SHRI GURU RAM RAI UNIVERSITY

Patel Nagar, Dehradun-248001, Uttarakhand, India

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

SYLLABUS FOR

Master of Science (M.Sc.)-Physics

School of Basic & Applied Sciences

(W.E.F 2024-2026)

Master of Science (M.Sc.)-Physics

OUTCOME BASED EDUCATION

Programme outcome (POs)

Students will be able to

PO 1	Implement strong theoretical and practical knowledge of physics to solve complex scientific problems.
PO2	Identify the situation-based problems, formulation, and action is taken based on analytical thinking and principles of science.
PO3	Formulate, design, experimental techniques, scientific tools, analysis of scientific data, interpretation of data, and establish a hypothesis for various interdisciplinary research problems.
PO4	Execute effective communication through interactive and presenting skills, technical report writings, and proper documentation of ideas.
PO5	Create a new conceptual, theoretical and operational approach to address various problems in interdisciplinary fields.
PO6	Enables individuals to function effectively in cross-cultural environments as an individual, and as a member or leaders.
PO7	Understand the contribution of scientific knowledge in environmental contexts for sustainable development.
PO8	Understand ethical issues, academic and research ethics, the need and value of lifelong learning, and the scientific misconduct of a scientist to serve society.
PO9	Enhance and adopt employability skills through research, internship, and dissertation.
PO10	Successfully compete in the state level, national level, and international level exams or competitions.
PO11	Lifelong learning of knowledge of physics
PO12	Implement the learning of physics in project management and finance

Program Specific Outcome (PSOs)

PSO 1	Associate the fundamental and advanced concepts in diverse branches of physics including classical mechanics, quantum mechanics, electrodynamics, statistical mechanics, atomic, nuclear, and particle physics, condensed matter physics, and electronics.
PSO2	Apply suitable methods to solve a wide range of problems and handle interdisciplinary projects as well as experimental data interpretation independently.
PSO3	Employ experimental skills for multi-disciplinary research work in cutting-edge areas of physics.
PSO4	Develop job-oriented analytical skills needed in research, consultancy, defense, entrepreneurial pursuit, and industry.

Eligibility for admission:

Any candidate who has passed undergraduate degree in any branch of Science or Engineering with Physics and Mathematics as two of the subjects, after the completion of 10+2 scheme with qualifying marks minimum 45% by any state from recognized University/Institute is eligible for admission. However, SC/ST, OBC and other eligible communities shall be given relaxation as per university rules.

Duration of the Programme: 2 Years

STUDY & EVALUATION SCHEME: Choice Based Credit System (CBCS)

Master of Science (M.Sc.)-Physics

First Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC101	Classical Mechanics	3	0	0	3	40	60	100
2	Core	MPHC102	Mathematical Physics	3	0	0	3	40	60	100
3	Core	MPHC103	Electrodynamics and Astrophysics	3	0	0	3	40	60	100
4	Core	MPHC104	Electronics	3	0	0	3	40	60	100
Practical										
1	Core	MPHL105	Laboratory Course I	0	0	8	4	40	60	100
2	Core	MPHL106	Laboratory Course II	0	0	8	4	40	60	100
			Total	12	0	16	20	240	360	600

*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination

Second Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC201	Atomic and Molecular Physics	3	0	0	3	40	60	100
2	Core	MPHC202	Solid State Physics	3	0	0	3	40	60	100
3	Core	MPHC203	Statistical Physics	3	0	0	3	40	60	100
4	Core	MPHC204	Quantum Mechanics	3	0	0	3	40	60	100
Practical										
1	Core	MPHL205	Laboratory Course I	0	0	8	4	40	60	100
2	Core	MPHL206	Laboratory Course II	0	0	8	4	40	60	100
			Total	12	0	16	20	240	360	600

*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination

Third Semester

S. N o.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC301	Advanced Quantum Mechanics	3	0	0	3	40	60	100
2	Core	MPHC302	Nuclear Physics	3	0	0	3	40	60	100
3	Core	MPHC303	Seminar	3	0	0	3	40	60	100
4	Elective -I	MPHE304 0R MPHE306	Condensed Matter Physics 0R Laser Physics	3	0	0	3	40	60	100
5	Elective -II	MPHE305 0R MPHE307 0R MPHE308	Digital and Communication Electronics 0R Astrophysics 0R High Energy Physics	3	0	0	3	40	60	100
Practical										
1	Elective	MPHE 304/ 305 / 306/307 /308	Laboratory Course	0	0	8	4	40	60	100
Self-Study course										
1	SSC**	MPHS310 0R MPHS311	Physics Of Nano Materials 0R Quantum Electrodynamics	0	0	0	3	40	60	100
			Total	15	0	08	22	240	360	600

*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination, SSC- Self-Study course

****Self-study course (SSC):** Maximum 06 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating grades). Students have to opt self-study courses either in third semester or in fourth semester. This will be conducted and evaluated at Departmental level.

Fourth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC401	Computational Physics	3	0	0	3	40	60	100
2	Core	MPHC402	Particle Physics	3	0	0	3	40	60	100
Practical										
1	Core	MPHL403	Laboratory Course	0	0	8	4	40	60	100
Project/Thesis										
1	Core	MPHD404	Dissertation	0	0	0	10	60	240	300**
Self-Study course										
1	SSC***	MPHS405 0R MPHS406	Environmental Physics 0R Bio Physics	0	0	0	3	40	60	100
			Total	24	0	08	20	180	420	600

*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination, SSC- Self-Study course

**The distribution of marks for the Dissertation will be as below:

Periodical Presentation	60 Marks
Dissertation	180 Marks
Viva Voce	60 Marks
Total	**300 Marks**

The dissertation/ project report shall be evaluated jointly by the supervisor and one external examiner.

*****Self-study course (SSC):** Maximum 06 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating grades). Students have to opt self-study courses either in third semester or in fourth semester. This will be conducted and evaluated at Departmental level.

Summary of the Credit

Year	Semester	Max Credit
1	1	20
	2	20
2	3	22
	4	20
Total		82

Examination Scheme (Except project):

Components	Ist Internal	IInd Internal	External (ESE)
Weightage (%)	20	20	60

Master of Science (M.Sc.)-Physics

Course code	**: MPHC101**				
Course Name	**: Classical Mechanics**				
Semester /Year	**: I / 1st**				
		L	T	P	C
		3	0	0	3

Course Objective:
The aim and objective of the course on Classical Mechanics is to train the students in Lagrangian and Hamiltonian formalisms for applications in the modern branches of physics such as Quantum Mechanics, Condensed Matter Physics, Astrophysics, etc.

Course Contents

Unit I
Lagrangian formulation and Variational Principle: Mechanics of particles and system of particles, conversion law, constraints, degree of freedom, generalized coordinates, D'Alembert's principle, Lagrange's equations of motion from D'Alembert's principle, application of Lagrange's equation of motion to a particle and system of particles, Hamilton's variational principle, Euler- Lagrange's differential equation.

Unit II
Hamilton's formalism: Need of Hamilton's procedure, Legendre's transformation and Hamilton's equation of motion, physical significance of H, cyclic coordinates, Hamilton's equation in cylindrical and spherical coordinates and applications, applications of Hamilton's equation of motion to a particle and system of particles, Motion Under Inverse Square Law- Kepler's Problem, Rutherford Scattering

Unit III
Principle of least action: Canonical or contrast transformation, their advantages and examples, condition for a transformation to be canonical, Poisson brackets: Definition and properties, Invariance with respect to Canonical transformation, equation of motion in Poisson's Bracket form, Jacobian's form.

Unit IV
Mechanics of Rigid Bodies and Theory of Small Oscillations: Coordinates of rigid body motion, Euler's angle, and angular momentum of a rigid body moments and products of inertia, principle axis transformation, Euler's equation of motion of a rigid body, stable and unstable equilibriums. Lagrange's equation of motion for small oscillators, normal coordinates and normal mode frequency of vibrations.

Text book [TB]:

TB1. Gupta K.C., "Classical Mechanics of particles and Rigid Bodies", Wiley Eastern (2001).

TB2. Goldstein H., Classical Mechanics, Pearson Education Asia Pte Ltd. House (2002).

Reference books [RB]:

RB1. Rana N. C and Joag P S, Classical Mechanics, Tata McGraw-Hill (1991)

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define and describe Lagrangian formulation, Variational Principle, Hamilton's formalism, principle of least action and mechanics of Rigid bodies and theory of small Oscillation.
CO2	Understand Lagrange's Equations, Hamilton's Variational Principle, Canonical Transformation, Hamilton's Formulation, principle of least action and mechanics of Rigid bodies.
CO3	Apply Lagrange's Equations, Hamilton's Formulation, Canonical transformation, Poisson brackets to various systems
CO4	Analyze constraints, degree of freedom, generalized coordinates, D'Alembert's principle, conservation theorems, Poisson brackets, mechanics of rigid bodies, theory of small Oscillation
CO5	Evaluate angular momentum, energy, moment of inertia, theorems on rigid body and applications of Lagrangian, Hamiltonian , canonical and Poissions bracket formulation
CO6	Solve Problems on Lagrangian, Hamilton's formulation, Canonical transformation, Poissions bracket , mechanics of Rigid bodies and theory of Oscillation.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	1	1	2	2	1
CO2	1	2	3	1	1	1	1	2	2	3	2	1	2	2	1	1
CO3	1	2	2	2	1	2	1	2	1	2	2	1	3	3	1	1
CO4	1	2	3	2	1	2	1	1	2	2	2	1	2	2	1	1
CO5	1	2	2	1	1	1	1	1	1	3	2	1	2	2	1	1
CO6	2	2	1	2	2	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC102**				
Course Name	**: Mathematical Physics**				
Semester /Year	**: I / 1st**				
		L	T	P	C
		3	0	0	3

Course Objective:

The main objective of the course on Mathematical Physics is to impart knowledge about various mathematical tools/ techniques employed to study physics problems. Using these tools MSc student would understand and handle theoretical treatments to study physics problems if he/she chooses to pursue research in physics as a career.

