Proposed PG Syllabus of Physics

There will be four semesters in M. Sc. and each semester will have four papers. Each semester will be of 20 credits, which in turn will be equally distributed among the four papers: 5 credits each paper x 4 papers.

An end-term examination for 70 marks, in each paper, will be conducted by the University; the rest of 30 marks will be awarded through the process of internal assessment:

SEMESTER1 (JULY TO DECEMBER)

Paper 1 (70 + 30)

MATHEMATICAL PHYSICS & RELATIVITY

Unit1: Matrices

Linear vector spaces, Linear independence and orthogonality of vectors, Linearoperators. Matrix representation.The algebra of matrices.Special matrices. Rank of a matrix. Elementary transformations.Elementary matrices.Equivalent matrices.Eigenvalues and eigenvectors of matrices.Diagonalisation of matrices.

Unit2: Special Functions & Differential Equations

Special functions (Hermite, Bessel, Laguerre and Legendre functions).Generating Functions, Recursion Relations, Second order Linear One Dimensional Equations with Variable Coefficients, Solution by Series Expansion,Hermite, Bessel, Laguerre and Legendre Equations, Physical Applications.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Mem. 4
Prof.MadanJee	Prof. N Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit3: Fourier and Laplace Transforms

Fourier Transform, Definition, Properties, Representations, Fourier sine and cosine transforms, Fourier Transforms of Dirac Delta function, Transforms of Derivatives, Parseval's Theorem, Applications to Partial Differential Equations. Laplace transform: L.T., Simple properties and Examples of L.T., Convolution Theorem and Applications, Laplace Transform Method of Solving Differential Equations.

Unit4: General Theory of Relativity

Inconsistencies of Newtonian gravitation with STR, Principles of equivalence, Principle of general covariance, Metric tensors and Newtonian Gravitational potential, Logical steps leading to Einstein's field equations of gravitation, Schwarzschild's exterior solution, singularity, event horizon and black holes, Qualitative discussions on: White Dwarfs, Neutron stars and Black Holes, Static Black Holes, Cosmological red shift, Hubble's law. Big Bang, Early Universe, Elementary Ideas of Tachyons.

Text and Reference Books:

1. Mathematical Methods for Physicists, by G. Arfken
2. Matrices and Tensors of Physicists, by A.W. Joshi
3. Advanced Engineering Mathematics, by E. Kreyszig.
4. Special Functions& Their Applications, by N.N.Lebedev.
5. Special Functions, by W.W. Bell
6. Mathematical Methods for Physicists and Engineers, by K.F. Reily, M.P. Hobson and S.J. Bence
7. Mathematics for Physicists, by Mary L. Boas
8. Mathematical Physics, by B.D. Gupta
9. Mathematical Physics, by H.K. Dass
10. Mathematical Physics, by Rajput

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Paper 2 (70 + 30)

QUANTUM MECHANICS

Unit1: Representation Theory

Linear vector space – State space, Dirac notation and Representation of State Spaces, Concept ofKets, Bras and Operators, Expectation Values, Superposition Principle, Orthogonality, Completeness, Expansion of State Vector, Change of basis, Unitary operators.
Matrix representation of wave function and operators.Energy spectrum of one dimensional harmonic Oscillator using matrix mechanics. Definition of generalized angular momentum, operators for J_+, J_-, J_z,Addition of two angular Momentna, coupled and uncoupled representation. ClebschGordon Coefficients, Spectrum of eigenvalues of total angular momentum. Calculation of C.G. coefficients when (1) $J_1 = ½$, $J_2 = ½$, (2) $J_1 = ½$, $J_2 = 1$.

Unit2: Approximation Methods

Time-independent Perturbation Theory for Non-degenerate and Degenerate States, Their Applications to Stark and Zeeman effectsin Hydrogen Atom and Helium Atom, Time-dependent Perturbation Theory, Its Application to SemiclassicalTheotry of Interaction of Atoms with Radiation, calculation of first order transition amplitude, transition probability and derivation of Fermi's Golden rule, Adiabatic and Sudden Approximations and Their Applications. WKB Approximation and its Application to Bound State Problem and Tunneling.

