FACULTY OF HUMANITIES AND SCIENCES

DEPARTMENT OF PHYSICS

M.Sc. (Physics)

ACADEMIC SESSION 2017-2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY

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

HUMANITIES AND SCIENCES 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.

M.Sc. Physics

The M.Sc. program 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. It also aims to enable students to develop insights into the techniques used in current fields and allow an in-depth experience of a particular specialized research area. In addition, the M.Sc Program is meant to develop professional skills in students that play a meaningful role in industrial and academic life and give students the experience of teamwork, a chance to develop presentation skills and learn to work to deadlines. The M.Sc. program 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.

PROGRAM OBJECTIVE

The objective of the program is

- To prepare students for careers in University teaching and research.
- To develop thorough and in-depth knowledge of various courses in Physics such as Electronics, Quantum Mechanics, Nuclear Physics, and Condensed matter Physics, Laser, Nanotechnology, etc.
- To inculcate strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- To develop strong student skills in research, analysis and interpretation of complex information.
- To prepare the students to successfully compete for employment in Research labs and teaching and to offer a wide range of experience in research methods, data analysis to meet industrial needs.

PROGRAM OUTCOMES

After completion of the program, the students will:

- Apply knowledge and skill in the design and development of Electronics circuits to cater the needs of Electronic Industry.
- Become professionally trained in the area of electronics, optical communication, nonlinear circuits, materials characterization and lasers.
- Excel in the research related to Physics and Materials characterization.
- Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behavior and communication skills as well as a commitment to life-long learning.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
DEPARTMENT OF HUMANITIES AND SCIENCES

STRUCTURE AND SYLLABI OF M.SC. PHYSICS (4 SEMESTER COURSE)

SEMESTER I

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 101	Mathematical Physics	4	0	0	25	75	100	4	DCC
PHL 102	Classical Mechanics	4	0	0	25	75	100	4	DCC
PHL 103	Quantum Mechanics-I	4	0	0	25	75	100	4	DCC
PHL 104	Electronic Devices and IC Technology	4	0	0	25	75	100	4	DCC
PHP 105	Electronics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 106	Seminar	2	0	0	50		50	0	DCC
XXX	MOOC**								MOOC
Total Marks							**550**	**24**	

* DCC – Discipline Core Course; MOOC – Massive Open Online Course
**The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given list on the Swayam portal or the list given by the Department/ University from 1st semester to 3rd semester as notified by the University. (Instructions to students overleaf)
L – Lecture; P - Practical; Tutorial

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.
2. The department coordinators will be the course coordinators of their respective departments.
3. Every student has to pass a selected MOOC course within the duration ass specified below:

Programme	**Duration**
B. Tech.	Sem. I to Sem. VII
M.Sc./M.Tech./M.A./MBA	Sem. I to Sem. III
B.Sc./MCA	Sem. I to Sem. V

The passing of a MOOC course is mandatory for the fulfillment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.
5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.
6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.
7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.
8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.
9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

SEMESTER II

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 201	Atomic and Molecular Physics	4	0	0	25	75	100	4	DCC
PHL 202	Nuclear and Particle Physics	4	0	0	25	75	100	4	DCC
PHL 203	Condensed Matter Physics	4	0	0	25	75	100	4	DCC
PHL 204	Electrodynamics and Plasma Physics	4	0	0	25	75	100	4	DCC
PHP 205	Physics Laboratory-I	0	0	20	30	70	100	8	DCC
PHP 206	Seminar	2	0	0	50		50	0	DCC
XXX	Audit Course*	2	0	0	25	75	100	0	AUD
Total Marks							**650**	**24**	

- DCC – Discipline Core Course; AUD-Audit Course; L – Lecture; P – Practical: T-Tutorial
- *provided by the Department/ University.

