RANI CHANNAMMA UNIVERSITY, BELAGAVI

Department of Physics (CBCS)

(w.e.f 2016-17)

Course Structure and Scheme of Examination

III SEMESTER – MASTER OF PHYSICS

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		
Compulsory Courses										
1	16MScPHCT31	Statistical Mechanics	04	-	03	20	80	100	4	04
2	16MScPHCT32	Classical Electrodynamics	04	-	03	20	80	100	4	04
Specialization Courses										
3	16MScPHST33	Electronics -I/ Condensed Matter Physics-I/ Atomic, Molecular & Optical Physics-I/ Nuclear and Particle Physics-I	04	-	03	20	80	100	4	04
4	16MScPHSP34	**Practicals:** Electronics -I/ Condensed Matter Physics-I/ Atomic, Molecular & Optical Physics-I/ Nuclear and Particle Physics-I (along with the specialization practicals, C programming also to be carried out)	-	03	03	20	80	100	03	02
5	16MScPHSP35	**Practicals:** Electronics -I/ Condensed Matter Physics-I/ Atomic, Molecular &	-	03	03	20	80	100	03	02

		Optical Physics-I/ Nuclear and Particle Physics-I								
6	16MScPHPP36	**Project preliminary:** Preliminary work for the final year project	-	02	--	100	--	100	02	01
7	16MScPHSS37	Self Study: Laser Physics/Optical Fiber/ Ferromagnetic Materials/Nuclear waste management/ Advanced Instrumentation/ Advanced Material Science/Nuclear Instrumentation/Microprocessor/advanced spectroscopic techniques/plasma Physics/Astrophysics/Vacuum technology/Density Function Theory		04	---	100	--	100	02	02
Open Elective Courses										
8	16MScPHOT38	Physics of Nano Materials (OEC)	04	-	03	20	80	100	4	04
TOTAL			**16**	**12**		**320**	**480**	**800**	**28**	**23**

III SEMESTER

Course 16MScPHCT31: 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. **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 & General interactions, Quasi – static processes, Quasi – static work done by pressure, Exact & inexact differentials.

08 hours

Unit II

Statistical Thermodynamics: Irreversibilty & 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: Ensemble representation: Isolated system, System in contact with heat reservoir, Simple applications of canonical distribution, Systems with specified mean energy, Calculation of mean values in a canonical ensemble, Connection with thermodynamics, Ensemble used as approximations, Grand canonical & other ensembles, alternative derivation of the canonical distribution. **Simple applications of Statistical Mechanics:** Partitions, functions & their properties, ideal monatomic gas (calculation of thermodynamic quantities), Gibb's paradox, Validity of classical approximation, Equipartition theorem(Proof & simple application)

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. **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.

12 hours

Unit V

Irreversible Processes & Fluctuations: Brownian Motion, Langevin equation, Calculation of mean square displacement, Relation between dissipation & fluctuation force, Correlation function & the friction constant, Calculation of mean square velocity increment, velocity correlation function & mean square displacement, Fokker – Planck equation. Fourier Analysis, Ensemble & time averages, Wiener – Khintchine relations, Nyquist's theorem, Nyquist's theorem & equilibrium conditions, Fluctuations & Onsager relations.

10 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 (2^{nd} 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).

Course 16MScPHCT32: 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 filed 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 filed.

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

(7+3) hours

Unit IV

Wave guides: Fields at the surface and within a conductor, cylindrical cavities and wave guides, modes in rectangular wave guide. **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.

(2+6) 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.

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 COURSES

Course 16MScPHCT33: 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)

Course 16MScPHCT33: Condensed Matter Physics - I

Teaching hours per week : 4

No. of Credit: 4

Unit I

Periodic Structures : Reciprocal lattice and its properties, periodic potential and Bloch theorem, reduction to Brillourin zone, Born-von Karman boundary conditions. Number of states in the band. **Electron States :** Nearly free electron model, discontinuity at zone boundary, energy gap and Bragg reflection. Tight binding method, band width and effective mass in linear lattice and cubic lattices. APW and **k.p.** methods of band structure calculations.

10 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 frequency and mass, cyclotron resonance. 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, extremely orbits.