Course Contents

Unit I

Differential Equations: Special equations of Mathematical Physics, Series Solution, Bessel functions of first and second kind, generating function, Integral representation and recurrence relations for Bessel's functions of first kind, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality; Legendre polynomials: recurrence relations, Parity and orthogonality, Hermite functions, Laguerre functions.

Unit II

Complex Variable: Introduction, Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula, Taylor and Laurent's expressions, residues at various poles, theorem of residues, Contour integration.

Unit III

Matrix and Tensors: Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values-Eigen vectors and Diagonalisation of matrices, Coordinate transformation, Covariant and contravariant Tensors, addition, multiplication and contraction of tensors, Associated tensors.

Unit IV

Partial Differential Equations: Partial differential equations, Separation of variables. One dimensional wave and heat equation, two-dimensional heat equation and Laplace equation.

Unit V

Fourier series, and Fourier transform

Fourier series: definition and expansion of periodic functions. Dirichlet's conditions, Complex representation of Fourier series, problems related to periodic functions Fourier integrals, convergence of FS, solving simple partial differential equations using Fourier's series- Fourier transforms: sine, cosine & complex transforms- solving simple partial differential equations using Fourier transform- Fourier transforms of standard functions, Solution of PDE using Fourier transform. Dirac delta function.

Text book [TB]:

TB1. Harper C. Analytical Mathematics in Physics, Prentice Hall (1999).

TB2. Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, NewYork (1983).

Reference books [RB]:

RB1. Arfken G. and Weber H.J., Mathematical Methods for Physicists, Academic Press (2005).

RB2. Dass H.K., Mathematical Physics, S.Chand (2018).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe differential equations, partial differential equations, matrix and tensors and complex variable
CO2	Illustrate Special function (Bessel's, Legendre, Hermite functions, Laguerre functions), recurrence relations, Parity and orthogonality, Cauchy's integral theorem, Eigen Values-Eigen vectors, for solving definite integral, Laplace equation, Fourier Transform.
CO3	Understand Taylor and Laurent's expressions, residues at various poles, theorem of residues, Contour integration, partial differential equations using boundary value problems, wave and heat equation, two-dimensional heat equation, Fourier series
CO4	Explain Schur's Lemmas and orthogonality theorem and, Fourier Transform of various functions
CO5	Analyze the applications of Fourier Transform, covariant and contravariant Tensors.
CO6	Solve the matrix and tensors, Coordinate transformation, vector spaces,

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	1	1	1	1	2	2	1	1	2	2	1
CO2	2	3	1	1	2	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	2	3	2	1	1	2	1	2	2	1	3	3	1	1
CO4	2	3	2	2	2	1	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	1	1	1	3	2	1	2	2	2	1
CO6	2	2	1	2	2	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC103**				
Course Name	**: Electrodynamics and Astrophysics**				
Semester /Year	**: I / 1st**				
		L	T	P	C
		3	0	0	3

Course Objective:

This course gives an overview on various topic of classical electrodynamics including Maxwell equations, gauge invariance, classical radiation from accelerating charges. To develop observation skills to be able to explain astronomical features and stellar system.

Course Contents

Unit I

Maxwell's equations and Electromagnetic waves: Maxwell's equations and their physical significance. Equation of continuity and relaxation time, Vector and scalar potentials, Lorentz and Coulomb gauge, electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions.

Unit II

Radiations from moving charges: Concept of Retarded potentials, Lienard Wiechert potentials, Multipole expansion of EM fields, Electric dipole radiations. Fields produced by moving charges, radiations from an accelerated charged particle, Radiations from an accelerated charged particle at low velocities in circular orbits-Larmor formula.

Unit III

The Solar System: Aspects of the sky: Concept of Celestial Coordinates and spherical astronomy. Astronomical telescopes. Study of Planets: Classification of the Planets, Orbits, Laws of planetary motion, Asteroids, Meteors and Meteorites: Discovery of minor planets (Asteroids). Meteors and Meteorites. Meteorites, its types and composition. Meteorite craters. Nature of dust particles and origin of comets.

Unit IV

Sun As a Star: History of Sun, Sun's interior, the photosphere, the solar atmosphere, Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Magnitude scale and magnitude systems. [8]

Unit V

Stellar System: The Hertzberg- Russell Diagram: The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, nuclear fusion, condition for nuclear reaction in stars. Types of galaxies, Structure and features of the Milky Way Galaxy. [8]

Text book [TB]:

TB 1. Modern Electrodynamics by A. Zangwill, Cambridge, 2013.
TB 2. Introduction to Electrodynamics by D. Griffiths

Reference books [RB]:

RB 1. P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)
RB 2. J.B. Marion: Classical Electromagnetic Radiation
RB 3. Landau and Lifshitz: The Classical theory of Fields (Pergman Press)

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the Maxwell's equations and electromagnetic waves, Radiations from moving charges, stellar System, sun as a star, and the solar system
CO2	Discuss the formulation of Lienard Wiechert, Retarded potential and Hertzberg-Russell Diagram.
CO3	Illustrate Poynting's theorem and Maxwell's equations to solve problems of classical electrodynamics, the orbits Laws of planetary motion
CO4	Classify the concept of modern astrophysical observations, the photosphere, the solar atmosphere, Salient features of sunspot
CO5	Evaluate the understanding of our present picture of stellar system, Meteors and Meteorites, Atmospheric extinction. Absolute magnitudes and distance modulus
CO6	Express Nuclear fission, nuclear fusion, condition for nuclear reaction in stars, Structure and features of the Milky Way Galaxy, accelerated charged particle at low velocities in circular orbits-Larmor formula.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	1	1	2	1	1	2	2	1
CO2	1	2	3	2	3	1	1	2	2	1	2	1	2	2	1	1
CO3	3	1	2	2	2	2	1	2	2	1	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	1	2	1	2	2	1	1
CO5	2	1	3	2	2	1	1	1	2	1	2	1	2	2	1	2
CO6	2	1	2	2	2	1	1	1	2	1	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHC104				
Course Name	: Electronics				
Semester /Year	: I / 1st				
		L	T	P	C
		3	0	0	3

Course Objective:

The main objective of the course on electronic is to impart knowledge and keen understanding of the basic power amplifiers components, circuit representations and integrations, device structures, principle of operations, and analysis.

Course Contents

Unit I

Power amplifiers: Types of power amplifiers-series fed class A amplifier-series fed transformer coupled class B: push pull circuits-harmonic distortion in amplifiers-class C and D amplifiers-design considerations.

Unit II

Feedback in amplifiers: Feedback principle-effect of feedback on stability-nonlinear distortion input and output impedance-bandwidth-different types of feedback. Criteria for oscillation-phase shift, Wein bridge, crystal oscillator-frequency stability, astable, mono stable and bistable multivibrators, Schmitt trigger-bootstrap sweep circuits.

Unit III

Operational amplifiers: Differential amplifier-ideal and real op-amp-input and output impedance frequency response-applications: amplifiers, mathematical operations, active filters, waveform generators-analog computations-comparators-S and H circuit-voltage regulator.

Unit IV

Optoelectronics: Optical fibers: graded index step index fibers-refractive index profiles-propagation of optical beams in fibers-mode characteristics and cut off conditions-losses in fibers-signal distortion group delay material and wave guide dispersion. Optical sources: Light emitting diodes-LED structure internal quantum efficiency-injection laser diode comparison of LED and ILD.

Unit V

Optical detectors: PN junction photo diodes-PN photo detectors-avalanche photo diode-performance comparison.

Text book [TB]:

TB 1. Millman & Halkias: Integrated Electronics (McGraw Hill)
TB 2 .Semiconductor Electronics by A.K. Sharma, New Age International Publisher (1996)
TB 3. Laser and Non-linear optics by B.B. Laud., Wiley Eastern Limited (1985)

Reference books [RB]:

RB 1. Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons
RB 2. Semiconductor Devices - Physics and Technology by S.M. Sze, Wiley (1985)
RB 3. Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define and describe Power amplifiers, Feedback amplifiers, Operational amplifiers, Optoelectronics and Optical detectors
CO2	Understand about Principle and working of different Power amplifiers, Feedback amplifiers, Operational amplifiers, Optoelectronics and Optical detectors
CO3	Illustrate and Explain various oscillators, multivibrators, optical fibers, LED, ILD, Optical Detectors, and applications of operational amplifiers.
CO4	Analyse the characteristics of power amplifiers, operational amplifiers, feedback amplifiers, various optical fibers and optical detectors.
CO5	Distinguish between different power amplifiers, oscillators, multivibrators operational amplifiers, feedback amplifiers, various optical fibers and optical detectors
CO6	Design various electronic circuits such as power amplifiers, oscillators, multivibrators, operational amplifiers, feedback amplifiers, various optical fibers and optical detectors for practical purposes.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	3	1	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	2	2	2	2	2	2	2	2	1	2	2	1	3	3	1	2
CO4	3	2	2	1	3	2	2	1	2	2	2	1	2	2	2	1
CO5	2	1	2	2	2	1	2	2	1	3	2	1	2	2	2	1
CO6	2	1	2	2	2	1	2	2	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHL105**				
Course Name	**: Laboratory Course – I**				
Semester /Year	**: I / 1st**				
		L	**T**	**P**	**C**
		0	**0**	**8**	**4**

Course Objective:

To teach the student's properties of various semiconductor and transistor characteristics by having the students perform hands on experiments supervised by a specialized instructor.