SEMESTER III

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL 301	Advanced Quantum Mechanics	4	0	0	25	75	100	4	DCC
PHL 302	Statistical Mechanics	4	0	0	25	75	100	4	DCC
PHL 303	Laser Technology	4	0	0	25	75	100	4	DCC
PHL 304	Microprocessor	4	0	0	25	75	100	4	DCC
PHP 305	Electronics Lab-II	0	0	20	30	70	100	8	DCC
PHP 306	Seminar	2	0		50		50	0	DCC
XXX	Open Elective*	3	0	0	25	75	100	3	OEC
Total Marks							**650**	**27**	

- DCC – Discipline Core Course; OEC – Open Elective Course; L – Lecture; P – Practical
- *The department offers two open elective courses which can be taken by students of other departments.

SEMESTER IV

Subject Code	Title	L	T	P	Internal Assessment	End-semester Examination	Total	Credits	Category Code
PHL401A	Photonics	4	0	0	25	75	100	4	DEC
PHL401B	Radiation Physics								
PHL 402A	Electronic Communication System	4	0	0	25	75	100	4	DEC
PHL 402B	Electronic Devices and Communication								
PHL 403A	Nano Science and Technology	4	0	0	25	75	100	4	DEC
PHL 403B	Computational Physics								
PHL 404A	Material Science	4	0	0	25	75	100	4	DEC
PHL 404B	Smart Materials								
PHL 405	Dissertation	2	0	0	30	70	100	8	DCC
Total Marks							**500**	**24**	

- DCC – Discipline Core Course; DEC – Discipline Elective Course; L – Lecture; P - Practical
- Students have to select one DEC paper from each group or the course offered by the Department.
- Elective Courses can be offered subject to availability of requisite resources/ faculty in the University/Department.

Grading Scheme

*Percentage	Grade	Grade Points	Category
90-100	O	10	Outstanding
80-90	A+	9	Excellent
70-80	A	8	Very Good
60-70	B+	7	Good
50-60	B	6	Above Average
45-50	C	5	Average
40-45	P	4	Pass
<40	F	0	Fail
......	Ab	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

PHL 101

SUBJECT NAME: MATHEMATICAL PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 functions of a complex variable and calculus, special functions, elements of group theory, Integral Transforms.

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, Evaluation of real definite integrals.

Unit II: Special Functions (12 hrs.)

Bessel Functions: Bessel functions of the first kind $J_n(x)$, Generating function, Recurrence relations, Expansion of $J_n(x)$ when n is half an odd integer, Integral representation; Legendre Polynomials $P_n(x)$: Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of $P_n(x)$; Associated Legendre polynomials and their orthogonality, Hermite and Laguerre Polynomials: generating function & recurrence relations only.

Unit III: Matrices and Group Theory (12 hrs.)

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

Unit IV: Integral Transforms (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.
Laplace Transforms, Transforms of some Elementary Functions, Properties of Laplace transform, Transform of Derivatives, Transform of Integrals, Convolution theorem and its applications, Inverse Laplace Transform by partial fractions method

COURSE OUTCOMES

After completion of the course, students will have would be able

- To solve real definite integrals in theoretical Physics.
- To use special functions for solving Quantum Mechanical Problems.
- To use matrices for solving linear algebraic equations and to use group theory for understanding of crystallography.
- To use integral transforms for analysis of wave mechanics.

REFERENCE BOOKS:

1. Arfken: Numerical methods for Physicists
3. Ghatak: Mathematical Physics
4. H.K. Dass: Mathematical Physics
5. M. R. Spiegel: Schaum's Outlines Complex Variables
6. M. Tinkam: Group theory and Quantum Mechanics
7. B. Baumslag, B. Chandler: Schaum's Outlines Group Theory

M.Sc. PHYSICS I SEM

PHL 102

SUBJECT NAME: CLASSICAL MECHANICS

NO OF CREDITS:4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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, Routhian procedure and equations,

Unit II: Poisson bracket and theory of small oscillations (12 hrs.)
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, Eigen value 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, H-J Theory: H-J equation and their solutions.

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, driven-damped harmonic oscillator

COURSE OUTCOME

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

- Understand the Lagrangian and Hamiltonian formalisms so that they can apply these methods to solve real world problems.
- Understand the theory of small oscillations and concept of Poisson bracket.
- Understand the Two-body central force problem and H-J theory.
- Understand the multi-disciplinary topic 'Chaos' which will enable the students to learn non-linear dynamics.

REFERENCE BOOKS:

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

PHL 103

SUBJECT NAME: QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

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. This course would enable students to comprehend the basic structure of Quantum Mechanics and to use it in different branches of Physics like Atomic and Molecular Physics, Nuclear Physics, Condensed Matter Physics etc.

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:

- Understand the general formalism of Quantum Mechanics.
- Understand the theory of Angular Momentum and its application in quantum mechanics.
- Understand the theory of scattering and calculation of Phase Shifts in Simple Cases.
- Apply the perturbation theory for time independent and time dependent cases.

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

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

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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. 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.

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 and amplifiers, Construction of JFET, MOSFET, 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

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

- Understand various semiconductor devices the fabrication of ICs
- Understand the working and characteristics of BJT and FET.
- Understand the working and applications of Op-Amp (IC-741) and 555 Timer.
- Understand the Digital Circuits and Systems

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 I SEM

PHP 105

ELECTRONICS LAB I

NO OF CREDITS: 8

L	P		
		SESSIONAL:	30
		THEORY EXAM:	70
0	16	TOTAL:	100

COURSE OBJECTIVE

This course is designed to provide students with fundamental concepts of Electronic Circuits for lab experience such as study of operation of Oscillators and Waveform generators like multivibrators and Schmitt trigger. This lab will also give students the preview of 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
PHL 201
SUBJECT NAME: ATOMIC AND MOLECULAR PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 hetero-nuclear 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 and 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 effects-g factor.

COURSE OUTCOME

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

- Understand the fundamental aspects of atomic and molecular physics.
- Understand the molecular structure.
- Carry out experimental and theoretical studies on atoms and molecules, with focus on the structure and dynamics of atoms and molecules, and
- Understand resonance spectroscopy; NMR, ESR.

REFERENCE BOOKS:

1 Concepts 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, Tata McGraw –Hill publishing company limited.
5 Introduction to Atomic spectra by H.E. White
6 Spectra of diatomic molecules by Gerhard Herzberg
7 Principles of fluorescence spectroscopy by Joseph R. Lakowicz

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

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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)

Liquid drop model, Shell model, 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.

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 and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.
- Understand the mechanism and kinematics of nuclear reactions.

- Describe the basic features involved in alpha and beta decays and nuclear forces
- Comprehend 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
PHL 203
SUBJECT NAME: CONDENSED MATTER PHYSICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 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 behavior in a periodic potential, such as the tight binding model, to explain the electronic structure of materials will be done qualitatively and quantitatively.

Unit I: Symmetry and Reciprocal Lattice
crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, reciprocal lattice, reciprocal lattice (sc, bcc, fcc) Bragg's law in direct and reciprocal lattice, crystal structure factor (bcc, fcc), atomic form factor, Scattering factors, 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 mono-atomic and 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, Metal-Semiconductor junctions.

UNIT IV: Methods To Evaluate The Energy Levels

Tightly bound electron approximation method, application to simple cubic lattice, Wigner-Seitz approximation, pseudo potential method, Fermi 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: S.O. Pillai

M.Sc. PHYSICS II SEM

PHL 204

SUBJECT NAME: ELECTRODYNAMICS AND PLASMA PHYSICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVES

To have a deep understanding of electrodynamics using scientific methods and to apply the concepts of electromagnetic theory for various communication systems.

Unit I: Introduction to Electrodynamics (12 hrs.)

Energy stored in an electric and magnetic fields. Continuity Equation, Displacement Current, Maxwell's equations, power flow in an electromagnetic field and pointing theorem. Electromagnetic waves in a homogeneous medium-solution for free space conditions. Uniform plane waves, the wave equations for a conducting medium, Sinusoidal time variations, Maxwell's equations using phasor notation. Wave propagation in a loss less medium, wave propagation in a conducting medium, wave propagation in a good dielectric.

Unit II:Electromagnetic Waves (12hrs)

Reflection & Refraction of Plane waves:- Boundary Conditions, Laws of reflection and refraction of plane waves, Reflection by a perfect dielectric – normal and oblique incidence, Fresnel relations, Brewster's angle, Reflection by a perfect conductor – normal incidence, Power loss in a plane conductor.

Polarization:- Linear, elliptical and circular Polarization, Direction cosines.

Dispersion and Scattering:- Radiative reaction force, scattering and absorption of radiation, Thompson scattering and Rayleigh Scattering, Polarization of Scattered Light, Normal and anomalous dispersion, Dispersion relation of EM waves in Solids, Liquids and gases.

Unit III: Electromagnetic fields and Radiation by Moving Charges (12 hrs.)

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.

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 & Waveguides(12 hrs.)

Elementary Concepts: Plasma as fourth state of matter, Various kinds of Plasma, Quasineutrality of plasma, Debye Shielding, Plasma Parameters, Plasma production and heating of the plasma, Plasma Oscillations and plasma frequency expression, Fluid equations, electron plasma wave, ion acoustic wave, Magnetoplasma and Plasma Confinement, plasma instabilities, applications of Plasma.

Wave guides:- TE, TM and TEM waves, TE and TM modes in rectangular wave guides, concept of cut off frequency.

COURSE OUTCOMES

Students who have completed this course should

- Have a deep understanding of electromagnetic theory and propagation of EM waves though various media.
- Be able to understand the phenomena of reflection, refraction, polarization and dispersion of EM waves.
- Understand the fields and potentials due to moving charges.
- Be able to understand the concepts of Plasma Physics and waveguides.

REFERENCE BOOKS:

1.Classical Electrodynamics by J.D. Jackson.
2. Introduction to Electrodynamics by D. J. Griffiths.
3. Introduction to Plasma Physics by Francis F. Chen.
4. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.

M.Sc. PHYSICS II SEM

PHP 205

SUBJECT NAME: **PHYSICS LAB II**

		SESSIONAL:	30
L	P	THEORY EXAM:	70
0	16	TOTAL:	100

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

COURSE OBJECTIVE

To develop basic experimental knowledge in physics by extending knowledge and processes used by physics which produce 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

- Utilize scientific method for formal investigation of physical laws.
- 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
PHL 301

SUBJECT NAME: ADVANCED QUANTUM MECHANICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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. The course is planned as a continuation of Quantum Mechanics course taught in first semester.

Unit I: Solution of Schrodinger Equation for Three Dimensional Problems: (12hrs)

The Three Dimensional Harmonic Oscillator in both Cartesian and Spherical Polar Coordinates, Eigenvalues Eigenfunctions and the Degeneracy of the States; Solution of the Hydrogen Atom Problem, The Eigenvalues Eigenfunctions and the Degeneracy.

Unit II: 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 III: 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 IV: 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:

- Understand the foundations of Quantum mechanics
- Acquire working knowledge of relativistic quantum mechanics.
- Understand the concept of identical particles
- Understand Field quantization and concepts

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

PHL 302

SUBJECT NAME: STATISTICAL MECHANICS
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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. It aims to derive the macroscopic behavior of a system in terms of mechanics of its microscopic constituents, and finds application in almost all branches of Physics. 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 micro-canonical 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 Ensemble theory.
- Be able to solve Quantum statistical mechanics problems for simple non –interacting system,
- Have a basic understanding of Statistical mechanics of interacting system
- Be able to understand low temperature physics.

REFERENCE BOOKS:

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

M.Sc. PHYSICS III SEM

PHY-303

SUBJECT NAME: LASER TECHNOLOGY

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 : Monochromaticity, 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. Homo-structure and Hetero-structure 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, Ultrafast laser

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

Propagation of Electromagnetic Waves in Nonlinear Medium, Self-Focusing, Phase Matching Condition, Raman Scattering: Stimulated Raman Scattering, Hyper Raman Scattering and CARS, Two Photon Absorptions process.

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.

COURSE OUTCOME

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

- Understand the basic principles of laser system
- Know about the working of various laser including gas, liquid and solid state laser
- Understand the non linear processes in which self focusing, phase matching conditions and raman scattering.
- Know cooling and trapping of atoms along with Bose Condensation.

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

M.Sc. PHYSICS IV SEM
PHY 304
SUBJECT NAME: MICROPROCESSOR
NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The objective of this course is to familiarize the students 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: 8086Microprocessor 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 the basics of microprocessor and 8085 microprocessor.
- Understanding of the Intel 8086 architecture. Knowledge of the 8086 instruction 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

PHP 305

		SESSIONAL:	25
L	P	THEORY EXAM:	75
0	16	TOTAL:	100

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

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 Demodulation
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 understand the operation and design of digital system.
- The students will able to work on microprocessor, interfacing & programming on pc.

PHL 401A

SUBJECT NAME: PHOTONICS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 optical fiber wavegudes and their applications.
- Comprehend the use of input/output devices in optical fiber communication.
- Understand the transmission charscteristics of optical fibers.
- Develop a clear understanding of optical fibre communication, fiber technology and 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 (PHL 401B)

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 chain reactions and nuclear diffusion.
- 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

PHL 402A

SUBJECT NAME: ELECTRONIC COMMUNICATION SYSTEM

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to develop an understanding of microwaves, waveguide and klystron. The course aims to develop 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 communication systems.
- Have basic knowledge of frequency modulation and radar system.
- Have knowledge of pulse communication and its applications
- Comprehend broadband communications.

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

PHL 402B
SUBJECT NAME: ELECTRONIC DEVICES AND COMMUNICATION

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 the construction and working semiconductor devices, p-n junction, MOSFET etc
- Have an in-depth knowledge of microwave devices.
- Understand the basic principle of memory devices.
- Understand the principle of communication and its various techniques.

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: PHL -403A
SUBJECT NAME: **NANO SCIENCE AND TECHNOLOGY**

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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, Band Structure, Density of states of nanoscale Size, dimensionality effects, size effects, properties of materials & nanomaterials; Era of nanostructres of carbon: Fullerenes, Graphene and Carbon Nano Tubes, BN Nano Tubes.

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

Quantum Well Structures: electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of a quantum well structure, quantum dots, quantum wires. Resonant tunneling quantized energy levels, reflection and transmission by a potential step and by a rectangular barrier, Quantum confinement effect in nanomaterials.

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

Top-Down & Bottom-Up, Lithographic techniques and its limitations, Non lithographic techniques, Fabrication of Nanomaterials by different Methods: -Plasma Arc discharge, Sputtering, pulse laser deposition, Ball Milling, Molecular beam epitaxy, Evaporation, Chemical vapour deposition, Electro deposition, Sol gel Method.

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

Electron Microscopy: SEM and TEM, Scanning Probe Microscopy (SPM), TEM, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). UV-visible, Deep Level Transmission(DLT) and Raman spectroscopy.

COURSE OUTCOME

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

- To understand the basics of Nano Science and Nano Technology.
- To apply the Quantum Mechanics for Nanomaterials.
- To learn the various Growth Techniques of Nanomaterials.
- To use the Characterization Tools of Nanomaterials for research applications.

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

PHL - 403 B

SUBJECT NAME: **COMPUTATIONAL PHYSICS**

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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 eigenvalue 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:

- Learn about the various integration and diffractions methods.
- Deduce Numerical solution of ordinary differential equations.
- Generate the random numbers using various techniques.
- Simulate selected physics problems using various computational methods.

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

PHL 404A

SUBJECT NAME: MATERIAL SCIENCE

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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: Free energy, grain boundaries, twin interfaces, and stacking fault; volume Defects: precipitates and dispersants

Unit II: Mechanical Properties (12 hrs.)

Stress Strain Curve; Stress: tensor and concentration; stress in two dimension, Elastic Deformation: Isotropic and Anisotropic; Anelastic and Viscous deformation; Plastic Deformation: True stress and Strain, Critically resolved shear stress; Slip theory: Perfect and real crystal; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, strain aging, solid solution strengthening; Creep & its Mechanism, Fracture: Introduction.

Unit III: Metallurgy (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; Diffusion: Fick's law, Kirkendall Effects, Atomic model of diffusion, Nernst-Einstein relation Phase transformation: Nucleation, Growth and Overall Transformation Kinetics, and Process: Precipitation, Solidification, Crystallization, and Glass transition

UNIT IV: Materials Characterization (12 hrs.)

Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and energy losses: Nuclear and electronic; Ion Beam characterization Technique: Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.

COURSE OUTCOME

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

- Understand structure and defects based properties relationship for Crystal Metals & Ceramics materials
- Gain knowledge of behavior of metal, ceramic and polymers under mechanical forces
- Select materials for design and construction
- Understand Material characterization through Ion beam techniques

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. Materials Science and Engineering by V. Raghavan
4. Fundamentals of Surface and Thin Film Analysis by L.C. Feldman and J.W. Mayer

M.Sc. PHYSICS IV SEM

PHL 404B

SUBJECT NAME: SMART MATERIALS

NO OF CREDITS: 4

		SESSIONAL:	25
L	P	THEORY EXAM:	75
4	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 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

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

- Understand the structure of composite materials and the areas of application.
- Differentiate between different types of ceramics, their synthesis and different constituents
- Learn about the various kind of materials and their alloys for different industrial applications.
- Classify the various kinds of dielectrics and their applications in different devices.

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

AUDIT COURSE
COURSE CODE: APHL-203A

SUBJECT NAME: RENEWABLE ENERGY RESOURSES

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE: This course will enable students learn and understand the importance of alternate energy resources. They will also study the fundamentals of renewable energy resources.

SYLLABUS

UNIT I: PRINCIPLES OF SOLAR RADIATION:

Limitation of conventional energy sources, need and growth of alternative energy sources, basic scheme and application of direct energy conservation, Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II: SOLAR ENERGY COLLECTION, STORAGE AND APPLICATIONS

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors; Different methods of storage: Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT III: WIND ENERGY AND GEOTHERMAL ENERGY
Wind energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria; Geothermel energy: Resources, types of wells, methods of harnessing the energy, potential in India.

UNIT IV: OCEAN ENERGY

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

COURSE OUTCOME:

At the end of the course, a fully engaged student will be able to:

1. Understand the principles of solar energy and its environmental impact.
2. Learn the basics of solar energy collection and storage.
3. Study the basics of wind energy and geothermal energy.
4. Comprehend the use of ocean energy as an alternate source of energy.

REFERENCE BOOKS:

1. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. Non-Conventional Energy Systems / K Mittal /Wheeler
4. Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, P.H.I.

5. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers
6. Renewable Energy Resources – Twidell & Wier, CRC Press(Taylor & Francis)

OPEN ELECTIVE

COURSE CODE: OPHL-305A

INTRODUCTION TO ASTROPHYSICS AND COSMOLOGY

NO. OF CREDITS-3

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE:

To show how the properties of astronomical objects and the Universe relate to simple physical laws and processes

SYLLABUS

UNIT I :The Universe and its physics: A tour of the Universe, its scale and contents; Gravity; Pressure; Radiation Observational astronomy**:** the electromagnetic spectrum; geometrical optics; resolving power, and the diffraction limit; telescopes and detectors; gravitational waves; Distances**:** parallax measurements, standard candles

UNIT II: Physics of the Sun and Stars: blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening; hydrogen spectral lines and Doppler effect; Hertzprung-Russell diagram; Freefall and Kelvin-Helmholtz time; nuclear fusion; basic stellar structure (hydrostatic equilibrium, equation of state); white dwarfs, neutron stars and black holes

UNIT III: Planetary systems: Kepler's laws; Detection methods of extrasolar planets; search for life elsewhere.

UNIT IV: Star formation: the interstellar medium; stellar populations; the interstellar medium; galaxy rotation curves, mass and dark matter; Galaxy collisions; central engines; Cosmology**:**Olber's paradox, Hubble's Law; the age of the Universe; Evolution of the Universe: Madau diagram; Evidence for the Big Bang (blackbody radiation, nucleosynthesis); dark energy and the accelerating Universe.

COURSE OUTCOMES

On completion successful students will be able to:

1. Have an understanding of the role and physics of detectors and telescopes including geometric optics and understand how distances are measured.
2. Know how basic laws of physics determine the properties and evolution of stars.
3. Know Kepler's Laws and how they relate to extrasolar planet detection.

4. Understand how the dynamics of galaxies indicate the presence of dark matter and demonstrate an understanding of the evolution of our Universe.

References:

1. Carroll, B.W. & Ostlie, D.A., *An Introduction to Modern Astrophysics* (Pearson)

OPEN ELECTIVE
COURSE CODE: OPHL-306A

PHYSICS AND OUR WORLD

		SESSIONAL:	25
L	P	THEORY EXAM:	75
3	0	TOTAL:	100

Note: The question paper will be of two parts. Part I will consist of 10 questions of 1.5 marks each. It should cover the entire syllabus. Part II will consist of six questions of 15 marks each out of which the student has to attempt any four.

COURSE OBJECTIVE

The course aims to provide the students fundamentals of Physics and of our world

UNIT-I: Space and Time

A discussion on length scales and dimensions, Galaxies, The solar system and the planet Earth, Rotation and Revolution of the Earth, Seasons, Calendars in History and the recording of time, Laws of motions- A Discussions of principles, theories and models, Gravitation, Planetary motion and Keplar's Laws, the laws of motion in the eyes of Galileo and Newton.

UNIT-II: Theory of Relativity

The relationship between Space and time: A basic account of theory of Relativity, Does nature differentiate between left and right ?- The notion of Parity, Is there an "Arrow" of time?. Entropy and Laws of Thermodynamics, The Size of the Universe- Is the Universe expanding?

UNIT-III: Matter and Energy

Discrete and continuous matter- a brief historical survey, Atoms and molecule: Structure of atoms, the nucleus, Elementary particles, Unification of forces. Equivalence of matter and energy, Nuclear energy and thermodynamics power. The Periodic table of elements, chemical bonds and molecules, Large molecules and living matter.

UNIT-IV Electromagnetic Energy

Waves and oscillations, Electromagnetic radiation and spectrum, Propagation of waves, Energy in the atmosphere- Wind and solar energy, Weather predictability and chaos, Indeterminacy, The quantum world—an introduction, Debates on the conceptualization of physical realities- is nature unreasonably mathematical?

COURSE OUTCOME

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

- Understand the relation between space and time.
- Learn the about the elementary particles and equivalence of energy and matter
- Learn about matter and energy
- Comprehend the basics of Electromagnetic energy

REFERENCE BOOKS:

1. The Evolution of Physics-Einstein and L. Infeld, Toughstone 1967
2. The Ascent of Man-J. Bronowski, laffle and Brown Company, 1976
3. Commos- Carl sagan, McDonald and Company, 2003.