चौधरी रणबीर सिंह विश्वविद्यालय,जीन्द

CHAUDHARY RANBIR SINGH UNIVERSITY, JIND

(Haryana Government University under Act 28 of 2014)
Recognized u/s 2(F) and & 12-B of UGC Act,1956

A meeting of the Adhoc Committee for deciding Course Syllabii, Scheme of Examination, Infrastructure, Lab Setup etc of M.Sc. (Physics) held on 21-06-2018 at 11:00 a.m. in the Conference Hall, at CRSU, Jind.

The following members were present:

1.	Prof. S.K. Sinha, Dean Academic Affaris, CRSU, Jind	Convener
2.	Prof. R.P. Tandon, Department of Physics & Astrophysics, University of Delhi, Delhi	Member
3.	Dr. Rajesh Punia, Associate Professor, Department of Physics, MDU, Rohtak	Member
4.	Dr. Sajjan Dahiya, Assistant Professor, Department of Physics, MDU, Rohtak	Member

The Committee framed the scheme and syllabi of M.Sc. Physics under Choice Based Credit System and submitted the hard copy as well as soft copy of the same for consideration and further necessary action.

The Meeting ended with a vote of thanks to the Chair.

Sajjan 21/6/18
(Sajjan Dahiya)

R. Punia 21/06/18
(Rajesh Punia)

R Pal Tandon 21.6.18
(R.P. Tandon)

21/06/18
(S.K. Sinha)

The Scheme and Syllabi
Department of M.Sc. Physics

Prepared by

Prof. R.P. Tandon, Department of Physics & Astrophysics, University of Delhi, Delhi

Dr. Rajesh Punia, Associate Professor, Department of Physics, MDU, Rohtak

Dr. Sangeeta Singh, Associate Professor, Department of Physics,GVM PG College,Sonipat.

Dr. Sajjan Dahiya, Assistant Professor, Department of Physics, MDU, Rohtak

Prof. Kulbir Singh Department of Physics, Thapar University, Patiala.

CRS University, Jind.

Scheme and Syllabi of
M. Sc. PHYSICS (Four Semesters) Course
Under Choice Based Credit System
(Effective from the Academic Session 2018-19)

Semester-I

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max Marks
Paper - I	18PHY21HC1	Mathematical Physics	4+0+0=04	04	80+20
Paper – II	18PHY21HC2	Classical Mechanics	4+0+0=04	04	80+20
Paper - III	18PHY21HC3	Quantum Mechanics –I	4+0+0=04	04	80+20
Paper - IV	18PHY21SC1	Electronics-I	4+0+0=04	04	80+20
Paper – V	18PHY21HCL1	Practical: General Physics	0+0+8=8	04	100
Paper - VI	18PHY21SCL1	Practical : Electronics	0+0+8=8	04	100

Note:

- All papers in M.Sc. 1st semester are mandatory.
- Total Credits = 24 [Hard Core = 16; Soft Core = 8]

Semester-II

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper - VII	18PHY22HC1	Quantum Mechanics-II	4+0+0=04	04	80+20
Paper – VIII	18PHY22HC2	Nuclear and Particle Physics	4+0+0=04	04	80+20
Paper - IX	18PHY22HC3	Solid State Physics	4+0+0=04	04	80+20
Paper - X	18PHY22SC1	Electronics-II	4+0+0=04	04	80+20
Paper – XI	18PHY22HCL1	Practical: General Physics	0+0+8=8	04	100
Paper - XII	18PHY22SCL1	Practical : Electronics	0+0+8=8	04	100
Paper – XIII	18PHY22OE1	Open Elective – I	4+0+0=04	04	100
Paper – XIV		Foundation Elective	2+0+0=02	02	50

(R.P TANDON) (Sajjan) Rajesh Punia 21/06/18 (RAJESH PUNIA)

- Hard Core Courses are mandatory for M.Sc. 2nd Semester students.
- Paper XIII will be chosen by M.Sc. Physics Students from the basket of Open Elective papers provided by the University.
- Paper XIV will be chosen by M.Sc. Physics Students from the pool of Foundation Electives provided by the University.
- Total Credits = 30 [Hard Core = 16; Soft Core = 08; Open elective = 04; Foundation elective = 02]

Semester-III

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max. Marks
Paper - XV	19PHY23HC1	Statistical Mechanics	4+0+0=04	04	80+20
Paper - XVI	19PHY23HC2	Electrodynamics	4+0+0=04	04	80+20
Paper - XVII	19PHY23DE1	Material Science – I	4+0+0=04	04	80+20
		Or			
Paper - XVIII	19PHY23DE2	Computational Physics - I	4+0+0=04	04	80+20
Paper – XIX	19PHY23DE3	Radiation Physics-I	4+0+0=04	04	80+20
		Or			
Paper – XX	19PHY23DE4	Nuclear Physics-I	4+0+0=04	04	80+20
Paper – XXI	19PHY23SCP	Project	0+0+16=16	08	200
Paper-XXII	19PHY23OE1	Open Elective Part - II	4+0+0=04	04	100

Note:

- Paper XXII will be chosen by M.Sc. Physics Students from the pool of Open Electives provided by the University. .
- Total Credits = 28 [Hard Core =08; Soft Core = 08; Discipline Elective =08; Open elective = 04]

Semester-IV

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credit	Max Marks
Paper – XXIII	19PHY24HC1	Atomic and Molecular Physics	4+0+0=04	04	80+20
Paper – XXVI	19PHY24HC2	Physics of Nano-materials	4+0+0=04	04	80+20
Paper - XXV Paper – XXVIII	19PHY24DE5 19PHY24DE6	Material Science – II **Or** Computational Physics- II	4+0+0=04 4+0+0=04	04 04	80+20 80+20
Paper– XXIX Paper – XXX	19PHY24DE7 19PHY24DE8	Radiation Physics-II **Or** Nuclear Physics-II	4+0+0=04 4+0+0=04	04 04	80+20 80+20
Paper– XXXI Paper–XXXII	19PHY24DEL1 19PHY24DEL3	Practical: Material Science **or** Practical Computational Physics	0+0+8=8	04	100
Paper–XXXIII Paper–XXXIV	19PHY24DEL3 19PHY24DEL4	Practical: Radiation Physics **Or** Nuclear Physics	0+0+8=08	04	100

Note:

- Total Credits = 24 [Hard Core = 08; Discipline Elective = 16]

Note:

- **Abbreviations** : 18PHY21HC : 18 stands for year of implementation, PHY21 stands for Physics two year course 1st semester and HC means hard core course; SC means soft core; DE means Discipline Elective; HCL means hard core Laboratory; DEL means Discipline Elective Laboratory; SCP means Soft Core Project; SCL means soft core Laboratory; OE means open elective; FE means foundation elective
- Elective papers will be offered according to the availability of the Teachers in the Department.
- Each theory paper will include 20% marks as internal assessment

Break up of internal assessment marks:

Assessment Examination	15 Marks (Best two out of three assessment examination of 7.5 Marks)
Attendance	5 Marks
Total	20 Marks

Distribution of marks in Practical Examination is as under:

Experiment	40 Marks
Viva-voce	40 Marks
Laboratory Report	20 Marks
Total	100 Marks

Distribution of marks for Project Evaluation is as under

Dissertation	80 Marks
Presentation & Viva-voce	80 Marks
Internal evaluation by Supervisor	40 Marks
Total	200 Marks

Note: The evaluation of project will be conducted by an outside subject expert.

