Baddi University
of Emerging Sciences & Technology

SCHEME & SYLLABUS
Of
M.Sc. PHYSICS (Four Semesters) Course

(Effective from Academic Session 2020-21)

Department of Physics
School of Sciences

Scheme and Syllabus of M.Sc. Physics
Four Semesters (Credit System)

SEMESTER I

S. No.	Subject Code	Subject Title	Credit	Teaching Hours per week		
				Theory (L)	Tutorial (T)	Practical (P)
1	PPY -101	Mathematical Physics	4.5	4	1	-
2	PPY -102	Classical Mechanics	4.5	4	1	-
3	PPY -103	Quantum Mechanics-I	4.5	4	1	-
4	PPY -104	Electronic Circuit and Devices-I	4	4	0	-
5	PPY -105	Physics Laboratory - I	6	-	-	12
		Total	23.5	16	3	12

SEMESTER II

S. No.	Subject Code	Subject Title	Credit	Teaching Hours per week		
				Theory (L)	Tutorial (T)	Practical (P)
1	PPY -151	Condensed Matter Physics-I	4	4	0	-
2	PPY -152	Statistical Mechanics	4.5	4	1	-
3	PPY -153	Quantum Mechanics -II	4.5	4	1	-
4	PPY -154	Electrodynamics	4.5	4	1	-
5	PPY -155	Physics Laboratory - II	6	-	-	12
6	PPY -156	Seminar-I	3	-	-	3
		Total	26.5	16	3	15

SEMESTER III

S. No.	Subject Code	Subject Title	Credit	Teaching Hours per week		
				Theory (L)	Tutorial (T)	Practical (P)
1	PPY -201	Condensed Matter Physics-II	4	4	0	-
2	PPY -202	Nuclear & Particle Physics-I	4	4	0	-
3	PPY -203	Atomic and Molecular Physics	4	4	0	-
4	PPY -204	Numerical Methods and Computational Physics	4	4	0	-
5	PPY -205	Physics Laboratory - III	6	-	-	12
6	PPY -206	Seminar II	3	-	-	3
		Total	25	16	0	15

SEMESTER IV

S. No.	Subject Code	Subject Title	Credit	Teaching Hours per week		
				Theory (L)	Tutorial (T)	Practical (P)
1	PPY -251	Physics of Nano materials	4	4	0	-
2	PPY -252	Nuclear & Particle Physics-II	4	4	0	-
3		Elective-I	4	4	0	-
4		Elective-II	4	4	0	-
5	PPY -253	Project	6	-	-	2
6	PPY -254	Paper Presentation	3	-	-	3
		Total	25	16	0	5

List of Elective Subjects

The department may offer electives based on student's choice, provided at least 6 students opt for a particular elective and also based on faculty availability. Courses at level of M. Sc program in Baddi University may be chosen as elective based on student's interest after discussing with the faculty advisor.

(Student will choose any TWO subjects from the given list of elective subjects)

	List Of Elective Subjects			
S. No.	Course Code	Course Title	Credit	Teaching Hours per week
1	PPY -271	Condensed Matter Physics: Material Science	4	4
2	PPY - 272	Fibre optics & optical communication	4	4
3	PPY - 273	Experimental Techniques in Physics	4	4
4	PPY-274	Physics of Lasers	4	4
5	PPY - 275	Electronic Circuit and Devices-II	4	4
6	PPY - 276	Optoelectronics	4	4
7	PPY - 277	Environmental Physics	4	4
8	PPY-278	Astrophysics	4	4
9	PPY-279	Science of Renewable Energy Sources	4	4

Total Credit of the course

Semester I	Semester II	Semester III	Semester IV	Total Credit of the Course
23.5	26.5	25	25	100

General guidelines:

1. If a course is being taught by two or more teachers, they should coordinate among themselves the coverage of course material as well as the internal assessment of the students to maintain uniformity.
2. Each theory course in a semester has been designed for a period of 48-54 lectures. The total number of actual lectures delivered may vary at most by 10 %.
3. The books indicated as references are suggestive of the level of coverage. However, any other standard book may be followed.
4. In specialization courses, new specializations may be added to the list from time to time keeping in view the expertise available in the Department and/or the emergence of new frontier areas of specialization.
5. New experiments in the Laboratory Courses may be added from time to time.

BADDI UNIVERSITY OF EMERGING SCIENCES & TECHNOLOGY

SCHOOL OF SCIENCES

Objective of the course: M.Sc. Physics

Our Master of Science (Physics) programme is a versatile degree that provides students with the optimal balance between a defined sequence of study and flexible course options. Physics embraces the study of the most basic natural laws and is about explaining how and why things work on scales ranging from the sub-nuclear, through the everyday, and on to the entire cosmos. Our course helps you explore and identify basic principles governing the structure and behavior of matter, the generation and transfer of energy, and the interaction of matter and energy. You will apply your knowledge to areas such as developing advanced materials, electronic and optical devices, and equipment for a wide range of fields such as medicine, mining, astronomy and geophysics.

Our unique programme will give you a deep understanding of the role of physics in newly developing areas in the material sciences and photonics, an understanding of basic physical principles is one of the keys to advancing knowledge.

The curriculum provides the theoretical and practical knowledge, and in addition, gives the exposure of training in the institutes /organization like BARC, IGCAR, CAT, IPR, TIFR, IITs to PG students. Further, students are encouraged to participate and be a part of organizing seminars, workshops, meets, schools and conferences.

The main course objectives of M. Sc. Physics are to:

- Strengthen the theoretical & experimental capabilities of the students. Comprehensive theoretical and experimental knowledge in major areas of Physics such as material science, electronics, nuclear physics etc.
- Impart higher level knowledge and understanding of physics concepts and phenomena.
- Apply the theory of physics for newer applications.
- Enable students to analyze mathematical models of physical systems for enhancement

of system performance and arrive at limitations of physical systems.

- Enhance students' ability to develop mathematical models of defined physical systems.
- Prepare students to evaluate the soundness of concepts proposed.
- Prepare students' skills to pursue physics as a teaching and research career.
- Train students in team work and in lifelong learning for continuous professional development.
- Enhance the problem solving approach of the students through practices, regular tests and pre-examination tests with special attention on National Eligibility Test (NET)/Graduate Aptitude Test in Engineering (GATE)/Joint Entrance Screening Test (JEST) syllabus.
- Generate placement avenues along with the academic alliance with power sectors, industries/corporations, scientific institutions like BARC, CAT, IITs, IPR, IISc, DRDO, SINP, IUC, IGCAR, ONGC, IBM, DGFC, forensic laboratories, energy sector etc.
- Motivate the students towards research.

DETAILED COURSES OF STUDY

M.SC. PHYSICS, SEMESTER-I

Course Code	Course Title	L	T	P	Credit
PPY-101	MATHEMATICAL PHYSICS	4	1	0	4.5

Prerequisites: Little knowledge of algebraic operations, differentiation and integration.

Course Objectives: This course has been developed to introduce students to some topics of mathematical physics which are directly relevant in different papers of M. Sc. Physics course. It includes elements of group theory, special functions, and functions of a complex variable and calculus of residues. On completion of this course, students would be able to handle the mathematics that appears invariably in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

UNIT I (3 Questions)

Matrices: Definitions and types of matrices, solution of linear algebraic equations, characteristic equation and diagonal form, eigen values and eigen vectors problems, Cayley-Hamilton theorem, functions of matrices.

Elementary Statistics: Introduction to probability theory, random variables, Binomial,
Poisson and Normal distribution.

Complex Analysis: Functions of complex variable, analytic functions and Cauchy-Riemann conditions, Cauchy's integral theorem and integral formula, Liouville's theorem, Power series, Taylor's and Laurent's series, calculus of residues poles, singularity, Cauchy's residue theorem, evaluation of residues, evaluation of definite integrals.

Basics of vector calculus.

Unit II (3 Questions)

Linear Differential Equations: Introduction, types and solutions, reduced equation, method of partial fraction, linear dependence and Wronskian, second order equation, series solutions – Frobenius'method, series solutions of the differential equations of Bessel, Legendre, Leguerre and Hermite polynomials, generating functions, some recurrence relations.

Integral Transforms Fourier series, Fourier integral theorem, Fourier transform–Parseval's identity and related problems, Laplace transform, convolution theorem, transform of derivatives, application to ordinary differential equation.

Unit III (2 Questions)

Group Theory: Basic definitions, Multiplication table, conjugate elements and classes. Subgroups, Isomorphism and Homomorphism. Definition of representation and its properties. Reducible and irreducible presentation. Characters of a representation, Topological groups and Lie groups, three dimensional rotation groups. The symmetry group D_2 and D_3, Unitary groups U(1), orthogonal groups SO(2) and SO (3).

Tensors: Introduction, definitions, contraction, direct product, Quotient rule. Levi-Civita symbol, Non Cartesian tensors, metric tensor. Covariant differentiation.

Course Outcomes:

1. Students will learn important mathematical functions such as the function of Bessel, the polynomial of Legendre, the function of Greens, etc., their basic physics properties and applications, so that in various courses they need to understand theoretical treatment.
2. The goal of the course is to provide for the M.Sc. Students with the mathematical techniques he/she needs in this class to understand theoretical treatment in various courses taught and to develop a good history if he/she decides to pursue research as a career in physics.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw-Hill, New Delhi (1970).
2. G. B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5th edition, Academic Press, London (2001).
3. E. Kreyszig, Advanced Engineering Mathematics, 5th edition, Wiley Eastern (1991).
4. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, NewDelhi),(2005).
5. Mathematical Methods of Physics - J. Mathews and R. L. Walker, Second Edition,
6. Addison-Wesley.
7. Matrices and Tensors in Physics - M. R. Spiegel, Schaum Series.
8. Linear Algebra – Seymour Lipschutz, Schaum Outlines Series.
9. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern Ltd, 1975.
10. Analysis - M. R. Spiegel, Schaum Series.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-102	CLASSICAL MECHANICS	4	1	0	4.5

Prerequisites: knowledge of laws of motions, dynamics.

Course Objectives: The aim and objective of the course on Classical Mechanics is to train the students of M. Sc. class in the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems. The multi-disciplinary topic 'Chaos' will enable the students to learn the techniques to handle the problems from the field of non-linear dynamics.

UNIT I (3 Questions)

Lagrangian Formulation: System of particles: Centre of mass, total angular momentum and total kinetic energies of a system of particles, conservation of linear momentum, energy and angular momentum. Constraints and their classification, degrees of freedom, generalized co-ordinates, virtual displacement, D'Alembert's principle, Lagrange's equations of motion of the second kind, uniqueness of the Lagrangian, Simple applications of the Lagrangian formulation

Hamiltonian formulation: Generalized momenta, canonical variables, Legendre transformation and the Hamilton's equations of motion, Examples of (a) the Hamiltonian of a

particle in a central force field, (b) the simple harmonic oscillator, cyclic co-ordinates and conservation theorems, derivation of Hamilton's equations from variational principle.

Canonical transformation-I: Generating functions (four basic types), examples of canonical transformations, the harmonic oscillator in one dimension, Poisson brackets, equations of motion in terms of Poisson brackets.

Unit II (3 Questions)

Canonical transformation-II: properties of Poisson brackets (anti symmetry, linearity and Jacobi identity), Poisson brackets of angular momentum, The Hamilton-Jacobi equation,
Linear harmonic oscillator using Hamilton-Jacobi method.
Central forces: Reduction of two particle equations of motion to the equivalent one-body problem, reduced mass of the system, conservation theorems (First integrals of the motion),equations of motion for the orbit, classification of orbits, conditions for closed orbits, the Kepler problem (inverse square law force).
Rigid body dynamics: Degrees of freedom of a free rigid body, angular momentum and kinetic energy of a rigid body, moment of inertia tensor, principal moments of inertia, classification of rigid bodies as spherical, symmetric and asymmetric, Euler's equations of motion for a rigid body, Torque free motion of a rigid body, precession of earth's axis of rotation, Euler angles, angular velocity of a rigid body, notions of spin, precession and notation of a rigid body.

Unit III (2 Questions)

Scattering in a central force field: General description of scattering, cross-section, impact parameter, Rutherford scattering, centre of mass and laboratory co-ordinate systems transformations of the scattering angle and cross-sections between them.
Small oscillations: Types of equilibrium, quadratic forms for kinetic and potential energies of a system in equilibrium, Lagrange's equations of motion, normal modes and normal frequencies, examples of (i) longitudinal vibrations of two coupled harmonic oscillators, (ii)Normal modes and normal frequencies of a linear, symmetric, tri atomic molecule, (iii)oscillations of two linearly coupled plane pendulum.

Course Outcomes:

1. In the Lagrangian and Hamiltonian formalisms, the course will prepare students to the degree that they can use these in modern fields such as Quantum Mechanics, Quantum Field Theory, Condensed Matter Physics, Astrophysics, etc.

2. Upon successful completion of the course, students will be able to describe and understand the movements of discrete and continuous mechanical systems, describe and comprehend the planar and spatial motion of a rigid body, and use Lagrange-Hamilton formalism to describe and understand the movement of a mechanical system.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading: 1. H. Goldstein, Classical Mechanics, 2nd edition, Narosa Publishing House (1994). 2. W. Greiner, Classical Mechanics, Springer-Verlag (2003). 3. Classical mechanics, K. N. SrinivasaRao, University Press (2003). 4. Classical mechanics, N. C. Rana and P. S. Joag, Tata McGraw-Hill (1991). 5. Classical dynamics of particles and systems, J. B. Marian, Academic Press (1970) 6. Introduction to classical mechanics, Takwale and Puranik, Tata McGraw-Hill (1983). 7. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4th edition, Pergamon press (1985).
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-103	QUANTUM MECHANICS-I	4	1	0	4.5
Prerequisites: In order to study elementary quantum mechanics you must ideally have an understanding of the following mathematical ideas: Complex numbers, Partial and Ordinary, differential equations, Integral calculus I-III, linear algebra, fourier analysis.					
Course Objectives: This course aims at providing an elementary introduction to the basic principles of (non-relativistic) Quantum Mechanics, and its wave-mechanical and matrix-mechanics formulations. Starting with the mechanics of a single spin-less particle, formulation is extended to deal with spin and a system of many identical particles.					
UNIT I (3 Questions). **General formulation of Quantum Mechanics**: Recapitulation of basic concepts: Eigen values and Eigen functions, Schrodinger's time dependent and					

independent wave equation, Potential Step, Rectangular Potential Barrier and tunnelling, The square potential well. Potential with bounded states: Linear Harmonic Oscillator.

Matrix Mechanics: Hermitian and unitary matrices, Transformation and diagonalization of matrices, Matrices of infinite rank, Representation of dynamical variables and wave functions as matrices, Choice of basis, Change of basis, Hilbert space representation; Dirac's ket and bra notations; Time-development of quantum system: Schrödinger, Heisenberg and interaction pictures, Link with classical equations of motion, Quantization of a classical system, Application to motion of a particle in an em field; Matrix theory of the harmonic oscillator: Spectrum of Eigen values and Eigen functions, Matrices for position, momentum and energy operators (energy representation).

Unit II (3 Questions)

Quantum theory of Angular Momentum: Orbital angular momentum operator L, Cartesian and spherical polar co-ordinate representation, Commutation relations, Orbital angular momentum and spatial rotations, Eigen values and Eigen functions of L^2 and L_z, Spherical harmonics; General angular momentum J: Eigen values and Eigen functions of J^2 and J_z, Matrix representation of angular momentum operators, Spin angular momentum, Wave function including spin (Spinor); Spin one-half: Spin Eigen functions, Pauli spin matrices; Addition of angular momenta, Clebsch-Gordan coefficients and their calculation for $j_1= j_2 =1/2$, $j_1=1$, $j_2 =1/2$ and $j_1= j_2 =1$.

Unit III (2 Questions)

Many-particle systems: Many-particle Schrodinger wave equation; Identical particles: Physical meaning of identity, Principle of in distinguish ability and its consequences, Exchange operator, Symmetric and anti-symmetric wave functions, Connection between spin, symmetry and statistics, Fermions and bosons; Spin and total wave function for a system of two spin ½ particles, Pauli exclusion principle and Slater determinant; Application to the electronic system of the helium atom (para- and ortho helium).

Course Outcomes:

1. The goal of the course is to equip students with angular momentum, perturbation theory, scattering theory and quantum field theory techniques so that they can use them according to their requirements in different branches of physics.

2. Student will learn the application of Time- independent Perturbation Theory, understand the WKB approximation and also know the application and validity of Born Approximation.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Quantum Mechanics : M.P. Khanna, (HarAnand, New Delhi)(2009)

2. A text book of Quantum Mechanics, P.M. Mathews and K.Venkatesan (Tata McGraw
Hill, New Delhi) (2004).
3. Quantum Mechanics: V.K Thankappan (New Age, New Delhi) (2005).
4. Quantum Filed Theory : H. Mandl and G. Shaw, (Wiley, New York)1993 .
5. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi) (1998).
6. Quantum Physics: S. Gasiorowicz (Wiley India Edition, New Delhi)(2009).
7. Advanced Quantum Mechanics: J.J. Sakurai (PearsonEducation, India) (2009).
8. Quantum Mechanics (3rd edition) by L. I. Schiff.
9. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain.
10. Introduction to Quantum Mechanics (2nd edition) by David J. Griffiths.
11. Quantum Mechanics by A. K. Ghatak and S. Loknathan.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-104	ELECTRONIC CIRCUIT AND DEVICES	4	0	0	4

Prerequisites: Analog Circuit Analysis.

Course Objectives: Through this course on electronic devices and circuits, the students are supposed to understand basic physics of semiconductor materials and the construction and operation of pn-diode and BJT under different operating conditions.

UNIT I (3 Questions).

Basics of semiconductor electronics: Review of basics of Semiconductors, bipolar junction transistor, the Ebers-Moll's model; Network theorems: node theorem, mesh theorem, Millman's theorem, Thevenin's theorem, Norton's theorem, superposition theorem.

Transistors and Oscillators: JFET. Basic structure and operation of JFET, the FET small signal model, Comparison of p and n channel FETS, low frequency common source andcommon drain FET amplifiers, FET Biasing, FET as a voltage variable resistor (VVR);metal oxide semiconductor field effect transistor (MOSFET), physical structure, operation and characteristics, enhancement and depleted modes of operation.

Feedback sinusoidal oscillators: phase shift oscillators, Wein bridge oscillators, Tuned circuit oscillators, Hartley and Colpitt's oscillators, crystal oscillators; Multi vibrators: bistable multi vibrators, Schmitt trigger circuit, monostable and a stable multi vibrators

Unit II (3 Questions)

Amplifier models, feedback and biasing: Analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Analysis of amplifiers with voltage series, voltage shunt, current series and current shunt negative feedbacks; Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltagefeedback bias, bias sources for integrated circuits, Circuits for stabilization of Q-Point.

Operational Amplifiers Basics: The basic OPAMP, inverting and non-inverting OPAMPS, the differential amplifiers, common moderejection ratio (CMRR), the emitter coupled differential amplifier, the transfer characteristics of differential amplifier, an IC OPAMP (MC 1530 Motorolla) and its dc analysis, offset voltages and currents, universal balancing techniques, measurement of OPAMP parameters.

Unit III (2 Questions)

Logic Systems: Basic Concepts of dc positive, negative and dynamic logic systems, Logic gates (AND, OR, NOT, NOR, NANDand EX-OR gates)in DL, RTL, DTL and TTL logic families, Number systems, Binary arithmetic, Boolean algebra, de-Morganlaws. Multiplexers, demultiplexers, adders, subtractors, comparators, FLIP FLOPS (SR, JK, T, D)Registers, shift registers(serial and parallel operations),Asynchronous counters (up, down, up-down, decade) andsynchronous counter (up, down, up-down, decade), Analog-to-digital converters, digital-to-analog converters.

Course Outcomes:

1. Student will learn transducers strain gauge, thermostat, magneto resistive sensor and signal Conditions data acquisition & conversion.

2. This course covers semiconductor physics, computer physical concepts and their basic applications, passive and active filter analysis, OPAMP-based analog circuits, and introduction to different communication

techniques and students will introduce integrated circuit technology basics, 8085 microprocessor design, instruction set, memory and I/O device interfacing.
Assessment Model: • Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks • Average of TWO Mid-Terms (50 Marks) – 20 Marks • Attendance – 5 marks • End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1. Integrated Electronics by J. Millman and C. C. Halkias 2. Electronic devices and circuits by Y. N. Bapat 3. Microwave devices and circuits by Samuel Y. Liao 4. Physics of semiconductor Devices by S. M. Sze 5. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick 6. OPAMPs and linear IC circuits by Ramakant A. Gayakwad 7. Pulse, digital and switching waveforms by J. Millman and H. Taub 8. Modern Digital Electronics (3rd Ed.) by R. P. Jain 9. Electronic fundamentals and applications by J.D. Ryder
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-105	PHYSICS LABORATORY-I	0	0	12	6

Prerequisites: Student have basic knowledge of lab instruments and apparatus.

Course Objectives: The aim of the course on Physics Laboratory is to train students in handling the basic tools of experimental physics, and their use in laboratory demonstration of important physical phenomenon and the underlying principles of physics.

Note: Students are expected to perform at least 06 experiments from each unit.

UNIT I

1. To determine Planck's constant using photocell.
2. To determine the electric charge of an electron using Millikan oil drop experiment.
3. To study the potential energy curve of the magnet-magnet interaction using air-track setup
4. To estimate the rotational period of sun using sunspots observations.
5. Diffraction of laser light by single slit and diffraction grating – (a) determination of
   wavelength of laser (b) Determination of distance between two slits using interference of laser light through double slit
6. (a) Determination of refractive index of glass and Perspex using total internal reflection. (b) Determination of refractive index of liquids using shift in the diffraction pattern.
7. Study of laser beam characteristics and determination of divergence, and beam waist size with knife edge.
8. Determination of wavelength of iron arc spectral lines using constant deviation with spectrometer.
9. Determination of elastic constants of glass (and Perspex) by Cornu's interference method.
10. Determination of wavelength of sodium light by Michelson's interferometer.
11. Determination of wavelength of sodium light using Fabry Perot etalon.
12. Verification of Malus' law
13. Study of intensity distribution of elliptically polarized light
14. Study of elliptically polarized light using Babinet compensator.
15. Determination of thickness of mica sheet using Edser Butler Fringes.

