Semester-I

Introduction to Mathematical Physics & Classical Mechanics
Major Course I (MJC-1)

Course Title	Credit	Credit Distribution	
		Theory	Practical
Introduction to Mathematical Physics & Classical Mechanics	6	4	2

Course Outcomes

After completion of the course, the student will be able to-

CO 1-Understand various mathematical techniques used in Physical Problems. Know the difference between Newtonian Mechanics and Analytic Mechanics.

CO 2- Understand utility of scalars and vectors and their operations- algebraic and D-operator

CO 3- Understand the concept of Pseudo force and its importance with application in real life situations.

CO 4-Realize the idea of centre of Mass and Laboratory frame.

CO 5- Understand the orbit of communication and Remote sensing satellite.

MJC -1(T)-4 Credit

Unit I-Concept of Differentiation & Integration- **01 Credit (15 hrs)**

Differential calculus: Geometric Meaning of derivative; Maxima & Minima; Approximation of derivative; Partial Differentiation, Approximation using Taylor and Binomial series.

Integral Calculus: Geometric Meaning of integration, order and degree of differential equation, Solution of First order (homogeneous & Non-homogeneous), Integrating Factor, Exact and Inexact Differentials, D-operator & Solution of Second order Differential Equation.

Unit II-Vector Algebra &Vector Calculus- **01 Credit (15 hrs)**

Vector Triple Products & their significance; concept of scalar & vector fields, Gradient of scalar , Divergence & Curl of vectors and their physical applications in Physics (e.g. Equation of continuity , Euler's equation of motion, Bernoulli's theorem, Fourier heat flow, Poisson's and Laplace's equation in a gravitational field, Gauss's law of in Electrostatic, etc.).

Unit III- Fundamentals of Dynamics – **01 Credit (15 hrs)**

Inertial and Non-Inertial Frame of Reference, Rotating frame of Reference, Centrifugal and Coriolis Forces with their applications (Effect on value of 'g', On path of freely falling body, Geo- physical effect); Foucault pendulum, Direct proof of rotation of Earth.

Unit IV- Centre -of- Mass Frame and Central Forces **01 Credit (15 hrs)**

Lab frame & Centre of Mass frame, Two dimensional collision in physical problems, Relation connecting Scattering angle, Recoil angle, final velocities in C-frame & L-frame, Cross section & Rutherford scattering, Central forces and their equations,: General Equation of central orbit, Kepler's law of Planetary motion , Artificial satellite.

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Suggested Books :

1. H. Goldstein, C. P. Poole and J. F. Safko, Classical Mechanics, Addison-Wesley
2. N. C. Rana and P. S. Jong, Classical Mechanics, Tata McGraw-Hill.
3. Classical mechanics- J.C. Upadhyay
4. Classical mechanics- A.B Gupta
5. Classical mechanics- Tackwale & Puranik
6. Mathematical Physics- Pipes **OR** W.W. Bell
7. Innovative Mathematical Physics—Prof B. C. Rai
8. S. L. Gupta, V. Kumar and H. V. Sharma, Classical Mechanics, PragatiPrakashan.
9. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
10. Mathematical Methods for Physicists, Arfken, Weber and Harris, Elsevier

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MJC -I(P)-2 Credit

The theory involved in the prescribed practical should be discussed in class and students should be made familiar with associated concepts.

At least 6 experiments must be performed-

1. Elementary measuring apparatus – Use of Vernier calliper, Screw guage and Spherometer.
2. To determine least Count of (i) Travelling Microscope (ii)Spectrometer (iii) Polarizer.
3. To Evaluate value of "g" using Bar Pendulum
4. To Evaluate value of "g" using Kater's Pendulum
5. To Verify Conservation of linear Momentum using curved track apparatus.
6. To Determine Young's modulus of Elasticity by Flexure of Beam
7. To Determine Elastic constants for the material of a wire by Searle's method
8. To Determine Surface Tension by method of ripples/use of Capillary tube
9. To Determine Co-efficient of Viscosity of liquid by Stokes method/Poiseuille's method of flow of water through Capillary.
10. To study the motion of spring-mass system and to evaluate spring constant/value of 'g'.
11. To evaluate average error, standard deviation, and percentage error in measurement of focal length of a concave mirror/Convex lens.

The CIA examination in Practical should be just as Mock test and it must be on the Pattern of proper 3hrs End- semester Examination.

Sl. No.	Component	CIA	End- Semester
1	Experiment Allotted	15	45
2	Continuous Pratical Record	05	10
3	Viva-Voce	10	15
		30	**70**
		Total = 100 Marks	

Suggested Books :

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.
5. Properties of Matter- D. S. Mathur

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Semester-2
Major Course II (MJC-2)

Course Title	Credit	Credit Distribution	
		Theory	Practical
Oscillations and Waves	6	4	2

Oscillations and Waves

Course Outcomes

After completion of the course, the student will be able to-

CO 1-understand the concept of Periodic and Oscillatory motion with application of free , Damped and Forced Oscillation in Physical Situation.

CO2-learn application of Lissajou Figure in different Physical Problems

CO3-explore the working of various Musical Instrument.

CO4-understand the Physics behind Accoustic of Building.

CO5-know the technique of sound Recording and Reproduction.

MJC -II(T)-4 Credit

Unit I :- Basics of Oscillations **01 Credit (15 hrs)**

Idea of S.H.M., its differential equation and solutions, Energy in S.H.M. Two body oscillation, coupled Pendulum: Normal modes of vibration, Compound Pendulum, Free, Damped and Forced Oscillations, Transient and steady states, Electrical Oscillations Resonance: Sharpness of Resonance and Quality factor.

Unit II :- Superposition of Oscillations **01 Credit (15 hrs)**

Addition of two S.H.Ms: Concept of Lissajou Figure, its Geometrical Composition & Application, Stationary waves as combination of oscillations (Waves in a linear bounded medium), Vibration of string and Sonometer .

Unit III :-Wave Motion **01 Credit (15 hrs)**

Wave front, Equation of Wave Motion, Superposion of two Harmonic waves : Interference, Beats & combination of tones, pressure, energy and intensity in wave propation, musical instruments.

Unit IV :- Sound Waves **01 Credit (15 hrs)**

Sound wave: Proparation and speed of sound (Accoustic) waves in media , speed in air : Newton's formula & Laplace Correction, Characteristics of Musical sounds & their analysis, Musical scale & consonance, Sound recording and reproduction, Accoustic of Buildings.

Suggested Books :

1. Waves & Oscillation- B. S. Agrawall .
2. Waves & Oscillation- Dongre & Bhattacharya
3. The Physics of Vibrations and Waves, H. J. Pain, John Wiley & Sons Ltd.
4. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill
5. Waves and Oscillations, N Subrahmanyam, Brij Lal, Vikas Publishing House Pvt Ltd.
6. Theory of Vibration- W. T. Thomson
7. A Textbook of Sound- D.R. Khanna & R.S Bed.

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MJC -II (P)-2 Credit

Oscillations and Waves

The theory involved in the prescribed practical should be discussed in class and students should be made familiar with associated concepts.