Course Contents

List of experiments: At least 5 experiments are to be performed:

1. Study of LCR circuit
2. Transistorized LCR bridge
3. Study of UJT
4. Study of MOSFET
5. Study of NPN and PNP transistor characteristics
6. Study of DIAC
7. Study of TRIAC
8. e/m by Zeeman Effect
9. Study of IC- Based Power supply
10. Measurement of wavelength of He-Ne laser using interference and diffraction pattern

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of Zeeman effect and interference pattern to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHL106				
Course Name	: Laboratory Course – II				
Semester /Year	: I / 1st				
		L	T	P	C
		0	0	8	4

Course Objective:

To teach the students properties of semiconductors, oscillator, amplifier and different network theorems by having the students perform hands on experiments supervised by a specialized instructor.

Course Contents

List of experiments: At least 5 experiments are to be performed:

1. Study of FET
2. R.C. coupled amplifier
3. T.C. coupled amplifier
4. Study of feedback amplifier
5. Study of Hartley oscillator
6. Study of Colpitt oscillator
7. Study of Wien bridge oscillator
8. Design and study of different network theorems
9. Design and study of phase shift oscillator
10. Study of operational amplifier

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as amplifier and oscillator to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	1	2	2	2	1	1	2	2	1
CO2	3	2	2	2	3	2	2	2	2	3	2	2	2	2	2	1
CO3	2	2	1	3	2	2	1	2	2	2	2	1	3	2	3	1
CO4	2	2	1	2	2	2	1	1	2	2	2	1	2	1	2	2
CO5	3	2	2	2	3	2	2	1	2	3	2	2	2	2	2	1
CO6	2	2	1	2	2	2	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHC201				
Course Name	: Atomic and Molecular Physics				
Semester /Year	: II / 1st	L	T	P	C
		3	0	0	3

Course Objective:

The main objective of the course on atomic and molecular physics is to impart knowledge about various atomic spectroscopy. Using these tools MSc student would understand and handle various spectroscopic concepts to study physics problems if he/she chooses to pursue research in physics as a career.

Course Contents

UNIT I

Atomic Spectroscopy: Hydrogen, Helium and Alkali spectra, Alkaline spectra, Vector atom model of Hydrogen atom, Relativistic correction, Spin-orbit coupling, Hydrogen fine structure, Spectroscopic terms, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling, Hyperfine structure.

UNIT II

Atom in Magnetic and Electric Field: Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field, Paschen-Back effect, Magnetic interaction energy in strong field, Stark effect, First order Stark effect in hydrogen, Quantum mechanical treatment of both the effects.

UNIT III

Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, . Rotational fine structure of electronic-vibration transitions, Electronic spectra.

UNIT IV

Spin Resonance Spectroscopy: Electron spin resonance and nuclear magnetic resonance spectroscopy

Text book [TB]:

TB 1. C.N. Banwell, E.M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).

TB 2. R. Kumar, Atomic and Molecular Physics, Campus Books International (2013).

Reference books [RB]:

RB 1. B.H. Bransden & C. J. Joachin Physics of Atoms and Molecules.2nd Edition Prentice Hall (2003).

RB 2. H.E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the atomic spectra, atoms in electric and magnetic field, molecular spectroscopy and spin resonance.
CO2	Understand hydrogen spectra, rotational and vibrational spectra. Rotational and vibrational spectra of diatomic molecule
CO3	Apply coupling jj and L-S, rigid rotator, Zeeman effect, ESR and NMR. Franck-Condon principle. Rotational fine structure of electronic-vibration transitions.
CO4	Analyse spectroscopic term, hyperfine structure and Raman spectroscopy. Spin-orbit coupling
CO5	Evaluate Born opp. Approximation, Pauli's exclusion principle, Stark effect, First order Stark effect in hydrogen, Parity,
CO6	Formulate Lande interval rule, electronic spectra. Hydrogen, Helium and Alkali spectra

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	2	2	1	1	1	1	2	2	1	1	2	2	1
CO2	1	2	2	3	2	1	2	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	2	1	3	2	1	2	2	1	3	3	2	1
CO4	1	2	2	2	2	1	2	2	2	2	2	1	2	2	1	2
CO5	1	2	1	3	2	1	3	2	1	3	2	1	3	2	2	1
CO6	1	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHC202				
Course Name	: Solid State Physics				
Semester /Year	: II/ 1st				
		L	T	P	C
		3	0	0	3

Course Objective:

To study the structure and some of the basic properties of the solid materials. This course includes detail description of lattice dynamics, crystal, electronic structure and Brillouin zone of materials.

Course Contents

Unit I

Crystal Structure: Periodic arrays of atoms, Primitive lattice cell, fundamental types of lattices, index system for lattice planes, Simple crystal structure, Atomic radii, coordination number, Cesium chloride structure. Hexagonal Close Packed Structure, Diamond Structure, cubic Zinc Sulphide structure, point group.

Unit II

Reciprocal lattice: diffraction waves by crystals, Bragg's law, Scattered wave amplitude, Laue equations. Brillouin zones, reciprocal lattice to SC lattice, B C C lattice, F C C lattice, structure factor of B C C structure, F C C lattice, Atomic form factor.

Unit III

Crystal Binding and Elastic Constants: Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic compliance and stiffness constants, Elastic waves in cubic crystals, Experimental determination of elastic constants.

Unit- IV

Lattice Vibrations: Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis, quantization of elastic waves, Phonons, Phonon momentum, Inelastic scattering of photons by phonons.

Text book [TB]:

TB 1. Kittel C., Introduction to Solid State Physics, John Willey (2004).
TB 2. Dekker A.J., Solid State Physics, Prentice Hall (1965).
TB 3. Mayers H. P., Introduction to Solid State Physics, Taylor & Francis (1997).

Reference books [RB]:

RB 1. S.O. Pillai, Solid State Physics
RB 2. Ashcroft N.W. and Mermin N.D., Solid State Physics, Harcourt Asia Pvt. Ltd. (1976).

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Describe the crystal structure and system of the solids, Reciprocal lattice, Crystal Binding and Elastic Constants, Lattice Vibrations
CO2	Understand diffraction waves by crystal, Bragg's law, elastic waves in cubic crystals, quantization of elastic waves, analysis of elastic springs, reciprocal lattice
CO3	Apply Laue's equations, Brillouin zones, group velocity. Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis
CO4	Crystal structures, analyse elastic springs, phonon momentum, closed packed structure.
CO5	Evaluate fundamental types of lattice, Two atoms per primitive basis, packing factor
CO6	Express the ionic crystal, covalent crystal, metals, Bonding in solids, hydrogen bonds

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	1	1	2	2	2	2	1	1	2	2	1
CO2	1	2	2	2	1	2	2	2	1	3	2	1	2	2	1	1
CO3	2	2	1	2	2	2	1	2	2	1	2	2	2	2	2	1
CO4	2	2	1	2	2	2	1	2	2	1	2	3	2	1	1	2
CO5	2	2	2	2	2	1	1	2	1	2	2	2	1	1	2	1
CO6	3	2	2	2	2	1	1	2	1	2	2	2	1	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHC203				
Course Name	: Statistical Physics				
Semester /Year	: II/ 1[st]				
		L	T	P	C
		3	0	0	3

Course Objective:

The main objective of the course on statistical physics is to impart knowledge about macroscopic and mesoscopic systems employed to study physics problems.

Course Contents

Unit I

Classical Statistics: Macro and microstates, connection between statistics and thermodynamics, Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boltzmann's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

Unit II

Application of classical distribution to the ideal gases: Degrees of freedom, translational motion, Helmholtz free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.

Imperfect gases: Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases.

Unit III

Quantum Statistics: Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non-degenerate, weakly degenerate and strongly degenerate cases, liquid Helium B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

Unit IV

Black Body Radiation: Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law, high temperature measurements.

Text book [TB]:

TB 1. Reif F., Fundamentals of Statistical and Thermal Physics, McGraw Hill (1985).
TB 2. . Landau and Lifshitz: Statistical Physics

Reference books [RB]:

RB 1. Pathria R.K., Statistical Mechanics, Butterworth-Heinemann (1996).
RB 2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe Basic Postulates, Application of classical distribution to the ideal gases, Imperfect gases, Quantum Statistics, Black Body Radiation
CO2	Understand statistics, phase space, ensembles, liquid helium, absorption and emission of radiation.
CO3	Examine partition function, Sackur tetrode equation, B.E condensation principle, Wein's displacement formula, Gibb's paradox, Liouville's theorem
CO4	Deduce Stefan's law, ensembles, pressure energy relationship, Rayleigh Jean's formula, Statistical equilibrium, specific heat of solids
CO5	Evaluate partition functions, viral coefficients, Planck's distribution, pressure and energy relationship of photons, Phase space.
CO6	Formulate Gibb's paradox, degenerate cases, Vander Waal constant and Virial coefficient.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	1	2	2	1	1	2	2	1
CO2	2	3	1	2	3	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	2	2	2	2	2	2	1	2	2	1	3	3	2	1
CO4	2	3	2	2	3	2	1	2	2	2	2	1	2	2	1	2
CO5	3	2	2	2	2	1	1	2	1	3	2	1	3	2	2	1
CO6	2	2	1	2	2	1	1	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC204**				
Course Name	**: Quantum Mechanics**				
Semester /Year	**: II/ 1st**	L	T	P	C
		3	0	0	3

Course Objective:

To apprise the students regarding the quantum mechanics and its advanced concepts and their use in various situations pertaining to static and dynamic conditions.