M.Sc. Physics Semester-I Paper -I

Mathematical Physics: 18PHY21HC1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit -I

Vector spaces, Norm of a Vector, Linear independence & dependence, basis and dimension, Isomorphism of Vector spaces, scalar/Inner product of vectors, Orthonormal basis, Gram-Schmidt Orthogonalization process, Linear operators, Matrices, Cayley-Hamiltion Theorem, Inverse of matrix, Orthogonal, Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Similarity transformation, Matrix diagonalization, Simultaneous diagonalization and commutativity

Unit -II

Linear ordinary differential equation equations of first and second order, Second order linear differential equation with variable coefficients, ordinary point, singular point, series solution around an ordinary point, series solution around a regular singular point; the method of Frobenius, Wronskian and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solutions of Laguarre and Hermite's equations

Unit- III

Special functions, Generating functions for Bessel function of integral order $J_n(x)$, Recurrence relations, Integral representation; Legendre polynomials $P_n(x)$, Generating functions for $P_n(x)$, Recurrence relations, orthogonality, Rodrigue's Relation; Hermite Polynomials; Generating functions, Rodrigue's relation &orthogonality for Hermite polynomials; Laguerre polynomials, Generating function and Recurrence relations, Orthogonality, Rodrigue's Relation, The Gamma Function, The Dirac – Delta Function

Unit –IV

Complex variables: Analyticity and Cauchy-Riemann Conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Cauchy's residue theorem, Singular points and evaluation of residues, Jordan's Lemma, Evaluation of infinite integrals using Cauchy's residue theorem and Jordan's Lemma; Integral transform, Laplace transform, Properties of Laplace transforms such as first and second shifting property, Laplace Transform of Periodic Functions, Laplace transform of derivatives, Laplace Transform of integrals, Inverse Laplace Transform by partial fractions method, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Applications of Fourier Series, Fourier Transforms, Fourier sine and cosine Transforms, Fourier transform of derivatives, Applications of Fourier Transforms

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

[1] Mathematical Physics by B. S. Rajput
[2] Matrices and Tensors for Physicists, by A. W Joshi

[3] Mathematical Physics by Mathews and Walkers
[4] Mathematics for Physicists by Mary L Boas
[5] Mathematical Methods for Physicists (6th edition) by Arfken and Weber
[6] Mathematical Physics by H K Dass
[7] Mathematical Physics by P.K. Chattopadhyay (T)

M.Sc. Physics Semester-I Paper -II
Classical Mechanics: 18PHY21HC2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Newton's law of motion, Mechanics of a system of particles, Degrees of freedom, Constraints, Generalized coordinates, Principle of virtual work, D'Alembert's principle and Lagrange's equations of motion, some applications of Lagragian formulation, Velocity dependent potentials and dissipation function, motion of a charged particle in electromagnetic field, Hamilton's principle, derivation of Lagrange's equations from the Hamilton's principle, Conservation laws and cyclic coordinates

Unit-II

Two body problem and its reduction to the equivalent one body problem, Central force: definition and characteristics, differential equation for the orbit, condition for closure and stability of circular orbits, Kepler's laws and equations, Rutherford scattering; Moving coordinate systems and Motion in a central force field: Rotating frames, inertial forces, terrestrial applications of Coriolis force, Generalized coordinates of a rigid body, Euler's angles, Infinitesimal rotations as vectors, angular velocity and its components, angular momenta and inertia tensor, Rotational kinetic energy of a rigid body, Euler's equations of motion a rigid body

Unit-III

Variational Principle, Principle of least action, derivation of equations of motion, variation and end points, H-J Theory: H-J equation and their solutions, use of H-J method for the solution of harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties, Action angle variables for completely separable systems, the Kepler's problem in action angle variables

Unit-IV

Canonical transformation: generating functions, properties of Poisson bracket, angular momentum, Poisson brackets, Potential energy and equilibrium: One dimensional oscillator, Stable, unstable and natural equilibrium, two coupled oscillators: Solution of differential equation to find normal coordinates and normal modes, Theory of small oscillations: Eigen value equation and its solution, Small oscillations in normal modes, Examples of coupled oscillators: Two coupled pendulums and double pendulum, Vibrations of Tri-atomic molecule

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books

[1] Classical Mechanics by N C Rana and P S Joag (Tata McGraw Hill, 1991)
[2] Classical Mechanics by H Goldstein (Addison Wesley, 1980)
[3] Mechanics by A. Sommerfeld (Academic Press, 1952)
[4] Introduction to Dynamics by I perceival and D Richards (Cambridge Univ. Press, 1982)
[5] Classical Mechanics by J.C. Upadhayaya

R. Punia

M.Sc. Physics Semester-I Paper -III
Quantum Mechanics-I: 18PHY21HC3

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Wave particle duality: Young's two slit experiment, Bragg's X-ray experiment, Photo-electric experiment, Compton effect, Wave and particle nature of E.M. radiations, Electron and Neutron diffraction, Davisson and Germer experiment; Wave packets: Superposition of two and large number plane waves, Phase velocity and Group velocity, De Broglie relation; Measurement and Uncertainty Principle: Position momentum measurement by Heisenberg's microscope, Position - momentum measurement by single slit experiment; Physical and statistical interpretation of wave function, Operators for different physical quantities; Schrodinger equation: Free particle, Free wave packet, Particle in a box; Expectation values of different operators; Equation of continuity, Gaussian wave packet and its spread with time, Wave function in momentum space, The Ehrenfest theorem; Uncertainty of expectation values, Commuting and non-commuting operators

Unit-II

Time independent Schrodinger equation and stationary states; Characteristics of wave function: Finiteness, continuity and orthogonality; One dimensional problems: Detailed description of Particle in a box, Potential step, Rectangular potential barrier, Potential well of finite depth, and Linear harmonic oscillator; Linear Vector Space: Hermitian operators, Dirac Bra and Ket notations, Matrix representations of state vectors and operators, linear transformations in ordinary and linear vector space; Unitary transformations: change of basis in ordinary space and linear vector space; Linear harmonic oscillator by operator method: The creation and annihilation operators, Energy Eigen states, matrix representation and Eigen values of various operators, The coherent states, Time evolution of coherent states,

Unit-III

Orbital angular momentum: Its Components, Commutation relations, Representation in spherical polar coordinates, Eigenvalues and Eigen functions of $\hat{L}^2$ and $\hat{L}_z$, Measurement of orbital angular momentum components and its spatial rotation, Raising and lowering operators, Eigen values and Eigen vectors of angular momentum operators using spherical harmonics, Matrix representation of angular momentum operators for $j = 1$ and $j = 1/2$; Spin angular momentum: orbital angular momentum and spin, Electron spin operators and spin Eigen states, total wave function of electron, The Stern-Gerlach experiment, Spin and rotation; Addition of angular momenta: Addition of two angular momenta, Recursion relations for the C-G coefficients, Possible values of j, addition of two spin ½ angular momenta, addition of j = 1 and j = ½ angular momenta

Unit-IV

Particle in a cubic potential box, Cubic Box with periodic boundary conditions, Density of states for free electron gas in metals (1D, 2D and 3D), spherically symmetric potentials and separation of Schrödinger equation in angular and radial part, Free particle in spherical polar co-ordinates, expansion of plane waves in spherical harmonics; Schrödinger equation for two body system; Hydrogen atom: Energy Eigen values, Radial Eigen functions, Radial probability distribution, degeneracy; Three dimensional harmonic oscillator: Anisotropic and isotropic harmonic oscillator, Eigen values and Eigen functions and degeneracy

Sajjan R. Punia

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Text and Reference Books

1. Principles of Quantum Mechanics by Ishwar Singh Tyagi (Pearson)
2. Quantum Mechanics Concepts and Applications by Nouredine Zettili (Wiley)
3. Quantum Mechanics by B.H. Bransden and C.J. Joachain (Pearson)
4. Introduction to Quantum Mechanics by D.J. Griffiths (Pearson)
5. Principles of Quantum Mechanics by R. Shankar (Springer)
6. Quantum Mechanics by Ghatak and Loknathan

M.Sc. Physics Semester-I Paper -IV
Electronics-I: 18PHY21HC4

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit -I

Intrinsic and extrinsic semiconductors, Charge carriers in semiconductors, Direct and indirect band gap semiconductors, Current flow due to drift and diffusion of carriers, p-n junction diode: Basic structure, Energy band diagram, Built-in potential, Electric field, space charge width and Qualitative description of current flow in forward and reverse bias, Varactor diode, Junction breakdown mechanism, Zener diode as voltage regulator, clipping and clamping circuits, Junction, PIN and Avalanche photodiode, Solar cell, Light emitting diode (LED) and Semiconductor laser

Unit- II

Transistors: Bipolar junction Transistor (BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Field Effect Transistors: Junction Field Effect Transistor (JFET), Metal Oxide Semiconductor Field Effect Transistor (MOSFET, Concept of AC load line, Biasing methods of BJT and FETs, Negative Resistance devices: Tunnel Diode, Backward Diode, Uni-junction Transistor, p-n-p-n devices and their characteristics, Thyristor, Silicon Controlled Switch its characteristics

Unit- III

Kirchhoff's current and voltage law, Network theorems: Thevenin theorem, Norton theorem, maximum power transfer theorem, Transistor models and parameters, Equivalent circuits, Two-Port devices and Hybrid model, Transistor Hybrid model, Transistor h-parameters, Conversion for h-parameter for three Transistor Configurations, Analysis and comparison of different configurations of Transistor Amplifier Circuits, Linear Analysis of a Transistor Circuit, Miller's Theorem and its Dual, Cascading Transistor Amplifiers, classification of amplifiers, frequency response, RC coupled amplifier and its low frequency response