Unit3: Scattering

Differential and total scattering cross-sections, scattering amplitude, relation between differential scattering cross/section and scattering amplitude, Laboratory and centre of mass reference frames, relation of scattering angles and cross-sections in Laboratory and C.O.M. systems, Partial wave analysis, expression for scattering amplitude and total scattering cross section in terms of Phase shifts, scattering by a perfectly rigid sphere and by square well potential, Deduction of optical theorem from scattering cross section. Born approximation, validity of Born approximation, Application of Born approximation to square well.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	D. T. P. Singh

Unit4: Identical Particles

Multiparticle Wave function, particle exchange operator, symmetric and anti symmetric wave functions, collision ofidentical particles and their scattering amplitude, Identical particles, Pauli exclusion principle, spin-statistics connection.The Dirac equation.Properties of the Dirac matrices.The Dirac particle in an external electromagnetic field.The non-relativistic limit of the Dirac equation and the magnetic moment of the electron.

Text and Reference Books:

1. L.I. Schifff, Quantum Mechanics. (McGrae-Hill).
2.A. K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications (Macmillan India Ltd.)..
3. B. Craseman and J.D. Powell, Quantum Mechanics (Addison Wesley).
4. A.P. Messiah, Quantum Mechanics (Addison Wesley).
5. J.S. Sakurai, Modern Quantum Mechanics
6. Mathews and Vankatesan, Quantum Mechanics
7. G P Singh, Quantum Mechanics (BharatiBhawan)

Paper 3 (70 + 30)

ELECTRONICS

Unit1: Carrier Concentration & Transport

Introduction to Electronic Materials, Crystal planes (Miller Indices), Crystal Structures of Si and GaAs, band theory of solids, Fermi levels in intrinsic and doped semiconductors, degenerate semiconductors derivation of intrinsic carrier concentration, carrier mobility and drift velocity, Resistivity and Conductivity, Hall effect, diffusion phenomenon, Haynes-Shockley experiment, Einstein's relationship, carrier injection & Direct bandgap, recombination processes (direct), Auger recombination, continuity equation, high field effects.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit2: P.N. Junction Theory

P.N. junction: thermal equilibrium condition, depletion region (abrupt and linearly graded junctions), depletion capacitance: C-V characteristics, impurity distribution, and varactor; I-V characteristics; generation-recombination and high-injection effects, temperature effect, charge storage and transient behaviour; minority carrier storage, diffusion capacitance, junction breakdown: tunnelling effect and avalanche multiplication; semiconductor hetero-junctions.

Unit3: Photonic Devices and BJT's

Energy momentum relationship, direct and indirect bandgap semiconductors, transferred electron effect (Gunn Diode), quantum mechanical phenomenon, tunnel diode, IMPATT Diode, Semiconductor LED's and LASER's Photodiodes (Hetero-junctions) emission in semiconductors, optical absorption, spontaneous and stimulated emission. The Transistor action, active mode operation, current gain, Static characteristics, modes of operation (Ebers-Moll Model), I-V characteristics of CB and CE configurations, frequency response of BJT's, basic concepts of HBT and Thyristors.

Unit4: Digital Electronics

Clock waveform and its characteristics; One bit memories; RS, JK, JK-master slave, D and T Flip Flops (Unlocked, Locked and Edge triggered); Counters; Modulus of Counter; Asynchronous 2-bit, Up/Down and decade counter; Design of synchronous counter (Mod-8); Resistors: Shift Resistors (SISO, SIPO, PISO and PIPO); Applications of Shift Register.

Text and Reference Books

1. Semiconductor Devices: Physics & Technology; S.M.Sze, John Wiley & Sons.
2. Solid State Electronics Devices: Ben. G. Streetman; Prentice-Hall of India Ltd.
3. Physics of Semiconductor Devices: M.Shur; Prentice-Hall of India Ltd.
4. Physics of Semiconductor Devices: S.M.Sze: Wiley Eastern Limited.
5. Semiconductor Devices & Integrated Electronics; A.B. Milnes; B.S. Publishers & Distributors, New Delhi.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Paper 4 (70+30)

Practical (Spectroscopy)

1. Measurement of Brewster angle of a substance and hence determine the refractive index.
2. To verify the Malus law.
3. To Study the Optical Activity of Sugar Solution at Different Concentrations
4. To Determine the Wave length of Sodium Light with the Help of Michelson Interferometer.
5. To Determine the Wave length of Sodium Light with the Help of Febry Perot Interferometer.
6. To Determine the Spot Size and the Angle of Divergence of a Given Laser Source.
7. To Determine the Numerical Aperture of a Fibre by Measuring the Diameter of Laser Beam.

Other experiments would be added in due course

SEMESTER 2 (January to June)

Paper 5 (70 + 30)

CONDENSED MATTER PHYSICS

Unit1: Crystals

The Crystalline State of Solids, Lattice waves, Vibrations of one –dimensional monatomic lattice, Linear diatomic lattice, Three dimensional lattice, Quantization of Lattice vibrations, conceptof phonon, Inelastic scattering of neutrons and X-rays by phonon, Debye's model of specific heat, Thermal conductivity, Mean-free path of phonons, Free Electron Theory of Metal and its Applications: Child's Law, Richardson's Formula, Photoelectric Effect, Work Function.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit2: Band Theory of Solids

Energy bands in solids, The Bloch theorem, Kroning-penney model.Brillouin zones.Number of states in the band.Band gap in the nearly free electron model.classification of solids on the basis of band theory, effective mass, Concept of Holes, Fermi surface and Fermi gas, Hall Effect, Impurities in SC, SC Devices, PN Junction and Transistor.

Unit3: Dielectrics & Ferroelectrics

Polar and Non-polar Dielectrics, Dielectric Properties in Static and Alternating Fields, Lorentz Field, TheClasius-Mosotti Equation, Polarization, Electric Polarizability, Ionic and OrientationalPolarizability, Structural Phase Transition, London Theory of Phase Transition, Ferroelectricity, Dipole Theory of Ferroelectricity, Classification of Ferroelectric Materials

Unit4: Phase Transition in Solids

Quantum Theory of Diamagnetism, Paramagnetism and Ferromagnetism, Anti- ferromagnetism, Ferrimagnetism, Ferrites, Superconductivity, Survey of important experimental results. Critical temperature.Meissner effect. Type I and type II superconductors. Thermodynamics of superconducting transition.London equation. London penetration depth. Energy gap.Basic ideas of BCS theory.High-T_c superconductors.

Text and Reference Books:

1. Introduction to Solids by Azaroff
2. Crystallography for Solid State Physics by Verma and Srivastava
3. Solid State Physics by Kittle
4. Solid State Physics by M.A. Wahab
5. Elementary Solid State Physics by Omar
6. Crystal Structure Determination by G.H. Stout, L.H. Jensen
7. Principals of Condensed Mater Physics by Chaikin and Lubensky.
8. Solid-state physics (Wiley eastern) byC. Kittel.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Paper 6 (70 + 30)

SPECTROSCOPY AND LASER PHYSICS

Unit1: Molecular Spectra

Born-Oppenheimer Approximation, Qualitative Description of Different Types of Energies, Salient features of rotational spectra, Rotational spectra of diatomic molecule as a rigid rotator, Energy levels and spectra of a non-rigid diatomic molecule, Salient features of Variational-Rotational spectra, vibrating diatomic molecule as a harmonic oscillator and as anharmonic oscillator, Morse Potential. Diatomic molecule as Vibrating Rotor, Vibration Spectra of Diatomic Molecules, P, Q, R Branches.Raman effect and its salient features, vibrational Raman Spectra, Pure rotational RamanSpectra, Vibrational-Rotational Raman Spectra.