Course Contents

Unit I

Introduction: A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation. One dimensional potential step, tunnelling, Hydrogen atom, particle in a three-dimensional box.

Unit II

Matrix Formulation of Quantum Mechanics: Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Unit III

Symmetry in Quantum Mechanics: Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J_+, J_-, J_z, J_2. Concept of spin, Pauli spins matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator, non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Unit IV

Approximation Methods for Bound State: Time independent perturbation theory for non-degenerate and degenerate systems up to second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect with electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

Text book [TB]:

TB 1. David J. Griffiths, Introduction to Quantum Mechanics. 2nd ed. Upper Saddle River,NJ: Pearson Prentice Hall (2004).

TB 2. Zettili N.,Quantum Mechanics: Concepts and Applications, 2nd Ed, John Wiley (2009).

Course code	**: MPHC204**				
Course Name	**: Quantum Mechanics**				
Semester /Year	**: II/ 1st**	L	T	P	C
		3	0	0	3

Course Objective:

To apprise the students regarding the quantum mechanics and its advanced concepts and their use in various situations pertaining to static and dynamic conditions.

Course Contents

Unit I
Introduction: A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation. One dimensional potential step, tunnelling, Hydrogen atom, particle in a three-dimensional box.

Unit II
Matrix Formulation of Quantum Mechanics: Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Unit III
Symmetry in Quantum Mechanics: Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J_+, J_-, J_z, J^2. Concept of spin, Pauli spins matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator, non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Unit IV
Approximation Methods for Bound State: Time independent perturbation theory for non-degenerate and degenerate systems up to second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect with electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

Text book [TB]:

TB 1. David J. Griffiths, Introduction to Quantum Mechanics. 2nd ed. Upper Saddle River,NJ: Pearson Prentice Hall (2004).
TB 2. Zettili N.,Quantum Mechanics: Concepts and Applications, 2nd Ed, John Wiley (2009).

Reference books [RB]:

RB 1. Bransden B. H. and Joachain C. J., Quantum Mechanics, 2nd Ed, Pearson Education (2000).
RB 2. Schiff L. I., Quantum Mechanics, 3rd Ed, McGraw Hill Book Co. (1990).

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Define and describe basic postulates of quantum mechanics, Matrix Formulation and symmetry in Quantum Mechanics, Approximation Methods for Bound State
CO2	Understand Schrodinger equation, potential problems, Time independent and Time-dependent perturbation theory, Matrix Formulation and symmetry in Quantum Mechanics
CO3	Apply Schrodinger equation and different approximation methods in various systems and explain Clebsch-Gordon coefficients,
CO4	Analyse various operators, Fermi Golden Rule, Semi-classical treatment of radiation. Einstein coefficients, Zeeman effect, Pauli spins matrices, Poisson brackets and commutation relations
CO5	Evaluate commutation relations, eigenvalues, first order Stark effect in hydrogen atom, WKB approximation
CO6	Solve the problem One dimensional potential step, tunnelling, Hydrogen atom, particle in a three-dimensional box and applications of Variation principle, time dependent and independent perturbations.

<u>CO- PSO-PO Mapping:</u>

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	2	2	2	2	1	2	2	1	3	3	2	1
CO4	2	2	1	2	3	2	1	2	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	2	1	3	2	1	3	2	2	1
CO6	3	2	2	2	2	1	1	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHL205				
Course Name	: Laboratory Course – I				
Semester /Year	: II/ 1st				
		L	T	P	C
		0	0	8	4

Course Objective:

To teach the students optics and electronics phenomenon by having the students perform hands on experiments supervised by a specialized instructor.

Course Contents

List of experiments:

1. Multivibrator: bistable / monostable / Astable
2. Design and study of FET amplifier
3. Design and study of MOSFET amplifier
4. Ionization potential of Mercury using gas filled diodes
5. Michelson interferometer
6. Fabry Perot interferometer
7. Fresnel's law
8. Determination of absorption coefficient of iodine vapour
9. B-H curve
10. Study of pin connection and biasing of various linear IC's and timers 555

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of amplifier and B-H curve to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHL206**
Course Name	**: Laboratory Course – II**
Semester /Year	**: II/ 1st**

L	T	P	C
0	0	8	4

Course Objective:

To teach the students modulation and demodulation, CRO, Ultrasonic waves, and Planks constant by having the students perform hands on experiments supervised by a specialized instructor.

Course Contents

List of experiments:

1. Study of amplitude modulation and demodulation
2. Study of frequency modulation and demodulation
3. Lecher wire experiment
4. Determination of magnetic susceptibility
5. Study of CRO.
6. Velocity of Ultrasonic waves
7. Linear Air track
8. Determination of Planks constant
9. Logic gate AND/OR /NAND/NOR/NOT gates
10. Design and study of UJT relaxation oscillator

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of modulation and demodulation and magnetic susceptibility pattern to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	1	2	2	3	2	1	2	2	1	1	2	1	2	3	2
CO3	2	1	2	1	2	2	1	3	3	1	3	2	1	2	2	2
CO4	2	1	1	2	2	2	1	2	2	1	2	2	1	2	3	2
CO5	1	1	1	1	3	2	1	2	2	1	2	2	1	2	2	2
CO6	1	1	1	1	2	2	1	2	2	1	2	2	1	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC301**				
Course Name	**: Advanced Quantum Mechanics**				
Semester /Year	**: III/ 2nd**				
		L	T	P	C
		3	0	0	3

Course Objective: The main objective of the course on Advanced Quantum mechanics is to impart knowledge about various approximation methods in physics and to give them ideas about laboratory and center of mass frame and study the scattering phenomena in both these frames.

Course Contents

Unit I

Scattering Theory: General considerations: kinematics, wave mechanical picture, scattering amplitude, differential and total cross section. Green's function for scattering. Partial wave analysis: asymptotic behavior of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation to potential, effective range theory. Application to low energy scattering; resonant scattering, Breit-Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances. Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Born approximation; its validity, Born series.

Unit II

Identical Particles: The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and Para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

Unit III

Relativistic Wave Equations: Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, interaction with electromagnetic fields, Hydrogen-like atom (to show it does not yield physical spectrum), non-relativistic limit. Extension of Klein-Gordon equation to spin 1 particles. Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

Unit IV Quantization of wave fields: The quantization of wave fields, Classical and quantum field equations, quantization of non-relativistic Schrodinger equation, second quantization, N-representation, creation and annihilation operators.

Text book [TB]:

TB 1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH)
TB 2. R.P Feynman and A.R.Hibbs; Quantum Mechanics and Path Integrals.
TB 3. L. I. Schiff, Quantum Mechanics (McGraw Hill).

Reference books [RB]:

RB 1. Thankappan, V.K., Quantum Mechanics, New Age International (2004).
RB 2. Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).
RB 3. S. Davydov, Quantum Mechanics (Pergamon).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define and describe scattering theory, identical particles, Relativistic Wave Equations, Quantization of wave fields
CO2	Understand various scattering techniques foe low and high energy particles, , Klein-Gordon equation, Dirac equation formulation, theory of identical particles, Quantization of wave fields
CO3	Apply partial wave and Born approximation techniques to various systems, K-G and Dirac equation, Pauli's exclusion principle to different systems.
CO4	Analyse theory of identical particles, Pauli's exclusion principle, second quantization, Covariance of Dirac equation, scattering amplitude, differential and total cross section and Green's function for scattering.
CO5	Evaluate the problems based on partial wave and Born approximation. Distinguish between Lab. Frame and center of mass frame
CO6	Formulate and develop understanding on theory of identical particles, N-representation, creation and annihilation operators, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron,

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	2	2	2	2	2	2	1	2	2	3	1	2	1	2	2	1
CO3	2	1	3	3	2	2	1	2	2	2	3	2	1	2	2	1
CO4	2	1	2	2	1	2	1	1	2	2	2	2	1	2	1	2
CO5	2	2	2	2	2	2	1	1	2	3	2	2	1	2	2	1
CO6	2	1	2	2	2	2	1	1	2	2	2	2	1	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC302**				
Course Name	**: Nuclear Physics**				
Semester /Year	**: III/ 2^{nd}**				
		L	T	P	C
		3	0	0	3

Course Objective:

The objective of the course is to provide an understanding about the general nuclear properties and knowledge of nuclear models: liquid drop model, shell model and collective model. To provide knowledge and understanding of scattering process and decay phenomenon.

Course Contents

Unit I

General Properties & Models-: Nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, parity, statistics, Binding energy, Liquid drop model, Semi- empirical mass formula, nuclear fission, Shell model, Collective model.

Unit II

Nuclear Forces and Detector – Ground state of deuteron, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces, G.M. Counter, cyclotron, Electron & Proton Synchrotron.

Unit III

Radioactive decay: Radioactive decay equation equilibrium units, Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, Wu's experiment, parity violation in beta decay.

