SYLLABUS FOR M.Sc IN PHYSICS
FOR THE SESSION 2005-06 AND OWRAD

Reference: No.381-41/Acad-II dated 15-8-2005 Annexure III, Part –D
Updated on 16/02/2015

M.Sc. (Physics) Courses are divided into the following categories.

1. M.Sc. Physics program (General) (Option-I)
2. M.Sc. Physics With Specialization (Option-II)
   i. Specialization in Solid State Physics. (Category-i)
   ii. Specialization in Nuclear Physics. (Category-ii)
   iii. Specialization in Digital Communication. (Category-iii)
   iv. Specialization in Microwave Communication. (Category-iv)
   v. Specialization in Nuclear Radiations. (Category-v)
   vi. Specialization in Computational Physics (Category-vi)
   vii. Specialization in Medical Physics (Category-vii)
   viii. Specialization in Electronics. (Category-viii)
   ix. Specialization in Geophysics (Category-ix)
   x. Specialization in Materials Physics (Category-x)
   xi. Specialization in Plasma Physics (Category-xi)
   xii. Specialization in Environmental Physics (Category-xii)

1. M.Sc. Physics Program (General)

M.Sc. Physics (Part-I)
There is no change in the courses or the weights given to the courses in this category. The existing courses will run as they are, both in M.Sc. Physics (Part I) and (Part II). The structure of the M.Sc. (Part I) is as under.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-511 Mathematical Methods of Physics</td>
<td>I</td>
<td>100</td>
</tr>
<tr>
<td>PHY-512 Electrodynamics</td>
<td>II</td>
<td>100</td>
</tr>
<tr>
<td>PHY-513 Classical Mechanics</td>
<td>III</td>
<td>50</td>
</tr>
<tr>
<td>PHY-514 Thermal Physics and Statistical Mechanics</td>
<td>IV</td>
<td>50</td>
</tr>
<tr>
<td>PHY-515 Atomic and Molecular Physics</td>
<td>V</td>
<td>100</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab-I</td>
</tr>
<tr>
<td>Lab-II</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</table>

M.Sc. Physics (Part-II)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-632 Electronics</td>
<td>VII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab-III</td>
</tr>
<tr>
<td>Lab-IV</td>
</tr>
<tr>
<td>Comprehensive Viva-Voce</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

2. M.Sc. Physics with Specialization
The specialized scheme is offered in the M.Sc (Part II), preferably after a successful completion of the M.Sc. (Part I). The distribution of the courses is as under:

Specialization in Solid State Physics (Category-i)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-638 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
</tr>
</tbody>
</table>
PHY-633 Solid State Physics VIII 100
PHY-634 Nuclear Physics IX 100
PHY-635 Special Solid State Physics X 50

Laboratories:
Lab-III 50
Lab-IV 50
Comprehensive Viva-Voce 100
Total 600

Specialization in Nuclear Physics (Category-ii)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-638 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
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<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
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<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
</tr>
<tr>
<td>PHY-636 Special Nuclear Physics</td>
<td>XI</td>
<td>50</td>
</tr>
</tbody>
</table>

Laboratories
Lab-III 50
Lab-IV 50
Comprehensive Viva-Voce 100
Total 600

Specialization in Digital Communication (Category-iii)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-632 Electronics</td>
<td>VII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-639 Introductory Nuclear Physics</td>
<td>XIV</td>
<td>50</td>
</tr>
<tr>
<td>PHY-637 Digital Communication</td>
<td>XII</td>
<td>100</td>
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</tbody>
</table>

Laboratories
Lab-III 50
Digital Signal Processing Lab 50
THES-649 50
Total 600

Specialization in Microwave Communication (Category-iv)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-632 Electronics</td>
<td>VII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-639 Introductory Nuclear Physics</td>
<td>XIV</td>
<td>50</td>
</tr>
<tr>
<td>PHY-6310 Microwave Communication</td>
<td>XV</td>
<td>100</td>
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</tbody>
</table>

Laboratories
Lab-III 50
Microwave Laboratory 50
THES-649 50
Total 600

Specialization in Nuclear Radiation (Category-v)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-638 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
</tr>
</tbody>
</table>
PHY-633 Solid State Physics  
PHY-634 Nuclear Physics  
PHY-6311 Nuclear and radiation Physics

**Laboratories**
- Lab-III  
- Lab-IV  
- THES-649

**Total** 600

**Specialization in Computational Physics (Category-vi)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-638 Introductory Electronics</td>
<td>XIII</td>
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<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
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<tr>
<td>PHY-6312 Computational Physics</td>
<td>XVII</td>
<td>75</td>
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**Laboratories**
- Lab-III  
- Lab-IV  
- Computational Laboratory  
- THES-649