At least 6 experiments must be performed:-

1- To determine frequency of Tuning Fork using Sonometer / verify laws of transverse vibration of stretched string
2- To determine frequency of Tuning Fork using Electrically maintained Melde's apparatus.
3- To determine the frequency of A. C. Mains using a sonometer and an electromagnet.
4- To Find the Speed of sound in the materials of given rod with a Kundt's tube / Quincke's tube.
5- To determine Speed of Ultrasonic waves in any given liquid (e.g. Kerosene)
6- To study motion of Spring – Mass System.
7- To study the directional characteristic of Microphone using signal Generator, Amplifier, microphone, multimedia & C. R. O.
8- To determine the damping constant , relaxation time and quality factor of damped mechanical oscillator using simple Pendulum with bobs of different material (Aluminium , Brass, Wood etc.)
9- To determine torsional constant using Torsional Pendulum.
10- To determine speed of sound using Resonance column Apparatus.

The CIA examination in Practical should be just as Mock test and it must be on the Pattern of proper 3hrs End- semester Examination.

Sl. No.	Component	CIA	End- Semester
1	Experiment Allotted	15	45
2	Continuous Pratical Record	05	10
3	Viva-Voce	10	15
		30	**70**
		Total = 100 Marks	

Suggested Books :

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11/e, 2011, Kitab Mahal.

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SEMESTER- III

MJCPHY03: Thermal Physics &Thermodynamics

Course Title	Credit	Credit Distribution	
		Theory	Practical
Thermal Physics &Thermodynamics	5	3	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Comprehended the basic concepts of thermodynamics, the first and the second law of thermodynamics.

CO2: Understand the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations.

CO3: Learn about Maxwell's relations and use them for solving many problems in Thermodynamics.

CO4: Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energy, mean free path of molecular collisions transport phenomenon like: viscosity, thermal conductivity, diffusion and Brownian motion.

CO5: Get background for further studies and research in different subject areas namely condensed matter physics, chemistry , material science and life sciences.

MJCPHY03: Thermal Physics &Thermodynamics (T)- 03 Credit		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Kinetic Theory of Gases** Maxwell-Boltzmann Molecular Speed distribution Law for an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (no derivation). Molecular Collisions: Mean Free Path. Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian motion, Langevin and Einstein's theories and experimental determination of Avogadro's no., Rectilinear flow of heat in a metal rod, Relation between thermal & electrical conductivities.	13
2	**Real Gases** Behavior of Real Gases. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real Gases. Joule-Thomson Cooling.	09

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3	**Zeroth and First Law of Thermodynamics** Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature, Work, Heat, State Functions and path functions, First Law of Thermodynamics, Internal Energy for ideal and real gases, Applications of First Law of thermodynamics in case of thin film, stretched wire, hydrostatics, and specific Molar Heat Capacity for gases, Relation between C_p and C_v.	09
4	**Second Law of Thermodynamics** Cyclic ,reversible and irreversible process, Carnot engine, Carnot cycle, Second Law of thermodynamics. Principle of heat engine and refrigerator Kelvin-Planck and Clausius Statements. Concept of Entropy, Clausius Inequality, Second Law in terms of Entropy, Temperature–Entropy diagrams. Third Law of thermodynamics, Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz & Gibb's Functions, Maxwell's Relations, Co-efficient of performance, Clausius-Clapeyron equation and phase transition (1st and 2nd order)	15
	TOTAL	**48**

MJCPHY03: Thermal Physics &Thermodynamics (P)- 02 Credit	
1.	To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2.	To determine the Coefficient of Thermal Conductivity of good conductor (Cu) by Searle's Apparatus.
3.	To determine the Coefficient of Thermal Conductivity of good conductor (Cu) by Angstrom's Method.
4.	To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlto's disc method.
5.	To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6.	To study the variation of Thermo-emf of a Thermocouple with difference of Temperature of its two Junctions using a null method.
7.	To determine Mechanical Equivalent of Heat (J) with the help of Joule's calorimeter.
8.	To plot a graph between temperature and pressure at constant volume using Joly's apparatus and to find the coefficient of increase of pressure at constant volume.
9.	To study the adiabatic expansion of a gas and hence to find the value of the ratio of specific heat at constant pressure to specific heat at constant volume for air using Clement and Desorme's apparatus.

Suggested Readings :

1. Thermal Physics - S. Garg, R. Bansal and C. Gosh (Tata McGraw-Hill.)
2. Heat and Thermodynamics - M.W. Zemansky, Richard Dittman (McGraw-Hill.)
3. A Treatise on Heat – Meghnad Saha, and B.N. Srivastava (Indian Press)
4. Classical and Quantum Thermal Physics - R. Prasad (Cambridge University Press)
5. Modern Thermodynamics with Statistical Mechanics - Carl S. Helrich (Springer)
6. Thermodynamics, Kinetic Theory & Statistical Thermodynamics - Sears & Salinger (Narosa)
7. Concepts in Thermal Physics - S.J. Blundell and K.M. Blundell (University Press)

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SEMESTER- III

MJCPHY- 04: Electricity & Magnetism

Course Title	Credit	Credit Distribution	
		Theory	Practical
Electricity and Magnetism	4	3	1

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Understand the basic concepts of electrostatics.

CO2: Understand the dielectric and magnetic properties of matter.

CO3: Understand the electromagnetic induction and electric circuits.

CO4: Provides background for further studies and research in different subject areas .

MJCPHY03: Thermal Physics &Thermodynamics (T) - 03 Credit		
Unit	Topics to be covered	No. of Lectures
1	**Electrostatics:**Electric Field and potential, Field due to a uniformly charged sphere, Gauss Law and its applications: The Field of a conductor. Electric dipole, Field and potential due to an electric dipole, Dipole approximation for an arbitrary charged distribution, Electric quadruple, Field due to a quadrupole, Electrostatic Energy of a uniformly charged sphere, Poisson and Laplace Equations, applications of Laplace equation.	10
2	**Dielectric Properties of Matter:**Electric field in matter and Electrical susceptibility and Dielectric polarization, Dielectric constant, Polarisation vector, Surface Charge and bound charge, Displacement Vector **D**, Relations between **E**, **P** and **D**.	08
3	**Magnetism:**Magnetic field , Magnetic force and Torque on a current carrying conductor, and loop placed in a magnetic field, Biot – Savart's Law and its simple applications: straight wire and circular loop, Magnetic Dipole, Magnetomotive force and Ampere's Circuital theorem and its applications to calculate magnetic field due to current carrying wire and solenoid and toroid. Gauss's law of magnetism (Integral and Differential Forms). Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (I),or intensity of magnetisation. Magnetic Intensity (H). Relation between B, I and H. Magnetic Energy stored in Matter. Magnetic Circuit. Potential Energy of a Current Loop placed in a magnetic field.Ballistic Galvanometer:. Electromagnetic Damping, Logarithmic Damping, Critical Damping Resistance(CDR)	12