Unit IV

Nuclear Reactions- Q-value of nuclear reaction, Bohr's Theory of compound nucleus, scattering cross section of nuclear reaction (phase shift method), Breit Wigner single level resonance formula for scattering cross section.

Text book [TB]:

TB1. B.R. Martin : Nuclear & Particle Physics
TB2. Tayal, D.C. , Nuclear Physics, Himalaya Publishing House, Mumbai
TB3. Nuclear & Particle Physics-B.R. Martin & G. Shaw

Reference books [RB]:

RB1. S.B. Patel : Nuclear Physics
RB2. M.K. Pal : Theory of Nuclear Structure

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the general properties & models, nuclear forces and detector, radioactive decay, nuclear reactions
CO2	Explain the binding energy, Liquid drop model, Shell model magic number and spin parity related to shell model, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces
CO3	Illustrate the Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, radioactive decay, various decay phenomena and their process
CO4	Analyze the nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistic, the principle and application of G.M counter and synchrotron.
CO5	Evaluate the Q-value of nuclear reaction, parity violation in beta decay, electromagnetic decays. Ground state of deuteron
CO6	Express the stimulation Electron & Proton Synchrotron, Nuclear magnetic moments, Binding energy

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC303**				
Course Name	**: Seminar**				
Semester /Year	**: III/ 2nd**				
		L	**T**	**P**	**C**
		0	**0**	**8**	**4**

Course Objective: The main objective of this course to analyze, construct and evaluate scientific information and research topics. Students will make a quality scientific presentation and speak in front of a scientific audience.

Course Contents

Presentation topic must be related to the student's current research and innovation, nanoscience and technology, any material characterization and analytical techniques, and current thesis or project.

Text book [TB]:

1. R. Williams, Non-Designer's Presentation Book, The: Principles for effective presentation design
2. N. Duarte, Slide: ology: The Art and Science of Creating Great Presentations

Reference books [RB]:

1. G. Reynolds, Presentation Zen: Simple Ideas on Presentation Design and Delivery

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Remember scientific information.
CO2	Develop and understand quality scientific presentation.
CO3	Present and explain and apply scientific information.
CO4	Classify and analyze scientific work for presentation.
CO5	Evaluate scientific information and then analyse it.
CO6	Develop scientific understanding towards research oriented topics

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	2	1	2	2	1	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHE304**				
Course Name	**: Condensed Matter Physics**				
Semester /Year	**: III/ 2nd**				
		L	T	P	C
		3	0	0	3

Course Objective: The main objective of the course on Condensed Matter Physics is to aware students about the defects in crystal, dielectric and magnetic properties, superconductivity, Nano Material Science and Technology etc.

Course Contents

Unit I

Defects in crystals and Magnetism: Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects. Concentration of Schottky defect and Frenkel defects, intrinsic and extrinsic vacancies, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector. Dia, Para and ferromagnetism, Langevin theory of paramagnetic, Ferromagnetism, Weiss molecular theory, Ferromagnetic domains, Antiferromagnetism, Neel's theory, ferrites.

Unit II

Energy Bands: Nearly free electron model, One dimensional free electron case, nearly free electron case, energy bands in one-dimension, Bloch function, Bloch theorem, Kronig penny model, Number of possible wave function in a band, crystal momentum, the concept of effective mass and holes, hole band construction, metal, insulator and semiconductor. Origin and Magnitude of the energy gap, tight binding approximation.

Unit III

Superconductivity: Experimental Survey, Occurrence of super conductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, critical fields and critical currents. London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors,

Unit IV

Dielectrics and ferroelectrics: Macroscopic description of dielectric constants, static, electronic and ionic, orientational polarizability of molecules, Complex dielectric constant, Dielectric loss and relaxation time, Polarization, Macroscopic electric field, depolarization fields, local electric field and atom, ferroelectric crystals, classification of ferroelectric crystals, antiferroelectricity, ferroelectric domains, piezoelectricity.

Unit V

Nano Material Science and Technology: History, Origin, Synthesis, Applications and advantages, Fullerenes, Carbon nanobuds, carbon nanotubes as quantum wires, Quantum dots, Quantum wires, Quantum well & application, Areas of Nanotechnology, nanomaterials, nanoelectronics, nanobiotechnology, nanofabrication, Micro Electro Mechanical systems (MEMS)

Text book [TB]:

TB1. Handbook of Nano Structured Materials and Nano Technology: Nalva

TB2. Nano Technology: Richard Booker and Earl Boysen

Reference books [RB]:

RB1. Principle of condensed matter Physics: Chaikimand Luben sky

RB2. Solid State Physics: Kubo and Ngamia

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the defects in crystals and magnetism energy bands, Superconductivity Energy, Defects in crystals and Magnetism, dielectrics and ferroelectrics, Nano Material Science and Technology
CO2	Express the magnetic and dielectric properties of the solids, Quantum well & application, Nearly free electron model, One dimensional free electron case,
CO3	Determine the defects present in the crystals, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, Classify BCS Theory related to Superconductor.
CO4	Analyse the Complex dielectric constant, History, Origin, Quantum dots, Synthesis, Applications and advantages, Quantum wires, Quantum well
CO5	Evaluate Nanotechnology, ferroelectric domains, piezoelectricity, High temperature superconductors.
CO6	Express the nanobuds, carbon nanotubes as quantum wires, critical fields and critical currents, Colour centres, F-Centre, V-Centre, dislocation.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	2	2	2	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHE305**				
Course Name	**: Digital and Communication Electronics**				
Semester /Year	**: III/ 2nd**	L	T	P	C
		3	0	0	3

Course Objective:

The objective of the course is to provide an understanding about Boolean algebra and knowledge of Combinational and Sequential logic circuits, modulation and demodulation techniques used in communication system and to aware students about RADAR system.

Course content:

Unit I

Boolean Algebra ,Logic Gates & Combinational Circuits: Binary codes (Weighted, BCD,2421, Gray code, Excess 3 code, Error detecting code, Error correcting codes, ASCII, EBCDIC), De-Morgan's Theorem, Sum of Products (SOP), Product of Sums (POS), Minterms &Maxterms, Karnaugh maps and minimization. Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR. Adders, Subtractor, Serial adder/ Subtractor, Parallel adder/ Subtractor, Carry look ahead adder, BCD adder, Magnitude Comparator, Multiplexer, Demultiplexer, Encoder, Decoder, Parity-checker, Code converters

Unit II

Sequential Circuits: Flip flops: Latches, RS, JK, T, D and Master-Slave, Characteristic table and equation. Edge triggering, Level Triggering. Registers & Counters: Asynchronous/ Ripple counters, Synchronous counters, Modulo–n Counters, Shift registers, Universal shift register, Shift counters, Ring counters.

Unit III

Modulation -Amplitude Modulation-Theory, Plate Modulated class C amplifier, Balanced Modulator, Single Side Band modulation (phase shift method), Frequency modulation – Theory, Reactance tube modulator, transistor reactance modulator, FET reactance modulator. Digital Modulation, PAM, PPM, PWM, Principle of PCM, **Demodulation-** Envelope diode detector, Foster Seeley phase discriminator, Ratio Detector. **Transmitters & Receivers-** A.M Transmitter, F.M. transmitter, TRF Receiver, Super heterodyne receiver, amplitude limiting.

Unit IV

Transmission Lines– TL Equations and their solutions, characteristic impedance, lossless open and short-circuited lines, standing wave ratio and refection coefficient, stub matching, **Antenna** – Radioactive field strength, power and radiation patterns of an elementary electric doublet and linear antenna, effects of ground reflection. Hertz antenna, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Antenna array (Broad side & End fire arrays), Horn Antenna, Parabolic reflectors, Lens Antenna.

Unit V

Radar Systems- Principle of Radar, Basic arrangement of Radar system, Azimuth and Range measurement, operating, Characteristics of systems, Radar transmitters and Receivers, Duplexers, Indicator unit, maximum range of a Radar set.

Text book [TB]:

TB1. A. Anand Kumar : Fundamentals Of Digital Circuit

TB2. Thomas L. Floyd: Digital Fundamentals

Reference books [RB]:

RB1. Malvino& Leach: Digital Principles and Applications

RB2. Morris Mano: Digital Design

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe Boolean Algebra ,Logic Gates & Combinational Circuits, Sequential Circuits, Modulation & Demodulation, Transmission Lines, Modulation, Radar Systems
CO2	Explain the flip flops, counter, register and its logic circuit, antenna, RADAR, TL Equations and their solutions, characteristic impedance
CO3	Determine the application of modulation and demodulation techniques, Principle of Radar, Basic arrangement of Radar system, Registers & Counters, Logic Gates
CO4	Illustrate modulation, Demodulation, Multiplexer, Demultiplexer, Encoder, Decoder, transmitters and receivers, Adder and Subtractor
CO5	Evaluate the Hertz antenna, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Registers, Asynchronous and Synchronous Counters, Adders and Subtractors.
CO6	Express the Logic Gates, Ring counters, use of K-map to simplify the Boolean algebra expression, Excess 3 code

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	3	2	2	2	2	2	2	1	2	2	1	3	3	1	2
CO4	2	2	2	2	3	2	2	1	2	2	2	1	2	2	2	1
CO5	2	2	2	2	2	1	2	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	1	2	2	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHE 306				
Course Name	: Laser Physics				
Semester /Year	: III/ 2nd				
		L	T	P	C
		3	0	0	3

Course Objective: The main objective of the course on Laser physics is to aware students about the laser and its types and phenomena of laser spectroscopy, optical fibres and principles of holography.

