs)
At the end of the course, the students can/will be able to

1. Discuss the differences and similarities between different vacuum based deposition techniques
2. Evaluate and use models for nucleating and growth of thin films
3. Examine the relation between deposition technique, film structure, and film properties, discuss typical thin film applications,
4. Select proper deposition techniques for various applications.
5. Understand the basic concepts about the thin film technology
6. The importance of use of thin films in application and research.

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UNIT I
Growth and structure of films
General features - Nucleation theories - Post-nucleation growth - Four stages of film growth incorporation of defects during growth - Thin film structures - Structural defects.
Thickness Measurement Methods: Electrical methods Mass methods – Optical interference method – Photometric – Ellipsometry – multiple beam Interferometry – Other methods – Substrate cleaning.

UNIT II

Preparation of Thin Films

Physical methods: thermal evaporation - vapour sources - Wire, crucible and electron beam gun - sputtering mechanism and methods – Epitaxy methods – Molecular beam epitaxy (MBE). Chemical methods: chemical vapour deposition and chemical solution deposition techniques - spray pyrolysis - laser ablation.

UNIT III

Properties of Thin Films

Electrical and dielectric behaviour of thin films - components - thin film diode and transistor - strain gauges and gas sensors. Anisotropy in magnetic films - domains in films - computer memories - superconducting thin films - mechanical properties: testing methods - adhesion - surface and tribological coatings. Annealing – Agglomeration and oxidation.

UNIT IV

Transport properties of semiconducting and insulating Films

Semiconducting films; Theoretical considerations - Experimental results – Photoconduction – Field effect thin films – transistors, Insulation films Dielectric properties – dielectric losses – Ohmic contracts – Metal – Insulator and Metal – metal contacts – DC and AC conduction mechanism .

UNIT V

Applications

Thin films optics, Optical - reflection and anti-reflection coatings - interference filters - electrophotography, solar cells: current status of bulk silicon solar cells – Fabrication technology – Photo voltaic performance: Emerging solar cells: GaAs and $CulnSe_2$ -Spintronic - applications.

SUGGESTED BOOK

1. Chopra, K.L. Ist edition 2004, Thin film Phenomena, Mc Graw hill
2. Chopra, K.L. and Das, S.R Ist edition2013 Thin films solar cells. Springer.
3. Thin Film Fundamentals- A. Goswami, New Age International Pvt Ltd.
4. Anderson, J.C.2011 Ist edition The use of thin films in physical investigation, Academic press
5. Berry,Hall and Harris.2003, illustrated edition Thin films technology,Van Nostrand Reinhold publishing
6. George Hass and others (Ed). Physics of thin films, vol. 12.Academic press 2001
7. Holland, L Ist edition 2004, Vacuum deposition of thin films.Weily Publication
8. Milton Ohring, The Materials Science of Thin Films, Academic Press, 2001

9. Meissel. L.T and R. Glang., 2000 Handbook of thin film technology, Tata McGraw Hill, New Delhi.
10. https://nptel.ac.in/content/storage2/courses/112108092/module2/lec08.pdf
11. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/113104075/lec41.pdf

SEMESTER – I

18PHP211 **GENERAL PHYSICS PRACTICAL – II** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objective

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.
- To emphasize the importance of measurement which is central to physics.
- To empower the student to acquire engineering skills and practical knowledge, which help the student in their everyday life.

Course Outcomes (COs)

After the course the student will/ can able to

1. Handle various difficult instruments.
2. Verify laws studied in the different theory course.
3. Measure different properties of materials.
4. Classify the materials with the properties
5. Overcome the fear of experimental skill
6. Built his own equipments for measuring the properties of materials

ANY TEN EXPERIMENTS

1. Fabry – Perot interferometer – Determination of wavelength.
2. Arc spectra – Copper and Iron
3. Determination of V-I characteristics of a solar cell.
4. Susceptibility – Quinke's method
5. Susceptibility – Gouy method
6. Hall Effect
7. Measurement of resistivity and conductivity of dielectric using Four-probe apparatus.

8. Compressibility of a liquid – Ultrasonic Interferometer, and verify with Ultrasonic Diffractometer
9. Determination of Stefan's constant.
10. Laser Diffraction at sharp edge – Determination of wavelength.
11. Series LCR circuit: (i) Determination of the resonance frequency using variable frequency source, (ii) To study the resonance of LCR using AC mains.
12. Kelvin's double bridge – To measure low resistance.

SUGGESTED BOOK

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12th Edition, Pragathi Prakashan, Meerut
4. Gupta S.L. and V.Kumar, 2002, Practical Physics, 25th Edition, Pragathi Prakashan, Meerut
5. B.L Worsnop & H T Flint,1951,Advanced Practical Physics For Students, 9th revised Edition, Littlehampton Book Services Ltd.
6. https://nptel.ac.in/courses/115/105/115105110/

SEMESTER – II

18PHP212 ELECTRONICS PRACTICAL – II 4H – 2C

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- The course is designed to train the students so that they can efficiently handle various Instruments
- To understand the Biasing network for BJT and FET, transient analysis and frequency response of BJT and FET in single stage and multistage amplifier
- To understand the frequency response feedback amplifier using BJT and FET and Tuned amplifier
- To understand the operation of Oscillators and waveform generators
- To learn the usage of digital electronics measurements.
- To develop intellectual communication skills and discuss the basic principles of Scientific concepts in a digital electronics