Unit2: Effect of External Fields

Basic Principles of Interaction of Spin and Applied External Fields, NMR Spectroscopy: Nuclear spin magnetic moment, Interaction of nuclear magnet with external magnetic field, NMR Spectrometer, Chemical; Analysis Using NMR,Mossbauer Effect, Recoilless Emission of Gamma Rays, Magnetic Hyperfine Interaction, ESR Spectroscopy: Electron spin interaction with external magnetic field, ESR spectrum, Applications.

Unit3: Laser

Broadening of Spectral Lines, Gaussian Beam and its Properties, Laser Cavity, Longitudinal and Transverse Modes of Lase Cavity, Mode Selection, Gain in Regenerative Laser Cavity, Threshold for 3- and 4-Level Laser Systems, Mode Locking, Pulse Shortening – Picosecond and Femtosecond Operation, Nd-YAG Laser, SC Laser, Diode Pumped Solid State Laser, CO2 Laser, Excimer Laser, Dye Laser, High Power Laser System, Applications of Laser.

Unit4: Laser Interaction

Laser Fluorescence and Raman Scattering, Ultrahigh Resolution Spectroscopy with Laser and Their Applications, Laser Induced Multi-photon Processes and Their Applications, Propagation of Laser in Medium having Variable RI, Optical Fibre, Light Wave Communication.

30/3/12	30/3/12	30/3/12	30/3/12	30/3/12	30/3/12	30/3/12
Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Text and Reference Books:

1. G. Herzberg. 'Molecular Spectroscopy (Diatomic Molecules)' Van-Nostrand.
2. G. M. Barrow. 'Molecular Spectroscopy'.McGraw-Hill.
3. J.MichaelHollas. ' Modern spectroscopy'. John-Wiley & sons.
4. C. L. Banwell and E. M. McCash. 'Fundamentals of Molecular Spectroscopy' Tata- McGraw-Hill..
5. G.Aruldhas 'Molecular Spectroscopy'.
6. Bransden and Joachin. 'Atoms and Molecules'
7. Elements of Spectroscopy by Gupta, Kumar, Sharma.

Paper 7 (70 + 30)

CLASSICAL ELECTRODYNAMICS AND PLASMA PHYSICS

Unit1: Electromagnetic Field

Review of four vector and Lorentz transformation in four dimensional space, Electromagnetic field tensor. Transformation of fields,LagrangianFormulation of the motion of a charged particle in an Electromagnetic field, Maxwell's equations.Retarded potentials, Lienard-Wiechert Potentials, Potentials for a charge ion in uniform motion, fields of an accelerated charge, Radiation from an accelerated charged particles at low velocity,Linear and Circular acceleration and angular distribution of power Radiated.

Unit2: Charged Particles in Electromagnetic Fields

Bremsstrahlung,Synchrotron radiation and Cerenkov radiation, Reaction Force of Radiation. Motion of Charged Particles in Electromagnetic Field, Uniform E and B Fields, Non-uniform Fields, Diffusion Across Magnetic Fields. Time Varying E and B Fields, Adiabatic Invariants: First, Second Third Adiabatic Invariants.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh
30/3/12	31/3/12	30/3/12	30/3/12	30/3/12	30/3/12	30/3/12

Unit3: Elementary Concept of Plasma

Plasma parameters, Mobility of charged particles; effect of magnetic field on the mobility of ions and electrons,Plasma Confinement, Pinch Effect, Instability in Pinched Plasma Column, Plasma Oscillations, Short Wavelength of Plasma Oscillation and Debye Shielding Distance.Dielectric Constant of Plasma; Quasi-neutrality of PlasmaDiffusion of electrons and ions, Formation of Van Allen Belt, Magnetoconvection and Sun spots, Solar Wind

Unit4: Wave Phenomena in Plasma

Hydrodynamical Description of Plasma, Hydromagnetic Waves; Alfven and Magnetosonic Waves, Wave Phenomena in Magnetoplasma;Polarization, Phase velocity, Group Velocity and Resonances, Electromagnetic waves propagating parallel and perpendicular to magnetic field, Appleton-Hartee formula and propagation through ionosphere and magnetosphere.Magnetohydrodynamic (MHD) equations, magnetic, viscosity, pressure, Reynold number, etc.

Text and Reference Books:

1. Panofsky &Phillps : Classical Electricity and Magnetism
2. Biltencourt : Plasma Physics.
3. Chen : Plasma Physics
4. Jackson : Classical Electrodynamics.
5. Electrodynamics by Kumar & Gupta & Singh.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Paper 8(70 + 30)

Practical (Electronics)

1. To Verify TRUTH TABLE of Half-Adder and use it to explain various possible combinations of LOGIC GATES in Half-Adder's circuit.

2. To Verify TRUTH TABLE of Full-Adder and use it to explain various possible combinations of LOGIC GATES in Full-Adder's circuit.

3. To Verify TRUTH TABLE of Half-Subtractor and use it to explain various possible combinations of LOGIC GATES in Half-Subtractor's circuit.

4. To Verify TRUTH TABLE of Full-Subtractor and use it to explain various possible combinations of LOGIC GATES in Full-Subtractor's circuit.

5.To study the temperature dependence of Hall coefficient of a given semiconductor.

6. Determination of Band gap of a given semiconductor material by four probe technique.

7. To Design and study an active Band Pass Filter.

8. To Design and Study a Current Controlled Oscillator.

9. To Design and Study a RC Phase Oscillator.

Other experiments would be added in due course.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

SEMESTER 3 (JULY TO DECEMBER)

Paper 9 (70 + 30)

STATISTICAL MECHANICS

Unit1: Fundamentals of Quantum Statistics

Quantum Mechanical Ensemble, Density Matrix, QuantumLiouville's Theorem, Density matrix for stationary ensembles (Micro canonical, Canonical and Grand canonical),Partition Function of a System of Free Particles, Free Particle in a Box, Harmonic oscillators, rigid rotators.Para magnetism, concept of negative temperature. Ideal Quantum Gas in Various Ensembles, Statistics of Occupation Numbers.

Unit2: Ideal Bose Gas

Properties and Thermodynamic Behaviour of Ideal Bose Gas, Bose-Einstein condensation, Liquid He, Transition in liquid He^4, Superfluidity in He^4, Photon gas, Planck's radiation law.Phonon gas, Debye's theory of specific heat of solids, Low Behaviour of Bose Gases.

Unit3: Ideal Fermi Gas

Properties of Ideal Fermi Gas and its Thermodynamic Behaviour, Review of the thermal and electrical properties of an ideal electron gas, Pauli Paramagnetism, Landau levels, Landau diamagnetism, White dwarf and Neutron stars, Statistical Model of Atoms.

Unit4: Interacting Systems

Cluster Expansion for Classical System, Radial Distribution Function, Thermodynamic Functions in terms of Radial Distribution Functions, Quantum Cluster Expansion, Weakly Interacting Bose Gas,Low Temperature Behaviour of Fermi Gases, Ising Model, Exact solution of one-dimensional Ising system (Matrix methods). Bragg-William's approximation (Mean field theory).

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Text and Reference Books:

1. Statistical and Thermal Physics by F. Reif.
2. Statistical Mechanics by K. Huang.
3. Statistical Mechanics by R.K. Pathria
4. Statistical Mechanics by R. Kubo
5. Statistical Physics by Landau and Lifshitz.

Paper 10 (70 + 30)

NUCLEAR AND PARTICLE PHYSICS

Unit1: Nuclear Reactions

Direct and Compound Nuclear Reaction Mechanisms, Expressions for Scattering and Reaction Cross Sections in Terms of Partial Wave Amplitudes, Resonance, Breit-Wigner Single-Level Formula, Tensor Forces, S and D States, Neutron-Proton and Proton-Proton Scattering, Effective Range Theory, Spin Dependence of Nuclear Forces, Charge Independence and Charge Symmetry of Nuclear Forces, Isospin Formulism.

Unit2: Nuclear Models

Single Particle Model of the Nucleus, Angular Momenta ans Parities of Nuclear Ground States, Qualitative Discussion and Estimates of Transition Rates, Magnetic Moment and Schmidt Support of the Model, Spin-Orbit Coupling, Magic Numbers, Introduction to Interacting Boson Model.

Unit3: Nuclear Decay

Electromagnetic Interactions in Nuclei, Transitions in Nuclei, Parity and Angular Momentum Element Synthesis, A Brief Review of Standard Model, Selection Rules, Internal Conversion, Fermi Theory of Beta Decay, Curie Plots, Comparative Half-Life, Allowed and Forbidden Transitions, Detection and Properties of Neutrinos, Gamma Decay, Nuclear Isomerism.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit4: Particle Physics

Quark Model of Nucleon, Charm, Bottom and Top Quarks and Higher Symmetry, Interaction Between Elementary Particles, Hadrons and Leptons, Quark-Gluon Interaction, Particle Physics and Thermodynamics in the Early Universe, Quark-Gluon Plasma, Stellar Evolution and Element Synthesis, A Brief Review of Standard Model.

Text and Reference Books:

1. Nuclear Physics : R.R. Roy and B.P. Nigam
2. Nuclear Physics :D.Halliday
3. Introduction to Nuclear Physics : H.A. Enge
4. Nuclear Physics : E. Fermi
5. Nuclear Physics : I Kaplan
6. Concepts of Nuclear Physics : B.L. Cohen
7. Nuclein-Nucleon interactions : G.E. Brown And A.D. Jackson.
8. Nuclear Interaction : Side Benedetti
9. Nuclear Structure, Vo.1 and Vol. 2 :A.Bohr and B.R. Mottelson.
10. Atomic Nucleus : R.D. Evans.

Paper 11(70 + 30)

COMPUTATIONAL PHYSICS AND PROGRAMMING

Unit1: Solution of Equations

Solution of Linear and Non-linear Algebraic Equations and Transcendental Equations, Convergence of Solutions, Solution of Simultaneous Linear Equations, Gaussian Elimination, Iterative Method, Matrix Inversion, Eigenvalues and Eigenvectors of Matrices.

Unit2: Differentiation, Integration and Fitting

Finite Differences, Interpolation with Evenly Spaced and Unevenly Spaced Data Points, Curve Fitting, Polynomial Least Square and Cubic Spline Fitting, Numerical Differentiation and Integration, Newton-Cotes Formula, Gauss Method.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit3: Differential Equations

Numerical Solution of Ordinary Differential Equations, Euler and Runge-Kutta Methods, Predictor and Corrector Method, Elementary Ideas of Solutions of Partial Differential Equations.

Unit4: Programming

Principles of Digital Computers, Compilers, Interpreters and Operating Systems, FORTRAN Programming, Flow Charts, Integer and Floating Point Arithmetic, Built in Functions, Executable and Non-executable Statements, Control and Input-Output Elements, Subscripted Variables, Subroutines and Functions, Simple FORTRAN Programs.

Text and Reference Books:

1. Sastry: Introductory Methods of Numerical Analysis.
2. VettermingTeukolsky, Press and Flannery: Numerical Recipes.
3. An Introduction to Numerical Analysis by Kendall E. Atkinson.

Paper 12 (70 + 30)

PRACTICAL (Numerical Analysis)

1. To find out roots of quadratic/cubic equations by the METHOD OF LINEAR INTERPOLATION; comparison with the analytically obtained results in case of quadratic equation. [Ex. $\mathbf{X^3 + X^2 - 3X - 3 = 0; 2X^2 - X - 6 = 0}$].

2. Evaluation of variables of set of linear equations by the METHOD OF SYSTEMATIC ELIMINATION (GAUSS METHOD)

   [Ex. $\mathbf{10x_1 - 7x_2 = 7}$
   $\mathbf{2x_2 + 6x_3 - 3x_1 = 4}$
   $\mathbf{5x_1 - x_2 + 5x_3 = 6}$]

3. Solution of set of linear equations by ITERATIVE METHOD (GAUSS-SIEDEL METHOD)

[Ex. $8x_1 - x_2 - x_3 = 8$

$2x_1 + x_2 - 9x_3 = 4$

$x_1 - 7x_2 + 2x_3 = -4$]

4. To use POLYNOMIAL FIT (LAGRANGIAN POLYNOMIAL METHOD) for the given data set & estimate of the data point at the given x value.

[Ex.

X_i	Y_i [=f(X_i)]
3.2	22.0
2.7	17.
1.0	14.2
4.8	38.3

5. Use of DIVIDED DIFFERENCE METHOD to obtain a smooth fit for the given set of data points.

[Ex.

X_i	Y_i [=f(X_i)]
3.2	22.0
2.7	17.
1.0	14.2
4.8	38.3

6. Use of FORWARD DIFFERENCE (NEWTON-GREGOTY) METHOD to differentiate the given function and comparison with the analytically obtained result.

[Ex. $f(x) = e^x$ (or, X^3)]

7. Use of the THREE-TERM FORMULA OF GAUSS QUADRATURE to evaluate the given integral.

[Ex. $I = \int_{-1}^{+1} (X^4 + X^2 + X + 1)\,dX$

8. Use of a TWO-TERM GAUSSIAN QUADRATURE FORMULA to evaluate integration of a trigonometric function and comparison of the same with the analytically obtained result.

[Ex. $I_1 = \int_0^{\pi/2} sinX dX \quad I_2 = \int_0^{\pi/2} cosX dX$]

9. Solution of a 1st order differential equation at the given X value by using the TAYLOR-SERIES METHOD.

[Ex. $\frac{dy}{dx} = X + Y$ with initial condition **Y(0) = 1**].

Note: All questions can be set with different simple functions or equations, as may be the case. Choice of the function /equation should preferably be such that it can be solved analytically, as well. It will ensure comparison between numerically and analytically obtained values.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr T. P. Singh

SEMESTER 4 (JANUARY TO JUNE)

Paper 13 (70 + 30)

ELECTIVE PAPER

13a LASER PHYSICS

Unit1: Basic Principle

Historical background of laser, Einstein coefficients and stimulated light amplification, population inversion, creation of population inversion in three level & four level lasers, Resonator, Stability, Various types of Resonators, Resonator for high gain and high energy lasers, Properties of Gaussian beam, Gaussian beam focusing.

Unit2: Different laser systems

Gas Lasers: Molecular gas lasers- CO_2 laser &N_2 ,Ionic gas laser – Ar^+ laser, high pressurepulsed gas laser,Solid State Laser: Nd:YAG laser, Nd:Glass laser, comparison of performances,Free electron laser; semiconductor diode laser

Unit3: Non – Linear Processes

Propagation of Electromagnetic waves in non-linear medium, Self – focussing, phase matching condition, Fibre lasers.Stimulated Raman scattering and Raman lasers, CARS, Saturation and Two photon absorptions.

Unit4: Novel Applications of Laser

Cooling and trapping of atoms, Principles of Doppler and Polarization gradient cooling Quantitative description of ion traps, Optical traps and magneto-optical traps, Evaporative cooling and Bose condensation.

30/3/12	31/03/12	30/3/12	31/3/12	31/3/12	30/3/12	30/3/12
Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Text and Reference Books

1. Laser Spectroscopy and Instrumentations : Demtroder
2. Laser Cooling and Trapping : Ghosh
3. Frontiers in Atomic, Molecular and Optical Physics : Sengupta
4. Principles of Lasers : Svelto

13b NUCLEAR PHYSICS

Unit1: Beta and Gamma decay

Fermi's theory of beta decay, allowed and forbidden transitions, selection rules, non-conservation of parity in beta decay, direct evidence for the neutrino, gamma–decay and selection rules (derivation of transition probabilities not required).

Unit2: Interaction of charged particles

Energy Loss of Charged Particles and gamma rays: Mechanism, Ionization formula, Stopping power and range, radiation detectors – multi-wire proportional counter, scintillation counter and Cerenkov detector.

Unit3: Reactor Physics

Slowing down of neutrons in a moderator, average log decrement of energy per collision, slowing down power, moderating ratio, slowing down density Fermi age equations, four-factor formula.

Unit4: High energy physics

Types of interaction in nature-typical strengths and time-scales, conservation laws, charge-conjugation, Parity and Time reversal, CPT theorem, Gell-Mann-Nishijima formula, intrinsic parity of pions, resonances, symmetry classification of elementary particles, quark hypothesis, charm, beauty and truth, gluons, quark-confinement, asymptotic freedom.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

13c PLASMA PHYSICS

Unit1: Elementary concepts

Plasma Oscillations, Debye Shielding, Plasma Parameters, Magneto-plasma, Plasma confinement (Pitch Effect, Magnetic Mirrors), Formation of Van Allen Belt.

Unit2: Hydro-dynamical Description of Plasma

Fundamental Equations, Hydro-magnetic Waves, Magneto-sonic and Alfven Waves, Magnetic convention and Sun Sports, Bipolar Magnetic Regions and Magnetic Buoyancy, Magnetized Winds (Solar Wind),

Unit3: Wave Phenomena in Magneto-plasma

Polarization, Phase Velocity, Group velocity, Cut-offs, Resonance for Electromagnetic Wave propagating Parallel and Perpendicular to the Magnetic field, Propagation At Finite Angle. Trapped Particle Motion (Collisions, Conductivity), Diffusion Along and Across Magnetic Field, Convection Electric Field, Ring Current.

Unit4:

Multi-fluid Theory, Equation of State, Frozen in Field Concept, Stationarity and Equilibria, MHD waves in Dipolar Magnetic Field, Sources of wave Energy and Instabilities. Boltzmann-Valsov Equation, Transport Equation, Landau Damping, Wave Amplification, Role of Magnetic Field, Waves in Planetary Magneto-sphere.

Text and Reference Books

1. Basic space Plasma Physics : Baumjohau
2. Plasma Physics : Bittencourt
3. Plasma Physics and Controlled Fusion : Chen

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int Member 4
Prof.MadanJee	Prof. N K Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh

Unit1: Transmission Line

Transmission Line and Wave guide Basic Line equations, general solution for a Line terminated by an impedance, Reflection coefficient, Impedance matching, Concept of guided wave, Propagation through rectangular wave guide, T.E. and T.M. modes of propagation.

Unit2: Microwave electronics

Principles of velocity modulation, cause of low efficiency of conventional valves as amplifiers and oscillators at ultra high frequencies, Cavity Resonators, Basic principles of two cavity Klystrons, Reflex Klystrons, Magnetron, Travelling Wave Tube.

Unit3: Filters

Classical theory and design of constant K-type Filter, Modern Filter theory, Second Order Active Filters, Low pass, high pass, Band pass, Band reject, Butterworth and equal component, Sallen – Key filters.

Unit4: Microprocessor

Number and character representation, Essentials of micro computer hardware, Memory organization central processing unit organisation, Addressing technique, Assembly language, Typical Instruction sets. Input and output techniques, Interrupt technique.Architecture of 8086 / 8088 Intel Microprocessor.

Ex. Member1	Ex. Member2	Int. Member1	Int. Member2	Int. Member3	HOD Physics	Int. Member4
Prof.MadanJee	Prof. N P. Singh	Prof. R P Singh	Dr. G P Tiwary	Dr. V. Kumar	Dr. A. Kumar	Dr. T. P. Singh