Course contents:

Unit I

Basic principles and modulators: Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion, spatial and temporal coherence, Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acoustic optic effect, Raman and Bragg regimes, acoustic optic modulators, magneto-optic effect, optical directional couplers and optical switches, phase modulators.

Unit II

Types of lasers, Optical sources and detectors: Gas lasers, He-Ne, argon ion, N_2, CO_2 lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers, spin flip lasers, laser spikes, mode locking Q-switching, Laser devices, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light, photodiodes: structure, materials and working, PIN photodiodes, avalanche photodiodes, micro channel plates, photo detector, noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD.

Unit III

Non- linear optics and Fiber optics: Theory of non-linear phenomenon, second and third harmonic generation, phase matching, parametric generation, self-focusing, Basic characteristics of optical fibers, structure and fundamentals of waveguides, step and graded index fibers, signal degradation in optical fibers, absorption scattering, radiation and core cladding losses, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers.

Unit IV

Laser spectroscopy: Laser fluorescence spectroscopy using CW and pulsed lasers, Single photon counting, Laser Raman spectroscopy, multiphoton processes, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy.

Unit V

Holography: Basic principles, construction and reconstruction of holograms, applications of holography, laser interferometry, laser applications in industry and medicines

Text book [TB]:

TB1. K.R. Nambiar: Lasers: Principles, types and Applications

Reference books [RB]:

RB1. Lasers: Ghatak and Thyagrajan

RB2. O. Svelto: Principles of Lasers

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the Basic principles and modulators, Types of lasers, Optical sources and detectors, Non- linear optics and Fiber optics, and Laser spectroscopy Holography
CO2	Illustrate the Gas lasers, He-Ne, argon ion, N2, CO2 lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers
CO3	Explain Laser interferometry, PIN photodiodes and modulator, Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion
CO4	Analyse the photo detector, LED etc. for practical purposes, optical fiber, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light
CO5	Evaluate Distinguish laser interferometry, PIN photodiodes, Electro optic effect, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy
CO6	Express various applications of laser in research field, Einstein's coefficients, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MPHE307					
Course Name : Astrophysics					
Semester /Year : III/ 2nd					
		L	T	P	C
		3	0	0	3

Course Objective: The main objective of the course on astrophysics is to impart knowledge about the physics of stars and aware students about photometry, spectroscopy, interstellar matter, classification of galaxies and cosmology.

Course contents:

Unit I

Physics of the Stars: Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration, parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Solar motion and its determination. Peculiar velocities. Single and Two star stream hypothesis. Velocity ellipsoid. Comparison with solar neighborhood. Bottlinger's diagram. HR diagram, HD and MK spectral classification of stellar spectra. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax.

Unit II

Fundamental Equations, Detectors, Photometry and Spectroscopy: Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Stellar models: Russell- Voigt theorem. Dimensional discussions of mass-luminosity law. Astronomical photometry and spectroscopy. Simple design of an astronomical photometer. Observing technique with a Photometer Correction for atmospheric extinction. Radio Astronomy Techniques. Electro-magnetic spectrum. Radio window. Design and construction of a simple radio telescope. Receiver systems. Design and construction of a simple radio interferometer.

Unit III

Galactic System and Extragalactic Systems: Interstellar Matter, Oort limit. Interstellar extinction. Estimate of color excess. Visual absorption. Interstellar reddening law and Polarisation. Spin temperature. Interstellar magnetic fields. Stromgren's theory of H II regions. Physical processes in planetary nebulae. Galactic Structure: General galactic rotational law. Oort's theory of galactic rotation. Determination of Oort's constants. Spiral structure of our Galaxy from optical and radio Observations. Size and mass of our galaxy. Classification of galaxies and clusters of galaxies. Hubble sequence. Galaxy interactions. Determination of the masses and extragalactic distances. Active Galaxies: Active galaxies and galactic nuclei. Properties of Radio galaxies and Quasar.

Unit IV

Super dense Objects: Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation. Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies. Formation, features and properties of Neutron stars, Pulsars and black holes.

Unit V

Gravitation & Cosmology: Conceptual foundations of GR and curved space-time: Principle of equivalence, Connection between gravity and geometry, Form of metric in Newtonian, limit Metric tensor and its properties, Einstein's field equations, observational tests of general relativity. Models of the universe: Steady State Models. Standard Model: The expanding universe, Hubble's law. Microwave background radiation Friedman-Robertson-Walker models, the early universe, Elementary ideas on structure formation. Implications of the dark matter in modern cosmology.

Text book [TB]:

TB 1 W.M.Smart: Text book of Spherical Astronomy

TB2. K.D.Abhyankar: Astrophysics:Stars and Galaxies (Tata McGraw Hill Publication)

Reference books [RB]:

RB1. D.Mihalas: Galactic Astronomy
RB2. S.Chandrasekhar: Principles of Stellar Dynamics

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the Physics of the Stars, Fundamental Equations, Detectors, Photometry and Spectroscopy, Galactic System and Extragalactic Systems, Super dense Objects, Gravitation & Cosmology
CO2	Explain the stellar evolution, the concept of Black holes, Statistical parallaxes. Solar motion and its determination. Peculiar velocities. Single and Two-star stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlinger's diagram. HR diagram.
CO3	Explain the types of binary stars, Design and construction of telescope Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies
CO4	Analyse the classify stellar energy and mass distribution in research field, Einstein's field equations, observational tests of general relativity. Models of the universe: Steady State Models. Standard Model: The expanding universe, Hubble's law. Microwave background radiation Friedman-Robertson-Walker models, the early universe
CO5	Distinguish Mass and radius relation, Galactic Structure, Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation.
CO6	Express Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs, Determination of the masses and extragalactic distances, Galaxy

	Interaction

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	1	1	2	2	1	2	2	2	1
CO2	3	2	1	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	2	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	3	2	1	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	1	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHE308**				
Course Name	**: High Energy Physics**				
Semester /Year	**: III/ 2nd**				
		L	T	P	C
		3	0	0	3

Course Objective: The main objective of the course on high energy physics is to impart knowledge about the Scattering Matrix and Feynman Rules, Classical and quantum field equations, color gauge invariance and QCD.

Course contents:

Unit I:

Classical and Quantum Field Equations: Coordinates of the field, Classical Lagrangian Equation, Classical Hamiltonian Equations, Quantum Equations for the Field, Fields with more than one component, Complex Field, Quantization of the Non-relativistic Schrodinger Equation, Classical Lagrangian and Hamiltonian Equations, Quantum Equations, The N-representation, Creation and Destruction Operators, Number Operators, Anti-commutation Relations, Equations of Motion, Physical Implications of Anti-commutation, Representation of Anti-commuting operators

Unit II:

Quantization of fields and Renormalization of QED: Quantization of Dirac field covariant anti-commutation relations, Quantization of electromagnetic field. Interaction Lagrangian for the fields, QED Lagrangian. Self-energy correction, vacuum polarization and vertex correction, classification of Divergences, Renormalization of mass and charge, wave function renormalization.

Unit III:

Scattering Matrix and Feynman Rules: The S-Matrix reduction of S- Matrix chronological product, Wicks theorem Furry's theorem Covariant perturbation theory interaction Lagrangian for QED, Feynman Diagrams and Feynman rules for QED in configuration and momentum space, Electron- Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation , Compton scattering. Symmetries and conservation laws, Norther's Theorem, U (1) Gauge Invariance, Baryon and Lepton number conservation, the concept of gauge invariance; Global and Local gauge invariance, spontaneous Breaking of Global gauge invariance, Goldstone Bosons, the Higgs mechanism, Generalized local gauge invariance-Abelian and non-Abelian gauge invariance.

Unit IV

Color gauge invariance and QCD: The standard model of fundamental interaction, general mass terms, Cabibbo Angle, Kobayashi- Maskawa matrix and CP violation, The SU (5) Grand unified theory, The generators of SU (5), The choice of Fermion representations spontaneous breaking of SU (5) symmetry Fermion masses and mixing angles.

Unit V

Weinberg- Salam theory of electroweak unification, the matter fields, the gauge fields, the gauging of SU (2) XU (1), The vector bosons, The fermions sector, Helicity states, parity, charge conjugation Fermion masses, Fermion assignments in the electroweak model, spontaneous symmetry break down, Fermion Mass generation. The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10).

Text book [TB]:

TB 1. Donald H. Perkins: Introduction to High energy physics
TB 2. Quantum electrodynamics , A.I. Akhiezer and Berestetski

Reference books [RB]:

RB1. Theory of photons and electrons, J.M. Jauch and E. Rohrlich
RB2. Relativistic Quantum field, J.D. Bjorken and S. D. Drell.

Course outcomes (COs):
Upon successful completion of the course a student will be able to

CO1	Describe the classical and quantum field equations, quantization of fields and Renormalization of QED, Scattering Matrix and Feynman Rules, Color gauge invariance and QCD, Weinberg- Salam theory of electroweak unification
CO2	Discuss the application of scattering Matrix and Feynman Rules the quantization of fields, Global and Local gauge invariance, Electron- Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation, Compton scattering. Symmetries and conservation laws, Norther's Theorem
CO3	Compute Classical Lagrangian and Hamiltonian Equations Quantum Equations, Fermion Mass generation. The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, Kobayashi- Maskawa matrix and CP violation
CO4	Analyze area of high energy physics, classical predictions of SU The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10)
CO5	Discriminate Cabibbo Angle, Complex Field, Quantization of the Non-relativistic Schrodinger , Fermions Masses , quark and Lepton masses, Creation and Destruction Operators, Number Operators, Anti-commutation Relations, Equations of Motion, Physical Implications of Anti-commutation, Representation of Anti-commuting operators
CO6	Express Interaction Lagrangian for the fields, QED Lagrangian, Number Operators, Symmetries and conservation laws

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : **MPHL 309**					
Course Name : **Laboratory Course**					
Semester /Year : III/ 2nd					
	L	T	P	C	
	0	0	8	4	

Course Objective: The main objective of this Lab. course is to impart practical knowledge in different fields such as solid state physics, electronics, Laser physics etc. to the students.