**Total** 600

**Specialization in Medical Physics (Category-vii)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-638 Introductory Electronics</td>
<td>XIII</td>
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<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
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<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
</tr>
<tr>
<td>PHY-6313 Medical Physics</td>
<td>XVIII</td>
<td>100</td>
</tr>
</tbody>
</table>

**Laboratories**
- Lab-III  
- Lab-IV  
- THES-649

**Total** 600

**Specialization in Electronics (Category-viii)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-632 Electronics</td>
<td>VII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-639 Introductory Nuclear Physics</td>
<td>XIV</td>
<td>50</td>
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<tr>
<td>PHY-6314 Advanced Electronics Circuit Theory</td>
<td>XIX</td>
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</table>

**Laboratories**
- Lab-III  
- Lab-IV  
- THES-649

**Total** 600

**Specialization in Geophysics (Category-ix)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
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<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
</tbody>
</table>
PHY-634 Nuclear Physics  IX  100
PHY-638 Introductory Electronics  XIII  50
PHY-6315 Geo-Physics  XX  100

**Laboratories:**
Lab-III  50
Lab-IV  50
THES-649  50

**Total 600**

**Specialization in Materials Physics (Category-x)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-636 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
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<tr>
<td>PHY-6316 Special Material Physics</td>
<td>XXI</td>
<td>50</td>
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</tbody>
</table>

**Laboratories:**
Lab-III  50
Lab-IV  50
THES-649  100

**Total 600**

**Specialization in Plasma Physics (Category-xi)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-636 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
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<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
</tr>
<tr>
<td>PHY-6317 Special Plasma Physics</td>
<td>XXII</td>
<td>50</td>
</tr>
</tbody>
</table>

**Laboratories:**
Lab-III  50
Lab-IV  50
THES-649  100

**Total 600**

**Specialization in Environmental Physics (Category-xii)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Paper</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY-631 Quantum Mechanics</td>
<td>VI</td>
<td>100</td>
</tr>
<tr>
<td>PHY-633 Solid State Physics</td>
<td>VIII</td>
<td>100</td>
</tr>
<tr>
<td>PHY-636 Introductory Electronics</td>
<td>XIII</td>
<td>50</td>
</tr>
<tr>
<td>PHY-634 Nuclear Physics</td>
<td>IX</td>
<td>100</td>
</tr>
<tr>
<td>PHY-6318 Special Environmental Physics</td>
<td>XXIII</td>
<td>75</td>
</tr>
</tbody>
</table>

**Laboratories:**
Lab-III  50
Lab-IV  50
Computational Laboratory  25
THES-649  50

**Total 600**

**Note**

Present we have merged three laboratories namely “Atomic and Molecular Physics Lab”, “General Physics Lab” and “Optics and Spectroscopy Lab” are reshaped/regrouped as Lab-I and Lab-II, for the M.Sc. Part I. Similarly the labs “Electronics Lab”, “Solid State Physics Lab” and “Nuclear physics Lab” for MSc. Part II are revised into Lab-III and Lab-IV. There are also some special laboratories in for M.Sc. Par II such as Digital Signal Processing. These laboratories have to be strengthened up to the level of UGC curriculum. Digital Signal Processing laboratory has to
be enhanced to have hardware for the understanding of the fundamental concepts involved A/D and D/A converts, and basic types of audio and video digital filters. Microwave Laboratory has to be set up for the Microwave Communication. We have also Centralized Resource Laboratory for Material Science, which can be used for the understanding of the crystal structure. External examiners as well as internal examiners will be appointed for each laboratory. The Chairman of the Department will be ex-officio-internal examiner for all the laboratories.

### COURSE CONTENTS OF M.Sc. (PART-I)

**PHY-511 MATHEMATICAL METHODS OF PHYSICS (Paper-I)**  
**Marks: 100**

Vectors in Classical Physics: Differentiation of vectors, Fields, Directional derivatives and gradients, Line integrals, Green’s theorem in the plane, Divergence and divergence theorem. The Curl and Stokes’s theorem


Complex Variable, Functions of a complex variable, Catchy Riemann conditions and analytic functions, Catchy integral theorem and integral formula, Taylor and Laurent series. Fourier series, Examples of Fourier series, pointwise and mean convergence of Fourier series, Applications of Fourier Series. Calculus of residue, Complex integration

Linear Vector Spaces and Matrices, Linear vector spaces, Gram-Schmidt orthogonalization, Matrices, Eigen-values and eigenvectors of a matrix, Hilbert spaces, Orthogonalization.

Special Functions, Bessel functions and Hankel functions, Spherical Bessel functions, Legendre polynomials, Associated Legendre polynomials, Spherical harmonic Laguerre polynomials, Hermite polynomials.


Tensors in Physics, Tensor algebra, vectors of manifolds, the fundamental tensor, Tensors in non-relativistic Physics.

Boundary Value Problems and Green’s Functions: Boundary value problems in Physics, Non-Homogeneous boundary value problems and Green’s functions, k Green’s functions for one dimensional problem, Eigen-function expansion of Green’s function. Construction of Green’s functions Green’s functions in higher dimensions.

Group Theory, Groups, Invariant subgroups and factor groups, Group representation, Character of a representation, Character tables, Decomposition of a reducible representation into irreducible ones, Lie groups and lie algebras.

**BOOKS RECOMMENDED**


**PHY-512 ELECTRODYNAMICS (Paper-II)**  
**Marks: 100**

Fundamental Concepts, Recapitulation of the fundamental concepts, Induction B, Magnetic intensity H, Maxwell’s equations in differential and integral forms, Poynting theorem and energy conservation.
Boundary value Problems: Poisson and Laplace’s equations in spherical and cylindrical coordinates, conducting sphere in a uniform electric field, cylindrical harmonics. Electrical images: a point charge near a conducting plane, a point charge and conducting sphere, line charge and line image.

Static Electromagnetic Fields, Electrostatic fields in several dielectric media, Magneto static fields of magnetized matter, Magnetostatic field of stationary current, Magnetization current.

Time Dependent Electromagnetic Fields, Maxwell’s equations for quasi stationery fields, Potentials of a rapidly varying field, Fields of uniformly moving and accelerated charges, Radiation from an accelerated charge, Field of oscillating magnetic fields, multiple fields.

Reflection Refraction of Electromagnetic Waves, Laws of reflection and refraction, Fresnel’s formula, Total reflection, Refraction in a conducting media, Reflection from a conducting surface.


Skin Effect and Wave Guides, Higher frequency current in a semi infinite conductor, internal impedance at high frequencies, Waves guided by parallel plane conductor, Transmission by a rectangular. Power transfer and attenuation, Wave guides as cavity resonators, Q of a cavity resonator, Waves guided by dielectrics.

Electrodynamics and Special Relativity, Covariance of Maxwell’s equations, Principle of Lorentz transformation and applications, the four vector systems, Transformation of electromagnetic field vectors and potentials, The Doppler effect, Covariant formulation of Physical laws and vacuum electrodynamics, The Lorentz force, Motion of a charge in electromagnetic field, Electromagnetic Momentum – Energy tensor.

BOOKS RECOMMENDED


PHY-513 CLASSICAL MECHANICS (Paper-III)  

Elementary principles, Brief survey of Newtonian mechanics of a single particle and system of particles, Constraints, D’ Alembert’s principle, Lagrange’s equations for conservative and non-conservative systems and their applications.

Variational Principles, Calculus of variation and Hamilton’s some techniques of calculus of variation, Application of Variation principle. Derivation of Lagrange’s equations from Hamilton’s principle.

Two Body Central Force problem, Two body problem and its reduction to one body equivalent problem, equation of motion and solution for one body problem, Kepler’s laws, laboratory and center of mass coordinate systems and their mutual transformations, Rutherford Scattering formula.

Hamilton’s Equation of motion, Hamiltonian functions, Legendre transformation and Hamilton’s equation of motion, conservation theorems, cyclic coordinates, Physical significance of Hamiltonian for simple cases.

Canonical Transformations, Examples of canonical transformations, Lagrange’s and Poisson’s brackets, Condition for transformation to Canonical Legendre equation of motion, Liouville’s theorem

BOOKS RECOMMENDED


**PHY-514 THERMAL PHYSICS AND STATISTICAL MECHANICS (Paper-IV)  Marks: 50**

Equilibrium Thermodynamics, Basic postulates, fundamental equations and equations of state, response functions Maxwell’s relations, reduction of derivatives. Cavity radiators and Black body radiations, Kirchhoff’s laws, radiation density and pressure of radiation, Stefan’s law, Wein’s Law, Rayleigh Jean’s law, and their inadequacies, Planck’s law.

