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	-	03	03	20	80	100	03	02

		Physics-I/ Atomic, Molecular & 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**

IV 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	16MScPHCT41	Quantum Mechanics - II	04	-	03	20	80	100	04	04
2	16MScPHCT42	Advanced Mathematical Methods in Physics	04	-	03	20	80	100	04	04
Specialization Courses										
3	16MScPHST43	Electronics -II/ Condensed Matter Physics-II/ Atomic, Molecular & Optical Physics-I/ Nuclear and Particle Physics-II	04	-	03	20	80	100	04	04
4	16MScPHST44	Electronics -III/ Condensed Matter Physics-III/ Atomic, Molecular & Optical Physics-III/ Nuclear and Particle Physics-III	04	-	03	20	80	100	04	04
5	16MScPHSP45	**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
6	16MScPHPP46	**Project: (Specialization)**	-	08	--	20	80	100	08	05
TOTAL			**16**	**11**		**120**	**480**	**600**	**25**	**23**

IV SEMESTER

Course 16MScPHCT41: Quantum Mechanics - II

Teaching hours per week : 4

No. of Credit: 4

Unit I

Linear Vector Spaces: Vectors in Hilbert space, dual Hilbert space, bra and ket vectors, scalar product. Orthogonality and normalization of vectors, linear operators, relation between two operators, Hermitian operators and reality of Eigen values. Matrix representation of transformation theory.

10 hours

Unit II

Quantum dynamics: Principles of superposition, dynamical variables, Hermitian operators, quantum Poisson brackets and equation of motion, position representation and Schrodinger equation, momentum representation, Schrodinger and Heisenberg pictures, Generalized uncertainty principle, Matrix mechanics : simple harmonic oscillator by matrix method

10 hours

Unit III

Angular Momentum: Commutation relations between angular momentum operators, Eigen values of J_Z and J^2, matrix elements for J^2, J_X, J_y, and J_Z. Addition of two angular momenta, phase convention, Clebsch-Gordan coefficients (qualitative).

10 hours

Unit IV

Approximation methods: 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 (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).

3. Quantum Mechanics – Theory and Applications (3rd Edition): A. Ghatak and S. Lokanathan, Mac Millan India Ltd. New Delhi (1984)

4. A Text book of quantum Mechanics : P. M. Mathews and K. Venkateshan, Tata Mc Graw – Hill, New Delhi (1987)

5. Quantum Mechanics by Amit Goswami

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

ReferenceBooks:

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)

Course 16MScPHCT42: : Advanced Mathematical Methods in 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).

Course 16MScPHCT44: : 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)

Course 16MScPHCT44: : 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. 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, Lyddane –Sachs-Teller relation and its implications, thermodynamics of ferroelectric phase transition, ferroelectric domains, hysteresis in ferroelectrics, P-E curve. Phase transition in Barium Titanate, $BaTiO_3$, and Triglycine Sulphate and their dielectric properties. 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. 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, gaint 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 : 5th 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)

Course 16MScPHCT44: : 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 Measutrements10 hours

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 (2^{nd} 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).

Course 16MScPHCT44: 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).

Course 16MScPHST44: : 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).

Course 16MScPHCT44: : 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 photocell. Semiconductor lasers: homojunction diode laser, double heterostructure diode laser,.

10 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.

Thin Film Physics : Introduction to epitaxial growth. Preparation of thin films: Spray pyrolysis and spin coating methods. Chemical vapor deposition, MOCVD, MBE and thermal evaporation methods. **Characterization:** X-ray diffraction and photoluminescence study.

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.

12 hours

Unit III

Superconductivity : Occurrence of superconductivity, destruction of superconductivity by magnetic field, heat capacity and energy gap, microwave and infrared properties, type I and type II superconductors, high T_C superconductors, perovskite structures, structure and properties of cuprate superconductors BSCCO and YBCO. Thermodynamics of superconductivity, London equations, coherence length, flux quantization in superconducting ring, duration of persistent current.

10 hours

Unit IV

BCS Theory : Attraction between Cooper – pairs, accomplishments of BCS theory.

Tunneling : Basic concepts of tunneling, metal-insulator tunneling, metal-insulator-superconductor tunneling, supercondutror-insulator-superconductor tunneling, Cooper-pair tunneling. A. C. and D. C. Josephson effect, macroscopic quantum interference. D C SQUIDS

06 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, 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, micelles and reverse micelles. **Biological Methods:** Role of plants and bacteria in metal (magnetic and non-magnetic) nanoparticle synthesis. **Characterization techniques:** IR/UV/VIS, Raman, Photoluminescence, Electron Microscopy (SEM/TEM); Scanning Probes (STM, AFM), Particle Size Analysis using XRD-light Scattering, Electrical (I-V and C-V), Porosity (BET method), Zeta potential, nano-indentation.**Polymers:** Basic concepts, classification of polymers, effect of temperature, mechanical and electrical properties.**Liquid crystals:** Classification, orientational order and inter molecular forces, magnetic effects, optical properties, applications.

12hours

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).

Course 16MScPHSP44: Atomic, Molecular & Optical Physics – III

Molecular Spectra & Molecular Structure of Polyatomic Molecules

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).

Course 16MScPHSP44: 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 Fussion**: 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

Detectors: Different types of scintillators, photomultiplier tubes, preamplifiers: charge sensitive and voltage sensitive preamplifies, Linear amplifier, Single channel analyser, analog to digital convertor, Multi-channel analyser, NaI (Tl) gamma ray spectrometer.

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).

Course 16MScPHSP45: 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).

Course 16MScPHSP45: 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. Assignments using C-programming.
8. Magnetostriction study in Fe, Ni, Co and Cu using Michelson Interferrometer.
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. Programming with C language: i. finding the roots of n quadratic equations using C programme. ii. Iteration method using C programme, iii analysis of xrd pattern coefficient using C programme.

(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).

Course 16MScPHSP45: 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.

Course 16MScPHSP45: Practical – Nuclear 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).

16MScPHPP46: Project-Electronics
• 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.

16MScPHPP46: Project-Condensed Matter 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.

16MScPHPP46: 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.

16MScPHPP46: Project-Nuclear & Particle 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.