Unit - IV

Differential amplifier, CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Inverting and non-inverting amplifier, basic applications- summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier, Integration, differentiation, analog computation, Logarithmic amplifier, antilogarithmic amplifier, Digital to analog conversion–ladder and weighted resistor types, analog to digital conversion- counter type, Butterworth active filters circuits

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books

1. Solid State Electronic Devices by Ben G. Streetman (Pearson)
2. Semiconductor Physics and Devices by Donald A Neamen (Tata-McGraw Hill)

3. Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill)
4. Linear Integrated Circuits by D. Roy Choudhary and Shail Jain (Wiley Eastern Ltd)
5. Electronic Devices and Circuits, by David A. Bell (Oxford)
6. Electronic fundamentals and applications by J. D. Ryder
7. Op- Amps and Linear Integrated Circuits by Gayakwad (Pearson)
8. Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley)

M.Sc. Physics Semester-I Paper -V

Practical: General Physics-18PHY21HCL1

Theory Marks: 100

Time: 4 Hours

1. To study the velocity of sound and its variation with temperature using Ultrasonic interferometer.
2. Measurement of Hall Coefficient of given semiconductor, Identification of charge carrier type and estimation of carrier concentration.
3. To determine e/m ratio of electron using Helical Method.
4. To determine numerical aperture of a optical fiber and size of Lycopodium Powder using semiconductor laser.
5. Determination of wavelength of He-Ne laser using engraved scale as a diffraction grating and measurement of thickness of thin wire.
6. To calibrate a prism spectrometer with mercury lamp and hence to find the Cauchy's constants.
7. Determination of Boltzmann Constant from forward I – V characteristics of Si-diode.
8. Determination of Planck's constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colors.
9. To determine refractive indices of liquids, transparent and translucent solutions and solids using Abbe-refractometer.
10. To determine the wavelength of a laser using the Michelson interferometer.

Note: A student required to perform atleast eight (08) experiments out of these experiments.

M.Sc. Physics Semester-I Paper -VI

Practical: Electronics-18PHY21SCL1

Theory Marks: 100
Time: 4 Hours

1. Find the frequency and amplitude of given electrical signal using C.R.O.
2. To design a power supply of ± 12 V using regulator ICs.
3. To design a voltage regulator circuit using Zener diode.
4. To design and study of clipping and clamping circuits.
5. To design common emitter amplifier and study its frequency response.
6. To design and implement the following LOGIC GATES using different discrete components: OR, AND, NAND and NOR.
7. To study and validate Network theorems.
8. To study the output and transfer characteristics of a JFET and find its drain resistance, trans-conductance and amplification factor.
9. To study rectifier and filter circuits and draw wave shapes.
10. To study frequency response of RC coupled Amplifier.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester.

Sajjan R. Punia

M.Sc. Physics Semester-II Paper -VII

Quantum Mechanics-II: 18PHY22HC1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Time Independent perturbation theory: Meaning of perturbation, non-degenerate perturbation theory; Harmonic oscillator subjected to different perturbation: x, x^2, x^3 and x^4; Degenerate perturbation theory: two and g fold cases; The Stark effect, The Fine structure of hydrogen; Zeeman Effect: Normal and Anomalous, Variational Principle, Ground state of He-atom by both perturbation and varitional method, Estimation of ground state energy of hydrogen molecule by perturbation method, WKB approximation: General formulism, validity, Bound states of Potential wells with no, one and two rigid walls, Tunneling trough a barrier

Unit-II

Time dependent perturbation theory: Transition probability, Transition probability for constant and harmonic perturbations, adiabatic and sudden approximation; Interaction of atoms with radiation: classical treatment of incident radiation, Quantization of E.M. field, Transition rates for absorption and emission of radiation; Electric Dipole Approximation: Transition rates within dipole approximation, selection rules for electric dipole transitions, Magnetic quantum numbers , angular momentum quantum numbers, Spontaneous emission: Einstein A and B coefficients, Life time and Line width

Unit-III

Scattering and cross-section, Connection between scattering angle in Lab and CM frames, Connecting the Lab and CM cross sections, Scattering amplitude spineless particles, Scattering amplitude and differential cross sections, Solution of Schrödinger equation for scattering problem, Born approximation and its validity; Partial wave analysis: Partial wave analysis for elastic and inelastic scattering, Scattering from a square well potential and Hard sphere potential

Unit-IV

Many particle systems: Schrodinger equation, Interchange symmetry, System of distinguishable identical particles; System of identical particles: identical particles in classical and quantum mechanics, exchange symmetry, symmetrization postulate, constructing symmetric and anti-symmetric wave functions, system identical non interacting particles, wave function of two particles, three particle and many particle systems, Pauli's exclusion principle and Slater's determinant; Spin states of a two electron system; States of the helium atom; Collision of identical particles

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Text and Reference Books:

1. Principles of Quantum Mechanics by Ishwar Singh Tyagi (Pearson)
2. Quantum Mechanics Concepts and Applications by Nouredine Zettili (Wiley)
3. Quantum Mechanics by B.H. Bransden and C.J. Joachain (Pearson)
4. Introduction to Quantum Mechanics by D.J. Griffiths (Pearson)
5. Principles of Quantum Mechanics by R. Shankar (Springer)
6. Quantum Mechanics by Ghatak and Loknathan(Springer)
7. Quantum Mechanics by Powell and Crassman(Dover)

M.Sc. Physics Semester-II Paper -VIII
Nuclear and Particle Physics: 18PHY22HC2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Basic characteristics of nucleus: Size, Density, Nuclear mass, Packing fraction, Binding energy, spin, parity, Angular momentum, Magnetic dipole moment, Electric quadrupole moment, Isospin, and Statistical properties of nucleus; Two nucleon problem: Common potentials used for calculation of nuclear forces viz. Wigner, Majorana, Bartlett and Heisenberg potentials, The ground state of deuteron, Excited states of the deuteron, Qualitative features of Nucleon – nucleon scattering, Neutron – proton (n-p) scattering at low energies, Scattering length, Significance of sign of scattering length, Coherent and incoherent, Spin dependence of n – p scattering, Singlet state in n – p scattering, and Effective range theory in n – p scattering; Meson theory of nuclear force (Qualitative discussion)

Unit-II

Types of nuclear reactions: compound and direct nuclear reactions, Reaction cross – section, Reaction cross - section in terms of partial wave treatment, Balance of mass and energy in nuclear reactions, O equation and its solution; Fermi gas model of nucleus; Liquid drop model: Similarities between liquid drop and nucleus, semi-empirical mass formula, Bohr-Wheeler theory of fission, Merits and limitations of Liquid drop model; Shell model: Experiment evidences for shell effect, Magic numbers, Main assumptions of single particle shell model, Spin-orbit coupling in single particle shell model, Estimation of spin, parities and magnetic moments of nuclei by single particle shell model

Unit-III

Nuclear Decays: Alpha (α) decay, α- disintegration energy, Range of α-particles, Range – energy relationship for α-particles and Geiger – Nuttall law; Beta decay, Pauli's neutrino hypothesis, Fermi theory of beta decay, Kurie plot, selection rules for beta decay, Fermi and Gamow-Teller Transitions, Parity non-conservation in beta decay, Detection and properties of neutrino; Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules; Internal conversion, Nuclear isomerism

Unit-IV

Elementary Particle Physics: Classifications of elementary particles: fermions and bosons, particles and antiparticles; Fundamental interactions in nature; Type of interaction between elementary particle: Symmetry and conservation laws; Classification of hadrons: Strangeness, Hypercharge, Gelleman - Nishijima formula, Elementary ideas of CP and CPT invariance; Quark model, Baryon Octet, Meson Octet, Baryon Decuplet, Gell-Mann-Okubo formula for octet and decuplet, necessity of introducing colour quantum number, SU (2) and SU (3) multiples (qualitative only)

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Text and Reference Books:

1. Nuclear Physics Theory and Experiment by R.R. Roy and B.P. Nigam (New Age International (P) Limited, Publishers)
2. Nuclear Physics- An introduction by S B Patel (New Age International (P) Limited, Publishers)
3. Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury (Mc Graw Hill Education)
4. Introductory Nuclear Physics by Kenneth S. Krane (Wiley, New York)
5. Introductory Nuclear Physics by Y.R. Waghmare (Oxford – IBH, Bombay)
6. Nuclear Physics, 2nd addition by Kapaln (Narosa, Madras)
7. Introduction to Nuclear Physics by F.A. Enge (Addison-Wesley)
8. Nucleon Interaction by G.E. Brown and A.D. Jackson (North-Holland, Amsterdam)
9. Nuclear and Particle Physics by S L Kakani and Shubhra Kakani (Viva Books)
10. Introduction to high Energy Physics by P.H. Perkins (Addison-Wesley, London, 1982)
11. Page **17** of **52**Introduction to Elementary Particles by D. Griffiths (Harper and Row, New York, 1987)

M.Sc. Physics Semester-II Paper -IX

Solid State Physics– 18PHY22HC3

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

States of mater: Solid liquid and gases; Periodic array of atoms: Crystal translation vectors and lattices, Symmetry operations, the basis and the crystal structure, Primitive lattice cell; Fundamental types of lattices: two and three dimensional lattice types; conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, primitive lattice cell of FCC, BCC and HCP; Packing fraction: Simple cubic, BCC, FCC, HCP and diamond structures; X-rays; Bragg's Law; Experimental diffraction methods: Laue method, Rotating crystal method, Powder method; Laue derivation of amplitude of scattered wave, scattering from lattice of point atoms, Reciprocal Lattice: fundamental vectors of the reciprocal lattice, spacing of the planes of crystal lattice, Ewald construction, Brillouin Zones, reciprocal lattice of BCC and FCC lattice; Geometric structure factor of BCC, FCC, diamond lattice and NaCl, Atomic scattering factor

Unit-II

Balls and spring model of a harmonic crystal, Vibrations of one dimensional monoatomic lattice: dispersion relation, periodic boundary condition and features of dispersion curve; Vibrations of one dimensional diatomic lattice: dispersion relation, optical and acoustic branches and features of dispersion curve, Classical lattice heat capacity; Quantum theory of lattice heat capacity: average energy of a harmonic oscillator, Einstein Model, Phonon density of states in one and three dimensions, Debye continuum model, Anharmoic effects, thermal expansion, phonon thermal conductivity

Unit-III

The Drude model: Assumptions, dc and ac conductivity of metals, thermal conductivity of metal; Lorentz modification of Drude model; the Fermi Dirac distribution function; The Sommerfeld model; the density of states, Free electron gas at 0K, Energy of electron gas at 0K, Electron heat capacity; Thermionic and Field enhanced emission from metals, Change of work function, The contact potential between two metals; Sommerfeld theory of electronic conduction in metals, Static magneto-conductivity, The Hall coefficient, Matthiessen' rule, Basics of thermoelectric power, the Thomson effect and the Pelletier effect

Unit-IV

Periodicity of potential and its consequences; Bloch theorem and its proof; periodicity of Bloch functions and their Eigen values; Kronig – Penny model; The nearly fee electron model; Zone schemes for energy bands: Extended, reduced and the periodic zone schemes; Energy bands in general periodic potential and solution near zone boundary; Insulators, metals and Semiconductors; Tight binding approximation its application to simple cubic, BCC and FCC crystals concepts of holes, Fermi surface : construction of Fermi surface in two- dimension, de Hass van alfen effect, cyclotron resonance

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Sajjan R.Kais

Text and Reference Books:

1. Introduction to Solid State Physics by C. Kittle (8th edition Wiley)
2. Elements of Solid State Physics by J.P. Srivastava(PHI)
3. Solid State Physics by A.J. Dekker (Macmillan)
4. Solid State Physics by Ashcroft and Mermin (Cengage Learning)
5. Elementary Solid State Physics by Ali Omar (Addison Wesley)
6. Solid State Physics by M.A. Wahab (Narosa)

M.Sc. Physics Semester-II Paper -X

Electronics –II: 19PHY22SC1

Theory Marks: 80

Internal Assessment Marks: 20

Time: 3 Hours

Unit-I

Binary operation of a system; Different logic gates: Symbols, truth table and their realization using diodes/ transistors; De Morgan's law, logic symbol of NAND and NOR using diode transistor logic; Transistor-Transistor logic(TTL); Resistor-Transistor logic(RTL); Propagation delay times; Standard gate assemblies, Binary adders: half adder, parallel operation, full adder, MSI adders, serial operation; Decoder/Demultiplexer: BCD system, BCD to decimal decoder, conversion of decoder to demultiplexer, 4-to-16 line decoder/demultiplexer; Data selector/multiplexer: parallel to serial conversion, sequential data selection; Encoders; Read only memory: code converters, programming of ROM and its applications; Seven segment display; Digital comparator and parity checker

Unit-II

1-bit memory: A sequential system, 1-bit storage cell; Flip flops: SR flip flop, clocked SR flip flop, Preset and Clear, Race around condition, JK flip flop, Master-slave JK flip flop, D and T Flip flop; Shift Registers: Serial-to-Parallel converter, Parallel-to-serial converter, Parallel in parallel out, serial in serial out, Right and left shift register, Counters: Shift register ring counter, Twisted ring counter, Ripple Counter, Up down counter, Divide by N counter, Synchronous counter and applications of counters; Digital MOSFET circuits: Inverter, NAND and NOR operation using MOSFET, CMOS, Dynamic and static MOS Shift Register; MOS based ROM and RAM

Unit-III

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation: PAM, PTM, PWM, PPM, PCM; Resonant Cavity, Klystrons and Magnetron – velocity modulation, basic principle of two cavity klystron and reflex klystron, principle of operation of magnetron, Hot electrons, Transferred electron devices, Gunn effect, principle of operation, Modes of Operation, Read diode, IMATT diode, TRAPATT diode.

Unit-IV

Integrated Circuits and their Fabrication: Types of Integrated Circuits, Analog and Digital Integrated Circuits, Semiconductor Device Fabrication: Crystal Growth, Epitaxial Growth, Thermal Oxidation, Photolithography, Dry and Wet Etching, Impurity Doping: Thermal Diffusion and Ion Implantation, Metallization: Thermal Evaporation, e-Beam Evaporation and DC Sputtering, Packaging and Testing, Process Flow for the Fabrication of Monolithic Transistor, Monolithic Diodes, Integrated Resistors, and Integrated Capacitors

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Sajjan R. Punia

Text and Reference Books

1. Integrated Electronics by J. Millman and C.C. Halkias (Tata-McGraw Hill)
2. Digital Electronics by William Gothmann (Parentice Hall of India)
3. Digital Principles and Applications by Donald P leach, Albert Paul Malvino (McGraw-Hill)
4. Solid State Electronic Devices by Ben G. Streetman (PHI)
5. Fundamental of Electronics by J.D. Ryder (Prentice Hall Publication)
6. Foundation for Microwave Engineering by Robert E. Collin (Wiley)
7. Semiconductor Devices - Physics and Technology by S.M. Sze (Wiley)

M.Sc. Physics Semester-II Paper -XI
Practical: General Physics-18PHY22HCL1

1. To measure the resistivity of a Ge crystal using four probe method at different temperatures and find its energy band gap.
2. Lattice dynamic kit:
   (i) To study the dispersion relation of monoatomic lattice and to find the cut off frequency.
   (ii) To study the dispersion relation of diatomic lattice: acoustical, optical branches, Energy gap and comparison of experimental and theoretical values.
3. Determination of Lande g-factor of DPPH using ESR spectrometer.
4. To study the band gap of a semiconductor material using p-n junction diode and find the diffusion potential of the diode.
5. To study B-H curve of a given sample and find the energy loss in ferromagnetic material.
6. To determine the dielectric constant of polar and non-polar liquids.
7. Determination of ionization potential of mercury.
8. To determine Stefan's constant using black body radiations from copper plates (Electrical Method).
9. To study the characteristics (illumination, I-V, Power-load, Areal and Spectral characteristics) of a Solar cell.
10. To study the energy levels of Ar using Frank-Hertz experiment.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester.

M.Sc. Physics Semester-II Paper -XII
Practical: Electronics-18PHY22SCL1

Theory Marks: 100
Time: 4 Hours

1. To study the frequency response of a single stage negative feedback amplifier for voltage series and shunt feedback.
2. To study the frequency variation in RC phase shift, Colpitt and Hartley Oscillators.
3. To study the applications of operational amplifier as summer, astable multivibrator, Schmitt trigger, integrator and differentiator.
4. To study the frequency/amplitude modulation and demodulation.
5. To study the analog to digital conversion and digital to analog conversion circuits.
6. To study analog comparator circuit.
7. To study the binary module-6 and 8 decade decoder and shift register.
8. To study the BCD to seven segment display.
9. To study the I-V characteristics of uni-junction transistor and its application as saw tooth wave generator.
10. To study the I-V characteristics of silicon-controlled rectifier and its applications.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester.

