Department of Physics

w.e. f. Session 2015-16

M.Sc. PHYSICS

INTEGRAL UNIVERSITY, LUCKNOW (2015-16)

Evaluation Scheme

Semester-II

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 407	Quantum Mechanics-II	Core	3	1	0	15	10	25	75	100	3:1:0	4
2	PY 408	Electromagnetic Theory	Core	3	1	0	15	10	25	75	100	3:1:0	4
3	PY 409	Condensed Matter Physics	Core	3	1	0	15	10	25	75	100	3:1:0	4
4	PY 410	Nuclear and Particle Physics	Core	3	1	0	15	10	25	75	100	3:1:0	4
5	PY 411	Digital Electronics	Core	3	1	0	15	10	25	75	100	3:1:0	4
PRACTICALS													
6	PY 412	Programming & Condensed Matter Physics 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-1 Quantum Mechanics -II

PY 407 **L T P**
3 1 0

Unit1 Angular Momentum 08

Rotation operators, angular momentum algebra, eigenvalues of J^2 and J_z, Matrix representation of S_x, S_y, S_z, J_x, J_y, J_z, J^2, spinors and Pauli matrices, addition of angular momenta, Clebsch-Gordon coefficients.

Unit2 Identical Particles & Time-independent Approximation Methods 08

Indistinguishability, symmetric and antisymmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle. Non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, variational methods, WKB method, tunnelling.

Unit3 Time-dependent Problems 08

Schrödinger and Heisenberg picture, time-dependent perturbation theory, transition probability calculations, golden rule, adiabatic approximation, sudden approximation, beta decay as an example.

Unit4 Scattering Theory 08

Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

Unit5 Relativistic Quantum Mechanics

Klien-Gordon equation, Dirac equation and its plane wave solution, Significance of negative energy solutions, Spin angular momentum of the Dirac particle, Electron in EM fields, Spin-orbit interaction, Dirac equation for a particle in a central force field.

References:

1. Same as in Quantum Mechanics I plus
2. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume II).*
3. A. Messiah, *Quantum Mechanics (Volume II).*
4. Flügge, *Practical Quantum Mechanics.*
5. J.J. Sakurai, *Modern Quantum Mechanics.*
6. K. Gottfried, *Quantum Mechanics.*

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Paper-2 Electromagnetic Theory

PY 408 **L T P**

3 1 0

Unit1 Electrostatics 08

Differential equation for electric field, Poisson and Laplace equations, formal solution for potential with Green's functions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy.

Unit2 Magnetostatics 08

Biot-Savart law, differential equation for static magnetic field, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.

Unit3 Maxwell's Equations 08

Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution.

Unit4 Electromagnetic Waves 08

Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.

Unit5 Radiation & Covariant Formulation of Electrodynamics 08

Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, antenna, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula. Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.

References:

1. J.D. Jackson, *Classical Electrodynamics.*
2. D.J. Griffiths, *Introduction to Electrodynamics.*
3. J.R. Reitz, F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory.*
4. W.K.H. Panofsky and M. Phillips, *Classical Electricity and Magnetism.*
5. F.F. Chen, *Introduction to Plasma Physics and Controlled Fusion.*

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Paper-3 Condensed Matter Physics

PY 409 **L T P**

3 1 0

Unit1

Free Electron Theory and Transport Phenomena in solids: **08**

Drude theory, Review of Sommerfeld model of Free electron gas, critique of free-electron model, Boltzmann Transport Equations, Electrical and Thermal Conductivity of metals, Wiedemann-Franz law, Hall effect and magneto-resistance, Thermo-electric effects.

Unit2

Bonding in Solids and Crystal Lattices **08**

Bond classifications: Nature of bonding, ionic crystals, cohesive energy and Medulung Constant, covalent, molecular and hydrogen bonding. Bravais lattices and their classification. Symmetry operations, reciprocal lattice, X-ray diffraction, Bragg's law, Von Laue's formulation, Miller indices, relation between Miller Indices of a family of planes and inter planar spacing.

Unit3

Band Theory of Solids **08**

Energy spectra in atoms, molecules and solids, formation of energy bands, comparative picture of bands structure of metals, semiconductors and insulators. Electron wave equation in a periodic potential (Bloch theorem), Kronig Penney model. Motion of electron in a one dimensional periodic potential, crystal momentum and effective mass. Brillouin zones and Fermi surface. Cyclotron Resonance and De hass Van Alphen Effect.

Unit4

Lattice Dynamics 08

Wave motion of one dimensional atomic lattice, group velocity and phase velocity, vibrations of a one dimensional lattice with two atoms per primitive cell, normal modes of vibrations, density of states, quantization of vibrations (Phonons), inelastic scattering of photons by long wavelength phonons. Thermal properties of solids: Specific heat, Dulong Pettit's law, Einstein and Debye model of specific heat.

Unit5

Magnetism & Superconductivity 08

Origin of magnetism, classical theory of diamagnetism and paramagnetism, ferromagnetism, hysteresis, energy loss, Curie law, Weiss theory of ferromagnets and Curie-Weiss law. Superconductivity: Thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors.

References:

1. C. Kittel, *Introduction to Solid State Physics.*
2. N.W. Ashcroft and N.D. Mermin, *Solid State Physics.*
3. J.M. Ziman, *Principles of the Theory of Solids.*
4. A.J. Dekker, *Solid State Physics.*
5. G. Burns, *Solid State Physics.*
6. M.P. Marder, *Condensed Matter Physics.*

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Paper-4 Nuclear & Particle Physics

PY 410 **L T P**
3 1 0

UNIT 1 : **Basic Nuclear properties and Nuclear forces:**
Mass, Charge, and Constituents of the nucleus, Nuclear size and distribution of nucleons, Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Characteristics of nuclear forces -Range and strength, Ground and exited states of deuteron, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces. Scattering length, Yukawa hypothesis.

UNIT 2 : **Nuclear reactions and Detectors:**
Nuclear Reactions and Cross sections, Type of reactions and Conversation laws. Q- value and its significance. Resonance: Breit-Wigner Dispersion Formula, The compound Nucleus, Statistical theory of Nuclear Reactions, Geiger-Muller Counter, Semiconductor detectors.

UNIT 3 : **Nuclear disintegration and models :**
Review of the Semi-empirical mass formula, Liquid drop model, Single particle Shell model. Tunneling theory of alpha decay, Fermi theory of Beta decay, inverse beta process, Double-beta decay, Different types of neutrinos: the two neutrino experiment, The neutrino helicity, Gamma decay, Fermi and Gammow- Teller selection rules.

UNIT 4 : **Particle Physics I:**
Classification and properties of elementary particles , Leptons, Baryons, mesons, particles and antiparticles, excited states and resonances, Various types of interactions, gravitational, electromagnetic, weak and strong interactions and their mediating quanta, Conservation rules in fundamental interactions.

UNIT 5 : **Particle Physics II:**
Charge symmetry and charge independence, Parity and charge conjugation, Conservation of parity and its violation in different types of interactions. Gell-Mann Nishijima formula, Strange particles, associated production, strangeness and decay modes of charged Kaons, Isospin and its conservation. Idea of eight fold way and quarks.

References:

1. G.D. Coughlan and J.E. Dodd, *The Ideas of Particle Physics.*
2. D. Griffiths, *Introduction to Elementary Particles*.
3. D.H. Perkins, *Introduction to High Energy Physics.*
4. I. Kaplan, *Nuclear Physics.*
5. R.R. Roy and B.P. Nigam, *Nuclear Physics.*
6. M.A. Preston and R.K. Bhaduri, *Structure of the Nucleus.*
7. M.G. Bowler, *Nuclear Physics.*

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Paper-5 Digital Electronics

PY 411 **L T P**
3 1 0

Unit 1 Operational Amplifier Basic and Application 08

Review of Feedback, Linear Circuit, Op-Amp Basic, Inverting and Non-inverting amplifiers, Unity follower, Summing amplifiers, Integrator, Differentiator, Op- Amp Specifications- DC Off-set parameter, Frequency parameters, Imperfection in Op- Amplifier application- multiple stage gain, Voltage summing and subtraction, Current controlled voltage source, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.

Unit 2 Digital Logic Gates 08

Symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), Multi- collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic- Review of MOSFET, MOSFET Inverter with active load, MOSFET NOR and NAND gates, Complementary MOS (CMOS)-CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS.

Unit 3Digital Electronics and Logic Gate 08

Binary, Octal, Hexadecimal number system, Base conversion system, Bipolar junction and Field Effect transistor as switches, Basic digital logic gates (OR, AND and NOT, NOR, NAND and Exclusive OR), XOR gate, Boolean laws and theorem, Sum of Product (SOP) and Peroduct of Sum (POS) method, Karnaugh map, pair, quad and octave, POS simplification, min term, max-term.

Unit 4 Application of Digital Logic Gate 08

Half adder and Full adder circuit, multiplexers, demultiplexer, Flip- Flop and Registers- RS Flip Flop, D- Flip Flop, T- Flip Flop, JK- Flip Flop, JK Master- Slave Flip Flop, Astable, Monostable and Bi-stable multivibrator, types of registers, serial-in-serial out, serial-in-parallel out, parallel-in-serial out, parallel-in parallel out, Counters and Convertors- asynchronous and synchronous counter, Mod-3 and Mod-5 counters, shift counters, Digital-to Analog Converters-D/A converter, ladder network, A/D converters.

Unit 5 Microprocessor 08

Intel 8085 microprocessor architecture, interfacing devices, BUS timing, instruction set, simple illustrative program.

Text and Reference Books

1. Electronic Device and Circuit: R. Boylested and L. Nashdsky
2 .Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
3. Digital Principles and Implementation: A.P. Malvino and D.P. Leach
4. Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad

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PY 412: Programming and Condensed Matter Physics lab

Students assigned the general laboratory work will perform at least eight (08) experiments of the following: (04 from each unit)

Unit A

1. Solution of transcendental or polynomial equations by the Newton Raphson method.
2. Linear curve fitting and calculation of linear correlation coefficient.
3. Numerical integration using the Simpson's method.
4. Numerical first order differentiation of a given function.
5. Matrix inversion and solution of simultaneous equation.

Unit B

1. To determine resolving/dead time of a GM counter by double source method.
2. Study of Hall Voltage as a function of probe current and magnetic field and determination of Hall Coefficient and carrier concentration in given sample.
3. Preparation of nanocrystalline powder specimen by ball milling: analysis of their x-ray spectra and particle size estimation by Scherrer formula.
4. Magnetic parameters of a magnetic material by hysteresis loop tracer.
5. Dielectric constant of insulating and ferroelectric materials at room and elevated temperatures.