Elements of Probability Theory, Probabilities, thermodynamic Probabilities, statistical interpretation of entropy, Boltzmann H-theory,

Formulation of Statistical Methods, Ensembles, counting of states (in classical and quantum mechanical systems with examples)


Partition Function, Relation with thermodynamic variables, examples (collection of simple harmonic oscillators, Pauli and Van Vleck paramagnetic, Theorem of equipartition of energy).

Statistical Mechanics of Interacting Systems, Lattice vibrations in solids; Van der Waals Gas: mean field calculation; Ferromagnets in Mean Field Approximation.

**BOOKS RECOMMENDED**


**PHY-515 ATOMIC AND MOLECULAR PHYSICS (Paper-V)  Marks: 100**


Normal Zeeman Effect, Spin-Orbit coupling, Exclusion principal, Electron configuration in many-electron atoms, Hund’s electron spectra, X-ray spectra.

X-rays, Production of X-rays, measurement of the intensity of X-rays, Diffraction of X-rays and Bragg’s law, single Crystal X-ray spectrometer, typical X-ray spectra, diffraction of X-rays Spectra, X-ray powder crystal diffraction, the scattering of X-rays by the atoms and number of electron per atom, characteristic X-ray spectra, X-ray energy level diagram, X-ray absorption spectra, X-ray critical voltage, X-ray terms and selection rules, Radiation less transitions, Auger Effect, production of characteristic X-ray spectra, Related problems.


Rotational Energy Levels, Diatomic molecules, Ploy-atomic molecules, Vibrational energy-levels, Vibration-rotation spectra, Electronic spectra.
BOOKS RECOMMENDED


COURSE CONTENTS OF M.Sc. (PART-II)

PHY-631 QUANTUM MECHANICS (Paper-VI)          Marks: 100


Formalism of Quantum Mechanics, The state of a system, Dynamical variables and operators, Commuting observable, Heisenberg uncertainty relations, Time evaluation of a system, Schrodinger and Heisenberg pictures, symmetry principles and conservation laws.

Angular Momentum, Orbital angular momentum, Angular momentum and rotations, The eigenvalues and eigen functions of Land Lz, Matrix representation of angular momentum operators, Spin angular momenta, Addition of angular momenta.

Schrodinger Equation in Three Dimensions: Separation of Schrodinger equation in Cartesian coordinates, Central potentials, the free particle, and three dimensional squares well potential, the hydrogen atom, three dimensional isotropic oscillator.

Approximate Methods, Time independent perturbation theory for non degenerate levels, the variational method, The WKB approximation, and Time dependent perturbation theory.

Identical Particles and Second Quantization: Indistinguishability of identical particles, Systems of identical particles, Quantum dynamics of identical particle systems, Angular momenta and spin ½ boson operators.


Relativistic Quantum Mechanics: Schrodinger relativistic equation, Probability and current densities, Klein-Gordon equation and hydrogen atom Dirac relativistic equation,

BOOKS RECOMMENDED

PHY-632 ELECTRONICS (PAPER-VII)  Marks: 100

DC circuit analysis, circuit theorems: Kirchhoff’s laws, superposition, reciprocity theorem, Thevenin and Norton’s theorems, maximum power transfer theorem.

AC circuit analysis, Circuit transient; capacitor and inductor as circuit elements: wave shaping. Network analysis in frequency domain; mesh current method, node voltage method, thevenin’s and Norton’s methods. RLC series and parallel resonance circuits, Q-factor, low pass, high pass circuits, differentiating and integrating circuits.


BJT, CB, CE and CC biasing circuits, stability factors, bias compensation. Quiescent point, Graphical method, dc and ac load lines. Approximate methods.

BJT. As small signal low frequency amplifier: Circuit models for the transistor, input/output impedances, current and voltage gains, and input/output phase relationship. Low frequency analysis, Bode plots.

Feedback amplifiers: The concept of feedback, feedback connections, feedback amplifiers (Phase and frequency considerate) positive feedback, stability analysis, and oscillation. Basic oscillator circuits, Phase-shift, Colpitts, Hartley and crystal oscillators.

Small signal high frequency amplifier, BJT circuit models, frequency analysis, general frequency considerations, gain-bandwidth trade-off, Bode diagram, Zeros and poles.

Operational amplifiers, 741 operational amplifiers: Basic characteristics, DC offset parameters, Non-inverting and inverting, differentiator and integrator, voltage summing, voltage buffer. High pass, low pass and band pass filters of elementary level.

Power amplifiers: Compound configuration, Cascade and cascade connections, Darlington and complementary symmetry pairs, Class A, Class B, Class C and Class D amplifications, and auto frequency amplifiers.


Special devices: SCR, DIAC, TRIAC, Unijunction transistor as circuit elements, circuit models and elementary level circuits involving these elements.

BOOKS RECOMMENDED

PHY-633 SOLID STATE PHYSICS (Paper-VIII)  
Marks: 100

Crystal Growth and Structure, Equilibrium phase diagrams and growth kinetics, Equilibrium Freezing, Principles of zone melting, Nucleation, Various methods of crystal growth, A Review of crystal structure and diffraction, Scattering from atoms and crystals, Diffraction conditions and intensities.


Free Electron Theory, Classical theory, Sommerfield model, Quantum mechanical treatment, Fermi Dirac statistics, and applications.

Band Theory, Block theorem, Kroning-Penny model, Ziman model, Feynman model, applications, Nearly Free electron approximation, and tight binding approximation.

Lattice Dynamics, Vibration of one-dimensional mono as well as diatomic lattices, Vibrational modes of crystals, Optical modes in ionic crystals, Scattering and interactions of phonons.

Semiconductors, Theory of semiconductors, Extrinsic semiconductors, Mobility of current carriers, Minority carriers, Life time, Surfaces, Contacts Semiconductor devices; Theory of p.n. junctions, tunneling, p-n junction devices and their circuit models.

Dielectric Properties, Terminology, Equivalent circuits, Mechanisms of polarization, Effective field, Electronic, ionic and Orientational polarization, distortional and interfacial polarization.

Magnetism, Weiss theory of electromagnetism, Ferromagnetism, Para magnetism and diamagnetism.

BOOKS RECOMMENDED

PHY-634 NUCLEAR PHYSICS (Paper-IX)  
Marks: 100

Basic Properties of Nucleus, Nuclear size, mass, binding energy, semi empirical mass formula, angular momentum, nuclear moment, parity and statistics, quadrupole moment. Aston and Bainbridge mass spectrometer

Nuclear Models, Liquid Drop Model, Calculation of semi empirical formula, Shell model, Collective model.

Nuclear Forces, Central and non central forces, Nuclear potentials (exponential, Square-well, Gaussian And Yukawa); Bartlett and Majorana exchange forces, Yukawa’s theory of nuclear forces.
Nuclear Reactions, Direct reactions, Reactions involving the formulations of compound nucleus, Stripping reactions, Resonance reactions, Bohr’s theory of compound nucleus and its limitations, Breit-Wigner one level formula including the effect of angular momentum. Cross section for nuclear reactions

Theories of Radioactive decay, Alpha Decay Energy, range, ionization potential and stopping power of alpha particles, Quantum mechanical theory of alpha decay, alpha particle spectra, long range particles and fine structure, nuclear energy levels, Beta Decay, Energy, velocity, and range of beta particle, Fermi’s theory of beta decay, Neutrino hypothesis, direct evidence of anti-neutrino, non-conservation of parity, Gamma Decay, Energy, range and nature of gamma rays, theory of gamma decay, classification of gamma decays, internal conversion.


Nuclear Radiation Detection and Measurements, Interaction of nuclear radiation with matter, photographic emulsions, Gas-filled detectors, Scintillation counters and solid state detectors, Cloud chambers and bubble chambers.

Elementary Reactor Physics, Strong, electromagnetic and weak interactions, Conservation laws, Violation of parity Conservation in weak interactions, neutrino and anti-neutrino, direct evidence of antineutrino, muons, the mean life of muons, spin and magnetic moment of muons, the pions, spin and mean-life of charged and neutral pions, the strange particles, k-mesons, hyperons and hyprefragments.

Neutron Physics, Neutron sources, Radioactive sources. Photo neutron sources, charged particle sources, Reactor as a neutron source, slow neutron detectors, fast neutron detectors, measurement of neutron cross-section as a function of energy, slowing down of neutrons, nuclear fission, Description of fission reaction, Mass and energy distribution of fission fragments, average number of neutron released, theory of fission and spontaneous fission, nuclear chain reaction and application.

Thermonuclear Reactions K, Mechanism of fusion process, Energy released in fusion process, Sources of energy in stars controlled thermonuclear fusion, The Pinch effect and its types.

BOOKS RECOMMENDED


PHY-635 SPECIAL SOLID STATE PHYSICS (Paper-X)  Marks: 50

Crystal Defects, Point defects: line defects, surface defects, volume defects. Importance of crystal defects in relation to the properties of materials (introduction)

Phase Transformation, Equilibrium phase diagram for complete and portal miscibility, phase changes in materials, Eutectic, Eutectoid, peritectic, pertitectoid, hyper eutectoid and hypo-eutectoid reactions, martensites, commercial alloys, Iron-Carbon system, Alloy Steel, Aluminum- Copper system, Copper Zinc system, Strengthening mechanism, Heat Treatment.
Ceramics and Composite, Introduction to ceramics, crystal structures of ceramics, AX type, AmXp type, AmBnXp type structures, Imperfections in ceramics, impurities in ceramics, Stress Strain behavior of ceramics, Introduction to Composites, Microscopic composites, Dispersion strengthened composites, Particle reinforced composites, fire reinforce composites, Matrix phase, fire phase, Influence of fire length, orientation and concentration Metal-Matrix fire composites, Hybrid Composites, Macroscopic Composites, Composites, Structure Laminates.


Superconductivity, Introduction, Type I and type II superconductors, Meissner Effect, Critical Temperature and Critical Field, BCS theory.

BOOKS RECOMMENDED


PHY-636 SPECIAL NUCLEAR PHYSICS (Paper XI) Marks.50

Nuclear Structure and Spectroscopy, Semi-empirical mass formula, detailed study of symmetry effects, nuclear angular momentum and nuclear states, shell model, liquid drop model and optical model, theory of deuteron.


Elementary Particles, Brief introduction of nuclear forces, basic properties of elementary particles, decay schemes and conservation laws.

Nuclear Fission, Fusion and Plasma, Theory of Nuclear Fission and Nuclear Fusion, Sub-Critical and super-critical chain reactions, Controlled thermonuclear reactions, confinement of plasma, Kurchatov experiment for the confinement of plasma.

BOOKS RECOMMENDED


PHY-637 DIGITAL COMMUNICATION (Paper–XII) Marks: 100

Theory of Signals, Introduction to communication systems, signals and systems, classification of signals, Fourier Series and Transforms., Parseval’s relation, Frequency-domain, Time-domain and spatial-domain, concepts of
signals processing, convolution, band limiting of waveforms, energy and power spectral densities, autocorrelation and cross correlation of periodic and non-periodic signals, Wiener-Khinchin theorem, sampling theorem.

Analogue Modulation systems, Amplitude Modulation: Mathematical representation of AM modulation, frequency spectrum and power relation in the AM wave, frequency translation, recovery of the base-band signal, maximum allowable modulation, the square-law demodulator, modulator spectrum, single-sideband modulator, balanced modulator, vestigial sideband and compatible single sideband modulator, frequency multiplexing, a base-band signal receiver. Frequency Modulation: Angle and phase modulation, spectrum of FM modulation, modulation index, bandwidth of modulated signals, frequency multiplication, FM demodulator.

Digital Modulation systems, Pulse amplitude, pulse width, pulse position and pulse code modulation, bandwidth requirements, generation and detection of PAM, PWM, PPM and PCM signals, quantization of signals, electrical representation of binary digits, techniques of digital modulation, probability error in digital modulation schemes.


Analogue and Digital Filters, Laplace Transform, Z-Transform, Low pass and high pass filters (Butterworth and Chebyshev types), introduction to digital filters, and design of digital filters.

Information Theory and Coding, Discreet messages, concept of amount of information, average information, entropy, information rate, Shannon’s theorem, channel capacity, relationship between bandwidth and signal-to-noise ratio, polynomial coding, hamming coding, parity check coding, coding for error detection and correction, convolution error control code, upper bound of the probability error with coding, comparison of error rates in coded and uncoded transmission.

Data Transmission and Networks, Introduction, Switching centers, packet switching centers, packet format, software control, store and forward, protocols, error correction and detection, Hagen burger error correcting system.

BOOKS RECOMMENDED

5. Communication system by Hayking.

PHY-638 INTRODUCTORY ELECTRONICS (Paper-XIII)  
Marks: 50

Semiconductor diode and applications, Diode, characteristics, applications as half and full wave rectifiers, bridge rectifier, simple capacitor input filter, diode detector.

Transistor amplifiers, Transistor, characteristics in CE & CB configurations, use as CE, CB & CC amplifier, graphical treatment of CE amplifier, self-biasing, frequency- bandwidth of an amplifier.

Transistor Oscillators, Negative and positive feedback, transistor as an oscillator phase shift, Hertley and Collpit oscillators.

Special Circuit, Devices, FET,UJT, Darlingston pair, complementary symmetry, Logic gates (AND, NAND, OR NOR, INVETER).

BOOKS RECOMMENDED


**PHY-639 INTRODUCTORY NUCLEAR PHYSICS (Paper XIV)**

**Marks: 50**

Basic properties of Nucleus, Size of the Nucleus, mass of nucleus, isotopic masses, Energy and mass units, spin moments of nucleus, parity, and statistics.

Particle Accelerators, Electrostatic Accelerators, the Cyclotron, the Betatron, Linear Accelerators, Frequency-Modulated Cyclotron, Electron Synchrotron, Proton Synchrotron.

Beam Transport and Detecting Devices, Bending magnets, Quadrupole magnets, Velocity Spectrometers, photographic Emulsion, Gas-Filled Detectors, Scintillation Counters and solid State Detectors, Cerenkov Counters, Cloud Chambers, Principles of particle identification.


Nuclear Reactions, Discovery of Artificial Disintegration, The (x,p) Reaction the (x,m) Reaction, simple Alpha particle capture, Radioactive Capture, Disintegration by proton, Deuteron, Photons, Neutron, Electron Capture by Nuclei.

Fission and Fusion of Nuclei, Discovery of nuclear fission, fission of Uranium, Energies of the fission fragments, neutrons from thermal fission of U. Energy of neutrons tertiary fission U, Delayed Neutron, Spontaneous fission, Fission of heavy nuclei, fission of lighter nuclei, fission of heavy nuclei, chain reaction process within a reactor, types of nuclear reactors, transuranin elements, stellar energy of nuclear origin, stellar fusion of light Nuclei.


**BOOKS RECOMMENDED**


**PHY-6310 MICROWAVE COMMUNICATION (Paper XV)**

**Marks: 100**

Radio-wave propagation, Factors involved in propagation of radio waves, ground wave propagation, space wave propagation, reflection of waves by Earth, effects of earth imperfection and geographical terrain, maximum usable frequency, extended range propagation.

Guided Waves, Transmission lines, characteristic impedance, Schmith Chart, impedance matching, TE and TM waves, cutoff frequencies, coaxial cable, conducting wave guides, dielectric slab wave guides, optical fiber, micro strip, micro strip as a transmission line.
Modulation, Demodulation and Noise, Need for modulation, amplitude and frequency modulation, recovery of the base-band signal, maximum allowable modulation, the square-law demodulator, modulator spectrum, single-sideband modulator, balanced modulator, method of generating SSB modulator, vestigial sideband and compatible single sideband modulator, sources of noise.

Microwave Circuit Analysis, Microwave amplifiers, equivalent circuits of microwave amplifiers, small signal amplifications, frequency bandwidth and power output, microwave oscillators, equivalent circuits of microwave oscillators, frequency of oscillation of single resonator line and coaxial resonator-line.

Antennae: Short electric dipole, antenna radiation resistance, gain and effective aperture, Array theory, horizontal and vertical pattern, introduction to various antenna (e.g. linear, traveling waves, small loop, helical etc), micro strip as an antenna, radiation from a micro strip antenna.


Geostationary and Sun-synchronous Satellites, satellite position (Clark’s orbit), antenna alignment, satellite charts, path losses, uplink and downlink, TDMA in satellite communication, factors involved in determining the performance of digital satellite linked, INTELSAT IV and INTELSATV.

BOOKS RECOMMENDED


PHY-6311 NUCLEAR AND RADIATION PHYSICS (Paper XVI) Marks: 100

Dosimetry, Absorbed dose, unit of absorbed dose, equivalent dose, effective dose, Kerma, Roentgen, Related problems.

Biological Effects of Radiation, Interaction of Radiation with Human body, deterministic effect, stochastic effects, RBE (Radiobiological effectiveness), cell cycle and radio-sensitivity, fractionation and radio-sensitivity, the oxygen effect, Tissue Control Probability (TCP) and Normal Tissue Complication Probability (NTCP). Related problems.

Radiological Protection and Management, Severity of dose, source of radiation, Radiation protection factors distance, time, activity, annual limit of intake, radioactive waste and its classification, management of radioactive waste (disposal of low, intermediate and high level waste). Related problems.

Radiation Detection, Gamma Camera, Ionization Chamber, Scintillation counter, (organic & inorganic).

Basic Scattering Theory and Reaction Rate, Rate of reaction, cross-section, and general theory of scattering. Concept of differential and total scattering cross section, neutron-proton scattering, proton-proton scattering and neutron-neutron scattering. Related problems.

Elementary Particles, Brief introduction of nuclear forces, basic properties of elementary particles, decay schemes and conservation laws.


Reactor Physics and Diffusion Theory, Theory of nuclear reactors, mechanism of reactors critical mass/size, diffusion theory, neutron flux, mean crow flight distance, related topics and problems

BOOKS RECOMMENDED

**PHY-6312 COMPUTATIONAL PHYSICS (Paper XVII)**

Marks: 75

Numerical Methods, Numerical Solutions of equations, Regression and interpolations, Numerical integration and differentiation. Error analysis and technique for elimination of systematic and random errors

Modeling & Simulations, Conceptual models, The Mathematical models, random numbers and random walk doing Physics with random numbers computer simulation. Relationship of modeling and simulation. Some systems of interest for Physicists such as motion of falling objects, Keplers problems, Oscillatory motion, Many particle systems, Dynamic systems, wave phenomena, field of static charges and current diffusion, populations genetics etc.

Computer Language, A level language or Computational Software such as Mat-lab

**BOOKS RECOMMENDED**


**PHY-6313 MEDICAL PHYSICS (Paper XVIII)**

Marks: 100

**PHY-6314 ADVANCED ELECTRONIC CIRCUIT THEORY (Paper XIX)**

Marks: 100

**PHY-6315 GEO-PHYSICS (Paper XX)**

Marks: 100

**PHY-6316 SPECIAL MATERIAL PHYSICS (Paper XXI)**

Marks: 50

Types of Materials, Introduction to various types of materials, single and multiphase materials, metals and alloys, ceramics, glasses, glass-ceramics, composites, polymers, Advanced nano-materials

Structure of Materials, Atomic bonding, Primary and secondary bonding, amorphous and crystalline materials, Crystal structures (Single and polycrystalline), Crystal systems, Polymorphism, Rules for packing of ionic materials, Types of ionic materials, Imperfections and Impurities in materials, Perovskite and spinel structures.

Processing, phase and microstructural analysis, Material designing and processing, Solubility limit, Solid solutions, Gibbs phase rule, Hume-Rothery rules, Unary and binary phase diagrams, Proper and improper binary systems, Scattering of X-rays by materials, phase analysis, micro-structural analysis of materials using optical and scanning electron microscopy.
Properties of materials, Mechanical, electrical, dielectric, optical and magnetic properties of materials in terms of atomic behavior, composition-microstructure-property-relationships


BOOKS RECOMMENDED


PHY-6317 SPECIAL PLASMA PHYSICS (Paper XXII)  

Occurrence of plasma in nature, definition of Plasma, concept of temperature, Debye Shielding, the plasma parameters, Criteria of plasma, application of Plasma, single particle motion in uniform E and B fields in non uniform E and B fields, time varying , Adiabatic Invariants, the fluid Equation of motion, Fluid drifts perpendicular to B field, electron plasma waves, sound waves, ion waves, validity of the plasma approximation, comparison of ion and electron waves, electrostatic ion waves perpendicular to B, the lower hybrid frequency, electromagnetic waves with B = 0, electromagnetic waves perpendicular to B, cut offs and resonance, electromagnetic waves parallel to B, hydro magnetic waves, magneto sonic waves.

BOOKS RECOMMENDED:


PHY-6318 SPECIAL ENVIRONMENTAL PHYSICS (Paper XXIII)  

Introduction the Essentials of Environmental Physics, The econ system, living in green house, enjoying the sun, transport of matter, energy and momentum, the social and political context.

Basic Environmental Spectroscopy: Black body radiation, the emission spectrum of Sun, the transition electric dipole moment, the Einstein coefficients, Lambert -Beer's Law, the spectroscopy of bio molecules, solar uv and life, the ozone filler.

The Global Climate, The energy balance, a zero-dimensional Greenhouse Model, elements of weather and climate, climate variations and modeling.

Transport of Pollutants, Diffusion, flow in rivers, ground water flow, equations of fluid dynamics, turbulence, turbulence diffusion, Gaussian plumes in air, turbulent jets and planes.

Radiation: General laws of radiation, natural Radiation, interaction of electromagnetic radiation and plants, utilization of photo synthetically active radiation.
Aerosol Physics: Introduction, size distribution, shape, and structure of aerosol particles, combustion aerosols, marine aerosols, aerosol sources and formation, aerosol properties, aerosol impact on air quality and cloud properties.

Atmosphere and Climate, Structure of the atmospheres, vertical profiles in the lower layers of the atmospheres, lateral movements in the atmosphere, atmospheric circulation, cloud and precipitation, the atmospheric greenhouse effect.

Climatology and Measurements of Climate Factor, Data collection and organization, statistical analysis of climatic data, climatic indices, general characteristics of measuring equipments, measurement of temperature, air humidity, surface wind velocity, radiation balance, precipitation, atmospheric pressure, automatic weather stations.

BOOKS RECOMMENDED