10 hours

Unit III

Lattice Vibrations: Review of one dimensional monatomic and diatomic lattice vibrations (qualitative discussion). Normal modes of three dimensional monatomic lattice, symmetry in q-space : the first Brillouin zone (three-dimensional). Density of states of a lattice. Specific heat: Exact theory. Thermal conductivity, **Scattering of X-rays, neutrons and light by phonons**: Inelastic x-ray scattering, neutron scattering by a crystal, zero-phonon scattering, one-phonon scattering and two-phonon scattering. Light scattering; Brillouin and Raman. Microwave ultrasonics. Lattice optical properties in the infrared. The polariton.

10 hours

Unit IV

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 V

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.

14 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).

Course 16MScPHCT33: : Atomic, Molecular & 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)

Course 16MScPHCT33: : Nuclear & 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. Non existence 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 (Qualitative) Meson theory of nuclear force: Yukawa and pseudo scalar theory, one pion exchange potential.

10 hours

Unit IV

Elementary Particles: Pion –nucleon scattering and its resonances. Strange particles: Associated production-strangeness quantum number, Gell –Mann and Nishijima formula, Kaons, lambda, sigma, and omega hyperons

10 hours

Unit V

Interactions and their Unification: Fundamental interactions conservation laws, quark model, colour quark and gluons, quark dynamics, charm, beauty and truth quarks, GUT 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)

Course 16MScPHSP34: Practical Electronics - I

Each practical is of 3 hours per week and with 3 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)

Course 16MScPHSP34: Practical Condensed Matter Physics – I

Each practical is of 3 hours per week and with 3 Credits

1) Study the temperature dependence of resistivity of a semiconductor (Four probe method) and its energy gap determination.

2) Magnetic Susceptibility determination by Quinke's method.

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

11) Tracing BH curves for ferromagnetic materials and calculation of magnetic susceptibility.

12. 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
7. London (1968).

Course 16MScPHSP34: 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 forC.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).

Course 16MScPHSP34: Nuclear 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)

Course 16MScPHSP35: Electronics – II

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

Experiments based on the following topics will be set:

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)

1. **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).

Course 16MScPHSP35: Practical Condensed Matter Physics – II

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

Experiments based on the following topics will be set:

1) Structure Factor calculations.
2) d-spacing calculations.
3) Indexing of Tetragonal system.
4) Calculation of relative integrated intensity.
5) Indexing of Hexagonal system.
6) Determination of structure of CdTe.
7) Precise parameter determination by (a) extrapolation method and (b) Cohens's method.
8) Size and stress estimation of nano particles from the measured width of its diffraction pattern
9) X-ray structure analysis of small inorganic molecules and their vibrational structure from force-field calculations.
10) Determination of compressibility and bulk modulus of the liquid by ultrasonic method (experiment).
11) 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.

13) Magneto optic Faraday effect (Experiment),
14) 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).

Course 16MScPHSP35: 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)

Course 16MScPHSP35: Nuclear physics – II

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

Experiments based on the following topics will be set:

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)
.Op-Amps and Linear Integrated Circuits: Ramakanth A Gayakawad, Prentice-Hall of India (1995).

Course 16MScPHSP36: Project preliminary

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 three 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. The assessment shall be only through internal assessment component only (no final semester end examination).

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.

- Review of first semester Instrumentation syllabus.
- 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.
- The group of students shall only work on the topic decided during the final semester.

Course 16MScPHSP37: Self Study course

Fiber Optics:

Introduction to the optical fibre, comparison of optical fibre with other interconnectors. Concept

of an optical waveguide, rays and modes, principle of light guidance in optical waveguides, fibre types. Electromagnetic analysis of simple optical waveguide: Basic waveguide equation, propagation mode of symmetric step index planar waveguide, TE and TM modes of symmetric step index planar waveguide, mode cut-off condition, mode theory for optical fibre waveguide, scalar wave-equation and modes of fibre, modal analysis for step index fibre, WKB analysis for multi mode fibre, fractional power in the core modal analysis of parabolic index medium. Transmission characteristics of optical fibers: Attenuation and dispersion, linear and nonlinear scattering losses, fiber bending losses, Intramodal dispersion losses. Dispersion shifted and dispersion modified fibers. Fabrication of fibers. Fiber alignment joint losses, coupling losses, splices and connectors. Beam connectors and expanders, couplers, wavelength division multiplexing couplers. Fiber Bragg grating. Fiber optic network and distribution.

