Integrated M.Sc. (Physics) 2024-2026

PROPOSED SCHEME FOR 5 Year Integrated B.Sc. and M.Sc.(Physics) Program
1st YEAR FIRST SEMESTER

Teaching Scheme						Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Name	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	IMSPH 101	DCC-1	Mathematical Physics-I	DCC	**4**	3	1	0	3	-	25	-	25	50	-
2.	IMSPH 103	DCC-2	Introduction to Mechanics	DCC	**4**	3	1	0	3	-	25	-	25	50	-
3.	IMSPH 105	DCC-3	Elements of Electricity and Magnetism	DCC	**4**	3	0	2	3	-	15	25	20	40	-
4.	IMSPH 107	GEC-1	For other Department offering IMSc Physics I	GEC	**4**	3	0	2	3	-	15	25	20	40	
5.	ISEC 1yy	SEC-1	From the pool of SEC	SEC	**2**										
6.	IVAC 1yy	VAC-1	Choose from the pool of VAC	VAC	**2**										
7.	IAEC 1yy	AEC-1	Choose from the pool of AEC	AEC	**2**										
		Total			**22**										
		For exit one project			**4**										

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added courses (VAC)
22	**12**	**4**	**-**	**2**	**2**	**2**

PROPOSED SCHEME FOR 5 Year Integrated B.Sc. and M.Sc.(Physics) Program
1st YEAR SECOND SEMESTER

Teaching Scheme						Contact Hours/ Week			Exam Duration		Relative Weightage %				
S. No.	Subject Code	Course Title	Course Name	Course Type	Credit	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	IMSPH 102	DCC-4	Mathematical Physics-II	DCC	**4**	3	1	0	3	-	25	-	25	50	-
2.	IMSPH 104	DCC-5	Physics of Vibrations and Waves	DCC	**4**	3	1	0	3	-	25	-	25	50	-
3.	IMSPH 106	DCC-6	Analog Electronics	DCC	**4**	3	0	2	3	-	15	25	20	40	-
4.	IMSXX XXX	GEC-2	For other Department offering IMSc Physics II	GEC	**4**	3	0	2	3	-	15	25	20	40	
5.	IAEC 1yy	AEC 2	Choose from the pool of AEC	AEC	**2**										
6.	ISEC 1yy	SEC-2	From the pool of SEC	SEC	**2**										
7.	IVAC 1yy	VAC-2	Choose from the pool of VAC	VAC	**2**										
		Total			**22**										
		For exit one project			**4**										

Credits

Total	Core	Generic Electives (GE)	Department Specific Electives (DSE)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Value added courses (VAC)
22	**12**	**4**	**-**	**2**	**2**	**2**

Course Code: Course Title	Course Structure			Pre-Requisite
IMSPH101 **Mathematical Physics-I** I.M.Sc. Semester-I	**L**	**T**	**P**	**NIL**
	3	**1**	**0**	

Course Objectives:
To impart knowledge about various mathematical tools employed to study physics problems.

Course Outcomes (COs):

1. Understand the fundamentals of vector algebra
2. Study basic concepts and applications of Laplace transforms
3. Solve differential equations of various types.
4. Describe special functions and their recurrence relations.
5. To identify various numerical methods for a variety of multidisciplinary applications

S. No.	Content	Contact Hours
Unit 1	**Vector Algebra:** Definitions, Addition of vectors, Product of vectors-scalar and vector product of two, three and four vectors, Geometrical interpretation of vector product, lines and planes in space, cylinders and quadric surfaces, Basics related to vector differentiation	**6**
Unit 2	**Laplace Transforms:** Definition and examples of Laplace Transforms, properties of Laplace Transforms, Inverse Laplace transforms, Solution of differential equations by Laplace Transforms, Applications of Laplace transforms	**11**
Unit 3	**Differential Equations:** Ordinary differential equations, First order differential equations, Higher order linear homogeneous differential equations with constant coefficients, Non-homogeneous second order linear differential equations with constant coefficients, Method of solving linear differential equations by changing the Independent variables, Method of variation of parameters, Applications to Differential equations.	**11**
Unit 4	**Special Functions:** Beta, Gamma, Delta and Error functions – Bessel, Hermite, Legendre, Associated Legendre and Laguerre functions – Generating functions – Recurrence relations – Applications in physics.	**11**
Unit 5	**Numerical Analysis:** Finite difference, Forward and backward differences, Interpolation formulas for equal intervals, Least square fitting, Trapezoidal and Simpson's rule, Runge-Kutta method.	**6**
	Total	**45 hrs**

Books:

S. No.	Name of Books/Authors/Publisher
1.	Vector Analysis, Murray Spiegel, 2 Ed., 2017, Schaum's outlines series.
2.	Differential Equations, George F. Simmons, 2007, McGraw Hill.
3.	An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
4.	Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
5.	Higher Engineering Mathematics by H.K. Dass and Rajnish Verma, 2018, S. Chand & Company Ltd.

