RANI CHANNAMMA UNIVERSITY, BELAGAVI

Department of Physics (CBCS)

(w.e.f 2016-17)

Course Structure and Scheme of Examination

I SEMESTER – MASTER OF SCIENCE

Sl. No	Subject Code	Subject Title	Teaching Scheme Hours / Week		Examination				Student contact hours	Credits
			Theory	Practical	Duration (hrs)	I.A. Marks	Theory/ Practical	Total Marks		
1	16MScPHCT11	Mathematical Methods in Physics	04	-	03	20	80	100	04	04
2	16MScPHCT12	Classical Mechanics	04	-	03	20	80	100	04	04
3	16MScPHCT13	Nuclear and Particle Physics (General)	03	-	03	20	80	100	03	03
4	16MScPHCT14	Condensed Matter Physics (General)	03	-	03	20	80	100	03	03
5	16MScPHCT15	Instrumentation	02	-	1.5	10	40	50	02	02
6	16MScPHCP16	Practical-I (Nuclear and Particle Physics)	-	03	03	20	80	100	03	02
7	16MScPCP17	Practical-II (Condensed Matter Physics)	-	03	03	20	80	100	03	02
8	16MScPHSS18	Self Study: Errors and Measurements/ FORTRAN Programming.		04	---	100	--	100	02	02
TOTAL			**16**	**10**		**210**	**520**	**750**	**24**	**22**

SYLLABUS

I SEMESTER

Course 16MScPHCT11: Mathematical Methods of Physics

Teaching hours per week : 4

No of credits : 4

Unit I

Special functions : Separation of the Helmholtz equation in Cartesian, circularcylindrical 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, orthogonlity theorem, haracter 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

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).

Course 16MScPHCT12: Classical Mechanics

Teaching hours per week : 4

No of credits : 4

Unit I

Lagrangian Mechanics: Constraints, generalized co-ordinates, Alembert's principle, Lagrange equation from D'Alemberts Principle, Velocity dependent potentials and dissipation function. Applications of Lagrangian formulation. 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.

10 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

10 hours

Unit III

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. Torque free motion. Motion of symmetric top – Nutational motion.

10 hours

Unit IV

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

10 hours

Unit V

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

08 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).

Course 16MScPHCT13: Nuclear and Particle physics (General)

Teaching hours per week 3
Number of credits 3

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. **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 IV

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 V

Interaction of radiations with Matter: 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**: Energy loss of heavy charged particles and electrons by ionization and radiations processes. Application of stopping power.

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)

Course 16MScPHCT14: Condensed Matter Physics (General)

Teaching hours per week 3

Number of credits 3

Unit I

Crystal Structure: Lattice translational vectors and lattices, basis and crystal structure, primitive and non-primitive cells, Wigner-Seitz cell; fundamental types of lattices, Miller indices, Crystal planes and directions. Symmetry elements, point groups and space groups (qualitative). Examples of simple crystal structures, NaCl, CsCl, HCP structure, Diamond, cubic ZnS and Hexagonal ZnS (Quartzite) structure. **Reciprocal lattice and Crystal diffraction:** Interpretation of Reciprocal Lattice. Reciprocal lattices of SC, BCC and FCC. Diffraction condition and Bragg's law in reciprocal space, Ewald construction, Laue equations, Brillion zones. Atomic form factor, structure factor and its calculations in base centered, body center and FCC cubic cell. Experimental methods of x-ray diffraction, Laue, rotating crystal and Debye -Scherer powder method

10 Hours

Unit II

Crystal binding: Interatomic 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.

8 Hours

Unit III

Free electron model of metals: Free electron Fermi gas in three dimensions, Fermi surface. Fermi-Dirac distribution. Heat capacity of electron gas. Electrical conductivity and Ohm's law, Mattheissen's rule. Thermal conductivity, Weidman Franz law. **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. Intrinsic carrier concentrations, position of Fermi level. Electrical conductivity and mobility and their temperature dependence. Energy gap determination.Hall effect in semiconductors.**Superconductivity:** Occurrence of superconductivity. Destruction of superconductivity by magnetic field. Meisner effect. Type I and Type II superconductors. **Magnetic properties :** Review of basic formulas, Magnetic susceptibility, Classification of 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.

12 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).

Course 16MScPHCT15: Instrumentation

Teaching hours per week 2

Number of credits 2

Structural and composition characterization: Basics of X – ray diffraction (XRD), grazing incidence and powder XRD, Transmission Electron Microscope Scanning Electron Microscope, Energy dispersive X – ray analysis, X – ray photoelectron Spectroscopy, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM) EELS.

Optical spectroscopy and Raman Spectroscopy: Review of molecular and vibrational spectroscopy. Fourier Transform Infrared Spectroscopy (FTIR), UV- Vis. Spectroscopy, and Raman Spectroscopy. Raman effect - classical theory, elementary quantum theory, pure rotational Raman spectra - linear molecules, vibrational Raman spectra polarization of light and Raman effect, techniques and instrumentation of Raman and IR spectroscopy, structure determination by IR and Raman spectroscopy - simple examples, fundamentals of SERS.

