YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY FARIDABAD

SYLLABUS

M.Sc. PHYSICS

(w.e.f. 2016-2017)

2 Years(4 Semesters) Full time Programme

VISION AND MISSION OF THE UNIVERSITY

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

VISION AND MISSION OF THE DEPARTMENT

Vision:

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

Mission:

- To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.
- To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.
- To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.
- Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.
- To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

ABOUT THE PROGRAM

The M.Sc. programme in Physics aims to provide students with a sound knowledge of the principles of Physics which form a thorough basis for careers in Physics and related fields, enable students to develop insights into the techniques used in current fields and allow an in-depth experience of a particular specialised research area. In addition, the M.Sc Programme is meant to develop professional skills for students to play a meaningful role in industrial or academic life, and give students the experience of teamwork, a chance to develop presentation skills and learn to work to deadlines. The M.Sc. programme includes a number of lecture courses and Laboratory courses both relevant to the discipline and forward-looking with respect to recent developments and state-of-the-art achievements.

OBJECTIVE OF THE PROGRAM

The objective of the program is to prepare students for careers in University teaching and research. It also aims to develop thorough and in-depth knowledge of various subjects in Physics such as Electronics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, Lasers, Nanotechnology, etc. The M.Sc. Physics programme will also inculcate strong student competencies in Physics and its applications in a technology-rich, interactive environment.

Structure and Syllabi of
M. Sc. PHYSICS (Four Semesters) Course
(Effective from the Academic Session 2016-17)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHY 101	Mathematical Physics	4	0	0	40	60	100	4	DCC
PHY 102	Classical Mechanics	4	0	0	40	60	100	4	DCC
PHY 103	Quantum Mechanics-I	4	0	0	40	60	100	4	DCC
PHY 104	Electronic Devices and IC Technology	4	0	0	40	60	100	4	DCC
PHY 105	Electronics Laboratory-I	0	0	20	50	100	150	8	DCC
PHY 106	Seminar	2	0	0	50		50	0	DCC
Total Marks							**600**	**24**	

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHY 201	Atomic and Molecular Physics	4	0	0	40	60	100	4	DCC
PHY 202	Nuclear and Particle Physics	4	0	0	40	60	100	4	DCC
PHY 203	Condensed Matter Physics	4	0	0	40	60	100	4	DCC
PHY 204	Electrodynamics and Plasma Physics	4	0	0	40	60	100	4	DCC
PHY 205	Physics Laboratory-I	0	0	20	50	100	150	8	DCC
PHY 206	Seminar	2	0	0	50		50	0	DCC
	Audit Course	2	0	0	25	50	75	0	MAC
Total Marks							**675**	**24**	

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHY 301	Advanced Quantum Mechanics	4	0	0	40	60	100	4	DCC
PHY 302	Statistical Mechanics	4	0	0	40	60	100	4	DCC
PHY 303	Laser Technology	4	0	0	40	60	100	4	DCC
PHY 304	Microprocessor	4	0	0	40	60	100	4	DCC
PHY 305	Electronics Lab-II	0	0	20	50	100	150	8	DCC
PHY 306	Seminar	2	0		50		50	0	DCC
	Open Elective Course	3	0	0	25	50	75	3	OEC
Total Marks							**675**	**27**	

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHY 401A	Photonics	4	0	0	40	60	100	4	DEC
PHY 401B	Radiation Physics								
PHY 402A	Electronic Communication System	4	0	0	40	60	100	4	DEC
PHY 402B	Electronic Devices and Communication								
PHY 403A	Nano Science and Technology	4	0	0	40	60	100	4	DEC
PHY 403B	Computational Physics								
PHY 404A	Material Science	4	0	0	40	60	100	4	DEC
PHY 404B	Smart Materials								
PHY 405	Dissertation	2	0	0	50	150	200	8	DCC
Total Marks							**600**	**24**	

***Students have to select one specialization paper from each group or the course offered by the department from each group.**

Grading Scheme

*Percentage	Grade	Grade Points	Category
95-100	O	10	Outstanding
85-95	A+	9	Excellent
75-85	A	8	Very Good
65-75	B+	7	Good
55-65	B	6	Above average
45-55	C	5	Average
40-45	P	4	Pass
<	F	0	Fail
	AD	0	Absent

***Lower limit included, upper limit excluded**

The multiplication factor for CGPA is 10

1. Automatic Rounding
2. Average difference between actual percentage and CGPA percentage ± 2.5%
3. Worst case difference between actual percentage and CGPA percentage ± 5% if somebody in all the 8 semesters in all the exams (around 75 in numbers) consistently scores at the bottom of the range, say 55 of 55-65 which is a very remote possibility.

M.Sc. PHYSICS I SEM

PHY 101

SUBJECT NAME:MATHEMATICAL PHYSICS

NO OF CREDITS:4

L	P		
		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course has been developed to introduce students to some topics of mathematical physics which are directly relevant in different papers of Physics course. It includes elements of group theory, special functions, functions of a complex variable and calculus.

Unit I: Theory of functions of a Complex variable (12hrs)

Function of a Complex variable, Exponential functions, Logarithmic functions, Analyticity and Cauchy condition, Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, Harmonic functions, Cauchy's Integral Theorem, Cauchy's Integral formula, Taylor's Series and Laurent's series and expansion, Zeroes and Singular Points, Multi valued functions, Residues, Cauchy's Residue Theorem, Jordon's Lemma .

Unit II: Fourier Transform (12hrs)

Fourier Integral theorem, Fourier Sine, Cosine and Complex transforms with examples, Properties of Fourier transform, Fourier transforms of Derivatives, Parseval's theorem, Convolution theorem, Fourier transform of Integrals, Introduction to Fast Fourier Transform .

Unit III: Laplace Transform (12hrs)

Integral Transforms, Transforms of some Elementary Functions, Properties of Laplace transform, Transform of Derivatives, Transform of Integrals, Convolution theorem and its applications.

Unit IV: Matrices and Group theory (12hrs)

Matrices: Orthogonal, Unitary and Hermitian Matrices with examples, Independent elements of orthogonal and unitary matrices of order 2, Matrix diagonalization, Eigen values and eigenvectors, Fundamental of group theory: Definition of a group and illustrative examples, Group multiplication table, rearrangement theorem, cyclic groups.

COURSE OUTCOME

After the successful completion of the course, students would be able to

- handle mathematics that appears invariably in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.
- solve intense and rigorous mathematical problems involved in theoretical and experimental physics.

REFERENCE BOOKS:

1. Arfken: Numerical methods for Physicists
2. Pipes: Mathematics for Physicists and Engineers
3. Ghatak: Mathematical Physics
4. Boas: Mathematical Methods in Physical Sciences
5. M. Tinkam: Group theory and Quantum Mechanics

M.Sc. PHYSICS I SEM

PHY 102

SUBJECT NAME: CLASSICAL MECHANICS

NO OF CREDITS:4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of Lagrangian and Hamiltonian which allow simplified treatments of many problems in classical mechanics. The course aims to provide the foundation for the modern understating of dynamics.

Unit I: Lagrangian and Hamiltonian formulations (12 hrs.)
Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; The Hamiltonian Formalism:

Canonical formalism, Hamiltonian equations of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Rauthian procedure and equations,

Unit II: Poisson bracket and theory of small oscillations (12 hrs.)

Poisson bracket, special cases of Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications; Theory of small oscillations: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule, beyond small oscillations; the damped driven pendulum.

Unit III: Two-body central force problem and H-J theory (12 hrs.)

Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, the Laplace-Runge-Lenz vector,; H-J Theory: H-J equation and their solutions, use of H-J method for the solution of harmonic oscillator problem.

Unit IV: Introductory non-linear dynamics (12 hrs.)

Classical Chaos: Periodic motion, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic anharmonic oscillator and undamped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, bifurcation, driven-damped harmonic oscillator

COURSE OUTCOME

Students who have completed this course should

- Have a deep understanding of Newton's laws.
- Be able to solve the Newton equation for simple configurations using various method.,
- Understand the foundation of chaotic motion.
- Be familiar with the Lagrange & Hamilton equation.
- Be able to apply the Variational principles to real physical problems.
- Be able to model mechanical system, both in inertial & rotating frames, using Lagrange and Hamilton equations.

REFERENCE BOOKS:

1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko, Pearson Edition

2. Classical Mechanics of particles and rigid bodies by K. C. Gupta

3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor

4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajaseka

M.Sc. PHYSICS I SEM

PHY 103

SUBJECT NAME: QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To develop familiarity with the physical concepts and facility with the mathematical methods of quantum mechanics. To encourage the development of self-discipline and work habits that are useful both in academic course work and in the real world.

UNIT-I: General formalism of Quantum Mechanics (12hrs)

Overview of Linear Vector Space, Basis, operators, Interpretative postulates of quantum mechanics, Dirac Notations of Bra and Ket, Matrix Representation of Observables and States, Determination of Eigen values and Eigen functions of Observables, orthogonality, completeness. Hilbert space representation, Matrix Representations, Change of Representation and Unitary Transformation, Co-ordinate and Momentum Representations, Equations of Motion in Schrodinger and Heisenberg Pictures.

UNIT-II: Theory of Angular Momentum (12hrs)

Orbital angular momentum operator L, Cartesian and spherical polar co-ordinate representation, Commutation Rules for Angular Momentum, Eigen values and Eigen functions of L^2 and L_z General angular momentum operator J Eigen values and Eigen functions of J^2 and J_z Matrix Representation of Angular Momentum Operator, Spin angular momentum, Wavefunction including spin(Spinor), spin one half: spin Pauli Spin Matrices.

UNIT-III: Scattering (12hrs)

Differential and Total Cross-Sections, Laboratory and center of mass frame, Theory of Partial Wave and Calculation of Phase Shifts in Simple Cases, Integral Form of Scattering Equation, Born Approximation, Its Validity and Simple Applications.

UNIT-IV: Perturbation Theory (12hrs)

Perturbation Theory of Non-degenerate Systems with first order correction, Application to Normal He Atom, Zeeman Effect, Perturbation Theory for Degenerate Systems, First order correction, Stark Effect in H-Atom, Time Dependent Perturbation Theory, Fermi's Golden Rule and Example of Harmonic Perturbations.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Connect the historical development of quantum mechanics with previous knowledge and learn the basic properties of quantum world with development aspects of quantum mechanics.
- understand and explain the differences between classical and quantum mechanics
- understand the idea of wave function, Schrödinger representation, spot, identify and relate the eigenvalue problems for energy, momentum, angular momentum and central potentials explain the idea of spin.

REFERENCE BOOKS:

1. Ghatak & Lokanathan: Quantum Mechanics
2. Schiff: Quantum Mechanics
3. Dirac: Principles of Quantum Mechanics
4. Sakurai: Modern Quantum Mechanics
5. Das and Melissinos: Quantum Mechanics - A Modern Introduction

M.Sc. PHYSICS I SEM

PHY 104
SUBJECT NAME: ELECTRONIC DEVICES AND IC TECHNOLOGY
NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

This course is designed to understand the basics of transistors and their applications as amplifiers in CB, CE and CC configuration. Designing of simple circuits like amplifiers (inverting and non inverting), comparators, adders, integrator and differentiator using op-amps will be discussed.
The second part of the course will give an introduction to digital electronics in which the different building blocks in digital electronics using logic gates and implementation of simple

logic function using basic universal gates will be covered. The concepts of RAMs, ROMs, memory, Flip flops, counters etc will be discussed in brief.

Unit I: Semiconductor Devices and Fabrication of ICs (12 hrs)

Metal/Semiconductor Contact, MOS Junction (Accumulation, Depletion and Inversion), Interface States and Their Effects, Fabrication of ICs, monolithic Integrated Circuit Technology, planar process, Fabrication of Bipolar Transistor, Resistor, capacitor, FET.

Unit II: Bipolar junction transistor and Field effect transistor (12 hrs)

PNP and NPN transistors, basic transistor action, emitter efficiency, base transport factor, current gain, input and output characteristics of CB, CE and CC configurations, Construction of JFET, Idea of channel formation, pinch off and saturation voltage, current voltage output characteristics.

Unit III: Op-Amp (IC-741) and 555 Timer (12 hrs)

DC coupled amplifiers, common mode rejection ratio, Block Diagram of Op-Amp, Input offset voltage, Input bias current, Slew Rate, Frequency Response and Compensation, Feedback in amplifiers, Inverting and non inverting amplifiers, Linear application of op amp: summing, difference, Integration, differentiator, Non-Linear application of op amp: Comparator, Zero crossing detector, Schmitt trigger

555 Timer: 555 Timer – Description and block diagram - Monostable operation, Astable operation

Unit IV: Digital Circuits and Systems (12 hrs)

Binary Adders, full adder and half adder, serial and parallel adders, binary subtractor, Digital comparator, BCD to decimal Decoder, multiplexer, Demultiplexer, Memory Concept, RAM, ROM, PROM, EPROM, EEPROM, Flip-Flops: SR, JK, Master Slave, D Type, T Type, Shift register, Asynchronous counter, Up-Down counter, Divided by N counter.