4	**Electromagnetic Induction:** Faraday's and Lenz's Laws. Mutual and Self Induction,self and Mutual inductances of a solenoid and system of current carrying loop, Energy stored in a Magnetic Field, Electric field induced due to time varying Magnetic field, magnetic field induced due to Time varying electric field. Introduction to Maxwell's Equations	05
5	**Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Reactance and Complex Impedance. Series and parallel LCR Circuit: Resonance, Quality Factor, and Band Width, Power in AC Circuits	10
	Total	45

MJCPHY- 04: Electricity & Magnetism (P) - 02 Credit

1. Use of Multimeter for measuring (a) Resistance, (b) AC and DC Voltages, (c) DC Current, (d) Capacitance, and (e) Checking electrical fuses.
2. To calibrate the ammeter and voltmeter by potentiometer.
3. To find the low resistance by Carey Foster's bridge after calibrating the bridge wire.
4. Measurement of low resistance using Potentiometer.
5. To determine the high resistance by leakage method.
6. Figure of merit of moving coil galvanometer.
7. To determine the angle of dip in the laboratory using an earth inductor.
8. Compare the capacities of capacitors by De Sauty' bridge.
9. To study the characteristics of a series RC Circuit.
10. To verify the Thevenin and Norton theorems.
11. To verify the Superposition, and Maximum power transfer theorems.
12. To determine self inductance of a coil by Anderson□s bridge.
13. To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
14. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.

Suggested Books :

1. Electricity and Magnetism, Basudev Ghosh (Books And Allied (P) Ltd
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn (Benjamin Cummings)
3. Electricity ad Magnetism
4. Fundamentals of Electricity and Magnetism, Arthur F. Kip (McGraw-Hill)
5. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury (Tata McGraw-Hill)
6. Fundamentals of Electricity and Magnetism D.N Vasudev (S. Chand & Co)
7. Electricity and Magnetism- R. Murugeshan (S. Chand)
8. Electricity and Magnetism-K.K. Tiwary (S. Chand)
9. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, (Asia Publishing House)
10. A Text Book of Practical Physics, I. Prakash & Ramakrishna, (Kitab Mahal)
11. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, (Heinemann Educational Publishers)
12. Engineering Practical Physics, S. Panigrahi and B.Mallick, Cengage Learning
13. B. Sc. Practical Physics, C. L. Arora, S. Chand and Co.

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SEMESTER – IV

MJCPHY05: Mathematical Physics-II and Introduction to Computational Methods

Course Title	Credit	Credit Distribution	
		Theory	Practical
Mathematical Physics-II and Introduction to Computational Methods	5	3	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Master the basic elements of complex mathematical analysis.
CO2: Solve differential equations that are common in physical sciences.
CO3: Apply group theory and integral transforms to solve mathematical problems of interest in Physics.
CO4: Understanding how to use special functions in various physics problems
CO5: Provides background for further studies and research in different subject areas .

MJCPHY05	Mathematical Physics and Introduction to Computational Methods (T) -03 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Curvilinear Coordinates, Tensors and special functions:** Spherical and Cylindrical Coordinate Systems. Ordinary Integrals of Vectors, Line, surface and volume integrals of Vector fields. Tensors : Elementary properties, Contra variant and covariant tensors, Symmetric and Anti-symmetric tensors. Singular Points of Second Order Linear Differential Equations and their importance , Frobenius method and its applications to differential equations Legendre, Bessel, Hermite and Laguerre Differential Equations.	09
2	**Partial Differential Equations and Complex Analysis :** Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Complex Numbers Graphical Representation Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Integration of function of a complex variable.	10
3	Introduction : Importance of Computers in Physics , Algorithms and Flow Charts : Algorithm Definition, properties and development. Flowchart: concept of flowchart , symbols , guidelines, types. Sum of two matrices, sum & Products of a finite series , calculations of Sin (x) as a series.	06
4	Scientific Programming : Usage of Linux an Editor, some fundamental Linux commands (Internal & External commands) Development of FORTRAN, Basic elements of FORTRAN : Character set, constants and their types, variables and their types , Keywords , variable Decleration and concept of instruction and program. Operators : Arithmatic, Relational , Logical and Assignment operators. Expressions : Arithmatic Relational, Logical , Character and Assignment Expressions. FORTRAN Statements: I/O statements	06

	(unformatted/formatted), Executable and Non-Executable statements, Layout of FORTRAN program, Format of writing program and concept of coding.	
5	Control statements : Types of Logic (sequential, selection, Repetition), Branching statements (Logical IF, Arithmatic IF, Block IF , Nested Block IF, SELEC CASE and ELSE IF Ladder Statements), Looping statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping statements (Unconditional GO TO , computed GO TO, Assigned GO TO), Subscripted variables, Functions and Subroutines (Arithmetic statements, Function, Function subprogram and subroutine), Examples from physics Problems.	09
	Total	40

MJCPHY05	**Mathematical Physics and Introduction to Computational Methods (P) -02 Credit**
1.	Errors & error Analysis: Truncation & rounding of errors, absolute & relative errors.
2.	Differential equations: Solutions of ordinary differential equation, solution of first order differential equation, solution of quadratic equation.
3.	Computer Architecture and Organization, Memory and Input/Output devices.
4.	Basics of Scientific computing : Binary and decimal arithmetic, Floating point numbers, Algorithms, Single & Double precision arithmetic, underflow & overflow.
5.	**Programs :** Sum & average of a list of numbers, Largest of a given list of numbers and its location in the list, Sorting of numbers in ascending descending order, Familiarity with DOS commands, Linux Commands and FORTRAN commands.

Suggested Readings :

1. An Introduction to Computational Physics : T. Pang (Cambridge University Press)
2. Elementary Numerical Analysis : K.E Atkinson (Wiley India Edition)
3. Numerical Recipes in C : The Art of Scientific Computing, W.H. Pressetal (Cambridge University)
4. Introduction to Numerical Analysis : S. S Sastry
5. Mathematical Methods for Physicists : Arfken, Weber (Pub. Elsevier)
6. Mathematics for Physicists : Susan M. Lea (Pub. Thomson Books)

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Semester IV

MJCPHY06: Electrodynamics and Electromagnetism

Course Title	Credit	Credit Distribution	
		Theory	Practical
Electrodynamics and Electromagnetism	5	5	0

Course Outcomes

After completing the course, the students will be able to:

CO1: Establish and analyse four Maxwell's equations of electromagnetism.

CO2: Uunderstand the propagation of electromagnetic waves in vacuum, dielectrics, conductors and also in guided media and the phenomenon of reflection and refraction of plane waves at different boundaries.

CO3: Understand the importance of energy flow (Poynting Theorem) and its usefulness.

CO4: Get background for further studies and research in different subject areas.

MJCPHY06	Electrodynamics and Electromagnetism (T) - 05 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Maxwell's Equations:** Equation of continuity, Displacement Current Maxwell's equations in differential and Integral forms; Vector and scalar potentials, Poynting theorem and Poynting vector, energy conservation (qualitative idea of momentum conservation). Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density, Description of Lorentz force.	10
2	**Electromagnetic Wave Propagation in unbounded media:** Propagation of plane EM waves in free space, and dielectrics ,Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation of EM wave through conducting media, relaxation time, skin depth.	14
3	**EM Wave Propagation in Bounded Media:** Boundary conditions at a plane interface between two media. Reflection and Refraction of plane waves at plane interface between two dielectric media — Laws of Reflection and Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection. Metallic reflection (normal Incidence).	14
4	**Polarization of Electromagnetic Waves:** Description of Linear, Circular and Elliptical Polarization. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction.	10

5	**Transmission Line:** Propagation of e.m. wave through transmission line, reflection coefficient, standing wave, characteristic impedance, propagation constant. **Wave Guides:** Fundamentals of wave guides, Condition of continuity at the interface. Expressions for field components, TE and TM modes. Propagation properties, cutoff frequency,. Field energy and Power transmission. **Optical Fibres:** Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).	12
	Total	**60**

Suggested Books:

1. Introduction to Electrodynamics, D.J. Griffiths, Benjamin Cummings. ,
2. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner,Springer
3. Electromagnetic Fields & Waves, P. Lorrain & D. Corson, W.H. Freeman& Co.
4. Electromagnetics, J. A. Edminster, Schaum Series, Tata McGraw Hill.
5. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, Cambridge University Press.
6. Electrodynamics and Plasma Physics S.L.Kakan ,C. Herajan, CBS publisher
7. Electrodynamics :K.K Chopra &G.C Aggrawal
8. Classical Electrodynamics J D Jakson Wiley

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Semester IV

MJCPHY07: **Optics**

Course Title	Credit	Credit Distribution	
		Theory	Practical
Optics	5	3	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Understand Interference as superposition of waves from coherent sources derived from same parent source.

CO2: Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture.

CO3: Understand Fraunhoffer and Fresnel Diffraction.

CO4: Gain experience of using various optical instruments and making finer measurements of wavelength of light using Newton's Rings experiment, Fresnel Biprism, etc.

CO5: Get background for further studies and research in different subject areas.

MJCPHY 7	Optics (T) - 3 credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Interference:** Light as EM Wave(Historical Perspective),Superposition of waves, Conditions for interference, Interference by Division of Wavefront (Fresnel's Biprism, Lloyd's single mirror) and by Division of Amplitude (Interference by Film), Newton's Ring, Complex Representation for Intensity calculation, Stoke's treatment.	12
2	**Interferometer:** Michelson interferometer and its applications, Multiple beam interference in parallel film, Fabry-Perot interferometer, Coherence – Spatial and Temporal.	08
3	**Fraunhofer Diffraction:** Conditions for diffraction, Fraunhofer diffraction due to single, double and multiple slits, Plane transmission grating. **Fresnel diffraction:** Fresnel half- period zones, Zone plate, Huygen's-Fresnel principle, Diffraction by a circular aperture, Diffraction by a straight edge,Rayleigh's criterion for limit of resolution, Resolving power of Grating, Telescope and Microscope.	12
4	**Polarization and Double Refraction:** Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by double refraction, Nicol prism, Quarter wave plate, Half wave plate, Babinet's compensator, Production and analysis of circularly and elliptically polarized light, Optical activity and Fresnel's theory, Bi-quartz polarimeter. Elementary ideas of LASERs,Einstein's A & B coefficients, Population Inversion and Holography.	13
	TOTAL	45

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MJCPHY 7	Optics (P) - 02 Credit
1.	To determine Magnifying Power of a telescope by the Slit method/ Linear Scale using Microscope.
2.	To find the height of an inaccessible object (altitude or angular diameter of the Sun) using Sextant.
3.	To find angle of prism/ angle of minimum deviation and hence refractive index of material of prism using Spectrometer.
4.	To find value of Cauchy's Constant A and B for the material of a given prism using a Mercury Vapour Lamp.
5.	To determine Resolving Power of a prism.
6.	To determine diameter of a thin wire by studying the diffraction (and interference) pattern.
7.	To determine wavelength of sodium light using a plane diffraction grating.
8.	To determine Resolving Power of a plane transmission grating.
9.	To establish the dispersion relation for a plane transmission grating.
10.	To verify Fresnel's Law of reflection and refraction by using a plane refracting surface.
11.	Simple experiment demonstrating different applications of LASER and Optical Fibre.
12.	Determination of wavelength of light using biprism on optical bench.
13.	To determine the wavelength of the monochromatic light by Newton's Ring
14.	To determine the specific rotation of the cane sugar solution using bi-quartz polarimeter.

Suggested Readings :

1. Practical Physics : Geeta Sanon (S.Chand & Company); Harnam Singh & P.S. Hemne (R.Chand & Co.)
2. A Text Book of Practical Physics: Indu Prakash, Ramakrishna&A.K.Jha, Kitab Mahal
3. Advanced level Physics Practicals: Michael Nelson and Jon M. Ogborn, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes: D.P.Khandelwal, Vani Pub.
5. Practical Physics: G.L. Squires, Cambridge University Press.
6. A Laboratory Manual of Physics – D.P.Khandewal.
7. Optics- Eugene Hecht (Pearson).
8. Optics(Classical & Quantum)-Dr. R.K.Kar(Books & Allied).
9. Optics: Ajoy Ghatak, McGraw-Hill Education, New Delhi
10. Fundamental of Optics. Jenkins & White (Mc Graw Hill)
11. Fundamental of optics: B. K. Mathur,
12. Optics: Francis Weston Sears Addison-Wesley Publishing Company

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SEMESTER – V

MJCPHY08: **Elements of Modern Physics**

Course Title	Credit	Credit Distribution	
		Theory	Practical
Elements of Modern Physics	5	5	0

Course Outcomes

After the completion of the course, the student will be able :

CO1: To understand the inadequacy of classical Mechanics.

CO2: To understand the historical development of Quantum Concepts.

CO3: To understand the behaviour of mother nature at microscopic level.

CO4: To prepare background for interdisciplinary research in condensed matter / Material Science/atomic Physics/Life Science etc.

CO5: To enhance employability skills as scientific officers at different research orientated centres

CO6: To promote application of nuclear energy in various areas

CO7: To Get background for further studies and research in different subject areas.

MJCPHY08	Elements of Modern Physics (T) - 6 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Particle Properties of Radiations** Black Body Radiation and Planck's quantum Hypothesis, Discovery and Explanation of Photoelectric effect, Compton Scattering, Pair Production and Annihilation. **Wave Aspect of Particles** Idea De Broglie wavelength and matter waves, Davisson-Germer experiment for diffraction of electron, G.P. Thomson Experiment ,Phase velocity, wave packets and Concept of Velocity .	10
2	**Wave-Particle Duality** Concept of Wave-particle duality, Heisenberg Uncertainty Principle, Uncertainty relations involving canonical pair of variables and their Derivation from Wave Packets, Estimation of minimum energy for a confined particle using uncertainty principle, origin of natural width of emission lines, Uncertainty Principle and concept of Bohr Orbit.	10

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3	**Atomic Structure** Introduction of Sommerfeld Quantization rule, Bohr -Sommerfield atomic theory ,Explanation of Hydrogen and Hydrogen-like Spectra, Comparison between H and He+ Spectra, Corrections for finite nuclear mass and corresponding variations in Rydberg Constant, Relativistic correction .	10
4	**Wave Mechanical Description of electron particles,** The Schrodinger Wave equation, properties ,concept of normalization of Wave function , Expectation value, Schrodinger equation for non-relativistic particles, Concept of operators in quantum mechanics. Time independent Schrodinger equation, Probability, probability current densities, Idea of energy eigenvalues and eigenfunctions	10
5	**Fundamental Properties of Nucleus** Size, constituent and structure of atomic nuclei, Idea of Isotope, Isobar, Isotope and Mirror nuclei , Mass defect, Packing fraction, Binding energy, Binding Energy per nucleon versus Mass number Curve. Stability of the nucleus and Nature of Nuclear force , Law of radioactive decay, Mean life and Half-life, successive radioactive disintegration, Basic Idea of Alpha , Beta and Gamma decay, Idea of energy-momentum and parity conservation in nuclear decay process, Q-value in nuclear reaction. Radiation Detector, Ionization Chamber, Geiger-Muller Counter, Neutron detection, Spark chamber, Bubble, Cloud and Scintillation, Cherenkov radiation.	20
	TOTAL	60

Suggested Readings :

1. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill.
2. Introduction to Modern Physics – H.S. Mani & G.K Mehta (PHI)
3. Elements of Nuclear Physics - M L Prasad, RPS (Kedarnath Ramnath)
4. Q. Mechanics – H.C Verma (Surya Pub.)
5. Atomic & Nuclear Physics - K. Gopala Krishnan (Mac Million India Ltd.)
6. Modern Physics - S.K Gupt & B.S. Agarwal (Kedarnath Ramnath)
7. Introduction to Modern Physics – F.K Richtmyer, E.H Kennad , T. Lauritsen (Mac Grow)

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SEMESTER – V

MJCPHY09: **Basic Electronics**

Course Title	Credit	Credit Distribution	
		Theory	Practical
Basic Electronics	5	3	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Understand fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.

CO2: Design of different types of the Digital circuits, and to give the computational details for Digital Circuits.

CO3: Draw characteristics of devices like PNP and NPN junction diode and truth tables of different logic gates.

CO4: Understand basic elements and measurement of their values with multimeter and their characteristic study.

CO5: Get background for further studies and research in different subject areas.

MJCPHY 9	Basic Electronics (T) - 3 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Digital Circuits:** Diffrence between Analog & Digital Circuits .BinaryNumbers.Decimal to Binary & vice-versa. AND,OR and NOT Gates(Realisation using Diodes & Transistors) NAND and NOR Gates as Universal gates.XOR and XNOR Gates.	04
2	**Basic Circuit Operations:** Du Morgan's Theorem. Boolean Laws .Simplification of Logic Circuit using Boolean Algebra.Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map (For Advanced Learners) **Combinational circuits:** Basic idea of Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors.	08
3	**Semiconductor Devices :** P-andN-type semiconductors. Energy Level Diagram. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode.P-N junction & its characteristics.Static and Dynamic Resistance.Principle and structure of (1) LEDs (2) Photodiode (3) Zener Diode (4) Solar .Cell. **Electronic Devices and their Applications:** (1) Rectifier Diode: Half-wave Rectifiers. Full-wave Rectifiers (Centre-tapped and Bridge), Calculation of Ripple Factor and Rectification Efficiency. (2) Voltage	14

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	Regulation using Zener Diode. **Bipolar Junction transistors**:n-p-n and p-n-p Transistors, Characteristics of CB, CE and CC Configurations. Current gains α and β parameters, Relations between α and β parameters. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow: Active, Cutoff and Saturation Regions. **Amplifiers:** Transistor Biasing circuits and Stability. Fixed Bias and Voltage Divider Bias circuit for CE Amplifier. (h-parameter Equivalent Circuit). Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Class A, B & C Amplifiers (For Advanced Learners).	
4	**Operational Amplifiers (Black Box approach):** Characteristics of an Ideal and Practical Op-Amp (IC 741), Open – loop Gain . CMRR, Concept of virtual ground. Applications of Op-Amp:(1) Inverting and Non-Inverting Amplifiers (2) Adder (3) Subtractor (4) Differentiator (5) Integrator . Feedback and Oscillation: Effects of Positive and Negative Feedback on Gain and Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC andWien Bridge oscillator.	08
5	**Instrumentations:** Introduction to CRO:Block Diagram and Applications of CRO: (1) Study of Waveform (2) Measurement of Voltage ,Current ,Frequency and Phase Difference. **Power Supply:** Half Wave Rectifiers ,Centre-tapped and Full wave Rectifiers ,Calculation of Ripple Factor and Rectification Efficiency ,Basic Idea about capacitor filter , Zener Doide and Voltage Regulation. **Timer IC:** IC 555 Pin diagram and its applications as Astable and Monostable Multivibrators.	11
	TOTAL	**45**

MJCPHY09	**Basic Electronics (P) - 2 Credit**
1.	To measure (a) Voltageand (b) Time period of a periodic waveform using CRO.
2.	To test a Diode and Transistor using a Multimeter.
3.	To design a switch (NOT gate) using a transistor.
4.	To verify and design AND, OR, NOT and XOR gates using NAND gates.
5.	Half Adder ,Half Subtractor and 4-bit Binary Adder
6.	To study V-I characteristics of P-N junction ,Zener and Light emitting diode.
7.	To study the characteristics of a Bipolar Junction Transistor in CE configuration.
8.	To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
9.	To design Inverting amplifier using Op-amp (741) and study its frequency response.
10.	To design an Astable Multivibrator using IC 555 Timer .
11.	To design a precision a Differentiator using an Op-Amp 741.

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Suggested Readings :

1. Electronic Principles & Applications: A.P.Malvino ,D.P.Leach and Saha(McGraw Hill).
2. Modern Digital Electronics- R.P.Jain ,Tata McGraw Hill,4th Edition.
3. Principles of Electronics:-V.K.Mehta& Rohit Mehta(s.Chand& Comp).
4. Basic Electronics Devices :-D.P.Kothari& I J Nagrath(McGraw Hill Educ).
5. Hand Book of Electronics-Gupta & Kumar.
6. Foundation of Electronics - Chattopadhyay; Rakshit;Saha;Purikait(Wily).

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Semester – VI

MJCPHY10: Analytical Mechanics & Special Theory of Relativity

Course Title	Credit	Credit Distribution	
		Theory	Practical
Analytical Mechanics & Special Theory of Relativity	4	4	0

Course Outcomes

After completion of the course, the students will be able to :

CO1: Understand Physical Principle behind derivation of Lagrange and Hamiltonion Equation.

CO2: Understand Canonical Transformation

CO3: Analysis the Centre of mass and Laboratory frames of reference and their use in explaining elastic and inelastic collisions

CO4: Understand the Planetary motions and motions of satellites using the principles of gravitation and Kepler's laws. Getting an idea of postulates of special theory of relativity and their implications.

CO5: Get background for further studies and research in different subject areas.

MJCPHY10:	Analytical Mechanics & Special Theory of Relativity (T) - 4 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Constrainsts** : Holonomic, Non Holonomic, Scleronomous, Rheonomous, D'Alembert's Principle, Virtual Displacement, Principle of virtual work, concept of generalized co-ordinates, Derivation of Lagrange's equation from D'Alembert's Principle , simple applications of Lagrange's equations. **Variational Principle and Hamiltonian formalism:** Calculus of variation and its applications, Hamilton's Principle, Derivation of Lagrange's equations of motion from Hamilton's Principle, Velocity-dependent potential, Cyclic coordinates, Symmetries and conservation laws, Legendre transformation, Hamilton's equations of motion and its applications, Principle of least action.	15

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2	**Canonical Transformation:** Canonical transformation and its applications, Poisson Brackets, Jacobi identity, Hamilton-Jacobi equation, Action-angle variables, Theory of small oscillations.	10
3	**Motion of a Rigid body :** Euler's Angle, Kinematics of rotation, Euler's equation of Motion, Twisting Torque on a Elastic Cylinder.	08
4	**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Lorentz contraction. Time dilation. Relativistic addition of velocities. Variation of mass with velocity. Mass less Particles. Mass-energy Equivalence Four vectors.	15
	TOTAL	**48**

Suggested Books :

1. An introduction to mechanics - Kleppner D., Kolenkow R. J. (McGraw-Hill)
2. Mechanics, Berkeley Physics, vol.1 - Kittel C., Knight W., et.al. (Tata Mc Graw - Hill)
3. Physics - Resnick, Halliday and Walker ,Wiley (8/e)
4. Cengage Learning - Fowles G. R. and Cassiday G.L...
5. Sands M.Feynman Lectures,Vol. I- FeynmanR. P., Leighton R. B. (Pearson Education)
6. Mechanics - Mathur D. S. , S.Chand (Company Limited)
7. Special Relativity - B.C. Rai
8. University Physics - Sears F. W, Zemansky M. W., Young H.D... 13/e (Addison Wesley)
9. Physics for scientists and Engineers with Modern Phys. - JewettJ. W., Serway R. A. (Cengage Learning)
10. Theoretical Mechanics - Spiegel M.R. (Tata McGraw Hill)
11. Special Theory of Relativity - S. Chand.
12. Relativity - Gupta & Kumar (Pragati Prakashan)

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SEMESTER-VI

MJCPHY11: **Statistical Mechanics**

Course Title	Credit	Credit Distribution	
		Theory	Practical
Statistical Mechanics	5	5	0

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Basic knowledge of thermodynamic systems.

CO2: Understand the basic idea about statistical distributions.

CO3: Impart the knowledge about the phase transitions and potentials.

CO4: Understand the applications of statistical laws

CO5: Get background for further studies and research in different subject

MJCPHY11:	Statistical Mechanics (T) - 5 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Classical Statistics** Macrostate and Microstate, Phase Space, Elementary Concept of Ensemble, Entropy and Thermodynamic Probability. Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur-Tetrode equation, Law of Equipartition of energy, its applications to Specific Heat and its Limitations.	15
2	**Classical Theory of Radiation** Black Body Radiation, Kirchhoff's law, Stefan-Boltzmann law(Thermodynamic proof), Radiation Pressure. Wien's Displacement Law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.	10
3	**Quantum Theory of Radiation** Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental verification. Deduction of (1) Wien's Distribution Law (2) Rayleigh-Jeans Law, (3)Stefan-Boltzmann Law, (4) Wien's Displacement Law from Planck's Law.	10
4	**Bose-Einstein Statistics** Bose-Einstein distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, Properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.	10

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5	**Fermi-Dirac Statistics** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, Chandrasekhar Mass Limit.	15
	TOTAL	60

Suggested Readings:

1. Statistical Mechanics, R.K. Patharia, Butterworth Heinemann: Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, Tata McGraw-Hill.
3. An Introduction to Statistical Mechanics & Thermodynamics, R. H. Swendsen, Oxford Univ. Press.
4. Kersan Huang, Wiley India Pvt. Ltd.
5. Statistical Mechanics, Agrawal & Eisner, Wiley Ind. Pub.
6. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, (Springer).

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SEMESTER-VI

MJCPHY12: Quantum Mechanics & its Application

Course Title	Credit	Credit Distribution	
		Theory	Practical
Quantum Mechanics & its Application	5	3	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Learn to represent quantum states by ket vectors, physical observables as operators and their time evolution.

CO2: Understand commutator brackets between observables and their properties.

CO3: Learn concept of system of identical non- interacting particles: dynamics of two level systems, qubits.

CO4: Get background for further studies and research in different subject

MJCPHY12: Quantum Mechanics & its Application (T) - 3 Credit		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Wave-Particle duality** Need of quantum mechanics, de Broglie's theory of matter wave, concept of Wave Packet, Fourier transform and momentum -space wave function. Postulates of quantum mechanics,Explanation of Heisenberg's Uncertainty relation	05
2	**Time Independent Schrodinger Wave Equation** Derivation of Time independent Schrodinger wave equation, Physical intrepation of wave function. Application of Time independent Schrodinger wave equation in case of Hydrogen atom, Linear harmonic oscillator.PotentialWell,Potential Barrier	10
3	**Formalism of Quantum Mechanics** Hilbert Space and Concept of Ket and Bra notations, Representation of position operator in momentum space. Representation of momentum -operator in position space,Representation of eigen-state vector in momentum space and position space.	10
4	**Time Dependent Schrodinger Wave Equation** Dynamical evolution of a quantum state, Properties of time-development operator, Derivation of dynamical equation for an operator of a quantum system and its Consequences. Comparative Study of Schrodinger picture, Heisenberg picture and interaction picture.	10

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5	**Angular Momentum Operator** Orbital Angular momentum operator and its Commutation relation, Spin angular momentum operator and Pauli's spin matrices. Commutation relation of Pauli's spin matrices, ladder operator for total angular momentum operator and its Commutation relation, Spin-Orbit Coupling in atoms(L-S and J-J coupling),Bohr Magneton	10
	TOTAL	**45**

MJCPHY09:	**Quantum Mechanics & its Application (P) - 2 Credit**

1. Solve the Schrodinger equation for the ground state & the 1st excited state of Hydrogen atom.
2. Solve the Radial equation for an atom.
3. Estimate the Energy values of Linear harmonic oscillator with the given data.
4. Estimate the Energy values in Potential Well having defined with & depth.
5. Estimate the allowed Energy values of given Potential Barrier.

Suggested Readings :

1. Quantum Mechanics, Eugen Merzbacher, John Wiley and Sons, Inc.
2. Quantum Mechanics, G. P. Singh, (Pub: Bharti Bhavan)
3. Quantum Physics, H. C. Verma, (Pub: Surya Publication)
4. Introduction to Quantum Mechanics, David J. Griffith, Pearson Education
5. Quantum Mechanics, Walter Greiner, Springer
6. Quantum Mechanics, Bruce Cameron Reed, Jones and Bartlett Learning.
7. A Text book of Quantum Mechanics, P. M. Mathews and K.Venkatesan, McGraw Hill.
8. Quantum Mechanics, Leonard I. Schifi, Tata McGraw Hill.
9. Principle of Quantum Mechanics, Ishwar Singh Tyagi, Pearson Publication.

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SEMESTER – VII

MJCPHY13: Physics of Atoms and Nuclei

Course Title	Credit	Credit Distribution	
		Theory	Practical
Physics of Atoms and Nuclei	5	3	2

Course Outcomes

After the completion of the course, the student will be able to understand:

CO1: To understand the idea of spectra of one and two valence electron atoms.

CO2: To understand the effect of external fields on spectral lines

CO3: To understand the concept of vector atom model.

CO4 To understand the structure of nucleus

CO5: To promote interdisciplinary research in spectroscopy and element analysis

CO6: Get background for further studies and research in different subject

MJCPHY13: Physics of Atoms and Nuclei (T) - 3 Credit		
Unit	**Topics to be covered**	**No. of Lectures**
1	**H-spectra** Fine structure of hydrogen spectra (H_α-line), Wilson-Sommerfeld quantization rule, Problems related to Bohr theory, Bohr-Sommerfeld theory and Ionization Potentials, Bohr-Sommerfeld (B-S) theoretical explanation of fine structure H-spectra, shortcomings of B-S theory, Stern-Gerlach Experiment to demonstrate the existence of electron spin, Difference between spectra of inner core electron (X-ray spectra) and optically active valence electron (UV-Visible and I.R. Spectra).	10
2	**Quantum mechanics of H-atom** Physical interpretation and properties of wave-function, Quantum mechanical treatment of one-electron atomic system (Hydrogen atom).Solution of Schrodinger equation for Hydrogen atom using separation of variables, Associated Legendre Polynomial,Hypergeometric series, Recurrence Formula, Spherical Harmonics,Interpretation of quantum numbers and electron-probability density, Expectation value and parity of eigenfunctions.	10

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3	**Concept of Vector Atom model** Orbital magnetic dipole moment, Behaviour of magnetic dipole in external magnetic field, Larmor Precession, Space quantization, coupling of orbital and spin angular momentum, Spectroscopic term and their notations. Lamb Shift, Pauli's Exclusion Principle and wave function for identical particle system, Zeeman effect and Paschen Back effect for one electron system	08
4	**Spectra of 1 and 2 electron system (Alkali and Alkaline Earth Element)** Feature and explanation of Spectra of Alkali elements, Resonance lines and fine structure in Alkali spectra, Intensity ratio of Na- doublet lines, Interaction energy for L-S and J-J coupling for Alkaline Earth elements.	10
5	**Nuclear Models** Essence of Liquid drop model, Salient Features and Predictions of Shell model, Brief idea of Collective Model, Alpha particle model and Fermi gas model, Nuclear reaction and its types, Artificial Transmutation, Experimental determination of Q-value, Deuteron problem and its wavefunction, Central force and Non-Central force, Yukawa's model and π-meson.	10
	TOTAL	**48**

MJCPHY13:	**Physics of Atoms and Nuclei (P) - 2 Credit**

1. To determine e/m by Millikan's oil drop method.
2. To draw the plateau curve for a GM count.
3. To study Zeeman Effect
4. To study specture of simple atoms.
5. To study H-line
6. To study Arc-Spectrum and its simulation Experiments.

Suggested Readings :

1. Physics of atoms and Molecule – Bransden & Jochain (Pearson)
2. Atomic and molecular Physics: Raj kumar (Kedarnath & Ram Nath)
3. Concepts of Nuclear Physics by B L Cohen, Tata McGraw Hill Publication
4. Physics and Engineering of Radiation Detection by S N Ahmed, Academic Press Elsevier,
5. Nuclear Physics: Roy & Nigam (Wiley Easter Ltd.) - John Lilley (Willy Indian.)

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SEMESTER – VIII

MJCPHY14: **Research Methodology**

Course Title	Credit
Research Methodology	5

The Paper will be common for all students of faculty of Science. There is a common Syllabus for MJC – 14, already done.

SEMESTER – VII

MJCPHY 15: **Solid State Physics**

Course Title	Credit	Credit Distribution	
Solid State Physics		Theory	Practical
	6	4	2

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Elucidate the concept of lattice, crystals and symmetry operations.

CO2: Understand the elementary lattice dynamics and its influence on the properties of materials.

CO3: Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior.

CO4: Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.

CO5: Get background for further studies and research in different subject

MJCPHY15:	Solid State Physics (T) - 4 Credit	
Unit	**Topics to be covered**	**No. of Lectures**
1	**Crystal Structure:** Solids: Amorphous and Crystalline Materials, Lattice and Basis, Bravais Lattices. Lattice Translation Vectors, Types of Bravais Lattices, Unit Cell. Miller Indices. Reciprocal Lattice, Brillouin Zones, Diffraction of X-rays by Crystals. Bragg's Law.	12
2	**A. Crystal Bonding:** Elementary idea of Bonding in Solids, Cohesive Energy of Ionic Crystals, Lennard Jones Potential. **B. Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains, Acoustical and Optical Phonons, Dulong and Petit's Law, Einstein theory Debye theory of specific heat of solids, T^3— law.	12
3	**A. Free Electron Theory**: Theory of free electron gas, Fermi surface, Fermi Energy, Density of States. **B. Elementary Band Theory:** Bloch Theorem. Kronig-Penny Model, Band Gap, Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, Measurement of conductivity (Four Probe Method), Mobility, Hall Effect & Hall coefficient.	12
4	**A. Magnetic Properties of Matter:** Origin of magnetism, Langevin's theory of Diamagnetism and Paramagnetism. Ferromagnetism and Antiferromagnetism. Curie-Weiss law, Ferromagnetic Domains.	12

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	B. Superconductivity: Critical Temperature. Critical Magnetic Field, Meissner effect. Type Iand Type II Superconductors, London's Equation and Penetration Depth. Isotope effect, Idea of BCS theory(Basic Concept). **C. Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius-Mossotti Equation.	
	TOTAL	**48**

MJCPHY15:	**Solid State Physics (P) - 2 Credit**
Practical	
1.	Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2.	To measure the Magnetic susceptibility of Solids.
3.	To determine the Coupling Coefficient of a Piezoelectric crystal.
4.	To measure the Dielectric Constant of a dielectric Materials with frequency
5.	To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR).
6.	To determine the refractive index of a dielectric layer using SPR.
7.	To study the PE Hysteresis loop of a Ferroelectric Crystal.
8.	To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9.	To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150°C) and to determine its band gap.
10.	To determine the Hall coefficient of a semiconductor sample.

Suggested Readings :

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, Tata Me-Graw Hill.
4. Solid-state Physics, H. Ibach and H. Luth, Springer.
5. Solid State Physics – R. L. Singhal, P.A. Alvi, (KedarNath, RamNath), M.A. wahab (Nurosa), S.O Pillai (New Age Pub.
6. www.youtube.com/distinctphysics - Lecture videos.

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SEMESTER – VIII

MJCPHY16: **Physics of Laser and Molecules**

Course Title	Credit	Credit Distribution	
Physics of Laser and Molecules		Theory	Practical
	4	3	1

Course Outcomes

After the completion of the course, the student will be able to:

CO1: To understand the working of LASER- Sources.
CO2: To understand the applications of different types of LASER in day to day life.