Sajjan
R. Punia

M.Sc. Physics Semester-II Paper -XIII

Sources of Energy – I: 18PHY22OE1

Theory Marks: 80
Internal Assessment: 20
Time: 3 hours

Unit- I

Limitation of conventional energy sources, need and growth of alternative energy sources, basic scheme and application of direct energy conservation, Solar energy: Introduction, The characteristics of the sun, Definitions related to solar radiations, solar radiation geometry, Estimation of daily solar radiation, Theory of solar cells, Solar cell materials, solar drying, solar furnaces, Solar cooking, solar greenhouse technology, solar thermal power generation, solar cell array

Unit- II

Solar Thermal Energy: Solar radiations, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations

Unit- III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental consideration, estimates of geothermal power, nature of geothermal fields, advantages & disadvantages of geothermal energy forms, applications of geothermal energy, Geothermal power plant, Fuel Cells: Principle, working of various types of fuel cells, performance and limitations

Unit- III

Wind Energy: Wind power and its sources: Principle of working of Wind Energy, performance and limitations of energy conversion systems. Site selection, criteria, momentum theory, and wind characteristics

Text and References Books:

1. Renewal Energy Resources by John Twideu and Tony Weir (BSP Publications)
2. Energy Resources: Conventional & Non-Conventional by M.V.R. Koteswara Rao (BSP Publications)
3. Non-Conventional Energy Resources by D.S. Chauhan (New Age International)
4. Renewal Energy Technologies: A Practical Guide for Beginners by C.S. Solanki (PHI Learning)
5. Advances in energy system and Technology by Peter Auer (Academic Press)
6. Non-conventional Energy sources by G.D. Rai (Khanna Publishers)
7. Introduction to Non-Conventional Energy Resources by Raja A.K. (Scitech Publications)
8. Fundamentals of Solar cells. Photovoltaic Solar Energy by Fahrenbruch and Bube

M.Sc. Physics Semester-II Paper -XIV
Foundation elective--18PHY22FE1

Note: Paper-XIV will be chosen by M.Sc. Physics Students from the list of Foundation Elective papers offered by the University.

M.Sc. Physics Semester-III Paper -XV
Statistical Mechanics: 19PHY23HC1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

UNIT- I

The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution; Elements of Ensemble Theory: Phase space and Liouville's Theorem, The micro canonical ensemble theory and its application to ideal gas of monatomic particles, Equipartition and virial theorems, canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations

UNIT -II

The grand canonical ensemble: Equilibrium between a system and a particle-energy reservoir and significance of statistical quantities, Classical ideal gas in grand canonical ensemble theory. Density and energy fluctuations; Elements of Quantum Statistics: Quantum states and phase space, quantum statistics of various ensembles, An ideal gas in quantum mechanical ensembles, statistics of occupation numbers

UNIT-III

Ideal Bose Systems: Basic concepts and thermodynamic behavior of an ideal Bose gas, Bose Einstein condensation, Laser cooling of atom as an example of Bose Condensate, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Planck's Radiation formula (Black body radiation); Ideal Fermi Systems: Thermodynamic behavior of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism

UNIT -IV

Elements of Phase Transitions: First- and second-order phase transitions (Introduction), Diamagnetism, paramagnetism, and ferromagnetism. a dynamical model of phase transitions, Ising Model, Fluctuations: Thermodynamic Fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Statistical Mechanics by R.K. Pathria (Butterworth-Heinemann, Oxford)
2. Statistical Mechanics by K. Huang (Wiley Eastern, New Delhi)
3. Statistical Mechanics by B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi)
4. Elementary Statistical Physics by C. Kittel (Wiley, New York)
5. Statistical Mechanics by S.K. Sinha (Tata McGraw Hill, New Delhi)

6. Statistical Mechanics by Gupta and Kumar
7. Statistical and Thermal Physics by F. Reif

M.Sc. Physics Semester-II Paper -XVI
Electrodynamics: 19PHY23HC2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Introduction, Coulomb's Law, Gauss Law, Scalar potential, Laplace and Poisson's equations, Electrostatic potentials, energy and energy density of the electromagnetic field, Multipole expansion, Dipole moment, quadrupole moment; Biot-Savart Law, Ampere's theorem, Magnetic Vector potential, magnetic field of a localized current distribution, Magnetic moment, force and torque on a current distribution in an external field, Magnetostatic energy, Magnetic induction and magnetic field in macroscopic media

Unit-II

Static fields in material media, Polarization vector macroscopic equations, Molecular polarizability and electric susceptibility, Claussius-Mossotti relations, Models of Molecular Polarizability. Energy of charges in dielectric media, Uniqueness Theorem, Dirichlet and Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic Boundary value problem with Green function Method of images with examples, Magnetostatic Boundary value problems

Unit-III

Electromagnetic induction, Faraday's Law of induction, Displacement current, Maxwell equations, Scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, General Expression for the electromagnetic fields energy, conservation of energy, Poynting's Theorem, Conservation of momentum Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting's theorem for a complex vector field. Waves in conducting media, skin depth, EM waves in rare field plasma and their propagation in ionosphere.

Unit-IV

Reflection and Refraction of EM waves at plane dielectrics interface, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection, Brewster's angle, Total internal reflection, Parallel plate transmission lines, Wave guides, TE and TM waves, Rectangular wave guides and cavity resonators, Solutions of the inhomogeneous wave equation in the absence of boundaries, Fields and Radiation of a localized oscillating source. Electric dipole and electric quadrupole fields, centre fed linear antenna

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Classical Electrodynamics by S.P. Puri, (Tata McGraw Hill, New Delhi) OR Alpha Science International Ltd., India
2. Classical Electrodynamics by J.D. Jackson, (Wiley Eastern, New Delhi)
3. Introduction to Electrodynamics by D.J. Griffiths, (Prentice Hall India, New Delhi)
4. Electromagnetic Field Theory Fundamentals by Bhag Singh Guru and H.R. Hiziroglu (Cambridge University Press)
5. Electromagnetics by B.B. Laud

Sajjan

R. Puri

M.Sc. Physics Semester-II Paper -XVII
Material Science –I: 19PHY23DE1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Crystals of inert gases: Van der Waals-London Interaction, Repulsive Interaction, Equilibrium Lattice Constants; Cohesive Energy; Ionic crystals: Electrostatic or Madelung energy, Evaluation of the Madelung constant; Covalent crystals; Metals; Hydrogen bonds, Atomic radii, Ionic crystal radii, Lattice vacancies; Diffusion; Color centers: F centers, Other centers in alkali halides; Frenkel defects; Schottky vacancies

Unit-II

Langevin diamagnetism equation; Quantum theory of diamagnetism of mononuclear systems Paramagnetism: Quantum theory of paramagnetism, Rare earth ions, Hund rules, Iron group ions Crystal field splitting, Quenching of the orbital angular momentum, Spectroscopic splitting factor, Van Vleck temperature-independent paramagnetism; Cooling by isentropic demagnetization; Nuclear demagnetization; Paramagnetic susceptibility of Conduction electrons

Unit-III

Ferromagnetic order: Curie point and the exchange integral, Temperature dependence of the saturation magnetization, Saturation magnetization at absolute zero; Magnons: Quantization of spin waves, Thermal excitation of Magnons; Ferri-magnetic order: Curie temperature and susceptibility of ferri-magnets, Iron garnets; Anti-ferromagnetic order: Susceptibility below the Neel temperature, Anti-ferromagnetic Magnons; Ferromagnetic domains: Anisotropy energy, Transition region between domains, Origin of domains, Coercivity and hysteresis

Unit-IV

Occurrence of superconductivity, Destruction of superconductivity by magnetic fields; Meissner effect; Heat capacity; Energy gap; Microwave and infrared properties; Isotope effect; Thermodynamics of the superconducting transition; London equation; Coherence length BCS theory of superconductivity; BCS ground state; Flux quantization in a superconducting ring Duration of persistent currents; Type-II superconductors; Vortex state; Estimation of H_{C1} and H_{C2}: Single particle tunneling; Josephson superconductor tunneling; Dc and Ac Josephson effect; Macroscopic quantum interference