Course contents:

Condensed Matter Physics:

List of experiments: At least 5 experiments are to be performed

1. Determination of elastic constant of crystals by optical methods
2. Study of fluorescence spectra of a given compound
3. Study of color centers
4. Determination of lattice parameters using powder method.
5. Determination of hall coefficient using Hall effect
6. Determination of Energy gay of a semiconductor by four probe method
7. ESR
8. Dielectric constant

Electronics:

List of experiments: At least 5 experiments are to be performed

1. Study of regulated power supply (723).
2. Study of Timer (555).
3. A to D and D to A convertor
4. 1 of 16 Decoder/Encoder
5. Study of Multiplexer/Demultiplexer
6. Study of Comparator and Decoder
7. Study of different flip- flop circuits (RS, JK, D type, T-type, Master slave).
8. Study of Digital combinational and sequential circuits
9. Study of Microprocessor (8085)
10. Study of SCR, DIAC, TRIAC
11. Study of IC- Based Power supply

12. Microwave experiment.

13. Shift Registers

14. Fiber Optics communication

Laser Physics:

List of experiments: At least 5 experiments are to be performed

1. Study of the vibrational levels of Iodine.

2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate.

3. Determination of the intrinsic life time for a dye molecule.

4. Determination of change in dipole moment in excited state using Solvatochromic shift method.

5. Measurement of non-radiative decay rate for a known sample.

6. Determination of the quantum yield of known samples using steady state spectroscopy.

7. Study of electro optic effect

8. Study of Acousto-optic effect

Astrophysics:

List of experiments: At least 5experiments are to be performed

1. Study of Hubble's law (from given data)

2. Study of constant density neutron star

3. Study of the static parameters of a Neutron Star model with inverse square density distribution

4. Study of star cluster from a given data

5. Study of Extinction coefficients

6. Study of variability of stars

High Energy Physics:

List of experiments: At least 5 experiments are to be performed

1. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector.

2. Energy spectrum of gamma rays using gamma ray spectrometer.

3. Absorption coefficient of aluminum using gamma-ray spectrometer.

4. Characteristics of Scintillation Detector.

5. Study of gamma-gamma unperturbed angular correlations.

6. Study of particle tracks using a Nuclear Emulsion Detector.

7. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy. 8. Mossbauer spectrometer

Note: Students have to perform those experiments which are related to their chosen elective Paper

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as Condensed Matter Physics Electronics/ Laser Physics/ Astrophysics to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHS310**				
Course Name	**: Physics of Nano Materials**				
Semester /Year	**: III/ 2nd**				
		L	T	P	C
		0	0	0	3

Course Objective: The main objective of the course on Physics of Nano Materials is to impart knowledge about the physics in quantum well, quantum wire and quantum dot and to aware the students about size, shape-controlled synthesis of nanomaterials and their future applications in industry.

Course contents:

Unit I

Nanoparticles: Synthesis and Properties: R F Plasma Chemical Methods, Thermolysis, Pulsed laser Methods, Biological Methods, Synthesis using micro-organisms, Synthesis using Plant extract, Metal Nanoclusters, Magic Numbers, modeling of Nano Particles, Bulk of Nano Transitions.

Unit II

Carbon Nano Structures: Nature of Carbon Clusters, Discovery of C60, Structure of C60 and its crystal, Superconductivity in C60, Carbon Nano Tubes: Synthesis, structure, Electrical and Mechanical Properties. Graphene: Discovery, Synthesis and Structural Characterization through TEM, Elementary concept of its applications

Unit III

Quantum Wells, Wires and Dots: Preparation of Quantum Nano Structures, Size Effects, Conduction Electrons and Dimensionality, Properties Dependent on Density of States. Analysis Techniques for Nano Structures/Particles: Scanning Probe Microscopes (SPM), Diffraction Techniques, Spectroscopic Techniques, Magnetic Measurements.

Unit IV

Bulk Nano Structure Materials: Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers, Metal Nano Cluster, Composite Glasses, Porous Silicon.

Text book [TB]:

TB1. Edward L. Wolf: Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd ed., Wiley-VCH (2015)

TB 2. Handbook of Nano Structured Materials and Nano Technology: Nalva

Reference books [RB]:

RB1. Introduction to Nano Technology: Poole and Owners
RB2. Quantum Dots: Jacak, Hawrylak and Wojs

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the nanoparticles: Synthesis and Properties, carbon nano structures, carbon nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
CO2	Understand the synthesis and properties of nanomaterials, Carbon Nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
CO3	Apply Nanoscience and Nanotechnology in modern device applications and in various fields
CO4	Analysis of various properties of nanomaterial by using different techniques
CO5	Evaluate the Different properties of nanomaterial for various fields.
CO6	Develop nanomaterials for various field applications, Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	2	1	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	3	2	2	2	1	2	2	3	2	2	1	2	1	1
CO3	2	1	2	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	2	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	1	3	2	1	2	1	2	1	3	2	1	2	2	2	1
CO6	2	1	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MPHS 311				
Course Name	: Quantum Electrodynamics				
Semester /Year	: III/ 2nd				
		L	T	P	C
		0	0	0	3

Course Objective: The main objective of the course on Quantum Electrodynamics is to impart knowledge about the relativistic quantum mechanical equations, namely, Dirac equation and to aware students about second quantization and related concepts.

Course contents:

Unit I

Dirac equations, Properties of Dirac Matrices, Projection Operators, Traces, Feynman's theory of Position.

Unit II

Second quantization of Klein Gordon field, Creation and annihilation operators, commutation relations, Quantisation of electromagnetic field, Creation and annihilation operators, commutation relation, Fock space representation, interaction fields.

Unit III

Dirac (interaction) picture, S-matrix and its expansion. Ordering theorems, Feynman graph and Feynman rules. Application to some problems.

Unit IV

Rutherford Scattering and Compton scattering, calculations of cross sections using Feynman graphs.

Text book [TB]:

TB1. Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics, Tata McGraw Hill (2004).

TB 2. Schweber, Bethe and Hoffman: Mesons and Fields

Reference books [RB]:

RB1. Bjorken and Drell: Relativistic Quantum Fields
RB2. Muirhead: The Physics of Elementary Particles

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define and describe Dirac equations, operators, K-G Equation, Second quantization Rutherford Scattering and Compton scattering, matrix Mechanics.
CO2	Understand Quantisation of electromagnetic field Rutherford Scattering and Compton scattering.
CO3	Explain Feynman graphs for different interactions, -matrix and its expansion
CO4	Classify scattering phenomenon, Feynman's theory of Position, Second quantization of Klein Gordon field, interaction fields.
CO5	Evaluate Matrix and Feynman Rules, Dirac (interaction) picture, Properties of Dirac Matrices
CO6	Solve Creation and annihilation operators, commutation relation, Projection Operators, Traces, cross sections using Feynman graphs.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	1	2	2	1	1	2	2	1	1	2	2	1
CO2	1	2	2	1	2	2	2	2	2	3	2	2	2	2	1	2
CO3	3	2	2	2	3	3	2	2	1	2	2	1	3	3	2	1
CO4	2	2	2	1	2	2	2	1	2	2	2	1	2	2	1	1
CO5	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2	1
CO6	2	2	2	1	2	2	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHC401**				
Course Name	**: Computational Physics**				
Semester /Year	**: IV/ 2^{nd}**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective: The main objective of the course on computational physics is to impart knowledge about how to solve physics problems through different numerical techniques and use computer programming for analysis of data.

Course contents:

Unit I

Roots of functions, interpolation, extrapolation, integration by trapezoidal and Simpson's rule, Runge-Kutta Method, Least square fitting method.

Unit II

Eigenvalues and eigenvectors of matrices, power and Jacobi method, solution of simultaneous linear equations Gaussian elimination, Pivoting, Iterative method, matrix inversion.

Unit III

Flowchart and algorithms-Problem analysis flowchart of some basic problems. The concept and properties of algorithmic languages, elementary algorithm development algorithm involving decision and loops.

Unit IV

C-Programming: selection of C programming loops and control, constructs, arithmetic and logic operators, Strings, arrays, pointers, floats and other types, input, output, control constructs, recursion structures, sub Programmes and modules.

Text book [TB]:

TB1. MK Jain, S.R.K. Iyengar, RK Jain: Numerical Methods
TB2. Reema Thereja: Programming in C

Reference books [RB]:

RB1. V Rajaraman: Computer Programming in c.
RB2. Let us C: Yashwant Kanetkar

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define and describe Roots of functions, Eigenvalues and eigenvectors of matrices, interpolation, Flowchart and algorithms, basics of C-Programming.
CO2	Understand interpolation, numerical integration methods, Flowchart and algorithms, C-Programming. Eigenvalues and eigenvectors of matrices,
CO3	Apply Roots of functions, Runge-Kutta Method, numerical integration, C-Programming methods to various problems.
CO4	Analyse the various interpolation methods, matrix inversion methods, Flowchart and algorithms, C-Programming to apply in various problems
CO5	Evaluate problems based on Roots of functions, Runge-Kutta Method, numerical integration, interpolation, Flowchart and algorithms, C-Programming
CO6	Formulate data types, operators, loops, arrays, pointers, Strings, input-output in C-Programming. Solve problems based on Gauss Jordan, Jacobi, Gaussian elimination, Gauss-Seidel method

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course Code	: MPHC402				
Course Name	: Particle Physics				
Semester /Year	: IV/ 2nd				
		L	T	P	C
		3	0	0	3

Course Objective: The objective of the course is to provide an understanding about the elementary particles and knowledge of conservation laws, interaction and its properties and Quark structure of the particles.