COURSE OUTCOMES

- Learn how operational amplifiers are modeled and analyzed, and to design Op-Amp circuits to perform operations such as integration, differentiation and filtering on electronic signals.
- Design and Verify the operation of amplifiers and comparators
- Convert numbers from one system to the other and employ Boolean algebra to describe the function of logic circuits.

REFERENCE BOOKS:

1. Bransden and Joachain: Physics of Atoms and Molecules
2. Thyagarajan and Ghatak: Lasers - Theory and Applications
3. Cagnac and. Pebay-Peyroula: Modern Atomic Physics

4. White: Introduction to Atomic Spectra
5.Kuhn: Introduction to Atomic Spectra

MSc PHYSICS I SEMESTER LAB

ELECTRONICS LAB I

PHY 105

COURSE OBJECTIVE

This course is designed to provide students with fundamental concepts of Electronic Circuits for lab experience. Transient analysis and frequency response of Single and Multistage BJT and FET Amplifier. Study of operation of Oscillators and Waveform generators like multivibrators and Schmitt trigger. Study the various applications of op-amp and flip flops.

Students assigned the electronic laboratory work will perform at least 8 experiments of the following

1. To design full adder and full subtractor and verify its truth table using logic gates.
2. To design JK Flip flop and realize up down counter using it.
3. To study negative feedback in op amp (summing/difference.
4. To construct an astable multivibrator using transistor and to determine the frequency of oscillation.
5. To design basic comparator and Zero crossing detector using 741 op amp.
6. Application of op-amp as an integrator/differentiator amplifier.
7. To design an astable and monostable multivibrator using 555 timer.
8. To study the common emitter transistor using npn transistor.
9. To study Zener diode as a voltage regulator.
10. To design 4 bit shift register using JK Flip flop.
11. To design multiplexer/demultiplexer.

COURSE OUTCOMES

• Verify the working of diodes, transistors and their applications.
• Build a common emitter/base/collector amplifier and measure its voltage gain.
• Understand the use of CRO.
• Explore the operation and advantages of operational amplifiers.
• Learn to design different types of filters and apply the same to oscillators and amplifiers.
• Exploring the circuitry which converts an analog signal to digital signal.

M.Sc. PHYSICS II SEM
PHY 201
SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS
NO OF CREDITS: 4

L	P		
		SESSIONAL:	40
		THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the fundamentals of atomic and molecular physics. To provide a coherent and concise coverage of traditional atomic and molecular physics.

UNIT-1: Atomic Physics (12hrs)

Fine structure of hydrogen atoms-mass correction, Spin orbit term, Darwin term, Intensity of fine structure lines, ground state of two electron atoms-perturbation theory and variation method. Many electron atoms- LS and jj coupling schemes, Lande interval rule. Terms for equivalent & non-equivalent electron atom. Space Quantization: stern Gerlach experiment, normal & anomalous Zeeman effect, Stark effect, Paschen-Back effect; Intensities of spectral line: General selection rule, Hyperfine Structure, Isotope Shifts and Nuclear Size Effects.

UNIT-II: Molecular Structure(12hrs)

Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronic structure of diatomic molecules. Description of Molecular Orbital and Electronic Configuration of Diatomic Molecules: H_2, H_2^+. Co-relation diagram for heteronuclear molecules.

UNIT-III: Molecular Spectra(12hrs)

Rotation, Vibration-rotation and electronic spectra of diatomic molecules. The Franck Condon Principle. Raman Spectroscopy: Introduction, pure rotational Raman Spectra, vibrational Raman spectra, Nuclear spin and intensity alternation in Raman spectra, Isotope effect and Raman spectrometer. Dissociation and pre dissociation, Dissociation energy, Rotational fine structure of electronic bands.

UNIT-IV: Resonance Spectroscopy(12hrs)

NMR: Basic principles- classical and quantum description-Bloch Equation-spin-spin ans spin-lattice relaxation times-chemical shift and coupling constant- experimental methods-single and double coil methods; ESR: Basic principles, ESR Spectrometer-nuclear interaction and hyperfine structure-relaxation ects-g factor.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Apply general considerations of quantum physics to atomic and molecular system; make general orders of magnitude of estimation of physical effects.
- Explain how light interacting with atom and effect of magnetic field on the spectrum.
- Recognize the general features of Atomic/Molecular spectroscopy and its application in real world.

REFERENCE BOOKS:

1. **Millman and Halkias: Integrated Electronics**
2. **Gayakwad: OP-AMPS and Linear Integrated Circuits**
3. **Jacob Millman and Arvin Grabel: Microelectronics**

M.Sc. PHYSICS II SEM
PHY 202
SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

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

Unit I: Detectors and Accelerators (12hrs)

Interaction of Nuclear Radiations with matter; Interaction of charged Particles and of Gamma Rays with matter, Stopping power of Heavy charged particles Range and Straggling, Absorption of Gamma- Rays, the P.E effect , Compton Effect and Pair production, Nuclear detectors for high Energy Physics, Spark Chamber Cerenkov Detector, GM counter, Scintillation detector

Unit II: Nuclear Reaction (12hrs)

Types of Nuclear Reactions, Nuclear Reaction Kinematics, Nuclear transmutations, Transmutations by alpha particles, protons, neutrons, deuterons, etc, Nuclear Cross section, Expression for Scattering and Nuclear Cross-section, Reaction Mechanism- Direct and Compound nuclear reactions, Compound Nucleus theory, Energy levels of nuclei, Continuum Theory of Nuclear Reaction, Resonance cross- sections, Breit-Wigner Dispersion Formula.

Unit III: Radioactive decay and Nuclear forces (12hrs)

Alpha particles, their charge to mass ratio, range, energy, Gamow's Theory of Alpha-Decay, Fermi's Theory of Beta-Decay, Curie's Plots; the neutrino, its detection and properties, Gamma Radiation, measurement of Gamma-Ray energy, Deuteron problem; neutron-proton and proton-proton scattering at low energies; Partial wave Analysis, Shape Independent effective range theory in n-p scattering.

Unit IV: Particle Physics (12hrs)

Units of high energy physics, Classification of particles-fermions and bosons, Particles and antiparticles, Strange particles, Basic idea of different fundamental types of interactions with suitable examples, Quarks flavors and their quantum numbers, Quarks as constituents of Hadrons

COURSE OUTCOME

After the successful completion of the course, students would be able to

- describe the basic interaction mechanisms for charged particles and electromagnetic radiation relevant for radiation detectors.
- explain the importance of detecting various types of ionizing radiations at different energies.
- explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- describe the basic features involved in alpha and beta decays, nuclear forces and various kinds of nuclear reactions besides the fundamentals of elementary particle physics.

