Course Structure of

Five Year Integrated M.Sc.

in Physics

(Session 2019 – 2020 Onward)

Department of Physics

Veer Surendra Sai University of Technology (VSSUT)

Siddhi Vihar, P.O.: Engineering College Burla,

Sambalpur–768018, Odisha, India

www.vssut.ac.in

Vision

The Department of Physics provides a creative and stimulating environment for the education of future generations of scientists and technocrats. The scientific works of faculties are connected with innovative teaching techniques and competitive research. The Department envisaged to create synergy between Science and Technology along with industrial relevance with a mission for motivation towards research and development.

Mission

M1: To impart knowledge of Physics to all classes of people.

M2: To provide interdisciplinary research environment within the institute.

M3: To promote the knowledge of Physics in the frontier areas of Science and Technology by

organizing seminars, conferences and refresher courses

Program Outcomes

PO-1. Achieving good knowledge in Physical Sciences, students will be trained to compete various national level tests.

PO-2. Scientific and analytic training for pursuing higher studies in physical and applied Sciences.

PO-3. Theoretical and computational ideas that help to develop experimental skills.

PO-4. Physical approach that would guide in rationalising complex issues of various branches of science.

PO-5. Real time analysis of basic physics at various levels of matter.

PO-6. Develop the logic and ability for circuits and instrumentations.

Program Educational Outcome (PEO)

PEO-1: To provide quality education in Physical Sciences for producing Scientifically and analytically sound students

PEO-2: To prepare the students in taking challenges available both in theoretical and experimental

physics for pursuing quality research

PEO-3: To provide enthusiastic environment for students to develop academic, administrative and social capacities and responsibilities

Program Specific Objective (PSO)

PSO-1: Have thorough exposure to improve the knowledge of various branches of physics to address the physical problems with the help of computational and experimental tools.

PSO-2: Excel the numerical, analytical and observation skills by offering group discussions, technical writings and research oriented activities.

Veer Surendra Sai University of Technology, Burla, Odisha
Model Course Structure
For
Five Year Integrated M. Sc in Physics
(Effective from July-2019)

CODE	1st Semester	L-T-P	Credits
IPH01001	Physics –I (Thermodynamics)	3-1-0	4
ICH01001	Chemistry- I	3-1-0	4
IMA01001	Mathematics-I	3-1-0	4
BCE01001	Environmental Science	3-0-0	2
IPH01002	Physics Lab-I	0-0-3	2
ICH01002	Chemistry Lab- I	0-0-3	2
	TOTAL CREDIT		18

CODE	2nd Semester	L-T-P	Credits
IPH02001	Physics-II (Waves and Optics)	3-1-0	4
ICH02001	Chemistry-II	3-1-0	4
IMA02001	Mathematics-II	3-1-0	4
BHU02001	English for Communication	3-0-0	2
IPH02002	Physics Lab-II	0-0-3	2
ICH02002	Chemistry Lab-II	0-0-3	2
	TOTAL CREDIT		18

CODE	3rd Semester	L-T-P	Credits
IPH03001	Mathematical Physics-I	3-1-0	4
IPH03002	Mechanics	3-1-0	4
IPH03003	Analog Electronic Systems and Applications	3-1-0	4
IPH03004	Programming in C	3-0-0	2
IPH03005	Analog Electronic Lab	0-0-3	2
IPH03006	Mathematical Physics Lab	0-0-3	2
	TOTAL CREDIT		18

CODE	4th Semester	L-T-P	Credits
IPH04001	Electricity and Magnetism	3-1-0	4
IPH04002	Mathematical Physics-II	3-1-0	4
IPH04003	Elements of modern Physics	3-1-0	4
IPH04004	Digital Systems and Applications	3-1-0	4
IPH04005	Digital Electronic Lab	0-0-3	2
IPH04006	Electricity and Magnetism Lab	0-0-3	2
	TOTAL CREDIT		20

CODE	5th Semester	L-T-P	Credits
IPH05001	Quantum Mechanics and Application	3-1-0	4
IPH05002	Solid state Physics	3-1-0	4
	Elective -I	3-1-0	4
	Elective -II	3-1-0	4
IPH05003	Solid state Lab	0-0-3	2
	Elective Lab -I	0-0-3	2
	TOTAL CREDIT		20

CODE	6th Semester	L-T-P	Credits
IPH06001	Statistical Mechanics	3-1-0	4
IPH06002	Electromagnetic Theory	3-1-0	4
	Elective –III	3-1-0	4
	Seminar	3-1-0	2
IPH06003	Laser Lab	0-0-3	2
	TOTAL CREDIT		16

CODE	7th Semester	L-T-P	Credits
IMA07001	Mathematical Methods	3-1-0	4
IPH07001	Classical Mechanics	3-1-0	4
IPH07002	Quantum Mechanics- I	3-1-0	4
IPH07003	Electronics and Instrumentation	3-1-0	4
IPH07004	General Practical- I	0-0-3	2
IPH07005	Computational Physics Lab	0-0-3	2
	Audit- I	0-2-0	0
	TOTAL CREDIT		20

CODE	8th Semester	L-T-P	Credits
IPH08001	Quantum Mechanics- II	3-1-0	4
IPH08002	Statistical Mechanics	3-1-0	4
IPH08003	Electrodynamics	3-1-0	4
IPH08004	Atomic, Molecular Physics & Spectroscopy	3-1-0	4
IPH08005	General Practical –II	0-0-3	2
	Workshop Practice / Soft Skill and Professional English	0-0-3	2
	Audit- II	0-2-0	0
	TOTAL CREDIT		20

CODE	9th Semester	L-T-P	Credits
IPH09001	Condensed Matter Physics	3-1-0	4
IPH09002	Nuclear and Particle Physics	3-1-0	4
	Elective- IV	3-1-0	4
	Open Elective	3-1-0	4
IPH09003	General Practical –III	0-0-3	2
	Technical Writing and Seminar	0-0-3	2
	TOTAL CREDIT		20

CODE	10th Semester	L-T-P	Credits
	Elective –V	3-1-0	4
	Elective–VI	3-1-0	4
	Projects	0-0-3	4
IPH10001	Advanced Experiments	0-0-3	2
	Comprehensive Viva-voce	0-0-0	2
	TOTAL CREDIT		16

Pool of Subjects for Departmental Electives		
Elective-I	**Elective-II**	**Elective- III**
1.Basic Instrumentation(IPHPE501) 2.Experimental Techniques(IPHPE502) 3. Physics of Devices and Communication (IPHPE503)	1. Classical Dynamics(IPHPE504) 2. Energy Physics (IPHPE504) 3. Nanomaterials and application(IPHPE505) 4. Physics of Earth(IPHPE506)	1.Applied Optics(IPHPE601) 2. Astronomy and Astrophysics (IPHPE602) 3. Computational Physics (IPHPE603) 4. Weather forecasting(IPHPE604)

Pool of Subjects for Departmental Electives		
Elective-IV	**Elective-V**	**Elective- VI**
1. Advanced Experimental Techniques(IPHPE901) 2. Advanced Quantum Mechanics(IPHPE902) 3. Programming for computational Physics (IPHPE903) 4. Quantum Information and Measurement(IPHPE904) 5. Vacuum Technology(IPHPE905)	1. Introduction to Non-linear Dynamics(IPHPE101) 2. Particle Physics(IPHPE102) 3. Physics of Semiconductor Devices(IPHPE103) 4. Spectroscopy(IPHPE104) 5. Thin Film Technology(IPHPE105)	1. Atmospheric Physics(IPHPE106) 2. Biophysics(IPHPE106) 3. Crystallography(IPHPE106) 4. Laser Physics(IPHPE107) 5.Soft Condensed Matter Physics(IPHPE108)

Pool of Subjects for Open Elective (For Other Department Students)
1. Elementary Biophysics (IPHOE901)
2. Medical Physics (IPHOE902)
3. Radiation Safety (IPHOE903)
4. Renewable energy and energy harvesting (IPHOE904)

Audit:

Sl. No.	Subject
1	English for Research Paper Writing
2	Disaster Management
3	Sanskrit For Technical Knowledge
4	Value Education
5	Constitution of India
6	Pedagogy Studies
7	Stress Management By Yoga
8	Personality Development through Life Enlightenment Skills

Course: Integrated M.Sc. (1st semester)

Subject: THERMODYNAMICS

Module-I: INTRODUCTION TO THERMODYNAMICS: Recapitulation of Zeroth and First law of Thermodynamics:

SECOND LAW OF THERMODYNAMICS: Reversible and Irreversible process with examples. Kelvin-Planck and Clausius Statements and their Equivalence, Carnotôs Theorem, Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Module- II: ENTROPY: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Principle of Increase of Entropy, Temperature-Entropy diagrams for Carnotôs Cycle, Third Law of Thermodynamics, Unattain ability of Absolute Zero.

THERMODYNAMIC POTENTIALS: Extensive and Intensive Thermodynamic Variables, Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs free energy, Their Definitions, Properties and Applications.

PHASE TRANSITIONS: First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations.

Module- III: MAXWELLôS THERMODYNAMIC RELATIONS: Derivations and applications of Maxwellôs Relations, Maxwellôs Relations: (1) Clausius-Clapeyron equation (2) Relation between Cp and Cv (3) TdS Equations,(4)Joule-Kelvin coefficient for Ideal and Vander Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process.

Module-IV: KINETIC THEORY OF GASES

DISTRIBUTION OF VELOCITIES: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Sterns Experiment, Mean, RMS and Most Probable Speeds, Degrees of Freedom, Law of Equipartition of Energy (No proof required), Specific heats of Gases.

MOLECULAR COLLISIONS: Mean Free Path, Collision Probability, Estimates of Mean Free Path, Transport Phenomenon in Ideal Gases:(1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Module-V: REAL GASES: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrewôs Experiments on CO_2Gas.Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van der Waalôs Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule-Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Van der Waal Gases, Temperature of Inversion, Joule-Thomson Cooling.

TEXT AND REFERENCE BOOKS:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw- Hill)
3. Theory and experiments on thermal Physics, P.K. Chakrabarty (New central book agency)
4.Thermodynamics, Kinetic Theory and Statistical Thermodynamics-Sears and Salinger (Narosa)
5. A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press)
6. Heat, Thermodynamics and Statistical Physics, N.Subrahmanyam and Brij Lal (S. Chand Publishing)
7. Thermal & Statistical Physics M. Das, P.K. Jena, S. Mishra, R.N.Mishra(Shri Krishna Publication)

Course Outcomes:

CO1	Explain second law of thermodynamics including why it is necessary, how it is defined by Kelvin-Planck and Clausius, and its applications. Compare the Thermodynamic Scale of Temperature and Perfect Gas Scale of temperature and show their equivalence.
CO2	Explain the concept of entropy, Calculate the entropy changes that take place during different Thermodynamic processes.
CO3	Learn how to derive Maxwellôs relations in terms of derivatives of thermodynamic variables, and its applications.
CO4	Describe the distribution of velocities in an ideal gas through Maxwell-Boltzmann distribution law ,apply kinetic theory to explain different transport phenomena.
CO5	Compare the behavior of real gases to that predicted by ideal gas model.Understand the Joule Thomson effect for real and Vander Waals gases.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	2
CO2	3	3	3	3	1	1
CO3	2	3	3	2	2	1
CO4	2	3	3	2	2	1
CO5	3	3	3	1	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2.6	3	3	2	2	1.2

Course: Integrated M.Sc. (1st Semester)
Subject: PHYSICS LAB-I

LIST OF EXPERIMENTS:

1. Verification of laws of transverse vibration of a string by using Sonometer
2. Determination of surface tension of water by capillary rise method.
3. Thermal conductivity of a bad conductor by Lee's method
4. Determination of Youngs Modulus of wire by Searleôs method.
5. Determination of Rigidity modulus of wire by static method
6. Velocity of sound by resonant method
7. Determination of Youngôs modulus of the material of a metal bar by the method of bending of beam(Cantilever)
8. To study the standing waves on a stretched string and verify the relation between tension, frequency and number of loops
9. Determination of 'g' by bar pendulum
10. Determination of mechanical equivalent of heat by electrical method

Course: Integrated M.Sc. (2nd Semester)
Subject: WAVES AND OPTICS (PHYSICS-II)

Module–I:

Fermats principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics, Cardinal points and Cardinal planes of an optical system, Idea of dispersion, Application to thick Lens and thin Lens, Ramsden and Huygens eye piece.

Module-II:

Simple harmonic oscillator, Damped harmonic oscillator, Power loss, Q-Factor, Under damped, Over damped motion, Critical damping, Forced vibration, Resonance, Sharpness of resonance, Wave equation, longitudinal waves in a gaseous medium, Composition of simple harmonic Waves.

Lissajous figures [Superposition of two orthogonal S.H.M(i) of equal frequencies (ii) in the frequency ratio 2:1.]

Module–Ill:

Interference: Conditions of interference, interference by division of wave front, Biprism and determination of a, Interference by a thin film with two (i) parallel and (ii) non-parallel refracting surfaces, Newton's ring and determination of a of mono chromaticight, Michels on lnterferometer-

(1) Idea of form of fringes (Notheoryrequired), (2)Determination of Wave length,
(3)Wave length Difference, (4) Refractive Index, and (5) Visibility of Fringes.

Module–I V:

Diffractionoflight,typesofdiffraction,Fraunhofferdiffraction:Singleslit, multiple slits, Diffraction grating, Resolving power of grating, Fresnel's Assumptions. Fresnel's Half-Period Zones For Plane Wave, Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple FociofaZone Plate, Comparison of zone plate with a convex lens, Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit.

Module–V:

Elementary Idea about polarized and unpolarize light, polarization by reflection and refraction, Malu's law. Brewster's law, Double refraction, ordinary and extra ordinary rays, construction and uses of Nicolprism, Half wave and quarter wave plates, Mathematical analysis of linearly, circularly and elliptically polarize light, Construction and application of Polari meter.

TEXT AND REFERENCE BOOKS:

1. Waves: Berkeley Physics Course, vol.3, Francis Crawford, 2007, Tata McGraw-Hill
2. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata Mc Graw Hill
3. Optics: Zenkins and White
4. Optics: A. Ghatak
5. Principle of Optics: B.K Mathur
6. Geometrical and Physical optics : P.K. Chakraborty

Course Outcomes:

CO1	To acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature
CO2	To be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
CO3	To be able to make approximate judgements about optical and other wave phenomena when necessary.
CO4	To acquire skills allowing the student to organise and plan simpler laboratory course experiments and to prepare an associated oral and written report.
CO5	Understand optical phenomena such as polarisation, birefringence, interference and diffraction in terms of the wave model.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	2	2	2
CO3	3	3	3	2	3	2
CO4	3	3	3	3	3	3
CO5	2	2	2	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	2	2	3

Course: Integrated M.Sc. (2nd Semester)

Subject: PHYSICS LAB-II

1. Determination of 'g' by bar pendulum
2. Newtonôs ring
3. Familiarization with Schusterôs focusing method
4. Dispersive power of the prism using mercury source
5. Determination of grating element using plane Diffraction grating
6. To determine the refractive index of a thin glass plate using Michelsonôs interferometer
7. Resolving power of diffraction grating
8. Brewsterôs law verification
9. Determination of modulus of rigidity of material using torsional pendulum
10. To determine *g*, the acceleration of gravity at a particular location using katerôs pendulum

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Course: Integrated M.Sc. (3rd Semester)

Subject: MATHEMATICAL PHYSICS-I

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Module-I : VECTOR ALGEBRA: Recapitulation of vectors: Properties of vectors under rotations, Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields. Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, Del and Laplacian operators, important vector identities (8 Lectures)

Module-II: ORTHOGONAL CURVILINEAR COORDINATES: Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems, Comparison of velocity and acceleration in cylindrical and spherical coordinate system.

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gaussô divergence theorem, Greenôs and Stokes Theorems and their applications (12 Lectures)

Module-III: CALCULUS -I:First Order Differential Equations and Integrating Factor, Second Order Differential equations: Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral. (6 Lectures)

Module-IV: CALCULUS-II: Partial Differential Equations: Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, ectangular and circular membranes, diffusion Equation.

(6 Lectures)

Module-V:COMPLEX NUMBERS: Complex conjugates, Modulus and argument, graphical representation and trigonometric form, Functions of a complex variable, Limit, continuity and differentiability, Analytic function, Necessary and sufficient conditions for analytic function: Cauchy-Riemman differential equations in Cartesian and polar form, Cauchyôs integral theorem and formula (8 Lectures)

TEXT AND REFERENCE BOOKS:

1. Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication)
2. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K.Dash (Sri krishnaPrakashan)
3. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)
4. Mathematical Methods for Physicists, G.B. Arfken, H .J. Weber, F. E. Harris (2013, 7thEdn.,Elsevier)
5. Mathematical Physics C. Harper (Prentice Hall India)
6. Complex Variable: Schaumôs Outlines Series M. Spiegel (2ndEdn, McGraw Hill Edu)
7. Complex variables and applications, J. W. Brown and R.V.Churchill
8. Mathematical Physics, Satya Prakash (Sultan Chand)
9. Mathematical Physicsï H.K.Dass, Dr. Rama Verma (S. Chand Publishing)

Course Outcomes:

CO1	Learn about Gradient, Divergence and Curl in orthogonal curvilinear and their typical applications in physics.
CO2	Learn about special type of matrices that are relevant in physics and then learn about tensors.
CO3	Get introduced to Special functions like Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions and their recurrence relations
CO4	Learn different ways of solving second order differential equations and familiarized with singular points and Frobenius method
CO5	Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms, their inverse transforms etc

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	2

Course: Integrated M.Sc. (3rdSemester)
Subject: MECHANICS

Course Objectives:

1. To understand the concepts and principles of Rotational Dynamics and Non-inertial systems
2. To understand the concepts of Elasticity, Fluid motion, and viscosity
3. To solve the problems related to oscillations, gravitation and central force motion
4. The use of special theory of relativity in mechanics

Module-I: ROTATIONAL DYNAMICS: Centre of Mass, Motion of CoM, Centre of Mass and Laboratory frames, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, Calculation of moment of inertia for cylindrical and spherical bodies, Kinetic energy of rotation.

NON-INERTIAL SYSTEMS: Non-inertial frames and fictitious forces, Uniformly rotating frame, Laws of Physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications.

Module–II:ELASTICITY: Relation between Elastic constants, twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever

FLUID MOTION: Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a Capillary Tube, Surface tension.

VISCOSITY: Poiseuilles Equation for Flow of a Liquid with corrections.

Module–III:GRAVITATION AND CENTRAL FORCE MOTION: Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Weightlessness, Potential and field due to spherical shell and solid sphere, Motion of a particle under a central force field, Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution, The first Integrals (two), Keplerôs Laws of Planetary motion, Escape velocity.

Module-IV: OSCILLATIONS: Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values.Damped oscillation. Equation of motion and solution (cases of oscillatory, critically damped and overdamped) Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Bar Pendulum, Katerôs Pendulum

Module-V: SPECIAL THEORY OF RELATIVITY: Michelson-Morley Experiment and its out-come, Postulates of Special Theory of Relativity, Lorentz Transformations, Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, Relativistic addition of velocities, Variation of mass with velocity, Mass less Particles, Mass energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics, Transformation of Energy and Momentum.

TEXTAND REFERENCE BOOKS:

1. Mechanics, D.S. Mathur (S. Chand Publishing)
2. Introduction to Special Relativity, R. Resnick (John Wiley)
3. Introduction to Mechanics Daniel Klapnner and Robert Kolenkow, McgrawHill.
4. Mechanics by K.R Simon
5. Mechanics, Berkeley Physics, vol.1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)
6. Physics, Resnick, Halliday and Walker (8/e.2008, Wiley)
7. Theoretical Mechanics-M.R. Spiegel (Tata McGrawHill).
8. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)
9. Mechanics-M.Das, P.K.Jena and R.N. Mishra (SrikrishnaPublications)

Course Outcomes:

CO1	This course offers knowledge on various concepts and principles of mechanics which is helpful to understand the advanced mechanics concepts involved in higher semesters
CO2	To understand the concepts and principles of Rotational Dynamics and Non-inertial systems.
CO3	To understand the concepts of Elasticity, Fluid motion, and viscosity.
CO4	To solve the problems related to oscillations, gravitation and central force motion
CO5	The use of special theory of relativity in mechanics

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	3	2	1
CO2	2	2	3	3	3	1
CO3	3	3	2	2	3	2
CO4	3	1	3	3	2	1
CO5	2	3	3	2	3	1

1:Slight(Low)2:Moderate(Medium)3:Substantial(High)-:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	2	3	2	2

Course: Integrated M.Sc. (3rd Semester)

Subject: ANALOG ELECTRONICS SYSTEM AND APPLICATIONS

Module-I:

Semiconductor Diodes: P-and N-type semiconductors, energy level diagram, conductivity and Mobility, Concept of Drift velocity, PN junction, fabrication(simple idea), Barrier formation in PN Junction Diode, Static and Dynamic Resistance, Current flow mechanism in Forward and Reverse Biased Diode ,Drift velocity, derivation for Barrier Potential, Barrier Width and current Step Junction.

Module-II:

Twoterminaldeviceandtheirapplications:(1)RectifierDiode:Half-waveRectifiers.Center-tappedandbridgetypeFull-waveRectifiers, Calculation of Ripple Factor and Rectification Efficiency, LandCFilters(2)ZenerDiodeandVoltageRegulation,PrincipleandstructureofLEDS,(2)Photodiode(3)SolarCell.

Module-III:

Transistors:Construction(pnpandnpn)oftransistorsandprinciplesofoperation,CE circuit,CEV-Iinput-outputcharacteristicsandcurrentgain,currentamplificationfactor,relationbetweenŮandɓactiveregion,cut-offregion,saturationregion,dynamicoutputresistance,currentgain, CB circuit, CB characteristics : input and output characteristics, CC circuit, input and output characteristics.

Module-IV:

Amplifiers: Transistor biasing, Methods of transistor biasing and stabilization, D.C. load line, Common base and Common emitter biasing, Common base and common emitter amplifiers, Classification of class A, Band C amplifiers, Push- pull amplifier(class B), Resistance-Capacitance(RC) coupled amplifier (two stage), concept of bandwidth, Feedback in amplifiers, Advantages of negative feedback, Emitter follower.

Module-V:

Oscillators: Oscillators, Principle of oscillation, classification of oscillators, Condition for self-sustained oscillation: Bark hausen criterion for oscillation, Tuned collector common emitter oscillator, Hartley oscillator, C.R.O.(Principle and Working).

TEXTANDREFERENCE BOOKS:

1. N.Bhargava..C.KulshreshthaandS.C.Gupta,BasicElectronicsandLinearCircuitsby
2. J.P. Agarwal, Amit Agarwal, Solid State Electronics, Pragati Prakashan,(Meerut)
3. J.D. Ryder, Electronics Fundamentals and Applications by (PrenticeHallofIndia).
4. B.L. Thereja, Solid State Electronics

Course Outcomes:

CO1	Understand different blocks in communication system and how noise affects communication using different parameters
CO2	Distinguish between different amplitude modulation schemes with their advantages, disadvantages and applications
CO3	Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes
CO4	Identify different radio receiver circuits and role of AGC
CO5	Sample analog signal and recover original signal without any distortion

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	2	3	2	2
CO3	3	3	3	3	3	2
CO4	3	3	2	2	3	3
CO5	3	2	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (3rd Semester)
Subject: PROGRAMMING IN C

Module-I:
Introduction to computing- Block architecture of a computer, bit, bytes, memory, representation of numbers in memory. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flow charts. C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. (8 Lectures)

Module II:
Operators and Expressions-Operators, Precedence of operators. Decision Control Structure, Loop Control Structure and Case Control Structure. Functions- Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion. (8 Lectures)

Module III:
Arrays- 1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration &Initialization, String Handling Functions. ointers- Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation. Structure- Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, typedef, Enumerated Data Type, Bit Fields. (10 Lectures)

Module-IV:
Union- Array of Union Variables, Union inside Structure. Storage Class. Preprocessor Directives- Types, Pragma Directives, Conditional Directives. Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations. (10 Lectures)

Module-V:
Advanced Issues in Input & Output ï using argc & argv. Operation on Bits. (4 Lectures)

TEXTANDREFERENCEBOOKS:
1. C: The Complete Reference: Herbert Schildt
2.Computer Fundamentals &Programming in C: Reema Thareja, Oxford University Press.
3.Let us C- Y.Kanetkar, BPB Publications.
4.Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
5.C How to Program- Deitel and Deitel, Pearson Education.
6.The C programming Language- Brian W. Kernighan and Dennis M. Ritchie,Prentice-Hall.

Course Outcomes:

CO1	After the completion of this course, the students will be able to develop applications
CO2	The course is designed to provide complete knowledge of C language
CO3	Students will be able to develop logics which will help them to create programs, applications in C
CO4	Also by learning the basic programming constructs they can easily switch over to any other language in future
CO5	Gets a wide knowledge of numerical methods in programming that can be used to solve many problems which does not have an analytic solution

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (3rd Semester)
Subject: ANALOG ELECTRONIC (LAB-III)

1. Characteristics of FET, MOSFET
2. Characteristics of BJT
3. Characteristics of UJT
4. Modulation and demodulation
5. Measurement of Voltage and time period of a wave form using CRO
6. Square wave response od an RC circuit
7. Hartley ï Colpitt Oscillator
8. Characteristics of Zeener Diode
9. Ge and Si-Diode characteristics
10. LED characteristics

Course: Integrated M.Sc. (3rd Semester)
Subject: MATHEMATICAL PHYSICS LAB

This lab provides hands on experiments based on subjects taught in the course Mathematical Physics I using the computer package Wolfram Mathematica which affords both symbolic and numerical computational ability supported by comprehensive graphical tools for visualization of the various concepts.

Module-1
Brief introduction to Mathematica and its capabilities with demonstrations. Note Book interface with palettes to carry out interactive numerical and symbolic computations. Basic commands for Mathematica, variables. Lists, assignments evaluation , delayed evaluation substitution

Module-II
Vector algebra and calculus

1. Vector dot and cross products, vector plots of various kinds, parametric plots
2. Gradient divergence and Curl of various vector fields and scalar functions and their visualizations
3. Gradient divergence and Curl in spherical polar, cylindrical coordinates for different vector and scalar fields
4. Integration of vectors and scalars.

Module-III
Ordinary differential equations
1. Solution of 1st order ordinary differential equations symbolically using DSOLVE and visualization. Initial and boundary value problems
2. Solution of 1st order ordinary differential equations numerically using NDSOLVE and visualization. Initial and boundary value problems.
For linear and nonlinear ODE's: simple harmonic, double pendulum, projectile, Duffing oscillator

Module-IV:
Partial differential equations
1. Solution of partial differential equations symbolically. V using DSOLVE and visualization. Initial and boundary value problems
2. Solution of partial differential equations numerically using NDSOLVE and visualization. Initial and boundary value problems.
For the solution of wave equation for vibrational modes of astret chedstring, rectangular and circular membranes, diffusion Equation.

Module-V:
Complex analysis
Graphical representation of complex numbers and functions, complex series, Cauchy- Riemman differential equations in Cartesian and polar form using Mathematica

Course: Integrated M.Sc. (4th Semester)
Subject: ELECTRICITY AND MAGNETISM

Course Objectives: The purpose of this course is to improve understanding of the enormous variety of electro magnetic phenomena in terms of a few relatively simple laws, and to exploit the laws of electromagnetism from our everyday experience by specific examples of how electromagnetic phenomena manifest themselves.

Module-I: Electric Field and Electric Potential, Electric flux, Gauss Law with applications to charge distributions with spherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential and Electric Field of a dipole, Force and Torque on a dipole, Potential calculation in different simple cases, Laplace and Poisson equations, The Uniqueness Theorem, Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor. Method of Images and its application to (1)Plane Infinite Sheet and(2)Sphere.

Module–II: Gradient, Divergence and Curl operators, Gauss divergence Theorem, Stokeôs Theorem, Magnetic Field, Magnetic Force, Lorentz Force, Biot Savarts Law, Current Loopasa Magnetic Dipole and its Dipole Moment (analogy with Electric Dipole), Amperes Circuital Law and its application to (1) Solenoid (2) Toroid(3) Helmholtzcoil, Properties of B, BallisticGalvanometer:TorqueonacurrentLoop,CurrentandChargeSensitivity,Electromagneticdamping,Logarithmicdamping,CDR.

Module–III: Dielectric Properties of Matter: Electric Field inmatter, Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric, Displacement vector D, Relations between E, P and D, Gauss Law in dielectrics.

Module-IV: Magnetic properties of Matter: Magnetization vector (M), Magnetic Intensity(H), Magnetic Susceptibility and permeability, Relation between B, H, M, Ferromagnetism, B-H curve and hysteresis. Electromagnetic Induction: Faradays Law, Lenzs Law, Self-Inductance and Mutual Inductance, Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwells Equations.

Module-V: Electrical Circuits: AC Circuits: Kirchhoffôs laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance (2) Power Dissipation (3) Quality Factor, (4) Band Width, Parallel LCR Circuit. Network theorems: Ideal Constant ï voltage and Constant-current Sources, Network Theorems: The venin theorem, Norton theorem, Super position theorem, Reciprocity theorem, Maximum Power Transfer theorem, Applications to DC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

TEXT AND REFERENCE BOOKS:

1. IntroductiontoElectrodynamics-D.J.Griffiths(Peson,4thedition,2015)
2. Electricity and Magnetism D.C. Tayal (Himalaya Publishing house)

Course Outcomes:

CO1	To improve understanding of the enormous variety of electromagnetic phenomena in terms of a few relatively simple laws
CO2	To exploit the laws of electromagnetism from our everyday experience bys specific examples of how electromagnetic phenomena manifest themselves
CO3	Understand the basic mathematical concepts related to electromagnetic vector fields
CO4	Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density
CO5	Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (4th Semester)

Subject: MATHEMATICAL PHYSICS-II

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Module-I: Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Even and odd functions and their Fourier expansions and Application, Summing of Infinite Series
(8 Lectures)

Module-II: Sequences: Definition, Monotonic sequences, Bounded sequences, Convergent and Divergent Sequences**.**

Series: Infinite series, Oscillating and Geometric series, their Convergence, Divergence. Tests of Convergence, Comparison Test, Limit Comparison test, Ratio test, n^{th} root test (Cauchy root test), Alternating series, Absolute and Conditional convergence.
Power series and its convergence, Taylor and Maclaurin series (6 Lectures)

Module-III: Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Singularities of Bessels and Laguerre Equations, Frobenius method and its applications to differential equations: Legendre and Hermite Differential Equations, Legendre and Hermite Polynomials: Rodrigues Formula, Generating Function, Orthogonality.
(10 Lectures)

Module-IV: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral). Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular Function, Properties of Dirac delta function(8 Lectures)

Module-V: Complex Analysis -Functions of complex variable ï Zeros and singular points - Taylorôs series and Laurentôs series expansionï Cauchy's residue theorem ï evaluation of residues ï evaluation of definite integrals. (8 Lectures)

TEXT AND REFERENCE BOOKS:

1. Mathematical Methods for Physicists, G. B.Arfken, H. J. Weber, F. E. Harris (2013,7thEdn., Elsevier)
2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India)
3. Mathematical Physicsï H. K. Dass, Dr. Rama Verma (S. Chand Publishing)
4. Mathematical Physics C. Harper (Prentice Hall India)
5. Complex Variable: Schaumôs Outlines Series M. Spiegel (2nd Edition, McGraw Hill Education)
6. Complex variables and applications J.W. Brown and R.V. Churchill
7. Mathematical Physics, Satya Prakash (Sultan Chand)
8. Mathematical Physics B.D. Gupta (4thedition, Vikas Publication)

Course Outcomes:

CO1	The emphasis of course is on applications in solving problems of interest to physicists.
CO2	The students are to be examined entirely on the basis of problems, seen and unseen.
CO3	Learn about Gradient, Divergence and Curl in orthogonal curvilinear and their typical applications in physics
CO4	Learn about special type of matrices that are relevant in physics and then learn about tensors
CO5	Get introduced to Special functions like Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions and their recurrence relations

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (4th Semester)
Subject: ELEMENTS OF MODERN PHYSICS

Module-I:

Brief Review of Black body Radiation. Inadequacy of classical physics, Photo electric effect, Compton Effect, dual nature of radiation, wave nature of particles, de-brog lie hypothesis for matter waves, Detection, Demonstration and properties of Matter wave, Davision Germer Experiment, GP Thompsons experiment on electron diffraction, Bohr quantization condition

(6 Lectures)

Module-II:

Wave packet, Wave velocity, groupvelocity, Relation between group and wave velocity, Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gammaray microscope and electron diffraction through as lit, Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus, Uncertainty and complement arities.

(6 Lectures)

Module-III:

Atomic Models: Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and itslimitations. Bohrôs Model of Hydrogen atom, explanation of atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle correction for finite mass of the nucleus, Bohr correspondenceprinciple,limitationsofBohrmodel,FrankHertzExperiment,SornmerfeldsmodificationofBohrs Theoryand itôs limitations (10Lectures)

Module-lV:

Nuclear Physics: Size and structure of atomic nucleus and its relation with atomic weight, Packing fraction, Nature of the nuclear forces, NZ graph, Mass defect and binding energy, Liquid Drop model, semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Alpha, Beta and Gamma decay: Alpha decay, Beta decay, Paulis prediction of neutrino; Gammaray emission ,energy-momentum conservation

Fission and fusion: Fission-nature off ragments and emission of neutrons, chain reaction, Nuclear reactor: slow neutron interacting with Uranium 235, Nuclear fusion, Hydrogen bomb, solar energy

(12 Lectures)

Module-V:

Einsteinôs A and B coefficients, Metastable states, Spontaneous and stimulated emissions, Optical pumping and population inversion, Three level and four level lasers(Ruby laser and He-Ne Laser), Semiconductor laser. (6 Lectures)

TEXT AND REFERENCE BOOKS:

l. ConceptsofModernPhysics-ArthurBeiser (McGrawHill)
2. ModernPhysics-SKGuptaandB.S.Agarwal(KNRN,Meerut)
3. Modern Physics-MurugeshanandSivaprasad(S.Chand)
4. AtomicandNuclearPhysics-A.B.Gupta(NewCentral)
5. ModernPhysics-Serway(CENGAGELearnings)
6. TheoryandProblemsofModernPhysics,Schaumôsoutline,
7. R.GautreauandW.Savin-(TataMcGraw-Hill)

Course Outcomes:

CO1	The inadequacy of classical mechanics to some physical phenomenon and its solution by quantum mechanics
CO2	Mathematical formulation of quantum mechanics to understand some physical concepts.
CO3	Different atomic model for understanding physical phenomena at atomic level.
CO4	Basic properties of nucleus with different nuclear mechanism explained.
CO5	Introduction to laser with three and four level basic laser concepts are explained.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (4th Semester)

Subject: DIGITAL SYSTEMS AND APPLICATIONS

Module-I:

INTEGRATED CIRCUITS (QUALITATIVE TREATMENT ONLY): Active&Passivecomponents. Discretecomponents. Wafer Chip Advantages and drawbacks of ICs Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of lCs. Examples of Linear and Digital ICs.

Module-II:

DIGITAL CIRCUITS: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexa decimal numbers, AND OR and NOT Gates (realizationusing Diodesand Transistor). NAND and NOR Gatesas Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Boolean algebra: DeMorgan's Theorems.

Module-III:

BOOLEAN LAWS: Simplification of Logic Circuitusing Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truthtable in to Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Module-IV:

DATA PROCESSING CIRCUITS: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2'sComplement. Half and Full Adders. Half & Full Subtractors, 4-bitbinary Adder/Subtractor.

Module-V:

SEQUENTIAL CIRCUITS: SR,D, and JK Flip-Flops. Clocked(Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop, Counters, Registers

TEXT AND REFERENCE BOOKS:

1. A.P.Malvino, D.P. Leachand Saha, Digital Principles and Applications,7thEd, Tata McGraw Hill(2011)
2.Anand Kumar, Fundamentals of Digital Circuits, 2ndEdn, PHI Learning Pvt.Ltd.(2009)
3. Venugopal, Digital Circuits and systems,Tata McGraw Hill(2011)
4. GKKharate, Digital Electronics, Oxford University Press(2010)
5.R.J.Tocci,N.S.Widmer, Digital Systems: Principles& Applications,PHI Learning(2001)
6. Shimon P.Vingron, Logic circuit design,Springer(2012)
7.Subrata Ghoshal, Digital Electronics, Cengage Learning(2012)
8.S.K.Mandal, Digital Electronics, McGraw Hill(2010)

Course Outcomes:

CO1	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics
CO2	To understand and examine the structure of various number systems and its application in digital design
CO3	The ability to understand, analyze and design various combinational and sequential circuits
CO4	Ability to identify basic requirements for a design application and propose a cost effective solution
CO5	The ability to identify and prevent various hazards and timing problems in a digital design

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (4th Semester)
Subject: DIGITAL ELECTRONICS LAB (Lab-V)

LIST OF EXPERIMENTS:

1. Digital gates kit
2. Study of Multivibrator ï Astable
3. Study of Multivibrator ï Bistable
4. Study of Multivibrator ï Monostable
5. Network Theorems (Thevenin, Norton, Superposition & Reciprocity theorems)
6. OP-Amp as inverting, Non-inverting, summing amplifier
7. OP-amp as differentiator& integrator
8. R-F oscillator
9. Verification of De Morganôs Theorem
10. Design and performance study of regulated dc power supply

Course: Integrated M.Sc. (4th Semester)
Subject: ELECTRICITY AND MAGNETISM LAB (Lab-IV)

LIST OF EXPERIMENTS:

1. Determination of ballistic constant of a Ballisitic Galvanometer
2. Determination of (a) resistance per unit length of the bridge wire;
   (b) an unknown resistance using Carey Foster Bridge
3. Ferromagnetic Curie Temperature Kit
4. Frequency of AC mains using Sonometer
5. Hysteresis (P-E) Loop Tracer
6. B-H curve analysis
7. Study of RC coupled transistor amplifier
8. Determination of magnetic field along the axis of a coil using Stewart and Geeôs tangent galvanometer with sliding compass
9. Verification of Lorentz force relation using current balance
10. Determination of EMF and internal resistance of a cell using a stretched wire potentiometer

Course: Integrated M.Sc. (5th Semester)

Subject: QUANTUM MECHANICS AND APPLICATIONS

Course Objectives:

1. To introduce the quantum mechanics concepts
2. To study the various parameters and wave equations of quantum mechanics
3. To implement the parameters and equations to solve the physical problems.

Module-I: Schrodinger equation: Time dependent Schrodinger equation, Properties of Wave Function, Interpretation of wave function, Probability and probability current densities in three dimensions, Conditions for Physical Acceptability of Wave Function, Normalization, Linearity and Superposition Principles. Wave function of a free particle, Wave Packet, Fourier Transform and momentum space Wave function, Spread of Gaussian Wave packet, Evolution with time, Position and Momentum Uncertainty.

Module-II: Operators: Operators, Commutator Algebra, Position, Momentum Angular Momentum and Energy operators, Hermitian Operators, Expectation values of position and momentum, Ehrenfest Theorem, Eigen values and Eigen functions of Hermitian Operator, Energy Eigen Spectrum, Degeneracy, Ortho normality of Eigen functions, Linear Dependence. Orthogonalization.

Module-III: Time Independent Schrodinger equation in one dimension (1d), 2d and 3d, Hamiltonian, stationary states and energy eigen values, expansion of an arbitrary wave function as a linear combination of energy eigen functions, General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundary condition and emergence of discrete energy levels

Module-IV: Applications: Application to one dimensional problem-Square well potential, Quantum mechanics of simple Harmonic Oscillator-Energy Levels and energy eigen functions, ground state, zero point energy and uncertainty principle, One dimensional infinitely rigid box energy eigen values and eigen functions, normalization, quantum dot as example, Quantum mechanical scattering and tunneling in one dimension across a step potential and rectangular potential barrier.

Module-V: Atoms in Electric and Magnetic Fields: Electron angular momentum, Space quantization, Electron Spin and Spin Angular Momentum, Larmorôs Theorem, Spin Magnetic Moment, Stern Gerlach Experiment, Vector Atom Model, L-S and J-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyro magnetic Ratio and Bohr Magneton. Atoms in External Magnetic Fields: - Normal and Anomalous Zeeman Effect, Paschen back and Stark Effect (qualitative Discussion only)

TEXT AND REFERENCE BOOKS:

1. Introduction to Quantum Theory David Park (Dover Publications)
2. Introduction to Quantum Theory, D. J. Griffiths (Pearson)
3. Quantum Mechanics, Theory and applications, A. Ghatak and S. Lokanathan (McMillan India)
4. Quantum Mechanics-G.Aruldhas (Printice Hall of India)
5. Quantum Physicsï S. Gasiorowicz (Wiley)
6. Quantum Mechanics-G.R.Chatwal and S.K.Anand
7. Quantum Mechanics -J.L. Powell and B. Craseman (Narosa)
8. Introduction to Quantum Mechanics M.Das and P.K.Jena (Shri Krishna Publication)

Course Outcomes:

CO1	The quantum mechanics and its applications have been introduced
CO2	These preliminary concepts and applications are helpful in understanding the advanced concepts of quantum mechanics.
CO3	These preliminary concepts and applications are helpful in understanding the advanced concepts of quantum mechanics
CO4	Its helpful To study the various parameters and wave equations of quantum mechanics
CO5	To implement the parameters and equations to solve the physical problems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (5th Semester)
Subject: SOLID STATE PHYSICS

Course Objectives:

1. This course deals with crystalline solids and is intended to provide the basic physical concepts and mathematical tools used to describe solids.
2. The understand the Elementary lattice dynamics
3. To understand the various magnetic phases of matter and super conductivity
4. To analyze the dielectric nature of materials and to study the band theory using some models.

Module-I: Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis ï Central and Non-Central Elements. Unit Cell Miller Indices Reciprocal Lattice Bravais lattices, Point and space groups, Types of Lattices. Brillion Zones. Diffraction of X-rays by Crystals. Braggôs Law.Atomic and Geometrical Factor. (7 Lectures)

Module-II: Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petitôs Law, Einstein and Debye theories of specific heat of solids. T^3 law
(8 Lectures)

Module-III: Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials.
Classical Langevin Theory of diaï and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curieôs law, Weissôs Theory of Ferromagnetism and Ferromagnetic Domains.Discussion of B-H Curve. Hysteresis and Energy Loss. (8 Lectures)
Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field Meissner effect. Type I and type II Superconductors, Londonôs Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation) (6 Lectures)

Module-IV: Dielectric Properties of Materials: Polarization Local Electric Field at an Atom. Depolarization Field Electric Susceptibility Polarizability. Clausius Mosotti Equation Classical Theory of Electric Polarizability Normal and Anomalous Dispersion Cauchy and Sellmeir relations. Langevin-Debye equation Complex Dielectric Constant Optical Phenomena. (6 Lectures)

Module-V: Elementary band theory: Kronig Penny model. Band Gap Conductor, Semiconductor (P and N type) and insulator Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (Four probe method) & Hall coefficient. (6 Lectures)

TEXT AND REFERENCE BOOKS:

1. Introduction to Solid State Physics, Charles Kittel, 8thEdition, 2004, Wiley IndiaPvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4thEdition, 2015, Prentice-Hall ofIndia
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
8. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Course Outcomes:

CO1	knowledge on crystal symmetry which leads to substantial mathematical implications when dealing with solids.
CO2	Idea of describing basic experimental measurements, to show typical data sets and to compare these with theory
CO3	knowledge on crystal symmetry which leads to substantial mathematical implications when dealing with solids
CO4	Idea of describing basic experimental measurements, to show typical data sets and to compare these with theory
CO5	To understand the various magnetic phases of matter and super conductivity

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	1
CO2	2	3	3	2	2	1
CO3	2	3	3	2	2	1
CO4	2	3	3	2	2	1
CO5	2	3	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	2	2	1

Course: Integrated M.Sc. (5th Semester) ELECTIVE-I

Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Elective-I
1.Basic Instrumentation
2.Experimental Techniques
3. Physics of Devices and Communication

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-I-1)

Subject: Basic Instrumentation

Module-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac volt- age, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC milli voltmeter: Type of AC milli voltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac milli voltmeter, specifications and their significance.

Module-II

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), brief discussion on screen phosphor, visual persistence and chemical composition.Time base operation, synchronization. Front panel controls.

Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Module-III

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator, Brief idea for testing, specifications, Distortion factor meter, wave analysis.

Module-IV

Digital Instruments: Principle and working of digital meters, Comparison of analog and digital instruments, Characteristics of a digital meter, Working principles of digital voltmeter.

Module-V

Digital Multimeter: Block diagram and working of a digital multimeter, Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time-base stability, accuracy and resolution.

TEXT AND REFERENCE BOOKS:

1. A Text Books book of electrical technology-B.L.Theraja (S. Chand Publishing)
2. Digital circuits and systems Venugopal (Tata McGraw Hill)
3. Digital Electronics-SubrataGhoshal (Cengage Learning)
4. Electronic Devices and circuits - S. Salivahanan and N. S.Kumar (Tata Mc GrawHill)
5. Electronic Devices-Thomas L. Floyd (Pearson)

Course Outcomes:

CO1	The students will be able to demonstrate basic knowledge of Laplace Transform
CO2	Obtain the time response of systems using inverse Laplace transform
CO3	Find the Fourier series, Complex form of Fourier series, Fourier Integral and Fourier transform of the functions
CO4	Study the differential vector algebra and its properties
CO5	Study vector line integral and theorems in plane and surface

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	1
CO4	3	2	3	3	2	3
CO5	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-I-2)
Subject: EXPERIMENTAL TECHNIQUES

Module-I

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution.
(6 Lectures)

Module-II

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems.Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise. (6 Lectures)

Module-III

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Electrical, Thermal and Mechanical systems. Calibration. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. (8 Lectures)

Module-IV

Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.
(12 Lectures)

Module-V

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum.Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Molecular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization). (8 Lectures)

TEXT AND REFERENCE BOOKS:

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
4. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
5. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata Mc Graw Hill
6. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
7. Electronic circuits: Handbook of design & applications, U. Tietze, Ch. Schenk, Spring

Course Outcomes:

CO1	To make students aware of recent use of techniques and devices in research and physical phenomena analysis
CO2	The students will get basic concepts and principle behind the experimental techniques
CO3	It will help students for pursuing career at industry and research field
CO4	Describe and explain the working principles of the various techniques
CO5	Identify the strength and limitation of each technique, therefore, choose the right technique for characterization of properties

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	1
CO2	2	3	3	2	2	1
CO3	2	3	3	2	2	1
CO4	2	3	3	2	2	1
CO5	2	3	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	2	2	1

Course: Integrated M.Sc. (5th Semester) (ELECTIVE- I-3)
Subject: PHYSICS OF DEVICES AND COMMUNICATION

Module-I

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal- semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS. MOSFETï their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. (14 Lectures)

Module-II

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection, Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters. (6 Lectures)

Module-III

Multi vibrators: Astable and Mono stable Multi vibrators using transistors.

Phase Locked Loop(PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filterï Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). (8 Lecturers)

Module-IV

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. (6Lecturers)

Module-V

Optical lithography, Electron lithography, Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.(6Lectures)

TEXT AND REFERENCE BOOKS:

1. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
2.Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
3. Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
4. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
5. Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
6. Intro.to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
7.Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
8.PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, PH India

Course Outcomes:

CO1	student will be able to understand the current voltage characteristics of semiconductor devices.
CO2	Analyze dc circuits and relate ac models of semiconductor devices with their physical Operation
CO3	Design and analyze of electronic circuits
CO4	Evaluate frequency response to understand behavior of Electronics circuits
CO5	To verify the theoretical concepts through laboratory and simulation experiments

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (5th Semester) ELECTIVE-II

Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Elective-II
1. Classical Dynamics
2. Energy Physics
3. Nanomaterials and application
4. Physics of Earth

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-II-1)

Subject: CLASSICAL DYNAMICS

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Module-I

Generalised co-ordinates and Velocities, Generalised Force, Principle of virtual work Derivation of Lagranges equation of motion from DAlemberts Principles, Lagrangian and its Application to Simple, Compound and Double Pendulums, Single Particle in Space, Atwoods Machine, Dumb-bell, Linear harmonic oscillator.

Module-II

Hamiltons Principle, Calculus of Variation and derivation of Euler-Lagranges equation, Langranges Equations derived from Hamiltons Principles, Hamiltoian and its applications to Shortest Distance between two points in a plane, Geodesic Problem, minimum surface of revolution, Brachistochrone problem.

Module-III

The Equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, canonical momenta, Hamiltions equations of motion, Motion of charged particles in external electric and magnetic fields, Applications to central force motion and coupled oscillators.

Module-IV

Special theory of Relativity (Postulates of special theory of relativity),Lorentz transformations, Minkowski space, The invariant interval, light cone and world lines, space time diagrams, Times-dilation, length contraction and Twin paradox, Variation of mass with velocity mass energy relation

Module- V

Four Vectors: Space Like, Time-like and light-like. Four velocity and acceleration, Four momentum and energy-momentum relation. Doppler effects from a four vector perspective, Concept of four-force, Conservation of four momentum, Application to two body decay of an unstable particle

TEXT AND REFERENCE BOOKS:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko (Pearson) 2.Classical Mechanics N C Rana and P S Joag.
1. Mechanics-D.S.Mathur(SultanChand)
2. Solved problems in Classical Mechanics, O.L. Delange and J.Pierrus (Ox- fordpress)(2010)
3. Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra(Srikr- ishnaPrakashan)
4. Mathematical Physics with Classical Mechanics-Satya Prakash(Sultan Chandandsons)
5. Introduction to classical dynamics R.K.Takwaleand S.Puranik(Tata McGrawHill)
6. Classical Mechanics J.C.Upadhyay(HimalayanPublisher)
7. Classical Dynamics of particles and systems -S.T.Thorton andMarion (Cengagepublication)

Course Outcomes:

CO1	The conservation principles involving momentum, angular momentum and energy and understand that they follow from the fundamental equations of motion
CO2	Have a deep understanding of Newton's laws
CO3	Students learn about Lagrangian and Hamiltonian formulation of Classical Mechanics
CO4	It give the idea of the most fundamental of all physical sciences and subsequently relatively modern and challenging topic like chaotic dynamics at advanced level
CO5	Kinematics and Dynamics of rigid body in detail and ideas regarding Euler's equations of motion

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	2	1
CO2	2	3	3	3	2	1
CO3	2	3	3	3	2	1
CO4	2	3	3	3	2	1
CO5	2	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	3	2	1

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-II-2)
Subject: ENERGY PHYSICS

Objective: This paper deals with the practical usage of solar energy in various forms and other alternative energy sources.

Module-I: **Conventional Energy**
Sources Energy sources and their availability-Various forms of energy- Renewable and conventional energy systems-Comparison- Coal, oil and natural gas.

Module-II: **Solar Energy**
Solar Energy-Thermal application and solar radiation-Energy alternatives- Devices for thermal collection and storage- Thermal applications-Water heating-Space heating-Power generation-Instruments for measuring solar radiation and sunshine.

Module-III: Thermal Energy
Storage General characteristics- Definitions- Methods of classifications- Thermal energy storage-Sensible heat storage-Liquids- Solids- Latent heat storage-Thermal chemical storage.

Module-IV: Photo Conversion
Photo voltaic conversion- Principle and working of solar cells-Conversion efficiency- Single crystal and Poly crystalline silicon-Cadmium sulphide- Cadmium telluride.

Module-V: Other Forms of Energy
Wind energy- Recent developments- Hydro energy-Energy from waves and tides- Thermal energy-Energy from biomass- Biodiesel-Physical and chemical properties of Bio-diesel.

TEXT AND REFERENCE BOOKS:

1. Solar energy (Second edition), P. Sukhatme,Tata McGraw-Hill,2008.
2. Renewable energy sources and emerging Technologies, D. P. Kothari, K.C. Singal and Rakesh Ranjan. Prentice Hall of India, 2008
3. Renewable Energy sources and their Environmental Impact,S. A. Abbasi and NasemaAbbasi,PHI Learning Pvt. Ltd., 2008

Course Outcomes:

The student should be able to:

CO1	describe different energy sources, especially those of importance for the renewable energy supply
CO2	describe the physical and technical principles for different types of energy conversion
CO3	explain, use and evaluate energy systems based on a thermodynamic and physical context
CO4	explain and assess technical preconditions for and consequences of different energy conversion systems as well their environmental impact
CO5	take part in the public debate on energy supply, distribution of resources and climate

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-II-3)

Subject: Nano Materials and Applications

Module-I:

Nanoscale Systems: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, size effects in nano systems, Quantum confinement Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure and its consequences.

Module-II

Synthesis of Nanostructure Materials: Photolithography, Ballmilling. Gas phase condensation, Vacuum deposition, Physical vapour deposition (PVT): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition,

Module-III

Chemical Vapourdeposition (CVD), Sol-Gel, Electrodeposition, Spray pyrolysis, Hydrothemal synthesis, Preparation through colloidal methods, MBE growth ofquantum dots.

Module-IV

Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy

Module-V

Applications: Applications of nano particles, quantum dots, nano wires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nonmaterial Devices: Quantum dots hetero structure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots- magmetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems(NEMS)

TEXT AND REFERENCE BOOKS:

1. S.K. Kulkarni, Nanotechnology: Principles and Practices (Capital PublishingCompany)
2. Nano science and nanotechnology,K.K.Choudhury(Narosa)
3. Nano Science and nanotechnology, Sundar Singh (PragatiPrakashan)
4. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology(Wiley IndiaPvt. Ltd.).
5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
6. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook(Elsevier,2007).
7. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI LearningPrivate Limited).
8. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)

Course Outcomes:

CO1	The student will develop a fundamental knowledge of nanomaterials
CO2	The student will demonstrate a basic understanding of the length scale that defines nano for metal and semiconductor materials
CO3	The student will demonstrate an understanding of the properties of materials with strong dependence on size
CO4	The student will demonstrate an understanding of approaches to nanomaterials characterization
CO5	The student will demonstrate an understanding of the challenges on safe nanotechnology

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	2	1
CO2	2	3	3	3	2	1
CO3	2	3	3	3	2	1
CO4	2	3	3	3	2	1
CO5	2	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	3	2	1

Course: Integrated M.Sc. (5th Semester) (ELECTIVE-II-4)
Subject: PHYSICS OF EARTH

Module-I
Origin of universe, creation of elements and earth.A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography.Introduction to various branches of Earth Sciences.

Module-II
General characteristics and origin of the Universe. The Milky Way galaxy, solarsystem, Earthôs orbit and spin, the Moonôs orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameter sand its age.

Module-III
Energy and particle fluxes incident on theEarth.The Cosmic MicrowaveBackground.

Module-IV
TheSolidEarth:Mass,dimensions,shapeandtopography,internalstructure, magneticfield,geothermalenergy.The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. Riversystems.

Module-V
The Atmosphere: variation of temperature, density and composition with altitude,clouds
The Cryosphere: Polar caps and ice sheets. Mountaing laciers. The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

TEXT AND REFERENCE BOOKS:
1. Planetary Surface Processes, H.JayMelosh, Cambridge University Press, 2011.
2. Considera Spherical Cow: A coursein environmental problem solving, JohnHarte. University Science Books
3. Holmeôs Principles of Physical Geology. 1992. Chapman &Hall.
4. Emiliani,C, 1992.Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

Course Outcomes:

CO1	Students will acquire basic knowledge about the major areas Astronomy, Geology, Meteorology and Oceanography related to Earth processes
CO2	Students will learn basic processes related to the origin of Universe with fundamentals characteristics applied to the Earth and planets
CO3	Students will be able to recognize and use Cosmic Microwave Background,
CO4	Students will acquire basic structure and composition of the atmosphere, Cryosphere and biosphere for organization of the universe
CO5	Students will Get ideas about the solid earth, geometry and composition

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	2

Course: Integrated M.Sc. (5th Semester)

Subject: SOLID STATE LAB (Lab-VI)

1. To study the variation of resistivity and determine the energy gap of a semiconductor using Four Probe method
2. To determine the relative permeability of a given material.
3. To measure the variation of dielectric constant with temperature and verification of Curie Wiess law
4. Determination of dielectric constant of a given insulating material
5. To determine Hall coefficient of a semiconductor sample.
6. Lattice Dynamics Kit
7. Measurement of susceptibility of paramagnetic solution (Quinkôs tube method)
8. To measure magnetic susceptibility of solids
9. To draw the B-H curve of Fe using solenoid and determine energy loss from Hysteresis curve.
10. To determine the refractive index of a dielectric layer using surface Plasmon resonance (SPR).

Course: Integrated M.Sc (5th Semester, Elective I)

Subject: ANALOG ELECTRONIC LAB (Lab-VII)

LIST OF EXPERIMENTS:

1. To study the Characteristics of FET,
2. To study the Characteristics of MOSFET
3. To study the Characteristics of UJT
4. To study the Characteristics of SCR
5. To study the Characteristics of TRIAC
6. To study the Modulation and demodulation
7. To study the Square wave response of an RC circuit
8. To study the Active low pass filter
9. To study the Active high pass filter
10. To study the Active Band pass filter

Course: Integrated M.Sc. (6th Semester)

Subject: STATISTICAL MECHANICS

Module-I Elementary probability theory: Random variables, statistical distributions, cumulative distribution function, Binomial and Poissonôs distributions, Central limit theorem, Gaussian distribution, Entropy of a probability distribution. Random walks. (10 Lectures)

Module-II Classical Statistics-I: Macrostate and Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and Grand Canonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law (8 Lectures)

Module- III Classical Statistics-II : Thermodynamic Functions of an Ideal Gas, classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of equipartition of Energy (with proof)- Applications to Specific Heat and its Limitations, Negative Temperature. (10 Lectures)

Module-IV Radiation: Properties of Thermal Radiation, Blackbody Radiation, Pure Temperature dependence, Kirchhoffôs law, Stefan Boltzmann law: Thermodynamic proof, Radiation Pressure, Weins Displacement law, Wienôs distribution Law, Sahaôs Ionization Formula, Rayleigh Jeans Law, Ultra Violet catastrophe. (8Lectures)

Module-V Plancks Law of Black body Radiation: Experimental verification, Deduction of (1) Wienôs Distribution Law, (2) Rayleigh Jeans Law, (3) Stefan Boltzmann Law, (4)Weinôs Displacement Law from Planckôs Law (4 Lectures)

TEXT AND REFERENCE BOOKS:

1. Introduction to Statistical Physics by Kerson Huang(Wile
2. Statistical Physics, Berkeley Physics Course, F.Reif (Tata McGraw-Hill)
3. Statistical Mechanics, B.K. Agarwal and Melvin Eisner (New Age International)
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: FrancisW.Sears and Gerhard, L. Salinger (Narosa)
5. Statistical Mechanics: R.K.Pathria and Paul D. Beale (Academic Press)

Course Outcomes:

CO1	Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics
CO2	Apply the principles of statistical mechanics to selected problems
CO3	Grasp the basis of ensemble approach in statistical mechanics to a range of situatio
CO4	To learn the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws
CO5	Study important examples of ideal Bose systems and Fermi systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (6th Semester)
Subject: ELECTROMAGNETIC THEORY

Module-I:

Maxwell Equations: Maxwells equations, Displacement Current, Vector and Scalar Potentials, Lorentz and Coulomb Gauge, Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector, Electro-magnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density

Module-II:

EM Wave Propagation in Unbounded Media: Plane EM waves through Vacuum and isotropic dielectric medium, transverse nature of plane EM waves, Refractive index and dielectric constant, wave impedance, Propagation through conducting media, relaxation time, skin depth ,Electrical conductivity of ionized gases, plasma frequency, refractive index, application to propagation through ionosphere.

Module-III:

EM Wave in Bounded Media: Boundary conditions at a plane interface Between two media, Reflection and Refraction of plane waves at plane interface Between two dielectric media, Laws of Reflection and Refraction, Fresnel's Formulae for Perpendicular and parallel polarization cases, Brewster's law, Reflection and Transmission coefficients, Total internal reflection, evan escent waves, Metallic reflection (normal Incidence)

Module-IV:

Polarization of Electromagnetic Waves: Description of Linear, Circular And Elliptical Polarization, Uni-axial and Biaxial Crystals, Light Propagation in Uniaxial Crystal, Double Refraction, Polarization by Double Refraction, Ordinary and extraordinary refractive indices, Production and detection of Plane, Circularly and Elliptically Polarized Light, Quarter-Wave and Half-Wave Plates. Analysis of Polarized Light. Optical Rotation, Biots Laws for Rotatory Polarization, Fresnels Theory of optical rotation, Calculation of angle of rotation, Specific rotation

Module-V:

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface, Eigen value equations. Phase and group velocity of guided waves. Field energy and Power transmission

Course Outcomes:

CO1	Understand electric and magnetic fields and apply the principles of Coulombôs Law and Gaussôs law to electric fields in various coordinate systems
CO2	Identify the electrostatic boundary-value problems by application of Poissonôs and Laplaceôs equations
CO3	Understand the depth of static and time-varying electromagnetic field as governed by Maxwellôs equations
CO4	Formulate and analyse problems involving lossy media with planar boundaries using uniform plane waves
CO5	Apply concepts of this subject in Antenna Engineering and its applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (6th Semester) (ELECTIVE-III)

Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Elective-III
1.Applied Optics
2. Astronomy and Astrophysics
3. Computational Physics
4. Weather forecasting

Course: Integrated M.Sc. (6th Semester) (ELECTIVE-III-1)
Subject: APPLIED OPTICS

The quest to understand the 'nature of light' is a favorite inquiry of mankind since ancient times. By the advent of lasers, holography, and optical fibres in twentieth century the optics now-a-days finds application in several branches of science and engineering. The objective of this course is to apply the fundamental concepts of optics in lasers, optical fiber communications, optoelectronics and non linear optics.

Module-I

Lasers: an introduction, Planckôs radiation law (qualitative idea), Energy levels, Absorption process, Spontaneous and stimulated emission processes, Theory of laser action, Population of energy levels, Einsteinôs coefficients and optical amplification, properties of laser beam, Ruby laser, He-Ne laser, and semiconductor lasers;

Module-II

Optical fibres: Introduction and historical remarks, Total Internal Reflection, Basic characteristics of the optical fibre: Principle of light propagation through a fibre, the coherent bundle, The numerical aperture, Attenuation in optical fibre and attenuation limit; Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

Module-III

Introduction to Optoelectronics device, Light Emitting Diode (LED) and photo-detectors. Photo-transistors, Opto-isolators, Opto-Couplers.

Module-IV

Basics of holography: in-line and off-axis holography, refection, white light, rainbow and guided wave holograms, polarization holography, Imaging in the random media, Incoherent imaging techniques, Imaging as an inverse problem. X-ray tomography as an example. Optical coherence tomography, Wave front recovery from intensity measurements, Phase problem of optics, Diffuse optical tomography.

Module-V

Introduction to Non Linear Optics, Non Linear Optical Materials, Second and third harmonic generation NLO materials, Z-Scan technique.

TEXT AND REFERENCE BOOKS:

1.LASERS: Fundamentals & applications, K.Thyagrajan&A.K.Ghatak, 2010, Tata McGrawHill
2. Introduction to Fiber Optics, A. Ghatak& K. Thyagarajan, Cambridge University Press.
3. Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, VivaBooks
4. Optical Electronics, AjoyGhatak and K. Thyagarajan, 2011, Cambridge University Press
5. Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt.Ltd.
6. Optical Communications Essentials, G. Keiser, Tata McGraw-Hill
7. W. T. Silfvast ,Laser Fundamentals, Cambridge Univ. Press, Cambridge.
8. Industrial Applications of Lasers, J. F. Ready , 2nd Edn. Academic Press, San Diego.
9. An Introduction to Nonlinear Optics, G. C. Baldwin, Springer. ISBN 978-1-4613-4615-9
10. Electronic Devices and Circuit Theory, R. L. Boylestad, 10th Edition, Pearson Publication.
11.A Guide to Laser Safety, A. Roy Henderson, Chapman & Hall, London.
12. Electronic Devices and Circuits, J. B. Gupta, Katson Books
13. Applied Optics and Optical Design ï Robert R.Shannon&F.C.Wyant, Academic process.

Course Outcomes:

CO1	Identify few different applications of optics i.e. Laser, Fiber Optics and Optoelectronic.
CO2	Analyze different laser systems and its applications in various fields.
CO3	Apply the concept of optical fiber, its construction and importance in communication physics.
CO4	Classify the concepts of opto-isolaters and opto-couplers.
CO5	Interpret the concepts of Non Linear Optics (NLO)
CO6	Able to distinguish the different harmonic generation NLO materials

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (6th Semester) (ELECTIVE-III-2)

Subject: Astronomy& Astrophysics

Module-I

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. (7Lectures)

Module-II

Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, AstronomicalCoordinateSystems,GeographicalCoordinateSystems,HorizonSystem, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Side real Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. (8 Lectures)

Module-III

Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. (8 Lectures)

Module-IV

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). (7Lectures)

Module-V

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromo sphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology).**The solar family** (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. (5Lectures)

Stellarspectraandclassification Structure(AtomicSpectraRevisited,StellarSpectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification) (5Lectures)

TEXT AND REFERENCE BOOKS:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
4. Fundamental of Astronomy (FourthEdition),H.Karttunenetal.Springer
5. K.S. Krishnasamy, óAstro Physics a modern perspective,ôReprint, New Age International (p) Ltd, NewDelhi,2002.
6. BaidyanathBasu, óAn introduction to Astro physicsô, Second printing, Prentice-Hall of India Private limited, New Delhi,2001.
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, NarosaPublication.

Course Outcomes:

CO1	Define and analyze the basic concepts in astronomy
CO2	Describe the working principle of the telescope
CO3	Identify important constellations ï orient in space
CO4	Describe the planets of the solar system and their properties
CO5	Physical perceive and interpret phenomena in the Universe

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (6th Semester) (ELECTIVE-III-3)
Subject: COMPUTATIONAL PHYSICS

Course Objective

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.
Highlights the use of computational methods to solve physical problems
Use of computer language as a tool in solving physics problems (applications)

Module-I

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of linux as an Editor. Some fundamental Linux Commands (Internal and External commands). **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Module-II

FORTRAN PROGRAMMING: Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Module-III

FORTRAN PROGRAMMING-II: Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO- WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Module-IV

Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns-Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

Module-V

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot.importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

TEXT AND REFERENCE BOOKS:

1.Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.

2.Computer Programming in Fortran 77ò. V. Rajaraman (Publisher: PHI).

3.LaTeXï A Document Preparation Systemò, Leslie Lamport (Second Edition, Addison-Wesley, 1994).

4.Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

5.Schaumôs Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

6. Computational Physics: An Introduction, R.CVerma, et al. NewAgeInt.Publishers, New Delhi(1999)

7.A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

8. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn . , 2 007, Wiley India Edition.

Course Outcomes:

CO1	The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics
CO2	Highlights the use of computational methods to solve physical problems
CO3	Use of computer language as a tool in solving physics problems (applications)
CO4	Gets a wide knowledge of numerical methods in computational Physics that can be used to solve many problems which does not have an analytic solution
CO5	Solve problems in physics such as standing waves, central field motion, Kirchoffs law etc using python language

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (6th Semester) (ELECTIVE-III-4)

Subject: WEATHER FORECASTING

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Module-I

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics. (10 Lectures)

Module-II

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws. (6 Lectures)

Module-III

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes. (7 Lectures)

Module-IV

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate. (7 Lectures)

Module-V

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts. (10 Lectures)

TEXT AND REFERENCE BOOKS:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
5. Why the weather, Charls Franklin Brooks, 1924, Chpraman& Hall, London.
6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

Course Outcomes:

CO1	Understand the basics of atmosphere and related phenomena
CO2	Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns
CO3	Understand the various components that go into forecasting the weather
CO4	Produce rudimentary weather forecasts based on weather maps
CO5	Able to evaluate weather predictions based upon observational data and professional weather forecasts

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (6th Semester)
Subject: LASER LAB (Lab-VIII)

LIST OF EXPERIMENTS:

1. Measurement of wavelength of He-Ne laser.
2. Intensity of LED and laser.
3. Photo diode Characteristics.
4. Determination of wavelength of laser using grating
5. Determination of angle of divergence of a laser beam using He-Ne laser.
6. Determination of particle size of lycopodium powder using semiconductor laser.
7. Determination of acceptance angle and numerical aperture using fiber optic cable.
8. Measuring width of a narrow slit, diameter of a thin wire and counting number of slits in diffraction grating.
9. Bend-induced loss in a single-mode fiber.
10. Polarimeter experiment using Laser.

Course: Integrated M.Sc. (7th Semester)

Subject: MATHEMATICAL METHODS

Course Objectives: Mathematical Physics deals with mathematical concepts, techniques and essential tools for the studies of advanced Physics. The fundamental objective of this course is to provide some of the basic preparatory tools necessary for the study of advanced and fundamental quantum mechanics, advanced electro dynamics , the theories of relativity, spectroscopy and particle physics.

Module-I: Linear Algebra:

Review of Linear vector spaces: span, Basis sets ï Orthogonality and completeness, Quotient spaces and direct sums, Dual spaces , Linear operatorsï functions of operators, Derivatives of operators, Conjugation of operators, Normal operators, Generators, Projection operators, Matrix representations of linear operators, representation of operators under a change of basis, commutators, diagonalisaton of matrices with degenerate eigen values, Normed space, Banach space and Hilbert space, Parseval and Bessel inequalities (no derivation), Reisz-Fischer theorem (no derivation) and Stone-Weirstrass approximation theorem (no derivation) . (7 Lectures)

Module-II:Tensors:

Tensors as multilinear maps, Tensor products, Metric tensor, Contraction and quotient theorems, Cartesian tensors, Tensor calculus: Introduction to manifolds, parametric curves on a manifold: parametrization and arc length, tangent vectors, Tensor fields over a differentiable manifold, Alternating tensors, Kronecker delta and Levi-Civita symbol, Christoffel symbols, differential forms: basic ideas and applications (13 Lectures)

Module-III:Operator theory:

spectral decomposition theory for finite dimensional vector spaces: spectral theorem (results only), Bounded operators in Hilbert space, Compact sets- bounded, Open and closed subsets, Compact operators , Spectral theorem for compact hermitian operators only (no derivation). (6 Lectures)

Module IV: Finite groups: review of basic group theory: equivalence classes, cosets and quotient groups, representation of groups, Schurôs lemmas and the Great orthogonality theorem (no derivation), Applications to find character and character table (6 Lectures)

Module-V: Continuous groups: Lie groups and Lie algebras, Infinitesimal generators: Matrix and operator forms, Irreducible representations of SO(2) and SO(3) groups, Parameters space for SO(3), Orthogonality relations for SO(3), Unitary groups: SU(2), Relations between SU(2) and SO(3), SU(3) (10 lectures)

TEXT AND REFERENCE BOOKS:

1.SadriHassani: Mathematical Physics: A Modern Introduction to Its Foundations, Springer

2. Anadijiban Das: Tensors: The Mathematics of Relativity Theory and ContinuumMechanics, Springer

3. A.W. Joshi: Elements of Group Theory for Physicists

4. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions.

5. A Visual Introduction to Differential Forms and Calculus on Manifolds, Jon Pierre Fortney, Birkhauser 2018.

Course Learning Outcome: The post graduate student on completing this course successfully is expected to

1. Master the abstract foundational mathematical concepts of quantum mechanics
2. Be aware of rudimentary operator theory
3. Gain an usable familiarity with the aspects of the tensor theory that can be subsequently applied in field and relativity theories
4. Apply group theory in atomic and molecular spectroscopy
5. Be acquainted with the very basics of Lie group theory for its applications

Course Outcomes:

CO1	Master the abstract foundational mathematical concepts of quantum mechanics
CO2	Be aware of rudimentary operator theory
CO3	Gain an usable familiarity with the aspects of the tensor theory that can be subsequently applied in field and relativity theories
CO4	Apply group theory in atomic and molecular spectroscopy
CO5	Be acquainted with the very basics of Lie group theory for its applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	2

Course: Integrated M.Sc. (7th Semester)

Subject: CLASSICAL MECHANICS

Course Objectives: Classical Mechanics give the idea of the most fundamental of all physical sciences and subsequently relatively modern and challenging topic like chaotic dynamics at advanced level.

Module-I : Review: Application of Newton's Laws and Conservation Laws, Constraints: classification, Lagrangian dynamics: displacements classifications, D'Alemberts principle, Nature of forces of constraints, Virtual velocity, Variations, The fundamental equation of classical mechanics, Nature of given forces, Kinetic energy, The central principle, The principle of Hamilton,
Lagrange's principle of least action, Jacobi's principle of least action, Theory of generalized coordinates, Nature of generalized coordinates, the operator for generalized coordinates,
Fundamental equationin generalized coordinates, generalized potentials, velocity dependent potentials

Module-II:
The dynamical problem, Lagrange's multiplier rule, Derivation of Lagrange's equations from the fundamental equation, Derivation from Hamilton's principle, Hamilton's principle from fundamental equation, Special forms of Lagrange's equations: existence of potential, Holonomic systems, Rayleigh's dissipation function, principle of least action, Hamiltonian formulation: Legendre transformations, Hamilton's equations, Hamilton's equation from Hamilton's principle, Integral in variants of Poincare, Liouville's theorem on phase volume, Poisson brackets, Dynamical systems: Hamiltonian systems, Dissipative systems, Cyclic coordinates and conservation theorems

Module-III:
Canonical transforn1ations, Free canonical transformations, Hamilton Jacobi theory: Hamilton's principal function. Jacobi's complete integral, Time independent Hamilton Jacobi equation, Method of separation of variables, Canonical character of a transformation,Lagrangianbrackets,Jacobianmatrixofacanonicaltransformation,Invarianceof Poissonbracketsundercanonicaltransformation,Symmetry,invarianceandNoether'stheorem.

Module-IV:
Completely integrablesystems.Actionanglevariables,Canonicaltransformationtoactionanglevariables,Periodicandquasiperiodic motion,Examples:simpleharmonicoscillatorandcentralforces.Liouville'sintegrabilitytheorem,

Module-V:
Rigid body motion: Orthogonal transformations, Eulerangles, Coriolis force, Angular momentum and kinetic energy, Inertia tensor, Euler equations, Theory of small oscillations and normal coordinates

TEXT AND REFERENCE BOOKS:

1. J.H.Goldstein,Poole,ClassicalMechanics.Narosa(1985)
2.N.L.RanaandP.S.Joag,Classical MechanicsTMH(1991)

Course Outcomes:

CO1	Understanding of basics **mechanics** for one particle system **and that** can be extended to many particle systems.
CO2	The different types of co-ordinate systems, Space systems and their corresponding suitable mechanics.
CO3	The study of experimentally observed phenomena theoretically provides acritical understanding for further studies in physics.
CO4	The basic idea transformation system through the application of classical mechanics provides prerequisite for mathematical study.
CO5	The study of different brackets, action angle variables, that can be helpful to deal with higher problems of Mechanics.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	3	2	1
CO2	2	2	3	3	3	1
CO3	3	3	2	2	3	2
CO4	3	1	3	3	2	1
CO5	2	3	3	2	3	1

1:Slight(Low)2:Moderate(Medium)3:Substantial(High)-:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	2	3	2	2

Course: Integrated M.Sc. (7th Semester)
Subject: QUANTUM MECHANICS-I

Course objectives: Introduces the student to a more mature and formal treatment of quantum mechanics beginning with the concepts of Hilbert space and operators. Recent fields Like quantum information theory and related fields have reemphasized the importance of quantum theory fundamentals in a new light requiring a thorough treatment of advanced fundamentals of quantum mechanics.

Module-I: Fundamental preliminaries: Linear vector space, dimension and basis of a finite dimensional vector space, inner product and normed space, infinite dimensional space and Dirac Delta function, Hilbert space, Dirac notations: Bra and Ket vectors, Schmidt normalization, square integrable functions: wave functions, superposition of quantum states using Mach Zehnderinterferometer concept (no description of experiment) , theoretical discussion (no description of experiment) of the Stern-Garlach experiment, Observables and Operators: hermitian and unitary operators, commutators, eigen values and eigenvectors of an operator. Matrix representation of operators, simultaneous diagonalisation of commutating matrices with degenerate eigen values, projection operators, infinite dimensional operators, coordinate and momentum representations and transformations between t (13 Lectures)

Module-II: Symmetries, state evolution and composite quantum states: General view on symmetries and conservation laws, symmetries in quantum mechanics: spatial translation ï continuous and discrete, time translation, parity, time reversal, expectation value of an observable, time evolution, wave packets and propagators, Composite systems, tensor products of states and operators on product spaces, density matrix and reduced density matrix, entangled states: Bell states, (11 Lectures)

Module-III: Quantum dynamics: Schrodinger picture, Heisenberg picture, Heisenberg equation of motion, Ehrenfestôs theorem, Interaction picture, Solution of simple harmonic oscillator problem by operator method (6 Lectures)

Module-IV: Schrodinger equation for central potential: Introduction to angular momentum operators and spherical harmonics, Hydrogen atom, power series solution for the radial part, energy quantization and eigenstates (5 Lectures)

Module-V: General theory of angular momentum: J_x, J_y, J_z and J^2 and their commutation relations. Matrix representation of J_+, J_- , J_x, J_y, J_z and J^2 , eigen values and eigenstates of J_z, J^2 . and J^2, Spin 1/2 particles, Pauli spin matrices and their properties, rotation operator, addition of angular momenta and C.G. coefficients (8 Lectures)

Course outcomes

On completion of the course a student is expected to have a solid basis on the following aspects

1. Mathematical foundations of quantum mechanics with a proper working knowledge of representations of quantum mechanical operators in finite as well as infinite dimensional hilbert spaces.
2. Evolution of quantum states and the different ópicturesôof quantum mechanics and the operator formalism used in the harmonic oscillator problem
3. Basic knowledge of composite states and the density matrix formalism, Entanglement and Bell states
4. Concept of angular momentum in a central potential and the solution of the hydrogen atom problem.
5. The general angular momentum theory using operator formalism including spin, combination of angular momenta and C.G. coefficients

TEXT AND REFERENCE BOOKS:

1. Principles of Quantum Mechanics , R Shankar, 2nd Ed. Plenum press 1994.
2. Quantum Mechanics: Concepts and Applications,NouredineZettili ,Wiley, 2009.
3. Modern Quantum Mechanics Revised Edition, J. J. Sakurai, Addison Wesley.
4. Quantum Mechanics Vol. I &II,Claude Cohen-Tannoudji, Bernard Diu, et al., Wiley-VCH.
5. Quantum Mechanics: Fundamentals, Kurt Gottfried and Tung-Mow Yan, Springer.
6.Quantum Computing Explained, David McMahon, Wiley.

COURSE OUTCOMESS:	
CO1	Mathematical foundations of quantum mechanics with a proper working knowledge of representations of quantum mechanical operators in finite as well as infinite dimensional Hilbert spaces.
CO2	Evolution of quantum states and the different ópicturesôof quantum mechanics and the operator formalism used in the harmonic oscillator problem
CO3	Basic knowledge of composite states and the density matrix formalism, Entanglement and Bell states
CO4	Concept of angular momentum in a central potential and the solution of the hydrogen atom problem
CO5	The general angular momentum theory using operator formalism including spin, combination of angular momenta and C.G. coefficients

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	2	2	3	2
CO3	3	2	1	2	3	2
CO4	3	2	2	2	3	2
CO5	3	3	2	3	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); ñ---ñ: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (7th Semester)
Subject: ELECTRONICS AND INSTRUMENTATION

Course Objectives: This course provides the basic. power, digital electronic and concepts related to instrumentation which are essential to understand the basic electronic devices

Module-I: Network and Network theorems:

Mesh, node, super mesh and super nod eanalysis circuit analysis (D.C.analysis). Reduction of complicated network, Conversion between T and □-section, Bridged T network, Super position theorem, Reciprocity theorem, The venin's theorem, Norton's theorem, Maximum power-transfer theorem.

Module-II: Power Electronics:

JFET, MOSFET, UJT (Principle, construction, operation with characteristics) Multi vibrator, Astable, Mono stable, Bistable (Principle, Description and Operation), Wave Shaping Circuits: (i) Linear Wave shaping (using RC circuit), (ii) Nonlinear wave shaping using (Clipper and Clamper)

Module-III: Operational amplifier:

Differential amplifier (Circuit configuration and properties, ideal operational amplifier input and output impedances) Application of OP-AMP: Inverting amplifier, Non-inverting amplifier. Adder, substractor, integrator, differentiator, logarithmic amplifier, comparator (Principle Basic circuit operation and theory)

Module-IV: Digital Electronics:

A/ D converter and *D/ A* converter, Microprocessor: Basic concepts of Microprocessor, Microprocessor architecture, qualitative ideaon8085, Read only memory, Random access. Microcontroller: Basic Concepts

Module-V:

Instrumentation: Instrumentation amplifier, Electronic Voltmeters, Ammeters & Multimeter, function Generator

TEXT AND REFERENCE BOOKS:

1. J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw Hill(1995).
2. A.P. Malvino and D.P. Leach, Digital Principles and Applications, Tata McGraw Hill(1991).
3. Matthew N.0., Sadku, Charles K. Alexander, Fundamentals of Electric Circuits. McGraw Hill
4. R. Gaekwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of lndia (1995)
5. R.S. Gaonkar, Microprocessor, Architecture: Programming and Appl. with the 8085, Penram India
6. Electronic lnstrumentation, Tata McGraw Hill, HSKalsi

Course Outcomes:

CO1	Concept to understand and analyze different electrical circuits.
CO2	To understand the theory, concept and applications of various transistors.
CO3	To understand the theory, concept and applications of power electronics
CO4	To understand the theory and concept computational devices and memory.
CO5	To understand the construction and applications of some basic electronic measurement devices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	2	3	2	2
CO3	3	3	3	3	3	2
CO4	3	3	2	2	3	3
CO5	3	2	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (7th Semester)

Subject: GENERAL PRACTICAL LAB-I

LIST OF EXPERIMENTS:

1. Four probe method for resistivity measurement
2. Measurement of magnetic field and superposition of magnetic field
3. Planckôs Constant by Total Radiation Method
4. e/m by Zeeman effect (Fabry Parot Etalon)
5. Measurement of voltage and time period of a waveform using CRO
6. Square wave Response of an RC Circuit
7. Dielectric constant of solid by Lecherôs method
8. Determination of Boltzmann constant using PN Junction diode

Course: Integrated M.Sc. (7th Semester)
Subject: COMPUTATIONAL PHYSICS LABORATORY

Module-I

Mathematica Fundamentals review

Basic usage with Notebooks, using variables, lists, vectors and matrices, functions, Basic algebraic operations, Immediate versus delayed assignment of values to variables. Substitution, evaluation and delayed evaluation, functions, rudimentary calculus, plotting, data input and output

Module-II

Mathematica basic programming: Loops and conditional do loops in Mathematica with examples, event monitoring using Mathematica.

Module-III

Symbolic and numerical solution of algebraic and ODE's and PDE's in Mathematica:

1. Matrix inversion exercises
2. Eigen value and eigen vectors exercises
3. Schmidt orthogonalisation for a given set of vectors
4. Using DSOLVE to solve. Differential equations symbolically and visualizations
   Projectile in 3D space, motion in a gravitational field
5. Using NDSOLVE to solve partial differential equations symbolically and visulations
   Solution of a set of nonlinear ODE for:2dan harmonic oscillator, Henon-Heiles oscillator
6. Using NDSOLVE to solve Poisson and Laplace equations for electrostatics, Diffusion equations

TEXT AND REFERENCE BOOKS:

1. Numerical Analysis: Timothy Sauer: Pearson Education(2006)
2. Paul Wellin, Programming with Mathematica: An Introduction: Cambridge University Press(2013).

Course: Integrated M.Sc. (8th Semester)
Subject: QUANTUM MECHANICS-II

Course Objectives: This course helps to comprehend (a) some basic theories, (b) its applications, and the treatment for complex atoms. (c) The scattering theory is introduced to understand the advanced problems in physics.

Module-I: Time independent Perturbation Theory: Non-degenerate and Degenerate Cases, Applications: Zeeman and Stark effects. Time Dependent Perturbation Theory, Probability of state, Sinusoidal Perturbation, Fermiôs Golden rule, Einsteinôs transition probabilities.

Module-II: Variation method, Variational integral and its properties, Application to state of the Helium atom, WKB approximation, turning points, connection formulae, Applications of WKB. Bohr-Somerfield quantization condition.

Module-III: The spinning electron, The Helium atom, The Configurations 1s2s, 1s2p, The consideration of electron spin - Pauli exclusion principle, The accurate treatment of normal helium atom, Excited states of helium atom.

Module-IV: Slaterôs treatment of complex atoms: Exchange degeneracy, spatial degeneracy, Factorization and solution of secular equation, The Method of Self-consistent Field (SCF), Relation of the SCF method to the variation principle.

Module-V: Scattering Theory: Born Approximation, scattering cross section, Greenôs function, scattering from square well, screened coulomb potential, Yukawa potential, Partial Wave analysis, Born-Oppen Heimer Approximation, Hydrogen molecule ion problem.

TEXT AND REFERENCE BOOKS:

1. S. Gasiorowicz, Quantum Physics, John Wiley (Asia) (2000).
2. P. Atkins, Molecular Quantum Mechanics, Oxford University Press (2005).
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata Mc-Graw Hill (1995).
4. F. Schwabl, Quantum Mechanics, Narosa (1998).
5. Satyaprakash, Advanced Quantum Mechanics, Kedar Nath Ram Nath (2010).
6. L. I. Schiff, Quantum Mechanics, Mcgraw-Hill (1968).
7. B. H. Bransden and C. J. Joachain, Introduction to Quantum Mechanics, Longman (1993)
8. L. Pauling, and E. B. Wilson, Quantum Mechanics: With Applications to Chemistry, Mc-Graw Hill, New York (1935).
9.N. Zettili, Quantum Mechanics - Concepts and Applications 2nd edition, 2009.

Course Outcomes:

CO1	The treatment of many physical problems with advanced theories, and approximation techniques are expected to provide solution for various problems in sciences.
CO2	This course helps to comprehend some basic theories and its applications.
CO3	The treatment for ground and excited levels of atoms is understood
CO4	The scattering theory offers understanding of advanced problems in physics.
CO5	The relativistic and real time analysis of quantum mechanical systems is introduced.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	2	1
CO2	2	3	3	3	2	1
CO3	2	3	3	3	2	1
CO4	2	3	3	3	2	1
CO5	2	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	3	2	1

Course: Integrated M.Sc. (8th Semester)
Subject: STATISTICAL MECHANICS

Course Objectives: The course objectives are, first, to explain the foundations of statistical mechanics and, second, to work through most of the classic examples of statistical mechanics, as well as some current ones. At the end of the course, the student will be able to tackle the statistical mechanics questions that come up in all areas of experimental and theoretical physics.

Module-I:
Review of Thermodynamics: Laws of thermodynamics, entropy, potentials.
Statistical Thermodynamics : Macroscopic and micro scopic states, Postulates of statistical mechanics, Connection between statistics and thermodynamics, Classical ideal gas, Entropy of mixing and Gibb's paradox (8 Lectures)

Module-II: Ensemble Theory: Phasespace, Liouville's theorem, Micro canonical ensemble: examples, **Canonical Ensemble**: Partition function, classica lideal gas, Energy fluctuation, Equipartition and virial theorem, Harmonic oscillators, statistics of Paramagnetism, Grand Canonical Ensemble: Partition function, density fluctuation, correspondence with other ensembles (10 Lectures)

Module III:
Formulation of Quantum Statistics: Density Matrix, Ensembles in quantum statistical mechanics, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distribution, examples: free particle in a box, harmonic oscillator (10 Lectures)

Module–IV: **Ideal Bose Gas :** Thermodynamics, Bose- Einstein condensation, Phonons Ideal Fermi Gas: Thermodynamics, Theory of White dwarfs (8 Lectures)

Module-V:
Phase Transition: Thermodynamics of phase transition, phase transition of second kind, Paramagnetic and Ferromagnetic Phase transition, Discontinuity in specific heat **Ising Model**: Definition of Ising model, one dimensional Ising model (6 Lectures)

TEXT AND REFERENCE BOOKS:

1. R.K.Pathria, Statistical Mechanics, Butterworth-Heinemann (1996).
2. K. Huang, Statistical Mechanic, John Wiley Asia (2000).
3. F. Reif, Statistical and Thermal Physics, McGraw-Hill(1985).
4.W.Greiner, LNeise, and H.Stocker, Thermodynamics and Statistical Mechanics, Springer.
5.L.D. Landau and E. M.Lif shitz, Statistical Physic-I, Pergamon(1980).

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COURSE OUTCOMESS:	
CO1	Describe the laws of thermodynamics from both a macroscopic and microscopic point of view.Concept of phase space and density distribution.
CO2	Identify and solve the problems in statistical mechanics using ensemble theory.
CO3	Understand the quantum mechanical formulation of statistical mechanics. Knowledge of different kinds of distribution functions depending on particle nature.
CO4	Describe the differences between systems of bosons, fermions and classical gases from microscopic consideration. Detailed study of Boson gas and Fermion gas.
CO5	Explain phase transitions and magnetization, Knowledge of Ising Model

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	1	2	3	2
CO3	3	3	2	2	3	3
CO4	3	3	2	3	3	3
CO5	3	3	3	3	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); ñ---ñ: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	2.6	3	2.8

Course: Integrated M.Sc. (8th Semester)
Subject: ELECTRODYNAMICS

Course Objectives: Introduces advanced electrodynamics beginning with dispersion theory. Subsequently this course aims to put the study of electrodynamics in the context of the four dimensional Minkowski space (flat manifold) using special theory of relativity. This is essential as it is the special theory of relativity that truly unified the electric and magnetic fields as manifestations of asing leentity. This is carried out by using the concept of tensor fields. This in turn empowers the students to study electrodynamics phenomena in a general and consistent manner finally acquainting himself with field theoretic concepts.

Module-I

Dispersion: Normal and Anomalous Dispersion, Dispersion in non-conductors, Frequency dependence of permittivity, Kramers- Kronig relations, Cauchyôs formula. (5 Lectures)

Module -II

Radiation: Radiation from localized oscillating charges, Near and far zone fields, Multi pole expansion, dipole and quadrupole radiation, Centre fed linear antenna, Radiation from an accelerated point charge. Lienard- Wiechart potentials. Power radiated by a point charge: Lienard's formula and its non relativistic limit (Larmor's formula). Angular distribution of radiated power for linearly and circularly accelerated charges. (15 Lectures)

Module-III

Relativistic, Charged Particle Dynamics in Electromagnetic Fields: Motion in uniform static electric and magnetic fields, crossed electric and magnetic fields. (6 Lectures)

Module -IV

Review of Maxwell's equation and Special theory of relativity: Gauge transformations: Coulomb and Lorentz gauges, need for special theory of relativity, Tensor fields, Lorentz transformation as Four vector transformation: velocity, acceleration and force in Minkowski flat manifold, application to electromagnetic theory: ·relation between electric and magnetic fields, transformation of electric and magnetic fields, E.M. field tensors, Covariance of Maxwell's equations (14 Lectures)

Module-V

Lagrangian formulation of Electrodynamics

Lagrangian for a free relativistic particle, for a charged particle in an EMfield, Energy momentum tensor and related conservation laws (5 Lectures)

Course Learning Outcomes:

Upon completion of this course a student is expected to be

1. Capable of handling tensor applications in electrodynamics in the relativistic formalism
2. A dept in handling dynamics of charged particles under various field configurations.
3. Conversant with classical dispersion theory ,
4. Able to tackle radiation problems for various time varying charge and current distributions
5. Acquainted with the rudiments of the field theoretic formulation of electrodynamics

TEXT AND REFERENCE BOOKS:

1.J.D. Jackson, Classical Electrodynamics, John Wiley(Asia)(1999).
2. W. Panofsky and M. Philips, Classical Electricity and Magnetism, Dover Publications

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Capable of handling tensor applications in electrodynamics in the relativisitic formalism.
CO2	A depth in handling dynamics of charged particles under various field configurations
CO3	Conversant with classical dispersion theory
CO4	Able to tackle radiation problems for various time varying charge and current distributions
CO5	Acquainted with the rudiments of the field theoretic formulation of electrodynamics

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (8th Semester)
Subject: ATOMIC AND MOLECULAR PHYSICS

Course Objectives:

The course deals principally with atomic structure and the interaction between atoms and fields. Further, it deals with the binding of atoms in to molecules, molecular degrees of freedom (electronic, vibrational, and rotational), elementary group theory considerations and molecular spectroscopy.

Module-I:

Quantum state of one electron atoms, Magnetic Dipole moments, Electron Spin, Vector model of atom, Stern Gerlach Experiment, Spin-Orbit Interaction, Hydrogen Fine structure, Pauli's principle: identical particle, Formulation of Pauli's exclusion principle, Slater Determinant.

Module-II:

Central Field Approximation, Atomic orbitalôs and Hund's rule, interaction energy in LS and JJ coupling, Selection rules, Spectra of alkali elements, Spin orbit interaction and fine structure in alkali spectra

Module-III:

Normal and anomalous Zeeman effect-Paschen Back effect-Stark effect, Hyperfine Structure of Spectral lines, The Breadth of Spectral lines, Fine-structure of x-ray emission spectra

Module-IV:

The Born-Oppenheimer Approximation, Types of Molecular Spectra, Types of Molecular Energy states and associated spectra, Pure rotational: Explanation of rotational spectra on the basis of rigid rotator, Vibrational - Rotational spectra: Molecule as harmonic Oscillator, an harmonic Oscillator and vibrating rotator, Diatomic molecule as symmetric top, Thermal distribution of vibrational and rotational levels

Module-V:

Experimental arrangement, Quantum theory of Raman effect, Raman spectra as molecular spectra, IR versus Raman Spectra, Formation of Electronic spectra, Electronic band spectra in absorption, fine structure, rotational structure of three-branch bands, Frank-Condon Principle, Quantum mechanical formulation of Frank-Condon principle, Intensity distribution in emission and absorption bands. Isotope effect of electronic spectra.

TEXT AND REFERENCE BOOKS:

1. Atomic and Molecular Spectra: Laser by Rajkumar
2. Introduction to atomic spectra-H.E.White
3. Physics of atoms and Molecules-B.H. Bransden and C.J.Joachain
4. Spectroscopy Vol.I, II, III-Walker & Straughen.
5. Introduction of molecular spectroscopy-G.M. Barrow.
6. Spectra of atoms and molecules- P.F. Bernath.
7. Modern spectroscopy-J.M. Holias
8. Spectra of diatomic molecules-Herzberg
9. Fundamentals of molecular spectroscopy- C.B. Benwell
10. Molecular spectroscopy Jeanne LMichele
11. Molecular spectroscopy-J.M. Brown.

Course Outcomes:

CO1	The basic atomic model for one electron atom can be extended to many electrons atoms as well as molecules.
CO2	The different types of coupling and fine structure of spectra give an insight to deal with complex spectra.
CO3	The study of experimentally observed phenomena theoretically provides a critical understanding for further studies in physics.
CO4	The basic idea behind molecular spectra through the application of quantum mechanics provides prerequisite for experimental study.
CO5	The study of different spectra can be helpful to deal with higher research problems of physics.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	2	3	3	2	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	2	2
CO5	3	2	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	2

Course: Integrated M.Sc. (8th Semester)
Subject: GENERAL PRACTICAL –II

LIST OF EXPERIMENTS:

1. Determination of Planckôs constant using Photoelectric Effect
2. To study the Frank-Hertz Experiment
3. e/m by Thompsonôs method
4. To determine the resistance and inductance of the given unknown inductor by Maxwell's L/C bridge
5. Determination of Boltzmann Constant using I-V Characteristics of p-n diode
6. To study the Non-Destructive Testing ï Ultrasonic
7. Transistor characteristics (CE, CB and CC modes)
8. Study of solid state power supply for He ï Ne Laser
9. e/m by Milliken oil drop method
10. Magnetic Susceptibility of a Paramagnetic Liquid

Course: Integrated M.Sc. (9th Semester)
Subject: CONDENSED MATTER PHYSICS

Course Objectives:

1. To provide understanding of the entity of a material along with their properties and behaviour.
2. This also gives idea about tailoring the properties of the material for different device applications.
3. An attempt may be made to link condensed matter physics with other branches of physics.

Module-I: Properties of Metallic Lattices

The structure of metals, Defects in crystals; Point and line defects, Lattice defects and configurational entropy, Number of vacancies and interstitials as a function of temperature, Formation of lattice defects in metals, The interpretation of slip, dislocations: Edge and screw dislocations, Interaction between dislocations, Estimates of dislocation densities, The Frank-Read mechanism of dislocation multiplications.

(9 Lectures)

Module-II: Ferroelectric Materials

General properties of ferroelectrics, Classification and Properties of representative ferroelectrics, Piezeo, pyro electric effects, Electrostrictive effect, Dipole theory of ferroelectricity and its objections, Ionic displacements and theory of spontaneous polarization, Thermodynamics of ferroelectric transitions, Ferroelectric domains.

(7 Lectures)

Module-III: Conductivity of Metals

Features of the electrical conductivity of metals, A simple model leading to a steady state; drift velocity and relaxation time, The Boltzmann transport equation, The electrical conductivity at low temperatures, The thermal conductivity of insulators, The thermal conductivity of metals, The Hall effect in metals

(7 Lectures)

Module-IV: Soft Condensed Matter Physics

Perturbations of crystalline order: Weak and strong perturbations, Disordered crystal mesophases, ordered fluid mesophases, Types of liquid crystals, Classification according to molecular order, Polymorphism, Structural features of mesophases, Symmetry and order parameter, mean field theory of nematic liquid crystals, Polarizing microscope (8 Lectures)

Module-V: Physics of Phase Transitions

Introduction, Classification of phase transitions, Thermodynamic stability, Positive response function and convexity of free energy, Continuous phase transitions and its link to critical phenomena, The Ising Model: 1D, 2D, and 3D, Transitions with a change in structure, Transitions with no change in structure, Non-Equilibrium transitions (9 Lectures)

TEXT AND REFERENCE BOOKS:

1. A. J. Dekker, Solid State Physics, Macmillan & Co, Ltd, 1952.
2. S. Chandrasekhar, Liquid Crystals, 2nd Edition, Cambridge University Press, 1992.
3. M. Gitterman, V. Halpern, Phase Transitions: A Brief Account with Modern Applications, World Scientific Publishing Ltd. Singapore, 2004.
4. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

Course Outcomes:

CO1	The first two modules of the course provide the understanding of the entity of a material along with their properties and behavior
CO2	The rest modules give idea about prediction and analysis of properties of the material for different device applications
CO3	Theoretical interpretation and experimental arrangements will be understood.
CO4	This also gives idea about tailoring the properties of the material for different device applications
CO5	An attempt may be made to link condensed matter physics with other branches of physics

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (9th Semester)

Subject: NUCLEAR AND PARTICLE PHYSICS

Course objectives

To understand the basic idea about the properties of nuclear force. To provide an ability to construct the elementary idea to solve the fundamental problems of nuclear physics. To discuss the theoretical aspects of two-nucleon problem with both in bound and scattering states which can be exploited to explain in line with the experimental observations.

MODULE-I: BASIC IDEA ABOUT NUCLEI

Nuclear radius, mirror nuclei method for determination of nuclear radius, Nuclear density (mass density, Nucleon number density), spin, magnetic moment, Quadrupole moment, Mass defect, binding energy, semi empirical mass formula and its application (Mass parabola; prediction of stability of nuclei against beta decay)

MODULE-II: NUCLEAR SHELL MODEL

Magic number. Evidences of shell model, extreme particle shell model with square-well and harmonic oscillator potentials, spin-orbit coupling, determination of total angular momentum, parity, magnetic moment of nuclei using shell model.

MODUlLE-III: TWO-NUCLEON PROBLEM

Ground state of deuteron, dept hand range of relation, non-existence of excited state of deuteron, low energy n-p scattering, scattering length, spin dependence on n-p scattering, effective range theory for n-p scattering, p-p scattering, charge invariance of nuclear force, effect tive range theory for p-p scattering.

MODULE-IV: RADIO ACTIVITY

Alpha decay, range of alpha particles, range-·energy relation for alpha particles, Gieger-Nuttal law, Gamow theory of alpha decay.

Beta decay, Pauli-neutrino hypothesis, Fermi theory of beta decay, kurie plot

MODULE–V: NUCLEAR REACTION

Nuclear reaction, Q- Value of reaction, Derivation of reaction cross-section, optical theorem, Shadow scattering, Compound Nucleus model (Bohr Theory), Resonance, Breit-Wigner dispersion formula for l=O, optical model, Nuclear Fission, Nuclear fusion.

TEXT AND REFERENCE BOOKS:

1. Theory of Nuclear Structure: M.K.Pal (East-West Press, New Delhi)1982.
2. Nuclear Physics: Theory and Experiments by R.R. Roy and B.P. Nigam (New Age, New Delhi)
3. Basic Ideas and Concepts in Nuclear Physics by K. Hyde (Institute of Physics)2004.
4. Concepts of Nuclear Physics by B.L. Cohen (Tata Mc Graw Hill),2004.
5. Nuclear physics: Experimental and Theoretical, H.S.Hans (New Academic Science)2nded 201l.
6. Introductory Nuclear Physics: By KSKrane (John Wiley)1988.
7. Theoretical Nuclear Physics by JMB latt and Victor FW efaskopf (Springer-Verlag, New York) 1979.

Course Outcomes:

CO1	Basic idea about nuclear physics leads to the advanced studies in nuclear reaction and generation of nuclear energy through nuclear reactor.
CO2	The nuclear observables can be used to study higher nuclear phenomena both theoretically and experimentally.
CO3	The idea behind two-nucleon problem can be extended to many body problem and advanced learning in high energy physics.
CO4	The concept of radio activities can be exploited to apply various in various field of modern technology.
CO5	The concept of nuclear reaction can used to study the energy formation in stellar system.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	2	3	3	2	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	2	2
CO5	3	2	3	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	2

Course: Integrated M.Sc. (9th Semester) ELECTIVE PAPER –IV
Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Electives-IV
1. Advanced Experimental Techniques
2. Advanced Quantum Mechanics
3. Programming for computational Physics
4. Quantum Information and Measurement
5. Vacuum Technology

Course: Integrated M.Sc. (9th Semester) (ELECTIVE- IV-1)

Subject: ADVANCED EXPERIMENTAL TECHNIQUES

Module-I: Radiation Sources, Detectors and Sensors

Sources of Electromagnetic Radiations: Different types of radiations (X - rays, UV-VIS, IR, microwaves and nuclear) and their sources.

Detectors: X-rays, UV-VIS, IR, microwaves and nuclear detectors

Sensors: Sensorôs characteristics, Classification of sensors, Operation principles of sensors, Resistive, capacitive, inductive, electromagnetic, thermoelectric, elastic, piezoelectric, piezoresistive, photosensitive and electrochemical sensors. (13 Lectures)

Module-II: Structural Characterization -X-ray Diffraction ï Production of X-rays, Types (continuous and characteristics), Braggôs diffraction principle, Techniques used for XRD ï Laueôs method, Rotating crystal method, Powder (Debye Scherrer) method, Derivation of Scherrer formula for size determination, Neutron Diffraction: Principle, Instrumentation and Working (7 Lectures)

Module-III A: Thermal Analysis-Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors. (4 Lectures)

Module-III B: Spectroscopic characterization (principle, instrumentation and working): InfraRed (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray Absorption (XPS), Electron Spin Resonance (ESR). (4 Lectures)

Module-IV: Microscopic techniques: Optical Microscopy: Principle, Instrumentation and Working of optical microscopes, Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM), Transmission Electron Microscope(TEM), Scanning Tunneling Microscope(STM) and Atomic Force Microscope(AFM).

(6 Lectures)

Module-V: Electrical and Magnetic Characterization-Electrical characterization: Measurement of resistivity by four-probe method, Impedance and ferroelectric measurements.

Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle, Instrumentation and Working. (6 Lectures)

TEXT AND REFERENCE BOOKS:

1. Experimental Physics: Modern Methods by R. A. Dunlap (1997 Ed.) ï Oxford University Press

2. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.

3. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House 4. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers

5. Characterization of Materials, John B. Wachtman&Zwi. H. Kalman, Pub. Butterworth Heinemann

6. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001

Course Outcomes:

CO1	Have demonstrated sufficient skills on the instrument, both in theory and in practice, to keep the instrument in good shape
CO2	Be able to communicate the technique on an advanced research level to fellow researchers
CO3	Be able to coordinate/administrate the use of the technique/instrument in a research organization Be able to coordinate/administrate the use of the technique/instrument in a research organization Be able to coordinate/administrate the use of the technique/instrument in a research organization
CO4	Have gained a clear understanding of different vacuum pumps and the production and maintenance of vacuum systems and its uses and needs in Physics
CO5	Have grasped the idea of Cryogenics technology and its applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (9th Semester) (ELECTIVE- IV-2)
Subject: ADVANCED QUANTUM MECHANICS

Course Objectives:

1. To understand the various applications of quantum mechanics
2. To impart knowledge of advanced quantum mechanics for solving relevant physical problems
3. To understand the world of quantum field theory, and quantum electrodynamics.

Module-I: Relativistic Quantum Mechanics

Introduction, Klein-Gordon (KG) equation, current and probable density (continuity equation), KG equation in electromagnetic field, Diracôs relativistic equation, covariant and adjoint forms of Dirac equation, Spin-orbit energy, Negative energy states of electron.

Module-II: Quantization of Fields

Introduction, Relativistic Lagrangian and Hamiltonian of a charged particle in an EM field, Lagrangian and Hamiltonian formulations of field, Quantum equation for the field, Second quantization, Quantization of KG equation, Creation, Annihilation and number operators, Occupation number representation.

Module-III: Quantum Field theory

Canonical quantisation, Free propagators Quantization of fields, Real and charged scalars Second quantisation of real scalar field, Second quantisation of complex scalar field, Second quantisation of Dirac field, Second quantisation of Electromagnetic fields

Module-IV: Quantum Electrodynamics

Nonlinear Lagrangians, Fermions in an External Field, Interaction of Electrons with the Radiation Field: Quantum Electrodynamics (QED): The Lagrangian and the Hamiltonian Densities, Equations of Motion of Interacting Dirac and Radiation Fields.

Module-V: Interaction

Coupling of electron and electromagnetic field, The Interaction Representation (Dirac Representation), Wickôs Theorem, Feynman Diagrams and Rules of Quantum Electrodynamics

TEXT AND REFERENCE BOOKS:

1. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (2011)
2. G. Baym, Lectures on Quantum Mechanics, Benjamin/Cummings (1973)
3. F. Schwabl, Quantum Mechanics, Springer (1990)
4. D.J. Griffiths, Introduction to Quantum Mechanics, Pearson (2005)
5. Satyaprakash, Advanced Quantum Mechanics, Kedar Nath Ram Nath (2010).
6. **W. Greiner, J. Reinhardt**, Quantum Electrodynamics, Springer-Verlag, Berlin (2009).
7. J. D. Bjorken, S. D. Drell, Relativistic Quantum Mechanics, McGraw Hill (1978).

Course Outcomes:

CO1	Understanding of various applications of quantum mechanics
CO2	Knowledge of advanced quantum mechanics for solving relevant physical problems
CO3	Concepts ofquantum field theory, and quantum electrodynamics are explored.
CO4	Learners are expected to identify, understand, design, set up, and carry out the various physical phenomena to provide the theoretical predictions using advanced quantum mechanics.
CO5	Implementation of theoretical formalism for real time physical problems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	1
CO2	3	2	3	2	2	1
CO3	3	2	3	2	2	1
CO4	3	2	3	2	2	1
CO5	3	2	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	1

Course: Integrated M.Sc. (9th Semester) (ELECTIVE-IV-3)
Subject: PROGRAMMING FOR COMPUTATIONAL PHYSICS

Course Objective: Computational physics makes use of different programming languages as well as packages to reach its goal. In this course the student is introduced to the venerable Fortran 90 language which is still going strong in Physics research activities and acquaints oneself with the store house of subroutines available for scientific calculations. Recently however Python has become very popular with the physics community and the student is also exposed to Python programming so that he can make his choice depending on the problem at hand.

Module I: Introduction to Fortran 90: Basic structure of a Fortran 90 program: variables, Assignment statements, list directed input and output, Data types: Real, Integer, Character, Complex, Derived data types, control structures: branches, do loops , conditional do loops, array variables

Module II: Procedures and Structured Programming: Subroutines, Statement, Modules , sharing data using Modules, Module Procedures, Passing Procedures as Arguments to other Procedures, Internal Procedures, Scope and Scoping units, Recursive Procedures

Module III: Introduction to Python: Introduction to Python tools and libraries NumPy, Matplotlib, SciPy, f2Py Elementary Python programs, data types, conditionals and do loops, working examples of simple Python programs, .

Module IV: Python libraries: using NumPy for fast numerical calculations, use of Matplotlib for visualisation, f2Py for porting Fortran codes to Python, array manipulation in Python, data handling in Python

Module V: Programming examples: ODE applications using Fortran 90 and/or Python for Eigen values, projectiles, scattering, nonlinear dynamics problems, PDE examples in electrostatics and wave equations, molecular dynamics.

TEXT AND REFERENCE BOOKS:

1. Fortran 95/2003 for Scientists & Engineers, Stephen Chapman , McGraw -Hill.
2. Computational Physics Problem Solving using Python: R. H. Landau, M. J. *Paez*and C. C. Bordeianu , Wiley-VCH

Course Learning outcomes

1. A student who has taken this course will be able to carry out scientific programming to solve Physics problems on his/her own.
2. The portability of Fortran to Python will allow him/ her to successfully use the large store of legacy codes in Fortran in his Python programming effectively extending his programming scope.
3. Most importantly the student will gain a wider perspective being able to choose his tool best suited to the problem at hand.

Course Outcomes:

CO1	A student who has taken this course will be able to carry out scientific programming to solve Physics problems on his/her own
CO2	The portability of Fortran to Python will allow him/ her to successfully use the large store of legacy codes in Fortran in his Python programming effectively extending his programming scope
CO3	Most importantly the student will gain a wider perspective being able to choose his tool best suited to the problem at hand
CO4	Computational physics makes use of different programming languages as well as packages to reach its goal
CO5	Recently however Python has become very popular with the physics community and the student is also exposed to Python programming so that he can make his choice depending on the problem at hand

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (9th Semester) (ELECTIVE-IV-4)
Subject: QUANTUM INFORMATION AND MEASUREMENT

Module-I

Probability and information, The double slit experiment, Interference and information: Feynmanôs rules for interference, MZI and superposition, qubits,

Module -II

Which way information and complimentarity, quantum erasers and, interaction free measurement, density matrices and reduced density matrices, Schmidt decomposition, entanglement in bipartite systems, decoherence, Von Neumann measurements and back-action, pointer states, superselection rules ,envariance

Module-III

Bell states, EPR experiments, quantum error correction, ñno cloningò theorem, dense coding , teleportation, GHZ states, POVMs, non-orthogonal state discrimination, tomography and quantum states.

Module–IV Quantum logic circuits: single quibit and two quibit gates, universal quantum gates, realization of simple algorithms and experiments using quantum gates.

Module-V

IBM- Q quantum computer and its use to carry out quantum state manipulations to demonstrate superposition, entanglement, envariance.

TEXT AND REFERENCE BOOKS:

1.A first Introduction to Quantum Computing and Information- Bernard Zygelman-Springer (2018)
2. Quantum Computing Explained-Wiley-Interscience , David McMahon- ,IEEE Computer Society (2008)
3. Quantum Measurement Theory and its Applications, Kurt Jacobs, C.U.P, 2014
4. Quantum information, Stephen M. Barnett, Oxford University Press, 2008
5. Decoherence and the Quantum-to-Classical Transition, Maximilian A. Schlosshauer- (The Frontiers Collection) Springer (2007)
6. Quantum Computing A Gentle Introduction-(Scientific and Engineering Computation), Eleanor Rieffel, Wolfgang Polak-The MIT Press (2011)

Course Outcomes:

CO1	Understand quantum information theory, quantum computation, quantum cryptography and related topics
CO2	Understand density operators, quantum superposition, entanglement, nonlocality, teleportation
CO3	Understand quantum channels, quantum algorithms, measurement theory, Bell inequalities, no-cloning theorems
CO4	Familiarity with quantum graph states, topological quantum computation
CO5	Aware of some state-of-the-art physical implementations

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (9th Semester) (ELECTIVE-IV-5)

Subject: VACUUM TECHNOLOGY

Module-I

Introduction to vacuum technology, kinetic theory of gases, impingement rate of molecules on a surface, average velocity of gas and mean free path, gas transport properties (thermal conductivity, viscosity and diffusion), various ranges of vacuum, gas conductance of a vacuum line, gas impedance of a vacuum line, pumping speed, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes, pump down time. (8 Lectures)

Module-II

Vacuum generation (Pumps): Principles of pumping concept, Diaphragm pump, Rotary Vane pump, Turbomolecular pump, Diffusion pump, Cryopump, Getter pump, Sputter ion pump, Orbitron pump. (10 Lectures)

Module-III

Vacuum Gauges: Mc Leod, Thermocouple (Pirani), Penning, Hot cathode ionization (triode type), Bayard-Alpert Leak detection, Vacuum system design. (8 Lectures)

Module-IV

Low temperatures techniques: Refrigeration principle (including thermodynamical aspects) and low temperature production techniques (Throttling process). (4 Lectures)

Module-V

Analysis of gas at low pressures: Residual gas analyzers, Quadrupole mass spectrometer. Leaks and their detection: Types of leaks, Leak rate, leak size, mass flow; Leak detection methods: Pressure rise and drop tests, Tests using vacuum gauges, Bubble immersion test, Foam-spray test, Halogen and Helium leak detectors. Applications of Vacuum technology. (10 Lectures)

TEXT AND REFERENCE BOOKS:

1. Hand Book of Thin Film Technology, Maissel and Glange
2. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall
3. Vacuum Technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
4. High Vacuum Techniques, J. Yarwood, (Chapman and Hall, Londong, 1967)
5. Experimental Principles and Methods below 1K, O. U. Lounasmaa, (Academic Press, 1974)
6. Thermometry at Ultra Low Temperatures, W. Weyhmann

Course Outcomes:

CO1	Apply basic vacuum principles such as the behavior of gas and behavior of a vacuum system while evaluating a pump down.
CO2	Consider basic mechanisms and characteristics of vacuum system components such as pumps, valves and gauges while troubleshooting.
CO3	Be able to perform basic operations of a vacuum system such as measuring pressure correctly, venting a vacuum system, a rough pump down and a high vacuum pump down with correct valving sequence.
CO4	Be able to perform simple maintenance of vacuum systems including installation or replacement of various pipes, fittings, valves, gauges, and simple pumps.
CO5	Be able to perform vacuum trouble-shooting including leak isolation and detection.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	2	3	3	2
CO4	3	3	3	2	2	2
CO5	2	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	3

Course: Integrated M.Sc. (9th Semester)
Subject: GENERAL PRACTICAL – III

LIST OF EXPERIMENTS:

1. Geiger-Muller counter
2. Specific heat measurement of solids (calorimetry)
3. Hydrogen Spectra and Rydberg Constant
4. Energy band gap of a semiconductor using diode
5. ESR (Electron spin resonance)
6. Determination of Stefan constant
7. Determination of range of Beta-rays from Ra and Cs
8. Determination of wavelength of ultrasonic waves using Kundtôs tube method.
9. Determination of velocity of ultrasonic waves in a given liquid using ultrasonic Interferometer.
10. To measure to coefficient of absorption of sound of given materials at different frequencies
11. e/m by magnetron valve
12. V-I Charactristic of solar cell
13. Study of LCR circuit

Course: Integrated M.Sc. (10th Semester) ELECTIVE PAPER –V
Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Elective-V

1. Introduction to Non-linearDynamics
2. Particle Physics
3. Physics of SemiconductorDevices
4. Spectroscopy
5. Thin Film Technology

Course: Integrated M.Sc. (10th Semester) (ELECTIVE –V-1)

Subject: INTRODUCTION TO NONLINEAR DYNAMICS

Course Objectives: The course aims to introduce the students to abstract mathematical concepts that are integral for a proper grasp of the standard techniques used in nonlinear dynamics.

Module- I:Introduction to nonlinearity

Linear and nonlinear differential equations, Vector fields, Phase space and differential equations, Stability of steady states, Linearization of nonlinear systems, Oscillating solutions of nonlinear systems, limit cycles ,examples, Discrete time systems, Linear and nonlinear maps, Stability of the fixed points of maps, The logistic map, Iterations of maps (14 Lectures)

Module- II: Bifurcations

Saddle-Node bifurcation, Trans critical bifurcation, Pitchfork bifurcation, Hopf bifurcation, Flip bifurcation, Period doubling bifurcation. (8 Lectures)

Module-III: Deterministic chaos

Definitions and examples, Unpredictability and determinism, Poincare' sections, Strange attractors, The Lorenz system, logistic map, Lorenz system, Rossler systems. (7 Lectures)

Module-IV: Linear and nonlinear waves

Linear dispersive wave propagation, solution of the related initial value problem using Fourier transform methods, wave packet and dispersion, nonlinear dispersive waves: Russelôs Great Wave of Translation, Cnoidal and solitary waves, Korteweg- de Vries equation and the Solitary waves and Cnoidal wave solutions. (8 Lectures)

Module-V:Applications

Chaos in classical mechanics and electronics, Ecological systems: Simple and modified Lotka-Volterra equations for predator-prey mechanisms and species competition , Population dynamics and economic systems: application of the logistic equation, Biological and physiological systems: glycolysis (8 Lectures)

TEXT AND REFERENCE BOOKS:

1. H. Steven, and Strogatz, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering

2. Nonlinear Dynamics, Integrability Chaos and patterns, M. Lakshamanan and S Rajasekar, Springer

3.An Exploration of Dynamical Systems and Chaos , John Argyris, Gunter Faust, Maria Haase, Rudolf Friedrich, Springer (2015)

4.Differential Equations, Dynamical Systems, and an Introduction to Chaos ,Morris W. Hirsch, Stephen Smale and Robert L. Devaney , Academic Press (2012)

5. Chaos and Integrability in Nonlinear Dynamics An Introduction, M. Tabor, Wiley Inter science

Course Outcomes:

CO1	On completion of this course, the student is expected to have mastered the basic techniques for analyzing linear and nonlinear dynamical systems
CO2	It also equip the students to apply various numerical techniques to characterize different kinds of nonlinear dynamical systems
CO3	The students to abstract mathematical concepts that are integral for a proper grasp of the standard techniques used in nonlinear dynamics
CO4	Able to describe the concepts of various linear and non linear waves and its implementation to solve the mathematical problems.
CO5	Able to get the idea of chaos with its different application in various systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (10th Semester) (ELECTIVE-V-2)

Subject: PARTICLE PHYSICS

Module-I

Standard Model of Particle Physics, Particle Classification, Fermions and Bosons, Lepton Flavours, Quark Flavors, Electromagnetic, Weak and Strong Processes.

Module-II

Isospin, Strangeness, Hypercharge, Baryon and Lepton number, Baryon and Lepton number conservation, Gell Mann-Nishijima Scheme, Quarks in Hadrons, Mesons and Baryons Octet.

Module-III

Yukawaôs Theory, Neutrinos, Parity, Parity Conservation and non-conservation, Time reversal, Consequence of Time Reversal Invariance, Charge Conjugation.

Module -IV

G-Parity, Statement of CPT theorem and its consequence, Proof of equality of mass and life time for particle and anti-particle.

Module-V

Unitary symmetry and the classification of state, Hadrons and SU(3) multiples, Application of SU(3) flavor symmetry and broken SU(3) flavour symmetry, Gell Mann-Okubo mass formula for baryons and mesons, Coleman-Glashow relation.

TEXT AND REFERENCE BOOKS:

1. Elementary Particle Physics : D. J. Griffiths
2. Concepts of Particle Physics : Gottifried and Weisskiof
3. Particle Physics : R. Omnes

Course Outcomes:

CO1	Basic idea about nuclear physics leads to the advanced studies in nuclear reaction and generation of nuclear energy through nuclear reactor.
CO2	The basic idea of two-nucleon problem can be extended to many body problem and advanced learning in high energy physics.
CO3	The concept of nuclear reaction can used to study the energy formation in stellar system
CO4	understand the basic forces in nature and classification of particles and study in detail conservations laws and quark models in detail
CO5	be able to gain knowledge about various nuclear models and potentials associated

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	2	2	3
CO3	3	2	2	3	3	3
CO4	3	3	2	3	2	2
CO5	3	2	3	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Course: Integrated M.Sc. (10th Semester) (ELECTIVE-V-3)
Subject: PHYSICS OF SEMICONDUCTOR DEVICES

Course Objectives: To introduce to students the theory and applications of semiconductor device physics for electrical, electronics and computer engineering, and to know the characteristics of different semiconductor devices.

Module-I- Semiconductor fundamentals:
Quantum theory of solids, formation of energy bands, mathematical formulation of Kronig-Penney model, E-K-diagram in 2-Dand 3-D, Direct and indirect band gap semiconductor, energy bands in solids, classification of solids based on band theory, donor and acceptor in energy band model, effective mass of electron and hole, density of states, Fermi ï Dirac distribution function for electron and holes, Fermi energy and temperature dependence of Fermi energy

Module-II - Thermal equilibrium and Carrier transport phenomena:

Thermal equilibrium: Equilibrium distribution of electron and holes, the n_o and p_o equations, the intrinsic carrier concentration, the intrinsic Fermi-level position, extrinsic semiconductor, equilibrium distribution of electron and hole in extrinsic semiconductor, the n_o -p_o product, degenerate and non-degenerate semiconductor, Fermi energy level as a function of concentration and temperature with graphical representation, complete ionization, freeze out condition, partial ionization, compensated semiconductor,

Module-III- Carrier transport phenomena

Electron and hole mobility, drift current density and conductivity, carrier diffusion: diffusion current, total current density, Einstein relationship between diffusion coefficient and mobilities.

Module-IV- Semiconductor devices

P-N Junction: Depletion layer model, reverse biased PN junction, C-V characteristics, junction breakdown, carrier injection under forward bias, current continuity equation, excess carrier in forward biased, I-V characteristic, **BJT:** Introduction to BJT, collector and base current, current gain, base width modulation, Ebers-Moll model **MOS capacitor**: Flat band condition, surface accumulation, surface depletion, threshold condition and threshold voltage, MOS C-V characteristics

Module-V- Photonic Devices

Radiative transition and optical absorption, Light emitting diodes (Visible, organic, infrared), Photo detector: Photoconductor, Photodiode (construction, working, theory), Solar cell(solar radiation-n junction solar cell).

TEXT AND REFERENCE BOOKS:

1.D. Neamann: Semiconductor Physics and Semiconductor Devices, Tata McGrew Hill
2. C.C.Hu, Modern: Semiconductor Devices for Integrated circuits, Pearson(2010)
3. S.M.Sze: Semiconductor Devices ñPhysics and Technology),WILEY(2009)
4. R. A. Smith, Semiconductors, Academic Press (1978).
5. K. Seeger, Semiconductor Physics: An introduction, Springer Verlag (1991).
6. C. Hamaguchi, Basic semiconductor physics, Springer Verlag (2001).

Course Outcomes:

CO1	The students are expected to have the knowledge about the basic materials and properties of semiconductors with application to various circuits and devices
CO2	The theory and applications of semiconductor device physics for electrical, electronics and computer engineering, and to know the characteristics of different semiconductor devices
CO3	knowledge of semiconductor bonding and energy band models
CO4	ability to apply standard device models to explain/calculate critical internal parameters and standard haracteristics of the pn-junction diode
CO5	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Metal-Oxide- Semiconductor Field Effect Transistor

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (9^{th}/10^{th} Semester) (ELECTIVE-V-4)

Sub: SPECTROSCOPY

Course Objectives: The objectives of this course are to introduce the theory of the various instruments and the signals produced when analysing compound, and to equip the student with enough information to be able to interpret signals from spectroscopic instruments.

Module-I : Microwave spectroscopy

Pure rotational spectra of diatomic molecules - Polyatomic molecules - Study of linear molecules and symmetric top molecules - Hyperfine structure and quadruple moment of linear molecules - Experimental techniques - Molecular structure determination - Stark effect - inversion spectrum of ammonia - Applications to chemical analysis.

Module-II: Infrared spectroscopy

Vibrational spectroscopy of diatomic and simple ployatomic molecules - Harmonic Oscillator - Anharmonic Oscillator - Rotational vibrators - Normal modes of vibration of Polyatomic molecules - Experimental techniques - Applications of infrared spectroscopy - H2O and N2O molecules - Reflectance spectroscopy.

Module-III: Raman Spectroscopy

Classical theory of Raman Scattering - Raman effect and molecular structure - Raman effect and crystal structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Coherent anti-Stokes Raman Spectroscopy - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO2 molecules. Module-IV : NMR and NQR Techniques Theory of NMR - Bloch equations - Steady state solution of Bloch equations - Theory of chemical shifts - Experimental methods - Single Coil and double coil methods - Pulse Method - High resolution method - Applications of NMR to quantitative measurements. Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and nonaxial symmetry - Experimental techniques and applications.

Module-IV: ESR and Mossbauer Spectroscopy

Quantum mechanical treatment of ESR - Nuclear interaction and hyperfine structure - Relaxation effects - Basic principles of spectrographs - Applications of ESR method. M.Sc. Physics : Syllabus (CBCS) 14 Mossbauer effect - Recoilless emission and absorption - Mossbauer spectrum - Experimental methods - Massbauer spectrometer - Hyperfine interactions - Chemical Isomer shift - Magnetic hyperfine interactions - Electric quadruple interactions - Simple biological applications.

Module-V:

Photoelectron spectroscopy: Principles, Koopmanõs theorem, Photoionization process, ESCA or XPS, Chemical shift in ESCA, Binding energy, instrumentation Auger Electron spectroscopy (AES), AES Instrumentation, Applications of AES, Scanning Auger Microprobe (SAM)

TEXT AND REFERENCE BOOKS:

1. C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi.
2. G. Aruldas, 2001, Molecular Structure and Spectorscopy, Prentice- Hall of India Pvt.Ltd., New Delhi.
3. D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi.
4. Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, SpingerVerlag, New York.
5. Towne and Schawlow, 1995, Micorwave Spectroscopy, McGraw-Hill,
6. Raymond Chang, 1980, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo.
7. D.A. Lang, Raman Spectroscopy, Mc Graw-Hill International, N.Y.
8. John Ferraro, Introductory Raman Spectroscopy, Academic Press (2008)
9. H.Kaur, Spectro copy, APragati edition (2018)

Course Outcome: Students can understand the usage of different spectroscopic techniques to determine the molecular structure, energy levels, its application to physical and chemical analysis.

Course Outcomes:

CO1	know about different atom model and will be able to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and electric fields.
CO2	Have gained ability to apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules
CO3	Be able to apply the principle of Raman spectroscopy and its applications in the different field of science & Technology
CO4	To become familiar with different resonance spectroscopic techniques and its applications
CO5	to find solutions to problems related different spectroscopic systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	2	2	2
CO3	3	3	3	2	3	2
CO4	3	3	3	3	3	3
CO5	2	2	2	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	2	2	3

Course: Integrated M.Sc. (10th Semester)(ELECTIVE-V-5)
Subject: THIN FILM TECHNOLOGY

Module-I: Introduction to thin films

Overview of vacuum techniques, Comparison of thin and thick films, Theory of growth of thin films: Nucleation, condensation, Capillarity model, comparison of models, various stages of film growth.

Module-II: Deposition Techniques

Physical Vapour Deposition, Chemical Vapour Deposition, Molecular Beam Epitaxy, Sputtering, Spray pyrolysis, Dip coating and Spin coating, Photolithography, Electron-beamdeposition, Pulsed Laser Ablation.

Module-III: Electrical Properties

Source of Resistivity in Metallic conductors, Influence of thickness on the resistivity of thin films, Hall Effect & Magnet oresistance in thin films, Fuch-Sondhemir theory, T C Randits effects.

Module-IV: Mechanical properties

Adhesion & its measurement with mechanical and nucleation methods, stress measurement by using optical method. Optical properties: Absorption and transmission.

Module-V:Applications of Thin Films

Resistors, capacitors, junction devices (Metal semiconductor junction) Solar cells,! Cs, Optical coating, Thin film sensors (gas and humidity),Thin films for information storage, electro acoustics and telecommunication.

TEXT AND REFERENCE BOOKS:

1. Hand book of Thin Film Technology: Maissel and Giang,(Mc Graw Hill)
2. Thin Film Phenomena: K .L. Chopra,(McGraw Hill)
3.Material Science of Thin Films: M .Ohring, (Academic Press)
4.Thin Film Process:J .L. Vossen and Kern,(Academic Press)
5.Vacuum Technology(2nd revised edition),A.Roth,(NorthHollad)

Course Outcomes:

CO1	Discuss the differences and similarities between different vacuum based deposition techniques
CO2	Evaluate and use models for nucleating and growth of thin films
CO3	Asses the relation between deposition technique, film structure, and film properties
CO4	Discuss typical thin film applications
CO5	Motivate selection of deposition techniques for various applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	2	1
CO2	2	3	3	3	2	1
CO3	2	3	3	3	2	1
CO4	2	3	3	3	2	1
CO5	2	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	3	2	1

Course: Integrated M.Sc. (10th Semester) ELECTIVE PAPER –VI
Subject: To be offered by the Department from the following pool of subjects

Pool of Subjects for Departmental Elective-VI
1. Atmospheric Physics
2. Biophysics
3. Crystallography
4. Laser Physics
5.Soft Condensed Matter Physics

Course: Integrated M.Sc. (10th Semester) (ELECTIVE-VI-1)
Subject: ATMOSPHERIC PHYSICS

Module–I:Elements of earth's atmosphere: Review of origin and composition of the atmosphere, major components- nitrogen, oxygen, argon; minor components-watervapor, dustparticles, ozone; vertical variations in compositions- homosphere, heteorosphere, ionosphere; auroras; thermal structure of the atmosphere-troposphere, stratosphere, mesosphere, thermosphere; horjzontal distribution of temperature, pressure and density, distribution of winds, horizontal and vertical winds, land breeze and sea breeze.

Module–II: Atmospheric observations: Importance of meteorological observations, measurement of temperature and humidity, measurement of wind and pressure, measurement of precipitation, upper air observations- radiosonde, rawinsonde, rocketsonde, pyrgeometer, pyrheliometer. Radar, Doppler weather radar, applications.

Module–III: Radiation and energy budget: Electromagnetic spectrum of radiation, black body radiation-Plankôs law, thermo dynamical equilibrium, radiometric quantities, atmospheric absorption of Solar radiation-absorption and emission of radiation by molecules, absorptive and emissivity, Kirchhoff's law, reflectivity and transitivity, absorption of solar radiation by the atmosphere, Beer's law, indirect estimate of solar radiance at the top of the atmosphere, vertical profile of absorption; scattering of solar radiation, atmospheric absorption and emission of infrared radiation.

Module–IV: Atmospheric dynamics: Large scale motions, vorticity and divergence, streamline and trajectories, dynamics of horizontal flow- apparent and real forces, equation of motion, geostrophic wind, effect of friction, gradient wind, thermal wind, suppression of vertical motions, conservation law for Vorticity, potential vorticity; primitive equations- -pressure asave11ical coordinate, hydrostatic balance, thermodynamic energy equation, solution of the primitive equalions, applications atmospheric general circulation.

Module-V: Monsoon over India: Morphology of monsoon circulation, symmetric and asymmetric monsoon; Formation of monsoon disturbances, Structure of monsoon disturbances, Wind. temperature and pressure distribution over India in the lower, middle and upper atmosphere during pre, post and mid-monsoon season; Intra-seasonal variability of monsoon, Inter-annual variability of monsoon-anomalous over India and Asia, El Nino Southern Oscillation and dynamical mechanism for their existence.

TEXT AND REFERENCE BOOKS:

1. Basics of Atmospheric Science, AChandrasekar, PHI Publications, 2010.
2. Atmospheric Science-An Introductory Survey, John M Wallace and Peter V Hobbs, Academic Press, Elsevier,2006.
3. The atmosphere ,Frede{ickKLutgensand Edward J Ta.rbuck, Pearson Prentice Hall,2007.
4. Radar Mett:orology by S Raghavan, Kulwer Academic Publishers,2003
5. An introduction to Dynamic Meteorology,Holton JR, AcademicPress NY2006.
6. A course in Dynamic meteorology, Naval Pandarinath,B S Publications,2006.
7. The Physics of Monsoons, R N Keshvamurthy and M Shankar Rao,Allied Publishers.1992.

Course Outcomes:

CO1	Be able to describe the basic structure of an atmosphere and the climate system.
CO2	Be able to use fundamental thermodynamics to derive expressions for the variation of temperature, pressure, and air density with height.
CO3	Know the components of the Earthôs radiation balance.
CO4	Understand the scale approximations to the equations of motion (e.g. hydrostatic and geostrophic approximations).
CO5	Be familiar with mechanism of monsoon in India.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	2	2	2
CO3	3	3	3	2	3	2
CO4	3	3	3	3	3	3
CO5	2	2	2	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	2	2	3

Course: Integrated M.Sc. (10th Semester)(ELECTIVE –VI-2)
Subject: BIOPHYSICS

Objective: This paper helps to understand the applications of various microscopic tools in cell biology. This paper helps the reader to understand the fundamentals of macro molecular structure and the analytical techniques in characterizing bio molecular interactions and its structure

Module-I: Cell Organization Cell as the basic structural unit-Origin & organization of Prokaryotic and Eukaryotic cell-Cellsize& shape-Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyano bacteria, plant & Animal cell) ï Internal architecture of cells-cell organelles - compartment & assemblies membrane system ï Ribosome ï Polysomes ï Lysosomes -Peroxisomes-Connection between cell & its environment ï Extra cellular Matrix.

Module-II: Tools in Cell Biology Light microscope ï Resolving Power ï Phase contrast microscope-Detection of small differences in refractive indices ï Interference microscope-, Dark field microscope - Polarization microscope- Fluorescence microscope- Cyto photometry methods- Flow cytometry & cell sorting-Electron microscopy ï specimen preparation- Scanning Electron Microscopy (SEM) ï Transmission Electron Microscopy (TEM)- Applications.

Module-III: Macromolecular structure Nucleic acid structure: Chemical structure of the nucleic acid-Conformational possibilities of monomers and polymers- Double helix structure of DNA-Polymorphism of DNA-DNA nanostructures and the structure of transfer RNA. Proteins structure: Amino acids and the primary structures of proteins-Secondary-Tertiary-Quaternary structure and virus structure.

Module-IV: Separation Techniques Centrifugation: Principle of centrifugation- Analytical ultracentrifugation- Differential centrifugation- Density gradient centrifugation. Chromatography: Principles of chromatography- Paper chromatography- Thin layer chromatography (TLC)-Gas liquid chromatography (GLC) ï High performance liquid chromatography (HPLC). Electrophoresis: Principles-Factors affecting the migration of substances- Supporting media in electrophoresis- Gel electrophoresis-Poly acryl amide gel electrophoresis (PAGE)-Sodium dodecyl sulphate poly acryl amide gel electrophoresis (SOS-PAGE).

Module-V: Optical & Diffraction Techniques. Circular Dichroism and optical rotator dispersion-: Plane, circular and elliptical polarization of light- Absorption by oriented molecules ï Dichroic ratio of proteins and nucleic acids- Circular dichroism(CD) ï optical rotator dispersion (ORD)-Relation between CD and ORD-Application of ORD in conformation and interactions of biomolecules. Crystallization of proteins-preparation of heavy metal derivatives- Patterson synthesis- isomorphous replacement methods-structure factors of centro-symmetric and non- centro symmetric crystals- General remarks on Protein-Structure determination from X-ray diffraction data-Neutron diffraction- , Electron diffraction-,Synchrotron diffraction, Application in Biomolecular structural studies

TEXT AND REFERENCE BOOKS:

1.The Cell: A Molecular Approach, Geoffrey M. Cooper, A S M Press, 2013.
2.Biophysics, VasanthaPattabhi, N. Gautham, Narosa Publishing, 2009

Course Outcomes:

CO1	Explain models of biological systems and models dealing with statistical mechanics and transport phenomena
CO2	Solve qualitative and quantitative problems, using appropriate statistical mechanics and computing techniques
CO3	Perform experiments which involve making correct and appropriate use of a range of scientific equipment, keeping an accurate record of experimental work and analysing results and reaching non-trivial conclusions from them
CO4	Communicate at an advanced level the results of both theoretical and experimental work in various forms including written reports, oral presentations and poster presentations.
CO5	Collaborate effectively with team members for scientific investigations and for the process of learning.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	3	1
CO2	3	3	1	2	3	1
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2.2	2.6	2.8	2.2

Course: Integrated M.Sc. (10th Semester) (ELECTIVE-VI-3)

Subject: CRYSTALLOGRAPHY

Course Objectives : To understand the general principles of crystal and molecular structures and structure-property relationship, and to obtain the basic knowledge of X-ray diffraction analysis and phase transition problems.

Module-I

Symmetry of crystals, crystal projection and point groups, space groups.Production of X-Ray, X-Ray generator, absorption of X-Rays and principle of filter.Scattering of X-Ray by an electron, an atom and a unit cell, Structure factor calculations. Diffraction of X-Rays, Laue and Bragg equation, X-Ray powder diffraction, determination of lattice parameters by Debye-Scherrer method

Module-II

X-Ray diffractometer, X-Ray line profile analysis, broadening of diffraction line, size and strain broadening, Scherrer equation, Chemical analysis by X-ray Diffraction and X-ray fluorescence, Qualitative Analysis-Hanawalt method

Module-III

Quantitative Analysis-External Standard method, Direct Comparison method, Internal Standard method, Energy Dispersive X-ray(EDX), Wavelength Dispersive. Particle induced X-ray emission (PIXE) and their applications; Introduction to medical X-ray and X-ray techniques (radiography, radiotherapy, CT scanning)

Module-IV

Reciprocal lattice, sphere of reflection, Oscillation and Weisenberg photograph and their interpretation. Introduction to small Angle X-ray Scattering (SAXS) and its applications, Residual stress and its determination by X-ray diffraction, Elementary idea of Neutron and Electron diffraction.

Module-V

Fourier Series representation of electron density in crystals, projection of electron density in two dimensions. Phase problem and its solutions, trial and error method, Patterson function, Heavy atom method, Isomorphous replacement method, Direct methods, Use of Harker-Kasper inequalities, Refinement- differential synthesis and method of least squares.

TEXT AND REFERENCE BOOKS:

1. B. D.Cullity-ElementsofX-raydiffraction,Addison-WesleyPublishingCompany.
2. S. K. Chatterjee-X-ray diffraction-its theory and applications, Prentice Hall, India.
3. B. E. Warren-X-ray diffraction, Addison-Wesley Publishing Company.
4. A. R. Verma and O. N. Srivastava- X-ray Crystallography, New Age International Publisher.
5.H. P. Klug and L. E. Alexander-X-ray Diffraction procedures, John Wiley & Sons.
6. J. A. Nielson and D. McMorrow- Elements of Modern X-ray physics, John Wiley & Sons (2001)
7. G.V. Pavlinsky, Fundamentals of X-ray Physics, Cambridge International Sci. Pub(2008)
8. A. K. Singh, Advanced X-ray Techniques in Research and Industry-,Capital Publishing Company.
9. N. Kasai, M. Kakudo, X-ray diffraction by macromolecules, Springer (2005)

Course Outcome:

The following skills are expected at the end of this course:

1. Ability to describe fundamental crystallographic concepts,
2. Ability to extract the relevant information from a crystallographic paper,
3. Ability to find specific tools for solution of a given crystallographic problem

CO1	To understand the general principles of crystal structure of a material
CO2	To have some idea about Structure-property relationship.
CO3	To understand X-ray diffraction and its analysis in crystallography.
CO4	To understand the Concept of phase problems.
CO5	To understand and use of x-ray diffraction techniques for various application.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	2	3	2	2
CO3	3	3	3	3	3	2
CO4	3	3	2	2	3	3
CO5	3	2	2	2	2	2

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

Course: Integrated M.Sc. (9^{th} /10^{th} Semester)(ELECTIVE-VI-4)

Subject: LASER PHYSICS

Course Objectives:

1. To understand the basic concepts and phenomenology of lasing technique
2. To study the set up of various laser systems and absorption mechanisms
3. To analyse the dynamics of laser processes and spectroscopy

Module-I: Fundamentals and different levels of Lasers:

Review of Introduction to the Lasers, Population inversion, Transient population inversions, Processes that inhibit inversions, Saturation intensity, Laser Pumping: Two-, Three-level laser systems, Three-level laser with the intermediate level as the upper laser level, Three-level laser with the upper laser level as the highest level, Four-level laser system, Resonators, Vibrational modes of a resonator(8 Lectures)

Module-II: Various types of Lasers:

Solid (Ruby), Liquid (europium), Gas (He-Ne), ion (Argon-ion), Semiconductor, Excimer lasers, Dye and Chemical lasers (HCl), Metal vapour laser (He-Cd), Ground state absorption in Dye lasers, Triplet absorption in Dye lasers, Excited state absorption in excimer and solid state lasers, Absorption in semiconductor lasers (8 Lectures)

Module-III: Einstein Coefficients and Light Amplification

Einstein coefficients, Absorption and emission cross sections, Light Amplification, The threshold condition, Line broadening mechanisms (Natural, Collision, and Doppler) (8 Lectures)

Module-IV: Dynamics of Laser Processes:

Production of a giant pulse ï Q switching, Mechanical and electro-optical shutters, Giant pulse dynamics, Laser amplifiers, Ultra-short light pulses, Distributed feedback lasers, Gamma ray laser (7 Lectures)

Module-V: Laser Spectroscopy

Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect: Classical and Quantum treatment, Coherent anti-stokes Raman scattering (CARS), Spin-flip Raman laser, Free-electron laser (FEL), Photo-acoustic Raman Spectroscopy (PARS) (9 Lectures)

TEXT AND REFERENCE BOOKS:

1. W. T. Silfvast, Laser Fundamentals, Cambridge University Press, 1996
2. B. B. Laud, Lasers and Non-linear Optics, New-Age International Ltd, 2004
3. O. Svelto, Principles of Laser, Plenum, 1998.
4. K. Thyagarajan and A.K. Ghatak, Lasers: Fundamentals and Applications, Springer 1981.

Course Outcome: By the end of the course the students are expected to be able to:

- understand and explain the principles and design considerations of various lasers, modes of their operation and areas of their application.
- understand the principles of ultrashort pulse generation and amplification
- understand trends of development of modern lasersgain the basic skills of laser spectroscopy.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Capable of handling tensor applications in electrodynamics in therelativisitic formalism.
CO2	A depth in handling dynamics of charged particles under various field configurations
CO3	Conversant with classical dispersion theory
CO4	Able to tackle radiation problems for various time varying charge and current distributions
CO5	Acquainted with the rudiments of the field theoretic formulation of electrodynamics

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	1	3	3	2	1

Course: Integrated M.Sc. (10th Semester)(ELECTIVE-VI-5)
Subject: SOFT CONDENSED MATTER PHYSICS

Course Objectives: The main objectives of the course are:

1. To introduce the concepts of soft matter physics
2. To discuss the polymerization mechanism
3. To study the electronic properties of various alkali halides
4. To understand the magnetic relaxation and resonance phenomenon

Module-I: Liquid Crystals

Thermotropic, lyotropic, polymer based, Nematic, Smectic, cholesteric, Ferroelectric liquid crystals, Blue phase LCs, chemical structure of LCs, Building blocks of liquid crystals, structure-property relationship of liquid crystals, General structural features of mesogens, Effect of structure on mesophase thermal stability, Homologous series.

Module-II: Theory of Liquid Crystals

Introduction, The pair interaction potential, Mean field approximation, symmetry, structure and order parameters, Phase diagrams, The molecular potential, The possibility of second order transitions, Electro-optic phenomenon, Field induced birefringence, Twisted nematic effect, Guest-host effect

Module-III: Polymers

Basic concepts and definitions, Classification of polymers: Natural vs synthetic, Polymer structure: Linear, branched, Amorphous or crystalline, Homopolymer or copolymer, Molecular forces and chemical bonding in polymers, Polymerization mechanism.

Module-IV: Electronic Properties of Alkali Halides

Optical and thermal electronic excitation in ionic crystals, The upper filled band and the conduction band in ionic crystals, The ultraviolet spectrum of the alkali halides; excitons, The influence of lattice defects onthe electronic levels, The transformation of F centers into F' centers and vice versa, The photoe1ectric effect in alkali halides, The Hall effect and electron mobility, Color centers resulting from excess halogen, Color centers produced by irradiation with X-rays

Module-V: Magnetic Relaxation and Resonance Phenomena

Paramagnetic relaxation: Description, Relaxation mechanisms, Spin-lattice, spin-spin relaxation, Nuclear magnetic resonance: Nuclear magnetic moments, condition for resonance absorption, Bloch equation and complex susceptibility, The influence of molecular motion on the relaxation times

TEXT AND REFERENCE BOOKS:

1. Introduction to Liquid Crystals Ed. By E.B. Priestley, Plenum Press
2. Polymer Science and Technology, R. O. Edewele, CRC Press
3. Solid State Physics by A.J. Dekker, Macmillan & Co Ltd.
4. Liquid Crystals, S. Chandrasekhar, Cambridge university press
5. Text book of polymer science, 3rd Edition, F. W. Billmeyer Jr., John Wiley & Sons.

Course Outcome: This course provides the knowledge of Soft and condensed matter physics so that one can understand and refine the link between both based on other branches of physics.

Course Outcomes:

CO1	The concepts of soft matter physics help in new way of addressing the physical systems.
CO2	The knowledge of polymerization mechanism helps in developing macromolecules.
CO3	The electronic properties of various alkali halides help in developing commercially significant products.
CO4	The concept of magnetic relaxation and resonance phenomenon offers deeper understanding of atomic and nuclear properties of matter.
CO5	To refine the link between both based on other branches of physics.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	1
CO2	2	3	3	2	2	1
CO3	2	3	3	2	2	1
CO4	2	3	3	2	2	1
CO5	2	3	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	2	3	3	2	2	1

Course: Integrated M.Sc. (10^{th} Semester)
Subject: ADVANCED EXPERIMENTS LAB

LIST OF EXPERIMENTS:

1. FTIR Study of a given sample
2. To measure the frequency dependence of dielectric constant of a ferroelectric material ($BaTiO_3$) using an ôImpedance meterô
3. To find the band gap of a wide band gap semiconductor film by measuring its absorbance of light using UV-visible spectrophotometer
4. Principle and operation of Raman spectrometer
5. Solution of Linear algebraic equation: Gauss Jordan elimination, Singular Value Decomposition, Sparse linear system, Cholskey decomposition, QR decomposition.
6. Interpolation/extrapolation: Polynomial interpolation and extrapolation, cubic spline, interpolation in two more dimension.
7. Simulation of Bell state using Quantum computation method

Pool of Subjects for Open Elective (For Other Department Students)
1. Elementary Biophysics 2. Medical Physics 3. Radiation Safety 4. Renewable energy and energy harvesting

Course: Integrated M.Sc. (9thSemester) (OPEN ELECTIVE-1)

Subject: ELEMENTARY BIOPHYSICS

Module-I: FOUNDATIONS OF BIOPHYSICS:
Biophysics as an interdisciplinary science, aim and scope of biophysics. Chemical and physical forces between atoms and molecules: Atomic and molecular forces. Inter-atomic molecular bonds: Ionic, covalent and Vander Waals bonds, coordinate bonds and hydrophobic interaction. Mechanism of bond formation based on electronic orbital. Formation of molecular orbital, Sigma and Pi bonds, Hybridization. Examples of bond formation between C-C, C-N and carbon and other atoms.

Module-II: PHYSICAL METHODS OF INVESTIGATION OF MACROMOLECULES:
Biological macromolecules, General classification, Physical methods of determining size and shape of molecules. Separation methods: Diffusion, Sedimentation and osmosis. Viscosity and surface tension measurements.

Module-III : INSTRUMENTAL METHODS OF ANALYSIS OF BIOLOGICAL SYSTEMS:
Light scattering by .macro molecules. Optical activity, Absorption spectroscopy and spectrophotometry Calorimetry, IR and Raman spectroscopy for study of biomolecules.NMR spectroscopy for studying interactions and identification of bio-molecules. X-ray diffraction and microscopy for studying living matter (general treatment).

Module-IV: ISOTOPES AND RADIOACTIVITY:
Radioactive decay laws, production of radioisotopes (radio nuclides), allocation of radioactive traces, isotopic tracer method. Assay using radioactive substances, Labeling and detection methods using fluorescent molecules (a few examples).

Module-V: RADIATION BIOPHYSICS:
Radiation sources, Interaction of rad1tion with matter (general discussion), energy transfer process, measurement of radiation, Dosimetry, Biological effects of radiation, effect of radiation on living systems, radiation protection and radiation therapy.

TEXT AND REFERENCE BOOKS:

l. Essential of Biophysics - P. Narayanan, 2nd Edn., New Age International Publications. 2008.
2. Aspects of Biophysics ï William Hughes, John Wiley and Sons, 1979
3. Biochemistry of Nucleic acids ï Adams et al. Chapmann and Hall, 1992
4. Biophysics ï Vasantha Pattabi and N.Goutham, Narosa Publishing House, New Delhi. 2002.
5. Biophysics - Cotterill

Course Outcomes:

CO1	Explain models of biological systems and models dealing with statistical mechanics and transport phenomena
CO2	Solve qualitative and quantitative problems, using appropriate statistical mechanics and computing techniques
CO3	Perform experiments which involve making correct and appropriate use of a range of scientific equipment, keeping an accurate record of experimental work and analysing results and reaching non-trivial conclusions from them
CO4	Communicate at an advanced level the results of both theoretical and experimental work in various forms including written reports, oral presentations and poster presentations.
CO5	Collaborate effectively with team members for scientific investigations and for the process of learning.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	3	1
CO2	3	3	1	2	3	1
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2.2	2.6	2.8	2.2

Course: Integrated M.Sc. (9thSemester)
(OPEN ELECTIVE-2)
Subject: Medical Physics

Module-I

Basic Anatomical Terminology: Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal. **Mechanics of the body:** Skeleton, forces, and body stability. Muscles and dynamics of body movement. Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. **Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation.
Pressure system of body: Physics of breathing, Physics of cardiovascular system.(8 Lectures)

Module-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. **Optical system of the body:** Physics of the eye. **Electrical system of the body:** Physics of the nervous system, Electrical signals and information transfer. (8 Lectures)

Module-III

X-RAYS: Electromagnetic spectrum, production of x-rays, x-ray spectra, Brehmsstrahlung, Characteristic x-ray. **X-ray tubes & types**: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit. Single and three phase electric supply. Power ratings. Types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables. (8 Lectures)

Module-IV

RADIATION PHYSICS: Radiation units exposure, absorbed dose, units: red, gray, relative biological effectiveness, effective dose- Rem & Sievert, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, linear attenuation coefficient. **Radiation Detectors**: ionization (Thimble chamber, condenser chamber), chamber. Geiger Muller counter, Scintillation counters and Solid State detectors, TFT. (8 Lectures)

Module-V

MEDICAL IMAGING PHYSICS: Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. **Computed tomography scanner**- principle and function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display). (8 Lectures)

TEXT AND REFERENCE BOOKS:

1.Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
2. Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
3. Christensenôs Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
4. Physics of the human body, Irving P. Herman, Springer (2007).
5.Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003)
6. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
7. Handbook of Physics in Diagnostic Imaging: R.S.Livingstone: B.I. Publication Pvt Ltd.
8. The Physics of Radiology-H E Johns and Cunningham.

Course Outcomes:

CO1	Acquaint with the basic anatomical terminology to identify and describe locations of major organs and analyze their mechanism in terms of physics.
CO2	Explain the physics of eye, ear and nervous system of the body.
CO3	Understand the all aspects of X-ray production and the working principles of X-ray generators.
CO4	Gain the knowledge of radiation quantities, units and the interaction of radiation with matter. Also, acquaint with different kinds of radiation detectors and their working mechanisms.
CO5	Familiar with different medical imaging techniques like X-ray imaging, NMR, MRI, Ultrasound, Computed tomography scanner and their applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	3	1
CO2	3	3	1	2	3	1
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2.2	2.6	2.8	2.2

Course: Integrated M.Sc. (9thSemester) (OPEN ELECTIVE-3)

Subject: Radiation Safety

The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics

Module-I:

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. (8 Lectures)

Module-II:

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, **Interaction of Photons** - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons**- Collision, slowing down and Moderation. (9 Lectures)

Module-III:

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of *gas detectors* (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

(9 Lectures)

Module-IV:

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. (7 Lectures)

Module-V:

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterilization, Food preservation. (7 Lectures)

TEXT AND REFERENCE BOOKS:

1.W.E. Burcham and M. Jobes ï Nuclear and Particle Physics ï Longman (1995)
2.G.F.Knoll, Radiation detection and measurements
3.Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4.W.J. Meredith and J.B. Massey, ñFundamental Physics of Radiologyò. John Wright and Sons, UK, 1989.
5. J.R. Greening, ñFundamentals of Radiation Dosimetryò, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6.Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7.A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8.NCRP, ICRP, ICRU, IAEA, AERB Publications.
9.W.R. Hendee, ñMedical Radiation Physicsò, Year Book ï Medical Publishers Inc. London, 1981

Course Outcomes:

CO1	Learn the basics of atomic and nuclear physics including the nuclear reactions to understand the production of radioisotopes useful in various practical applications.
CO2	Acquaint with different types of radiations and their interaction with matter.
CO3	Acquire the knowledge of radiation measurements, quantities and units; and know the different types of radiation detectors.
CO4	Understand the principles involved in radiation monitoring and protection; and also get familiar with the nuclear waste and, itôs safe handling and disposal.
CO5	Familiar with the application of nuclear techniques in medical science, archeology, art and industry.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	2	2
CO5	3	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2.8	3	2.8	2.8

Course: Integrated M.Sc. (9thSemester) (OPEN ELECTIVE-4)

Subject: RENEWABLE ENERGY AND ENERGY HARVESTING

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Module-I:

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Module-II:

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Module-III:

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Module-IV:

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Module-V:

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

TEXT AND REFERENCE BOOKS:

1.Non-conventional energy sources - G.D Rai - Khanna Publishers, NewDelhi
2. Solar energy - M P Agarwal - S Chand and Co.Ltd.
3.Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing CompanyLtd.
4.Godfrey Boyle, ñRenewable Energy, Power for a sustainable futureò, 2004, Oxford University Press, in association with The OpenUniversity.
5.Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook,2009
6.J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich(USA).
7.http://en.wikipedia.org/wiki/Renewable_energy

Course Outcomes:

CO1	Understand the types of energy , energy storage and energy conversion systems.
CO2	Understand availability of solar radiation, solar geometry, instrument used for measuring solar radiation
CO3	Recognize the selection and design criteria of pumps and turbines
CO4	Have a basic knowledge of Ocean energy resources and technologies including Tidal energy, Wave power devices, Ocean currents and Salinity gradient devices.
CO5	Recognize hydrological facts and differentiate micro, mini and small hydro systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	2	3	3

Course: Integrated M.Sc. (7th and 8th Semester)

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Syllabus:

Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highmanǿs book .
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

AUDIT 1 and 2: DISASTER MANAGEMENT

Syllabus

Units	CONTENTS	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4 5 6	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness. **Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, Peopleós Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India	4

References:

1. R. Nishith, Singh AK, ' Disaster Management in India: Perspectives, issues and strategies New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.),ó Disaster Mitigation Experiences And Reflectionsó, Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studiesó,Deep &Deep Publication Pvt. Ltd., New Delhi.

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

References:

1. Abhyaspustakamói Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. Teach Yourself Sanskritó Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. Indiaós Glorious Scientific Traditionó Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language.
2. Ancient Sanskrit literature about science & technology can be understood.
3. Being a logical language will help to develop logic in students.

AUDIT 1 and 2: VALUE EDUCATION

Syllabus

Unit	*Content*	*Hours*
1	• Values and self-development ï Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship.	6
4	• Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. •Doing best for saving nature • Character and Competence ï Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively	

References:

1 Chakroborty, S.K. ' Values and Ethics for organizations Theory and practiceø, Oxford University Press, New Delhi

Course outcomes

Students will be able to 1.Knowledge of self-development
2.Learn the importance of Human values
3.Developing the overall personality

AUDIT 1 and 2: CONSTITUTION OF INDIA

Syllabus

Units	Content	Hours
1	**History of Making of the Indian Constitution:** • History • Drafting Committee, (Composition & Working)	4
2	• **Philosophy of the Indian Constitution:** • Preamble Salient Features	4
3	**Contours of Constitutional Rights &Duties:** • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties	4
4	**Organs of Governance:**	4
	• Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	
5	**Local Administration:** • Districtós Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of ElectedRepresentative, CEO • of Municipal Corporation. • Pachayati raj: Introduction, PRI: ZilaPachayat. • Elected officials and their roles, CEO ZilaPachayat: Position androle. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy	4
6	**Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.	4

References:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before thearrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP]under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

AUDIT 1 and 2: PEDAGOGY STUDIES

Syllabus:

Units	Content	Hours
1	• **Introduction and Methodology:**	4
	• Aims and rationale, Policy background, Conceptual framework and terminology • Theories of learning, Curriculum, Teacher education. • Conceptual framework, Research questions**.** • Overview of methodology and Searching.	
2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of includedstudies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effectivepedagogy? • Theory of change. • Strength and nature of the body of evidence for effectivepedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachersć attitudes and beliefs and Pedagogic strategies.	4
4	• Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	• **Research gaps and future directions** • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact.	2

References:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher educationresearch project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning ofbasic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272ï 282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, Ulearning to readócampaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions,and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum andguidance materials best support effective pedagogy?

AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Syllabus

Unit	Content	Hours
1	• Definitions of Eight parts of yog. (Ashtanga)	8
2	• Yam and Niyam. Do`s and Donâ€™ts in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

1. Yogic Asanas for Group Tarining-Part-Iâ€“:Janardan Swami Yogabhyasi Mandal, Nagpur
2. Rajayoga or conquering the Internal Natureâ€by Swami Vivekananda, AdvaitaAshrama(Publication Department), Kolkata

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dontós) • Verses- 71,73,75,78 (doós)	8
2	• Approach to day to day work and duties.	8
	• Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48.	
3	• Statements of basic knowledge. • Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 ï Verses 37,38,63	8

References:

1. Srimad Bhagavad Gitaóby Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartriharió Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achievethe highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**	**1**	**3**	**2**	**2**
CO2	**2**	**2**	**1**	**3**	**2**	**2**
CO3	**2**	**2**	**1**	**3**	**2**	**2**
CO4	**2**	**2**	**1**	**3**	**2**	**2**
CO5	**3**	**3**	**3**	**2**	**2**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	1	3	2	2