Course Name : Master of Science
Discipline : Physics
CHOICE BASED CREDIT SYSTEM
(For those who join in June 2023 and after)

II year M.Sc. PHYSICS

Semester	Part	Subject Name	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of Revision
III	Core 7	Solid State Physics I	6	4	25+75=100				✔					✔			**P24PHC31**	**Mark Change**
	Core 8	Quantum Mechanics II	6	4	25+75=100				✔					✔			**P24PHC32**	**Mark Change**
	Core 9	Nuclear and Particle Physics	6	4	25+75=100				✔					✔			**P24PHC33**	**Mark Change**
	Core Lab 1	**LAB: Digital Electronics & General Physics**	6	6	40+60=100				✔					✔	✔	✔	**P24PHCP31**	**Revised 12 %**
	Major Elective 3	Applied optics / Fiber optic Communication	6	5	25+75=100				✔							✔	**P24PHE31/ P24PHE32**	**Mark Change**
	Total		**30**	**23**														
IV	Core 10	Solid State Physics II	6	4	25+75=100				✔					✔			**P24PHC41**	**Mark Change**
	Core 11	Molecular Spectroscopy	6	4	25+75=100				✔					✔			**P24PHC42**	**Mark Change**
	Core 12	Thermodynamics and Statistical Mechanics	6	4	25+75=100				✔					✔			**P24PHC43**	**Mark Change**
	Major Elective 4	Nano Physics / Bio Physics	6	5	25+75=100				✔							✔	**P24PHE41/ P24PHE42**	**Mark Change**
	Core	Project & Viva-voce	6	5	50+50=100				✔					✔	✔	✔	P22PH4PV/ **P24PH4PV**	No Change
	Total		**30**	**22**														

SEMESTER – III

Course Title : **SOLID STATE PHYSICS I**	Total Hours : 6
Course Code : **P24PHC31**	Total Credits :4

Course Outcomes:

COs	CO Statement
CO1	Understanding the basic crystal structure and diffraction conditions
CO2	Getting the knowledge of Einstein and Debye models of specific heat
CO3	Knowing about Free Electron and Energy Band Theories
CO4	Learning about Semiconductor crystals
CO5	Understanding the concepts of Fermi Surfaces and Metals

Unit I: Crystal Structure

Lattice translation vectors – Basis – Primitive lattice cell – 2D and 3D lattice types – Index system for crystal planes – Simple crystal structures. *Diffraction and Reciprocal lattice*: Diffraction of waves by a crystal lattice – Bragg law – Reciprocal lattice vectors – Diffraction conditions – Brillouin Zones – Structure factor – Atomic form factor.

Unit II: Phonons: Lattice Vibrations and Thermal Properties

Lattice vibrations: Vibrations of lattice with monoatomic and diatomic basis – Dispersion relation – optical and acoustical branches – Classical theory of Specific heat – Phonon density of states – Einstein and Debye models of specific heat – Electronic contribution to specific heat – Anharmonic effect – Thermal expansion – Phonon collision process – Thermal conductivity.

Unit III: Free Electron and Energy Band Theories

Free electron gas: Periodic boundary conditions and free electron gas in 3D – Heat capacity of electron gas – Ohm's law – Mathiessen's rule and Umklapp process – Hall effect – Wiedmann Franz law – Nearly free electron model – *Energy bands:* Origin and the magnitude of energy gap – Bloch functions – Kronig-Penny model – Wave equation of an electron in a periodic potential – Restatement of Block theorem –Solution of the Central equation.

Unit IV: Semiconductor Crystals

Band gap: Band gap in semiconductors. *Equations of motion*: Physical derivation $\hbar\acute{k}$=F – Holes – Effective mass – Physical interpretation of effective mass – Effective masses in semiconductors – Intrinsic carrier concentration – Intrinsic mobility – Impurity conductivity – Donor and acceptor states. *Thermoelectric effect*: Thermal ionization of donors and acceptors – Thermoelectric effects – Semimetals.

Unit V: Fermi Surfaces and Metals

Zone schemes: Reduced, Extended and Periodic zone schemes. *Fermi surface and Energy bands*: Electron orbits – Hole orbits and Open orbits – Tight binding method for the calculation of energy bands – Wegner Seitz method – Cohesive energy. *Experimental methods in Fermi surface*: Quantization of orbits in a magnetic field – De Haas-Van Alphen effect – Extremal orbits – Fermi surface of Copper and Gold.

Book for study:

1. Charles Kittel, © 2005, Introduction to Solid State Physics, 8thEdition, Wiley & Sons, Inc., New York.

Unit I: Chapters 1& 2
Unit II: Chapters 4 & 5
Unit III: Chapters 6 & 7
Unit IV: Chapter 8
Unit V: Chapter 9

Books for Reference:

1. J.P. Srivastava, 2006, Elements of Solid State Physics, PHI Learning Pvt. Ltd., New Delhi.
2. S.O. Pillai, 1997, Solid State Physics, New Age International, New Delhi.
3. N.W. Ashcroft and N.D. Mermin, 2010, Solid State Physics, Rhinehart and Winton, New York.
4. A.J. Dekker, 2003, Solid State Physics, Macmillan India, New Delhi,
5. S.O. Pillai, 1994, Problems and Solutions in Solid State Physics, New Age International, New Delhi.

Course Title :**QUANTUM MECHANICS II**	Total Hours : 6
Course Code : **P24PHC32**	Total Credits : 4

Course Outcomes

COs	CO Statement
CO1	Learning the Scattering principle through various methods
CO2	Understanding the motion of relativistic particles
CO3	Getting knowledge of Angular momentum operators
CO4	Knowing about Time dependent perturbation and its application
CO5	Understanding the concept of variation method and WKB approximation

Unit I **18 Hours**

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 – Breit-Wigner formula – Scattering length

– Expression for Phase shifts – Integral equation – The Born approximation – Scattering by Screened Coulomb potential – Validity of Born approximation – Laboratory and Centre of Mass Coordinate systems

Unit II **18 Hours**

Relativistic wave equations: Klein-Gordon equation – Interpretation of Klien-Gordon equation – particle in a Coulomb field – Dirac's equation for a Free particle – Dirac matrices – Covarian form of Dirac Equation – Probability density – Plane wave solution – Negative energy states – Spin of Dirac particle – Magnetic moment of electron – Spin-orbit interaction

Unit III **18 Hours**

Angular momentum: The 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 – Angular momentum matrices – Spin anguar momentum – Spin vectors for Spin ½ system – Addition of Angular momentum

Unit IV **18 Hours**

Time Dependent Perturbation theory: Introduction – First order perturbation – Harmonic perturbation – Transitions to Continuum states – Absorption and Emission of Radiation – Einstein's A and B Coefficients – Selection rules

Unit V **18 Hours**

The Variation method: The Variational principle – Rayligh-Ritz method – variation method for Excited states – The Ground state of Helium – The Hydrogen molecule ion – The Ground state of Deuteron – **WKB Approximation:** The WKB method – The Connection formulas – Validity of WKB method – Barrier penetration – Alpha emission

Book for study:

Quantum Mechanics, G. Aruldhas, Sixth printing, 2006, PHI

Unit 1: Chapter 14 – 14.1 to 14.14

Unit 2: Chapter 15 – 15.1 to 15.12

Unit 3: Chapter 8 – 8.1 to 8.9

Unit 4: Chapter 12 – 12.1 to 12.7

Unit 5: Chapter 10 – 10.1 to 10.3, 10.5 to 10.7, Chapter 11 – 11.1 to 11.5

Books for reference:

1. Introduction to Quantum Mechanics, David J. Griffiths, Tenth Impression, 2018, Pearson.
2. A Text book of Quantum Mechanics - P.M.Mathews & K.Venkatesan - TMH Pub. Com. Ltd., New Delhi (2010) - II edition.
3. Basic Quantum mechanics, Ajoy Ghatak, Reprint 2014, Trinity
4. Quantum Mechanics, Satya Prakash, 2007, Pragatiprakashan Publisher, UttarPradesh

----

Course Title :**NUCLEAR AND PARTICLE PHYSICS**	Total Hours : 6
Course Code : **P24PHC33**	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Studying about the structure of nucleus and its properties
CO2	Understanding nuclear forces and meson theory
CO3	Getting knowledge of nuclear models
CO4	Learning about types of nuclear reactions
CO5	Understanding the classification of elementary particles and their fundamental interactions

UNIT–I

The Nucleus and their properties: Introduction-Rutherford scattering and estimation of the nuclear size- Measurement of nuclear radius-Constituents of the nucleus and their properties-Nuclear spin, Moments and Statistics.

Physical Tools: Interaction between particles and matter - A brief survey - Detectors for nuclear particles.

UNIT–II

Nuclear Forces: Introduction- Binding energy-Semi empirical mass formula-Quantum numbers for individual nucleons-Independence of atomic and nuclear properties-Quantum properties of nuclear states – Deuteron-Neutron –Proton scattering at low energies – Proton-Proton scattering at low energies-Meson theory of exchange forces.

UNIT-III

Nuclear models: Introduction-Fermi gas model-Liquid drop model-Shell model (Extreme Single Particle model) - Collective nuclear model-Unified model-super conductivity model.

UNIT-IV

Nuclear Reactions: Types of nuclear reactions-Conservation laws-Nuclear reaction kinematics-Nuclear Transmutations-Nuclear cross section-Classical analysis of cross section-Partial wave analysis of reaction cross section-**Thick target yield**-Requirement for a reaction-Reaction mechanism-General features of reaction cross sections-**Inverse reaction-Principles of detailed balance**-Compound nucleus-Compound nucleus reactions-Disintegration of a Compound nucleus -Continuum theory of nuclear reaction-Breit Wigner dispersion formula.

UNIT –V

Elementary Particles: Introduction-Classification of elementary particles-Fundamental interactions-Conservation laws.

Elementary particle symmetries – Quarks - Isospin of Quarks - Quantum chromodynamics.

Book for study:

1. Nuclear Physics - An Introduction by S.B.Patel. 2nd Edition, New Age International (P) Limited

   Unit I: 4.1.1 - 4.1.5, 1.1.1 – 1.1.3

2. Nuclear Physics by D.C.Tayal. Fifth revised & enlarged edition reprint 2010-Himalya publishing house.

   Unit II: 1.1, 1.6 - 1.10, 8.1- 8.3, 8.5, 8.12
   Unit III: 9.1 - 9.8
   Unit IV: 10.1 - 10.4, 10.7 - 10.17, 10.19, 10.20
   Unit V: 18.1 - 18.4, 18.18 - 18.20, 18.24

Books for Reference:

1. Nuclear Physics by Devanathan, Second edition-Narosa publishing house.
2. Nuclear Physics by S.N.Ghoshal. Reprint 2012-S.Chand.
3. Nuclear and Particle Physics an Introduction by B.R.Martin. Second edition-Wiley.
4. Introduction to Particle Physics by M.P.Khanna.

Course Title : LAB: **DIGITAL ELECTRONICS AND GENERAL PHYSICS**	Total Hours : 6
Course Code : **P24PHCP31**	Total Credits : 6

INTERNAL: 40 **EXTERNAL: 60**

Course Outcomes:

COs	CO Statement
CO1	Able to design Low pass, High pass & Band pass active filters.
CO2	Solving Simultaneous equations using the operational amplifier
CO3	Designing circuits to solve Boolean functions
CO4	Construct Half adder, Full adder, Half subtractor and Full subtractor circuits
CO5	Measure the resistance and resistivity of semiconductor wafers

1. Design and study of Low pass and High pass active filters.
2. Design and study of Band pass active filters
3. Solving Simultaneous equations using IC 741.
4. Construction of Half adder, Full adder,Half subtractor and Full subtractor circuits using gate ICs.
5. Design of circuits for Boolean functions optimized by K-Map method.
6. Determination of Hall Coefficient(R_H),carrier density (n), and carrier mobility(μ) of semiconductor materials.

7. Determination of specific charge of an electron using Mercury spectrum.
8. Determination of resistance and resistivity of Si & Ge semiconductor wafers using Four-probe method.

Course Title : **APPLIED OPTICS**	Total Hours : 6
Course Code : **P24PHE31**	Total Credits : 5

Course Outcomes:

COs	CO Statement
CO1	Studying the matrix methods in Gaussian optics.
CO2	Understanding the Fresnel and Fraunhoffer diffraction pattern and Fourier Transforming properties of lenses
CO3	Understanding the Frequency analysis of imaging system
CO4	Learning about the Principles and Applications of Holography

Unit I

Transformation matrices (refraction, translation, combined operations, conjugate planes) – Single lens (General formulation, The thin lens) – Principal planes (general transformation, application to thick lenses, combination of two image forming systems) – Image formation (General concepts of image formation – graphical construction of image formation) – Examples of paraxial optics (Image formation systems:- The Human eyes – Magnifier – Doublet – Telephoto lens)

Unit II

Matrix representation of polarization (the Jones calculus) – The principle of linear superposition – Young's experiment – the Michelson interferometer – theory of partial coherence – coherence time and coherence length – multiple beam interference: interference with multiple beam – theory of multilayer films.

Unit III

Foundations of scalar diffraction theory:Historical introduction – from a vector to a scalar theory – mathematical preliminaries – the Kirchhoff formulation of diffraction by a plane screen – the Rayleigh-Sommerfeld formulation of diffraction – comparison of the Kirchhoff and Rayleigh Sommerfeld theories – discussion of the Huygens-Fresnel principle.Fresnel and Fraunhofer diffraction:The Huygens-Fresnel principle in rectangular coordinates – the Fresnel approximation – the Fraunhofer approximation – examples of Fraunhofer diffraction patterns(Rectangular aperture, Circular aperture, The sinusoidal amplitude grating).

Unit IV

A thin lens as a phase transformation – Fourier transforming properties of lenses.Frequency analysis of optical imaging systems: Frequency response for diffraction limited coherent imaging – frequency response for diffraction limited incoherent imaging.

Unit V

Holography:Introduction – The basic principle – coherence requirements – resolution – Fourier transform holograms – volume holograms – applications.

Book for study:

1. Optics - Miles V. Klein and Thomas E. Furtak, Wiley India Pvt. Ltd., 2011
Unit I - Sections 3.3 (A, B, C), 3.4 (A, B), 3.5 (A)
2. Introduction to Modern Optics - Grant R. Fowles, Second edition, Dover publications, 1989
Unit II - Sections 2.5, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1, 4.4
3. Introduction to Fourier Optics - Joseph W. Goodman, 3rd edition, Viva Books Pvt. Ltd., 2007
Unit III & IV - Sections 3.1- 3.7, 4.1.2, 4.2-4.4
Sections 5.1, 5.2, 6.2, 6.3
4. Optical electronics - Ajoy Ghatak and K. Thyagarajan, Cambridge University Press, 2011.
Unit V - Sections 7.1-7.7

Books for Reference:

1. Optics – Eugene Hecht, Fifth edition Pearson, 2017.
2. Optics – Karl Dieter Moller, Second edition, Springer, 2010.
3. Physics of light and optics – Justin Peatross and Michael Ware, 2015 edition (https://optics.byu.edu/docs/opticsBook.pdf)

Course Title : **FIBER OPTIC COMMUNICATION**	Total Hours : 6
Course Code : **P24PHE32**	Total Credits : 5

Course Outcomes:

COs	CO Statement
CO1	Getting fundamental idea about Optical Fiber Communication
CO2	Understanding the structure and types of Optical Fiber
CO3	Learning about the types of solid state optical sources
CO4	Understanding the different techniques of power Launching & Coupling in optical fiber
CO5	Getting knowledge about Photo detectors

UNIT –I Overview of Optical Fiber Communication

The path to optical networks - Advantages of optical fibers –Optical spectral bands - Channel capacity – Decibel units – Telecom signal multiplexing – SONET/SDH multiplexing Hierarchy –WDM concepts – overview of element applications – windows and spectral bands – standardsfor optical fiber communications.

UNIT – II Optical Fibers and Signal Degradation

Single-mode fibers – propagation modes in single-mode fibers – Graded index fiber structure –Fiber materials – Glass fibers – Active glass fibers – plastic optical fibers – photonic crystal fibers – index guiding PCF – Photonic band gap fiber – Fiber fabrication – outside vapor – phaseoxidation – vapor phase axial deposition – Modified chemical vapor deposition – Plasmaactivated chemical vapor deposition – Photonic crystal fiber fabrication- Fiber optic cables,Attenuation – Scattering losses – Core and Cladding losses – Signal distortion in fibers

UNIT – III Optical Sources

Energy bands – intrinsic and extrinsic material – The p-n junctions – Direct and Indirect band gaps – Semiconductor device fabrication – LED's – LED structures – Light source materials –Quantum efficiency and LED power - Modulation of an LED – Laser diodes – Laser diode modes and Threshold conditions.

UNIT –IV Power Launching & Coupling

Source to fiber power launching – Power coupling calculation – Power launching versuswavelengths – Equilibrium Numerical aperture – Lensing schemes for coupling improvement –non-imaging microsphere – Laser diode to fiber coupling – fiber to fiber joints – Mechanicalmisalignment – Fiber related losses – fiber-end face preparation – LED coupling to single-modefibers – fiber splicing – splicing techniques – splicing single-mode fibers – optical fiberconnectors – connector types – single-mode fiber connectors.

UNIT – V Photo detectors

Physical principles of photodiodes – the pin photodetection – Avalanche photodiodes – Photodetector noise – noise sources – signal to noise ratio – Detector response time – Depletion layer photocurrent – Response time – Double hetero-structure photodiodes – avalanche multiplication noise structure for InGeAs APD's.

Text Books for study:

Optical Fiber Communication - Gerd Keiser - Fourth Edition Mc Graw Hill, International publishing Company Limited, New Delhi, 2008..

Unit I: Chap. (1) Sections 1.1.1, 1.1.2, 1.2, 1.3.5, 1.3.6, 1.4.1, 1.4.2, 1.5, 1.6.1, 1.6.2, 2.3.1 - 2.3.5,2.4.1, 2.4.2.

Unit - II: Chap. (2) Sections 2.5.1-2.5.2, 2.6, 2.7.1-2.7.3, 2.8.1-2.8.2, 2.9.1-2.9.5, 2.11.1-2.11.3, 3.1.1-3.1.5.

Unit-Ill: Chap. (4) Sections 4.1.1-4.1.5, 4.2.1-4.2.4, 4.3, 4.3.1.

Unit IV: Chap. (5) Sections 5.1, 5.1.1-5.1.4, 5.2, 5.2.1-5.2.2, 5.3, 5.3.1-5.3.3, 5.4, 5.5, 5.5.1-5.5.2, 5.6, 5.6.1-5.6.2.

Unit- V: Chap. (6) Sections 6.1, 6.1.1-6.1.2, 6.2, 6.2.1-6.2.2, 6.3, 6.3.1-6.3.3, 6.4, 6.5.

Book for Reference

1. Optical fibre and fibre optic communication systems - S K Sarkar - S.Chand Pub, 2007 edition
2. Fibre Optics technology & Applications-Stewart D. Personick-Khanna Publishers-Delhi

---

SEMESTER - IV

Course Title : **SOLID STATE PHYSICS II**	Total Hours : 6
Course Code : **P24PHC41**	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Understanding the concept of Superconductivity and its theories
CO2	Studying Dia, Para and Ferro magnetism
CO3	Getting knowledge about Optical properties of crystals
CO4	Understanding the theories of Dielectrics and Ferroelectrics
CO5	Studying various Lattice imperfections in crystals

Unit I: Superconductivity

Experimental survey: Occurrence – Destruction by magnetic fields – Type I and Type II superconductors – Meissner effect – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect. *Theory:* London theory of Meissner effect – Coherence length – BCS theory – BCS ground state – Flux quantization – DC and AC Josephson effect. High temperature Superconducting (HTSC) materials.

Unit II: Magnetism

Diamagnetism: Langevin theory of Diamagnetism – *Paramagnetism*: Quantum Theory of Paramagnetism – Crystal field Splitting and quenching of orbital angular momentum – *Ferromagnetism*: Ferrimagnetism and Antiferromagnetism: Curie point and exchange integral – Saturation magnetization – Ferromagnetic Domains and their origin – Magnons

Unit III: Optical properties

Plasmons: Dielectric function of the electron gas – Plasma optics – Longitudinal plasma oscillations – *Electrostatic screening:* Screened coulomb potential – Mott transition. *Polaritons:* LST relation – Electron and electron interaction – Fermi liquid – *Polarons:*Electron and Phonon interaction – Peierls instability of Linear metals. *Excitons:* Frenkel and Mott-Wannier excitons – Exciton condensation – Raman effect in crystals.

Unit IV: Dielectrics and Ferroelectrics

Maxwell equations: Polarization – Macroscopic electric field – Depolarization field – Local electric field – Lorentz field – Dipole field. *Dielectric constant and Polarizability*: Clausius-Mossotti relation – Various types of polarizability – Ferro electricity – its occurrence and classification – Soft optical phonons. *Structural phase transition*: Landau theory of phase transitions – First and second order phase transitions – Ferroelectric domains – Piezoelectric crystals.

Unit V: Lattice imperfections

Lattice Vacancies: Point defects – Schottky defects – Frenkel defects – Diffusion in metals – Fick's law – Color centers – F Center – Other centers in Alkali Halides. *Dislocations:* Burger vectors – Phenomenon of Slip, Edge, and Screw dislocations – Stress fields of dislocations – Low angle grain boundary

Book for study:

1. Charles Kittel, © 2005, Introduction to Solid State Physics, 8^{th} Edition, Wiley & Sons, Inc., New York.

   Unit I: Chapter 10
   Unit II: Chapters 11 & 12
   Unit III: Chapters 14 & 15
   Unit IV: Chapter 16
   Unit V: Chapter 20 & 21

Books for Reference:

1. J.P. Srivastava, 2006, Elements of Solid State Physics, PHI Learning Pvt. Ltd., New Delhi.
2. S.O. Pillai, 1997, Solid State Physics, New Age International, New Delhi.
3. N.W. Ashcroft and N.D. Mermin, 2010, Solid State Physics, Rhinehart and Winton, New York.
4. A.J. Dekker, 2003, Solid State Physics, Macmillan India, New Delhi.
5. S.O. Pillai, 1994, Problems and Solutions in Solid State Physics, New Age International, New Delhi.

Course Title : **MOLECULAR SPECTROSCOPY**	Total Hours : 6
Course Code : **P24PHC42**	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Learning the concepts of Microwave spectroscopy
CO2	Understanding Infrared spectroscopy and its applicatons
CO3	Getting knowledge of Raman spectroscopy
CO4	Understanding the concept of Electronic spectroscopy of Molecules

CO5	Knowing the principles of Spin Resonance Spectroscopy & Mossbauer Spectroscopy

UNIT I: Introduction

Characterization of Electromagnetic Radiation - Quantization of energy – Regions of spectrum Representation of spectra – Basic Elements of Practical Spectroscopy – Signal-to-noise: Resolving Power - The width and intensity of spectral transition.

Microwave Spectroscopy: The rotation of molecules-Rotational spectra-Diatomic molecules-Polyatomic molecules-Techniques and instrumentations-Chemical analysis by microwave spectroscopy-The microwave oven.

UNIT II : Infrared Spectroscopy

The vibrating diatomic molecules-The diatomic vibrating rotator-The vibration and rotation spectrum of carbon monoxide-Break down of the Born-Oppenheimer approximation-The interaction of rotations and vibrations-The vibrations of poly atomic molecules-The influence of rotation on the spectra of polyatomic molecules-Analysis by infrared techniques-Techniques and Instrumentation.

UNIT III : Raman Spectroscopy

Introduction -Pure rotational Raman spectra-Vibrational Raman spectra-Polarization of light and the Raman effect- Structure determination from Raman and Infrared Spectroscopy-Techniques and Instrumentation-Near Infrared FT-Raman spectroscopy.

UNIT IV: Electronic spectroscopy of Molecules

Electronic spectra of diatomic molecules-Electronic structure of diatomic molecules-Electronic spectra of polyatomic molecules-Techniques and Instrumentation-Molecular photoelectron spectroscopy.

UNIT V: Spin Resonance Spectroscopy

Spin and an applied field-Nuclear Magnetic Resonance Spectroscopy-Hydrogen nuclei-Techniques and Instrumentation-Electron Spin Resonance Spectroscopy

Mossbauer Spectroscopy

Principles of Mossbauer Spectroscopy-Applications of Mossbauer Spectroscopy

Book for study:

1. Fundamentals of Molecular Spectroscopy-4th Edition, C.N.Banwell and E.M.McCash-Tata McGraw-Hill.

Unit - I : Chapter 1 (Section 1.1 – 1.7)
Chapter 2 (Section 2.1 - 2.7)
Unit - II : Chapter 3 (Section 3.1 - 3.8)
Unit - III : Chapter 4 (Section 4.1 - 4.7)
Unit - IV : Chapter 6 (Section 6.1 - 6.5)
Unit - V : Chapter 7 (Section 7.1, 7.2, 7.4, 7.5)

Chapter 9 (Section 9.1,9.2)

Books for Reference:

1. Spectroscopy –B.P.Staughan and S.Walker – Vol.2, Chapman and Hall
2. Molecular Spectroscopy – Jack D.Graybeal – McGraw- Hill, 1993
3. Molecular Spectra and Molecular Structure – Vol.1 2nd Edition – G.Herzberg, Van Nostrand Reinhold.

Course Title : **THERMODYNAMICS AND STATISTICAL MECHANICS**	Total Hours : 6
Course Code : **P24PHC43**	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Understanding the state of the system at equilibrium under temperature, free energy, entropy, internal energy, pressure etc.,
CO2	Getting Knowledge of the physical properties of matter in bulk on the basis of the dynamical behaviour of its microscopic constituents
CO3	Knowing about the system of particles and its energy equation
CO4	Understanding the statistical thermodynamic parameters for ideal gas and solids

UNIT–I

Thermodynamic Potential: The laws of thermodynamics and their consequences – The Helmholtz function and the Gibbs function – Thermodynamic potentials – Maxwell's relations – Stable and unstable equilibrium – Phase transition – The Clausius-Clapeyron equation – The third law of thermodynamics (Nernst Heat theorem).

UNIT–II

Application of Thermodynamics: Chemical potential – Phase equilibrium and phase rule – The Gibbs-Duhem Equation – Dependence of vapour pressure on total pressure – Surface tension – Vapour pressure of a liquid drop – The reversible voltaic cell – Thermodynamics of Blackbody radiation – Thermodynamics of magnetism.

UNIT-III

Statistical Mechanics: Statistical description of system of particles–Basic postulates – Phase-space of a classical system – Liouville's theorem and its consequences – Ensembles: Canonical, Micro canonical, Grand canonical – The thermodynamic functions for ensembles – Energy states and energy levels – Microstates and macrostates – Thermodynamic probability.

UNIT-IV

Statistical Thermodynamics: Statistics: Bose-Einstein, Fermi-Dirac and MaxwellBoltzmann statistics – The statistical interpretation of entropy. Distribution function: BoseEinstein, Fermi-Dirac, Maxwell-Boltzmann– Comparison of distribution functions for indistinguishable particles – The partition function of a system – Thermodynamic properties of a system.

UNIT –V

Statistical Thermodynamics - Applications: The monoatomic ideal gas – The Sackur Tetrode equation for the monoatomic ideal gas – The distribution of molecular velocities – The Principle of equipartition energy –The quantized linear oscillator – The Einstein theory of the Specific heat capacity of a solid – The Debye theory of the specific heat capacity of solid – Black body radiation

Book for study:

1. F. W. Sears and G. L. Salinger. Thermodynamics, Kinetic theory and Statistical Thermodynamics, New Delhi: Narosa Publishing House; 1998. 3rd Edition

   Unit I: Chapter 7
   Unit II: Chapter 8
   Unit III: Chapter 11 and Ensembles* - reference book (2)
   Unit IV: Chapter 11
   Unit V: Chapter 12 and 13.

Books for Reference:

1. Keith Stowe. An Introduction to Thermodynamics and Statistical Mechanics. UK: Cambridge University Press; 2007. 2nd Edition.
2. 2. R K Pathria & Paul and D. Bealep. Statistical Mechanics. New York: Elsevier-Academic Press; 2011. 3rd Edition.

Course Title : **NANOPHYSICS**	Total Hours : 6
Course Code : **P24PHE41**	Total Credits : 5

Course Outcomes:

COs	CO Statement
CO1	Understanding the basic concepts of nano structures
CO2	Knowing the working principles of various microscopic devices
CO3	Getting knowledge of fabrication of nanostructures
CO4	Understanding the properties of individual nanoparticles
CO5	Knowing the quantum mechanical principles of nano structures

Unit I – Introduction – Nano structures – Nano crystalline materials - Electron microscope – Electron microscopy – General consideration for imaging – Analytical and imaging techniques – Sample preparation – Disadvantages of electron microscopes – Transmission electron microscope – Background – High resolution Transmission electron microscopy – Preparation and visualization of samples – Imaging simulation – Particle size analysis – Scanning electron microscope – detection of secondary electrons - detection of Backscattered electrons - Secondary electron imaging – Microscope imaging – Scanning probe microscopy – Imaging structures – The SPM as a robot – Sensing

Unit II – Atomic force microscopy – Introduction – Theory – Piezoelectric ceramic transducer –AFM instrumentation – Imaging modes – Measuring images with AFM – Resolutions in Atomicforce microscope - Probe surface interactions - Surface contamination – Electrostatic forces –Surface material properties – Vibrating sensing mode – Torsion modes – Mechanical surfacemodification – Electrical surface modification - Atomic force microscopy for nanoparticles –Qualitative analysis – Techniques – Direct growth by Chemical vapour deposition of AFM tips –CVD MWNT tip preparation - CVD SWNT tip preparation – Sample preparation –Nanolithography – Adhesive mask technique – Photolithography – resolution in projectionsystems – Limitations – Perspectives – Electron beam lithography – Electron energy depositionin matter – Spatial-phase-locked Electron beam lithography

Unit III – Fabrication of nanostructures – Milling – Lithographic processes – Lift-off process –Vapour phase deposition methods of fabrication – Plasma-assisted deposition methods offabrication – DC glow discharge – Magnetron sputtering – Vacuum arc deposition – Nanofabrication by scanning probe techniques – By Scanning force probes – Electrical structuregeneration by SFM – By Scanning tunneling microscope – Growth and characterizationtechniques – Molecular beam epitaxy – MBE apparatus – MOVPE – Liquid phase methods –Colloidal methods – Fabrication by sol-gel methods – basic process – The experimental –Conclusions – Electro deposition

Unit IV – Properties of individual nanoparticles – Metal nanoclusters – Magic numbers - Theoretical modeling of nanoparticles – Geometric structure – Electronic structure – Reactivity– Fluctuations – Magnetic clusters – Bulk to Nanotransition – Carbon nanostructures – Carbonmolecules – Carbon clusters – Carbon nanotubes – Applications of carbon nanotubes

Unit V – Quantum wells, Wires and Dots – Preparation of quantum nanostructures – Size anddimensionality effects – Excitons – Single electron tunneling – Applications – Superconductivity– Microelctromechanical systems – Nanoelectromechanical systems.

Book for study:

1. Instrumentations and Nanostructures by A.S. Bhatia, NuTech books, 2009

Unit I – Page 192-194, 201-204, Page 1 – 26, Page 52 – 64

Unit II – Page 65 – 86, Page 124 – 151
Unit III – Page 219 – 249

2. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J. Owens, Wiley Student edition, Reprint 2008
Unit IV – Page 72 – 89, Page 103 – 132
Unit V – Page 226 – 256, Page 332 – 345

Books for Reference:

1. T.Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill, New Delhi, 2012.
2. R.W. Kelsall, I.W. Hamley and M. Geoghegan, Nanoscale Science and Nanotechnology, John-Wiley & Sons, Chichester, 2005.
3. G. Cao, Nanostructures and Nanomaterials, Imperial College Press, London, 2004.

Course Title :**BIOPHYSICS**	Total Hours : 6
Course Code : **P24PHE42**	Total Credits : 5

Course Outcomes:

COs	CO Statement
CO1	Studying the Principle, working of different Microscopes used in Biology.
CO2	Understanding the Mechanism of human Ear
CO3	Getting knowledge about different types of Spectroscopy
CO4	Understanding the applications of Bioenergetics

UNIT - I: Nucleonics in Biology and Medicine

Elementary particles – radioactivity – isotopes – X-rays – Detection and measurement ofradioactivity.

UNIT - II: Microscopy in Biology and Medicine

Phase-Contrast Microscope – Interference Microscope – Fluorescence Microscope –Ultra-Violet Microscope – Electron Microscope – Scanning Electron Microscope – ScanningElectron-Probe Micro-Analysis – Centrifuge Microscope.

UNIT – III: Bioacoustic

Sound and its Characteristic – Function of Ear as a Hearing Organ – Physical Basis ofHearing – Unit of Intensity of Sound – transmission of Sound wave in the inner ear-Travellingwaves – Electrical Responses of Cochlea or Organ of Corti or Cochlear partition – PitchPerception – Perception of Loudness – Mechanism of Hearing – Beats and Dissonance – Combination of Tones.

UNIT - IV: Spectroscopies

Light Scattering (Rayleigh Scattering) – Optical Activity – Absorption Spectroscopy – Fluorescence Spectroscopy – Ultraviolet(UV) Spectroscopy – Atomic Spectroscopy – ElectronSpin Resonance Spectroscopy – Mass spectroscopy.

UNIT – V : Bioenergetics

Reversible thermodynamics – Irreversible thermodynamics – Information andtransmission – Photobioenergetics – Chemobioenergetics(oxidative Phosphorylation).

Book for study

1. A Text Book of Biophysics, R.N. Roy, New Central Book Agency (P) Ltd. 2005 Edition.
    - Unit I (Chapter 3 - Section 3.1 – 3.13)
    - Unit I (Chapter 7- Section 7.1 – 7.6)
    - Unit II (Chapter 13 - Section 13.1 – 13.8)
    - Unit III (Chapter 20 - Section 20.1– 20.4, 20.7 – 20.13)
2. Essentials of Biophysics – P. Narayanan, New age international publishers, 2009.
    - Unit IV (Chapter 8 - Section 8.1 – 8.5, 8.8 – 8.10).
    - Unit V (Chapter 13.1-13.3, 14.1, 14.2)

Reference Books

1. Biophysics, Vasantha Pattabhi & N.Gautham. Narosa Publishing House (2003).
2. Biophysics, G.R.Chatwal. Himalaya Publishing House (2011).

Course Title : **PROJECT & VIVA-VOCE**	Total Hours : 6
Course Code : **P24PH4PV**	Total Credits : 5

INTERNAL: 50 **EXTERNAL: 50**

Course Outcomes

COs	CO Statement
CO1	Learning to do literature survey
CO2	Understanding and designing the problem
CO3	Carrying out the research work and analysing the results.

- Project will be done by the final year students in the fourth semester under the guidance of respective guides.
- Project work should be carried out by the students individually or by a team of two students.
- **Project evaluation:**
  Internal marks 50 –to be awarded by the respective guide
  External marks 50 - to be awarded in the external Viva-voce examination.
- Minimum number of pages for M.Sc. project report should be 40.