CO3: To understand the concept of formation of Molecule
CO4: To understand the mechanism of spin Resonance Spectroscopy
CO5: To learn the working of Opto-electronic and Photonic devices

CO6: To enhance the employability in the field of optics
CO7: To explore research in the area of photonics
CO8: Get background for further studies and research in different subject

MJCPHY16:	**Physics of Laser and Molecules (T) - 3 Credit**	
Unit	**Topics to be covered**	**No. of Lectures**
1	Basic Theory of LASER: Energy levels and process of Absorption and Emission Einstein's Predication, Difference between spontaneous and stimulated emission Important features of stimulated emission Einstein's A and B Co-efficient,Light Amplification condition for enhanced stimulated emission, population inversion and pumping method and schemes (two level, three level and four level): Amplifier and Optical Resonator with threshold condition for Lasing.	12
2	Application of LASER in Holography,Concept of Temporal and Spatial Coherence, Principle method of generating and observing hologram, types of holograms. Application in consumer electronic industry (Barcode reader and its elements), in communication-basic principle and element of optical fiber communication. Numerical aperture of fiber optics cables. In medical science, LASER diagnostics, LASER in ophthalmology and LASIK, LASER-surgery and LASER in Dermatology.	14
3	Concept of molecule, Basic idea of molecular bonding-Ionic Non-Rigid rotator and covalent formation of molecules, Morse potential energy curve, Molecule as oscillator, Concept of dissociation, wave function of H_2^+ Valence bond, Linear Combination of Atomic Orbitals (L.C.A.O.) concept.	10

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4	Hamiltonian of molecule theory, Separation of electronic and nuclear motion (Born-oppenheimer approximation), Types of molecular energy states-vibrational, rotational and electronic, Types of molecular spectra-UV, IR, Raman; flame spectroscopy and flame photometry, X-Ray and Mossbauer spectroscopy.	12
5	Different Molecular spectroscopic techniques as a Tool- atomic absorption spectroscopy, Emission spectroscopy, Molecular Luminescence, Photo and Opto-acoustic spectroscopy (PAS/OAS), Nuclear Magnetic Resonance (NMR), Nuclear Quadrupole Resonance (NQR), Electron Spin Resonance (ESR) and Electron diffraction spectroscopy.	12
	TOTAL	**60**

MJCPHY16: Physics of Laser and Molecules (P) - 1 Credit	
1.	To verify Beer-Lambert law
2.	To detect impurity in given sample using spectrophotometer
3.	To determine speed light in air in Lab
4.	To calculate / evaluate the Numerical aperture of given fiber
5.	To use basic Transmission network using Demonstration Kit.
6.	To study Characteristics of LASER .
7.	To study UV/IR- Spectrum of given sample.

Suggested Readings :

1. Quantum Chemistry- R.K.Prasad (New Age International (P) Ltd.)
2. Physics of Atoms and Molecules B H Bransden and C J Joachain
3. Molecular Structure & Spectroscopy – G. Aruldhas (PHI)
4. Molecular Spectroscopy - B.K Sharma (Goel Publishing House)
5. Lasen Principle : Types & Application - K.R. Nambia (New Age Publication)
6. Laser & Opticals – L.V. Tarasor (Mir)7. Introduction Laser : Theroy & Application – M.N. Avdhanulu & P.S Hemne (S.Chand)

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Syllabus for 4 Year Undergraduate Programme under CBCS System

RESEARCH METHODOLOGY FOR FACULTY OF SCIENCE

SEMESTER-VII: MAJOR COURSE-14 (MJC-14)

Credits: Theory-05 **Full Marks:ESE-70 + CIA-30 = 100**

Objective of the Course

- To introduce fundamental of research process including problem identification. hypothesis concept and to draw conclusion.

Learning outcome:

After completion of this course the students will be able to

- Develop the skill of contextualization of knowledge and critical thinking
- Choose appropriate methods of research aims and objectives.
- Apply ethical principle in research work.
- Understand the philosophy of research integrity and publication ethics.

MJC-XIV :Research Methodology (Credit: 5)		
Unit	**Topics to be covered**	**No. of Hours (50)**
1	**Fundamental of Research**	
	1.1 Philosophy, concept, aims, objectives, purpose and scope of research.	04
	1.2 Types of Research : Descriptive *vs* Analytical, Pure *vs* Applied, Conceptual *vs* Empirical, Qualitative *vs* Quantitative,Scientific *vs*Technical.	03
	1.3 Good Laboratory Practices and safety measures.	02
2	**Concept of Research Problem and Research Designing**	
	2.1 Identifying the Research Problem: meaning; importance; sources; selecting, stating and evaluating a research problem	03
	2.2 Hypothesis: Designing and Testing	03
	2.3 Experimental Research and Design: Approximation of data, simulation and modelling	02
	2.4Sampling: Types of sampling, Questionnaire and observational methods of data collection.	03

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3	**Use of Tools and Techniques in Research**	
	3.1 Use of Search engines for reviewing of literature and data retrieving(Google scholar, PubMed, ResearchGate and ShodhGanga)	02
	3.2 Use of Software: Microsoft Word, Microsoft Excel, Latex,SPSS/R/MATLAB/SCILAB/EndNote	03
	3.3 Basic Statistical Methods and Techniques: Descriptive Statistics, Test of Significance, ANOVA, Regression Analysis.	03
	3.4 Electronic submission of paper in different journals, Transferring big files through software	03
4	**Scientific Communication**	
	4.1 Steps of Research Paper writing: Title, Abstract and Keywords, Introduction, Material and Methods, Results and Discussion, Conclusion, Conflict of Interest, Acknowledgment, Table and Graphs, Appendices.	04
	4.2 Research Proposal: Writing and Submission	03
	4.3 Funding Agencies: BCST, UGC, CSIR, ICMR,DST, DBT, ICAR	02
	4.4Seminar/Conference/Webinar presentation: Abstract writing and oral (PPT)and poster presentation.	02
	4.5Journal: Types, Indexing, Concept of Impact factor and Citation.	02
5	**Research Publication and Ethics**	
	5.1 Ethical issues in Research	02
	5.2 Plagiarism : Meaning, Types and Implications, Checking Software	02
	5.3 IPR: Patent, Copyright and Trademark	01
	5.4 UGC guidelines on Research Ethics	01
	TOTAL	**50**

Recommended Books:

1. Research Methodology- C.R. Kothari
2. Research Methodology :Methods & Technique (2023) – VimalSagar, AGPH, Bhopal
3. Research Methodology for PhD Coursework (2023)- D.N. Pandit, Hindustan Publishing Corporation, New Delhi
4. Statistics: A modern approach (2022) - D.N. Pandit, Hindustan Publishing
5. Essays on Research Methodology (2015)-Hegde D.S. Springer
6. Research Methodology Step by Step Guide for Beginners (2019)-Kumar R. Sage Publication.
7. Research Methodology for Science: Michael P. Marden Cambridge Univ. Press
8. Fundamentals of Research Methodology and Statistics (2006): Singh Y.K. New Edge Publication

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