REFERENCES:

1. A. H. Cherin: An Introduction to Optical Fibres,(McGraw Hill, 1983).
2. A. Ghatak and K. Thyagrajan, Optical Electronics,[(Cambridge Univ. Press 1989).
3. G. Kaiser: Optical fibre communication (McGraw Hill, Book Company, 1989).
4. D. Marcuse: Theory of Dielectric Optical waveguides, (Academic press New York: 1972).
5. N.S. Kapani: Fibre Optics (Academic Press, New York, 1967).

Vacuum technology:

Introduction into Vacuum Technology.

Ideal Gas Law. Avogadro's Number and Boltzmann's Constant, Particle Density, Pressure (Dentition). Gas Properties, Kinetic Gas Behaviour. Mean Free Path, Velocity Distribution, Pressure Creation, Surface Impingement Rate, Monolayer Formation Time. Ideal and Real Gas: Gas Flow, Flow Regimes. Viscous Flow, Molecular Flow and Transition Regime.

Vacuum Systems—Overview: Vacuum Chamber,
Pumps, Roughing Pump, High Vacuum Pump. Vacuum Pump Principles.
Roughing Pumps:Rotary Vane Pump, Rotary Piston Pump, Roots Pump, Diaphragm Pump.
High Vacuum Pumps I—Kinetic Transfer Pumps, Diffusion Pump, Turbomolecular Pump, Turbomolecular Drag Pump
High Vacuum Pumps II—Entrapment Pumps. Cryogenic Pumps I—Cryopump, Cryogenic Pumps II—Meissner Trap. Getter and Sputter Ion Pumps. Titanium Sublimation Pump (TSP). Sputter Ion Pump.
Vacuum Seals: Elastomer Seals, Metal Seals

Vacuum Measurement and Analysis
Introduction into Pressure Measurement:
Direct-Reading Pressure Gauges: Bourdon Gauge. Diaphragm Gauge. Capacitance Manometer (“Baratron”).
Indirect-Reading Gauges—Thermal Conductivity Gauges: Pirani Gauge. Thermocouple Gauge.
Indirect-Reading Gauges—Ionization Gauges. Penning Gauge. Bayard-Alpert Gauge.
Flow Meter and Mass Flow Controller. Mass Flow Meter. Mass Flow Controller.
Residual Gas Analysis (RGA). Mass Spectrometry Basics.
Desorption and Leaks: Gas Release from Solids. Vaporization. Diffusion. Thermal Desorption. Stimulated Desorption. Permeation. Gas Release During High Vacuum Pumping.
Leaks and Leak Detection: Type of Leaks. Leak Detection.
Vacuum Pump Applications: Selection. Examples of Vacuum Systems Used in Research.

References:

1. O’Hanlon JF (2003) A user’s guide to vacuum technology, 3rd edn. Wiley, New York
2. Umrath W (2009) Fundamentals of vacuum technology. Oerlicon Leybold Vacuum, Cologne

LASER PHYSICS:
Properties of laser beams: Intensity, monochromaticity, coherence, directionality, and brightness.
Interaction of radiation with matter: Absorption & stimulated emission, line broadening mechanism, transition cross section, absorption & gain coefficient, gain saturation (homogenous and inhomogeneous broadened line). Continuous wave and transient laser behaviour: Rate equations(Four level and three level laser). CW laser behaviour, power in laser oscillator, optimum output coupling, single mode oscillation, reasons for multimode oscillations, spatial hole burning, spectral hole burning, Lamb dip and active stabilization of laser frequency, Frequency pulling, relaxation oscillations in single mode lasers. Optical resonator: Matrix formulation of geometrical optics, Fabry Perot interferometer, photon life

time and cavity Q, plane parallel resonator, confocal resonator, Gaussian beam propagation and ABCD law, generalized spherical resonators, unstable resonators. Gain switching and cavity dumping, Q-switching and mode locking.

REFERENCES:

I. K. Shimoda, Introduction to Laser Physics(Springer Verlag, Berlin, 1984)

2. M. Sargent III, M.O.Scully and W.E.Lamb. Jr. Laser Physics, Forth Printing. (Addison Wesley, Reading, 1982).

3. D.C.O.Shea. An Introduction to Lasers and Their Application (Addision -Wesley. Reading, 1978)

4. O.Svelto, Principles of Lasers, (Plenum, New York, 1982).

5. K. Thyagrajan and A.K.Ghatak, Laser: Theory and Applications. (McMillan India. New Delhi, 1984).

6. A.K.Ghatak and K.Thyagrajan, Optical Electronics,(Cambridge Univ. Press, 1989).

7. A.Yariv, Quantum Electronics, 2nd Edition (John Wiley, New York, 1975).

Course 16MScPHSP38: Physics of Nano Materials(OEC)

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

Unit I

Nanotechnology,Frontier of future- an overview

Length scales, Variation of physical properties from bulk to thin films to nanomaterials, - confinement of electron energy states (LDOS) in 0D, 1D,2D and 3D systems (qualitative treatment) ; Surface, size, shape and assembly effects.

Bonding and crystal structure in solids, colloids and core-shell structures. Chemical and molecular interaction, functionalziation, basis for biological self-assembly and self- organization.

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, micelles and reverse micelles; 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–II

Characterization:

X-ray Diffraction (including Debye-Scherrer method), Optical Spectroscopy – IR/UV/VIS, Raman, Photoluminescence, Electron Microscopy (SEM/TEM); Scanning Probes (STM, AFM), Particle Size Analyser-light Scattering, Electrical (I-V and C-V), Porosity (BET method), Zeta potential, nano-indentation.

- Electronic and optoelectronic properties: Ballistic transport, Coulomb blockade, Diffusive transport,
- Dielectric properties: Polarisation, Ferroelectric behavior.
- Optical Properties: Photoconductivity, Optical absorption & transmission, Plasmons and Excitons, Luminescence and Phosphorescence.
- Magnetic properties: Nanomagnetism, magneto-resistance; Super Para Magnetism
- Thermal and Mechanical properties: changes in thermal transport, thermal transition temperatures, and interfaces with dissimilar materials. Improved hardness and toughness of metals and alloys
- Biological: Permeability through biological barriers, molecular recognition and biological assemblies.

10 hours

UNIT-III:

General Applications:

- Electrical, Electronics & Photonics- Switching glasses, Semiconductor devices including LEDs and Solar Cells, Photonic Crystals.
- Computer Science- Storage devices and Quantum computing etc

- Mechanical and Civil: Composites and their properties.
- Environmental and Chemical: Porous materials, Catalysis, tracers etc
- Biotechnology- Interaction between bimolecular and nanoparticle surface, nano- bio assemblies, Nanosensors etc

Specific Applications:

· Carbon and its allotropes: Fullerenes (C_{60}), Carbon nanotubes and Graphene:
· Applications of Carbon Nanotubes: Field emission, Fuel Cells, Display devices, Hydrogen storage.
· Nano-Medicine: Developments and protocols for diagnostics, drug delivery and therapeutics.

- Nanotribology: Friction at nanoscale, Nanotribology and wear-resistance, MEMS and NEMS
- Photo-electronics: Merger of photonics and electronics at nanoscale dimensions
- Single electron devices, molecular circuits
- Nanocomposites (i.e. metal oxide, ceramic, glass and polymer and core- shellbased);
- Biomemitics and Biomaterials, synthetic nanocomposites for
- Nanosensors: Temperature Sensors, Chemical and gas Sensors, Light and radiation sensors

20 hours

Unit IV

1. Chemical synthesis of Au and Ag nanoparticles and characterization by Optical spectroscopy of size dependence band-gap
2. Debye Scherrer analysis of XRD data of nanoparticles of different sizes.
3. Surface area and Pore size distribution of the BET data from a nano-porous material.
4. Some experiment to study mechanical strength of nanocomposite(nano-indentation)Societal issues of Nanotechnology: Prospects and Dangers; Commercial aspects, emerging industry and employment opportunities. 10 hours

TEXT 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. Plenty of Room for Biology at the Bottom-An introduction to bio-nanotechnology, E. Guzit, Imperial College Press

Refrence books:

1. Introduction to Nanotechnology, C P Poole & F J Owens, Wiley, 2003.
2. Understanding Nanotechnology, Scientific American 2002.
3. Nanotechnology, M Ratner & D Ratner, Prentice Hall 2003.

4. Nanotechnology, M Wildon, K Kannagara G Smith, M Simmons & B Raguse, CRC Press Boca Raton 2002.