Unit II

1. Addition, Subtraction and Binary to BCD conversion.
2. UJT Characteristics.
3. Study the gain frequency response of a given RC coupled BJT, CE amplifier.
4. Study of Clipping & Clamping circuits.
5. Study of shunt capacitor filter, inductor filter, LC filter and π filter using Bridge Rectifier.
6. Verify De-Morgan's law and different combinations of gates using Logic gates circuit.
7. Verify the truth table of RS & D flip flops and verify the truth table of

clocked RS & JK flips flops.

8. To study Hartley and Colpitt's Oscillators.
9. To study characteristics of FET and determine its Drain resistance and gain.
10. Study the characteristics of Tunnel Diode.
11. To study 2 bit, 3 bit and 4 bit Adder & Subtractor.
12. Study of transistor as CE, CB and CC amplifier.
13. To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations.
14. To study the characteristics of a regulated power supply and voltage multiplier circuits.
15. To study logic gates and flip flop circuits using on a bread-board.
16. To configure various shift registers and digital counters. Configure seven segment displays and drivers.

Course Outcomes:

1. Student will know about the variation of count rate with applied voltage and thereby determine the plateau, the operating voltage and slope of plateau (G M Counter).

2. With labs, student will know the practical knowledge of physics applications

Assessment Model:

Total Assessment (Out of 30 Marks)

Preferred Reading:

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1989).

Web Resources:

M.SC. PHYSICS, SEMESTER-II

Course Code	Course Title	L	T	P	Credit
PPY-151	CONDENSED MATTER PHYSICS-I	4	0	0	4

Prerequisites: Basic knowledge of classical theory, properties of solid.

Course Objectives: The course on condensed matter physics has focus on the crystalline state of matter and is meant to introduce students to crystal structure, basic concepts and principles underlying structure determination, lattice vibrations, energy band theory and salient features of superconductivity.

UNIT I (3 Questions).

Crystal structure: Recapitulation of basic concepts: Simple crystal structures- Sodium chloride, Cesium chloride, Diamond, and Zinc blende structures; Determination of crystal structure by diffraction: Reciprocal lattice and Brillouin zones (examples of sc, bcc and fcc lattices), Braggand Laue formulations of X-ray diffraction by a crystal and their equivalence, Laue equations, Ewald construction, Brillouin interpretation, Crystal and atomic structure factors, Structure factor of the bcc and fcc lattices; Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods.

Unit II (3 Questions)

Lattice dynamics and thermal properties: Classical theory of lattice vibration (harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, Two atoms per primitive basis- acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons; **Thermal properties:** Lattice (phonon) heat capacity, Normal modes, Density of states in one and three dimensions, Models of Debye and Einstein; Effects due to an harmonic crystal interactions.

Electronic properties of solids-I: Free electron gas model in three dimensions: Density of states, Fermi energy, Effect of temperature, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Hall effect; Failure of the free electron gas model.

Unit III (2 Questions)

Band theory of solids: Periodic potential and Bloch's theorem, Kronig-Penney model, Wave equation of electron in a periodic potential, Solution of the central equation, Approximate solution near a zone boundary, Periodic, extended and reduced zone schemes of energy band representation, Number of orbitals in an energy band, Classification into metals, semiconductors and insulators.

Superconductivity: Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic field, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the superconducting transition, London equation, Coherence length, Salient features of the BCS theory of superconductivity, BCS ground state; Flux quantization in a superconducting ring; Dc and Ac Josephson effects; Macroscopic long-range quantum interference; High Tc superconductors (introduction only).

Course Outcomes:

1. After the completion of this course, students will be Capable of correlating the X-ray diffraction pattern based on the corresponding reciprocal lattice for a given crystal structure.
2. Able to explain how the predicted electronic properties of solids differ in the classical free electron theory, quanta free electron theory and the nearly free electron model.
3. Capable of explaining various magnetic phenomena and defining the different kinds of magnetic ordering based on the interaction of the exchange.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Introduction to Solids by Azaroff
2. Crystallography for Solid State Physics by Verma and Srivastava
3. Solid State Physics by M.A. Wahab
4. Elementary Solid State Physics by Omar
5. Crystal Structure Determination by G.H. Stout, L.H. Jensen
6. Principals of Condensed Mater Physics by Chaikin and Lubensky
7. Introduction to Solid State Physics (7th edition) by Charles Kittel
8. Solid State Physics by Neil W. Ashcroft and N. David Mermin
9. Applied Solid State Physics by Rajnikant
10. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
11. Principles of the Theory of Solids (2nd edition) by J. M. Ziman

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-152	STATISTICAL MECHANICS	4	1	0	4.5

Prerequisites: Student is already fluent with calculus, along with differential equations. A solid grasp of vector calculus, as you'll see a lot of multiple integrals in cartesian and spherical coordinates.

Course Objectives: This course is intended to provide a firm foundation to students in a very fundamental subject of Statistical Mechanics which aims to derive the macroscopic behaviour of a system in terms of the mechanics of its microscopic constituents, and finds application in almost all branches of Physics.

UNIT I (3 Questions).

Thermodynamics Basic ideas: heat, temperature, work done. Laws of thermodynamics and their significance, specific heats, thermodynamic potentials, Maxwell relations, significance of entropy.

Classical statistical mechanics: Basic postulates of statistical mechanics, Macro- and micro states – Statistical equilibrium--Phase space, Ensemble: micro canonical, canonical, grand canonical; Density function, Liouville's theorem, Canonical distribution function: Evaluation of mean values in a canonical ensemble, Partition function--connection with thermodynamics; Statistical definition of entropy— Boltzmann equation and its significance; Ideal mono atomic gas, Gibbs' paradox, Equi partition theorem, specific heat of solids.

Unit II (3 Questions)

Quantum Statistical Mechanics: Quantum-mechanical ensemble theory: Density matrix, Equation of motion for density matrix, Quantum mechanical ensemble average; Statistics of indistinguishable particles, Two types of quantum statistics -Fermi-Dirac and Bose-Einstein statistics, Fermi-Dirac and Bose-Einstein distribution functions using micro-canonical and grand canonical ensembles (ideal gas only), Statistics of occupation numbers; Ideal Bose gas: Internal energy, Equation of state, Bose-Einstein Condensation and its critical conditions; Bose-Einstein condensation in ultra-cold atomic gases: its detection and thermodynamic properties; Ideal Fermi gas: Internal energy, Equation of state, Completely degenerate Fermi gas.

Unit III (2 Questions)

Fluctuations: Thermodynamic fluctuations and their probability distribution law, Spatial correlations in a fluid, Connection between density fluctuations and spatial correlations; Brownian motion, the Langevin theory of the Brownian motion (derivations of mean square displacement and mean square velocity of Brownian particle),Auto-correlation function and its properties, The fluctuation-dissipation theorem, Diffusion coefficient; the Fokker-Planck equation; Spectral analysis of fluctuations: the Wiener- Khintchine theorem

Course Outcomes:

1. This course develops the idea of classical thermodynamic laws and their applications and learns statistical interpretation of micro canonical, canonical and grand canonical ensembles of thermodynamics.

2. This course will equip the students with Ensemble theory techniques so that they can use them to consider the macroscopic properties of the bulk of matter in terms of its microscopic components.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Statistical Mechanics by R. K. Pathria (2nd edition).
2. Statistical Mechanics by R. K. Pathria and P. D. Beale (3rd edition).
3. Statistical and Thermal Physics by F. Reif.
4. Statistical Mechanics by K. Huang.
5. Statistical Mechanics by L. D. Landau and I. M. Lifshitz.
6. Statistical Mechanics by R. Kubo.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-153	QUANTUM MECHANICS-II	4	1	0	4.5

Prerequisites: Having introduced the basic structure of Quantum Mechanics in the course PPY-103

Course Objectives: this course has focus on the need and development of variety of approximate methods in Quantum Mechanics (perturbation theory, variational method and WKB approach) and their illustration by way of application to selected atomic and molecular systems.

UNIT I (3 Questions).

Approximate methods for bound states-I: Stationary perturbation theory: Non-degenerate case- First-order and second-order corrections to energy Eigen values and eigen functions, Perturbation of an oscillator (harmonic and an harmonic perturbations), Fine structure of hydrogen atom (Relativistic and spin-orbit coupling corrections), Ground state of Helium atom; Degenerate case- Removal of degeneracy in second order, Zeeman effect without electron spin, First-order Stark effect in n=2 state of Hydrogen; Rayleigh-Ritz variational method: Ground and excited states, Application to ground state of Helium, Van der Waals interaction using perturbation and variational methods.

Relativistic Quantum Mechanics: Klein- Gordon equation, Dirac equation and its plane wave solution, significance of negative energy solutions, spin angular momentum of the Dirac particle, The non-relativities limit of Dirac equation. Electron in electromagnetic fields, spin magnetic moment. Spin – orbit interaction, Dirac equation for a particle in a central field. fine structure of hydrogen atom, Lamb shift.

Unit II (3 Questions)

Approximate methods for bound states-II: The WKB approximation: Classical

limit, Approximate solutions, Asymptotic nature of solutions, Solution near a turning point, Special case of linear turning point, Connection at the turning point, asymptotic connection formulae, Application to energy levels of a quantum well, tunnelling Transition probability for constant and harmonic perturbations, Transition to a group of final states- The Fermi golden rule, Applications: Ionization of hydrogen atom, Interaction of an atom with em radiation (semi-classical treatment), Transition probability for induced absorption and emission.
Selected applications of Quantum Mechanics: Atomic structure of many-electron atoms: Central-field approximation, Periodic system of elements, Thomas-Fermi statistical model, Evaluation of the potential, Hartree's self-consistent fields and connection with the variational method, Correction to the central-field approximation (L-S and j-j couplings).

Unit III (2 Questions)

Quantum theory of scattering: Scattering experiments and cross-sections, Laboratory and centre-of-mass systems, Scattering amplitude and cross-section; Method of partial waves: Phase shift, Differential and total cross-sections, Relation between phase shift and scattering potential, Convergence of partial-wave series, Scattering by a finite square well, Resonances- Breit-Wigner formula, Scattering by a hard-sphere potential; Green's function method: Lippmann-Schwinger equation, Born series, First Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion; Scattering of two identical spin less bosons, and spin-1/2 fermions.

Course Outcomes:

1. The goal of the course is to equip students with angular momentum, perturbation theory, scattering theory and quantum field theory techniques so that they can use them according to their requirements in different branches of physics.

2. Student will learn the application of Time- independent Perturbation Theory, understand the WKB approximation and also know the application and validity of Born Approximation.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Quantum Mechanics: M.P. Khanna, (HarAnand, New Delhi) (2009)
2. A text book of Quantum Mechanics, P.M. Mathews and K.Venkatesan (Tata McGraw
Hill, New Delhi) (2004).
3. Quantum Mechanics: V.K Thankappan (New Age, New Delhi) (2005).
4. Quantum Filed Theory: H. Mandl and G. Shaw, (Wiley, New York) 1993.
5. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi) (1998).
6. Quantum Physics: S. Gasiorowicz (Wiley India Edition, New Delhi) (2009).