Course Outcomes (COs)

After completing the practical course the students can / will able to

1. Apply the analytical techniques and graphical analysis to the experimental data.
2. Verify laws studied in the different theory course.
3. Measure different properties of materials.
4. Gain the knowledge in quantization of electromagnetic fields.
5. Analyze the characteristics of oscillators and wave shaping circuits
6. Understand the basic concepts of amplifiers and operational amplifiers

ANY TEN EXPERIMENTS

1. Characteristics and an application of SCR
2. Study of various types of flip-flops (R-S, J-K, Master Slave J-K)
3. Shift register – Digital IC's
4. Schmitt trigger
5. Op-amp – Simultaneous Addition and Subtraction
6. Op-amp – V to I, I to V converter
7. V-I characteristics of a schotkky diode
8. V-I characteristics of photoconductive diode.

9. Op-amp Log and Antilog amplifier.
10. Op-amp –Analog computation second order differential equation
11. Op-amp comparator – Zero crossing detector, Window detector, time marker
12. 555 Timer application – monostable, linear, Astable multivibrators.
13. Virtual Lab (Flip flop, Logic gates)

SUGGESTED BOOK

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12th Edition, Pragathi Prakashan, Meerut
4. Gupta S.L. and V.Kumar, 2002, Practical Physics, 25th Edition, Pragathi Prakashan, Meerut
6. Ramakant A. Gayakwad, 2002, Op-amp and Linear Integrated Circuits ,4th Edition, Prentice Hall.
7. https://nptel.ac.in/courses/122/106/122106025/

SEMESTER III
4H- - 4C

18PHP301 QUANTUM MECHANICS – II

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

- The aim of this course is to make the students to understand the concepts of quantum physics and their applications in microscopic systems
- This **course** develops concepts in **quantum mechanics** such that the behaviour of the physical universe can be understood from a fundamental point of view.
- To acquire working knowledge of the Quantum Mechanics postulate on the physical systems
- This is a continuation of Quantum Mechanics – I. More detailed study of problems like scattering problem, relativistic quantum mechanics, quantum electrodynamics etc, are added in this paper to enrich the theoritical knowledge.
- To make the students capable of analyzing theoretical problems like interaction of particles, scattering of particles etc.
- To impart knowledge of advanced quantum mechanics for solving relevant physical problems

Course Outcomes (COs)

After completing the course the student will/can able to

1. Get the knowledge of non-relativistic and relativistic quantum mechanics including timedependent
2. perturbation theory, scattering theory, relativistic wave equations, and second quantization.
3. Understand concepts and to perform calculations of scattering of particles.
4. Understand and evaluate modern research utilizing quantum theory in condensed matter, nuclear and particle physics.
5. Acquire the basic knowledge on Eigen values and Eigen functions
6. Apply the Schrodinger wave equation to get Eigen values of bound systems
7. Understand the matrix formulation in quantum mechanics
8. Acquire the basic knowledge on angular momentum of quantum mechanical systems

UNIT - I

Angular momentum: Angular momentum operators – Angular momentum commutation relations – Eigen values and Eigen functions of L^2 and L_z – General angular momentum – Eigen values of J^2 and J_z – Ladder operators (J_+ and J_-) – Angular momentum matrices – Matrices for J^2, J_z, J_+, J_-, J_x and J_y – Spin angular momentum – Spin ½ systems – Spin vectors for spin ½ systems – Addition of angular momentum – Clebsh-Gordan coefficients.

UNIT -II

Scattering: Scattering cross-section – Scattering amplitude – Partial waves – Scattering by a central potential: partial wave analysis – Significant number of partial waves – Scattering by an attractive square-well potential – Briet-Wigner formula – Scattering length – Expression for phase shift – Integral equation – The Born approximation – Scattering by screened coulomb potential – Validity of Born approximation - Laboratory and center of mass co-ordinate systems.

UNIT - III

Many Electron Problem: Indistinguishable particles, Pauli principle – Inclusion of spin – Spin functions for two electrons – Spin functions for three electrons – The Helium atom – Central field approximation – Thomas-Fermi model of the atom – Hartree equation – Hartree-Fock equation – Molecular orbital theory: Hydrogen molecule ion H_2^+- Valence bond theory – Heitler-London theory of hydrogen molecule.

UNIT - IV

Relativistic quantum mechanics: Klein-Gordan equation – Interpretation of the Klein-Gordan equation – Particle in a coulomb field – Dirac's equation for a free particle – Dirac matrices – Covariant form of Dirac equation – Probability density – Negative energy states – Spin of the Dirac particle – Magnetic moment of the electron – Spin-orbit interaction – Radial equation for an electron in a central potential – Hydrogen atom – Lamb shift.

UNIT - V

Field theory: Introduction – Classical approach to field theory – Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field – Field: Lagrangian and Hamiltonian formulations – Quantum equation for the field – Second quantisation – Quantisation of non-relativistic Schroedinger equation – Creation, annihilation and number operators.

SUGGESTED READINGS

1. Aruldhas. G, 2008, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi.
2. Gupta, Kumar and Sharma, 2002, Quantum Mechanics, 22nd Edition, Jai Prakash Nath & Co, Meerut.