REFERENCE BOOKS:

1. **Preston and Bhaduri: Nuclear structure**
2. **Pal: Nuclear structure**
3. **Wong: Introductory Nuclear Physics**
4. **R.M Singru: Introduction to experimental Nuclear Physics**
5. **Tayal: Nuclear Physics**

M.Sc. PHYSICS II SEM
PHY 203
SUBJECT NAME: CONDENSED MATTER PHYSICS
NO OF CREDITS: 4

L	P		
		SESSIONAL:	40
		THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Our objective is to train students in the field of condensed matter physics and materials science. The course gives an introduction to the physics of condensed matter, including crystalline and amorphous solids. The concepts of lattice, crystal structure, reciprocal lattice, phonon, Fermi surface, Brillouin zone, metal and semiconductor theory and properties will be taught. The use of more sophisticated models of electron behaviour in a periodic potential, such as the tight binding model, to explain the electronic structure of materials will be done qualitatively and quantitatively. Quantum Hall phenomena in two dimensional electron gas systems will also be described.

Unit I: Symmetry and Reciprocal Lattice
crystal symmetry elements, concept of point group, the twenty three symmetry elements in a cubic crystal, fivefold rotation axis is not compatible with the lattice, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, reciprocal lattice, reciprocal lattice for sc, reciprocal lattice for fcc, reciprocal lattice for bcc, Bragg's law in direct and reciprocal lattice, crystal structure factor for bcc, crystal structure factor for fcc, atomic form factor, Intensity of diffraction maxima, extinction due to lattice centering.

Unit II: Lattice Vibration
The concept of lattice modes of vibration, elastic vibrations of continuous media, vibration of one dimensional monoatomic linear lattice, vibration of one dimensional diatomic linear lattice, particle displacement in two branches, wavelength limit of acoustic phonons, concept of phonons, inelastic scattering of photons and phonons, inelastic scattering of X rays by phonons, inelastic scattering of neutrons by phonons, electron phonon interaction, polarons, electron-electron interaction,

Unit III: Electronic Properties of Solids
Electrons in periodic potential, Kronig Penny model for band theory, brillouin zone, reduced zone, effective mass, physical interpretation of effective mass, distinction between metals, semiconductors and insulators, density of state function, density of electrons in conduction band, density of holes in valence bands, Donor and acceptor impurities in n-type and p-type semiconductors,

UNIT IV: Methods To Evaluate The Energy Levels

Tightly bound electron approximation method, application to simple cubic lattice, wigner-seitz approximation, pseudo potential method, Ferrmi surface, experimental methods in Fermi surface studies: quantization of orbits in magnetic field, de Hass van Alphen effect, Fermi surface of copper, Cyclotron resonance, Quantum Hall effect, direct absorption process, indirect absorption process.

COURSE OUTCOMES

- Recognize common crystal structures and describe their symmetries.
- Describe diffraction using the reciprocal lattice
- Determine the structure of crystalline materials by x-ray diffraction
- Use models to calculate dispersion relations for acoustical and optical phonons.
- Perform band structure calculations for simple systems in the weak potential- and in the Linear Combination of Atomic Orbitals approximations
- Describe the formation of band-structure in crystals.
- Describe the experimental methods to understand the Fermi surface in crystals.

REFERENCE BOOKS:

1.Introduction to Solid State Physics : Charles Kittel
2. Solid State Physics : A J Dekker
3. Solid State Physics: Saxena, Gupta, Saxena
4. Solid State Physics: S.O. Pillai

M.Sc. PHYSICS II SEM

PHY 204

SUBJECT NAME: ELECTRODYNAMICS AND PLASMA PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVES

To evaluate fields and forces in Electrodynamics and Magneto dynamics using scientific method and to provide concepts of relativity and its applications in branches of physical sciences.

Unit I: Electrostatics (12 hrs.)
Electric Field, Gauss Law, Differential form of Gauss Law, Electromagnetic scalar and vector potentials, Maxwell’s equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge. Boundary value problem, Poisson and Laplace equations, Solution of Laplace equation in Rectangular coordinates, Green’s Theorem, Dirichlet and Neumann boundary conditions, Formal solution of boundary value problem with Green’s function, Electrostatic potential energy and energy density.

Unit II: Polarization (12hrs)
Linear, elliptical and circular Polarization, Direction cosines. Reflection and refraction of place waves: Reflection by a perfect conductor – normal and oblique incidence. Reflection by a perfect dielectric – normal and oblique incidence. Power loss in a plane conductor. Dispersion and Scattering; Coherent and Incoherent Scattered Light, Polarization of Scattered Light, Dispersion in Solids, Liquids and gases.

Unit III: Electromagnetic Waves and Radiation by Moving Charges (12 hrs.)
Wave equation, Reflection and Refraction of electromagnetic waves at a plane interface between dielectrics, Wave propagation in a non-conducting and conducting media, Fresnel relations, Brewster's angle, Wave guides: TE and TM modes in rectangular wave guides; Moving point charges, Retarded potentials, Lienard-Wiechart potentials for a point charge, The fields of moving charge particles, Total power radiated by a point charge: Larmor’s formula and its relativistic generalization.

Unit IV: Plasma Physics (12 hrs.)
Elementary concepts, Derivation of moment Equations from Boltzmann Equation, Plasma Oscillation, Theory of simple oscillation, Electron oscillation in a plasma, Electronic oscillations when the motion of ions is also considered. Derivation of plasma oscillation using Maxwell's equation, Propagation of Electro-magnetic waves in plasma containing a magnetic field Quasineutrality of plasma, Debye shielding distance, Plasma production and heating of the plasma, Confinement of plasma, plasma instabilities.

COURSE OUTCOME

Students who have completed this course should

- Have a deep understanding of the theoretical foundations of electromagnetic phenomena.
- Be able to solve the Maxwell equation for simple configuration.
- Have a working knowledge of special theory of relativity.
- Be familiar with electrostatics and magneto statics.
- Be able to analyzes radiation system in which the electric dipole, magnetic dipole or electric quadruple dominate.

REFERENCE BOOKS:

1.Classical Electrodynamics by J.D. Jackson.
2.Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.
3.Electrodynamics by S. P. Puri.
4.Introduction to Electrodynamics by D. J. Griffiths.

CODE: PHY 205

SUBJECT NAME: **PHYSICS LAB II**

		SESSIONAL:	50
L	P	THEORY EXAM:	100
0	20	TOTAL:	150

Students assigned the general laboratory work will perform at least 8 experiments of the following:

COURSE OBJECTIVE

To develop the domain knowledge in the fields of physics by extending knowledge and processes used by physics which produced new and exciting technologies in everyday use.

1. To determine the Ionization potential of Lithium.
2. Determination of range of Beta-rays from Ra and Cs using GM Counter.
3. Measurement of resistivity of a semiconductor by four-probe method at different temperature and determination of band gap.
4. Determination of Lande's factor of DPPH using ESR spectrometer.
5. Determination of Hall coefficient of a given semiconductor and estimation of charge carrier concentration.
6. Study of Faraday effect using He-Ne Laser. To determine the angle of rotation as a function of the mean flux density using different colour filters. To calculate the corresponding Verdet′s constant in each case and to evaluate Verdet′s constant as a function of the wavelength.
7. Determination of dislocation energy of Iodine molecule by photography the absorption bands of I_2 in the visible region.
8. Determination of the wavelengths of the most intense spectral lines of He and Hg (two electron System).
9. Determination of e/m of electron by normal Zeeman effect using Febry Perot Etalon.

10. To verify the Compton scattering formula, derived from the quantum theory of electromagnetic radiation, and as a consequence, the mass of the electron will be determined.
11. To understand how electric and magnetic fields impact an electron beam and experimentally determine the electron charge-to-mass ratio.

12. To determine the hysteresis loss by C.R.O, use a hysteresis curve to measure the power loss of an iron core transformer • for comparison, measure the loss for a ferrite core transformer • estimate the curie point for ferrite.

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

On successful completion of this course, students should be able to

- To utilize the scientific method for formal investigation and to demonstrate competency with experimental methods that are used to discover and verify the concepts related to content and research knowledge.

M.Sc. PHYSICS III SEM
PHY 301

SUBJECT NAME: ADVANCED QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The aim of the course is to introduce students to the basics of relativistic quantum mechanics, classical and quantum field theories and quantum theory of radiation. The course is planned as a continuation of Quantum Mechanics course taught in first semester.

Unit I: Foundation of Quantum Mechanics (12hrs)

Development of Old Quantum theory, Quantum picture of Material particle, Equation of motion of matter waves, Normalized and orthogonal wave functions, Solution of the Schrodinger wave equation, The uncertainty principle, The free particle, Particle in one and three dimensional infinitely deep potential well, one dimensional harmonic oscillator.

Unit III: Relativistic Quantum Mechanics (12hrs)

Klein Gordon Equation, Klein Gordon equation in Electromagnetic field, Dirac's relativistic equation, Electromagnetic potentials: Magnetic moment of the electron, Negative energy solution, Anti-particles

Unit IV: Identical Particles (12hrs)

Introduction, Symmetrical and Antisymmetric wave function, Symmetrization postulate, Particle Exchange operator, Distinguishability of Identical particles, The Pauli's Exclusion principle, Slater determinant, Central Field Approximation, Hartee's Self consistent field approximation.

Unit V: Field Quantization(12hrs)

The Classical approach to Field theory, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field, The Lagrangian and Hamiltonian formulation, Creation, Annihilation and Number operators, Field and its canonical quantization, Quantization of Dirac Field. Hydrogen atom.

COURSE OUTCOME

After the successful completion of the course, students would be able to

- acquire working knowledge of relativistic quantum mechanics, second quantization and quantum theory of radiation.
- apply the techniques of quantum field theory in other branches of physics such as condensed matter physics, nuclear physics, particle physics etc.
- solve complex theoretical problems in astrophysics and metaphysics.

REFERENCE BOOKS:

1. Khanna: Quantum Mechanics
2. Lahiri and Pal: A first book on Quantum Mechanics
3. Griener: Quantum Mechanics
4. Liboff: Introductory Quantum Mechanics

M.Sc. PHYSICS III SEM

PHY 302

SUBJECT NAME: STATISTICAL MECHANICS
NO OF CREDITS: 4

L	P			
			SESSIONAL:	40
L	P		THEORY EXAM:	60
4	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

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. It makes use of the ensemble theory and covers both classical and quantum statistics. Generalization to systems of interacting particles is also considered. To demonstrate practical importance of the course, some simple applications from different branches of Physics are included.

Unit I: Ensembles: Review (12hrs)

Micro-canonical Ensemble, Entropy in Statistical Mechanics, Connection between Statistical and Thermo dynamical quantities, perfect gas in microcanonical Ensemble Partition function, Partition function and Thermo dynamical quantities, Gibb's Paradox, Canonical Ensemble , Perfect Monotonic Gas in Canonical Ensemble, Grand Canonical Ensemble, Perfect Gas in GCE

Unit II: Quantum Statistical Mechanics (12hrs)

Basic concepts, Postulates of Quantum Mechanics, Symmetric and Anti Symmetric Wave functions, Statistical Weight or a Priori Probability, Density Matrix, Bose Einstein Statistics, Fermi Dirac Statistics, Maxwell Boltzmann Statistics, Evaluation of constants α and β, Bose Einstein Gas and Bose Einstein (BE) Condensation, Maxwell Boltzmann distribution as a limiting case of BE distribution, Degeneracy and BE condensation, Correlation to Fermi Dirac gas.

Unit III: Statistical Mechanics of Interacting System (12hrs)

Theory of Imperfect Gases, Cluster Expansion of a Classical Gas, Mayer Cluster Expansion, Determination of Virial Coefficients, Equation of state, Linear Harmonic and Anharmonic oscillators..

Unit IV: Low Temperature Physics (12hrs)

Production and Measurement of Low temperature, Helium I and Helium II, Some Peculiar properties of Helium II and their Explanation, Landau theory, London's Theory, Ising Model .

COURSE OUTCOME

Students who have completed this course should

- Have a deep understanding of physical statistics and its relation to information theory,
- Be able to solve statistical mechanics problems for simple non –interacting system,
- Have a basic understanding of the phase transition,
- Be able to use linear response theory and kinetic equation approach,
- Be able to work out equation of state and thermodynamic potentials for elementary system of particle.

REFERENCE BOOKS:

1. Patharia: Statistical Mechanics
2. Huang: Statistical Mechanics
3. Ma: Statistical Mechanics
4. Landau and Lifshitz: Statistical Mechanics

CODE: PHY-303

SUBJECT NAME: **LASER TECHNOLOGY**

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

To understand the basic laser fundamentals, unique properties of the laser, types of practical lasers and laser safety, and industrial applications of high and low power lasers.

Apart from this, topics of current research interest will be also discussed, such as laser cooling and trapping which plays an important role in the realization of Bose-Einstein condensate in atomic vapors.

Unit-I: Basic Principle and Different Lasers (12hrs)

Laser characteristics : Spontaneous and Stimulated Emission, Absorption, Laser Idea, Pumping Schemes, Properties of Laser Beams : Monochromativity, Coherence, Directionality, Brightness, radiative transition and Amplified Spontaneous Emission, Non-radiative delay, Resonator, rate equations, Methods of Q-switching

Unit-II: Types of Lasers (12hrs)

Principle and Working of CO_2 Laser , Semiconductor Laser. Homostructure and Heterostructure P–N Junction Lasers, Nd-YAG Lasers. Principle of Excimer Laser. Principle and Working of Dye Laser. Free Electron Laser. Photo detector p-n diode, nano laser

Unit-III: Non-Linear Processes (12hrs)

Propagation of Electromagnetic Waves in Nonlinear Medium, Self-Focusing, Phase Matching Condition, Fibre Lasers, Stimulated Raman Scattering, and Raman Lasers, CARS, Saturation and Two Photon Absorptions.

Unit IV: Novel Applications of Laser (12hrs)

Cooling and Trapping of Atoms, Principles of Doppler and Polarization Gradient Cooling, Qualitative Description of Ion Traps, Optical Traps and Magneto-Optical Traps and Bose Condensation, Applications of Laser. Applications in biomedical, military and cosmetics.

COURSE OUTCOME

On successful completion of this course, students should be able to:

- Extend comprehensive knowledge, including of recent developments, concerning: solidstate lasers (including diode-laser pumped devices), semiconductor lasers, fibre lasers, vibronic and other tuneable lasers, organic lasers, laser amplifiers, and newly emerging gain media.
- Understand important aspects of laser active media as linewidth determining processes, dispersive/gain properties, spatial and frequency hole-burning.
- Practical applications of lasers in daily life

REFERENCE BOOKS:

1. Demtroder: Laser Spectroscopy and Instrumentation
2. Svelto: Principles of Lasers
3. Ghosh: Laser Cooling and Trapping

4. Sengupta: Frontiers in Atomic, Molecular and Optical Physics.
5. Laud: Laser and nonlinear optics

PHY 304
SUBJECT NAME: MICROPROCESSOR

NO OF CREDITS: 4

L	P		
		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The objective of this course is to become familiar with the architecture and the instruction set of an Intel microprocessor 8086. Assembly language programming will be studied as well as the design of various types of digital and analog interfaces. The student will be able to draw a block diagram of a simple computer consisting of a processor, RAM and ROM memory, ports, and the buses that interconnect these components

UNIT I : Introduction to Microprocessor and 8085 Microprocessor (12hrs)

Microprocessor evolution and types, Architecture, Microprocessor and computer languages: machine language, assembly language and high level language, advantage of assembly language, introduction to 8085 microprocessor, internal architecture, Timing and control unit, registers, data and address bus, status flags, pin configuration, Applications of microprocessors

UNIT II: 8086 Microprocessor (12hrs)

Introduction to 8086, overview of 8086 microprocessor family, 8086 internal Architecture, stack segment register, stack pointer registers, Accessing data in memory, Introduction to programming for 8086 microprocessor, program development steps, constructing the machine code for 8086 instructions, assembly language program development tools, writing simple program for use with an assembler.

UNIT III: 8086 Microprocessor System Hardware (12hrs)

Basic 8086 microcomputer system, pin diagram of 8086, minimum and maximum modes, timing diagram, physical memory organization, addressing memory (RAM, ROM) and ports in microcomputer system, 8086 addressing and addressing decoding, programmable parallel ports and handshake input and output, 8255 A internal block diagram, 8255 A operational modes and initialization, pin diagram of 8255 A

UNIT IV: Digital interfacing (12hrs)

Interfacing to keyboards, alphanumeric displays, interfacing microcomputer ports to high power devices Direct Memory Access (DMA) Data Transfer, Timing diagram of 8237 DMA, brief introduction of microcontroller, difference between microprocessor and microcontroller, pin diagram of 8051 microcontroller.

COURSE OUTCOME

- Understanding of the Intel 8086architecture.
- Knowledge of the 8086instruction set and ability to utilize it in programming.
- Learning addressing modes (Immediate, direct, extended, indexed modes)
- Understanding of the Intel 8086 real mode memory addressing.
- Ability to interface various devices to the microprocessor.
- Introduction to the microcontroller.

REFERENCE BOOKS:

1. Liu and Gibson: Microprocessor System the 8086 / 8088 Family
2. Hall: Microprocessor and Interfacing
3. Ram: Fundamentals of Microprocessor

MSc III SEMESTER LAB

ELECTRONICS LAB II

PHY 305

COURSE OBJECTIVE

- To provide practical knowledge and develop skill in digital system & microprocessor,
- To provide the practical knowledge of microwave test bench &measurement,
- To provide the knowledge of modulation and demodulation.

SYLLABUS

1. Microwave Characteristics and Measurements.
2. Nonlinear Applications of Op Amp.
3. PLL Characteristics and its Applications.

4. PAM, PWM and PPM Modulation and Demoduation
5. PCM / Delta Modulation and Demodulation.
6. Fibre Optic Communication.
7. Arithmetic Operations Using Microprocessors 8085 / 8086.
8. D/A Converter Interfacing and Frequency / Temperature Measurement with Microprocessor 8085 / 8086.
9. A/D Converter Interfacing and AC/DC Voltage / Current Measurement Using Microprocessor 8085/8086.
10. PPI 8251 Interfacing with Microprocessor for Serial Communication.
11. Assembly Language Program on PC

Note: Addition and deletion in the list of experiments may be made from time to time by the department.

COURSE OUTCOME

- The Students will have understanding of logic circuit, digital system and their devices
- The students will understand the operation and design of digital system.
- The students will able to work on microprocessor, interfacing & programming on pc.

M.Sc. PHYSICS IV SEM

PHY 401A

SUBJECT NAME: PHOTONICS

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with an understanding of basic optics, optical fibre communication system and devices, optical fibre sensors and fibre fabrication.

Unit I : Optical Fiber Waveguides (12hrs)

Introduction; Principle of Light Transmission in a fiber, Ray theory transmission, Electromagnetic mode theory for optical propagation, Modes in a planar waveguide, Fiber index profiles, multi-mode step-index fibers, multi-mode graded index fibers, single mode step index fibers.

Unit II: Input / Output Devices (12hrs)

Optical sources, the Laser, Basic concepts, semiconductor laser, light emitting diode, the semiconductor junction diode; Optical detectors, principle, important parameters of ODs, photodiodes, photo conductors, PIN photodiode

Unit III: Transmission characteristics of Optical Fibers (12hrs)

Attenuation in optical fibers, absorption losses, fiber bend losses, linear scattering losses, Rayleigh scattering, non-scattering losses, Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), Material dispersion, inter-modal dispersion.

Unit IV : Fiber technology Characterization and Optical Communication (12hrs)

Fiber materials, glass fibers, active glass fibers, plastic optical fibers (POF), Photonic crystal fibers (PCF), Index guiding PCF, Photonic band gap fibers, Fiber fabrication, Outside Vapor-phase oxidation, Vapor-phase Axial deposition. Principle components of an O.F.C.S, optical sources, optical detectors, optical amplifier, fiber couplers or directional couplers, Elementary idea of Optical Fiber Sensors

COURSE OUTCOME

After the successful completion of the course, students would be able to

- understand basic optics and related phenomena.
- develop a clear understanding of optical fibre communication.
- understand the application of optical fibres in making Sensor devices.

REFERENCE BOOKS:

1. Ghatak and Thyagrajan: Introduction to Fiber Optics
2. Keiser: Optical Fiber Communication
3. Gowar: Optical Communication System
4. Sapna Katiyar: Optical Fiber Communication
5. Senior: Optical Fiber Communication

M.Sc. PHYSICS IV SEM

SUBJECT NAME: RADIATION PHYSICS (PHY 401B)

NO OF CREDITS: 4

L T P **Max Marks: 60**
4 0 0

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide students with a deep understanding of radiation physics. The course also aims to make students familiar with thermal neutrons, nuclear spectrometry and analytical techniques.

Unit I: Thermal Neutrons (12hrs)

Energy distribution of thermal neutrons, Effective cross-section of thermal neutrons, lowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, slowing down power and moderating ratio, Slowing down density, slowing down time, Resonance escape probability

UnitII: Nuclear Chain Reaction and Nuclear diffusion (12hrs)

Neutron cycle and multiplication factor, Neutron leakage and critical size, Nuclear reactor and their classification. Thermal neutron diffusion, Neutron diffusion equation, Thermal diffusion length, Exponential pile, Diffusion length of a fuel moderator mixture, Fast neutron diffusion and Fermi age equation, Correction of neutron capture**.**

Unit III: Nuclear Spectrometry and Applications (12hrs)

Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g factors and hyperfine fields.

Unit IV: Analytical Techniques (12hrs)

Principles, Instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis techniques. Theory, instrumentation and applications of electron spin resonance (ESR) spectroscopy. Experimental techniques and applications of Mossbauer Effect, Rutherford backscattering.

COURSE OUTCOME:

After the successful completion of the course, the students would be able to :

- Understand the properties of thermal neutrons.
- Understand nuclear spectro-photometry and applications
- Use analytical techniques such as XRF, PIXE etc.

REFERENCE BOOKS:

1. Singru RM: Introduction to experimental nuclear physics
2. Glasstone and Edlund: The elements of nuclear reactor theory.
3. Murray: Introduction to nuclear engineering
4. Krane K.S: Introductory Nuclear Physics

M.Sc. PHYSICS IV SEM

PHY 402A

SUBJECT NAME: ELECTRONIC COMMUNICATION SYSTEM

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVES

The course aims to develop an understanding of microwave, waveguide and klystron. The course aims to develop a knowledge of Radar functions and its application. It also aims develop an understanding of communication system and signals.

Unit I: Introduction to communication system (12hrs)
Information transmitter, channel noise, receiver, need for modulation bandwidth requirements, noise and its types, representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-super hetrodyne receivers, communication receivers

Unit II: Frequency modulation and radar system (12hrs)
Description of FM systems, mathematical representation, comparison of wide band and narrow band FM, FM generation techniques, FM demodulators, FM receivers

Radar systems: Basics principals, pulsed radar systems, moving targets indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array, radar

Unit III: Pulse communication (12hrs)
Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PCM transmission system, telegraphy.

Unit IV: Broadband communication system (12hrs)
Frequency division multiplex (FDM), Time division multiplex (TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony

COURSE OUTCOME

Students who have completed this course should

- Gain knowledge and understanding of microwave analysis.
- Be able to apply analysis methods to determine circuit devices.
- Have knowledge of basic communication link design .
- Have knowledge of how a transmission and waveguide element works in impedance matching and filter circuits.

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

PHY 402B

SUBJECT NAME: ELECTRONIC DEVICES AND COMMUNICATION

NO OF CREDITS: 4

			SESSIONAL:	40
L	P		THEORY EXAM:	60
4	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

The aim of the course is to provide students with a thorough knowledge of Semiconductor devices, Microwave devices and memory devices.

Unit I: Semiconductor Devices (12hrs)

Review of p-n junction, metal semiconductor and metal oxide semiconductor junctions, review of JFET, MESFET and MOSFET- their frequency limits. Noise: Signal to noise ratio (SNR) and enhancement of SNR in instrumentation and communication

Unit II: Microwave Devices (12hrs)

Tunnel diode, transfer electron devices (Gunn diode), Avalanche transit time devices (Reed, Impact diodes, parametric devices), vacuum tube devices, reflex klystron and magnetron.

Unit III: Memory Devices (12hrs)

Volatile static and D-RAM, CMOS and NMOS, non volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD), Piezoelectric, pyroelectric and magnetic devices, SAW and integrated devices.

Unit IV: Communication (12hrs)

Basics of Modulation and demodulations, Difference between AM, FM and PM, mathematical and graphical analysis of AM signals, power relation, generation of AM waves, Block diagram of digital communication system, different communication techniques, advantage of digital communication, radar block diagram, basic radar range equation.

COURSE OUTCOME:

After the successful completion of the course, students would be able to

- understand semiconductor devices, p-n junction, MOSFET etc very well.
- Have an in-depth knowledge of microwave devices, memory devices and communication systems

REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

M.Sc. PHYSICS IV SEM

CODE: PHY-403A
SUBJECT NAME: **NANO SCIENCE AND TECHNOLOGY**

NO OF CREDITS: 4

		SESSIONAL:	40
L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Introduction to the underlying principles and applications of the emerging field of nanotechnology and nanoscience along with able to practically synthesize and characterize the nano material. Moreover this course introduces tools and principles which are relevant at the nanoscale dimension. Current and future nanotechnology applications in engineering, materials, physics etc will be discussed.

UNIT-1: Introduction To Nano Science And Nano Technology (12hrs)

Introduction to nanomaterials, Properties of materials & nanomaterials, role of size in Nanomaterials : nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, thin films, nano-compositor and advantages. Introduction to Carbon Nanostructures: Graphene, fullerenes, Carbon Nanotubes.

UNIT-II: Quantum Mechanics For Nanoscience (12hrs)

Electronic structure of 0-D, 1-D, 2-D, 3-D. Resonant tunneling quantized energy levels, Reflection and transmission by a potential step and by a rectangular barrier, band structure and density of states at Nanoscale. Semiconductor and metallic dots, optical spectra, Discrete charge states, Electrical transport in 0-D, coulomb blockade phenomena.

UNIT-III: Growth Techniques Of Nanomaterials (12hrs)

Top-Down & Bottom-Up, Lithographic techniques, Non lithographic techniques, Fabrication of Nanomaterials by different Methods: -Inert gas condensation, Arc discharge, Sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition, Electro deposition , chemical precipitation, Sol gel and green synthesis.

UNIT-IV: Characterization Tools Of Nanomaterials and Applications (12hrs)

X-ray diffraction, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). UV-visible, FTIR and Raman spectroscopy,
Nano sensors: biology and environment: Quantum dot, hetero structure laser and single electron devices.

COURSE OUTCOME

On successful completion of this course, students should be able to

Explain the nanoscale paradigm in terms of properties at the nanoscale dimension by apply key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology and identification of current nanotechnology solutions in design, engineering and manufacturing.

REFERENCE BOOKS:

1. Poole and Owens: Introduction to Nanotechnology
2. Nanoscale materials -Liz Marzan and Kamat
3. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)
4. Nano Engineering in Science & Technology: An introduction to the world of nano design by Michael Rieth.
5. Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing
6. Nalva (editor): Handbook of Nanostructured Materials and Nanotechnology

M.Sc. PHYSICS IV SEM

CODE: PHY-403 B

SUBJECT NAME: **COMPUTATIONAL PHYSICS**

NO OF CREDITS: 4

SESSIONAL: 40

L	P	THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

This course aims to develop in students computations skills to handle problems in theoretical and experimental physics. The student would be able to handle problems in differentiation and integration, solution of differential equations and simulate specific physical problems.

Unit I: Differentiation and Integration (12 hrs.)

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 II: Solution of Differential Equations (12 hrs.)

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method, Forth-order Runge Kutta method, Cubic splines method; Second order differential equations: Initial and boundary value problems, Numeric solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kutta method(when eigen value is given), Numerical Solutions of Partial Differential Equations Using Finite Difference Method.

Unit III: Random Numbers and Chaos (12 hrs.)

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling radioactive decay. Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, 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: Undamped motion, Damped motion, Driven and damped oscillator.

Unit IV: Simulation of selected physics problems (12 hrs.)

Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.

COURSE OUTCOME:

After the successful completion of the course, the student would be able to:

- Simulate specific physical problems in interference and diffraction.
- Model LR and LCR circuits driven by sine and square functions.

- Solve complex integral and differential equations.

REFERENCE BOOKS:

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 Recipes in Fortran, Cambridge University Press.
5. M L De Jong: Introduction to Computation Physics, Addison-Wesley publishing company.

M.Sc. PHYSICS IV SEM
PHY 404A

SUBJECT NAME: MATERIAL SCIENCE

NO OF CREDITS: 4

L	P		
		SESSIONAL:	40
		THEORY EXAM:	60
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

Expose the students to different classes of materials, Metals, Ceramics, Polymers, Composites, their properties, structures, imperfections, Defects and Diffusion present in them. Manipulate atomic/micro structural processes to create desired structure & processes.

Unit I: Imperfections in Solids (12 hrs.)

Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger’s vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in FCC, HCP and BCC lattice.

Unit II: Mechanical Properties (12 hrs.)

Stress Strain Curve; Elastic Deformation: atomic mechanism of elastic deformation and anisotropy of Young's modulus, elastic deformation of an isotropic material; Anelastic and Viscous deformation; Plastic Deformation: Schmid's law, critically resolved shear stress; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, low angle grain boundaries, yield point, strain aging, solid solution strengthening; Fracture: ideal fracture stress.

Unit III: Microstructure (12 hrs.)

Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Nucleation, Growth and Overall Transformation Kinetics; Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and annealing effects of trace-impurities, implantation induced alloying and structural phase transformation

UNIT IV: Materials Processing and Characterization (12 hrs.)

Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, applications; Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, applications; Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.

COURSE OUTCOME

- Understand structure-properties properties relationship for Crystal Metals & Ceramics structures
- Knowledge of applications of polymers, ceramics and composites
- Knowledge of contemporary issues relevant to Materials Science and Engineering.
- Able to select materials for design and construction

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Ion Implantation by G. Dearnally
4. Fundamentals of Surface and Thin Film Analysis by L. C. Feldman and J. W. Mayer

M.Sc. PHYSICS IV SEM

PHY 404B

SUBJECT NAME: SMART MATERIAL

NO OF CREDITS: 4

			SESSIONAL:	40
L	P		THEORY EXAM:	60
4	0		TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 2 marks each. It should cover the entire syllabus. Part II will consist of six questions of 10 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The goal of this course is to expose the students to the general area of smart materials like composites, polymers, dielectrics and ceramics with an emphasis on novel materials and emerging applications. Students will learn the potentials of smart sensors and actuators, the challenges associated with their uses.

Unit I: Composite materials (12hrs)
Agglomerated composites, cermets, laminates, Reinforced composite materials, classification of reinforced composite materials, flakes composite, whisker reinforced composites, hybrid composites, sandwich composites, fiber reinforced glass and glass ceramic composites, polymer concrete, fiber reinforced concrete (pRC), MMC and wood composites, advantages and limitations of composites, fibers, forms of reinforcing fibers, mechanic of composite laminates, generalized Hook's law and elastic constants

Unit II: Ceramic materials (12hrs)
Refractories, silica and silicates, glasses, glass-forming constituents, types of glasses, perovskite structure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC), pre-stressed concrete, rocks and stones, clay and clay based ceramics, chemically bonded ceramics.

Unit III: Materials and Alloys (12hrs)
Alloys, Alloys in different applications, heat resisting alloys, Cryogenic alloys, bearing metals (Baaits), Metals and alloys for nuclear industry, common ferrous and non ferrous alloys, monomers of polymer, Degree of polymerization, Mechanism of polymersation, additives in polymers, strengthening mechanism of polymers, deformation of polymers.

Unit IV Dielectric materials

Classification of dielectrics, polarization, basic properties of dielectrics, electrical susceptibility, power loss, electric breakdown, effect of temperature and frequency on permittivity, insulating materials, ferro-electrics, piezo-electrics, electrets, pyroelectrics and elecrostriction

COURSE OUTCOME

- Smart materials, their properties, distribution by type. The development of smart materials and structures. Areas of application of intelligent systems.
- Polymers and their synthesis, polymer curing. Conductive polymers and elastomers.
- Ceramic materials, piezoelectric materials, methods of using smart materials for temperature regulation, self-regulating heating elements.
- Metallic and nonmetallic materials with shape memory principles and applications.

REFERENCE BOOKS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Material Science and Engineering: K M Gupta