7. Advanced Quantum Mechanics: J.J. Sakurai (PearsonEducation, India) (2009).
8. Quantum Mechanics (3rd edition) by L. I. Schiff.
9. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain.
10. Introduction to Quantum Mechanics (2nd edition) by David J. Griffiths.
11. Quantum Mechanics by A. K. Ghatak and S. Loknathan.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-154	ELECTRODYNAMICS	4	1	0	4.5

Prerequisites: must be aware about electric charge and dynamic motion.

Course Objectives: Students will learn about electric field and its application. Also will study about electromagnetic waves.

UNIT I (3 Questions).

Electrostatics: Coulomb's law, Electric field, Gauss's law, applications of Gauss's law, Electric Potential, Poisson's equation and Laplace's equation, Work and energy in electrostatics Techniques for calculating potentials: Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, Method of Images, Multi pole expansion, Electrostatic fields in matter: Dielectrics, Polarization, Field inside a dielectric, Electric displacement, Linear dielectrics.

Unit II (3 Questions)

Magneto statics: Bio-Savart Law, Divergence and Curl of B, Ampere's law and applications of Ampere's law, Magnetic vector potential, Multi pole expansion. Magneto static fields in Matter: Magnetization, field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media

Maxwell's Equations and Electromagnetic Waves-I: Faraday's law – generalization of Ampere's law – Maxwell's equations – boundary conditions – scalar and vector potentials , Gauge transformation-Coulomb and Lorentz gauge – Poynting's theorem. Maxwell's equations in terms of potentials. Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media; Boundary conditions; Reflection and transmission at interfaces. Fresnel's laws.

Unit III (2 Questions)

Electromagnetic Waves-II: Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media Dispersion: Dispersion in non-conductors, free electrons in conductors and plasmas, Guided waves.

Radiation: Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, antenna, radiation by moving charges, Lienard - Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.

Course Outcomes:

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Classical Electrodynamics: S.P. Puri, (Tata McGraw Hill, New Delhi).
2. Classical Electrodynamics: J.D. Jackson, (Wiley Eastern, New Delhi).
3. Introduction to Electrodynamics: D.J. Griffiths, (Prentice Hall India,New Delhi)
4. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.
5. Introduction to Plasma Physics by F. F. Chen.
6. Introduction to Plasma Theory by D. R. Nicholson.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-155	PHYSICS LABORATORY-II	0	0	12	6

Prerequisites: Having introduced the basic knowledge in the course PPY-105.

Course Objectives: The aim of the course on Physics Laboratory is to train students in handling the basic tools of experimental physics, and their use in laboratory demonstration of important physical phenomenon and the underlying principles of physics.

Note: Students are expected to perform at least 06 experiments from each unit.

UNIT I

1. To determine e/m ratio using hellical method
2. To study variation of magnetic field along the axis of a circular coil.
3. To calculate the temperature coefficient of Thermistor.
4. To determine the Curie temperature of a given PZT sample.
5. Determine the coercivity, retentivity and saturation value of magnetic induction of the given sample by studying the B-H loop.

6. Determine the Hall coefficient of the given sample and hence find the carrier concentration and mobility.
7. Measurement of susceptibility of paramagnetic solutions by Quinck's Tube Method.
8. Measurement of magneto-resistance of a semi-conducting sample.
9. Study of Dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
10. Study of solar cell and characteristics.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. Find the energy gap of a given semi-conductor by reverse bias junction method.
13. To calculate the temperature coefficient of Thermistor.
14. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.

Unit II

1. Determination of dielectric constant using parallel plate capacitor.
2. To study the Stefan Boltzmann law of radiation with an amplifier.
3. Thermal electrical conductivity of metals.
4. To determine the velocity of ultrasonic waves using interferometer as a function of Temperature.
5. Temperature dependence of a ceramic capacitor - Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
6. To determine Percolation threshold and temperature dependence of resistance in composites.
7. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity.
8. To study the Kerr effect using Nitrobenzene.
9. Determination of Rydberg constant
10. Determination of velocity of ultrasonic waves in liquids using the method of diffraction and comparison with the mechanical method.
11. Verification of Beer-Lambert law.
12. Frank Hertz experiment for Quantization of Bohr's model of atom.

Course Outcomes:

1. Student will know about the variation of count rate with applied voltage and thereby determine the plateau, the operating voltage and slope of plateau (G M Counter).

2. With labs, student will know the practical knowledge of physics applications.

Assessment Model:

Total Assessment (Out of 30 Marks)

Preferred Reading:

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988).
2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986).
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-

Graw Hill, New Delhi (1989).
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-156	SEMINAR-I	0	0	3	3
Prerequisites: Student must know little knowledge of MS-Word for making a presentation.					
Course Objectives: This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 40 minutes duration on a topic as decided by the departmental seminar committee.					

Every students need to give three presentations from the topics related to the subjects.
Course Outcomes: 1. Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge. 2. Would help students in developing better communication skills and higher level of confidence.
Assessment Model: Total Assessment (Out of 100 Marks).
Preferred Reading: All books which is related to physics application and laboratory.
Web Resources:

M.SC. PHYSICS, SEMESTER-III

Course Code	Course Title	L	T	P	Credit
PPY-201	CONDENSED MATTER PHYSICS-II	4	0	0	4
Prerequisites: Having introduced the basic structure of Condensed Matter Physics-I in the course PPY-151.					
Course Objectives: The aim of Condensed Matter Physics-II is to expose students to topics like electron dynamics in semiconductors and metals, Fermi surface and its determination, optical properties of solids, dielectrics and					

ferroelectrics, and quantum-mechanical origin of magnetism.

UNIT I (3 Questions).

Semiconductor crystals and Fermi surfaces & metals: Semiconductor crystals: Band gap, Direct and indirect absorption processes, Motion of electrons in anenergy band, Holes, Effective mass, Physical interpretation of effective mass, Fermi surfaces and metals: Fermi surface and its construction for square lattice Electron orbits, Hole orbits, Open orbits; Wigner-Seitz method for energy bands, Cohesive energy; Experimental determination of Fermi surface.

Dielectrics and Ferroelectrics: Polarization, Macroscopic electric field, Dielectric susceptibility, Local electric field at an atom, Dielectric constant and polarizability, Clausius-Mossotti relation, Electronic polarizability, Classical theory of electronic polarizability; Structural phase transitions; Ferroelectric crystals and their classification; Landau theory of the phase transition; Anti-ferroelectricity, Ferroelectric domains.

Unit II (3 Questions)

Magnetism: Diamagnetism and paramagnetism: Magnetic susceptibility, Langevin diamagnetism equation, Quantum theory of diamagnetism; Quantum theory of paramagnetism- Curie law, Hund's rules, Paramagnetic susceptibility of conduction electrons; Ferromagnetism and anti-ferromagnetism: Ferromagnetic order, Electrostatic origin of magnetic interactions, Magnetic properties of a two-electron system, Singlet-triplet(exchange) splitting in Heitler-London approximation; Spin Hamiltonian and the Heisenberg model; Mean field theory-Curie-Weiss law; Spin waves- magnons, Bloch T3/2 law; Neutron magnetic scattering(principle);Ferromagnetic domains: Magnetization curve, Bloch wall, Origin of domains; Anti ferromagnetic order and magnons.

Unit III (2 Questions)

Optical properties of solids: Dielectric function of the free electron gas, Plasma optics, Dispersion relation for em waves, Transverse optical modes in a plasma, Transparency of alkalis in the ultraviolet, Longitudinal plasma oscillations, Plasmons and their measurement; Electrostatic screening, Screened Coulomb potential, Mott metal-insulator transition, Screening and phonons in metals; Optical reflectance, Kramers-Kronig relations, Electronic inter band transitions, Excitons: Frenkel and Mott-Wannier excitons; Raman effect in crystals; Electron spectroscopy with X-rays.

Course Outcomes:

1. After the completion of this course, students will be Capable of correlating the X-ray diffraction pattern based on the corresponding reciprocal lattice for a given crystal structure.
2. Able to explain how the predicted electronic properties of solids differ in the classical free electron theory, quanta free electron theory and the nearly free electron model.
3. Capable of explaining various magnetic phenomena and defining the different kinds of magnetic ordering based on the interaction of the exchange.

Assessment Model: • Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks • Average of TWO Mid-Terms (50 Marks) – 20 Marks • Attendance – 5 marks • End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1. Introduction to Solid State Physics (7th edition) by Charles Kittel. 2. Solid State Physics by Neil W. Ashcroft and N. David Mermin. 3. Applied Solid State Physics by Rajnikant. 4. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth. 5. Principles of the Theory of Solids (2nd edition) by J. M. Ziman.
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-202	NUCLEAR & PARTICLE PHYSICS-I	4	0	0	4
Prerequisites: Basic knowledge about moment, tensors and conservation laws.					

Course Objectives: The course aims to provide the students with an understanding of basic radiation interaction and detection techniques for nuclear physics, radioactive decays, nuclear reactions and elementary particle physics.

UNIT I (3 Questions).

Interaction of nuclear radiation with matter: (a) Interaction of charged particles: Energy loss of heavy charged particles in matter, Bethe-Bloch formula, energy loss of fast electrons, Bremsstrahlung. (b) Interaction of gamma rays: Photoelectric, Compton, and pair production processes.

Nuclear size and shape: Methods for determining the nuclear radius, Wave Mechanical properties of nucleus and statistics, electric and magnetic moments and nuclear shapes

Nuclear forces: Characteristics of nuclear forces, Ground state of the deuteron using square well potential, relation between the range and depth of the potential, Inadequacies of the central force, experimental evidence for the tensor force, magnetic moment and quadrupole moment of the deuteron, deuteron ground state as an admixture of s and d states.

Unit II (3 Questions)

Nuclear models and Nuclear decay: Nuclear models: Liquid drop model: Semi-empirical mass formula, stability of nuclei against beta decay, mass parabola and Shell model: Evidence for magic numbers, prediction of energy levels in an infinite square well potential, spin-orbit interaction, prediction of ground states pin, parity and magnetic moment of odd-A nuclei, Nordheim's rules. **Beta decay:** Fermi's theory of beta decay, Kurie plots, selection rules. **Gamma decay**: Multi polarity of gamma rays, Selection rules, Internal conversion (qualitative treatment).

Nuclear detectors and Nuclear Reactions: Scintillation Detectors-NaI (Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li ion drifted detectors, relation between the applied voltage and the depletion region in junction detectors. Type of reactions, conversation laws. Q-values and its significance, Laboratory and Centre of mass coordinates and their relationship, reaction cross sections.

Unit III (2 Questions)

Elementary particle physics: Types of interactions between elementary particles, hadronsand leptons, detection of neutrinos. Symmetries and conservation laws: conservation of energy, momentum, angular momentum, charge and iso spin, parity symmetry, violation of parity in weak interactions - handedness of neutrinos, Lepton number conservation, Lepton family and three generations of neutrinos. Charge conjugation symmetry, CP violation in weak interactions, Strange particles, conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, eight fold way (qualitative only), quark model, quark content of baryonsand mesons.

Course Outcomes:

1. Students will know the properties of the nucleus such as binding energy, magnetic dipole moment and CO-2 electric quadruple moment and study the achievement and limitations of nuclear physics models.

2. Students will have an idea of how particles interact with matter and will understand the elementary particles' nature, interaction, etc.

3. In nuclear models and nuclear reactions, students will be taught the basic aspects of nuclear physics such as static properties of nuclei, radioactive decays, nuclear forces and relatively advanced topics so that they understand the specifics of the underlying aspects so that they are prepared with the methods used to research these things.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Atomic and Nuclear Physics, S N. Ghoshal: Vol. II., 2000.
2. The Atomic Nucleus, Evans R. D.: Tata McGraw Hill, 1955.
3. Nuclear Physics, R. R. Roy and B. P. Nigam: Wiley-Eastern Ltd. 1983.
4. Nuclear Physics- an Introduction, S.B.Patel: New Age international (P) Limited, 1991.
5. Radiation Detection and Measurements, G.F. Knoll: 3rd edition, John Wiley and Sons,
2000.
6. Nuclear Radiation Detectors, S.S. Kapoor and V.S. Ramamurthy: Wiley-Eastern, New
Delhi, 1986. Nuclear Interaction, S. de Benedetti: John Wiley, New York, 1964.
7. Nuclear Radiation Detection, W.J. Price: Mc Graw Hill, New York, 1964.
8. Introduction to Elementary particles, D. Griffiths: John Wiley, 1987.
9. Elementary Particles, J. M. Longo, II Edition, Mc Graw-Hill, New York, 1973.
10. Introduction to Nuclear Physics, Wong, PHI.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-203	ATOMIC AND MOLECULAR PHYSICS	4	0	0	4

Prerequisites: Students must have the knowledge of quantum mechanics.

Course Objectives: The course illustrates the fundamental aspects of atomic and molecular physics, and will use quantum mechanics at different levels to understand the structure and dynamics of both atoms and molecules.

UNIT I (3 Questions).

Atomic Physics: Brief review of early atomic models. Hydrogenic atoms: Energy levels and selection rules, Relativistic corrections and fine structure, hyperfine structure, Lamb shift and isotope shift. Physical interpretation of quantum numbers, Terms for equivalent & non-equivalent electron atom, Space Quantization: Stern-Gerlach experiment, Interaction with external fields: Zeeman effect, Paschen-Back effect, Stark effect. Two electron atom: Ortho and para states and role of Pauli's exclusion principle, level schemes of two electron atoms. Many electron atoms: LS and JJ coupling schemes, Lande interval rule.

Unit II (3 Questions)

Molecular Physics: Rotation of molecules: Classification of molecules, Interaction of radiation with rotating molecules, Rotational spectra of rigid diatomic molecules, Isotope effect in rotational spectra, Intensity of rotational lines, Non rigid rotator, Information derived from rotational spectra; Infrared spectroscopy: The vibrating diatomic molecule, The diatomic vibrating-rotator spectra of diatomic molecules, Infrared spectrophotometer; Raman Spectroscopy: Introduction, Pure rotational Raman spectra, Vibrational Raman Spectra, Nuclear Spin and intensity alternation in Raman spectra, Isotope effect, Raman Spectrometer.

Unit III (2 Questions)

Electronic Spectra of diatomic molecules and Fluorescence spectroscopy: Born Oppenheimer approximation, Vibrational coarse structure of electronic bands, Progression and sequences, Intensity of electronic bands-Frank Condon Principle, Dissociation and pre-dissociation, Dissociation energy; Rotational fine structure of electronic bands, The Fortrat parabola, Electronic structure of diatomic molecules; Fluorescence spectroscopy: Fluorescence and Phosphorescence, Kasha's rule, Quantum Yield, Non radiative transition, Jablonski Diagram.

Course Outcomes: On completion of the course, the students shall have basic knowledge of modern atomic and molecular physics in order to

(i) master both experimental and theoretical working methods in atomic and molecular physics for making correct evaluations and judgments,

(ii) carry out experimental and theoretical studies on atom sand molecules, with focus on the structure and dynamics of atoms and

molecules, and (iii) Account for theoretical models, terminology and working methods used in atomic and molecular physics.
Assessment Model: • Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks • Average of TWO Mid-Terms (50 Marks) – 20 Marks • Attendance – 5 marks • End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1 Concept of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987). 2 Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York. 3 Molecular structure & spectroscopy, G. Aruldhas; Prentice – Hall of India, New Delhi. 4 Fundamentals of molecular spectroscopy, Colin N. Banwell & Elaine M. McCash,TMH 5 Introduction to Atomic spectra by H.E. White.
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-204	NUMERICAL METHODS & COMPUTATIONAL PHYSICS	4	0	0	4

Prerequisites: Basic idea of integration, differentiation and algebraic formulas.

Course Objectives: In theoretical physics, one comes across very frequently with the situations where the analytical solutions of the equations describing the physical system are not possible. In these situations the numerical methods for solving equations, evaluating differentiation, integration etc. provide a powerful tools to describe the physical phenomenon quantitatively.

UNIT I (3 Questions).

Errors and Solution of Algebraic Equations: Errors: Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant Digits, Computer caused loss of significance, Avoiding loss of significance in subtraction. Solutions of algebraic equations: Bisection method, Iteration method, Method of false position, Newton-Raphson method, Muller's method, Quotient-Difference method, Secant Method.

Interpolation and Curve fitting-I: Interpolation and Extrapolation: Finite differences, Forward differences, Backward differences, Central differences, Newton's formula for interpolation, Gauss central difference formula, Stirling's formula, Bessel's formula.

Unit II (3 Questions)

Interpolation and Curve fitting-II: Lagrange's interpolation formula, Hermite's interpolation formula. Least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions, Data fitting with cubic splines.

Differentiation and Integration: Differentiation: Taylor series method, Numerical differentiation using Newton's forward difference formula, Backward difference formula, Stirling's formula, Cubic splines method; Integration: Trapezoidal rule, Simpson's 1/3 rule, Gaussian Quadrature, Legendre–Gauss Quadrature, Numerical double integration, Numerical integration of singular integrals.

Unit III (2 Questions)

Random Numbers and Chaos: Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, Mixed multiplicative

congruential methods, Modelling radioactive decay. Hit and miss Monte-Carlo methods, Monte-Carlo calculation of pi, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals; Chaotic dynamics: Some definitions, The simple pendulum, Potential energy of a dynamical system. Portraits in phase space: Undammed motion, Damped motion, Driven and damped oscillator.
Course Outcomes: After completing this course the students will be able to understand the concepts involved in various numerical methods and to apply these methods in various physical situations using computer programming.
Assessment Model: • Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks • Average of TWO Mid-Terms (50 Marks) – 20 Marks • Attendance – 5 marks • End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1. F B Hildebrand, Introduction to Numerical Analysis, Tata McGraw Hill, New Delhi. 2. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi. 3. Suresh Chandra, Computer Applications in Physics, Narosa Publishing House. 4. William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery, Numerical Recipesin Fortran, Cambridge University Press. 5. M L De Jong, Introduction to Computation Physics, Addison-Wesley publishing company. 6. R C Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New AgeInternational Publisher. 7. S S Sastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd. 8. V Rajaraman, Computer Oriented Numerical Method, Prentice Hall of India Pvt. Ltd. 9. C Balachandra Rao and C K Santha, Numerical Methods, University Press 10. K E Atkinson, An introduction to numerical analysis, John Wiley and Sons. 11. Numerical Methods by E. Balagursawami.
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-205	PHYSICS LABORATORY-III	0	0	12	6

Prerequisites:

Course Objectives: This course is intended to impart hands-on training to students in handling somewhat specialized techniques in their respective chosen fields of specialization, one each from two groups viz. Group 1: Condensed Matter Physics, Nuclear Physics, and Particle Physics; Group 2: Computational Physics, Electronics, and Material Science. There is a close overlap between the experiments offered and the theory course.

Note : Students are expected to perform at least 04 experiments from each unit I, II and III

Unit I

1. Measurement of optical spectrum of alkaline earth atoms
2. Measurement and analysis of fluorescence spectrum of I_2 vapors.
3. Determination of characteristic parameters of an optical fiber.
4. Measurement of lattice parameter and indexing of powder photograph
5. Identification of unknown sample using powder diffraction method.
6. Analysis of single crystal rotation photograph.
7. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts (MnSO4, MnCl2) by Quincke's method
8. Ionic conductivity of NaCl: Study of the temperature variation of σ and estimation ofactivation energy
9. B-H curve of a Ferromagnetic material (both hard and soft)
10. Electrical resistivity of thin films
11. Magnetic susceptibility of Ferrous ammonium sulphate by Gouy's

balance method

12. To study various aspects of frequency modulation and demodulation.
13. Hybrid parameters of a transistor and design an amplifier. Determination of k/e ratio.
14. FET/MOSFET characteristics, biasing and its applications as an amplifier.
15. To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject passive filter.

Unit II

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}Kusing G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials
4. To find range and energy of β- particles
5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI(Tl) scintillation detector
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer.
9. Study of Compton scattering law for energy of scattered photons
10. To study Internal Conversion Coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of the spectrum of ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photon energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillation detector.

Unit III

Computational experiments using computer programming

1. Finite and infinite series
2. Root finding: (bisection, Secant and Newton-Raphson methods)
3. Solving first and second order ordinary differential equations including simultaneous
Equations (Euler and Runge-Kutta methods)
4. Numerical integration (trapezoidal, Simpson, Gauss quadrature, methods)
5. Matrices (arrays of variable sizes, addition, multiplication, Eigen values, eigenvectors, inversion, solutions of simultaneous equations).

Course Outcomes:

1. Student will know about the variation of count rate with applied voltage and thereby determine the plateau, the operating voltage and slope of plateau (G M Counter).

2. With labs, student will know the practical knowledge of physics

applications.
Assessment Model: Total Assessment (Out of 30 Marks).
Preferred Reading: 1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press, New Delhi (1988). 2. B.K. Jones, Electronics for Experimentation and Research, Prentice-Hall (1986). 3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, Tata Mc-Graw Hill, New Delhi (1989).
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-206	SEMINAR-II	0	0	3	3
Prerequisites: Student must know little knowledge of MS-Word for making a presentation.					
Course Objectives: This course makes a unique component of the curriculum. It is mandatory for every student to deliver a seminar of approximately 40 minutes duration on a topic as decided by the departmental seminar committee.					
Every students need to give three presentations topics of any subjects of Physics.					

Course Outcomes: 1. Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge. 2. Would help students in developing better communication skills and higher level of confidence.
Assessment Model: Total Assessment (Out of 100 Marks).
Preferred Reading: All books which is related to physics application and laboratory.
Web Resources:

M.SC. PHYSICS, SEMESTER-IV

Course Code	Course Title	L	T	P	Credit
PPY-251	PHYSICS OF NANO MATERIALS	4	0	0	4
Prerequisites: Include general knowledge in chemistry, physics and material science.					
Course Objectives: The aim and objective of the course on Physics of Nano-materials is to familiarize the students of M.Sc. Physics to the various aspects related to preparation, characterization and study of different properties of the nanomaterials so that they can pursue this emerging research field as career.					
UNIT I (3 Questions). **Introduction to nanomaterials**: Definition, reason for interest in nanomaterials, classification of nanostructures – 1D, 2D and 3D confinement.					

Overview of semiconductors: Electronic band structure, concept of the effective mass, optical processes, direct and indirect band gap semiconductors, exciton formation, super lattice – hetero structure.

Quantum size effect: Quantum confinement in one dimension: quantum wells, Electron confinement in infinitely deep square well square, square well of finite depth, optical absorption in quantum well in the case of hetero structure consisting of thin layer of GaAssandwiched between thick layers of AlGaAs. Quantum confinement in 2 dimensions: quantum wires, Quantum confinement in 3dimensions: quantum dots.

Tunnelling transport: T-matrices for potential step and square barrier, current and conductance. Resonant tunnelling.

Unit II (3 Questions)

Methods for preparation of Nano-materials: Bottom Up: Nano Particles (metal and semiconductor) – nucleation – growth – chemical bath deposition – capping techniques. Nano Structures: quantum dots, quantum well structures- Thin film deposition techniques, molecular beam epitaxy methods of growth -MOVPE – MOCVD. Physical vapour deposition for nano particles.

Top Down: Ball milling: details, size and time of milling, shaker mills, planetary mills, attrition mills. Electron Beam, Lithography – resists- use of positive and negative resists-lift of process. Ion-beam lithography-main chemical reaction – use. Self assembled molecular materials: principles of self-assembly – micellar and vesicular polymerization – self organizing inorganic nano particles. Langmuir Blodgett techniques. Carbon nano tubes (CNT)- Synthesis, Properties and Applications.

Unit III (2 Questions)

Characterization of nanomaterials: Diffraction techniques: X-ray Diffraction (XRD) – Crystallinity, particle/crystallite size determination and structural analysis.

Microscopic techniques: Scanning Electron Microscopy (SEM) – Morphology, grain size and EDX; Transmission Electron Microscopy (TEM) – Morphology, particle size and electron diffraction.

Scanning probe techniques: Scanning Tunnelling Microscopy (STM) – surface imaging and roughness; Atomic Force Microscopy (AFM) - surface imaging and roughness; other scanning probe techniques.

Course Outcomes:

1. Students will have achieved the ability to explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
2. Students would have the ability to compare the properties of nanostructures with their characteristics of scale, form and surface and understand the improved sensitivity of sensors based on nanomaterials.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks

• End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1. Introduction to Solid State Physics, Charles Kittel, VII edition, 1996. 2. Nano structured Materials-Processing, Properties and Applications, Edited by Carl. C. Koch, William Andrew Publishing, Norwich, New York, USA, 2004. 3. Nanoscale Science and Technology, Edited by Robert W Kersall, Ian W Hamley and Mark Geoghegan, John Wiley and Sons, UK, 2005. 4. Physics of Semiconductor Nanostructures, K P Jain, Narosa, 1997. 5. Nanotechnology: Molecular Speculations on global abundance, B C Crandall, MIT Press, 1996. 6. Physics of low dimensional semiconductor nanostructures, John H Davies, Cambridge University Press, 1997. 7. Nano Materials: Synthesis, Properties and Applications, Edited by A S Edelsteins, R C Cammarata, Institute of Physics Publishing, Bristol and Philadelphia, 1996. 8. Nano particles and nano structured films: Preparation, characterization and applications, Ed. J H Fendler, John Wiley and Sons, 1998. 9. Quantum dot heterostructures, D Bimerg, M Grundmann and N NLedentsoy, John Wiley and Sons.
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-252	NUCLEAR & PARTICLE PHYSICS-II	4	0	0	4
Prerequisites: Having introduced the basic structure of Nuclear & Particle					

Physics-I in the course PPY-202.

Course Objectives: One of the primary goal of nuclear physics, since from its inception, is to understand the exact nature of nuclear interaction and hence the structural and behavioural aspects of atomic nucleus. The nuclear scattering and reaction experiments are the most effective tools to achieve this goal.

UNIT I (3 Questions).

Interaction of nuclear radiation with matter: (a) Interaction of charged particles: Energy loss of heavy charged particles in matter, Bethe-Bloch formula, energy loss of fast electrons, Bremsstrahlung. (b) Interaction of gamma rays: Photoelectric, Compton, and pair production processes.

Nuclear size and shape: Methods for determining the nuclear radius, Wave Mechanical properties of nucleus and statistics, electric and magnetic moments and nuclear shapes

Nuclear forces: Characteristics of nuclear forces, Ground state of the deuteron using square well potential, relation between the range and depth of the potential, Inadequacies of the central force, experimental evidence for the tensor force, magnetic moment and quadrupole moment of the deuteron, deuteron ground state as an admixture of s and d states.

Unit II (3 Questions)

Nuclear models and Nuclear decay: Nuclear models: Liquid drop model: Semi-empirical mass formula, stability of nuclei against beta decay, mass parabola and Shell model: Evidence for magic numbers, prediction of energy levels in an infinite square well potential, spin-orbit interaction, prediction of ground states pin, parity and magnetic moment of odd-A nuclei, Nordheim's rules. **Beta decay:** Fermi's theory of beta decay, Kurie plots, selection rules. **Gamma decay:** Multi polarity of gamma rays, Selection rules, Internal conversion (qualitative treatment).

Nuclear detectors and Nuclear Reactions: Scintillation Detectors-NaI (Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li ion drifted detectors, relation between the applied voltage and the depletion region in junction detectors. Type of reactions, conversation laws. Q-values and its significance, Laboratory and Centre of mass coordinates and their relationship, reaction cross sections.

Unit III (2 Questions)

Elementary particle physics: Types of interactions between elementary particles, hadronsand leptons, detection of neutrinos. Symmetries and conservation laws: conservation of energy, momentum, angular momentum, charge and iso spin, parity symmetry, violation of parity in weak interactions - handedness of neutrinos, Lepton number conservation, Lepton family and three generations of neutrinos. Charge conjugation symmetry, CP violation in weak interactions, Strange particles, conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, eight fold way (qualitative only), quark model, quark content of baryonsand mesons.

Course Outcomes: After completing this course

1. The students will acquire the knowledge of various properties of strong nuclear interaction extracted through the scattering and reaction

experiments which in turn will help in understanding various nuclear models used to describe observed properties of atomic nuclei.
2. The course will provide the fundamental understanding of charge particle interaction, and the details of particle detectors and accelerators employed in particle physics.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Atomic and Nuclear Physics, S N. Ghoshal: Vol. II., 2000.
2. The Atomic Nucleus, Evans R. D.: Tata McGraw Hill, 1955.
3. Nuclear Physics, R. R. Roy and B. P. Nigam: Wiley-Eastern Ltd. 1983.
4. Nuclear Physics- an Introduction, S.B.Patel: New Age international (P) Limited, 1991.
5. Radiation Detection and Measurements, G.F. Knoll: 3rd edition, John Wiley and Sons,
2000.
6. Nuclear Radiation Detectors, S.S. Kapoor and V.S. Ramamurthy: Wiley-Eastern, New
Delhi, 1986. Nuclear Interaction, S. de Benedetti: John Wiley, New York, 1964.
7. Nuclear Radiation Detection, W.J. Price: Mc Graw Hill, New York, 1964.
8. Introduction to Elementary particles, D. Griffiths: John Wiley, 1987.
9. Elementary Particles, J. M. Longo, II Edition, Mc Graw-Hill, New York, 1973.
10. Introduction to Nuclear Physics, Wong, PHI.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-253	PROJECT	0	0	2	6

Prerequisites: Student must aware the entire topic and the applications related to physics.

Course Objectives: The aim of the project work is to expose the students to preliminaries and methodology of research in Theoretical Physics and Experimental Physics.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about at least 40 pages about the work done in the project (typed on single side of the paper and properly bound) will be submitted by a date to be announced by the departmental committee. Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per guidelines prepared by the committee.

Course Outcomes:

1. This course will introduce the students to preliminaries and methods of study.
2. It may consist of review of some research papers, creation of a laboratory experiment, fabrication of a system, working out some issue, participation in some ongoing research activity, analysis of data, etc.
3. In the thrust as well as non- thrust research areas of the department, project work could be in experimental physics or theoretical physics.

Assessment Model:

Total Assessment (Out of 100 Marks).

Preferred Reading:

All books which is related to physical sciences and laboratory.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-254	PAPER PRESENTATION	0	0	3	3

Prerequisites: Student must aware the entire topic related to their research.

Course Objectives: This course makes a unique component of the curriculum. It is mandatory for every student to give at least two paper presentation of approximately 40 minutes duration in the field of chosen specialization and on a topic as decidedby the departmental committee.

Initially assigned faculty members will describe about the types of research article (Letter, Review, Research Paper etc.) and tell about various component of a research article. Description about how to read a research articles? Every students need to give three presentation from research oriented topics of current interest (randomly picked up research papers or assigned by faculty members.

Course Outcomes:

1. Each and every student would get an opportunity to express his/her level of understanding of various concepts and this, apart from strengthening the subject knowledge, would help students in developing better understanding of research, communication skills and higher level of confidence.

Assessment Model:

Total Assessment (Out of 100 Marks).

Preferred Reading:

All books which is related to physical sciences and laboratory.

Web Resources:

ELECTIVE COURSES

Course Code	Course Title	L	T	P	Credit
PPY-271	CONDENSED MATTER PHYSICS: MATERIAL SCIENCES	4	0	0	4

Prerequisites: Students will need to have a sound foundation in quantum mechanics, statistical mechanics and electrodynamics because these are subjects that are commonly used/applied in more advanced topics repeatedly.

Course Objectives: This course aims to provide the students with a basic understanding of different kind of imperfections, deformation, strengthening mechanisms, different phase diagrams and phase transformations in solids.

UNIT I (3 Questions).

Formation and structure of materials: Introduction to Materials Science-Engineering materials - structure - property relationship, Review of ionic, covalent and molecular bindings, bond angle, bond length and bond energy, lattice energy - Madelung constant cohesive energy, van der Waal's Interaction-Lennard- Jones Potential, closed packed structure-packing efficiency and density of materials. Crystal imperfections: Review of crystalline imperfection, Schottky and Frenkel defects-Equilibrium concentrations, edge and screw dislocations, surface imperfections.

Unit II (3 Questions)

Elastics and plastics behaviour of materials: Atomic model of elastic behaviour-rubber like Elasticity-anelastic behaviour, viscoelastic behaviour, fracture of materials-Ductile and brittle fracture – Ductile brittle transition protection against fracture Plastic deformation by slip-shear strength of perfect and real crystals-CRSS ratio, maximum stress to move dislocation, methods of strengthening crystalline materials against plastic deformation-strain hardening, grain refinement, solid solution strengthening, precipitation strengthening.

Unit III (2 Questions)

Composite materials: Classification of composite materials, matrix materials-polymer, metals, ceramics, rein forcing materials- fibers, particles, concrete-concrete making materials,
structure, composition, properties and applications, polymer-concrete composites, fabrication,
structure, application of polymer matrix composites, metal matrix composites, ceramic matrix composites, metal matrix composites, ceramic-matrix

composites, carbon-fibre composites, fibre reinforce, particle reinforce composites with properties and applications.