3. Satya Prakash, 2003, Quantum Mechanics, New Edition Kedar Nath & Ram Nath & Co, Meerut.
4. Leonard I. Schiff, 2006, Quantum Mechanics, 3rd Edition, McGraw Hill International, Auckland.
5. Eugen Merzbacher, 2014, Quantum Mechanics, 3rd Edition, Wiley, Weinheim.
6. Mathews. P.M. and K. Venkatesan, 2nd edition 2013, Textbook of Quantum Mechanics, McGraw Hill International, Weinheim.
7. Chatwal R.G. and Sk. Anand, 4th editin 2004, Quantum Mechanics, Himalaya Publishing House, New Delhi
8. Thangappan. V. K., 2nd edition 2007, Quantum Mechanics, Tata McGraw Hill, New Delhi.
9. https://nptel.ac.in/courses/115102023/
10. https://nptel.ac.in/courses/122/106/122106034/
11. https://nptel.ac.in/courses/115/101/115101107/

SEMESTER III

18PHP302 LASER AND ITS APPLICATIONS **4H- - 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- Laser is a versatile tool with applications in almost all fields from medical to astronomy, communications, welding, cutting etc.
- This paper explains the characteristics of lasers, different types of lasers and their construction to apply for industircal use. Applications of lasers in different fields are also explained.
- To give exposure to students about the characteristics of different lasers, their fabrication techniques, applications etc.
- To make the student understand the principles of Lasers
- To enable the student to explore the field of Nonlinear optics
- To be able to apply the fundamental concepts of optics in lasers, optical fiber communications and optoelectronics

Course Outcomes (COs)

After completing the course the students can/will able to

1. Acquire fundamentals and principles of Laser action and Understand the basic conceptsof different types of lasers
2. Understand the absorption and spontaneous and stimulated emission in two level system,
3. The effects of homogeneous and inhomogeneous line broadening, and the conditions for laser amplification.
4. Operate and analyze the properties of the most common laser types, He-Ne, Argon-ion,and carbon-dioxide, ruby, titanium sapphire, neodymium YAG and glass, knowledge of other main laser types.
5. Classify fibers as single-mode, multimode step index and multi-mode graded index.
6. Describe modes in multimode fibers and mode field parameter in single-mode fibers.

UNIT- I

Laser Characteristics: Spontaneous and stimulated emission, Einstein's quantum theory of radiation, theory of some optical processes, coherence and monochromaticity, kinetics of optical absorption, line broadening mechanism, Basic principle of lasers, population inversion, laser pumping, two & three level laser systems, resonator, Q-factor, losses in cavity, threshold condition, quantum yield.

UNIT – II

Laser Systems: Solid state lasers- the ruby laser, Nd:YAG laser, ND: Glass laser, semiconductor lasers – features of semiconductor lasers, intrinsic semiconductor lasers, Gas laser - neutral atom gas laser, He-Ne laser, molecular gas lasers, CO2 laser, Liquid lasers, dye lasers and chemical laser.

UNIT-III

Advances in laser Physics : Production of giant pulse -Q-switching, giant pulse dynamics, laser amplifiers, mode locking and pulling, Non-linear optics, Harmonic generation, second harmonic generation, Phase matching, third harmonic generation, optical mixing, parametric generation and self-focusing of light.

UNIT – IV

Multi-photon processes: multi-quantum photoelectric effect, Theory of two-photon process, three- photon process, second harmonic generation, parametric generation of light,

Laser spectroscopy : Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect, Coherent anti-stokes Raman Scattering, Photo-acoustic Raman spectroscopy.

UNIT – V

Laser Applications : ether drift and absolute rotation of the Earth, isotope separation, Plasma, thermonuclear fusion, laser applications in chemistry, biology, astronomy, engineering and medicine. Communication by lasers: ranging, fiber Optics Communication, Optical fiber, numerical aperture, propagation of light in a medium with variable index, pulse dispersion.

SUGGESTED READINGS

1. Ajoy Ghatak & Thyagarajan 2nd edition, 2013, Laser Fundamentals and applications Laxmi Publications (P) Ltd
2. Laud, B.B.1st Edition 2011 Lasers and nonlinear optics, New Age Int.Pub.
3. Thyagarajan, K and Ghatak, A.K 2009: Lasers theory and applications Plenum press,
4. Ghatak, A.K.and Thyagarajan, K :2010 Optical electronics Cambridge Univ. Press
5. Maitland, A. and Dunn, M.H. 2013 : Laser Physics N.H.Amsterdam.
6. Hecht, 4th edition 2012 Laser Guide book McGraw Hill, NY.
7. Demtroder, W. : Laser Spectroscopy, Springe series in chemical physics vol.5, Springer verlag, Berlin, 2014.
8. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cy13/
9. https://www.digimat.in/nptel/courses/video/104104085/L01.html

18PHP303 **SEMESTER III**

ELECTROMAGNETIC THEORY AND ELECTRODYNAMICS 4H- - 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- The aim of this course is to provide the students with the fundamental principles of electrical energy (electro- magnetism).
- To understand the propagation of waves in different media, its transmission and reception.
- To understand, develop, and design various engineering applications involving electromagnetic fields.
- To expose the students to the ideas of electromagnetic waves and structure of transmission line
- To obtain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic fields
- To provide the understanding to the propagation of EM wave in free space, conductors & dielectrics.

Course Outcomes (COs)

After completing the course the students will/can able to

1. Formulate potential problems within electrostatics, magnetostatics and stationary current distributions in linear, isotropic media, and also solve such problems in simple geometries using separation of variables and the method of images.
2. Define and derive expressions for the energy both for the electrostatic and magnetostatic fields, and derive Poyntings theorem from Maxwells equations and interpret the terms in the theorem physically.
3. Understand the theories and properties of electrostatics
4. Analyze the interaction of electrostatic properties with matter.
5. Acquire the fundamental knowledge in Magnetostatics
6. Understand the basic concepts of electrodynamics.

UNIT- I

Electrostatics: Electric intensity – Electric potential – Gauss Law - Dielectric and its polarization - Electric displacement D – Dielectric constant ε_r – Polarisibiltiy α - Clausius-Mossotti relation (Non-polar molecules) – The Langevin equation (Polar molecules) – Electrostatic energy

Magnetostatics: Current density J – Ampere's law of force – Biot-Savart law – Ampere's circuital law – Magnetic scalar potential ϕ_m (no applications) – Magnetic vector potential A – Magnetisation and magnetization current – Magnetic intensity – Magnetic susceptibility and Permeability.

UNIT- II

Field Equations and Conservation Laws: Equation of continuity - Displacement currents - The Maxwell's equations derivations - physical significance - Poynting vector - Electro magnetic potentials A and ϕ - Maxwell's equations in terms of Electro magnetic potentials - Concept of gauge -Lorentz gauge - Coulomb gauge

UNIT- III

Propagation of Electromagnetic Waves: Electromagnetic waves in Free space - Isotropic dielectric - Anisotropic dielectric – Conducting media - Ionized gases.

Radiating systems: Oscillating electric dipole – Radiation from an oscillating dipole – Radiation from small current element.

UNIT- IV

Interaction of E.M.Waves with matter (Macroscopic): Boundary conditions at interfaces - Reflection and refraction – Frenel's laws-Brewster's law and degree of polarization - Total internal reflection and critical angle.

Interaction of E.M.Waves with matter (Microscopic): Scattering and Scattering parameters - Scattering by a free electron (Thomson Scattering) - Scattering by a Bound electron (Rayleigh scattering) – Dispersion Normal and Anomalous – Dispersion in gases (Lorentz theory) – Dispersion in liquids and solids.

UNIT – V

Relativistic Electrodynamics: Purview of special theory of relativity – 4-vectors and Tensors - Transformation equations for charge and current densities J and ρ – For electromagnetic potentials A and ϕ - Electromagnetic field tensor $F_{\mu\nu}$ - Transformation equations for the field vectors E and B - Covariance of field equations in terms of 4-vectors - Covariance of Maxwell equations in 4-tensor forms – Covariance and transformation law of Lorentz force.

SUGGESTED READINGS

1. Chopra & Agarwal 2004, Electromagnetic theory, 6th Edition, Nath & Co, Meerut.
2. Griffiths D., 2013, Introduction to Electrodynamics, 4th Edition, Printice Hall of India, New Delhi.
3. Paul Lorrain and Dale R Corson , Electromagnetic fields and waves , 3rd Edition, **W**. H. Freeman and Company New York.

4. Jacson. J.D., 2009, Classical Electro dynamics, 3rd Edition, Willey Eastern, New Delhi.
5. Schwaritz. M. 2008, Principles of Electro dynamics, McGraw Hill, Auckland.
6. Jordon and Balmain 2nd edition 2002, EMW radiating systems, Prentice Hall of India Pvt Ltd, New Delhi.
7. Gupta, Kumar and Singh, 2007, Electro dynamics, 19th Edition, Pragati Prakasan, Meerut, New Delhi.
8. Satya Prakash 10th revised 2003, Electromagnetic theory and Electro dynamics, Kedar Nath Ram Nath & Co, Meerut.
9. https://nptel.ac.in/courses/115101008/
10. https://nptel.ac.in/content/syllabus_pdf/104104085.pdf

SEMESTER III

18PHP304 DIGITAL ELECTRONICS AND MICROPROCESSOR 4H- - 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- Digital electronics is very important in present day life due to its applications in almost all fields of life. Any signals stored in memory are first digitized. So it is important to have knowledge about digital electronics.
- To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
- To prepare students to perform the analysis and design of various digital electronic circuits.
- This paper is intended to give an insight into the theory and applications of digital electronics, design of circuits with digital devices, details of microprocessor and its applications.
- To learn interfacing of real world input and output devices.
- To study various hardware & software tools for developing applications

Course Outcomes (COs)

At the end of the course, Students can

1. Acquire the basic knowledge of digital logic levels and application of digital electronics circuits.
2. Perform the analysis and design of various digital electronic circuits.
3. Acquire knowledge about Microprocessors and its need.
4. Able to identify basic architecture of different Microprocessors.
5. Foster to write the programming using 8085 microprocessor.
   Foster to understand the internal architecture and interfacing of different peripheral devices with 8085 Microprocessor.

UNIT -I

Flip Flops: SR, JK, JK Master Slave, T Flip flop & D Flip Flop (Symbol and Truth table)Registers (Types, shift operations) - Counters (Types, Designing of MOD 5 synchronous Counter, Construction and truth table - verification of MOD 16 Asynchronous UP, Down counter) - Multiplexer And demultiplexer (16:1 and 1:16 description and truth table verification) - Decoders and encoders (Definitions, Seven segment decoder, decimal to BCD encoder)

UNIT-II

Special Function ICs: Timer IC 555 (Block diagram, pin description) , Application as Astable, monostable, bistable multivibrator - VCO IC 566 (Block diagram and pin description) - PLL IC 565 (Block diagram and pin description) - Fixed voltage Regulator ICs 7800 and 7900 series - Voltage Regulator IC 723 (description, designing for low and high voltage)

UNIT- III

Microprocessor: Microprocessor Architecture, Pin out configuration of 8085-bus organization and timings –address bus, data bus, multiplexing address/data bus and control and status signal, Interrupts: maskable and non-maskable interrupt (concept), 8085 interrupt.

UNIT -IV

Programming Model of 8085: Instruction set-Data transfer, arithmetic, logical and branch instruction-Addressing modes -16 bit data transfer and memory related instructions-stack and subroutine instructions.

Simple Program: 8 bit addition-subtraction-multiplication- finding largest and smallest number, ascending and descending order, 16 bit addition,

UNIT- V

Interfacing Peripherals and Applications: Interfacing concepts-peripheral I/O instructions-Interfacing programs- Data Converters, LED interfacing, stepper motor interfacing, Hex Keyboard Interfacing.

SUGGESTED READINGS

1. Floyd, 2003, Digital Fundamentals, 8th Edition, Pearson education, New Delhi.
2. Ramesh Gaonkar 6th edition 2013 Microprocessor Architecture, Programming and Applications with 8085 ,PENRAM International P Ltd
3. Malvino and Leach, 2006, Digital Principles and Applications, 3rd Edition, Tata McGrawHill, New Delhi.
4. Aditya P. Mathur, 24th reprint 2006, Introduction to Microprocessor, 3rd Edition, Tata McGrawHill, New Delhi.
5. Morris Mano. M, 1st 2002, Digital Logic and Computer Design, Prentice Hall, New Delhi.
6. https://nptel.ac.in/courses/117103064/
7. https://nptel.ac.in/courses/117106086/

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SEMESTER – III

18PHP305A NANOSTRUCTURES AND CHARACTERIZATION 4H- - 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- This course introduces the fundamentals of nano-scale engineering and manufacturing.
- Current and future applications of nanostructured materials will be reviewed with respect to their impact in commercial products and technologies.
- The main physical forces controlling the nucleation and deposition of nanostructures will be presented allowing a better understanding of key design factors at the nano-scale. Well-established and novel synthesis/fabrication methods
- nanostructures will be critically discussed giving a broad overview of the state-of-the-art nanomanufacturing processes.
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization of nano materials
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of nano technologies

Course Outcomes (COs)

At the end of the course, Students will understand and:

1. Explain the fundamental principles of nanotechnology and their application to biomedical engineering.
2. Apply engineering and physics concepts to the nano-scale and non-continuum domain.
3. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature.
4. Design processing conditions to engineer functional nanomaterials.
5. Evaluate current constraints, such as regulatory, ethical, political, social and economical, encountered when solving problems in living systems.
6. Get motivated to select the deposition techniques for various applications

UNIT - I

Low Dimensional Structures : Preparation of quantum nanostructures - size and dimensionality effects - size effects - potential wells - partial confinement - conduction electrons and dimensionality - Fermi gas and density of states - properties dependent on density of states - excitons - single-electron tunneling - Aplications - infrared detectors - quantum dot lasers -

superconductivity. Microelectromechanical Systems (MEMS) - Nanoelectromechanical Systems (NEMS) –Fabrication of nanodevices and nanomachines - Molecular and Supramolecular Switches.

UNIT - II

Carbon Nanostructures : Carbon Molecules - Nature of the Carbon Bond - New Carbon Structures - Carbon Clusters -Small Carbon Clusters - Carbon Nano tubes - Fabrication - Structure – Electrical Properties - Vibrational Properties – Mechanical Properties - Applications of Carbon Nano Tubes - Computers - Fuel Cells - Chemical Sensors - Catalysis – Mechanical Reinforcement - Field Emission and Shielding. Solid Disordered Nanostructures - Methods of Synthesis - Failure Mechanisms of Conventional Grain sized Materials – Mechanical Properties – Nano structured Multi layers -Electrical Properties – Porous Silicon - Metal Nano cluster - Composite Glasses.

UNIT - III

Thermal, Microscopic and Infrared Analysis : Thermal analysis – DTA, DSC and TGA – methodology of DTA, DSC and TGA and Instrumentation. Microscopy – Electron microscopy – Principles and instrumentation – resolution limit – scanning tunnelling microscopy – principles – scanning tunnelling microscope - SEM & TEM. Atomic force microscope

UNIT - IV

Instrumentation: IR spectrophotometers – Theory and Instrumentation- Applications. Fourier transform techniques – FTIR principles and instrumentation. Raman spectroscopy – Principles, Instrumentation and Applications. Microwave Spectroscopy -Instrumentation and Applications

UNIT - V

Mass Spectrometry, Resonance Spectroscopy : Mass Spectrometry - Principle – Instrumentation – Types of ions produced in a Mass spectrometer - Interpretation of Mass spectra – Applications. NMR – Principles and Instrumentation – Chemical shift - Spin-spin coupling - Applications of NMR - Electron spin resonance spectrometry – Theory of ESR – Instrumentation - Interpretation of ESR spectra - Applications.

SUGGESTED READINGS

1. Charles P. Poole, Jr. and Frank J. Owens, Ist edition 2003, Introduction to Nanotechnology,Wiley,
2. Cornelius T Leondes, MEMS/NEMS: micro electro mechanical systems/nano electromechanical systems Volume 1, Design Methods, Springer, (2006).
3. G. Chatwal & Sham Anand, 5th edition 2013 ,Instrumental methods of Chemical Analysis, Himalaya

4. Norman D Colthup, Lawrence H Daly and Stephen E Wiberley, 2001 Introduction to Infrared and Raman spectroscopy, Academic press, NY.
5. H.H. Willard, L.L. Merrit, J.A.Dean & F.A. Settle, 7^{th} Instrumental methods of analysis, CBS Pub.
6. https://nptel.ac.in/courses/118104008/
7. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/118104008/lec10.pdf

SEMESTER III

18PHP305B SOLAR ENERGY AND ITS UTILIZATION 4H- - 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- Solar energy harvesting and utilizing for day to day purposes has become order of the day. The scarcity and increasing need of the fossil fuel has made man to think about alternate sources, the easiest and best being Solar energy. Hence the course introduced to get knowledge of solar energy and its utilization.
- To introduce the students to the world of solar energy, its different uses, the different methods of harvesting solar energy.
- To understand the basic concepts of energies produced from various energy sources, advantages and disadvantages
- To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of Solar Power Development and Management.
- To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Solar Power Development and Management.
- To develop a comprehensive technological understanding in solar PV system components

Course Outcomes (COs)

At the end of the course, Students will / can be able to

1. Impart the knowledge of Storage technologies form the autonomous renewable energy sources.
2. Explain the principles that underlie the ability of various natural phenomena to deliver solar energy.
3. Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.
4. Understand the basic principles in wind energy conversion and advantage and disadvantage of wind energy conversion systems.
5. Gain the knowledge about the energy produced from biomass and biogas.
6. Understand the concepts of solar cell and solar energy

UNIT -I

Introduction to Energy Sources: World Energy Features, Indian Energy Scene, Conventional and non-conventional energy sources, Prospects of renewable energy sources.

Solar Energy Source: Introduction, Solar constant, radiation on Earth's surface, Radiation geometry, Radiation measurements, Radiation data, Average solar radiation, radiation on tilted surfaces

UNIT – II

Solar Energy collectors : Principle of conversion of energy, Flat plate collector, Transmissivity of cover system, Collector energy balance equation, Thermal Analysis of FPC, Useful heat gain, Focusing collectors, advantages and disadvantages, Factors affecting collector performance.

Application of Solar Energy: Solar Water Heating, Heating and Cooling of Buildings, Thermo electric conversion, Power generation, PV cells, Solar distillation, Pumping, Cooking, Hydrogen production.

UNIT – III

Wind Energy: Principle of energy conversion, Power generation, Forces on blades, energy estimation, Wind data, Components of WECS, Classification of WECS, Advantages and Disadvantages, Types of Wind machines, Performance of Wind machines, Applications of wind energy.Problems

Energy from Biomass: Conversion technology, Factors affecting gas generation, classification of biogas plants, Advantages and disadvantages of different types of plants.

UNIT– IV

Fuel Cells: Design and Principle of operation, Classification, Types, Advantages and disadvantages, Conversion efficiency, Types of electrodes, Work output and EMF of Fuel Cells, Applications of Fuel Cells.

Thermo Nuclear Fusion Energy: Fusion Reactions, Requirements, Plasma, Magnetic and Inertial Confinement fusion, Muon Catalyzed Fusion, Characteristics of D-T Reaction, Advantages of Nuclear Fusion, Fusion Hybrid, Cold Fusion.

UNIT – V

Other Renewables: Geothermal, OTEC, Tidal, Waves, and Hydrogen (Generation and Application)

SUGGESTED READINGS

1. G.D.Rai, 2011 , Non conventional energy sources, Khanna Publishers
2. H P Garg & Prakash, 2000, Solar Energy -Fundementals and Applications ,First Revised Edition Tata McGraw-Hill Education, New Delhi.
3. S.P.Sukhatme. 2008 , Solar Energy, Tata McGraw-Hill Publishing Co. Ltd.
4. D. Mukherjee and S. Chakrabarti, 2005, Fundamentals of Renewable Energy Systems, New Age International Publishers.

5. D.S. Chauhan and S.K.Srivastava. 2004, Non Conventional Energy Resources, New Age International Publishers.
6. https://nptel.ac.in/courses/112105050/
7. https://nptel.ac.in/courses/115107116/

SEMESTER – III

18PHP305C **OPTOELECTRONICS** **4H- - 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- The aim of this course focuses to enable the students to understand optics and nonlinear optics concepts in physics
- Optoelectronics is the science that deals with designing devices that can detect or emit light in any part of the spectrum.
- This paper gives an introduction to semiconductors and light. The application of optics in electronics, usage of optical waves in communications, optical fibers are explained in this paper.
- This course builds on the basic knowledge of both fundamental physics and state-of-the-art technologies for optoelectronic components and fibre optics, in order to understand their important applications in optical communications and energy conversions that influence our society and everyday life
- To focuse on the physics of the interaction of photons with semiconductor materials.
- To give adequate knowledge and clear understanding about the fundamentals of optical property.

Course Outcomes (COs)

At the end of the course, Students will / can be able to

1. Conversant with the application of optical properties and processes in semiconductor optical sources.
2. Understand the operation of LEDs and lasers.
3. Be familiar with the structures and performance of LEDs and lasers.
4. Apply the knowledge of laser in holography
5. Gain the knowledge in Fourier optics and Fourier transforming properties of lenses
6. Understand the concepts of nonlinear optics and harmonic generations.

UNIT - I

Semiconductor Science and Light Emitting Diodes : Semiconductor energy bands - semiconductor statistics – extrinsic semiconductors – compensation doping – degenerate and non degenerate semiconductors – energy band diagrams in applied field - direct and indirect bandgap semiconductors, - p-n junction principles - open circuit- forward and reverse bias – depletion layer capacitance – recombination life time – p-n junction band diagram - open circuit - forward and reverse bias – light emitting diodes – principles - device structures - LED materials, heterojunction high intensity LEDs – double heterostructure – LED characteristics and LEDs for optical fiber communications - surface and edge emitting LEDs.

UNIT - II

Fiber Optics : Symmetric planar dielectric slab waveguide – waveguide condition – single and multimode waveguides – TE and TM modes – modal and waveguide dispersion in the planar waveguide – dispersion diagram – intermodal dispersion – intramodal dispersion – dispersion in single mode fibers – material dispersion – waveguide dispersion – chromatic dispersion – profile and polarization dispersion – dispersion flattened fibers - bit rate and dispersion – optical and electrical bandwidth – graded index optical fiber - light absorption and scattering – attenuation in optical fibers.

UNIT - III

Laser Principles : Laser oscillation conditions - diode laser principles - heterostructure laser diode – double heterostructure – stripe geometry – buried heterostructure – gain and index guiding - laser diode characteristics – laser diode equation - single frequency solid state lasers – distributed feedback –quantum well lasers - vertical cavity surface emitting laser - optical laser amplifiers.

UNIT - IV

Photodetectors and Photovoltaics : Principle of p-n junction photodiode - Ramo's theorem and external photocurrent - absorption coefficient and photodiode materials – quantum efficiency and responsivity - PIN-photodiode – avalanche photodiode – phototransistor - photoconductive detectors and photoconductive gain – noise in photo-detectors – noise in avalanche photodiode - solar energy spectrum - photovoltaic device principles – I-V characteristics - series resistance and equivalent circuit - temperature effects - solar cell materials, device and efficiencies

UNIT - V

Optoelectronic Modulators: Optical polarization, birefringence, retardation plates, electro-optic modulators – Pockels effect - longitudinal and transverse electro-optic modulators, Kerr effect, Magneto-optic effect, acousto-optic effect – Raman Nath and Bragg-types.

Non-linear optics: Wave propagation in an anisotropic crystal - polarization response of materials to light - second order non-linear optical processes – second harmonic generation - sum and frequency generation, optical parametric oscillation - third order non-linear optical processes - third harmonic generation - intensity dependent refractive index - self-focusing - non-linear optical materials, phase matching - angle tuning - saturable absorption - optical bistability - two photon absorption.

SUGGESTED READINGS

1. Ajoy Ghatak & Thyagarajan 2nd edition,2013,Laser Fundementals and applications Laxmi Publications (P) Ltd.
2. Jasprit Singh,1st edition2014 Optoelectronics: An introduction to materials and devices, Mc Graw Hill International Edn.
3. Pallab Bhattacharya, 2nd edition Semiconductor optoelectronic devices: Pearson(2008)
4. A.Yariv and P. Yeh,1st edition 2003 Optical waves in crystals: Propagation and Control of Laser Radiation, John Wiley and Sons Pub.
5. William T. Silfvast, Laser fundamentals, CUP 2nd Edn. 2009.
6. https://nptel.ac.in/courses/115102026/
7. https://nptel.ac.in/courses/115102103/

SEMESTER – III

18PHP311 ADVANCED PHYSICS PRACTICAL 4H- - 2C

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objective

- To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
- The course is designed to train the students so that they can efficiently handle various Instruments
- To learn the usage of optical systems for various measurements.
- Apply the analytical techniques and graphical analysis to the experimental data.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.
- To understand the programming knowledge in MATLAB for various physics problems and electronic circuits

Course Outcomes (COs)

At the end of the course, Students will / can be able to

1. Design and efficiently handle various instruments.
2. Verify laws studied in the different theory course.
3. Measure different properties of materials.
4. Gain the knowledge in quantization of electromagnetic fields.
5. Analyze the characteristics of oscillators and wave shaping circuits
6. Understand the basic concepts of amplifiers and operational amplifiers

ANY TEN EXPERIMENTS

1. Arc spectra – Aluminium and Brass
2. (i) Determination of wavelength of He-Ne laser – Ruler method.

   (ii) Determination of thickness of a wire using He-Ne laser.
3. Determination of e/m using Zeeman effect.
4. Measurement of thickness of a thin film using MBI technique.
5. G.M.Counter – Characteristics.
6. Experiment on rotatory dispersion of quartz.
7. Matlab Programming-Radioactive Decay
8. Matlab Programming-Numerical Integration

9. Matlab Programming-Double Integration
10. Matlab Programming-Solution of Ordinary Differential Equations
11. Matlab Programming-Computer Simulation of Equations of Motion for a System of Particles
12. Matlab Programming-Computer Simulation of 1-D and 2-D Lattice Vibrations
13. Matlab Programming-Computer Simulation of Kronig-Penney Model

SUGGESTED READINGS

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai.
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut.
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12th Edition, Pragathi Prakashan, Meerut.
4. B.L Worsnop & H T Flint. Advanced Practical Physics For Students, 9th revised Edition, Littlehampton Book Services Ltd.
5. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge05/
6. https://nptel.ac.in/courses/111/102/111102137/

SEMESTER – III

18PHP312 ADVANCED ELECTRONICS PRACTICAL 4H- - 2C

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To introduce different integrated circuit for students to understand the application to electronics circuits
- To understand the Biasing network for BJT and FET, transient analysis and frequency response of BJT and FET in single stage and multistage amplifier
- To understand the frequency response feedback amplifier using BJT and FET and Tuned amplifier.
- This course introduces the assembly language programming of 8085 Microprocessor. It gives a practical training of interfacing the peripheral devices with the 8086 microprocessor.
- To design and construction of circuits using analog component and trouble shooting of the circuits.
- To provide the real time experience on microprocessor in traffic signal and industry

Course Outcomes (COs)

On completion of this lab course the students will be able to:

1. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller.
2. Work with standard microprocessor real time interfaces including GPIO, serial ports, digital-to-analog converters and analog-to-digital converters;
3. Troubleshoot interactions between software and hardware;
4. Analyze abstract problems and apply a combination of hardware and software to address the problem
5. Practically study the working of different electronic components circuits.
6. Learn to minimize contributing variables and recognize the limitations of the equipment.

ANY TEN EXPERIMENTS

1. Pulse Width Modulation using IC's to control DC motor speed.
2. 4-bit up/down synchronous or asynchronous counters using IC 7473/7476
3. Frequency modulation/demodulation using IC's
4. Construct the circuit for multiplexer/demultiplexer using IC741
5. Design of active filters

6. Decade counters using IC7490 and 7473
7. Log and antilog circuit using OP-AMP
8. Microprocessor – LED interfacing and Musical tone generator interfacing
9. Microprocessor – interfacing of stepper motor and ADC wave form generation.
10. Microprocessor – Traffic light simulation
11. Microprocessor – interfacing of frequency or temperature measurement sensor
12. Microprocessor – Hexa Key Board interface.

SUGGESTED READINGS

1. Ramesh Gaonkar, 2013, Microprocessor Architecture Programming and Applications with 8085, 6^{th} edition, PENRAM International Pvt Ltd.
2. P. Horowitz and W. Hill, The Art of Electronics, Second edition, Cambridge University Press, 1989.
3. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Fifth edition, Oxford University Press, 2003.
4. https://nptel.ac.in/courses/108/105/108105102/
5. https://nptel.ac.in/courses/115/102/115102014/

SEMESTER IV

18PHP491 **PROJECT** **30H- - 15C**

Instruction Hours / week: L: 0 T: 0 P: 30 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- The aim of the M.Sc. Research project work is to expose the students to preliminaries and methodology of research in Theoretical Physics and Experimental Physics.
- To provides the students to get opportunity and participate in some ongoing research activity and development of a laboratory experiment.
- To provide the student with a broad spectrum of physics projects courses
- To emphasize the role of physics in life and other discipline (chemistry ,mathematics and biology)
- To develop the ability of the students to conduct, observe, analyzes and report an experiment and deal with physical models and formulas mathematically.
- To provide the student with different practical, intellectual and transferable skills.
- To understand the objective of a physics laboratory experiment, properly carry out the experiments, and appropriately record and analyze the results.
- To think creatively about scientific problems and their solutions.
- To design experiments, and to constructively question results they are presented with, whether these results are in a newspaper, in a classroom, or elsewhere.

Course Outcomes (COs)

After successful completion of the course, the student is expected to

1. Complete an independent research project, resulting in research outputs in terms of publications in journals and conference proceedings.
2. Demonstrate a depth of knowledge of Physics.
3. Complete an independent research project, resulting in research outputs in terms of publications in journals and conference proceedings.

4. Demonstrate knowledge of contemporary issues in their chosen field of research.
5. Demonstrate an ability to present and defend their research work.
6. Demonstrate an ability to succeed in problem solving in electronics
7. Solve physics problems using qualitative and quantitative reasoning including sophisticated mathematical techniques
8. Conduct independent research or work successfully in a technical position.
9. Successfully pursue career objectives in graduate school or professional schools, in a scientific career in government or industry, in a teaching career, or in a related career.
10. Apply their knowledge to develop the instruments.
11. Verify the basic principles and laws experimentally as a project.