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books

1. Introduction to Solid State Physics by C. Kittle (8th edition Wiley)
2. Elements of Solid State Physics by J.P. Srivastava(PHI)
3. Solid State Physics by A.J. Dekker (Macmillan)
4. Solid State Physics by Ashcroft and Mermin (Cengage Learning)
5. Elementary Solid State Physics by Ali Omar (Addison Wesley)

6. Solid State Physics by M.A. Wahab (Narosa)

M.Sc. Physics Semester - III Paper-XVIII
Computational Physics – I: 19PHY23DE2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Numerical Integration : Newton-cotes formulae : Trapezoidal rule, Simpson's 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limit approach ; Gauss-Legendre quadrature method; Monte Carlo (mean sampling) method for single, double and triple integrals, Numerical Differentiation: Taylor Series method; Generalized numerical differentiation: truncation errors. Roots of Linear, Non-linear Algebraic and Transcendental equations: Newton-Raphson method; convergence of solutions. Curve Fitting: Principle of least square; linear regression; Polynomial regression; Exponential and Geometric regression

Unit-II

Interpolation: Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and backward interpolation; Interpolation with unequally spaced points: Lagragian interpolation, Solution of Simultaneous Linear Equations: Gaussian elimination method, Pivoting; Gauss- Jordan elimination method; Matrix inversion .Eigen values and Eigen vectors: Jacobi's method for symmetric matrix

Unit-III

Numerical Solution of First Order Differential Equations: First order Taylor Series method; Euler's method; Runge-Kutta methods; Predictor corrector method; Elementary ideas of solutions of partial differential equations, Numerical Solutions of Second Order Differential Equation: Initial and boundary value problems: shooting methods

Unit- IV

Computer basics and operating system: Elementary information about digital computer principles; basic ideas of operating system, DOS and its use (using various commands of DOS); Compilers; interpreters; Directory structure; File operators.
Introduction to FORTRAN 77:Data types: Integer and Floating point arithmetic; Fortran variables; Real and Integer variables; Input and Output statements; Formats; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmetic IF and logical IF statements; Flow charts; Truncation errors, Round off errors; Propagation of errors, Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables; Subprograms: Function and SUBROUTINE; Double precision; Complex numbers; Common statement; New features of FORTRAN 90

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books

1. Introductory methods of Numerical Analysis by Sastry
2. Numerical Analysis by Rajaraman

3. Programming with FORTRAN 77 by Ram Kumar
4. Numerical Recipes in FORTRAN by Teukolsky, Vellerling and Flannery
5. FORTRAN programming and Numerical methods by Desai
6. Numerical Methods with FORTRAN IV case studies by Dorn and McCracken
7. Numerical methods for Mathematics, Science and Engineering by Mathew
8. Numerical methods for Scientific and Engineering Computation by Jain, Iyngar and Jain
9. An Introduction to Computer Simulation methods part I and Part II by Gould and Tobochnik
10. Introduction to Numerical methods and FORTRAN programming by McCalla
11. Computation Physics: An Introduction by Verma, Ahluwalia and Sharma

Gajjar

R. Punia

M.Sc. Physics Semester- III Paper-XIX
Radiation Physics– I: 19PHY23DE3

Theory Marks: 80
Internal Assessment: 20
Time: 3 Hrs.

Unit- I

The Nucleus and Radioactivity: Atomic structure, Nuclear mass, Binding energy, binding energy curve and its interpretation, Isotopes, Isotones, Isobars, Nuclear size, Radioactivity, Modes of radioactive disintegration, Nature and properties of radioactive radiations, Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes

Unit- II

Other Sources of Radiations: X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)

Unit-III

Interaction of Radiation with Matter: Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient

Unit -IV

Neutron Physics: Discovery of neutrons, Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter, Boron coated proportional counter, Helium-3 proportional counter, Fission counter, and Scintillation counters), Intermediate neutrons detectors, and Fast neutrons detectors, Neutron detection through slowing down of fast neutrons. Neutron monochromators and nuclear fission

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Radiation Detection and Measurement by Glenn F. Knoll (John Wiley & Sons, Inc).
2. Student Solutions Manual to accompany Radiation Detection and Measurement by Glenn F. Knoll (John Wiley & Sons, Inc).
3. Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury (Mc Graw Hill Education).

4. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005.
5. Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen.
6. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx
7. Nuclear and Particle Physics by S. L. Kakani and Shubhra Kakani (Viva books)

M.Sc. Physics Semester-III Paper -XX

Nuclear Physics –I: 19PHY23DE4

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Basic principle of ΔE-E detector telescopes, short range charged particles ΔE-E telescope, methods of particle identification using semiconductor and gaseous detectors, ΔE-E time of flight spectroscopy; Event by event particle identification system for heavy ion induced reaction analysis; neutron-gamma discrimination; Modem Gas Detectors: basic principle and operation of split anode ionization chamber, position sensitive ionization chamber, position sensitive proportional counter & multi wire proportional counter

Unit-II

Types of preamplifiers: basic idea of voltage sensitive and current sensitive pre-amplifiers, details of charge sensitive preamplifier and its applications; Amplifier Pulse Shaping Circuits: RC, Gaussian, delay-line, bipolar and zero cross-over timing circuits, pole zero cancellation and base line restorer; Coincidence Techniques: basic idea of coincidence circuit and its resolving time, basic principle of slow coincidence, slow fast coincidence and sum coincidence techniques; Single Channel Analyzer; Multi-Channel Analyzer; CAMAC Based Data Acquisition System

Unit-III

Ion Accelerators: Ion sources- basic features of RF ion source, direct extraction negative ions source (Duoplasmatron) and source of negative ions by Cs sputtering (SNICS); Basic principle and working of Tandom accelerator and Pelletron accelerator and its applications; Ion Beam Interaction in Soilds: Basic ion bombardment processes in solids- general phenomenon, ion penetration and stopping, ion range parameters, channeling, components of an ion implanter, energy deposition during radiation damage, sputtering process and ion beam mixing

Unit-IV

Nuclear stability, fission, prompt and delayed neutrons, fissile and fertile materials- characteristics and production, classification of neutrons on the basis of their energy, four factor formula, control of reactors, reactors using natural uranium, principle of breeder reactors, fast breeder reactor & doubling time, calculation of critical size and mass of reactor; Basic principle of neutron detection; Basic concept of fusion reactors

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
2. Introduction to Experimental Nuclear Physics by R. M. Singru
3. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo
4. Radiation Detection and Measurement by G. F. Knoll
5. The Physics of Nuclear Reactions by W. M. Gibson
6. VLSI Technology by S. M. Sze

M.Sc. Physics Semester-III Paper -XXI
Project –19PHY23DE4

Internal Assessment: 40
Dissertation: 80
Presentation and Viva – Voce: 80

M.Sc. Physics Semester-II Paper -XXII
Sources of Energy – II: 19PHY23OE1

Theory Marks: 80
Internal Assessment: 20
Time: 3 hours

Unit- I

Bio-mass: Introduction of biogas, Availability of bio-mass and its conversion theory, classification of biogas plants, principle & working of floating drum plant & fixed dome type plant- advantages & disadvantages. Biogas from plant waste, community biogas plants, utilization of biogas

Unit-II

Ocean Thermal Energy Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle, working, performance and limitations

Unit-III

Petroleum and Coal energy: Petroleum, origin, composition, production, extraction, octane number, kerosene, LPG, lubricants natural gas, physical properties and uses of coal, generis of coal, molecular structure, determination of fixed carbon content, coal for generation of electricity, zero emission power plants, coal reserves and mining

Unit-IV

Nuclear Energy: Nucleus and its constituents, charge mass, isotopes, isobars, mass defect, binding energy and nuclear stability, radiation and nuclear reactions; Nuclear fission, chain reaction, U^{235}, U^{238}, controlled nuclear fission and nuclear reactors, fast breeder reactor, nuclear fusion, condition for nuclear fusion reaction, Hydrogen bomb, Nuclear bomb

Text and References Books:

1. Renewal Energy Resources by John Twideu and Tony Weir (BSP Publications)
2. Energy Resources: Conventional & Non-Conventional by M.V.R. Koteswara Rao (BSP Publications)
3. Non-Conventional Energy Resources by D.S. Chauhan (New Age International)
4. Renewal Energy Technologies: A Practical Guide for Beginners by C.S. Solanki (PHI Learning)
5. Advances in energy system and Technology Vol I & II by Peter Auer (Academic Press)
6. Introduction to Non-Conventional Energy Resources by Raja A.K. (SciTech Publications)
7. Non-conventional Energy sources by G.D. Rai (Khanna Publishers)

Sajjan R. Punia

M.Sc. Physics Semester-IV Paper-XXIII
Atomic and Molecular Physics: 19PHY24HC1

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

One Electron systems and Pauli principle: Quantum states of one electron atoms, atomic orbitals, Hydrogen spectrum, Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra, Spectra of two electron systems, equivalent and non-equivalent electrons

Unit-II

The influence of external fields, Two electron system Hyperfine structure and Line broadening: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems , interaction energy in LS and jj coupling, Hyperfine structure (magnetic and electric, only qualitative)

Unit-III

Diatomic molecules and their rotational spectra: Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of rotational lines

Unit-IV

Vibrational and Rotational Vibration spectra of Diatomic molecules: Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Introduction to Atomic and Molecular Spectroscopy by V.K. Jain
2. Introduction to Atomic spectra by H.E. White
3. Fundamentals of molecular spectroscopy by C.B. Banwell
4. Spectroscopy Vol. I and II by Walker and Straughen
5. Introduction to Molecular spectroscopy by G. M. Barrow
6. Spectra of diatomic molecules by Herzberg
7. Molecular spectroscopy by Jeanne. L. McHale
8. Molecular spectroscopy by J.M. Brown
9. Spectra of atoms and molecules by P. F. Bemath
10. Modern spectroscopy by J.M. Holias

R. Punia

Sajjan

M.Sc. Physics Semester IV Paper XXIV
Physics of Nano-materials-19PHY24HC2

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, Insulators and Semiconductors, Concept of effective mass, Density of states in bands, Variation of density of states with energy, Variation of density of states and band gap with size of crystal, Electronic structure from bulk to quantum dot, Electronic states in direct and indirect semiconductor nano-crystals, Excitions in direct and indirect band gap semiconductors

Unit-II

Physics of reduced dimensional systems and devices: quantum confinement, electron confinement in one, Two and three dimensional infinitely deep square well potentials, Various low dimensional systems: Quantum well structure; Idea of quantum well structure, Electron wave function and energy in quantum well structure (infinite well approximation), Density of states and optical absorption in quantum well, Quantum wires: electron wave function and energy, density of states, Quantum dots: electron wave function and energy, density of states, idea of hetero-junction LED, Quantum well laser and quantum dot laser, Coulomb blockade and Single electron transistor

Unit-III

Synthesis/fabrication of Nanomaterials/nanostructures: bottom up and top down approaches for synthesis of nano materials, Synthesis of zero-dimensional nanostructures (nanoparticles): Sol-gel process, Synthesis inside micelles or using micro-emulsions and growth termination, epitaxial core-shell nanoparticles, Ball milling, One-dimensional nanostructures (Nanowires, Nanorods Nanotubes): vapor (or solution)-liquid-solid (VLS or SLS) growth and size control, Electrochemical deposition, Lithography, Two-dimensional nanostructures (thin films & quantum wells): Molecular beam epitaxy (MBE), MOCVD, Cluster beam evaporation, Ion beam deposition, Chemical bath deposition technique

Unit-IV

Characterization of Nanomaterials/nanostructures: Effect of particle size and strain on width of XRD peaks of Nanomaterials, Determination of crystallite/particle size and strain in Nanomaterials using Debye Scherrer's formula and Williamson–hall's plot, Transmission electron microscopy: basic principle, brief idea of set up, sample preparation, imaging modes (dark & bright field), Photoluminescence (PL) spectroscopy: Basic principle and idea of instrumentation, shift in PL peaks with particle size, Determination of alloy composition in thin films of compound semiconductors, Estimation for width of quantum wells, Raman Spectroscopy: Basic principle and idea of instrumentation, Variations in Raman spectra of Nanomaterials with particle Size, Study of Raman Spectra of Carbon Nanotubes and Graphene.

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Physics of Low Dimensional Semiconductors by John H. Davies (Cambridge Univ. Press)
2. Introduction to Nano-technology by Charles P. Poole & Jr. Frank J. Owens (Wiley Inter-science)
3. Quantum Mechanics for Nanostructures by Vladimir V. Mitin, Dmitry I. Sementsov & Nizami Z. Vagidov (Cambridge University Press)
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao (Imperial College Press)
5. Introduction to Nano: Basics to Nanoscience and Nanotechnology by Amretashis Sengupta & Chandan Kumar Sarkar (Editor) [Springer].
6. Solid State Physics by A. J. Dekker (Macmillan)
7. Essentials in nano-science and nanotechnology by Narendra Kumar, Sunita Kumbhat (Wiley)
8. Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films by C. Richard Brundle and Charles A. Evans, Jr. (BUTTERWORTH-HEINEMANN)

M.Sc. Physics Semester-IV Paper -XXV

Material Science-II: 19PHY24DE5

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Dielectric function of the electron gas: Definitions of the dielectric function, Plasma optics, Dispersion relation for electromagnetic waves, Transverse optical modes in a plasma Transparency of metals in the ultraviolet, longitudinal plasma oscillations; Plasmons; Electrostatic screening: Screened coulomb potential, Pseudopotential component U(0), Mott metal-insulator transition, Screening and phonons in metals; Polaritons; Electron-electron interaction: Fermi liquid, Electron-electron collisions; Electron-phonon interaction. Polarons; Optical reflectance: Kramers-Kronig relations, conductivity of collisionless electron gas, Electronic interband transitions

Unit-II

Excitons: Frenkel excitons, Alkali halides, Molecular crystals weakly bound (Mott-Wannier) excitons; Exciton condensation into electron-hole drops (EHD); Maxwell equations; Polarization; Macroscopic electric field: Depolarization field; Local electric field at an atom: Lorentz field, Field of dipoles inside cavity, Dielectric constant and polarizability: Electronic polarizability, Classical theory, some examples, Structural phase transitions; Ferroelectric crystals and their classification, Displacive transitions: Soft optical phonons, Landau theory of the phase transition, Second-order transition, First-order transition, Anti-ferroelectricity, Ferroelectric domains, Piezoelectricity

Unit-III

Band gap, Equations of motion: Physical derivation of $\hbar\vec{k} = \vec{F}$, Holes, Effective mass, Physical interpretation of the effective mass, Effective masses in semiconductors; Intrinsic carrier concentration; law of mass action; intrinsic mobility; Impurity conductivity: Donor states, Acceptor states, Thermal ionization of donors and acceptors; Energy bands in Silicon, Germanium and GaAs; Cyclotron resonance in semiconductors; Carrier lifetime and recombination; thermoelectric effects; Semimetals

Unit-IV

Description of solubility limit, Phases, Microstructure, Phase equilibria, Unary phase diagrams Binary phase diagrams: Binary Isomorphous systems, Interpretation of phase diagrams, Development of microstructure in Isomorphous alloys, Mechanical properties of Isomorphous alloys, Binary eutectic systems, Materials of Importance-Lead-Free Solders, Development of microstructure in eutectic alloys, Equilibrium diagrams having intermediate phases or compounds, Eutectoid and Peritectic Reactions, Congruent phase transformations, Ceramic and ternary phase diagrams, The Gibbs Phase Rule, The iron–carbon system

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Bajaj R. Punia

Text and Reference Books

1. Introduction to Solid State Physics by C. Kittle (8th edition Wiley)
2. Elements of Solid State Physics by J.P. Srivastava(PHI)
3. Solid State Physics by A.J. Dekker (Macmillan)
4. Solid State Physics by Ashcroft and Mermin (Cengage Learning)
5. Elementary Solid State Physics by Ali Omar (Addison Wesley)
6. Solid State Physics by M.A. Wahab (Narosa)
7. Materials science and engineering: an introduction by William D. Callister and Jr., David G. Rethwisch (Wiley)

M.Sc. Physics Semester-IV Paper XXVI
Computational Physics – II: 19PHY24DE6

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit - I

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling of radioactive decay. Hit and Miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals, chaotic dynamics: Some definitions, the simple pendulum, Potential energy of a dynamical system, Un-damped motion, Damped motion, Driven and damped oscillator.

Unit-II

Numerical solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kutta method(when Eigen value is given), Numerical Solutions of Partial Differential Equations using Finite Difference Method, Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.

Unit –III

MATLAB – I: Introduction, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, saving and loading data, plotting simple graphs Programming in MATLAB: Script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/ Output, Advanced data objects, structures, cells

Unit-IV

MATLAB – II: Linear Algebra; solving a linear system, Gaussian elimination, finding eigenvalues and Eigen vectors, matrix factorization, Curve fitting and Interpolation; polynomial curve fitting, least square curve fitting, interpolation, Data analysis and statistics, Numerical integration; double integration, Ordinary differential equation; first order linear ODE, second order nonlinear ODE, tolerance, ODE suite, event location, Non-linear algebraic equations

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Introduction to Numerical Analysis by F B Hildebrand (Tata McGraw Hill)
2. Fortran Programming and Numerical methods by R C Desai (Tata McGraw Hill)
3. Computer Applications in Physics by Suresh Chandra (Narosa Publishing House)
4. Numerical Recipes in Fortran 77 By William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery (Cambridge University Press)
5. Introduction to Computation Physics by M L De Jong (Addison-Wesley)
6. Computational Physics an Introduction by R C Verma, P K Ahluwalia and K C Sharma (New Age International)

7. Computer Oriented Numerical Methods by V Rajaraman (PHI)
8. An introduction to numerical analysis by K E Atkinson (John Wiley and Sons)
9. Getting Started with MATLAB by Rudra Pratap (Oxford University Press)
10. A concise introduction to MATLAB by William J Palm III (McGraw Hill)

M.Sc. Physics Semester-IV Paper XXVII
Radiation Physics – II: 19PHY24DE7

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Principles of radiation detection; Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films), Radiation Monitoring Instruments and Calibration check of radiation monitoring equipment

Unit- II

Biological Effects of Ionizing Radiation: Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect)

Unit-III

Principles of Radiological Protection: Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students; Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds

Unit-IV

Radiation Hazard: Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness

Note: The syllabus is divided into four units. **Nine** questions will be set in all. Question No.1 will be compulsory having four parts covering the whole syllabus. In addition there will be two questions from each unit and the student is to answer one question from each unit. Question paper is expected to comprise of numerical problems upto 30% of total marks. Level of numerical problems will be of national level exams such as CSIR- NET/JRF, GATE Physics etc.

Text and Reference Books:

1. Radiation Detection and Measurement by Glenn F. Knoll (John Wiley & Sons, Inc)
2. Student Solutions Manual to accompany Radiation Detection and Measurement by Glenn F. Knoll (John Wiley & Sons, Inc)
3. Concepts of Modern Physics by Arthur Beiser, S Mahajan, and S Rai Choudhury (Mc Graw Hill Education)

4. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005
5. Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen
6. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx
7. Radiation Biology: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2010

M.Sc. Physics Semester-IV Paper -XXVIII
Nuclear Physics –II: 19PHY24DE8

Theory Marks: 80
Internal Assessment Marks: 20
Time: 3 Hours

Unit-I

Qualitative features and phenomenological potentials, Exchange forces, generalized Pauli principle. The ground state of deuteron, Range-depth relationship for square well potential, Neutron-Proton scattering at low energies (below 10 MeV), Concept of scattering length and its interpretation, Spin dependence of neutron-proton scattering, Effective range theory of n-p scattering, Coherent scattering of neutrons on ortho and para hydrogen, Magnetic moment and its importance in the determination of exact ground state of deuteron

Unit-II

Nuclear reactions and cross sections, Resonance : Breit-Wigner dispersion formula for $\ell = 0$, Breit-Wigner dispersion formula for all values of ℓ, The compound nucleus, Continuum theory of cross section σ_c, Statistical theory of nuclear reactions, Evaporation probability and cross sections for specific reactions, Kinematics of the stripping and pick-up reactions, Theory of stripping and pick-up reactions

Unit-III

Liquid drop model, Outlines of Bohr and Wheeler theory of nuclear fission, Concept of magic numbers, The properties of magic nucleus, Nuclear Shell Model, Predictions of shell closure on the basis of harmonic oscillator potential, Need of introducing spin-orbit coupling to reproduce magic numbers. Extreme single particle model and its predictions regarding ground state spin parity, magnetic moment and electric quadrupole moments

Unit-IV

Nuclear surface deformations, General parameterization, Types of multipole deformations, Quadrupole deformations, Symmetries in collective space, Surface vibrations, Vibrations of a classical liquid drop, The Harmonic quadrupole oscillator, The collective angular momentum operator, The collective quadrupole operator, Quadrupole vibrational spectrum, Rotating nuclei, The rigid rotor, The symmetric rotor, The asymmetric rotor

Text and Reference Books:

1. Nuclear Physics: Theory and Experiment by R. R. Roy and B. P. Nigam (Wiley Eastern Limited)
2. Theory of Nuclear Structure by M. K. Pal (Affiliated East-West Press, New Delhi)
3. Nuclear Models by Greiner and Maruhn (Springer)
4. Nuclear Physics: An Introduction by W. E. Burcham (Longman Group Limited, London)
5. Nuclear Theory by R. G. Sachs (Addison-Wesley Publishing Company, Cambridge)
6. Introductory Nuclear Physics by K. S. Krane (Wiley)

M.Sc. Physics Semester-IV Paper -XXIX
Practical: Material Science –19PHY24DEL1

Theory Marks: 100
Time: 4 Hours

1. To study the B-H curve of a ferrite with temperature and find the ferromagnetic transition temperature of the material.
2. To determine the dielectric constant of PZT material with temperature variation and find its Curie temperature.
3. To study the magneto-resistance of bismuth crystal.
4. To measure the magnetic susceptibility of a paramagnetic material using Gouy's method.
5. To study thermo-luminescence of F-centers in alkali halide crystals.
6. To simulate X-Ray Diffraction Experiment
7. To determine the crystallite size and lattice strain using Williamson's Halls Plot from a given x-ray diffraction data.
8. Indexing and determination of lattice parameter of a Simple cubic crystal for a given x-ray diffraction data.
9. To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
10. To study the lead tin phase diagram.

Note: Out of the list as above, a student has to perform atleast 08 (eight) practicals in the semester.

Sajjan R. Punia

M.Sc. Physics Semester-IV Paper -XXX
Practical: Computational Physics –19PHY24DEL2

Theory Marks: 100
Time: 4 Hours

List of programs using FORTRAN

1. Numerical Integration
2. Least square fitting
3. Numerical solutions of equations (single variable)
4. Solution of H-atom problem
5. Solution of RL circuits
6. Numerical solution of simultaneous linear algebraic equations
7. Numerical solution of ordinary differential equation
8. Numerical Solution of second order ordinary differential equations
9. Motion of Projectile thrown at an angle
10. Simulation of Planetary Motion
11. Charging and discharging of Capacitor
12. Solution of LCR circuit

Note: Out of the list as above, a student has to perform atleast 08 (eight) computer programmes in the semester.

M.Sc. Physics Semester-IV Paper -XXXI
Practical: Radiation Physics –19PHY24DEL3

Theory Marks: 100
Time: 4 Hour

1. Investigation of the plateau and optimal operating voltage of a Geiger-Muller counter.
2. Investigation of statistical nature of counting rate.
3. To determine the resolving time of a GM counter.
4. To investigate the relationship between absorber materials (atomic number), absorption thickness and backscattering.
5. To verify the inverse square relationship between the distance and intensity of radiation.
6. To investigate the attenuation of radiation via the absorption of beta particles.
7. To determine the maximum energy of decay of a beta particle.
8. Measurement of range of α particle range in air using a spark counter.
9. Study of the attenuation coefficients of the γ rays for Al, Fe and Pb using NaI scintillation counter.
10. Measurement of γ ray energy of Cs-137 source using a NaI Scintillation detector.

Note: Out of the list as above, a student has to perform at least 08 (eight) practicals in the semester.

M.Sc. Physics Semester-IV Paper -XXXII
Practical: Nuclear Physics –19PHY24DEL4

Theory Marks: 100
Time: 4 Hour

1. Statistics of G.M. Counter.
2. Range of Alpha Particles in air using Spark counter.
3. Resolving time of G.M. Counter set-up.
4. Resolving time of a fast coincidence circuit.
5. Thickness measurement of Al Sheet using: (a) G. M. Counter. (b) Gamma Ray Absorption Experiment.
6. Study of resolving power of Gamma Ray Detector as a function of energy.
7. Efficiency Determination of NaI (Tl) Detector.
8. Study of Compton scattering experiment.
9. Study of Alpha-Spectrometer.
10. Study of Rutherford Back Scattering Experiment.

Note: Out of the list as above, a student has to perform at least 08 (eight) practicals in the semester