Course Outcomes:

1. It describes the understanding of fundamentals of ion implantation technique for materials processing besides various ion beam based methods of material characterization.
2. Student will able to explain how the predicted electronic properties of solids differ in the classical free electron theory, quanta free electron theory and the nearly free electron model.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Elements of Materials Science and Engineering: Lowrence H. Van Vlack, Addison Wesley, (1975).
2. Introduction to Ceramics: W D Kingery, H K Bower and VR`uhlman, John Wiley, (1960).
3. Foundations of Materials Science and Engineering-William F. Smith, McGraw Hills International Edition, (1986).
4. Materials Science and Engineering, V. Raghavan, Prentice Hall (1993).
5. Structure & Properties of materials-vol I-IV Rose, Shepard and Wulff (1987).
6. Polymer Science, V. R Gowariker, N.V. Vishwanathan, Joydev Shreedhar, Wiley Eastern (1987).
7. Text of Polymer Science, Fred. W. Billmeyer, John Wiley and Sons, Inc. (1984).

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-272	FIBRE OPTICS AND OPTICAL COMMUNICATION	4	0	0	4

Prerequisites: This course is intended for beginners. However, a few concepts from high-school physics might be used in the earlier stages.

Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics of the challenging field of Fibre Optics and Optical Communications such as principle of fibre optics, mode theory, design optimization and fibre characterization.

UNIT I (3 Questions).

The Semiconductor Laser Diode and light Emitting Diode: General description, Laser structure, Excitation Mechanism 9Modes and threshold conditions, resonant frequencies, single mode lasers, modulation of diodes, temperature effects), Light source linearity.

Principle of fiber optics: Ray optics and wave propagation, Fiber types: step index and graded index fiber structures, Concepts of Mode field diameter, Numerical Aperture and propagation modes. Attenuation in fibers: units, absorption, scattering losses, bending losses, core and cladding losses.

Mode theory for circular wave guides: Wave guide equations, Wave equations for Single mode fibers, Model equation, Modes in Single mode fibers, Linearly polarized modes, Power flow in Single mode fibers. Signal distortion in optical wave-guides: Group delay, material & wave guide dispersion, mode coupling.

Unit II (3 Questions)

Design optimization & Fiber Characterization: Fiber optic materials and

characteristics comparison of coaxial cable and optical fibers. Optical time domain reflectometry (OTDR) as a loss measurement method. Source to fiber power launching: Source outputs pattern, Power coupling calculation, Equilibrium NA, Lensing scheme for coupling improvement: Non-imaging microsphere, LD to fiber coupling. Idea of connectors, couplers and splicing.
Principles of photo detection, Semiconductor photo detectors, Optical receivers. Noise, S/N ratio for optical power and signal currents, Background radiation, Jhonson noise, Dark current shot noise, I/f noise, Combined effect of all the noise sources. Digital signals and bit Error Rates.
Fundamentals of modulation schemes, Modulation spectral, Analog, Pulse, and Digital modulation schemes. Direct detection method & heterodyne detection receivers, Homodyne detection optical receiver, Modulation parameter convertors.

Unit III (2 Questions)

Elementary idea of Electro-optic modulation, Acousto-optic modulation.Modulation of semiconductor devices. Design issues in an fiber optics communication Link: Power budget, Time budget, Optical repeaters and amplifiers, The optical-fiber laser. Idea of soliton propagation in optical fibers.
Spatial filter: Concepts and its applications, Holograms: Construction, reconstruction, classifications and applications of holography. Laser Raman Spectroscopy: Basic consideration, linear, Non-linear and stimulated Raman Spectroscopy. Elementary idea of CARS and Self focusing phenomena.

Course Outcomes:

1. Recognize and classify optical fiber structures and forms and address the impairments of the channel, such as losses and dispersion.
2. Analyze and classify the optical sources and detectors and discuss their principle of multiple coupling losses.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Optical communication, M. Mukunda Rao, Universities Press (2000)
2. Optical Communication, Components & Systems, J.H. Frang & V.k. jain, Narosa (2001)
3. Essentials of Optoelectronics, Alan Rogers, (Chapman & Hall), 1997
4. Optical Communication System, W.K.Pratt. (1968)
5. Optical Fiber Communication by G.Keiser, 2nd ed. Mc GRaw Hill
6. Fundamental of Opto-electronics by C.R.Pollock, Irwin (1995)
7. Laser Electronics, J.T.Verdeyen, Prentice Hall (1995)
8. Lasers and Electro-Optics: Fundamental & Engineering C.C.Davis, Cambridge (1996)
9. Lasers fundamentals by W.T. Silfvast, Cambridge(1996)
10. Principles of lasers, O.Svetto, Plenum (1989)
11. Laser Physics, L.V.Tarasoy, Mir (1983)

12. Quantum Electronics, A. Yavir, John Wiley (1992)
13. Fundamentals of Photonics, Saleh & TEich, John Wiley (1992)
14. Laser: Theory & Applications, A. Ghatak & TAyagrajan Macmillan India
15. Introduction to Laser Physics, K. Shimoda, Springer (1986)
16. Lasers & non-linear Optics, B.B. Laud.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-273	EXPERIMENTAL TECHNIQUES IN PHYSICS	4	0	0	4

Prerequisites: NIL

Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics of the challenging field of Environmental Physics such as essentials of environmental physics, Solar and Terrestrial radiation, Environmental Pollution and Degradation, Environmental change, and Remote Sensing and Global and Regional Climate.

UNIT I (3 Questions).

Safety measures in Experimental Physics: Occupational health and safety, chemical substances, radiation safety, general electrical testing standards, General laboratory and workshop practice.

Physical measurement: Measurement, result of a measurement, sources of uncertainty and experimental error, Systematic error, random error, Reliability-chi square test, Analysis of repeated measurement, Precision and accuracy, Elementary data fitting.

Instrumentation Electronics: Transducers, Transducer characteristics, selection of a instrumentation transducer, Transduceras an electrical element, modelling external circuit components, circuit calculations, ac and dc bridge measurements.

Unit II (3 Questions)

Vacuum techniques: Units of pressure measurement, characteristics of vacuum, applications of vacuum, Vacuum pump: Rotary, oil diffusion, turbo molecular pumps, Ion pumps. Vacuum gauges: Pirani and Penning gauges. Pumping speed of a vacuum pump.

Thin film techniques: Thin film techniques (overview), film thickness monitors, film thickness measurement. Measurement of low temperature Resistance thermometers, thermocouples.

Unit III (2 Questions)

Thin film deposition techniques: thermal evaporation, sputtering, chemical and physical vapour deposition method, laser ablation, LB films, ELD films, spin coating

Basic principle, working and instrumentation of: Impedance spectroscopy, Raman, FTIR, UV/VIS/NIR, VSM.

Course Outcomes: Upon completion, students should be able to:
1. describe and explain the working principles of the various techniques
2. Identify the strength and limitation of each technique; therefore, choose the right technique for characterization of properties.
3. Know the operational details and interpret the data obtained by the techniques.

Assessment Model:
- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Measurement, Instrumentation and Experimental desigh in Physics and Engineering-
Michael Sayer and Abhai Mansingh, Prentice Hall of India 2005.
2. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington and K.D
Robinson, McGraw Hill, 2003.
3. Electronic Instrumentation- H.S. Kalsi, TMH Publishing Co. Ltd. 1997.
4. Instrumentation Devices and Systems-C.S. Rangan, G.R. Sharma, V.S.V. Mani, 2nd
Edition, Tata McGraw Hill, New Delhi, 1997.
5. Instrumentation Measurement Analysis-B.C. Nakra, K.K. Chaudhary.II.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-274	PHYSICS OF LASERS	4	0	0	4
Prerequisites:NIL					
Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics idea and principle for operating of a laser. It includes various characteristics of a laser and its associated phenomena. Students also got principle and working of various types of lasers.					
UNIT I (3 Questions). **Laser-Introduction:** Characteristics of laser beam, Spontaneous & Stimulated Emission, Stimulated absorption, Relationship of Einstein's coefficient, Ideas of Light amplification by an atomic system. Cavity radiations and modes (one, two and three dimensions), Origin of Line shape function, Broadening of spectral line: Homogeneous (natural and collisional) and Inhomogeneous (Doppler) broadening					

mechanisms, Threshold condition for oscillation, Laser oscillation and amplification in a homogeneous broadened transition and its Gain saturation. Laser oscillation and amplification in an inhomogeneous system, Multi-mode oscillation, Spatial hole burning (Lamb dip), Efficiency of laser (various factors).

Unit II (3 Questions)

Laser Rateand Gaussian beam: Population inversion & rate equations for three and four level laser systems. Variation of Laser power around threshold. Optimum output coupling. Gaussian beam and its properties Physical description of Lowest order modes,

Some laser systems: Ruby, He-Ne, Nd: YAG, Dye lasers, CO_2, Semiconductor lasers.

Resonators: Preliminary considerations of optical resonator, Energy stored in optical resonators, Different types of resonators. Different types of losses in optical resonators (Diffraction losses), coating losses, and transmission losses.

Unit III (2 Questions)

Non-linear Optics: Interaction of radiation with a dielectric medium, dielectric susceptibility, Harmonic generation, Second harmonic generation, Phase matching criterion, coherence length for second harmonic radiation, optical mixing, third harmonic generation, self-focussing of light, parametric generation of light, basics of 2^{nd} order and 3^{rd} order nonlinear optics (fundamentals and important concepts).

Course Outcomes:

1. Explain operating concepts and laser construction and specify optical components that can be used to customize the laser's properties.
2. Relate the laser operation principles to atom and molecular physics, solid state physics, quantum mechanics and physical optics.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Laser Electronics, J.T.Verdeyen, Prentice Hall (1995)
2. Lasers & Electro-Optics : Fundamental & Engineering C.C.Davis, Cambridge (1996)
3. Lasers Fundamentals By W.T. Silfvast, Cambridge (1996)
4. Principles of Lasers, O.Svetto, Plenum (1989)
5. Laser Physics, L.V.Tarasov, Mir (1983)
6. Laser: Theory & Applications, A. Ghatak & Tayagrajan, Macmillan India
7. Introduction to Laser Physics, K. Shimoda, Springer (1986)
8. Lasers and Nonlinear Optics: B.B,. Laud, 2/e, New Age International (P) Publishers, 2002.

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-275	ELECTRONIC CIRCUIT AND DEVICES-II	4	0	0	4
Prerequisites: Having introduced the basic structure of Electronic circuit and devices-I in the course PPY-104.					
Course Objectives: The aim of this course is to train students to a host of important electronic device being used in vital practical applications. OPAMPs, the basic building block of analog electronics, is included so that students can grasp the basics of OPAMP and are able to understand and analyse complex practical circuits.					

UNIT I (3 Questions).

IC Fabrication: Silicon planar process, crystal growth, wafer production, thermal oxidation, high pressure oxidation, concentration enhanced oxidation, chlorine oxidation, lithography & pattern transfer, etching process, factors affecting the etching process, HF-HN03 system, do pant addition, ion implantation, diffusion, diffusion in concentration gradient, Fick's Laws, diffusivity variation, Segregation, CVD, epitaxial and non-epitaxial films.

Monolithic IC technology, BJT Fabrication, PNP transistor, multi-emitter Schottky transistor, super beta transistor fabrication, Fabrication of FET/NMOS enhancement as well as depletion transistor, Fabrication of CMOS devices, Monolithic diodes, Clean rooms & their classifications.

Unit II (3 Questions)

Semiconductor memory devices: organizations, operations, Classification and characteristics of memories, read only memory(ROM organization, PROM, EEPROM), RAM (Bipolar RAM, MOSRAM), Memory Storage Cell(both Bipolar and MOS RAM),Digital display, Seven Segment Display, Charged Couple Device Memory, Applications

Fundamentals of Microprocessors: ideal microprocessor, data bus, address bus, control bus, ALU, Registers, program counters, flags, timing and control sections, microprocessor based system, basic operations.

Unit III (2 Questions)

Micro sensors: General principles-types of sensors; optical sensors, thermal sensors, pressure sensors, magnetic field measurements. Measurement and control: Signal conditioning and recovery. Impedance matching, Op-amp based, instrumentation amp. Positive and negative feedback, filtering and noise reduction, shielding and grounding. Lock-in detector-principle – example of PSD, box-car integrator principle– block diagram.

Course Outcomes:

1. Student will learn transducers strain gauge, thermostat, magneto resistive sensor and signal Conditions data acquisition & conversion.
2. This course covers semiconductor physics, computer physical concepts and their basic applications, passive and active filter analysis, OPAMP-based analog circuits, and introduction to different communication techniques.
3. Students will introduce integrated circuit technology basics, 8085 microprocessor design, instruction set, memory and I/O device interfacing.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Integrated Electronics, J. Millman and C.C. Halkias (TataMcGraw-Hill, New

Delhi) (2008)
2. Digital Computer Electronics, A.P. Malvino and J.A. Brown(Tata McGraw-Hill, New Delhi)(2008)
3. Modern Digital electronics, R. P. Jain (Tata McGraw-Hill, NewDelhi)(2006)

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-276	OPTOELECTRONICS	4	0	0	4

Prerequisites: Basic knowledge of electronics.

Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics of the challenging field of Optoelectronics such as operation of a laser and its basic processes involved. It also includes basic idea about nonlinear optics and laser spectroscopy.

UNIT I (3 Questions).

Pumping Processes: Optical pumping, conversion efficiency, and electrical pumping, Physical description of discharge. Excitation by Resonant energy transfer, Physical description, Excitation mechanism applications and structure of He-Ne, Ruby, Nd:YAG, Dye laser and CO2 laser. Index ellipsoid, Pockel's and Kerr effects, Pockel effect in KDP crystal: Longitudinal and elementary idea of transverse configuration, Elementary idea of magneto-optic effect and acousto-optic effect, Design of Q switching laser (theory), Theory of mode locking. Methods for Q-Switching and mode locking: electro-optic effect and acousto-optic effect.

Unit II (3 Questions)

Nonlinear Optics: Introduction to nonlinear optics, Maxwell's equation in nonlinear medium, Steady state and transient nonlinear optical effects (Brief idea), Slowly varying envelope approximation, Three wave mixing phenomenon: Second harmonic generation and Parametric amplification. Four wave mixing phenomenon: Brillouin scattering, Optical phase conjugation and Optical bi stability (elementary idea).

Unit III (2 Questions)

Laser spectroscopy: Advantage of lasers in spectroscopy, High sensitivity methods of absorption spectroscopy; frequency modulation, intra cavity absorption (using single mode and multi-mode operation), Fluorescence excitation spectroscopy, photo acoustic spectroscopy, laser induced fluorescence, Idea of laser magnetic Resonance.

Course Outcomes:

1. This course will introduce students to the basics of the demanding optical fibre research area.

2. Understanding basic light properties and operating principles of basic optical components and demonstrating a mastery of basic light generation mechanisms (including lasers) through a comprehensive understanding and review of operating principles, functionality, design architectures and trade-offs Lasers with semiconductors.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Quantum Electronics, A Yavir, Jphn Wiley (1992) .
2. Laser: Theory & applications, A. Ghatak & Tayagrajan, Macmillan India.
3. Lasers & Electro-Optics: Fundamental & Engineering C.C.Davis, Cambridge
4. Lasers Fundamentals by W.T. Silfvast, Cambridge (1996) .
5. Principles of Lasers, O. Svetto, Plenum (1989).

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-277	ENVIROMENTAL PHYSICS	4	0	0	4

Prerequisites: NIL

Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics of the challenging field of Environmental Physics such as essentials of environmental physics, Solar and Terrestrial radiation, Environmental Pollution and Degradation, Environmental change, and Remote Sensing and Global and Regional Climate.

UNIT I (3 Questions).

Essentials of Environmental Physics

Structure and thermodynamics of the atmosphere. Composition of air. Greenhouse effect and enhanced Greenhouse effect. Transport of matter, energy and momentum in nature. Stratification and stability of atmosphere. Law of motion, hydrostatic equilibrium. General circulation of the tropics. Elements of weather and climate of India.

Solar and Terrestrial radiation

Physics of radiation. Interaction of light with matter. Rayleigh and Mie scattering. Laws of radiation (Kirchhoff's law, Planck's law, Wien's displacement law, etc.).Solar and terrestrial spectra. UV radiation problem.IR absorption energy balance of the earth atmosphere system.

Unit II (3 Questions)

Environmental Pollution and Degradation

Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion. Factors governing air, water and noise pollution. Air and water quality standards. Waste disposal. Heat island effect. Land and sea breeze. Puffs and plume. Gaseous and particulate matters. Wet and dry deposition. Stability and vertical motion of air. Horizontal motion of air and water. Pressure gradient forces. Viscous forces. Inertia forces. Reynolds number.

Unit III (2 Questions)

Environmental change, and Remote Sensing and Global and Regional Climate

Energy sources and combustion processes. Renewable sources of energy. Solar energy, wind energy, bio-energy, hydropower, fuel cells, nuclear energy. Forestry and bio-energy. Energy balance-a zero-dimensional Greenhouse model. Global climate models.

Course Outcomes:

1. After the course, the student is expected to consider how it is possible to apply mathematics and physics to environmental areas.
2. This course acquired a basic understanding of the process used and has basic meteorological, hydrological and geophysical skills.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley)

2. J.T.Hougtyion: The Physics of Atmosphere (Cambridge University Press, 19
3. J.T. widell and J. Weir: Renewable Energy Resources (Elbs, 1988).
4. Sol Wieder: An Introduction of Solar Energy for scientists and Engineers (
1982).
5. R.N. Keshavamurthy and M. Shankar Rao: The Physics of Monsoons (Allied
1992).
6. K.L.Kumar: Engineering Fluid Mechanics (S. Chand, 1994).
7. Landau & lifshitz: Fluid Mechanics, Pergamon Press (2000).

Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-278	ASTROPHYSICS	4	0	0	4

Prerequisites: NIL

Course Objectives: The aim and objective of the course on Astrophysics is the basic understanding of the astronomical techniques. To understand the nature and structure of the universe from terrestrial planets to galaxies. To understand the celestial phenomena related with the origin of the universe, galaxies, stars and planetary systems along with the synthesis of elements by stellar and primordial nucleosynthesis. Finally, to explore the future evolution of the universe.

UNIT I (3 Questions).

Astrophysics and Astronomy, Celestial coordinate systems (Sun-Earth system, Galactic Coordinate system). Star formation, Stellar Magnitudes, Classification of stars, H-D classification, Saha Equation of ionization, Hertzsprung-Russel (H-R) diagram. Gravitational energy, Virial theorem, Equations of stellar structure and evolution. Pre-main sequence evolution, Jeans criteria for star formation, fragmentation and adiabatic contraction, Evolution on the main sequence, Post main sequence evolution, Polytropic Models: Lane-Emden equation, simple stellar models: Eddington's model and Homologous model, Convective and Radiative stars, Pre-main sequence contraction: Hayashi and Henyey tracks.

Unit II (3 Questions)

Newtonian theory of stellar equilibrium, White Dwarfs, Electron degeneracy and equation of States, Chandrasekhar Limit, Mass-Radius relation of WD. Neutron Stars, Spherically symmetric distribution of perfect fluid in equilibrium. Tolman-Oppenheimer-Volkoff (TOF) equation, Mass-Radius relations of NS. Pulsars, Magnetars, Gamma ray bursts. Black holes, Collapse to a black hole (Oppenheimer and Snyder), event horizon, singularity. Formation of Accretion Disks, Differentially rotation systems in Astrophysics, Disk dynamics, Steady Disks, Disk formation in close binary systems through mass transfer, Accretion onto compact objects (Black Holes and Neutron Stars).

Unit III (2 Questions)

Thermonuclear reactions in stars, pp chains and CNO cycle, Solar Neutrino problem, subsequent thermonuclear reactions, Helium burning and onwards, nucleosynthesis beyond iron, r- and s- processes. Qualitative discussions on: Galaxies, Nabulae, Quasars, Brown dwarfs, Red Giant Stars, Nova, Supernova.

Course Outcomes:

1. Understanding the celestial phenomena associated with the origin of the universe, galaxies, stars and planetary systems, together with the stellar and primordial nucleosynthesis synthesis of elements.
2. This course includes a fundamental knowledge of astronomical methods, an understanding of the existence and composition of the cosmos, from

earthly planets to galaxies, and an analysis of the possible evolution of the universe
Assessment Model: • Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks • Average of TWO Mid-Terms (50 Marks) – 20 Marks • Attendance – 5 marks • End-Term (100 Marks) – 50 marks Total Assessment (Out of 100 Marks)
Preferred Reading: 1. Textbook of astronomy and astrophysics with elements of cosmology, V.B.Bhatia, Narosa publishing house, 2001. 2. Astrophysics – Stars and Galaxies, K. D. Abhyankar, University Press, 2001. 3. Theoretical Astrophysics (Vols. I, II, III) – T. Padmanavan (CUP). 4. Black Holes, White Dwarfs and Neutron Stars – S.L.Shapiro and S.A.Teukolsky (John Wiley, 1983).
Web Resources:

Course Code	Course Title	L	T	P	Credit
PPY-279	SCIENCE OF RENEWABLE ENERGY SOURCES	4	0	0	4

Prerequisites: little knowledge of energy.

Course Objectives: The aim and objective of this course is to expose the M.Sc. students to the basics of the challenging field of Science of Renewable Energy Sources such as solar energy, hydrogen energy, etc. It also includes use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

UNIT I (3 Questions).

Introduction :Production and reserves of energy sources in the world and in India, need for
Alternatives, renewable energy sources.

Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photo electrochemical solar cells. Applications.

Unit II (3 Questions)

Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photo catalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

Unit III (2 Questions)

Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC. Geothermal energy, Biomass energy.

Course Outcomes:

1. Interpret the sources of electricity, understand the forms of energy and energy, and interpret solar energy.

2. Explain the plants for solar energy and the collectors of solar energy.
3. Interpreting geothermal energy and describing the development of geothermal fluid electricity.

Assessment Model:

- Average of best four Quizzes out of six Quizzes (25 Marks) - 25 Marks
- Average of TWO Mid-Terms (50 Marks) – 20 Marks
- Attendance – 5 marks
- End-Term (100 Marks) – 50 marks

Total Assessment (Out of 100 Marks)

Preferred Reading:

1. Solar Energy: S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.
2. Solar Cell Devices: Fonash (Academic Press, New York), 2010.
3. Fundamentals of Solar Cells, Photovoltaic Solar Energy : Fahrenbruch and Bube (Springer,
Berlin), 1983.
4. Photo electrochemical Solar Cells: Chandra (New Age, New Delhi).

Web Resources: