RANI CHANNAMMA UNIVERSITY, BELAGAVI
Department of Physics (CBCS)
(w.e.f 2024-25)
Course Structure and Scheme of Examination

I SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	Subject Code	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	24MScPHCT11	Mathematical Methods of Physics	04	03	20	80	100	04
2	Core Subject	24MScPHCT12	Classical Mechanics	04	03	20	80	100	04
3	Soft Core	24MScPHST13	Nuclear and Particle Physics (General)	04	03	20	80	100	04
4	Soft core	24MScPHST14	Condensed Matter Physics (General)	04	03	20	80	100	04
5	Soft Core Practical	24MScPHSP15	Practical-I (Nuclear and Particle Physics)	04	03	20	80	100	04
6	Soft core Practical	24MScPHSP16	Practical-II (Condensed Matter Physics)	04	03	20	80	100	04
								Total Credits per Semester	**24**

II SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	Subject Code	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	24MScPHCT21	Quantum Mechanics-I	04	03	20	80	100	04
2	Soft Core	24MScPHST22	Atomic, Molecular & Optical Physics (General)	04	03	20	80	100	04
3	Soft core	24MScPHST23	Electronics (General)	04	03	20	80	100	04
4	Soft Core Practical	24MScPHSP24	Practical-I (Atomic, Molecular & Optical Physics)	04	03	20	80	100	04
5	Soft Core Practical	24MScPHSP25	Practical-II (Electronics)	04	03	20	80	100	04
6	Open Elective	24MScPHOT26	Modern Physics	04	03	20	80	100	04
								Total Credits per Semester	**24**

III SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	Subject Code	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	24MScPHCT31	Statistical Mechanics	04	03	20	80	100	04
2	Core Subject	24MScPHCT32	Classical Electrodynamics	04	03	20	80	100	04
3	Specialization	24MScPHST33	Condensed Matter Physics-I / Nuclear and Particle Physics-I/ Electronics -I/ Atomic, Molecular & Optical Physics-I	04	03	20	80	100	04
4	Specialization Practical-I	24MScPHSP34	Condensed Matter Physics-I / Nuclear and Particle Physics-I/ Electronics -I/ Atomic, Molecular & Optical Physics-I	04	03	20	80	100	04
5	Specialization Practical-II	24MScPHSP35	Condensed Matter Physics-I / Nuclear and Particle Physics-I/ Electronics -I/ Atomic, Molecular & Optical Physics-I	04	03	20	80	100	04
6	Open Elective	24MScPHOT36	Physics of Nanomaterials	04	03	20	80	100	04
7	Project Preliminary	24MScPHSP37	Preliminary work for the 4th semester project	02	--	--	--	--	--
								Total Credits per Semester	**24**

IV SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	Subject Code	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	24MScPHCT41	Quantum Mechanics - II	04	03	20	80	100	04
2	Core Subject	24MScPHCT42	Advanced Mathematical Methods in Physics	04	03	20	80	100	04
3	Specialization	24MScPHST43	Condensed Matter Physics-II / Nuclear and Particle Physics-II/ Electronics -II/ Atomic, Molecular & Optical Physics-II	04	03	20	80	100	04
4	Specialization	24MScPHST44	Condensed Matter Physics-III / Nuclear and Particle Physics-III/ Electronics -III/ Atomic, Molecular & Optical Physics-III	04	03	20	80	100	04
5	Specialization Practical	24MScPHSP45	Condensed Matter Physics-II&III / Nuclear and Particle Physics-II&III/ Electronics –II&III/ Atomic, Molecular & Optical Physics-II&III	04	03	20	80	100	04
6	Specialization Project	24MScPHSP46	Condensed Matter Physics-II&III / Nuclear and Particle Physics-II&III/ Electronics –II&III/ Atomic, Molecular & Optical Physics-II&III	08	Report Evaluation	20	80	100	04
								Total Credits per Semester	**24**

M.Sc., PHYSICS SYLLABUS

I SEMESTER

Core Subject: 24MScPHCT11: Mathematical Methods of Physics

Teaching hours per week : 4

No of credits : 4

Unit I

Special functions: Separation of the Helmholtz equation in Cartesian, circular cylindrical and spherical polar coordinates. **Legendre functions**: Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization; associated Legendre functions, spherical harmonics. **Bessel functions**: Bessel functions of the first kind, recursion relations, Orthogonality Hermite functions: Hermite polynomials, generating function, recursion relations; Orthogonality. Laguerre functions: Laguerre and associated Lauguerre polynomials, recursion relations; Orthogonality. Applications of special functions to problems in physics.

10 Hours

Unit II

Matrices: Vector spaces and subspaces, Linear dependence and independence, Basis and Dimensions, Gram-Schmidt orthogonalization procedure, Orthogonal, Hermitian, and unitary matrices, Eigenvalues and eigenvectors, diagonalization of matrices, Similarity transformations, applications to physical problems. **Integral Transforms**: Fourier transform: Definition, Fourier integral; inverse transform; Fourier transform of derivatives; convolution, Parseval's theorem; applications. **Laplace transform:** Definition, transform of elementary functions, Inverse transforms; transform of derivations; differentiation and integration of transforms; convolution theorem; solution of differential equations; problems in physics.

10 Hours

Unit III

Tensors: Coordinate transformation in linear spaces, curvilinear coordinates and their transformation; definition and types of tensors, contravariant and covariant tensors, symmetric and antisymmetric tensors, Tensor algebra: equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, lowering and raising of rank of tensors, the metric tensor**;** Christoffel symbols. Tensors in physics**.** 10 Hours

Unit IV

Group Theory: Groups, subgroups and classes; homomorphism and isomorphism, group representation, reducible and irreducible representation, Schur's Lemmas, orthogonality theorem, character of a representation, character tables, decomposing a reducible representation into irreducible representations, construction of representations, lie groups, rotation groups SO(2) and SO(3). Application to molecular spectra.

10 hours

Unit V

Differential equations: Variable separable method, linear first order differential equations, second order differential equations with constant coefficients and zero right hand side

Green's function: Non-Homogeneous boundary value problems and Green's function. Symmetry of Green's function for one-dimensional problems, Eigen function expansion of Green's function, Fourier Transform and Green's function in higher dimension, Some applications

10 hours

Text Books:

1. Mathematical Methods for physicists (4^{th} edition) : George Arfken & Hans J. Weber, Academic Press, San Diego (1995).
2. Mathematical Methods in Physical Sciences (2^{nd} edition): Mary L. Boas, John Wiley & Sons, New York (1983).
3. Mathematical Physics : P. K. Chatopadhyay, Wiley Eastern Ltd., New Delhi (1990).
4. Introduction to Mathematical Physics: Charlie Harper, Prentice-Hall of India Pvt. Ltd., New Delhi (1995)
5. Matrices and Tensors in Physics (3^{rd} edition): A.W. Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).
6. Elements of Group Theory for Phyicists (3^{rd} Edition): A.W.Joshi.,Wiley Eastern limited (1982).

Reference Books

1. Mathematical Methods for Physics and Engineering : K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge Univ. Press Cambridge (1998).
2. Advanced Mathematics in Physics and Engineering : Arthur Bronwell, Mc Graw-Hill Book Company, New York (1953).
3. Group theory and its Applications to Physical Problems: M.Hammermesh, Addision-Wesley, Mass (1962).
4. Schaum's Outline Series : Vector Analysis and Introduction to Tensor Analysis: M.R. Speigel, McGraw-Hill Company, Singapore (1983).

Core Subject: 24MScPHCT12: Classical Mechanics

Teaching hours per week : 4
No of credits : 4

Unit I

Newtonian Mechanics: Introduction to Newtonian Mechanics, single and many particle systems.
Lagrangian Mechanics: Constraints, Classification of constraints, generalized co-ordinates, D'Alembert's principle, Lagrange equation from D'Alembert's Principle, Velocity dependent potentials and dissipation function. Applications of Lagrangian formulation: simple pendulum and Atwood machine. Hamilton's principle, Derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: momentum conservation, cyclic co-ordinates, angular momentum conservation and conservation of energy.

14 hours

Unit II

Motion in central force field: Equivalent one body problem, motion in central force field, general features of motion, Equations of motion and first integrals. Motion in inverse square law of force field. Equation of orbit. Elliptic orbits, hyperbolic orbits & parabolic orbits. Elastic scattering in central force field, laboratory and center of mass co-ordinate systems. Rutherford scattering formula for alpha particles. Differential scattering cross section and impact parameter.

10 hours

Unit III

Hamiltonian Mechanics and Brackets: Legendre transformation. Hamilton equations of motion: conservation theorem and physical significance of Hamiltonian. Derivation of Hamilton's equation from a variation principle: Integrals of Hamilton's' equations. Canonical transformations. Principle of least action. Lagrange and Poisson brackets, Equation of motion in Poisson bracket notation.

10 hours

Unit IV

Hamilton-Jacobi Theory: Hamilton-Jacobi equation of motion for Hamilton's principle and characteristic functions, Harmonic oscillator problem as example of Hamilton-Jacobi method. Separation of variables in the Hamilton-Jacobi equation.

06 hours

Unit V

Motion of Rigid body: Fixed and moving co-ordinate systems. Euler theorem. Euler angle, angular momentum and kinetic energy of a rigid body. Inertia tensor, Euler's equations of motion. Force free motion of a symmetric top. Motion of heavy symmetric top with fixed point – Nutational motion. Effects of Coriolis force, Foucault's pendulum. Small Oscillations: Theory of small oscillations with example; normal modes of vibrations in diatomic coupled oscillator

10 hours

Text Books

1. Classical Mechanics: Goldstein, Narosa Publishing Pvt. Ltd. (1998).
2. Introduction to Classical Mechanics: R. G. Takwale & P. S. Puranik.-Tata McGraw Hill, New Delhi (1997).

Reference Books:

1. Classical Mechanics: Goldstein, C.Poole & J.Safko. Third edition. Pearson Education Asia (2002).
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, New Delhi (1991).
3. Classical Dynamics of Particles and Systems: J. B. Marion, Academic Press (1964).
4. Classical Mechanics of Particles and Rigid Bodies: Kiran. C. Gupta, - New Age m International (1998).

Soft Core: 24MScPHST13: Nuclear and Particle Physics (General)

Teaching hours per week 4
Number of credits 4

Unit I

Basic Properties: Nuclear matter radius & charge radius, Nuclear radius by high energy electron, neutron scattering, X-ray of muonic atom. Nuclear binding energy and separation energy, spin and magnetic momentum of odd A nuclei.

Nuclear Spin & Magnetic Moment: Experimental determination of spin by hyperfine structure in optical spectra & magnetic moment by Rabi's atomic beam method. Systematics of spin & magnetic moment for odd nuclei.

10 hours

Unit II

Nuclear Models: Liquid drop model, Semiemperical mass formula, Stability against beta decay, Stability against spontaneous fission, Fermi gas model-Fermi energy and kinetic energy. Shell Model: Evidence led to shell model. **Alpha Decay:** Gamow's theory of alpha decay, relation between mean life and decay energy, Hindrance factor. **Beta decay**: Neutrino hypothesis, Fermi theory of beta decay. **Gamma decay:** Gamma transition in nuclei & classifications. Internal conversion (Qualitative).

10 hours

Unit III

Nuclear Reaction: Types of nuclear reactions. Conservation laws. Q-values of a nuclear reaction and relation between Q value and energy of outgoing particle, threshold energy Compound nucleus model and its experimental verification (Goshal experiment). Briet- Wigner formula (qualitative). **Reactor Physics:** Condition for chain reaction, four factor formula, Thermal reactors, Fast breeder reactor.

10 hours

Unit IV

Interaction of radiations with Matter: **Interaction of gamma rays**: Photo electric effect, Compton effect, Pair production, Mass attenuation co-efficient, attenuation co-efficient for mixture and additivity law. Resonance scattering of gamma rays, Mossbauer effect and its simple applications.

Interaction of Charged particles with Matter: Interaction of charged particles: Energy loss of heavy charged particles in matter, Bethe-Bloch formula, energy loss of fast electrons, Bremsstrahlung.

10 hours

Unit V

Nuclear Detector: Principle and working of Geiger-Muller (GM) Counter, Scintillation Detectors-NaI(Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li ion drifted detectors, relation between the applied voltage and the depletion region in junction detectors.

Particle Physics: Classification of elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness,etc.). Gell –Mann and Nishijima formula. Quark model, baryons and mesons. C,P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak reaction. Relativistic kinematics.

10 hours

Text Books:

1. Nuclei and Particles: E. Serge -The Benjamin Publishing, Pvt. Ltd (1977)
2. Introductory Nuclear Physics: K.S. Krane- John Wiley & Sons(1987)
3. Atomic and Nuclear Physics : Vol.II S.N.Goshal –S.Chand and Company(1996)
4. Nuclear Physics: D.C.Tayal – Himalaya Publishing House (2009)

References Books:

1. The Atomic Nucleus : R.D.Evans – Tata Mc Graw Hill New Delhi (1992)
2. Physics of Nuclear Reactors: S. Garag, F.Ahmed and L.S.Kothri.- Tata Mc Graw Hill New Delhi (1986)
3. Introductory of Nuclear Physics: Samuel Wong –Prentice Hall (1996)
4. Fundamentals of Nuclear Physics : N.A.Jelly –Cambridge University Press (1990)
5. Introduction to Nuclear Physics: Harald A. Enge- Addison – Wisely (1996)

Soft Core : 24MScPHSP15: Practical-I (Nuclear and Particle Physics)

Each practical is of 4 hours per week and with 4 Credits

1) To study the characteristics of G M counter and determination of operating voltage and plateau length.
2) To verify the inverse square law relationship between distance and intensity of radiation.
3) To determine the dead time of a GM tube using the double source method.
4) To determine the mass absorption co-efficient of gamma and Beta rays using G M tube for aluminum, lead and copper foils.
5) Study of the performance of G. M. Counter and measurement of dead time by variable area method.
6) Study of characteristics of nuclear statistical counting for β-source using G M counter.
7) NaI (Tl) Scintillation detector-energy calibration, resolution and determination of gamma ray energy.
8) Beta ray absorption-end point energy of beta particles.
9) Life time of a short lived radio source.
10) Calculation of binding energy for different nuclei using semi-empirical mass formula. (assignment)
11) Calculation of coulomb energy for mirror nuclei. (assignment)
12) To determine Rutherford scattering of α-particle. (assignment)
13) Mott scattering (assignment).

(Minimum of 80% of the listed experiments per paper should be performed).

Soft Core: 24MScPHST14: Condensed Matter Physics (General)

Teaching hours per week 4

Number of credits 4

Unit I

Crystal Structure: Space Lattice, Lattice translational vectors, basis and crystal structure, Unit cells, primitive and non-primitive cells, Wigner-Seitz cell construction. Fundamental types of crystal systems: 7 crystal systems and 14 Bravais lattices, Miller indices, Crystal planes and directions. Coordination number, Number of atoms per unit cell, Relation between a and R, Atomic Packing Fraction (APF): expressions for SC, BCC and FCC. Examples of CsCl, Diamond, cubic ZnS structures.

Braggs Law and Crystal diffraction: Diffraction condition and Bragg's law in real space. Experimental methods of x-ray diffraction: Braggs X ray spectrometer, powder XRD, intensity verses 2θ plot. Reciprocal lattice: construction and interpretation of reciprocal lattice, properties. Relation between reciprocal lattice vectors and fundamental translation vectors (qualitative). Brillouin zones. 12 Hours

Unit II

Crystal binding: Inter atomic forces, types of bonding: covalent, ionic, metallic, hydrogen and van der Waals; cohesive energy, compressibility and bulk modulus. Ionic Crystals: Madelung-energy, Born-Mayer Model, evaluation of Madelung constant for an infinite line of ions.

Lattice vibrations and thermal properties: vibrations of one-dimensional monatomic and diatomic lattices, properties of lattice waves, phonons. Einstein and Debye models of lattice heat capacity. Lattice thermal conductivity.

10 Hours

Unit III

Free electron model of metals: Free electron Fermi gas in three dimensions, Fermi surface. Fermi-Dirac distribution. Density of State (statement and expression only). Heat capacity of electron gas. Electrical conductivity and Ohm's law, Matthiessen's rule. Thermal conductivity, Weidman Franz law. Hall effect in metals.

Energy bands in solids: Origin and Magnitude of energy gap. Bloch functions. Kronig-Penney model. Number of states in a band. Distinction between metals, insulators and semiconductors, Concept of holes. The dynamic effective mass of electrons and holes.

10 Hours

Unit IV

Semiconductors: Intrinsic and extrinsic semiconductors. Expression for Intrinsic carrier concentrations, position of Fermi level. Electrical conductivity and mobility and their temperature dependence. Energy gap determination by four probe method.

Superconductivity: Occurrence of superconductivity. Destruction of superconductivity by magnetic field. Meissner effect. Type I and Type II superconductors. Qualitative idea about BCS theory. Cooper pair formation. 10 hours

Unit V

Magnetic properties: Review of basic formulas, Magnetic susceptibility, Classification of magnetic materials, Diamagnetism, Langevin theory of diamagnetism, Classical and quantum theory of paramagnetism.

Defects in solids: Types of imperfections, Schottky and Frenkel defects and their concentrations. Edge and screw dislocations, Burger's vector construction. Colour centers.

08 hours

Text books

1. Introduction to Solid State Physics: C.Kittel.Wiley Eastern Ltd., Bangalore (1976).
2. Elementary Solid State Physics : M.A. Omar.Addison-Wesley Pvt.,Ltd.,New Delhi (1993).
3. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
4. Solid State Physics : F.W.Ashcroft & N.D. Mermin. Saunders College Publishing, NewYork (1976).

Reference Books

1. Introduction to Solids : L.V. Azaroff. McGraw-Hill inc, New york (1960).
2. Solid State and Semiconductor Physics: J.P.McKelvey. Harper and Row, Newyork (1966).

Soft Core: 24MScPHSP16: Practical-II (Condensed Matter Physics)

Each practical is of 4 hours per week and with 4 Credits

1) Analysis of X-ray diffraction Pattern (Powder XRD analysis, assignment).
2) d-spacing calculations using Debye Scherrer powder pattern (assignment)
3) Thermistor characteristic and its energy gap determination.
4) Determine the plank's constant with different wavelengths by reverse photo electric effect using photodiode.
5) Measurement of Hall coefficient in semiconductor and estimation of charge carrier concentration, carrier density mobility and type of semiconductor.
6) Determination of energy gap by reverse saturation current in a pn-junction.
7) Structure factor calculation of simple crystal structure (assignment).
8) Determination of Fermi energy and Fermi temperature of copper and silver.
9) Determination of e/k_b .
10) Defect formation energy in metals.
11) Electrical conductivity of ionic solids (NaCl) and determination of vacancy formation energy.
12) Determination of energy gap of a given semiconductor by determining its resistivity at various temperature by four probe method.

II SEMESTER

Core Subject: 24MScPHCT21: Quantum mechanics – I

No. of hours per week: 4

No. of credits: 4

Unit I

Basic Principles: Wave-particle duality, de Broglie hypothesis, Wave packets, Heisenberg uncertainty principle for position and momentum. electron diffraction, Hermitian operators, Eigen functions, eigen values and ortho normalization of eigen functions, completeness. State functions as probability amplitude and the principle of superposition. Momentum, Hamiltonian and energy operators, Schrodinger equation: time dependent and time independent. Probability density and probability current density, expectation values, Ehrenfest theorem; basic postulates of quantum mechanics. 12 hours

Unit II

Simple Applications: Eigenvalues and eigenfunctions of free particle, Dirac delta function and its properties; particle in a square well; simple harmonic oscillator by polynomial method. Tunneling phenomena: barrier transmission, leakage of free particle through a thick rectangular potential barrier, transmission and reflection coefficients for infinite and finite square well potential.

10 hours

Unit III

Hydrogen atom: Reduction of two-body problem to a single particle problem. Center-of-mass and relative motions; eigenvalues and eigenfunctions. Hydrogen- like atom, eigenvalues of energy and eigenfunctions, parity of eigenfunctions; angular momentum, expression for the three Cartesian components and the square of the angular momentum, their commutation relations, expression for the operators in polar coordinates, eigenvalues and eigenfunctions in terms of polar coordinates; eigenvalues and eigenfunctions of the square and z-component of angular momentum.

10 hours

Unit IV

Time-Independent Perturbation Theory: Eigenvalue of energy and eigenfunction in the first order approximation (the case of a system with non- degenerate energy levels). Application to anharmonic oscillator and to the ground state of Helium atom. **Time-Dependent Perturbation Theory:** First order perturbation, Transition from one discrete level to the other, to continuum states, Fermi Golden rule, another discrete level through an harmonic perturbation, to resonance transitions. Interaction of radiations with a system of atoms, transition dipole moment, Einstein A and B coefficients.

10 hours

Unit V

Elastic Scattering: Differential and total cross-section, phase analysis. Significance of the partial waves and phase shifts, S-wave scattering from a square well potential. The

Born approximation, derivation of the expression for differential scattering cross-section, condition for validity of the approximation: application to square well potential and screened coulomb potential. 08 hours

Text Books

1. Quantum Mechanics – Theory & Applications (3rd Ed): A.K. Ghatak & Loknathan, MacMillan India Ltd. 91984)

2. A Text of Quantum Mechanics: P.M. Mathews &K. Venkatesan, Tata McGraw-Hill, New delhi (1982)

3. Quantum Mechanics (2nd ed.), G. Aruldhas, Prentice Hall India Pvt.Ltd., New Delhi (2009).

Reference Books:

4. Quantum Mechanics (2nd Ed): V.K. Thankappan, new Age International (P) Ltd. (1993)

5. Introduction to Quantum Mechanics: L. Pauling & E. Bright Wilson, McGraw-Hill, N.Y.(1935)

6. Quantum Mechanics(3rd ed): L.I. Schiff, McGraw-Hill, N.Y.(1968)

7. Quantum Mechanics: E. Merzbacher, 2nd ed., Wiley, N.Y.(1970).

Soft Core: 24MScPHST22: Atomic, Molecular & Optical Physics (General)

Teaching hours per week: 4
No. of Credits:4

Unit I

Atomic Spectroscopy Quantum states of an electron in an atom. LS and JJ coupling schemes. Terms for equivalent and nonequivalent electron atom. Spectra of one electron systems. Qualitative idea of: Electron spin, spin orbit interaction, fine structure, relativity correction and radiation correction (Lamb Shift). Electric dipole selection rules. Intensity rules. Penetrating and non-penetrating orbits, quantum defect. Alkali type spectra. Spectrum of helium. Normal and anomalous Zeeman effect. Paschen-Back effect. Stark effect. Hyperfine structure and isotopic shifts, Shape and width of spectral lines: mechanisms; Natural, Doppler, Collision broadenings.

12 hours

Unit II

Microwave Spectroscopy: Microwave spectra (Far IR Spectra); Diatomic molecule as a rigid rotator, non-rigid rotator & symmetric top. Rotational spectra of diatomic molecules. Intensity distribution.

Infrared Spectroscopy: Diatomic Molecule as a harmonic oscillator, anharmonic oscillator, vibrating rotator. Vibrational spectra of diatomic molecules. Rotation-Vibration spectra of diatomic molecules. 08 hours

Unit III

Electronic Spectroscopy: Born-Oppenheimer approximation. Electronic spectra of diatomic molecules. Hund's cases. Vibrational structure of electronic transition. Selection rules. Franck-Condon principle. Intensity of bands in absorption and emission. Isotopic effect.

Raman Spectroscopy: Scattering of light. Rayleigh scattering. Blueness of ocean. Raman effect: Classical & Quantum theory of the Raman effect, Pure rotational & vibrational Raman Spectra. Difference between IR and Raman spectroscopy with examples.

Spectroscopic Techniques: Fluorescence Spectroscopy, Fourier transform infrared spectroscopy, Emission spectroscopy, Mossbauer Spectroscopy.

12 hours

Unit IV

Laser Physics: Absorption, spontaneous and stimulated emission. Einstein coefficients, Transition probability and lifetime of an atom in an excited state. Population inversion. Laser rate equations: The three level and four level systems. He-Ne laser. CO2 laser. Semiconductor laser: Homojunction and Heterojunction semiconductor Laser, photon and electron confinement. Properties of laser beam: directionality, monochromacity, intensity, coherence (temporal and Spatial). Applications of lasers.

10 hours

Unit V

Fiber optics: Types of fibers – single mode and multimode with different refractive index profiles. Ray theory of transmission, total internal reflection, acceptance angle, numerical aperture, skew rays. Optical fiber connectors, fiber alignment and joint loss, bending loss, fiber splices.

08 hours

Textbooks:

1. Introduction to Atomic Spectra : H.E. White, McGraw – Hill, Tokyo (1934)
2. Physics of Atoms and Molecules – 2nd Ed., Brans den B.H. and JoachainC.J., Pearson Education, India (2006)
3. Elementary Atomic Structure (2nd ed.) : G. K. Wood gate, Clarendon Press, Oxford (1980)
4. Molecular Spectra & Molecular Structure – Vol I : Herzberg, D. Van Nostrand Co. Princeton, J. J. (1945)
5. Spectroscopy – Vol. 3:S. Walker & B. P. Strauhghan, Chapman & Hall, Lon (1976)
6. Fundamentals of Molecular Spectroscopy : C. N. Banwell and E.M. McCash, Tata Mc Graw-Hill Co., 4th revised edition, (9th reprint, 2000)
7. Lasers and Non-Linear Optics : B. B. Laud, Wiley Eastern Ltd., New Delhi (1991).
8. An Introduction to Lasers & their Applications : Donald C. O' Shea, W. Russell Callen & William T. Rhodes, Addison-Wesley, N. Y. (1977).
9. Optical Fiber & Communications Principles & Practice : John M. Seniors, Prentice Hall Intl. Ltd. London (1992)

Reference Books:

1. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., New Delhi (1999).
2. Principles of Lasers : O. Svelto, Plenum Press, N. Y. (1982).
3. Laser Electronics : Joseph T. Verdeyen, Prentice-Hall of India Pvt. Ltd. NewDelhi (1989).
4. Lasers : Theory & Applications : K. Thyagarajan & A. Ghatak, MacMillan India, New Delhi (1981).
5. Laser Principles & Applications : J. Wilson & J.F.B. Hawkes, Prentice-Hall Intl. Inc. (1983)
6. Fiber Optics Sensors : D. A. Krohn, Instrument Soc. Am. (1988).
7. Encyclopedia of Lasers & Optical Technology : Robert A. Meyars, Academic Press, Cal. (1991).
8. Fiber Optic Communication : D. C. Agarwal, Wheeler Pub. (1993).
9. Optoelectronics – An Introduction : J. Wilson & J.F.B. Hawkes, Prentice – Hall Intl. Inc. (1983).

Soft Core Practical: 24MScPHSP24: Practical I (Atomic, Molecular& Optical Physics)

Each practical is of 4 hours per week and with 4 Credits

1) Study of Zeeman Effect: Determination of e/m for an electron.
2) To study the numerical aperture and bending loss of an optical fiber.
3) Determination of unknown wavelength of a laser source using grating and a laser source of known wavelength.
4) Study of interference and diffraction using single and double slits using He-Ne/semiconductor laser source.
5) Study of interference and diffraction using reflection grating and He-Ne/semiconductor laser source
6) Measurement of wavelength of sodium D line/wavelength separation of sodium D doublet lines using Michelson Interferometer.
7) Verification of Beers law. Determination of absorption coefficient.
8) To measure the wavelength of absorption bands of $KMnO_4$ and calculate it's Hartmann's constant using constant deviation spectrometer.
9) To find wavelength of prominent lines of the emission spectra of copper, iron and brass using constant deviation spectrometer.
10) Determine the spectral terms of sp and pd configuration for 'LS' and 'JJ' coupling (assignment).
11) Determine the spectral terms for equivalent electrons in L-S coupling and show splitting of energy levels with diagram for each term i) d ii) sp iii) pp, iv) pd, v) ppd (assignment).
12) Determine the spectral terms for non-equivalent electrons in L – S coupling and show splitting of energy levels with diagram for each term term i) d ii) sp iii) pp, iv) pd, v) ppd (assignment).

(Minimum of 80% of the listed experiments per paper should be performed).

Soft core: 24MScPHST23: Electronics (General)

Teaching hours per week 4

Number of credits 4

Unit I

Operational Amplifier: Ideal Op-Amp and practical Op-Amp, Input modes and parameters, open loop Op-Amp configuration. Op-Amp with negative feed-back, inverting, non-inverting and differential amplifiers. Feedback configurations – voltage series feedback amplifier, voltage shunt feedback amplifier and differential amplifier. averaging amplifier, **Op-Amp Applications**: Comparator, summing, integrator differentiator, instrumentation amplifiers, isolation amplifiers and Operational Transconductance Amplifiers, Log and Antilog amplifiers, Introduction to active filters;

12 hours

Unit II

Linear digital IC's, feedback and oscillator circuits

Timer IC unit operation, voltage-controlled oscillator, phase- locked loop, interfacing circuitry, feedback amplifier-phase and frequency consideration, oscillator operation types, phase shift oscillator, Wien bridge oscillator, triangular wave generator, tuned oscillator circuit, crystal oscillator, unijunction oscillator.

10 hours

Unit III

Digital Electronics: Number systems and Boolean algebra: and Boolean algebra; Karnaugh map: Reduction using Karnaugh map, Product of sums (POS) and sum of products (SOP) simplification. Implementation of Boolean Expressions.

Logic families: Metal Oxide semiconductors (MOSFET), inversion layer, enhanced MOSFET, PMOS, NMOS&CMOS (qualitative). Logic gate characteristics –propagation delay, speed, noise margin, fan-out and Power dissipation; Standard TTL and static CMOS gates. **Combinational Logic circuits**: Arithmetic circuits: Decoders, encoders, Multiplexers, de-multiplexers.

12 hours

Unit IV

Sequential circuits: Latches and Flip Flops (SR, D, JK, T); Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Sequential circuit design examples in VHDL and simulation. Memory units, random access memory (RAM). **A/D and D/A conversion circuits:** Introduction, filtering and sampling, quantization, quantization error, flash converter and dual slope converter, conversion errors. Binary weighted converter, R-2R ladder converter, characteristic properties.

10 hours

UNIT V

Introduction to communication Electronics:

Frequency Spectrum: MW, SW, FM, LHF, VHF, UHF, Microwave. Communication: Modulation, Demodulation, Optical Fiber Communication (OFC), satellite communication – uplink & downlink, cellular phone, Internet, Modem, Wi-Fi, Radar,

06 Hour

Text Books:

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op-Amps and linear Integrated Circuits :R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003).
5. Gateway to Ham Radio, Joseph Mattappally VU2JIM, Main Stream Media Books, Kochi, 2021.

Reference Books:

12 Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).

2. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
3. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
4. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006
5. Katz R.H., Borriello G., "Contemporary Logic Desing", Prentice Hall India, 2nd 2008 Edition.
6. Kohavi Z., Jha N.K., "Switching and Finite Automata Theory",Cambridge University Press, India, 2nd 2011Edition.
7. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008 Edition.

Soft core: 24MScPHSP25: Practical I (Electronics)

Each practical is of 4 hours per week and with 4 Credits

1). Construction of Astable and Monostable Multivibrator using IC- 555 timer and calculation of frequency.

2) Construction of adder, subtractor, differentiator and integrator using Op-Amp 741.
3) FET- as an amplifier.
4) MOSFET characteristics and application as an amplifier.
5) SCR- characteristics and its applications as a switching device.
6) Construction of decoder and encoder using NAND and NOT gates and verification of truth tables.
7) Construction of Karnaugh map for three and four variables.
8) R-2R ladder network D/A converter and its characteristics.

9) Design of low pass, high pass and band pass active filters using Op-Amp 741, and calculation of cut off frequency.Study of triggered SR, JK and D-flip-flops.

10) Construction of Wein bridge oscillator using Op-Amp 741 and comparison of its theoretical and practical values.

11) Simplification of Boolean expression and implementation using 2-input NAND gate IC7400.

12) Asynchronous & Synchronous Counters

(Minimum of 80% of the listed experiments per paper should be performed).

References:

12 Microelectronics Circuits : Adel S. Sedra and Kenneth C.Smith, Oxford University Press (1991).

2. Electronic devices and circuits: R.Boylsteadand Nashalsky: PHI publications (1999).
3. Electronics Principles: A.P.Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op-Amps and Linear Integrated Circuits : R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid Satte Physics : M.A.Omar, Addison Wisley Pub.Ltd. New Delhi (1993).
7. X-ray Diffraction : B.D.Cullity, Addison-Wisley Ltd. New York (1972).
8. Introduction to Solid State Physics: C.Kittel, Wiley Eastern Ltd. Bangalore, (1976).

10. Advanced Practical physics : (9th Edition) B.C.Worsnop & H.T. Flint Methuen & Co.Ltd.Lond (1951).

11. Instrumental Methods of Analysis : (6th Edition) H.H. Willard, L.L.Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).

12 .Experiments in Modern Physics: A.C. Melissions academic press (NY)(1966).

Open Elective: 24MScPHOT26: Modern Physics

Teaching hours per week 4
Number of credits 4

Unit I

Blackbody Radiation: Nature of Blackbody spectrum; classical radiation laws & their limitations; Planck's radiation law & quantum hypothesis. **The Photoelectric Effect:** Photoelectric Effect experiment; laws of Photoelectric Effect; Einstein Photoelectric Equation. **X- rays: P**roduction and properties of X- rays. Continuous and Characteristic spectrum of X rays. **The Compton Effect:** X-ray Compton scattering from an electron; expression for wavelength shift (no derivation). Experimental set-up for Compton Scattering. Simple problems.

10 hours

Unit II

Atomic Physics: Hydrogen spectrum; the Bohr model; experimental measurement of the Rydberg Constant; Franck Hertz Experiment. **Matter Waves:** The de Broglie wavelength & its relation with the Bohr Model; Davisson – Germer experiment. Heisenberg Uncertainty Principle. Momentum – position & energy – time relations. **Quantum Physics:** Idea of wave function & probability. One-dimensional time independent Schrodinger wave equation.

10 hours

Unit III

Molecular structure: Bonding Mechanisms: ionic bonds; Covalent bonds; the Hydrogen bond; Van-der Waal's Bonds. Molecular vibration & rotation Spectra. **Lasers:** Absorption, Spontaneous & Stimulated emissions; Population Inversion; Two level and three level energy system. Condition for laser action. Ruby laser energy level diagram and working.

10 hours

Unit IV

Solid State Physics: Crystal structure. Space lattice, building block of crystals. Primitiv and non primitive unit cells. Miller indices (qualitative). Seven crystal systems. X ray diffraction, Bragg's law; Bragg's X-ray spectrometer; **Magnetism:** Magnetic Moment; Magnetization. Classification of Magnetic Materials: Diamagnetic, Paramagnetic & Ferromagnetic materials.

10 hours

Unit V

Nuclear Structure: Nuclear properties: Charge, mass, size & structure; Binding Energy & nuclear forces. Radioactivity: Decay constant, half life. **Nuclear Fission:** Fission – basic process; a simple model; a typical nuclear reactor. **Semiconductor Physics:** Intrinsic and extrinsic semiconductors. Doping: p type and n type semiconductors. Types of carriers. pn junction. Junction potential, depletion region. Forward bias and reverse bias. pn junction diode. VI characteristics.

10 hours

Textbooks:

1. Modern Physics (2nd Ed) Serway, Moses & Moyer, Saunders College Pub,1997.
2. Fundamentals of Physics extended with Modem Physics (4^{th} Ed) Halliday, Resnick & Walker, John Wiley, 1993.
3. Concept of Modern Physics, (6^{th} edition) Aurther Beiser, McGraw Hill Publishing company.
4. Modern Physics, Kenneth Krane, Wiley India limited.

III SEMESTER

Core Subject: 24MScPHCT31: Statistical Mechanics

Teaching hours per week 4
Number of credits 4

Unit I

Introduction to Statistical Methods: Basic concepts of probability: Random walk & its general discussion. Macroscopic and Microscopic states, Phase space. **Statistical Formulation of the Mechanical Problem:** Specification of a system. Statistical ensemble, Basic Postulates, Probability calculations, behavior of density of states. **Interaction between Macroscopic Systems:** Thermal, Mechanical and General interactions, Quasi – static processes, Quasi – static work done by pressure, Exact & inexact differentials.

10 hours

Unit II

Statistical Thermodynamics: Irreversibility & the attainment of Equilibrium: Equilibrium conditions & constraints, Reversible & irreversible processes. **Thermal interaction between Macroscopic Systems:** Distribution of energy between systems in equilibrium, Approach to equilibrium, Temperature, Heat reservoirs, Sharpness of probability distribution. **General interaction between macroscopic systems:** Dependence of density of states on external parameters, Equilibrium between interacting systems, Properties of entropy, Statistical calculation of thermodynamic quantities.

10 hours

Unit III

Basic Methods & results of Statistical Mechanics: Micro-canonical ensemble, System in contact with heat reservoir, Canonical ensemble, Applications of canonical ensembles (Paramagnetism, Molecule in an ideal gas, Law of atmosphere), System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble, Connection with thermodynamics, Grand-canonical ensemble, Physical interpretation of Chemical potential in the equilibrium state, Mean values and fluctuations in grand canonical ensemble, Thermodynamic functions in terms of the Grand partition function

10 hours

Unit IV

Distribution Functions: Maxwell – Boltzmann, Bose – Einstein & Fermi - Dirac Statistics: Identical particles & symmetry requirements, formulation of statistical problem, the quantum distribution functions, Maxwell – Boltzmann Statistics, Photon Statistics, Bose – Einstein Statistics, Fermi – Dirac Statistics, Quantum Statistics in classical limit, Quantum states of single particle, Evaluation of partition function, Physical implications of the quantum mechanical enumeration of states.

08 Hours

Unit V

Applications of Statistical Mechanics: Classical partition functions and their properties, Calculations of thermodynamic quantities, Ideal monoatomic gas, Gibbs paradox, Equipartition theorem and its Simple applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid. Maxwell velocity distribution, Related distributions and mean values.

Black Body Radiation: Electromagnetic radiation in thermal equilibrium inside an enclosure, Nature of radiation inside an arbitrary enclosure, Radiation emitted by a body at temperature T. **Conduction Electrons in metals:** Consequences of Fermi–Dirac Distribution, Quantitative calculations of specific heat. Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature.

12 hours

Text books:

1. Statistical mechanics and properties of matter: Theory and applications: E.S.R. Gopal, John Wiley & Sons, New York (1974).

2. Statistical mechanics (2nd ed.): B.K.Agarwal and M. Eisner, New Age International (P)Ltd. Publishers, New Delhi (1998).

Reference Books :

1. Fundamentals of statistical and thermal Physics: F.Reif, McGrawHill Ltd., New Delhi (1965).

2. Elementary statistical physics: C. Kittel, John Wiley & Sons, New York (1958).

3. Statistical mechanics; Theory and applications; S.K.Sinha, TMH Pub. Ltd., New Delhi(1990).

Core Subject: 24MScPHCT32: Classical Electrodynamics

Teaching hours per week 4
Number of credits 4

Unit I

Introduction to Electrostatics: Laws of electrostatics in vector notation: Coulomb's law, Gauss's law in integral and differential forms. Scalar potential. Surface distribution of charges and dipoles and discontinuity in the field and potential. Poisson's and Laplace's equations. Boundary conditions and uniqueness theorem. Potential energy and energy density of electrostatic filed. Method of images, potential due to a point charge in presence of a grounded conducting sphere. Multipole expansion for potential, multipole expansion of the energy in an external filed. Dipole-dipole interaction

10 hours

Unit II

Electrostatics of Dielectrics: Elementary treatment of electrostatics in dielectrics: dielectric placed in an electric filed, polarization, electric displacement, Gauss's law, electric susceptibility, dielectric constant. Boundary conditions for a simple dielectric. Molecular polarizability and electric susceptibility, Clausius- Mossotti equation. Models for molecular polarizability, temperature dependence of molecular polarizability of polar and non-polar substance. Electrostatic energy in dielectric media. **Magnetostatics:** Introduction and definitions, Biot and Savart law, differential equations of magnetostatics and Ampere's fields of a localized current distribution, magnetic moment. Force and torque on energy of a localized current distribution in an external magnetic induction, macroscopic equations, boundary conditions on B and H, Magnetic scalar potential. Energy in magnetic field.

14 hours

Unit III

Electrodynamics: Faraday law of induction, displacement current, Maxwell's equations. Vector and scalar potentials. Gauge transformations, Lorentz gauge, Coulomb gauge. Poynting's theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields. **Electromagnetic Waves:** Plane waves in non-conducting and conducting medium, skin depth. Linear and circular polarizations

10 hours

Unit IV

Wave guides: Fields at the surface and within a conductor, cylindrical cavities and wave guides, modes in rectangular wave guide. Electromagnetic waves; reflection and transmission coefficients in normal and oblique incidence. **Electromagnetic radiation:** Retarded Potentials. Radiation from an oscillating dipole, liner antenna. Lenard-Wiechert potentials, potentials for a charge in uniform motion, power radiated by an accelerated charge (non-relativistic case), radiation when velocity and acceleration are collinear and perpendicular to one another, cyclotron and synchrotron radiation.

08 hours

Unit V

Magneto hydrodynamics and plasma physics: Introduction and definitions,magneto hydrodynamic equations, magnetic diffusion, viscosity and pressure. MHD flow between boundaries with crossed electric and magnetic fields, pinch effect, instabilities in pinched plasma column, MHD waves, plasma oscillations. Superconducting Tokamak, magnetic and inertial confinement of plasma.

08 hours

TextBooks:

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore (1978)

2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd.,New Delhi (1995)

Reference Books:

3. Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
4. Classical Electromagnetic Radiation: J.B.Marion, Academicpress, NewYork (1968)
5. Plasma Physics and Magnetofluid mechanics: A.B. Cambel, McGraw-Hill Book Company Inc., NewYork (1963)

SPECIALIZATION PAPERS

Specialization: 24MScPHST33: Condensed Matter Physics - I

Teaching hours per week : 4
No. of Credit: 4

Unit I

Reciprocal Lattice and crystal diffraction: Reciprocal Lattice, construction. Relation between fundamental translational vectors and reciprocal lattice vectors. Reciprocal lattice to SC, BCC and FCC lattices. Construction of Brillion zones. Atomic form factor, structure factor and its calculations in base centered, body centered and face centered cubic cells.
Energy Bands in Solids: Periodic potential and Bloch theorem: steady state solution. Band symmetry in k space: Brillion zone. Number of states in the band: Born-von Karman boundary conditions. **Electron States:** Empty lattice model, nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. Tight binding method, band width and effective mass in linear lattice.

12 hours

Unit II

Fermi Surface Studies: Extended, reduced and periodic zone schemes. Construction of Fermi surface in square lattice, Harrison construction, slope of bands at zone boundary, electron orbits, hole orbits and open orbits. Experimental methods: Electron dynamics in a magnetic field, , cyclotron resonance, cyclotron frequency and mass relation. Quantization of orbits in a magnetic field, Landau levels, degeneracy of Landau levels, quantization of area of orbits in **k** – space, de Hass-van Alphen effect, extremal orbits.

10 hours

Unit III

Electrical Transport in Metals and Semiconductors: Boltzmann equation, relaxation time approximation, electrical conductivity, thermal conductivity, thermoelectric effects. Calculation of relaxation time, scattering by impurities and lattice vibrations, Mattheisen's rule, temperature dependence of resistivity, residual resistance. 06 hours

Unit IV

Ferromagnetism: Review of Weiss theory of ferromagnetism, its successes and failures, Heisenberg exchange interaction, exchange integral, exchange energy, Spin waves (one dimensional case only), quantization of spin waves and magnons, density of modes, thermal excitation of magnons and Bloch $T^{3/2}$ law, specific heat using spin wave theory. Band theory of ferromagnetism. Ferromagnetic domains, hysteresis curve, magnetocrystalline anisotropy energy, Bloch wall, expression for energy and width. Magnetostriction.
Antiferromagnetism: Characteristic property of antiferromagnetic substance, Neutron diffraction experiment. Two sub-lattice model molecular field theory of antiferromagnetism, Neel temperature, Susceptibility below and above Neel temperature. **Ferrimagnetism:** Ferrimagnetic order, spinnel structure of ferrites, Curie temperature and susceptibility of ferrimagnets. Measurement of Magnetic Properties: Gouy's method, Quinke's method. Vibrationg Sample Magnetometry (VSM). SQUID magnetometry. Magneto optic Faraday effect, Magneto optic Kerr effect. 12 hours

Unit V

Nanostructured materials: Variation of physical properties from bulk to thin films to nanomaterials, -confinement of electron energy states in 0D, 1D,2D and 3D systems, density of states (derivation); Surface to volume ratio. Size, shape and assembly effects.

Synthesis of nanoparticles: Top-down approach: Lithography and soft processes, Ball milling, chemical stamping. Bottom-Up approach: Chemical Routes for Synthesis of Nanomaterials, Solvo-thermal and Sol-gel synthesis; Microemulsions, reverse micelles method. Combustion method. **Biological Methods:** Role of plants in metal (magnetic and non- magnetic) nanoparticle synthesis. **Characterization techniques:** Electron Microscopy (SEM/TEM); Scanning Probes (STM, AFM), Particle Size Analysis using XRD-Debye Scherrer formula, Electrical (I-V and C-V), Porosity (BET method), Zeta potential.

10 hours

Text Books:

1. Solid State Physics : N. W. Aschroft and A. D. Mermin, Saunders CollegePublishing New York (1976).
2. Principles of Theory of Solids : J. M. Ziman, Cambridge University Press, (1972).
3. Introduction to Solid State Physics : C. Kittel, Wiley Eastern Ltd, Bangalore(1976).
4. Lattice Dynamics : A. K. Ghatak and L. S. Kothari, Addison Wesley, Reading (1971)
5. The Physical Principles of Magnetism (new ed.) : A. H. Morrish, John Wiley& sons, New York (19).
6. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)

References Books :

1. Physics of Solids : F. C. Brown, Benjamin Inc. Amsterdam (1967).
2. Introduction to Theory of Solid State Physics : J. D. Patterson, Addision- Wesley Publishing Co. Reading (1971).

Specialization: 24MScPHST33 Nuclear and Particle Physics - I

Teaching hours per week: 4
No. of Credit: 4

Unit I

Basic Properties: Charge distribution in nuclei and nucleons by electron scattering experiment. **Electric quadrupole moment**: Expression for axial quadrupole moment, quadrupole moment of spheroidal nucleus. Quadruple moment due to single nucleon is a state J. **Magnetic dipole moment**: Nuclear g factor for neutron and proton, expression for g factor for a nucleon in a state J in special cases for odd proton and odd neutron on extreme single particle model, Schmidt limits.

10 hours

Unit II

Deuteron problem: Basic properties, ground state of deuteron for square well potential, relation between the range and depth of potential. Nonexistence of excited states, Basic properties of the n-n central force, deuteron in mixture of S and D states using magnetic moment. Range of tensor interaction using quadrupole moment.

10 hours

Unit III

Nucleon-Nucleon Scattering: Scattering of neutron by hydrogen molecules ortho and para hydrogen, spin dependence of nuclear force, effective range theory for n-p scattering. Qualitative features of P-P scattering, effect of coulomb and nuclear scattering. High energy n-p and P-P scattering. Meson theory of nuclear force: Yukawa and pseudo scalar theory, one pion exchange potential.

10 hour

Unit IV

Elementary Particles I: Pion–nucleon scattering and its resonances. Classification: spin and parity assignments; isospin, strangeness. Elementary ideas of SU(2) & SU(3). Gell-Mann-Nishijima scheme. C, P and T invariance. Quark model, colour quark and gluons, quark dynamics, charm, beauty and truth quarks. Fundamental interactions and conservation laws. Introduction to the standard model, Electroweak interaction-W & Z Bosons. Parity non-conservation in weak interactions.

12 hours

Unit V

Elementary Particles II: Gauge theory of weak interaction. Spontaneous symmetry breaking and Higgs mechanism. Electroweak unification. Glashow-Weinberg-Salam model of electroweak symmetry breaking. W±, Z0 masses. Basic ideas of a Grand Unified Theory, SU(5) theory and its predictions. Inclusion of gravity. Planck scale.

08 hours

Text Books:

1. Introduction to Nuclear Physics, S. B. Patel, New Age publication
2. Nuclei and Particles: E. Serge -The Benjamin Publishing, Pvt. Ltd (1977)
3. Introductory Nuclear Physics: K.S. Krane- John Wiley & Sons (1987)
4. Atomic and Nuclear Physics : Vol.II S.N.Goshal –S.Chand and Company(1996)
5. Nuclear Physics: D.C.Tayal – Himalaya Publishing House (2009).
6. Nuclear Physics: Theory and Experiment: R.R. Roy and B.P.Nigam,Wiley Estern Publications (1986).

Reference Books:

1. The Atomic Nucleus : R.D.Evans – Tata Mc Graw Hill New Delhi (1992)
2. Physics of Nuclear Reactors: S. Garag, F.Ahmed and L.S.Kothri.- Tata Mc Graw Hill New Delhi (1986)
3. Introductory of Nuclear Physics: Samuel Wong –Prentice Hall (1996)
4. Fundamentals of Nuclear Physics : N.A.Jelly –Cambridge University Press (1990)
5. Introduction to Nuclear Physics: Harald A. Enge- Addison – Wisely (1996)

Specialization: 24MScPHST33: Electronics - I

Teaching hours per week 4
Number of credits 4

Unit I

Transmission lines : Line of cascaded sections, transmission line generals solution, physical significance of the equations, the infinite line, wavelength , velocity of propagation, wave from distortion less line, telephone cable, introduction loading of telephone cable, reflection of line not terminated with characteristics impedance, open and short circuited lines, insertion losses.

10 hours

Unit – II

Lines at RF: Parameters of open wire line at high frequencies, parameter of co-axial cable at high frequencies, constant of lines of zero dissipations, voltages and current on dissipation less lines, standing wave ratio, impedance of open and short circuit lines, the ¼ wave line, ½ wave line , impedance matching of ½ wave line, single stub matching.

10 hours

Unit – III

Waveguides: Solution of wave equations in rectangular and cylindrical coordinates, TE and TM modes in rectangular and cylindrical wave guides, characteristics of rectangular and circular wave guides. **Antennas**: Isotropic radiator, gain, bandwidth, radiation pattern, directivity and effects of lengths of antenna, radiation of directional antenna, antenna of aperture, different types of apertures, effects of earth on antenna pattern, principle of pattern multiplication, phased arrays, Yagi-Uda antenna, helical antenna.

10 hours

Unit – IV

Communications Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem. **Digital communications**: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA.

12 hours

Unit – V

Satellite Communications : Introduction, Kepler's laws orbits, power systems, attitude control, satellite station keeping, antenna look angels, limits of visibility, frequency plans and polarization, transponders, up-link and down-link power budget calculations, digital carrier transmission, multiple access methods, fixed and mobile satellite service earth stations, INSAT

08 hours

Suggested Books:

1. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill (2006).
2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education (2005)
3. S. Wolf and R. F. M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004)
4. ELectronics communication system 4th edition: George Kennedy and Bernard Davis, Tata McGraw – Hill Publishing Company Ltd., New Delhi (1999).
5. Networks, Lines and fields: J.D Ryder, Prentice Hall India Pvt., Ltd., New Delhi(1995)

Reference Books

1. Communication systems: Simlon Hayklin, Wiley Estern Ltd.,New Delhi
2. Radio Engineering: G.K Mittal, Khanna Publishers, Delhi (1998)
3. Modern Communication system – principals and application Ltd, New Delhi(1998)

Specialization: 24MScPHST33: Atomic, Molecular and Optical Physics - I

Teaching hours per week: 4
No. of Credit: 4

Unit I

Complex Atoms: Vector atom model for three or more valence electronics. Derivation of spectral terms for three or more than three valence electrons. The chief characteristics of complex spectra the displacement law, alternation law of multiplicities, the Lande' Interval Rule. Inverted terms, Hund's rule (with example) Magnetic Filed Effects in Complex Atoms: Study of Zeeman effect in complex spectra; Paschen Back effect. Derivation of spectral terms by magnetic quantum numbers. Equivalent electrons and the Pauli's exclusion principle.

10 hours

Unit II

X-ray spectra: Emission & absorption spectra of X-rays, Regular and irregular doublet laws. X-ray satellites. Non-diagram lines, Isoelectronic sequences of atoms containing single and double valence electrons, Perturbation and auto ionization in atoms.

10 hours

Unit III

Electronic States: The hydrogen molecule ion: Outlet of MO treatment of H_2 and H_2electronic states and correlation of states. Building up Principles:determination of the term manifold from the concept of separated atoms, united atom & from the electron configuration.

10 hours

Unit IV

Coupling Cases: Coupling of rotation and electronic motion in diatomic molecules. Hund's coupling cases, Spin uncoupling, symmetry properties of rotational levels of Sigma and Pi electronic states.

10 hours

Unit V

Transitions: Types of allowed electronic transitions with selection rules. Rotational structure of bands due to transitions of singlet, double and triplet multiplicities; Perturbations.**Continuous and diffuse spectra:** Dissociation, predissociation and determination of heats of dissociation. Applications to astrophysics (earth and stellar atmosphere: comets).

10 hours

Text Books*:*

1. Introduction to Atomic Spectra : H.E. White, McGraw – Hill, Tokyo (1934)
2. Molecular Spectra & Molecular Structure – Vol I : Herzberg, D. Van Nostrand Co. Princeton, J. J. (1945)

3. Spectroscopy – Vol. 3:S. Walker & B. P. Strauhghan, Chapman & Hall, Lon (1976)

4. Elementary Atomic Structure (2^{nd} ed.) : G. K. Woodgate, Clarendon Press, Oxford (1980)

5. Atoms & Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1982)

6. Molecular Symmetry & Spectroscopy : G. Aruldhas

Reference Books*:*

1. Raman Spectroscopy : D. A. Long, Mc Graw – Hill, N. Y. (1977)

2. Quantum Chemistry : Ira Levine, Prentice – Hall of India, New Delhi (1991)

3. Fundamentals of Spectroscopy (2^{nd} ed : B. Narayan, Allied Publishers Ltd., New Delhi (1999)

4. Atomic & Molecular Spectroscopy : Mool Chand Gupta, New Age Intl. Ltd., New Delhi (2001)

Specialization Practical - I

24MScPHSP34: Practical Condensed Matter Physics – I

Each practical is of 4 hours per week and with 4 Credits

1) Magnetic Susceptibility determination by Quinke's method.
2) Determination of Specific heat of metals.
3) Gouy's method for the determination of magnetic susceptibility of various paramagnetic/diamagnetic samples.
4) Temperature dependence of susceptibility of a paramagnetic substance using Gouy's method.
5) Determination of elastic constants (Young's modulus in solids).
6) Thermal and electrical conductivity- Weidman-Franz law and Lorentz number determination.
7) Determination of electron-phonon coupling constant by measuring resistivity of copper/silver wire.
8) Determination of Curie temperature of a ferromagnetic material.
9) Determination of Energy Band Gap of Silicon, Germanium using diodes and light emitting diodes.
10) Tracing BH curves for ferromagnetic materials and calculation of magnetic susceptibility.
11. Diamagnetic susceptibility of water molecule. Gouy's experiment.

(Minimum of 80% of the listed experiments per paper should be performed).

Reference Books:

1. X-ray Diffraction : B. D. Cullity, Addison – Wesley, New York (1972)
2. X-ray diffraction procedures: H. P. Klug and L. E. Alexander, John Wiley and Sons inc. New York.
3. Interpretation of X-ray Powder Diffraction Pattern : H.P. Lipson and H. Steeple, Macmillan, London (1968)
4. Elementary Solid State Physics: M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (1993).
5. Elementary Solid State Physics : C. Kittle, Wiley Eastern Ltd., Bangalore (1976).
6. Introduction to Magneto chemistry : A. Earnshaw, Academic press London (1968)

24MScPHSP34: Nuclear and Particle Physics– I

Each practical is of 4 hours per week and with 4 Credits

1. Calibration of NaI (TI) Scintillation counter.
2. Calibration of X-ray proportional counter spectrometer.
3. Attenuation of beta particles - I
4. Attenuation of gamma rays - I
5. Magnetic beta ray spectrometer - I
6. Determination of Fluorescence yield using NaI(TI) Scintillator.
7. Study of Half life of Indium.
8. Compton Scattering.
9. Angular correlation of gamma rays.
10. Study of emitter follower circuit.
11. RC coupled amplifier.

Assignment

1.Verification of Mosley's law .

(Minimum of 80% of the listed experiments per paper should be performed).

1.Experiments in Modern Physics : A. C. Melissions, Academic Press (NY) (1966)

2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC, (1971)(Available in Nuclear Physics Laboratory)

3. Practical Nucleonics : F. J. Pearson., and R. R.Osborne, E & F. N. Spon Ltd. London (1960)

4. The Atomic Nucleus: R. D. Evans, Tata Mc Graw Hill Pub. Comp. Ltd. (1960)

5. Nuclear Radiation Detectors : S. S. Kapoor and V. S. Ramamurthy, Wiley Eastern Limited (1986)

6. Experimental Nucleonics : E. Bleuler and G. J. Goldsmith, Rinehart & Co.Inc. (NY) (1958)

7. A manual of experiments in reactor physics: Frank A. Valente, Macmillan company (1963)

8. A practical introduction to electronic circuits : Martin Harthley Jones,

Cambridge University Press (1977)
9. Integrated circuit projects : R. M. Marston, Newnes Technical Books (1978)
10. Semiconductor projects : R. M. Marston, A Newnes Technical Books (1978)
11. Waveform generator projects : R. P. Marston, A Newnes Technical Books (1978)

24MScPHSP34: Practical Electronics - I

Each practical is of 4 hours per week and with 4 Credits

Experiments based on the following topics will be set:

1. Analog experiments based on analog integrated circuits IC 741, 555, 565.
2. Analog to digital conversion experiments.
3. Power electronics experiments.
4. C-Programming

(New experiments may be added with the approval of BoS)

Reference Books:

1. Microelectronics Circuits : Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991)
2. Electronic Principles: A. P. Malvino, TMH Publications (1984).
3. Operational Amplifier and Linear IC's : Robert F. Coughlin and Frederick Driscoll, PHI publications (1994)
4. Op-Amps and Linear Integrated Circuits : R. Gayakwad, PHI publications, New Delhi (2000)
5. Digital Principles and Applications : A. P. Malvino and D. Leach, TMH Publications (1991)
6. Programming in ANSI – C (2^{nd} Edition); E. Balgurusamy, Tata Mc Graw Hill Pub. Company New Delhi (1992)

24MScPHSP34: Atomic, Molecular and Optical Physics – I

Each practical is of 4 hours per week and with 4 Credits

Experiments based on the following topics will be set:

1. Determination of Dispersion curve for C.D.Spectrograph and error curve using Fe and Cu lines.
2. Photographing the Fe and Cu spectra in juxtaposition and determination of the wave length f the Copper are lines (Linear Interpolation and Hartmann methods).
3. Photograph spectrum of Hg source with the Iron are spectrum in Juxta position on a Grating Spectrograph and determine the wave lengths of the prominent Hg lines. Draw the energy level diagram and transition of Hg atom.Zeeman effect (Photographic method)
4. Vibrational Analysis of Absorption bands of I_2
5. Spectroscopy Assignments in Computer Programming.

(New experiments may be added with the approval of BoS)

Reference Books:

1. X-ray Diffraction : B. D. Cullity, Addison – Wesley, New York (1972)
2. X-ray diffraction procedures: H. P. Klug and L. E. Alexander, John . Wiley and Sons inc. New York.
3. Interpretation of X-ray Powder Diffraction Pattern : H.P. Lipson and . H. Steeple, Macmillan, London (1968)
4. Elementary Solid State Physics: M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (1993).
5. Elementary Solid State Physics : C. Kittle, Wiley Eastern Ltd., Bangalore (1976).
6. Introduction to Magneto chemistry : A. Earnshaw, Academic press
7. London (1968).

Specialization Practical - II

24MScPHSP35: Practical Condensed Matter Physics – II

Each practical is of 4 hours per week and with 4 Credits

1) Structure Factor calculations.
2) Indexing of Tetragonal system.
3) Calculation of relative integrated intensity.
4) Indexing of Hexagonal system.
5) Determination of structure of CdTe.
6) Precise parameter determination by (a) extrapolation method and (b) Cohens's method.
7) Size and stress estimation of nano particles from the measured width of its diffraction pattern
8) X-ray structure analysis of small inorganic molecules and their vibrational structure from force-field calculations.
9) Determination of compressibility and bulk modulus of the liquid by ultrasonic method (experiment).
10) C-programs (only for practice, not to be given for exams)
    a) To find the roots of any n quadratic equations.
    b) To find the roots of a given equation using iteration method.
    c) To find XRD pattern coefficient.
11) Magneto optic Faraday effect (Experiment),
12) Magneto optic Kerr effect (Experiment).

(Minimum of 80% of the listed experiments per paper should be performed).

Reference Books:

1. X-ray Diffraction : B. D. Cullity, Addison – Wesley, New York (1972)
2. X-ray Diffraction procedures: H. P. Klug and L. E. Alexander. John
3. Wiley and Sons Inc. New York.
4. Interpretation of X-ray Powder Diffraction Pattern : H.P. Lipson and H. Steeples., Macmillan, London (1968)
5. Elementary solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (1993)
6. Elementary Solid State Physics : C. Kittle, Wiley Eastern Ltd., Bangalore (1976)
7. Introduction to Magneto chemistry: A. Earnshaw, academic press, London (1968).

24MScPHSP35: Nuclear and Particle Physics – II

Each practical is of 4 hours per week and with 4 Credits

1. Z dependence of external bremsstrahlung
2. Anthracene crystal beta ray spectrometer.
3. Determination of efficiency of GM counter.
4. Electron Capture transition energy using internal bremsstrahlung.
5. Si(Li) beta ray spectrometer.
6. Half life of K^{40}.
7. Gamma gamma angular correlation.
8. Nuclear reaction analysis.
9. Gamma-Ray Spectroscopy using NaI (TI) detector.
10. Alpha Spectroscopy with Surface Barrier Detector.
11. Determination of the range and energy of alpha particles using spark counter.
12. Study of attenuation of γ- particles using GM counter
13. Fission Fragment Energy loss measurements from Cr^{252} .
14. Study of gamma ray absorption process.

Assignment.

15. Shell model energies using harmonic oscillator potential and then spin-orbit interaction.
16. Mott's scattering

References:

1. Experiments in Modern Physics: A.C.Melissinos, Academic Press (NY) (1966)
2. Experiments in Nuclear Science, ORTEC Application Note. ORTEC,(1971)

3. (Available in Nuclear Physics Laboratory)
4. Practical Nucleonics: F.J.Pearson., and R.R.Osborne, E & F.N.Spon Ltd London (1960)
5. The Atomic Nucleus : R.D.Evans, Tata Mc Graw Hill Pub.Comp.Ltd(1960
6. Nuclear Radiation Detectors: S.S.Kapoor and V.S.Ramamurthy,Wiely Eastern Limited (1986)
7. Experimental Nucleonics: E.Bleuler and G.J.Goldsmith,Rinehart & Co Inc.(NY) (1958)
8. A manual of experiments in reactor physics: Frank A. Valente,Macmillan company (1963)
9. A practical introduction to electronic circuits: Martin Harthley Jones, Cambridge University Press (1977)
10.Integrated circuit projects: R.M.Marston Newnes Technical Books(1978)
11.Semiconductor projects: R.M.Marston A Newnes Technical Books(1978)
12.Waveform generator project: R.P.Marston A Newnes Technical Books(1978)
13.Linear Integrated Circuits: D.Roy Choudhary and Shail Jain, New Age International (1995).
14. Op-Amps and Linear Integrated Circuits: Ramakanth A Gayakawad, Prentice-Hall of India (1995)

24MScPHSP35: Electronics – II

Each practical is of 4 hours per week and with 4 Credits

Experiments based on the following topics will be set:

1. Study of different flip – flops.
2. Study of digital counters and registers.
3. Study of multiplexing, demultiplexing, adder and subtractor.
4. C-programming.

(New experiments may be added by obtaining the approval of BOS).

References:

1. Microelectronics Circuits : Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991)
2. Digital Principles and Applications : A. P. malvino and D. Leach, TMH publications (1991)
3. Digital Computer Fundamentals, Thomas C. Bartee, Mc Graw Hill Ltd. (1977)
4. Digital Logic and Computer Design: Morris Mano Prentice Hall of India Pvt. Ltd. New Delhi (2000)
5. Programming in ANSI – C (2^{nd} Edition): E. Balgurusamy, Tata Mc Graw– Hill Pub. Company, New Delhi (1992).
6. Programming in ANSI – C (2^{nd} Edition); E. Balguruswamy, Tata Mc Graw–Hill Pub. Company, New Delhi (1972).

24MScPHSP35: Atomic, Molecular and Optical Physics - II

Each practical is of 4 hours per week and with 4 Credits

Experiments based on the following topics will be set:

1. Vibrational analysis of emission bands of N_2. Study of Intensity variation with pressure and voltage changes.
2. Computer Programming: Spectroscopy assignments.
3. Spectrochemical Analysis of given mixture.
4. Study of Cu Spark spectrum with its Arc spectrum.
5. Determination of Screening Constant for Na doublets (using Grating spectrograph).
6. Excitation of AIO bands by burning aluminum in are and vibrational analysis of the band system by determining the wavelength of the band heads. Draw the Condon parabola using visual intensities.

Refrence books:

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication, Inc, New York (1963)

2. Practical Spectroscopy : G.R. Harrison, Prentice-Hall, New York (1948)

3. Practical Spectroscopy : C. Candler Hilger and Watts Ltd,Glassgow,(1949)

4. Atomic Spectra and Atomic Structure(2nd Edition)-G.Herzberg Dover Publication New York(1944)

5. Atomic Spectra-H.E. White.Mc Graw-Hill, NewYork(1934)

6. A Course of Experiments with He-Ne Laser(2nd Edition) : R.S.Sirohi,.Wiley Eastern, New Delhi(1991)

7. Principles of Lasers : Svelto.O, Plenum Press NewYork(1982)

8. Lab. Manuals

9. Molecular Spectra & Molecular Structure Vol. I : G. Herzberg,D.Van Nastrand Co, NewYork(1950)

10. Instrumental Methods of Analysis : H.H. Wiillard, L.L. Merit,J.A. Dean and F.A. Settle, J.K.Jain for CBS Publishers (1986

11. The Identification of Molecular Spectra : R.W.B. Pearse & A.G.Gydon, Wiley, NewYork(1961)

12 Asociation Energies and Spectra of Diatomic Molecules : A.G.Gaydon, Chapman and Hall, London (1947).

24MScPHSP37: Project preliminary (non-credit course)

Each practical is of 2 hours per week and non credit course

This course shall contain the prerequisite for the 4th semester major project. By the end of the 3rd semester a group of students shall (not more than four in a group) work under the guidance of a guide. In consultation with guides the broad area shall be decided within one week of the start of the semester. The group shall also formulate the skills and methodology of the project of the final semester. They shall also submit a report on the work.

After identifying the broad area of the project, the following activities may be carried out during the semester covering not less than 2 hours per week.

- Literature survey
- Problem identification
- Finalizing the title of the project

Note:

- The project topic shall be of relevance to the respective specialization subjects, which student is studying.
  - The broad area of the project shall be intimated to the Chairman, Department of Physics, Rani Channamma University within 15 days of the start of the semester.
  - The final specific problem defined shall be intimated to the Chairman, Department of Physics, Rani Channamma University at the end of the semester.

Open Elective: 24MScPHSP36: Physics of Nano Materials

Teaching hours per week: 4

No. of Credit: 4

Unit I

Length scales, Variation of physical properties from bulk to thin films to nanomaterials, - confinement of electron energy states in 0D, 1D,2D and 3D systems (qualitative treatment) ; Surface, size, shape and assembly effects. **Buckminsterfullerene:** Preparation and occurrence. C60, Graphene, carbon nano tubes: classification and properties.

10 hours

Unit II

Synthesis of Nanomaterials: Top-down approach: Lithography and soft processes, Ball milling, chemical stamping. **Bottom-Up approach:** Chemical Routes for Synthesis of Nanomaterials, Solvo-thermal and Sol-gel synthesis; Physical and Chemical Vapour Deposition, Sputtering, Laser ablation. **Biological Methods:** Role of plants and bacteria in metal (magnetic and non- magnetic) nanoparticle synthesis.

10 hours

Unit–III

Characterization techniques: X-ray Diffraction: Braggs law, Bragg's X ray spectrometer. XRD pattern, intensity vs 2θ plot. Particle size analysis using Debye Scherrer formula. Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM); Scanning Probes microscopy: Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM).

10 hours

Unit IV

Properties

Electronic and optoelectronic properties: Ballistic transport, Coulomb blockade, Diffusive transport. Optical Properties: Photoconductivity, Optical absorption & transmission, Plasmons and Excitons, Luminescence and Phosphorescence. Magnetic properties: Nanomagnetism, magneto-resistance and Super paramagnetism.

10 hours

UNIT-V:

General Applications: Nanomedicine, Nanobiotechnology, Green nanotechnology, Energy applications of nanotechnology, Industrial applications of nanotechnology, Potential applications of carbon nanotubes, Nanoart, Nanoelectronics.

(Ref: https://en.wikipedia.org/wiki/Applications_of_nanotechnology) 10 hours

Refrence books:

1. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
2. Nanocrystals: Synthesis, Properties and Applications. C. N. R. Rao, P. John Thomas and G. U. Kulkarni, Springer Series In Materials Science.
3. Nano Essentials- T.Pradeep/TMH
4. Introduction to Nanotechnology, C P Poole & F J Owens, Wiley, 2003.
5. Nanotechnology, M Ratner & D Ratner, Prentice Hall 2003

I V S E F

FOURTH SEMESTER

Core Subject: 24MScPHCT41: Quantum Mechanics - II

Teaching hours per week: 4

No. of Credit: 4

Unit I

Linear Vector Spaces: Hilbert space, Dirac's bra and ket notation, dynamical variables and linear operators, projection operators, unit operator, unitary operator, matrix representation of an operator, change of basis, unitary transformation. operator, Hermitian operators and reality of Eigenvalues, Eigen values and eigen functions of simple harmonic oscillator method.

10 hours

Unit II

Quantum dynamics: Principles of superposition, observables and operators, , Measurement in quantum mechanics: How measurement disturbs the systems, complete set of commuting operators (CSCO), uncertainty relations for operators, Time evolution operator, time evolution of expectation values, quantum Poisson brackets and equation of motion, Constants of motion, Schrodinger and Heisenberg picture, Heisenberg's matrix mechanics for harmonic oscillator.

08 hours

Unit III

Angular Momentum: Introduction, angular momentum operator and its representation, Eigen values and eigen functions of L^2, commutation relations, Angular momentum and rotations. Bra and Ket representation, Eigen values, ladder operators, Eigenvectors of J^2 and J_z. Angular momentum matrices for j=1/2 and j=1. Pauli wavefunction and equation, Theory of addition of two angular momenta, Clebsch Gordan coefficients, allowed values of j, singlet and triplet states (qualitative).

12 hours

Unit IV

Identical particles and Approximation methods: Identical particles in classical and quantum system, symmetric and asymmetric wave functions, Bosons and Fermions, wave function for three indistinguishable particles, spin and space wave function. First order perturbation theory for a degenerate energy level the secular equation, W.K.B. approximation, statement of connection for leakage across a potential barrier, application to alpha decay, and cold emission. The variational method and its application to the ground state of the helium atom.

10 hours

Unit V.

Relativistic Quantum Mechanics: The Klein – Gordon equation, the formation of equation. The Dirac equation, properties of the Dirac matrices, Probability density and the probability current density, solution of Dirac equation, positive and negative energy states, the hole theory of the positron, Zitterbewegung of the Dirac particle in free space, spin and magnetic moment. Bound state energy levels of hydrogen atom: energy levels and fine structure (without derivation).

10 hours

Text Book:

1. Quantum Mechanics (2nd Edition) : L. I. Schiff, Mc Graw – Hill Book Co, New York (1955).2. Quantum Mechanics vol. I : A. Messiah, North Holland Pub Co, Amsterdam (1962).

2. Quantum Mechanics – Theory and Applications (3rd Edition): A. Ghatak and S. Lokanathan, Mac Millan India Ltd. New Delhi (1984)
3. A Text book of quantum Mechanics : P. M. Mathews and K. Venkateshan, Tata Mc Graw – Hill, New Delhi (1987)
4. Quantum Mechanics by Amit Goswami

5.Quantum Mechanics (2nd edition) : G Aruldhas, Prentice Hall India Pvt. Ltd. New Delhi

Reference Books:

1. The Principles of Quantum Mechanics (4th Edition) : P. A.M. Dirac, Oxford, New York (1958)
2. Quantum Mechanics (1st Edition) : V. K. Thankappan, New Age Intl. Pvt Ltd., New Delhi (1985)
3. Quantum Mechanics : E. Merzbacher., John Wiley, New York (1970)
4. Modern Quantum Mechanics : J. J. Sakurai, Addison Wesley, Massachusetts (1994)

Core Subject: 24MScPHCT42: Advanced Mathematical Methods of Physics

Teaching hours per week : 4
No. of Credit: 4

Unit I:

Linear algebra: Eigen value problem: Eigen values of a symmetric tridiagonal matrix, singular value decomposition method, LU decomposition of a matrix, Solution of a system of linear equations by LU decomposition method. **Vector calculus:** Physical significance of gradient, divergence and curl, Green's and Stokes theorem, Operators in vector calculus.

08 hours

Unit– II

Numerical Methods:

Solution of algebraic and transcendental equations: the bisection method, the iteration method and the Newton – Raphson Method. **Interpolation**: forward backward and central differences. Newton's formulae for interpolation, Lagrange's interpolation formula, **Curve fittings**: Least square curves fitting procedures. Numerical integrations: trapezoidal rule, Simpson's 1/3 rule. **Solution of linear equations**: Gaussian elimination method eigenvalues problem. Numerical solutions of differential equations: Euler's method, Runge-Kutta Method.

12 hours

Unit III

Partial Differential Equations: Solution of Laplace's equation, Steady state temperature in a rectangular plate, Solution of Diffusion equation, Solution of wave equation, Steady state temperature in a cylinder, Vibration of a circular membrane, Integral transform solutions of partial differential equations.

12 hours

Unit IV

Numerical solutions of Partial Differential Equations: Finite difference approximations to derivatives, solution of Laplace's equation by Gauss-Seidel method, solution of Poisson equation, Heat equation in One dimension: Bender-Schmidt formula, solution of Heat equation by Gauss-Seidel method.

8 hours

Unit V

Probability Theory: Probability theorems, Methods of counting, Random variables, Mean, Standard deviation, Distribution functions, Continuous distributions, Binomial, Gaussian and Poisson distribution, Application to experimental measurements. **Error analysis:** Error calculations for a experimental data set, Least square fitting a straight line to a data set with error bars.

10 hours

References:

1) Mathematical Methods in the Physical Sciences, Mary. L. Boas, Wiley, (Third edition).

2) Introductory methods of numerical analysis (3 rd Edition): S. S. Sastry, Prentice –Hall of India Pvt. Ltd., New Delhi (2000).

3. Advanced Mathematics in Physics and Engineering : Arthur Bronwell, Mc Graw-Hill Book Company, New York (1953).

4. Mathematical Methods for Physics and Engineering : K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge Univ. Press Cambridge (1998).

5. Mathematical Methods for physicists (4th edition) : George Arfken & Hans J. Weber, Academic Press, San Diego (1995).

Specialization: 24MScPHST43: Condensed Matter Physics - II

Teaching hours per week: 4
No. of Credit: 4

Unit I

Dielectrics: Review of basic formulae, dielectric constant and polarizability, local field, Clausius-Mossotti relation, polarization catastrophe. Sources of polarizability, Dipolar polarizability: dipolar dispersion, Debye's equations, dielectric loss, dipolar polarization in solids, dielectric relaxation. Ionic polarizability. Lyddane –Sachs-Teller relation and its implications. Electronic polarizability: classical treatment, quantum theory, interband transitions in solids.

10 hours

Unit II

Ferroelectrics: General properties of ferroelectrics, classification and properties of representative ferroelectric crystals, dipole theory of ferroelectricity, dielectric constant near Curie temperature, microscopic source of ferroelectricity. Thermodynamics of ferroelectric phase transition, ferroelectric domains, hysteresis in ferroelectrics, P-E curve. Phase transition in Barium Titanate, $BaTiO_3$ and its dielectric property. Piezoelectricity and its applications.

10 hours

Unit III

Semiconductors: Elemental and compound semiconductors with examples and their structures, band structure of real Semiconductors, direct band gap and indirect band gap, conservation of momentum. Extrinsic semiconductors: Binding energy of impurity, impurity levels, Population of impurity levels, carrier concentration, Fermi energy and its dependence on impurity concentration and temperature. Introduction to Diluted Magnetic Semiconductors (DMS), and Spntronics.

10 hours

Unit IV

Transport in Semiconductors: Electrical conductivity and mobility, their dependence on temperature and scattering mechanisms, energy gap determination. Diffusion of carriers in semiconductors, diffusion equation and diffusion length. **Magnetic Field Effects:** Hall effect in metals and semiconductors, temperature effect, magnetoresistance, giant magnetoresistance (GMR) and colossal magnetoresistance (CMR), cyclotron resonance: effective mass determination and band structure determination.

Optical Properties: Interband and intraband absorption, fundamental absorption processes, absorption edge, exciton absorption, free carrier absorption, impurity involved absorption. Photoconductivity, luminescence.

10 hours

Unit V

Magnetic Resonance: Basic principles of paramagnetic resonance, spin-spin and spin–lattice relaxation. Bloch equations, steady state solutions. Basic principle of Nuclear Magnetic Resonance (NMR), Basic NMR instrumentation, FID and spin echo and signal detection. Chemical shift, magnetic shielding, Proton (^{1}H)-NMR, simple examples of methanol and ethanol, spin-spin coupling in ^{1}H-NMR. 2D NMR (qualitative discussion). Electron Paramagnetic Resonance (EPR), resonance condition, g-factor, nuclear hyperfine interaction. Basic instrumentation, determination of g-factor, line width and spin –lattice relaxation time.

10 hours

Text Books:

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York (1965)
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
3. Introduction to Solid State Physics : 5^{th} Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
4. Elementary Solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (2000)
5. Solid State and Semiconductor Physics : J. P. McKelvey, Harper and Row, New York (1966).

Reference Books :

1. Solid State Physics : N. W. Aschroft and A. S. Mermin, Saunders College Publishing, New York (1976)
2. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).Tata – McGraw Hill Publications, New Delhi (2000)
3. Principles of Electronic Instrumentation : A. J. Diefenderfer, and B.E. Hotton, Saunders college Publishing, London (1994)

Specialization: 24MScPHST43: Nuclear and Particle Physics - II

Teaching hours per week: 4

No. of Credit: 4

Unit I

Shell Model: Shell model for one nucleon outside core: Energy levels according to the infinite square well potential and harmonic oscillator potential, Effect of spin orbit interaction, prediction of ground state spin – parity of odd A nuclei and odd-odd nuclei-Nordhiem's rules magnetic moment of odd A nuclei. Configuration for excited states for two nucleons outside the core O^{-18} spectrum (qualitative) for two particles in d5/2 orbit and in the d 5/2 –S 1/20 orbits, configuration mixing.

10 hours

Unit II

Collective Model: Evidences for collective motion, vibrational energy levels of even nuclei. Rotational energy levels of deformed even – even nucleus. Moment of inertia-rigid body value – back bending –spectrum of odd A nuclei- Coriolis term. Nilson model: Calculation of energy levels and prediction of ground state.)

10 hours

Unit III

Nuclear Reaction I: (light ions reaction): Introduction of reaction mechanisms- comparison of features of compound nucleus model and direct reaction model. Partial – wave approach: Partial wave analysis of nuclear reactions expressions for scattering and reaction cross sections and their interpretation, shadow scattering – resonance theory of scattering and absorption – overlapping and isolated resonance . Briet – Wigner formula for scattering and Reaction shape of cross section curve near a resonance

10 hours

Unit IV

Nuclear Reaction II: (Heavy ions reaction): Characteristics of heavy ion reaction. Classical and semi classical descriptions of scattering , classical elastic scattering of particles deflection function of orbits and cross sections – rainbows and glories – semi classical scattering theory- WKB approximation.

10 hours

Unit V

Nuclear Reaction & Its Behavior: Nuclear reaction cross section & its behaviour near the threshold, Inversion reactions. Principle of detailed balance , Optical model, mean free path, Optical potential and its parameters for elastic scattering. Transfer reaction, semi-clasical description, plane wave Born approximation (PWBA) its predictions of angular distributions, Modifications introductions in the distorted wave Born approximation(DWBA). Spectroscopic factors, transfer reactions and the shell model.

10 hours

Text Books:

1.Nuclear Physics: Theory and Experiment: R.R. Roy and B.P.Nigam,Wiley Estern Publications (1986)
2. Atomic and Nuclear Physics Vol. II: S.N. Goshal. S. Chand and Company (1998).
3. Introductory Nuclear Physics : Kenneth S. Krane, John Wiley and sons (1988).
4. Physics of Nuclei and Particles: P. Marmier and E.Sheldon, Academic Press (1970)
5. Nuclear reaction : R.Singh and S N Mukharjee, New age International (1996)
6. Introductory Nuclear Reactions : G.R. Satchler,the Mac Millan Press(1980)

Reference books:

1.Subatomic Physics: Nuclei and Particles (Volume-II): Luc Valentin North Holland (1981).
2.Theoretical Nuclear Physics: J.M. Blatt and V.F. Weisskoff, Wiley (1992).
3.Subatomic Physics (Second Edition): Hans Frauenfelder and E.M. Henley, Prentice Hall (1991).
1. Introduction to Nuclear Physics: Herald. A. Enge, Addition-Wesley (1983).
2. Introductory Nuclear Physics: Samuel S.M. Wong, Prentice –Hall (1996).

Specialization: 24MScPHST43: Electronics-II

Teaching hours per week: 4
No. of Credit: 4

Unit I

Transducers: Basic principles of transducers, Different types of transducers, Classification, microphones, speakers, styain gauge, thermistor, pressure and displacement, transducers, Hall – effect transducers.

10 hours

Unit II

Instruments: Digital voltmeter, working principles, digital multimeter, digital frequency meter, measurement of frequency and time period, audio function generator, data acquisition systems.

08 hours

Unit III

Biomedical Instrumentation: Electrical signal produced by biological cells, transducers for detection of the biological signals. Analysis and recording of signals: ECG EMG EEG and NMR, magnetic resonance imaging, pace makers, defibrillators

10 hours

Unit IV

Signals and systems: Continuous and discrete signals, energy and power signals, definitions and transformations, continuous and discrete systems: linearity and the principle of superposition, linear time invariant systems. Convolution: continuous and discrete time convolution, differential equations and difference equations.

10 hours

Unit V

Transform domain representation of signals: Fourier analysis: continuous signals, analysis and synthesis of periodic signals; discrete time signals and systems. Fourier transform: continuous and discrete time transform, inverse Fourier transform, analysis and synthesis of aperiodic continuous and discrete time signals, properties of transform. Fast Fourier transform. Laplace transform: s-plane poles and zeros. Continuous time LTI systems. z- transform: definition and properties, inverse z – transform, discrete LTI systems

12 hours

Text Books

1. Electronic Measurements and Measuring techniques : A. D. Helfrick and W.D. Cooper
2. Electrical and Electronic measurements and techniques : A. K. Shawney The educational and Technical Publications, New Delhi (1985)
3. Biomedical digital signal procession : William J. Tompkins, Prentice hall of India Pvt. Ltd. (2000)
4. Electronic Signals and Systems : Paul A. Lynn, English Language Book 5. Society / Macmillan (1986)
6. Signals and Systems : S. Udyakumar, Bharat Book Prakashan, Dharwad (2000)

Reference Books

1. Communication systems: Simon Haykin, Wiley eastern Ltd. New Delhi (1983)
2. Modern Communication Systems – Principles and Applications : Leon W. Couch II, Prentice Hall of India Pvt. Ltd., New Delhi (1998)
3. Discrete time Signal procession –2nd Edition, A.V. Oppenheim, R. W. Schafer and J. R. Buck, Prentice Hall, New Jersey (1999)
4. Digital Signal Processing – A Computer Based approach : Sajith K. Mitra, Tata – McGraw Hill Publications, New Delhi (2000)
5. Principles of Electronic Instrumentation : A. J. Diefenderfer, and B.E. Hotton, Saunders college Publishing, London (1994).

Specialization: 24MScPHCT43: Atomic, Molecular & Optical Physics - II

Teaching hours per week: 4
No. of Credit: 4

Unit I

Absorption Spectroscopy: UV/Visible Spectrophotometry: Radiation sources, Filters, Monochromators, detectors. **Absorption Spectrophotometer** Instrumentation absorption spectrophotometry, theBeer'slaw,Solvent–effects; Bathochromic and Hypsochromic shift (Blue and Red shifts), Assignment of sigma and pi transitions. Derivative spectroscopy

10 hours

Unit II

Emission Spectroscopy: Fluorescence and Phosphorescence (with energy level diagram), Fluorimeter, fluorescence quantum yield. Lifetime measurements: Radiative and Natural lifetime, Decay curves, Single photon counting; Fluorescence Quenching, Rate parameters and energy transfer mechanisms. **Atomic emission Spectrophotometry:** Sources, atomic emission spectrometers, photographic intensity measurements. **Photoelectron spectrophotometry:** UV photoelectron spectrometers, chemical information from photoelectron spectroscopy (simple systems).

10 hours

Unit III

Holography and Astronomical Spectroscopy: Holography: Principle, construction and reconstruction of a hologram. Coherence requirements. Plane and volume holograms (qualitative). Applications.**Astronomical Spectrophotometer**: Photometry concept, Astronomical Photometer and its components, CCD astrophotography, optical telescopes: refracting ad reflecting (Newtonian and Cassegrain). Radio Telescope. Instrumentation for the solar studies: Solar Telescopes and Spectroscopes.

10 hours

Unit IV

Vibrational Spectroscopy: Infrared Spectrophotometry: Instrumentation, Sample handling. Radiation sources, Detectors, Spectrophotometers, FT – Spectrometers.
Raman Spectrometry: Laser sources, Detectors, Laser Raman Spectrometer, Sample Handling, Polarization Measutrements 10 hours

Unit V

Resonance Spectroscopy:

Microwave Spectrophotometry: Brief account of microwave sources, wave guides, detectors. Video, Source modulation and Stark modulation spectrometers. Microwave spectroscopy of mm and sub mm region.**Electron Spin Resonance (ESR) Spectrophotometry**: Basic Principle, Spectrometer, Spectra, hyperfine-interaction, g-factor, line widths. Interpretation of EPR spectra of free radicals.

Nuclear Magnetic Resonance (NMR) Spectrophotometry: Principle, types of spectrometers (cw & FT). Relaxation processes, chemical shifts.Continuous time LTI systems. z- transform: definition and properties, inverse z – transform, discrete LTI systems

10 hours

Text Books

1. Instrumental Methods of Analysis : H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
2. Spectroscopy – Vols. 1 To 3 (Ed) : B. P. Straughan and S. Walker, Chapman & Hall, London (1976)
3. Principles of Instrumental Analysis (5^{th} Ed): D. A. Skoog, F. J. Holler & T. A. Nieman, Harcourt Asia Pte. Ltd. (1998).
4. Optical Electronics : A Ghatak & K. Thayagarajan, Foundation Books, New Delhi (1991)
5. Microwave Spectroscopy of Gases : T. M. Sudgen and C. N. Kenny, D. Van Nostrand Co. Ltd London (1965)
6. Introductory Astronomy & Astrophysics: Zeilik & Gregory, Sounders College Pub. (1978)
7. The Planet Observer's Hand Book : Fred W. Price, Cambridge Univ Press (2000)
8. The Flammarion Book of Astronomy : Flammarion, George Allen & Unwin, London (1964)
9. Fundamentals of Molecular Spectroscopy : C. N. Banwell, Tata Mc Graw-Hill Co. (1983)

Reference Books:

1. Raman Spectroscopy : D. A. Long, Mc Graw-Hill Intl. Co. (1977)

2. Experimental Spectroscopy : R. A. Sawyer, Prentice – Hall, N. Y. (1951)
3. Chemical Spectroscopy (2nd ed) : W. R. Brode, Wiley, N. Y. (1943)
4. Optical Holography : R. J. Collier, C. B. Burckhardt & L. Lin, Academic Press (1971)
5. Radio Exploration of the Planetary System : Alex G. Smith & T. D. Cart, Affliated East West, New Delhi (1968)
6. Astronomy for Everybody: Robert H. Baker, Van Nostrand. N. Y. (1950)
7. Astronomical Spectroscopy : A. D. Thackeray, Eyre & Spottiswood Ltd. (1961)
8. Spectroscopy (Atomic & Molecular); Gurudeep Chatwal Sham Anand, Himalaya Pub. House (1987).

Specialization: 24MScPHST44: Condensed Matter Physics - III

Teaching hours per week: 4
No. of Credit: 4

Unit I

Semiconductor Devices: p-n junction in equilibrium: Space charge region, barrier potential, barrier thickness, contact field, junction capacitance and its determination, potential diagram of p-n junction. p-n junction in non – equilibrium: generation and recombination current. Continuity equations, current voltage relation, saturation current, tunnel diode, Gunn diode, LED and photodiode. Semiconductor lasers: homojunction diode laser, double heterostructure diode laser,

08 hours

Unit II

Low-dimensional semiconductor structures: MOSFET, Inversion layer, quantum well. Modulation doping, quantum wire, quantum dot and superlattice. Two – dimensional electron gas, energy levels and density of states expression. Quantum Hall effect. Fractional Quantum Hall Effect. **Thin Film Physics:** Introduction to epitaxial growt h. Preparation of thin films: Spray pyrolysis and spin coating methods. Chemical vapor deposition, MOCVD, MBE and thermal evaporation methods. RF DC magnetron sputtering deposition method. **Thickness measurements:** Electrical methods, (resistivity and capacitance measurements), Optical methods (optical absorption and interference) and vibrating quartz method. **Properties:** electrical conductivity, I-V characteristics, optical properties and determination of optical constants. Application of thin films as a gas sensor.

10 hours

Unit III

Superconductivity: Review of superconductivity. Heat capacity and energy gap, microwave and infrared properties, high T_C superconductors, perovskite structures, structure and properties of cuprate superconductors BCO. Thermodynamics of superconductivity, London equations, coherence length, flux quantization in superconducting ring, duration of persistent current. **Tunneling:** Basic concepts of tunneling, metal-insulator tunneling, metal-insulator-superconductor tunneling, superconductor-insulator-superconductor tunneling, Cooper-pair tunneling. A. C. and D. C. Josephson effect, macroscopic quantum interference. D C SQUIDS.

12 hours

Unit IV

Spintronics: Overview of spin electronics; Classes of magnetic materials; Quantum Mechanics of spin; Spin-orbit interaction; Exchange interaction; Spin relaxation mechanisms; Spin-dependent transport; Spin transfer torques; Current-driven switching of Magnetization and domain wall motion; Spin injection, Silicon based spin electronic Devices, Spin photo electronic devices, Nanostructures for spin electronics, Spintronic Biosensors, Spin transistors, Quantum Computing with spins. 10 Hours

Unit V

Quantum dynamics: Physics of solar cell and organic electronics

Basic principles of Photovoltaics; characteristics of the photovoltaic cell; Semiconductor Physics: generation and recombination of electrons and holes, Junctions; analysis of Junctions; Silicon solar cells; thin film solar cells; third generation solar cells; managing Light; Thermodynamic limit to efficiency-The Shockley-Queisser limit; Advanced Strategies for high efficiency solar cells; Organic semiconductor device physics; Semiconducting polymer Physics; Organic Transistors; Advanced materials for organic electronics; Organic Photovoltaics; Organic Light emitting diodes; Fabrications techniques for organic electronics. 10 Hours

Text Books:

1. Elementary Solid State Physics : M.A. Omar, Addison – Wesley Pvt.Ltd., New Delhi (1993).
2. Solid State Physics : N. W. Aschroft and A. S. Mermin, Saunders College Publishing, New York (1976).
3. Solid State and Semiconductor Physics : J. P. McKelvey, Harper and Row, New York (1966)
4. The Physics of Low Dimensional Semiconductors : J. H. Davies. Cambridge University press, (1998)
5. Introduction to nanotechnology, C.P.Poole Jr. and F.J.Owens, John Wiley and Sons, Singapore(2006)
6. Nano: The Essentials: T. Pradeep, Tata McGraw-Hill Publishing New Delhi (2007).
7. Physics of Thin Films : L. Eckertova, Cambridge University Press, Cambridge (1998)

Reference Books :

1. Solid State Physics :A. J. Dekker, Macmillan India Ltd., Bangalore (1981).Thin Film Phenomena : K. L. Chopra. Mc Graw – Hill Book Company, New York (1969).
2. Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat,(Kluwer, 2003)
3. Nanostructured Materials and Nanotechnology,(Ed) H.S.Nalwa, (Academic,2002)

Specialization: 24MScPHSP44: Nuclear & Particle Physics-III

Teaching hours per week: 4

No. of Credit: 4

Unit I

Nuclear Fission: Bohr-Wheeler theory of nuclear fission, saddle point, scission point, barrier penetration, shell correction to the liquid drop model, strutinsky's smoothing procedure, evidence for the existence of second well in fission isomers. Nuclear fission with heavy ions. Nuclear fission-fission time scale. **Nuclear Fusion**: Qualitative discussions on fusion reactions. **Slowing down of Neutrons:** Slowing down of neutrons by elastic collisions – logarithmic decrement in energy, number of collisions for thermalization, slowing down power, moderating ratio.

10 hours

Unit II

Neutron diffusion : Elementary theory of diffusion of neutrons- spatial distributions of neutron flux (I) in an infinite slab with a plane source at one end (II) in an infinite medium with point source at the center – reflections of neutrons – albedo.

Reactor Theory : Slowing down density, Fermi age equation correction for absorption, resonance escape probility, the pile equations. The buckling-critical size for spherical and rectangular piles, Classification of reactors, thermal neutron and fast breeder reactors.

10 hours

Unit III

Beta decay: Review of Fermi's theory of beta decay. Effect of finite mass of neutrino on shape of the beta spectrum. Classification of beta transition on the basis of ft values, selection rules and shapes of beta spectra. Universal Fermi interaction. Parity non – conservation in weak interaction – experimental verification (C.S. Wu experiment). Double beta decay, beta delayed nucleon emission.

10 hours

Unit IV

Gamma decay: Qualitative discussion of multiple radiation, selection rules, determination of gamma decay transition probability for single particle transition in nuclei- Weisskopf's estimates – comparison with experimental values, the angular correlation for dipole-dipole transitions, gamma-gamma correlation studies. Polarization of gamma radiation.

10 hours

Unit V

Skill enhancement: Instrumentation:

Detectors: Scintillation Detectors-NaI(Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li ion drifted detectors**. Nuclear Electronics:** photomultiplier tubes, preamplifiers: charge sensitive and voltage sensitive preamplifiers.

Linear pulse amplifier, Single channel analyser, analog to digital convertor, Multi-channel analyser, **Accelerators:** Basic components of accelerators, Ion sources: duoplasmatron ion source, ECR ion source. Principle, Construction and Working of Pelletron accelerator, Cyclotron accelerator. 10 hours

Text Books:

1. Structure of the Nucleus: M.A. Preston and R.K. Bhaduri Addision- Wesley (1975).
2. Atomic and Nuclear Physics Vol. II: S.N. Goshal. S. Chand and Company (1998).
3. Introductory Nuclear Physics : Kenneth S. Krane, John Wiley and sons (1998).
4. Subatomic Physics: Nuclei and Particles (Volume-II): Luc Valentin North Holland (1981).
5 . Techniques for nuclei and particles – W.R. Leo, Springer Verlag (1987).
6. Radiation detection and measurement: Glenn .F. Knoll, John Wiley and sons (1995).
7. Principles of charged particle acceleration: S. Humphris, John Wiley (1986).

Reference Books :

1. Theoretical Nuclear Physics: J.M. Blatt and V.F. Weisskoff, Wiley (1992).
2. Subatomic Physics (Second Edition): Hans Frauenfelder and E.M. Henley, Prentice Hall (1991).
3. Introduction to Nuclear Physics: Herald. A. Enge, Addition-Wesley (1983).
4. Introductory Nuclear Physics: Samuel S.M. Wong, Prentice –Hall (1996).

Specialization: 24MScPHST44: Electronics III

Teaching hours per week : 4
No. of Credit: 4

Unit I

Microprocessor Architecture: Introduction, microprocessor and its operations, architecture of 8085 microprocessor, memory, input and output devices, basic interfacing concepts, memory interfacing, interfacing input and output devices.

10 hours

Unit II

Programming of 8085 : Introduction, instruction classification, instruction format, over view of instruction set of 8085, data transfer operations, arithmetic operations, logic operations, branch operation ; Instructions for Looping, counting, and indexing, additional data transfer instructions, 16-bit arithmetic operation, logic operations : rotate, compare ; stack, subroutine, conditional call and return instructions.

12 hours

Unit III

Interfacing peripherals and applications: The 8085 interrupt, multiple interrupts and priorities, additional 8085 interrupts: TRAP, RST 7.5, 6.5 and 5.5, triggering levels, additional I/O concepts, DMA; Interfacing A/D and D/A converters, handshaking and polling, the 8155 multipurpose programmable interfacing device; Applications of 8155: interfacing 7-segment display, the 8155 timer as square wave generator

10 hours

Unit IV

Microcomputer organization: Contemporary multilevel Machines,

Evolution of multilevel systems, microprogramming, operating system, growth of computer architecture, CPU organization, design principle of modern computers, RISC and CISC systems, instruction level parallelism, and processor level parallelism. Primary memory; error correction codes, cache memory, memory packaging and types. Secondary memory: memory hierarchies, different types of storage devices, IDE, SCSI and RAID disks, Input and output devices.

10 hours

Unit V

Computer networks and Internets : Introduction, network structure and architecture, OSI reference model, services, network standardization, transmission media, transmission switching, ISDN network, LAN and WAN networks, ALOHA and LAN protocols ; Application layer : file transfer, access, and management, electronic mail, internet service

10 hours

Text Books :

1. Microprocessor Architecture, Programming, and Applications with
   8085/8080 A : Ramesh S. Gaonkar, New Age International Publishers Ltd. (1995).
2. Computer Networks : Andrew S. tanenbaum, Prentice Hall of India, New Delhi (1996)
3. Microcomputer theory and Applications : Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987)
4. Structured Computer Organization 4^{th} Edition : Andrew S. Tanenbaum, Prentice Hall of India, New Delhi (1999)
5. Introduction to Microprocessors (3^{rd} Edition) : Aditya P. Mathur, Tata – Mc Graw – Hall Publishing Company Ltd., New Delhi (1989)

Reference Books :

1. An introduction to digital computer design 4^{th} Edition : V. Rajaraman, Prentice Hall of India, New Delhi (2000)
2. Digital Logic and Computer design : Morris Mano, Prentice Hall of India, New Delhi (2000)
3. Digital Computer Fundamentals: Thomas C. Bartee, Mc Graw Hill, Kogakusha, Tokyo (1977).

Specialization: 24MScPHSP44: Atomic, Molecular and Optical Physics – III

Teaching hours per week : 4

No. of Credit: 4

Unit I

Molecular Symmetry: Point Groups, symmetrically equivalent atoms; simple triatomic molecules (C_2v, C_3v),Rotational Spectra: Classification of molecules as rotors: Linear, Symmetric top,Spherical top, Asymmetric top molecules. Energy levels: IR and Raman spectra.

10 hours

Unit II

Molecular Vibrations: Separation of rotational and vibrational motions; the secular equation for small vibrations (classical treatment). Normal modes of vibration. Normal coordinates. Simple illustrations. Factorization of secular equation; determination of number of normal co ordinates (symmetry species). The Secular equation in symmetry co-ordinates. Simple molecules (bent-symmetric XY_2 / pyramidal XY_3)

10 hours

Unit III

Vibrational Energy levels and Selection Rules: The Schrodinger's vibrational wave equation. Energy levels, Vibrational Spectra and Degeneracy. Symmetry properties of wave functions, overtones, combinations, components of electric Dipole Moment, and the Polarizability. Selection Rules for Infrared and Raman Spectra. The rule of mutual exclusion. Types of Force Fields; Group frequencies; the Product rule; Fermi resonance.

10 hours

Unit IV

Electronic Structure & Spectra: Classification of Electronic States based on angular momentum, spin, multiple components. Types of electronic transitions; Allowed transitions, general selection rules spin selection rules. Forbidden transitions: Magnetic and electric quadrupole transitions. Transitions due to vibronic and rotation electronic interactions.

10 hours

Unit V

Treatment of Molecular Orbitals: The Virial and Hellmann- Feynman theorems. Outline of Hartree – Fock SCF for molecules mathematical formulation, Roothaan equations, basis functions. The SCF MO treatment of water molecule. Concept of hybridization and hybrid orbitals.

10 hours

Tex Books

1. Molecular Vibrations : E.Bright Wilson, J. C. Decius, P. C. Cross, Dover Pub., Inc., N.Y. (1955)
2. Introduction to the theory of Molecular Vibrations and Vibrational Spectroscopy : a, Clarendon Press, Lon, (1976)
3. Vibrational Spectroscopy – Theory and Applications : D. N. Sathyanarayana, New Age International Pub., New Delhi (1996)
4. Fundamentals of Molecular Spectroscopy : C. N. Banwell, Tata Mc Graw-Hill, New Delhi (1983)
5. Atoms & Molecules : Mitchel Weissbluth, Academic Press, N. Y. (1978)
6. Molecular Spectra and Molecular Structure Vol. III-Electronic Spectra & Electronic Structure of Polyatomic Molecules : G.Herzberg, D. van Nostrand & Co. N. J. (1966)
7. Quantum Chemistry : Ira Levine, Prentice – Hall of India Pvt. Ltd., New Delhi (1991)

Reference Books:

1. Molecular Spectra and Molecular Structure Vol. II-Infrared & Raman Spectra of Polyatomic Molecules : G. Herzberg, D. van nostrand & Co. N. J. (1945)
2. Introduction to Infrared and Raman Spectroscopy : N.B. Colthup, L. H. Daly and S.E. Wiberley, Academic Press, N. Y. (1975)
3. Vibrating Molecules : P. Gans, Chapman & Hall, London (1971).
4. Vibration Spectra and Structure Vol. 4: (Ed) J. R. Durig, Elsevier Sci. Pub. Co. N. Y. (1975)
5. Physical Chemistry (2^{nd} Ed) : R. Stephen Berry, Stuart A. Rice & John Ross, Oxford Univ. Press, N. Y. (2000).

Specialization Practical

24MScPHSP45: Practical – Condensed Matter Physics – III

Each practical is of 4 hrs per week and with 4 Credits

1. Determination of Hall coefficient and mobility of charge carriers in metals.
2. Effect of temperature on Hall coefficient and mobility in metals.
3. Study of Magnetoresistance effect in Bismuth.
4. Study of Magnetoresistance effect in semiconductors.
5. Thermal expansion of solids.
7. Magnetostriction study in Fe, Ni, Co and Cu using Michelson Interferometer.
9. Defect formation energy in metals.
10. Ferroelectric phase transition and dielectric study in TGS single crystals.
11. Phase transition study in ferroelectric crystal $BaTiO_3$ and Curie temperature determination.
12. Solar cell characteristics, fill factor and efficiency study.
13. Effect of temperature on Hall coefficient and mobility in semiconductors.
14. Measuring the Resistivity of Very Low to Highly Resistive Samples at Different Temperatures using Four Probe Set-Up

(Minimum of 80% of the listed experiments per paper should be performed).

References Books:

1. X-ray Diffraction: B. D. Cullity, Addison – Wesley, New York (1972).
2. X-ray Diffraction Procedures H.P. Klug and L.E. Alexander, John Wiley and Sons inc. New York.
3. Interpretation of X-ray Powder Diffraction Pattern. H. P. Lipson and H. Steeple, Macmillan, London (1968)
4. Elementary Solid State Physics: M.A. Omar, Addison –Wesley Pvt.Ltd., New Delhi (1993).
5. Elementary Solid State Physics : C.Kittel, Wiley Eastern Ltd., Bangalore(1976).
6. Introduction to Magneto chemistry: A. Easrnshaw, Academic press, London (1968).

24MScPHSP45: Practical – Nuclear and Particle Physics – III

Each practical is of 4 hrs per week and with 4 Credits.

1. Determination of rest mass energy of electron using Scintillation detector.
2. Coincidence circuit.
3. Back scattering of beta rays.
4. Study of Scintillation detector.
5. Study of nuclear electronics.
6. Study of Gamma ray Spectrum.
7. Gamma-Gamma Coincidence studies.
8. Compton Scattering: Energy determination
9. Compton Scattering: Cross-section determination.
10. Neutron Activation Analysis measurement of the Thermal neutron flux.
11. Determination of energy of mu-mesons in pi-decay using nuclear emulsion technique.
12. Identification of particles by visual range in Nuclear Emulsion.
13. Study of Rutherford scattering.
14. To study the Solid state nuclear track detector.

Assignments.

15. Determination of Moseley's law.
16. Determination of nuclear radius parameter using Coulomb energy difference amongst mirror nuclei.

(Minimum of 80% of the listed experiments per paper should be performed).

References:

1. Experiments in modern Physics: A.C. Melissions, Academic Press (NY)(1966)
2. Experiments in Nuclear science, ORTEC Application note. ORTEC, (1971).
3. Practical Nucleonics: F.J. Pearson, and R.R. Osborne, E &F. N. Spon Ltd, London (1960).
4. The Atomic Nucleaus: R.D. Evans, tata Mc Graw Hill Pub. Comp. Ltd. (1960).
5. Nuclear Radiation Detectors: R.D. Kapoor and V.S. Ramamurthy, Wiely Eastern Limited (1986).
6. Experimental Nucleonics: E. Bleuler and G.J.Goldsmith, Rinehart & Co. Inc (NY) (1958).
7. A manual of experiments in reactor physics: Frank A. Valente the Macmillan company (1963).

24MScPHSP45: Practical – Electronics – III

Each practical is of 4 hrs per week and with 4 Credits

Experiments on the following topics will be set:

1. Programming of 8085 microprocessor.
2. Study of 8085 interfacing techniques.
3. Communication experiments using optical fiber kit and microwave bench.
4. C – programming

(New experiments may be added)

References:

1. Microprocessor Architecture, Programming, and Applications with 8085/8080 A : Ramesh S. Gaonkar, New Age International Publishers Ltd. (1995)
2. Computer Networks: Andrew S. Tanenbaum, Prentice Hall of India, New Delhi (1996).
3. Microcomputer theory and Applications: Rafiquzzaman Mohamed, John Wiley and Sons, New York (1987).
4. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
5. Digital Computer Fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
6. Digital Logic and Computer Design: Morris Mano., Prentice Hall of India Pvt. Ltd., New Delhi (2000).
7. Programming in ANSI – C (2^{nd} Edition); E. Balgurusamy, Tata-McGraw- Hill Pub. Company, New Delhi (1992).

24MScPHSP45: Practical – Atomic, Molecular & Optical Physics – III

Each practical is of 4 hrs per week and with 4 Credits.

1. Photograph the Zn and Ca triplets on Small Quartz Spectrograph and verify Lande' Interval Rule by determining the wavelengths of the corresponding triplets.
2. Determination of Spatial & Temporal Coherence of He-Ne laser.
3. Rotational Analysis of 0,0 band of BeO.
4. Vibrational Analysis of CN.
5. Fiber end preparation and measurement of Numerical Aperture.
6. Measurement of Optical Fiber Attenuation.
7. Experiments on Optical Fiber Sensors.
8. Spectroscopy assignments in Computer Programming.

Reference Books:

1. Experimental Spectroscopy (3rd Edition): R. A. Sawyer. Dover Publication,Inc, New York (1963).
2. Practical Spectroscopy: G. R. Harrison, et.al. Prentice – Hall, New York(1948).
3. Practical Spectroscopy: C. Candler, Hilger and Watts Ltd., Glassgow, (1949).
4. Atomic Spectra and Atomic Structure (2nd Edition) – G. Herzberg. DoverPublication New York (1944)
5. Atomic Spectra – H.E. White, Mc Graw –Hill, New York (1934).
6. A Course of Experiments with He-Ne Lasers (2nd Edition): R. S. Sirohi.Wiley Eastern, New Delhi (1991).
7. Principles of Lasers: Svelto. O, Plenum Press New York (1982).
8. Lab. Manuals.
9. Molecular Spectra & Molecular Structure Vol. I : G. Herzberg, D. Van Nastrand Co, New York (1950)
10. Instrumental Methods of Analysis : H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Settle, J. K. Jain for CBS Publishers (1986)
11. The Identification of Molecular Spectra: R.W. B. Pears & A. G. Gaydon, Wiley, New York (1961).
12. Dissociation Energies and Spectra of Diatomic Molecules: A. G. Gaydon, Chapman and Hall, London (1947).
13. Fiber Optic Laboratory Experiments: Joel Ng.

Project

24MScPHSP46: Project-Condensed Matter Physics

24MScPHSP46: Project-Nuclear & Particle Physics

24MScPHSP46: Project-Electronics

24MScPHSP46: Project-Atomic, Molecular & Optical Physics

- Topic(s) for the Project may be selected in consultation with the Supervisor.
- The project topic shall be of relevance to the respective specialization subjects, which student is studying.

First/Third Semester M.Sc. Degree Examination, Month/Year

(CBCS- 2024-25: Regular)

PHYSICS

Title of the paper here

Duration: 3 Hrs.		Max. Marks: 80

Instructions: **Question No. 1 is compulsory**.

1.		**(5 x 4 = 20)**
	a)	
	b)	
	c)	
	d)	
	e)	
2.	a)	
	b)	
		(4+8)
	OR	
3.	a)	
	b)	
		(4+8)
4.	a)	
	b)	
		(4+8)
	OR	
5.	a)	
	b)	
		(8+4)
6.	a)	
	b)	
		(4+8)
	OR	

7.	a)	
	b)	
		(4+8)
8.	a)	
	b)	
		(4+8)
	OR	
9.	a)	
	b)	
		(4+8)
10.	a)	
	b)	
		(4+8)
	OR	
11.	a)	
	b)	
		(4+8)

Instruction to set the question paper.

1. Question number 1 has 5 sub questions, one question each from five units.
2. Question number 2 and 3 are from unit I.
3. Question number 4 and 5 are from unit II.
4. Question number 6 and 7 are from unit III
5. Question number 8 and 9 are from unit IV.
6. Question number 10 and 11 are from unit V.
7. Wherever necessary, appropriate number of problems may be asked for Five marks
8. Student has to answer either question number 2 or 3, 4 or 5, 6 or 7, 8 or 9 and 10 or 11.
   Note: In case student answered both the questions from the same unit in full or part, highest marks from any one choice has to be considered.

RANI CHANNAMMA UNIVERSITY,

Vidyasangama, PB-NH-4, Bhutaramanahatti,

BELAGAVI – 591 156

M.Sc., Physics Course

STRUCTURE AND SYLLABUS

as per Revised Curriculum Framework (CBCS) for Post Graduate Course

I to IV Semesters

With Effect from the Academic Year 2024-25