Couse Code: Course Title	Course Structure			Pre-Requisite
IMSPH 103 Introduction to Mechanics I.M.Sc. Semester-I	**L**	**T**	**P**	Physics and Mathematics courses offered by Central Board of Secondary Education at higher secondary level or equivalent.
	3	**1**	**0**	

Course Objectives: The objective of Introduction to Mechanics is a comprehensive study of the fundamental principles governing the motion of particles and selected topics from special theory of relativity. This course also aims to cultivate a deep understanding of inertial and non-inertial reference frames, encompassing conservation principles, rigid body dynamics, gravitational motion and mechanics of continuous media. Through lectures, demonstrations, and problem-solving sessions, students will develop analytical skills and problem-solving proficiency essential for physics and engineering disciplines.

Course Outcomes (COs): By the end of this course, students should be able to:

1. Understand fundamental principles of classical mechanics.
2. Apply mathematical techniques to analyze motion and forces in inertial and non-inertial frames.
3. Solve problems involving rigid body dynamics and conservation laws.
4. Analyze gravitational motion and central force problems.
5. Comprehend the principles of mechanics in continuous media and special theory of relativity.

S. No.	Content	**Contact Hours**
Unit 1	**Inertial and Non- Inertial Systems Reference Frames**: - Inertial Frames and Galilean Transformations, Galilean Invariance and Conservation Laws, Non-inertial Frames and Fictitious Forces, Uniformly Rotating Frame. Physics Laws in Rotating Coordinate Systems, Coriolis force and its Applications.	**6 Hrs**
Unit 2	**Special Theory of Relativity:-** Michelson-Morely experiment and its implications, Postulates of special theory of relativity, Derivation of Lorentz transformation and physical significance of Lorentz invariance, Length contraction and time dilation, Concept of simultaneity, Relativistic velocity transformation relations, mass energy relation, Concept of zero rest mass of photon, Relativistic relation between energy and momentum.	**10 Hrs**
Unit 3	**Mechanics of Rigid Bodies:-** System of particles; Centre of mass, angular momentum, equations of motion; Conservation theorems for energy, momentum and angular momentum; Elastic and inelastic collisions; Rigid Body; Degrees of freedom, Euler's theorem, angular velocity, angular momentum, moments of inertia, theorems of parallel and perpendicular axes, equation of motion for rotation; Precessional motion; top and gyroscope	**12 Hrs**
Unit 4	**Gravitation and Motion under a central force**:- Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Two-body problem and its reduction to one-body problem and its solution, The energy equation and energy diagram, Kepler's Laws(Ideas only), Satellite in circular orbit, Geosynchronous orbits.	**10 Hrs**
Unit 5	**Mechanics of Continuous Media :** Elasticity, Hooke's law and elastic constants of isotropic solids and their inter-relation; Streamline (Laminar) flow, viscosity, Poiseuille's equation for flow of a liquid through a capillary tube.	**7 Hrs**
	Total	**45 hrs**

List of Experiments:

1. Measurements of length (or diameter) using Vernier calliper, screw gauge and travelling microscope.
2. To determine the Moment of Inertia of a Flywheel.
3. To determine the Acceleration due to Gravity (g) and Velocity for a freely falling body, using Digital Timing Techniques.
4. To study the motion of the spring and calculate (a) spring constant and, (b) .
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille‟s method).
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell‟s needle.
8. To determine the elastic Constants of a wire by Searle‟s method.
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater‟s Pendulum.

Books:

S. No.	Name of Books/Authors/Publisher
1.	An Introduction to Mechanics, Daniel Kleppner & Robert Kolenkow, 2007, Tata McGrawHill.
2.	Mechanics, DS Mathur, PS Hemne, 2012, S. Chand.
3.	University Physics, FW Sears, MW Zemansky& HD Young 13/e, 1986, AddisonWesley.
4.	Mechanics Berkeley Physics course, v.1: Charles Kittel, et.al. 2007, Tata McGrawHill.
5.	Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley.
6.	Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press

Course Code: Course Title	Course Structure			Pre-Requisite
IMSPH 105 **Elements of Electricity and Magnetism** I.M.Sc. Semester-I	**L**	**T**	**P**	**Class XII**
	3	**0**	**2**	

Course Objectives:

This course builds on the fundamentals of electricity and magnetism. Students can understand the laws of electromagnetism from their everyday experience by specific examples of how electromagnetic phenomena occurs. Also, they will be able to represent these electromagnetic phenomena and fields mathematically.

Course Outcomes (COs)

1. Comprehend the fundamental laws of electrostatics and magnetostatics and study their application to systems of point charges/currents as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
2. Evaluating electric fields and potentials with special techniques.
3. Understanding behaviour of electricity and magnetism inside matter.
4. Determine the magnetic force generated by a current carrying conductor
5. Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

S. No.	Content	**Contact Hours**
Unit 1	**Vector Analysis**: Review of vector algebra, vector calculus: Fundamental theorems of gradients, divergences, and curls. curvilinear coordinates.	**5**
Unit 2	**Electrostatics**: Electric field, Gauss's theorem in electrostatics and its applications (linear, plane, and cylindrical/spherical charge distribution), electric potential, Poisson's Equation and Laplace's Equation, Work, and energy in electrostatics: point and continuous charge distribution. Electric dipole. Capacitors.	**10**
Unit 3	**Electric field in matter**: dielectric medium, dielectric polarization, displacement vector, Gauss's theorem in dielectrics. Energy in dielectric systems	**8**
Unit 4	**Magnetostatics**: Magnetic force, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, Magnetic vector potential. Magnetic field in matter: Magnetization. Brief introduction of dia-, para- and ferro magnetic materials, Magnetic dipoles. Field due to magnetized object.	**12**
Unit 5	**Time varying fields**: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current	**10**
	Total	**45 hrs**

LIST OF EXPERIMENTS

1) Magnetic field variation along the axis of a circular coil current carrying coil.

2) To determine the Mass Susceptibility of anhydrous Manganese Sulphate ($MnSo_4.H_2O$) by Quicke's tube

3) Biot Savart's Law: Measuring the magnetic field of circular loop as a function of current

4) Biot Savart's Law: Measuring the magnetic field of the circular loop as a function of distance from the loop and radius of the loop

5) To find charge to mass ratio (e/m) of an electron

6) a. Study of electromagnetic induction by varying distance between the coils with and without an iron core.

b. Study of Lenz law using bar magnet

7) To investigate the behaviour of a transformer by variation of voltage and current.

8) To determine the specific rotation of a sugar solution using polarimeter.

Books:

S. No.	Name of Books/Authors/Publisher
1.	Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
2.	Schaum's Outlines of Electromagnetics by J. A. Edminister and M. Nahvi, 2019, 2019 McGraw-Hill Education
3.	Principles of Electromagnetics, Matthew N.O. Sadiku and S.V Kulkarni, 2015 Qxford University Press
4.	Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
5.	Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
6.	Engineering Physics|, H. K. Malik & A.K. Singh 2nd Edition , August 2017, McGraw-Hill.

Course Code: Course Title	Course Structure			Pre-Requisite
IMSPH 107 **Physics I** I.M.Sc. Semester-I	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objectives

This course typically aims to provide students with a foundational understanding of key physics concepts and principles. It is designed to develop analytical and problem-solving skills, as well as the ability to apply theoretical knowledge to practical situations.

Course Outcomes (COs)

1. To comprehend basic physics concepts such as kinematics, dynamics, energy, momentum, and rotational motion.
2. To apply the equations for relativistic momentum and energy, including the famous equation $E = mc^2$.
3. To solve a wide range of problems based on various optical phenomena using both theoretical and practical approaches.
4. To analyze the harmonic motion and thus solve the related problems.
5. To apply the wave equation to various physical contexts.

S. No.	Content	**Contact Hours**
Unit 1	Newton's Laws of Motion; Dynamics of uniform circular motion, Work-energy theorem; Conservation of linear momentum and Angular Momentum: Examples and applications, Equilibrium: Conditions for equilibrium, centre of mass, stability.	**8**
Unit 2	Relativity: Special Relativity; Postulates, Time Dilation; Doppler Effect; Length Contraction; Twin Paradox; Relativistic Momentum; Mass and Energy; Energy and Momentum	**10**
Unit 3	Geometrical Optics: Reflection, refraction, lens and mirror formulas, Wave Optics: Huygens' principle, interference, diffraction, polarization, Optical Instruments: Microscopes, telescopes, and other optical instruments.	**9**
Unit 4	Simple Harmonic Motion (SHM): Differential equation of SHM, energy in SHM. Applications of Oscillatory Motion: Pendulums, oscillations in mechanical systems. Damped Harmonic Motion (SHM): Heavy damping, critical damping, amplitude decay, Logarithmic decrement, relaxation time, energy decay, Q-value.	**8**
Unit 5	Forced Oscillations: Transient and steady state behaviour of a forced oscillator, variation of displacement and velocity with frequency of driving force, frequency dependence of phase angle between force, displacement and velocity, power supplied to oscillator, quality factor.	**10**
	Total	**45 hrs**

LIST OF EXPERIMENTS

1. To determine the moment of inertia of flywheel.
2. To determine the coefficient of damping, relaxation time and quality factor of a damped simple harmonic motion using a simple pendulum.
3. To determine the refractive index of the material of the prism using spectrometer.
4. To determine the dispersive power of the material of a prism using Spectrometer.
5. To determine the wavelength of yellow line of mercury light using Plane diffraction Grating.
6. To determine the wavelength of sodium light by Newton's rings.
7. To determine the specific rotation of a sugar using a polarimeter.
8. To determine the e/m ratio of an electron.

Books:

S. No.	Name of Books/Authors/Publisher
1.	Fundamentals of Physics by Halliday, Resnick, and Walker, 10th Edition John Wiley & Sons Inc
2.	The physics of vibration and waves by H. J. Pain, 6th Edition Wiley Student Edition
3.	Concepts of Physics by H.C. Verma, Bharati Bhawan Publishers & Distributor
4.	Engineering Physics|2nd Edition by Hitendra K. Malik, A.K. Singh
5.	Perspective of Modern Physics, by Arthur Beiser 1969/ McGraw-Hill Education
6.	Optics by Ajoy Ghatak (6th Edition McGraw-Hill Education)