Electric and thermal measurements: a.c. and d.c.electrical conductivity measurements as a function of temperature and frequencies. Magneto resistance measurements, specific heat measurements, Impedance spectroscopy: A.C. impendence spectroscopy, Thermo Gravimetric analysis (TGA), differential thermal analysis (DTA) and differential scanning calorimetric (DSC) analysis.

Nuclear Detectors: Scintillation detector-NaI(TI) gamma ray spectrometer, ; Principle, working and energy resolution. Semiconductor detectors.

Text Books:

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 Joachim C.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 No strand Co. Princeton, J. J. (1945)

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

6. Fundamentals of Molecular Spectroscopy: C.N.Barnwell and E.M.McCash, Tata Mc Graw-Hill Co., 4th revised edition, (9th reprint, 2000).

7. Elementary Solid State Physics: M.A.Omar, Addison Wisely Pub.Ltd. New Delhi (1993).
8. Introduction to Solid State Physics: C.Kittel, Wiley Eastern Ltd. Bangalore, (1976).
9. X-ray Diffraction: B.D.Cullity, Addison-Wisley Ltd. New York (1972).
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. Melissinosacademic press (NY)(1966).

Course 16MScPHCP16: Practical-I (Nuclear and Particle Physics)

Each practical is of 3 hours per week and with 2 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. Countr 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).

Course 16MScPHCP17: Practical-I (Condensed Matter Physics)
Each practical is of 3 hours per week and with 2 Credits

1) Analysis of X-ray diffraction Pattern.

2) Thermistor characteristic and its energy gap determination.

3) Determine the plank's constant with different wavelengths by reverse photo electric effect.

4) Measurement of Hall coefficient in semiconductor and estimation of charge carrier concentration, carrier density mobility and type of semiconductor.

5) Determination of energy gap by reverse saturation current in a pn-junction.

6) Structure factor calculation of simple crystal structure (assignment).

7) Measurement of resistivity of a semiconductor by four probe method at different temperatures and determination of band gap.

8) Determination of Fermi energy and Fermi temperature of copper and silver.

9) Indexing of cubic system.

10) Determination of e/k_b .

11) Defect formation energy in metals.

12) Electrical conductivity of ionic solids (NaCl) and determination of vacancy formation energy.

Course 16MScPHCP18: Self Study

No. of hours per week: 2
No. of credits: 2

Errors and Measurements

Uncertainties in Measurement: Measuring errors, Uncertainties parent and Sample distribution, Mean and standard deviation measurements

Probability Distributions: Binomial, Poisson, Gaussian or normal error

Error Analysis: Instrumental or statistical Uncertainties, Propagation of Error, Specific error formulas, Application of error equations

Estimation of Mean and error: Method of least squares, Statistical fluctuations, Probability test, Chi-square test of distribution

Monte –Carlo techniques: Introduction, random number, random numbers from probability distributions, specific distributions,

Least Square fit for a straight line: Dependent and Independent Variable, Method of least squares, Minimising Chi- square, error Estimation, limitations, Alternate methods

Least Square fit for a polynomial: Determinant solutions, Matrix solution, Independent parameters , non linear functions.

Testing the fit: Chi-square test for goodness of fit, linear correlation co-efficient, multivariable correlation, F test, Confidence interval

Book: Data reduction and error analysis for the physical sciences, 3rd Edition, Philip Bevington, D Keith Robinson, McGraw Hill publication, 2003

FORTRAN PROGRAMMING

FORTRAN programming language; Basic data types; variables and constants; Arithmetic expression; Assignment statement; I/O statement (Format free);
STOP & END statement; Constructions of simple FORTRAN Program. Arithmetic statement Functions; Library function in FORTRAN.
Control statements; Unconditional GOTO; Computed GOTO, Logical IF and Arithmetic IF. Subscripted variables; Arrays and DO statement; DIMENSION statement; CONTINUE statement

FORTRAN Programs of

1. Sum of the series
2. Largest and Smallest of Three given numbers
3. Roots of a quadratic equation with real coefficients
4. H.C.F. and L.C.M. of two integers
5. Numerical Integration : (a) Trapezoidal rule (b) Simpsons's 1/3 rule and
6. Five other programs given the course teacher

References:

1. F. B. Hildebrand –Introduction to Numerical Analysis (MacGraw Hill)
2. J. B. Scarborough – Numerical Mathematical Analysis (The Johns Hopkins Press) S. S. Sastry – Elementary Numerical Analysis
3. A. Gupta and S. C. Bose – Introduction to Numerical Analysis (Academic Press)
4. Hadley – Linear Programming 6. Gauss – Linear ProgrammingV. Rajaraman – Fortran – 77
5. P. S. Grover – Fortran