Course contents:

Unit I

Classification and Properties of Elementary Particles: Elementary Particles, their classification on the basis of their mass and spins (Leptons, Mesons, Baryons) and field quanta. Their general properties (mass, spins, life time and their production and decay modes), Antiparticles.

Unit II

Conservation Laws and Gauge Invariances: Conservation of Energy, Linear and Angular momentum, Spin, Charge, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation, Time Reversal, CP, CPT theorem, Global and Local gauge invariances.

Unit III

Fundamental Interaction: Qualitative ideas (Relative strengths, Ranges, Characteristic times and Mediators) of Gravitational, Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-week and Grand unifications.

Unit IV

Quark Model: Eight fold way, Quarks as building blocks of hadrons, six quarks (u,d,s,c,t and b), Antiquarks, General properties of quarks (Charge, Mass, Color – A new degree of freedom, quark confinement, Asymptotic freedom) Evidences for Quarks (Lepton scattering, Hadron Spectroscopy, Jet production), Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.

Text book [TB]:

TB1. Nuclear & Particle Physics-B.R. Martin & G. Shaw

TB2. Introduction to Elementary Particle Physics-D. Griffiths (John Wiley & sons)

Reference books [RB]:

RB1. Introduction to Nuclear & Particle Physics-VK Mittal, R.C. Verma&

S.C.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi, 2009) (All units 55pprox..)
RB2. Elementary Particle Physics-Gasiorowicz (John Wiley & sons,).

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Define Elementary Particles, Conservation of Energy, Fundamental Interaction Quark Model
CO2	Illustrate classification of elementary particles, CPT theorem, Global and Local gauge invariances, Evidences for Quarks, field quanta. Their general properties
CO3	Determine Quarks as building blocks of hadrons, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation
CO4	Analyse Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-week and Grand unifications.
CO5	Evaluate Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.
CO6	Formulate Eight fold way, six quarks (u,d,s,c,t and b), Antiquarks.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	1	1	2	2	1	1	2	2	1	2	1	1	1
CO2	2	2	1	1	2	2	2	2	2	3	2	2	2	2	2	2
CO3	3	3	2	2	3	3	2	2	1	2	2	1	2	2	1	1
CO4	2	2	1	1	2	2	2	1	2	2	2	1	2	1	2	1
CO5	2	2	2	2	2	2	2	2	1	3	2	2	2	2	1	1
CO6	2	2	1	1	2	2	2	1	1	2	2	1	2	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHL 403**				
Course Name	**: Laboratory Course**				
Semester /Year	**: IV/ 2nd**				
		L	T	P	C
		0	0	8	4

Course Objective: The main objective of the course is to impart knowledge about the use of algorithm, flowchart and C programming in solving different problems of physics.

Course contents:

List of experiments:

1. Study of computational softwares.

2. Study of numerical techniques.

3. Computer programming.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of modulation and demodulation and magnetic susceptibility pattern to calculate several physical parameters.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	3	1	1	2	2	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	1	2	1	2	1	2	2	1	3	3	1	1
CO4	3	2	1	1	2	2	1	1	2	2	2	1	2	2	1	1
CO5	2	1	1	1	1	1	1	1	1	3	2	1	2	2	1	1
CO6	2	1	1	1	1	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHD404**				
Course Name	**: Dissertation**				
Semester /Year	**: IV/ 2nd**				
		L	**T**	**P**	**C**
		0	**0**	**18**	**9**

Course Objective: The main objective of the course is to carry out extensive research. Student will able to identify gap, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research.

Course contents:

This course will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Observe practical experience of the research process.
CO2	Understands the principles of research.
CO3	Apply principles of research design to solve the problems in the field of research.
CO4	Create, analyse and critically evaluate various research solutions.
CO5	Evaluate links between theory and methods within their field of study
CO6	Create various research solution.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHS 405**				
Course Name	**: Environmental Physics**				
Semester /Year	**: IV/ 2nd**				
		L	**T**	**P**	**C**
		0	**0**	**0**	**3**

Course Objective: The main objective of the course on environmental physics. is to impart knowledge about the environmental changes like pollution and degradation etc. It also deals with remote sensing and interaction of light with matter.

Course contents:

Unit I

Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere. Composition of air. Green House Effect, Transport of Matter, Energy and momentum in Nature. Stratification and stability of atmosphere. Laws of motion, hydrostatic equilibrium.

Unit II

Solar and Terrestrial: Physics of Radiation, Interaction of light with matter, Rayleigh and Mie scattering, laws of radiation (Kirchhoff's law, Plank's law, Wien's displacement law etc.), solar and terrestrial spectra, and UV radiation. Ozone depletion problem, I R absorption.

Unit III

Environmental Pollution and Degradation: Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors Governing air, water and noise Pollution, Air and water quality standards. Waste Disposal. Gaseous and particulate matters, wet and dry deposition.

Unit IV

Environmental Changes and Remote Sensing: Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy, bioenergy, hydropower, fuel cells, Nuclear energy.

Unit V

Global and regional Climate: Elements of whether and climate. Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, viscous forces. Inertia forces, Reynolds number, enhanced Greenhouse effect, Global Climate Models.

Text book [TB]:

TB1. Clare Smith : Environmental Physics

TB2. J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley)

Reference books [RB]:

RB1. Egbert Boeker & Rienk Van Groundelle : Environmental Physics (John wiley)
RB2. J.T. Hougtion : The Physics of Atmosphere (Cambridge Univ.Press.)

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define the essentials of environmental physics, solar and terrestrial, Environmental Pollution and Degradation, Environmental Changes and Remote Sensing, Laws of motion. Global and regional Climate
CO2	Describe Energy and momentum in Nature, Ozone depletion problem, I R absorption, Elementary fluid dynamics, Physics of Radiation, Interaction of light with matter, Rayleigh and Mie scattering, laws of radiation (Kirchhoff's law, Plank's law, Wien's displacement law etc.)
CO3	Apply laws of radiation, Waste Disposal, Physics of Radiation, Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy
CO4	Analyse and deduce hydrostatic equilibrium, Diffusion, hydropower, fuel cells, Solar energy, wind energy, bioenergy.
CO5	Evaluate Gaseous and particulate matters, wet and dry deposition, Green House Effect,
CO6	Develop understanding and Express Energy sources and combustion processes, Turbulence and turbulent diffusion.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	1	2	2	1	1	1	2	1	1	2	2	1
CO2	3	2	2	1	2	2	2	2	2	2	2	2	2	2	1	2
CO3	2	2	2	2	3	3	2	2	1	3	3	1	3	3	2	1
CO4	2	2	1	1	2	2	2	1	2	2	2	1	2	2	1	2
CO5	3	2	2	2	2	2	2	2	1	2	2	2	2	2	2	1
CO6	2	2	2	1	2	2	2	1	1	2	2	1	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MPHS 406**				
Course Name	**: Bio Physics**				
Semester /Year	**: IV/ 2^{nd}**				
		L	**T**	**P**	**C**
		0	**0**	**0**	**3**

Course Objective: The main objective of the course is to impart knowledge about the organization of molecule like protein and separation and characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques.

Course contents:

Unit I

Introduction to Bio Physics: Molecular Organization, Different levels, Organization of Proteins- Primary, Secondary, tertiary and quaternary structures, Osmosis, Diffusion and Donnan Equilibrium.

Unit II

Conformational Analysis: Nucleic acids and their organization in living cells; interactions of Nucleic acids.

Unit III

Methods in Biophysical Analysis: CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy, Separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques. Absorption and Emission Spectroscopy- Principles and applications of visible, UV, IR, NMR, ESR and MS Spectroscopy.

Unit IV

Characterization of macromolecules using X-ray diffraction analysis. Use of analytical microscopy in elucidating the structure function relationship in- Prokaryotes: Electron Microscopy, Phase Contrast and Fluorescence microscopy and scanning tunneling microscopy. Radio Isotope Techniques: Detection and measurement of radioactivity, Geiger Muller Counters, Scintillation counting, Autoradiography and RIA; Applications of isotopes in biological studies

Text book [TB]:

TB1. Vasantha Pattabhi: Biophysics
TB2. B.S. Yadav: Textbook of Biophysics

Reference books [RB]:

RB1. David Freifelder: Physical Biochemistry
RB2. Willard Merrit, Dean and Settle: Instrumental methods of analysis

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe Molecular Organization, Nucleic acids and their organization in living cells.
CO2	Understand about absorption and emission Spectroscopy of bio molecules.
CO3	Illustrate about separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques.
CO4	Establishes the applications of isotopes in biological studies.
CO5	Evaluate applications of visible, UV, IR, NMR, ESR and MS Spectroscopy.
CO6	Formulate CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy, Separation.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	2	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	3	2	1	1	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	1	2	1	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	1	2	1	2	1	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated