Department of Physics

w.e. f. Session 2015-16

M.Sc. PHYSICS

INTEGRAL UNIVERSITY, LUCKNOW (2015-16)

Evaluation Scheme

Semester-I

SL. No	COURSE CODE	COURSE TITLE	Type of Paper	L	T	P	Evaluation Scheme				Subject Total	Credit	Total Credit
							CT	TA	Total	ESE			
THEORY													
1	PY 401	Mathematical Physics	Core	3	1	0	15	10	25	75	100	3:1:0	4
2	PY 402	Classical Mechanics	Core	3	1	0	15	10	25	75	100	3:1:0	4
3	PY 403	Quantum Mechanics-I	Core	3	1	0	15	10	25	75	100	3:1:0	4
4	PY 404	Statistical Mechanics-I	Core	3	1	0	15	10	25	75	100	3:1:0	4
5	PY 405	Solid State Electronics	Core	3	1	0	15	10	25	75	100	3:1:0	4
PRACTICALS													
6	PY 406	General &Optics Lab	Core	0	0	9	15	10	25	75	100	0:0:4	4
		Total		15	5	9	90	60	15	450	600	24	24

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Paper-I Mathematical Physics

PY 401 **L T P**
3 1 0

Unit1 Matrices 08

Linear vector spaces, matrix spaces, linear operators, eigenvectors and eigenvalues, matrix diagonalization, special matrices.

Unit2 Integral Transforms and Fourier Series 08

Laplace Transform: properties of L.T., shifting theorems on L.T., L.T. of derivatives, Derivatives of L.T., L.T. of integrals, integration of L.T., initial and final value theorems, inverse L.T. by partial fractions, Fourier Series, Dirichlet's conditions, determination of Fourier coefficients, F.S. for arbitrary period, half-wave expansions, Fourier integral theorem, Fourier sine and cosine transforms, Fourier Transforms of Dirac Delta function, simple problems.

Unit3 Complex Analysis 08

Analytic functions, Cauchy-Riemann conditions, classification of singularities, Cauchy's theorem, Taylor and Laurent expansions, analytic continuation, residue theorem, evaluation of definite integrals, summation of series, gamma function,

Unit4 Differential Equations and Special Functions 08

Linear ordinary differential equations and their singularities, series solution of second-order equations, Legendre's polynomial, Hermite polynomial, Laguerre and Bessel functions, classical polynomials, Sturm- Liouville problem, expansion in orthogonal functions, wave and heat equations in 2D & 3D.

Unit5 Group Theory 08

Symmetries and groups, multiplication table and representations, isomorphism & homomorphism, permutation group, translation and axial rotation groups, SO (2), SO (3), SU(2), lie algebra and representation of a lie group, translation group and reciprocal lattice.

References:

1. G.B. Arfken, *Mathematical Methods for Physicists*.
2. P. Dennery and A. Krzywicki, *Mathematics for Physicists*.
3. P.K. Chattopadhyay, *Mathematical Physics.*
4. A.W. Joshi, *Matrices and Tensors in Physics*.
5. R.V. Churchill and J.W. Brown, *Complex Variables and Applications.*
6. P.M. Morse and H. Feshbach, *Methods of Theoretical Physics (Volume I & II)..*

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Paper-2 Classical Mechanics

PY 402 **L T P**
3 1 0

Unit 1 Preliminaries 08

Newtonian mechanics of one and many particle systems, Simple Pendulum with rigid support, Two connected masses with string passing over a pully, Virtual work, Rolling mass inside or outside a circular ring, Constraints; their classification, D'Alembert's principle, generalized coordinates.

Unit2 Lagrangian and Hamiltonian Formulations of Mechanics 08

Calculus of variations, Hamilton's principle of least action, Lagrange's equations of motion, conservation laws, systems with a single degree of freedom, rigid body dynamics, symmetrical top, Hamilton's equations of motion, phase plots, fixed points and their stabilities.

Unit3 Two-Body Central Force Problem 08

Equation of motion and first integrals, classification of orbits, Kepler problem, scattering in central force field.

Unit4 Small Oscillations 08

Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates. Linearization of equations of motion. Vibrations of coupled systems, vibrations of tri-atomic molecule.

Unit5 Hamiltonian Mechanics and Chaos 08

Canonical transformations, Poisson brackets, Hamilton-Jacobi theory, action-angle variables, perturbation theory, integrable systems, introduction to chaotic dynamics.

References:

1. H. Goldstein, *Classical Mechanics.*
2. L.D. Landau and E.M. Lifshitz, *Mechanics.*
3. I.C. Percival and D. Richards, *Introduction to Dynamics*.
4. J.V. Jose and E.J. Saletan, *Classical Dynamics: A Contemporary Approach.*
5. E.T. Whittaker, *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.*
6. N.C. Rana and P.S. Joag, *Classical Mechanics*.

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Paper-3 Quantum Mechanics-I

PY 403 **L T P**
3 1 0

Unit1 Introduction 08

Linear vector Space, Empirical basis, wave-particle duality, electron diffraction, notion of state vector and its probability interpretation.

Unit2 Structure of Quantum Mechanics 08

Operators and observables, significance of eigenfunctions and eigenvalues, commutation relations, uncertainty principle, measurement in quantum theory.

Unit3 Quantum Dynamics 08

Time-dependent Schrödinger equation, stationary states and their significance, time-independent Schrödinger equation. Free-particle solution, wave packets, particle in a square well potential, transmission through a potential barrier, simple harmonic oscillator by wave equation and operator methods, charged particle in a uniform magnetic field, coherent states.

Unit4 Spherically Symmetric Potentials 08

Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.

Unit5 Symmetry in Quantum Mechanics

Symmetry operations and unitary transformations, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.

References:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume I).*
2. L.I. Schiff, *Quantum Mechanics.*
3. E. Merzbacher, *Quantum Mechanics*.
4. R.P. Feynman, *Feynman Lectures on Physics (Volume 3).*
5. A. Messiah, *Quantum Mechanics (Volume I).*
6. R. Shankar, *Principles of Quantum Mechanics.*

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Paper-4 Statistical Mechanics-I

PY 404 **L T P**
3 1 0

Unit 1 Elementary Probability Theory 08

Random variables, mean, variance and standard deviations, Binomial, Poisson and Gaussian distributions, central limit theorem. problems

Unit 2 Review of Thermodynamics 08

Basic postulates of thermodynamics, Extensive and intensive variables The Euler Equation, The Gibbs-Duhem relation, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) Electromagnetic radiation.

Unit 3 Formalism of Equilibrium Statistical Mechanics 08

Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles; microcanonical, canonical, grand canonical, and NPT ensembles and their connection to thermodynamic variables, fluctuations in energy density and no. of particles in various ensembles, applications of various ensembles, statistical mechanics of a system of harmonic oscillators, equation of state for a non-ideal gas, Vander Waals' equation of state, Meyer cluster expansion, Virial coefficients.

Unit 4 Quantum Statistics-1 08

The density matrix, application of quantum statistics to (i) an electron in a magnetic field (ii) A free particle in a box (iii) and a linear harmonic oscillator. Bose-Einstein statistics, applications of the formalism to; Ideal Bose gas, Debye theory of specific heat of solids, thermodynamics of black-body radiation, Bose-Einstein condensation, experimental studies on atomic BEC.

Unit 5 Quantum Statistics-2 08

Fermi-Dirac statistics, Thermodynamic behavior of Ideal Fermi gas, thermionic emission, photoelectric emission, Pauli paramagnetism, electronic specific heat, white dwarf stars, mass radius relationship, Chandrashekhar limit,

References:

1. F. Reif, *Fundamentals of Statistical and Thermal Physics.*
2. K. Huang, *Statistical Mechanics.*
3. R.K. Pathria, *Statistical Mechanics.*
4. D.A. McQuarrie, *Statistical Mechanics.*
5. S.K. Ma, *Statistical Mechanics.*

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Paper-5 Solid State Electronics

PY 405 **L T P**
3 1 0

Unit I: Conduction Mechanism in Metals & Semiconductors **08**

Mobility and conductivity, Density of states, Equilibrium concentration of electrons and holes- the Fermi level and energy distribution of carriers inside the bands- temperature dependence of carrier concentration inside the bands - Carrier transport in semi conductors - drift of carriers in electric fields, carrier flow by diffusion - constancy of Fermi level across junction, recombination, Einstein relation, continuity equation.

Unit II: Junction Devices **08**

Theory of PN junction diode, Zener diode , Photodiode, Tunnel diode, PIN diode & Varactor diode, GUNN diode, Transistor biasing, CB, CE, CC configurations, Input output characteristics, Early Effect, Graphical analysis of the CE configuration, Thermal stabilization, The operating point, Bias stability.

Unit III: Transistor Models **08**

Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model, The r_e transistor model, Ebers-Moll model.

UNIT IV: Field Effect Transistors **08**

Construction and characteristics of JFET, transfer characteristic, The FET small signal model, Measurement of g_m and r_d, JFET fixed bias, Self bias and voltage divider configurations, Use of FET as voltage controlled resistor, JFET source follower (common-Drain) configuration, JFET Common – Gate configuration, Depletion and enhancement type MOSFETs.

Unit V: Power Electronics **08**

SCR: Its operation, characteristics, SCR as Series Static switch, variable resistance phase controller, battery charging regulator, as a temperature controller, as emergency lighting system, as voltage sensor, as sawtooth generator, silicon controlled switch, light activated SCR, Shockley diode, Diac, Triac, UJT Characteristics and Applications.

Text and Reference Books:

1. Solid State Electronic Devices by B.G. Streetman
2. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
3. Integrated Electronics by J. Millman and C.C. Halkias
4. Introduction to Semiconductor Devices by M. S. Tyagi

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PY 406: General & Optics Lab

Students assigned the general laboratory work will perform at least eight (08) experiments of the following:

1. To determine the wavelength of prominent lines of mercury with the help of reflection grating.
2. (a) To plot the power distribution of a laser beam.
   (b) To determine the divergence of a given laser source.
3. The study of elliptically and circularly polarised light with help of Babinet's compensator.
4. To determine the thickness of air film between glass plates, the integral part of the order of fringes at the center and the fractional part, if any, in an Etalon.
5. To determine the wavelength of sodium light using Michelson's Interferometer.
6. To study the transfer characteristics of UJT & FET.
7. To study the design of CE Amplifier.
8. To study the design of Regulated Power Supply.
9. Determination of band gap of semiconductor from temperature dependence of resistivity using Four Probe Method.
10. Design of simple logic gates using transistors.