Revised

Curriculum for

Four-Year Undergraduate Programme

PHYSICS (Hons.) with Research

under NEP 2020

(w.e.f academic year 2026-27)

Bhattadev University
Pathsala - 781325
Assam, INDIA

Table : Course Structure for FYUGP in Physics (Hons.) with Research/without Research

NCrF Level	Semester	Course Category	Course Code	Course Title	Credit (L-T-P)	Sem. Credit
4.5	1st of FYUP	Major 1	PHY 1101004CC	Mathematical Physics I	3-0-1	20
		Minor 1	XYZ 1101004MC	From other subject/discipline	3-0-1	
		MDC 1	XYZ 1101003MD	From other discipline which was not studied in Class XI or XII	3	
		AEC 1	XYZ 1101002AE	ENG 1101002AE / ASS 1102002AE	2-0-0	
		SEC 1	XYZ 1101003SE		2-0-1	
		VAC 1	VAC 111002VA		2-0-0	
		VAC 2	VAC 112002VA	Select for the option of VAC	2-0-0	
	2nd of FYUP	Major 2	PHY 1201004CC	Mechanics	3-0-1	20
		Minor 2	XYZ 1201004MC	From other subject/discipline	3-0-1	
		MDC 2	XYZ 1201003MD	From other discipline which was not studied in Class XI or XII	3	
		AEC 2	XYZ 1201002AE	ENG 1201002AE / ASS 1202002AE	2-0-0	
		SEC 2	XYZ 1201003SE		2-0-1	
		VAC 3	VAC 121002VA		2-0-0	
		VAC4	VAC 122002VA	Select for the option of VAC	2-0-0	
Students exiting the programme after securing 40 credits will be awarded UG Certificate provided they secure 4 credits in work based vocational courses						
5.0.	3rd of FYUP	Major 3	PHY 2101004CC	Wave, Oscillation and Sound	3-0-1	20
		Major 4	XYZ 2102004CC	Mathematical Physics - II	3-0-1	
		Minor 3	XYZ 2101004MC	From other subject/discipline	4	
		MDC 3	XYZ 2104003MD	From other discipline which was not studied in Class XI or XII	3	
		AEC 3	XYZ 2101002AE	ENG 2101002AE / ASS 2101002AE	2-0-0	

		SEC 3	XYZ 2101003SE		2-0-1	
	4th of FYUP	Major 5	PHY 2201004CC	Optics	3-0-1	22
		Major 6	PHY 2202004CC	Thermal Physics	3-0-1	
		Major 7	PHY 2203004CC	Electricity and Magnetism	3-0-1	
		Major 8	PHY 2204004CC	Ancient Indian Astronomy	3-1-0	
		Minor 4	XYZ 2201004MC	From other subject/discipline	4	
		AEC 4	XYZ 2201002AE	ENG 2101002AE / ASS 2101002AE	3-0-1	
Students exiting the programme after securing 82 credits will be awarded UG Diploma in Physics provided provided they secure 4 credits in work based vocational courses						
5.5	5th of FYUP	Major 9	PHY 3101004CC	Mathematical Physics – III	3-0-1	22
		Major 10	PHY 3102004CC	Electromagnetic Theory	3-0-1	
		Major 11	PHY 3103004CC	Quantum Mechanics	3-0-1	
		Major 12	PHY 3104004CC	Electronics - I	3-0-1	
		Minor 5	XYZ 3101004MC	From other subject/discipline	3-0-1	
		Internship	PHY 3101001IN	Internship during the summer vacation	0-0-2	
	6th of FYUP	Major 13	PHY 3201004CC	Atomic Physics	3-0-1	20
		Major 14	PHY 3202004CC	Nuclear Physics	3-1-0	
		Major 15	PHY 3203004CC	Condensed Matter Physics	3-0-1	
		Major 16	PHY 3204004CC	Electronics-II	3-0-1	
		Minor 6	XYZ 3201004MC	From other subject/discipline	3-0-1	
Students who want to undertake 3-year UG programme will be awarded UG Degree in Physics (B.Sc. in the Major Subject and Minor Subject) upon securing 124 credits Credit						
6	7th of FYUP	Major 17	PHY 4101004CC	Classical Mechanics	3-1-0	20
		Major 18	PHY 4102004CC	Applications of Quantum Mechanics	3-0-1	
		Major 19	PHY 4103004CC	Research Methodology	3-0-1	
		Major 20	PHY 4104004CC	Molecular Physics and Spectroscopy	3-0-1	

		Minor 7	XYZ 4101004MC	From other subject/discipline	3-0-1	
	8th of FYUP	Major 21	PHY 4201004CC	Statistical Mechanics	3-0-1	20
		Major 22	PHY 4201004CC	Electronic Measurement Systems	3-0-1	
		Major 23	PHY 4201004CC	Renewable Energy Physics and Sustainability	3-0-1	
		Major 24	PHY 4201004CC	Nanomaterials and their Applications	3-0-1	
		Minor 8	XYZ 4201004MC	From other subject/discipline	3-0-1	

Note: In the eighth semester, students who fulfil the eligibility criteria prescribed by the University Regulations may opt for the 12-credit course **PHY-4204005RP:Research Project** and upon successful completion of the programme, these students shall be awarded the B.Sc. in Physics (Honours with Research) degree. Students who are not eligible for or do not opt for the research pathway shall complete three courses of 4 credits each (PHY 4202004DE, PHY 4203004DE, and PHY 4204004DE) and shall be awarded the B.Sc. in Physics (Honours) degree without Research .

11.0 COURSES OF PHYSICS FOR THE FYUGP:

The Department of Physics offers a comprehensive range of courses under the Four-Year Undergraduate Programme (FYUGP) of Bhattadev University. These include Major Courses for students pursuing B.Sc. in Physics and B.Sc. in Physics (Hons.), and Minor Courses for students from other disciplines who wish to acquire foundational knowledge of Physics and develop scientific understanding, analytical thinking, and quantitative problem-solving skills as part of their academic journey. The Multidisciplinary Courses (MDCs) of Physics provide students from diverse disciplines with opportunities to explore the principles and applications of Physics and their relevance to contemporary science, technology, and society. The Skill Enhancement Courses (SECs) from Physics focus on developing practical skills in electronics, instrumentation, scientific programming and computational techniques. These SEC courses equip students with hands-on experience and technical competencies relevant to modern scientific research, industry, and emerging technologies. The semester-wise distribution of Major, Minor, Multidisciplinary (MDC), and Skill Enhancement Courses (SEC) offered under the FYUGP curriculum in Physics is given below.

(A) Major Courses:

Table : List of Major Courses for FYUGP in Physics(Hons.)

Sl. No.	Course Code	Name of the Course	Credit	Semester
1	PHY 1101004CC	Mathematical Physics I	3-0-1	First
2	PHY 1201004CC	Mechanics	3-0-1	Second
3	PHY 2101004CC	Wave and Oscillations	3-0-1	Third
4	PHY 2102004CC	Mathematical Physics-II	3-0-1	Third

5	PHY 2201004CC	Optics	3-0-1	Fourth
6	PHY 2202004CC	Thermal Physics	3-0-1	Fourth
7	PHY 2203004CC	Electricity and Magnetism	3-0-1	Fourth
8	PHY 2204004CC	Ancient Indian Astronomy	3-1-0	Fourth
9	PHY 3101004CC	Quantum Mechanics	3-0-1	Fifth
10	PHY 3102004CC	Electromagnetic Theory	3-0-1	Fifth
11	PHY 3103004CC	Electronics-I	3-0-1	Fifth
12	PHY 3104004CC	Mathematical Physics - III	3-0-1	Fifth
13	PHY 3201004CC	Atomic Physics	3-0-1	Sixth
14	PHY 3202004CC	Nuclear Physics	3-1-0	Sixth
15	PHY 3203004CC:	Condensed Matter Physics	3-0-1	Sixth
16	PHY 3204004CC	Electronics - II	3-0-1	Sixth
17	PHY 4101004CC	Classical Mechanics	3-1-0	Seventh
18	PHY 4102004CC	Applications of Quantum Mechanics	3-0-1	Seventh
19	PHY 4103004CC	Research Methodology	3-0-1	Seventh
20	PHY 4104004CC	Molecular Physics and Spectroscopy	3-0-1	Seventh
21	PHY 4201004CC	Statistical Mechanics	3-0-1	Eight
22	PHY 4202004CC	Electronic Measurement Systems	3-0-1	Eight
23	PHY 4203004CC	Renewable Energy Physics and Sustainability	3-0-1	Eight
24	PHY 4204004CC	Nanomaterials and their Applications	3-0-1	Eight
25	PHY 4204005RP	Research Project*	0-0-12	Eight

* In the eight semesters eligible students as per University Regulations get the option to choose a course of Research Project of 12 Credit (PHY 4204005RP) while the other have to go for the three course of 4 Credit each (PHY 4202004CC, PHY 4203004CC and PHY 4204004CC)

(B) Minor Courses:

Table : List of Minor Courses for FYUGP for various disciplines

Sl. No.	Course Code	Name of the Course	Credit	Semester
1	PHY 1101004MC	Mathematical Physics-I	3-0-1	First

2	PHY 1201004MC	Mechanics	3-0-1	Second
3	PHY 2101004MC	Wave and Oscillations	3-0-1	Third
4	PHY 2201004MC	Optics	3-0-1	Fourth
5	PHY 3101004MC	Electricity and Magnetism	3-0-1	Fifth
6	PHY 3201004MC	Atomic Physics	3-0-1	Sixth
7	PHY 4101004MC	Electronics - I	3-0-1	Seventh
8	PHY 4101004MC	Electronics - II	3-0-1	Eight

PHY 1101004CC: MATHEMATICAL PHYSICS - I

NCrF Level:	4.5	
Programme:	Four-Year Undergraduate Programme	**Semester:** First
Course Category:	Major Course (Core Course)	
Credits (L – T – P):	3- 0-1	
Credit Hours:	Theory - 45 Hours, Practical - 30 Hours	
Prerequisite:	Class XI & XII (NCrF Level 3.0 & 3.5) Mathematics	

1.0 COURSE OBJECTIVES

The course aims to develop essential mathematical, analytical and critical-thinking skills that enable students to understand, formulate, model and solve diverse problems in physics. IIt provides a strong foundation for advanced studies, computational analysis, and practical applications in both theoretical and experimental physics. The objectives of the course are as follows:

- To develop proficiency in graphical representation and interpretation of elementary functions, including Taylor series approximations, error estimation and curve fitting.
- To understand vector algebra and calculus using index notation, vector integrals and related theorems and interpret gradient, divergence and curl in physical contexts.
- To acquire a strong foundation in matrix theory and apply linear algebraic methods to analyze, model, and solve physical and geometrical problems effectively.
- To apply analytical, numerical and computational techniques for solving ordinary and partial differential equations and analysing real-world physics problems using modern tools.

2.0 COURSE LEARNING OUTCOMES

After completing this course, students will be able to,

CLO	Outcomes
CLO1:	Apply Taylor series to elementary functions, interpret their graphs and use vector operations in terms of index notation as well as Cartesian transformation of vectors.
CLO2:	Apply vector differential calculus to evaluate gradients, divergence, curl, Laplacian operators, and interpret their geometrical and physical significance in scalar and vector fields.
CLO3:	Apply line, surface, and volume integration techniques to evaluate scalar and vector fields and utilize Green's, divergence and Stokes' theorems to analyze physical phenomena.
CLO4:	Gain a thorough understanding of matrix theory, various types of matrices, fundamental theorems and their applications in solving mathematical and physical problems.
CLO5:	Learn various methods to solve ordinary differential equations and partial differential equations along with their applications in real-time physics problems.
CLO6:	Analyze and interpret data through graphical plotting, error estimation, curve fitting and apply computational techniques using spreadsheets, calculators and open-source software.

3.0 SKILLS TO BE LEARNED

- To perform and use matrix operations in solving various problems of physics.
- To formulate, solve and interpret differential equations for various practical problems.
- To apply graphical, numerical, and matrix-based methods to determine roots of equations and solve systems of linear equations.

4.0 DETAILED CONTENTS OF THE COURSE: THEORY

Credit: 3 **Classroom Teaching: 45 Hours**

SECTION 1: [15 Marks in the End Term Examination]

Functions: Functions and their representation through table, graph and equation, combination and symmetry of Functions, different types of elementary functions like linear, quadric, polynomial , algebraic, transcendental functions, trigonometric, exponential, hyperbolic functions, piecewise defined functions,, inverse of a function, transformation of functions, interpreting graphs of functions using the concepts of calculus, Taylor's series expansion for elementary functions. scalar function vs vector function, Multivariable functions. **[3 Hours]**

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Index notation and summation convention, scalar and vector product and their physical significance, Product of vector of two, three and four vectors and representation in index notation using δ_{ij} and ε_{ijk}, Invariance of scalar product under rotation transformation. Scalar fields and vector fields. **[5 Hours]**

Vector Differentiation: Differentiation of a scalar and vector, Partial derivatives of functions with multiple variable - Product Rule, Quotient Rule, Power Rule, Chain Rule; Vector differential operator $\vec{\nabla}$ Gradient of a scalar field and its geometrical interpretation, normal and directional derivatives, Divergence and curl of a vector field and their physical significance. Del and Laplacian operators, Vector identities. **[7 Hours]**

SECTION 2: [15 Marks in the End Term Examination]

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals: Jacobian. infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **[5 Hours]**

Matrices: Types of matrices, rank of a matrix, Addition, substation, Multiplication of matrix, Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrix. Trace of a Matrix. Inner Product. Inverse of a matrix, Eigen-values and Eigenvectors, Cayley- Hamilton Theorem. **[10 Hours]**

SECTION 3: [15 Marks in the End Term Examination]

Ordinary Differential Equations: Formation of differential equations, first order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor, Applications to physics problems. Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complementary function, particular integral and general solution, Determination of particular integral using method of undetermined coefficients and method of variation of parameters, Cauchy-Euler equation, Initial value problems. Applications to problems.**[12 Hours]**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry **[3 Hours]**

5.0 DETAILED CONTENTS OF THE COURSE: PRACTICUM

Credit: 1 **Laboratory Work: 30 Hours**

In the practicum component, students gain hands-on experience in plotting mathematical curves both manually on graph paper and digitally using spreadsheet applications. Students investigate various functions, analyze their characteristics and errors, solve equations numerically, and prepare laboratory reports documenting calculations, graphs, observations, and results. This practicum enhances analytical, computational and problem-solving skills, effectively connecting theoretical concepts with practical applications.

In the practicum, the instructor has the flexibility to introduce additional exercises that directly correlate with and reinforce the topic discussed in the laboratory class. The suggestive activity and the laboratory work that is performed by the students are:

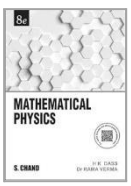
(A) Data Analysis using graphical plot in graph paper

1) To plot linear, quadratic, polynomial, algebraic, transcendental, trigonometric, exponential and hyperbolic functions on graph paper and study their characteristics.
2) To determine the roots of mathematical functions graphically by identifying the points of intersection of the curves with the x-axis.
3) To perform graphical differentiation and integration of functions, determine rates of change and areas under curves and interpret their physical significance.
4) To estimate the area under a curve graphically and compare it with analytical results.
5) To linearize nonlinear data using suitable graphical transformations and determine characteristic parameters from the resulting linear plots.
6) To apply interpolation and extrapolation techniques to graphical data for estimating unknown values within and beyond datasets
7) To analyze the convergence and accuracy of Taylor series approximations for logarithmic, exponential and trigonometric functions through graphical error analysis.
8) To calculate mean, standard deviation, and percentage error from experimental data and evaluate the accuracy, precision, and reliability of measurements.
9) To analyze the correlation between two variables using scatter plots and determine the best-fit line through graphical analysis.
10) To determine decay constants or growth parameters from exponential data using graphical methods and analyze the associated physical processes.

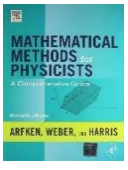
(B) Numerical Computation

1) To solve Algebraic and Transcendental equation graphically and numerical techniques using Bisection, Newton Raphson, False position and Secant methods though calculator/spreadsheet.
2) To Solve the system of quadratic equation like $\alpha = \tan tan\, \alpha$, $I = I_0\left[\frac{\sin sin\, \theta}{\alpha}\right]^2$
3) Determine the inverse of and matrices using cofactor method
4) To solve a linear system of four/five different equations using the matrix inverse method.
5) To Solve linear systems of four/five different equations using Gauss elimination method.
6) To Solve a system of four/five different equations using the Gauss-Jordan elimination method.
7) To Solve a system of four/five different equations using the various LU-decomposition methods.
8) To perform matrix factorizations and determine eigenvalues and eigenvectors for linear systems.
9) To fit a curve to a data set using various mathematical and computational methods,.
10) o analyse the convergence, accuracy and errors of numerical methods in solving equations.

6.0 TEXT BOOKS

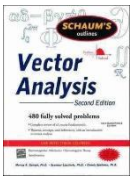


Name: Mathematical Physics
Author:H.K. Dass and R. Verma
Edition:8th Ed. (2022)
Publisher: S. Chand & Company.
ISBN: 978-9352837229

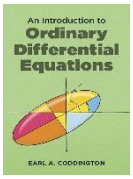


Name: Mathematical Methods for Physicists,
Author: G.B. Arfken, H.J. Weber, F.E. Harris
Edition:7thEdn
Publisher: Elsevier
ISBN:978-9381269558

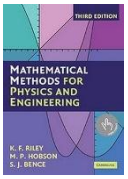
7.0 REFERENCE BOOKS AND MATERIALS



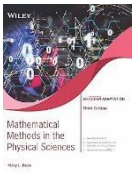
Name: Schaum's Outline of Vector Analysis
Author: Spiegel Murray
Edition:2nd Ed (2009).
Publisher: McGraw-Hill Education, India
ISBN: 978-0071615457



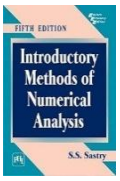
Name: An introduction to ordinary differential equations,
Author:E.A. Coddington
Edition:23 March 2012
Publisher: Dover Publications
ISBN:978-0486131832



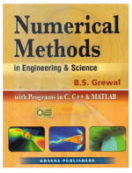
Name: Mathematical Methods for Physics and Engineering
Author: Ken F. Riley, Mike P. Hobson, Stephen J. Bence
Edition: Third edition (1 January 2018)
Publisher: Cambridge University Press;
ISBN:978-0521139878



Name: Mathematical Methods in the Physical Sciences
Author: Mary L. Boas; Abhinav P. Singh; K. Mondal; Maheshwary; S. Anand
Edition:3rd Ed. (2023)
Publisher: Wiley India Private Limited
ISBN: 978-9354644252



Name: Introductory Methods of Numerical Analysis
Author:S.S.Sastry
Edition:5th Ed.
Publisher: Prentice Hall India Learning Private Limited
ISBN:978-8120345928



Name: Numerical Methods in Engineering & Science
Author:B. S. Grewal
Edition:10th Ed.
Publisher: Khanna Publishers
ISBN: 9788174092489

8.0 MAPPING OF CLO TO PLO

The CLO and their mapping with the PLO of B.Sc. in Physics (Hons.) are specified in the table below

Course Learning Outcomes	Programme Learning Outcomes (PLOs)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

8.0 ASSESSMENT SCHEME

Assessment shall be conducted on a continuous basis throughout the semester to evaluate the student's attainment of the course learning outcomes through various academic activities appropriate to the nature of the course. The evaluation shall take into account the student's conceptual understanding, analytical ability, practical skills, academic performance, participation, and overall progress. The distribution of marks for the assessment shall be as follows:

Component	% of Marks		
	Internal Assessment	End Term Examination	Total
Theory	25	45	70
Practicum	10	20	30

ASSESSMENT OF PRACTICUM:

The assessment of the practicum shall comprise Continuous Internal Assessment and an End-Term Examination. The Continuous Internal Assessment shall evaluate the student's laboratory performance, practical skills, conceptual understanding, regularity, participation and progress throughout the semester.

In the End-Term Examination, each student shall be assigned four or five laboratory tasks, depending on their weightage, selected randomly from the department-approved list of experiments. The student shall complete the assigned tasks within the stipulated time, submit a laboratory report, and appear for a viva voce examination. The final assessment shall be based on the student's performance in the assigned experiments, the quality of the laboratory report, performance in the viva voce examination and the Laboratory Notebook maintained throughout the semester.

PHY 1201004CC: MECHANICS

NCrF Level: 4.5

Programme: Four Year Undergraduate Programme **Semester:** Second

Course Category: Major Course (Core Course)

Credits (L – T – P): 3- 0-1

Credit Hours: Theory: 45 Hours, Practical 30 Hours

Prerequisite: Class XI & XII (NCrF Level 3.0 & 3.5) Physics & Mathematics

1.0 COURSE OBJECTIVES

The course is to develop a comprehensive understanding of the fundamental principles of mechanics as well as basic properties of matter like elasticity, viscosity and surface tension. Additionally, the course aims to enhance critical thinking and problem-solving skills and to apply these principles to practical and real-world problems. The objectives of the course are to:

- Provide a comprehensive understanding of particle dynamics, reference frames, collisions, and centre-of-mass motion for the analysis of physical systems.
- Develop the ability to apply the principles of translational and rotational dynamics, including the determination of moments of inertia for various mass distributions and rigid body motion.
- Introduce the concepts of gravitation, Kepler's laws, and orbital mechanics to explain the motion of planets, satellites, and other celestial bodies, along with their practical applications.
- Equip students with practical skills to investigate the mechanical properties of matter, including elasticity, viscosity, surface tension, torsion, and bending, while promoting the safe use of laboratory instruments, accurate data analysis, and scientific report writing.

2.0 COURSE LEARNING OUTCOMES

After completing this course, students will be able to,

CLO	Outcomes
CLO1:	Explain inertial and non-inertial frames, apply Galilean transformations, analyze center-of-mass motion, conservative forces, and collision dynamics in mechanics.
CLO2:	Apply principles of special relativity to explain Lorentz transformations, relativistic effects, velocity addition, and mass-energy equivalence phenomena
CLO3:	Understand the analogy between translational and rotational dynamics along with the of moment of inertia as well as to calculate moment of inertia for different mass distributions
CLO4:	Analyze central-force motion through effective potential concepts, orbital stability, Kepler’s laws, planetary motion, and artificial satellite dynamics.
CLO5:	Analyze the theoretical foundations of elastic properties, fluid flow and surface phenomena, and relate their underlying principles to physical systems.
CLO6:	Demonstrate proficiency in using laboratory measuring instruments safely to study mechanics and properties of matter and prepare clear, structured scientific reports.

3.0 SKILLS TO BE LEARNED

- To solve problems related to linear and rotational motion
- To solve practical problems related to elasticity, viscosity and surface tension. n
- Use of various types of measuring instruments used in Physics Laboratories.

- Art of scientific report wringing of laboratory work.

4.0 DETAILED CONTENTS OF THE COURSE: THEORY

Credit: 3 **Classroom Teaching: 45 Hours**

SECTION 1: [15 Marks in the End Term Examination]

Frame of reference: Inertial frames - Galilean transformations and Galilean invariance, Non-inertial frames - Rotating frame of reference, centrifugal force, coriolis force and its applications. **[5 Hours]**

Conservation Laws Center of mass: Conservative force, force as negative gradient of potential, Potential energy curve, Centre of mass of discrete and continuous objects. Equation of motion of center of mass, L-frame and C-frame, elastic and inelastic collisions in the center of mass of laboratory frames. **[7 Hours]**

Special Theory of Relativity: Postulates of Special Theory, Lorentz transformations (deduction not necessary), relativity in simultaneity, Time dilation & Length contraction, Velocity addition theorem, variable mass (deduction not necessary), Mass-Energy Equivalence Principle. **[5 Hours]**

SECTION 2: [15 Marks in the End Term Examination]

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical). Application of parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation **[8 Hours]**

Central Force Motion (Newtonian Approach): General features of motion under central force, Two-body problem - Reduction to a one-body problem and its solution, f effective potential energy and stability of orbits for central potentials of the form kr^n for n=2 and -1 using energy diagram, nature of for n=-2, Kepler's problem, Kepler's laws for planetary motion, orbit for artificial satellites. **[7 Hours]**

SECTION 3: [15 Marks in the End Term Examination]

Elasticity: Relation between the three elastic constants, Poison's ratio, Twisting torque on a Wire, Torsional pendulum, Bending of beam and cantilever **[6 Hours]**

Kinematics and Dynamics of Fluids : steady and unsteady flow, Equation of continuity and conservation of mass in fluid flow. Euler's equation of motion for an ideal fluid and its physical significance. Bernoulli's theorem, applications to fluid flow through pipes **[6 Hours]**

Surface Tension: Pressure difference across a curved surface, expression for excess pressure inside a spherical drop and spherical shop bubble, Jaeger's method and Ferguson method. **[3 Hours]**

5.0 DETAILED CONTENTS OF THE COURSE: PRACTICUM

Credit: 1 **Laboratory Work: 30 Hours**

The practicum begins with training in fundamental laboratory measurement techniques essential for scientific investigations. Students then perform experiments on motion and material properties, analyse data to determine physical quantities, follow standard laboratory procedures, and prepare concise reports presenting methodology, results, analysis, and conclusions.

In this component of the course, the teacher has the flexibility to introduce additional activities/experiments that directly correlate with and reinforce the theoretical concepts covered in the course curriculum. The suggested experiments are grouped into the following sections and their objectives may be modified or refined in accordance with the assigned academic weightage and laboratory requirements.

PART 1: LABORATORY ACTIVITY AND SKILLS:

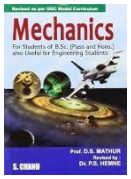
1) Use Vernier calipers to measure the external diameter of small spherical and cylindrical objects, and the internal diameter and depth of a cylindrical vessel.
2) Use a screw gauge to determine the diameter of a wire and the thickness of a thin sheet.

3) Determine the radius of curvature of a spherical surface using a spherometer.
4) Use a travelling microscope to accurately measure small linear distances and separations.
5) Use a sextant to measure the angular elevation of an object and determine the height of a building or other tall structure.
6) Measure the dimensions, volume, and density of regular and irregular solid objects using appropriate measuring instruments.
7) Determine the least count, identify zero error, and apply zero correction for precision measuring instruments.
8) Estimate absolute, relative, and percentage errors, and propagate uncertainties in calculated physical quantities.
9) Record experimental observations systematically using appropriate SI units, significant figures, and scientific notation.

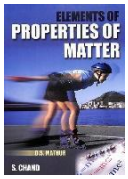
PART 2: SUGGESTIVE EXPERIMENTS:

1. To study the relation between the limiting frictional force and the normal reaction and hence determine the coefficient of friction between two contacting surfaces.
2. To study the component of gravitational force acting along an inclined plane and verify its dependence on sin θ by graphical analysis.
3. To determine the centre of mass of a system of discrete masses and of a continuous body having cylindrical or spherical symmetry by experimental methods.
4. To verify the law of conservation of mechanical energy using a spring–mass system.
5. To determine the effective length of a second's pendulum by constructing L–T and L–T^2 graphs using a simple pendulum.
6. To determine the acceleration due to gravity (g) using a bar pendulum/ Kater's pendulum.
7. To determine the moment of inertia of a flywheel about its axis of rotation.
8. To determine the moment of inertia of a rigid body using a torsional pendulum.
9. To determine the moment of inertia of a given body using an inertia table.
10. To determine Young's modulus of a material by bending of a beam (uniform and non-uniform).
11. To determine the rigidity modulus of a wire by static torsion method.
12. To determine the Young's Modulus of a Wire by Optical Lever Method
13. To determine rigidity modulus and moment of inertia using a torsional pendulum.
14. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
15. To determine Young's Modulus, Rigidity Modulus and Poisson ratio of a wire by Searle's method.
16. To study bending moment and deflection in a cantilever.
17. To determine the coefficient of viscosity of a liquid by Poiseuille's method.
18. To determine the surface tension of water by capillary rise method and verification of Jurin's Law.
19. To verify Stokes' law and hence to determine the coefficient of viscosity of a liquid.
20. To determine the Reynolds number and study the transition from laminar to turbulent flow.
21. Determination of Surface Tension of a liquid-by-liquid drop method.
22. To determine surface tension of a liquid by Jaeger's method.

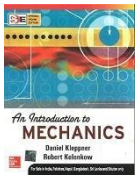
6.0 TEXT BOOKS



Name: Mechanics
Author: D.S. Mathur
Edition: 2000
Publisher: S. Chand & Company Ltd.
ISBN: 978-8121905992



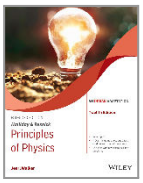
Name: Properties of Matter
Author: D.S. Mathur
Edition: 2010
Publisher: S. Chand & Company Ltd.
ISBN: 978-8121908153



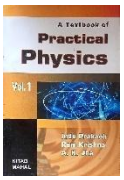
Name: Mechanics
Author: D. Kleppner, R.J. Kolenkow
Edition: 2017
Publisher: McGraw Hill Education
ISBN: 978-0070647787

7.0 REFERENCE BOOKS AND MATERIALS

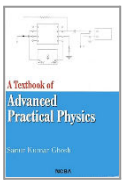
Name: Mechanics, Berkeley Physics, vol.1
Author: C.Kittel, W.Knight
Edition: 2nd Ed.
Publisher: McGraw-Hill Education, India
ISBN: 978-0070702134



Name: Fundamentals of Physics
Author: David Halliday, Robert Resnick, Jearl Walker
Edition: 12th Ed.
Publisher: Wiley
ISBN: 978-9357460835



Name: A textbook of Practical Physics
Author: Indu Prakash, Rama Krishna, A.K. Jha
Edition: 2011
Publisher: Kitab Mahal
ISBN: 978-8122504163



Name: A Textbook of Advanced Practical Physics
Author: Samir Kumar Ghosh
Edition: 2008
Publisher: New Central Book Agency
ISBN: 978-8173812439

8.0 MAPPING OF CLO TO PLO

The CLO and their mapping with the PLO of B.Sc. in Physics (Hons.) are specified in the table below

Course Learning Outcomes	Programme Learning Outcomes (PLOs)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

8.0 ASSESSMENT SCHEME

Assessment shall be conducted on a continuous basis throughout the semester to evaluate the student's attainment of the course learning outcomes through various academic activities appropriate to the nature of the course. The evaluation shall take into account the student's conceptual understanding, analytical ability, practical skills, academic performance, participation, and overall progress. The distribution of marks for the assessment shall be as follows:

Component	% of Marks		
	Internal Assessment	End Term Examination	Total
Theory	25	45	70
Practicum	10	20	30

ASSESSMENT OF PRACTICUM:

The assessment of the practicum shall comprise Continuous Internal Assessment and an End-Term Examination. The Continuous Internal Assessment shall evaluate the student's laboratory performance, practical skills, conceptual understanding, regularity, participation and progress throughout the semester.

In the End-Term Examination, each student shall be assigned one or two laboratory tasks, depending on their weightage, selected randomly from the department-approved list of experiments. The student shall complete the assigned tasks within the stipulated time, submit a laboratory report, and appear for a viva voce examination. The final assessment shall be based on the student's performance in the assigned experiments, the quality of the laboratory report, performance in the viva voce examination and the Laboratory Notebook maintained throughout the semester.

PHY 1101004MC: MATHEMATICAL PHYSICS - I

NCrF Level:	4.5	
Programme:	Four-Year Undergraduate Programme	**Semester:** First
Course Category:	Minor Course	
Credits (L – T – P):	3- 0-1	
Credit Hours:	Theory - 45 Hours, Practical - 30 Hours	
Prerequisite:	Class XI & XII (NCrF Level 3.0 & 3.5) Mathematics	

1.0 COURSE OBJECTIVES

The course aims to develop essential mathematical, analytical and critical-thinking skills that enable students to understand, formulate, model and solve diverse problems in physics. IIt provides a strong foundation for advanced studies, computational analysis, and practical applications in both theoretical and experimental physics. The objectives of the course are as follows:

- To develop proficiency in graphical representation and interpretation of elementary functions, including Taylor series approximations, error estimation and curve fitting.
- To understand vector algebra and calculus using index notation, vector integrals and related theorems and interpret gradient, divergence and curl in physical contexts.
- To acquire a strong foundation in matrix theory and apply linear algebraic methods to analyze, model, and solve physical and geometrical problems effectively.
- To apply analytical, numerical and computational techniques for solving ordinary and partial differential equations and analysing real-world physics problems using modern tools.

2.0 COURSE LEARNING OUTCOMES

After completing this course, students will be able to,

CLO	Outcomes
CLO1:	Apply Taylor series to elementary functions, interpret their graphs and use vector operations in terms of index notation as well as Cartesian transformation of vectors.
CLO2:	Apply vector differential calculus to evaluate gradients, divergence, curl, Laplacian operators, and interpret their geometrical and physical significance in scalar and vector fields.
CLO3:	Apply line, surface, and volume integration techniques to evaluate scalar and vector fields and utilize Green's, divergence and Stokes' theorems to analyze physical phenomena.
CLO4:	Gain a thorough understanding of matrix theory, various types of matrices, fundamental theorems and their applications in solving mathematical and physical problems.
CLO5:	Learn various methods to solve ordinary differential equations and partial differential equations along with their applications in real-time physics problems.
CLO6:	Analyze and interpret data through graphical plotting, error estimation, curve fitting and apply computational techniques using spreadsheets, calculators and open-source software.

3.0 SKILLS TO BE LEARNED

- To perform and use matrix operations in solving various problems of physics.
- To formulate, solve and interpret differential equations for various practical problems.
- To apply graphical, numerical, and matrix-based methods to determine roots of equations and solve systems of linear equations.

4.0 DETAILED CONTENTS OF THE COURSE: THEORY

Credit: 3 **Classroom Teaching: 45 Hours**

SECTION 1: [15 Marks in the End Term Examination]

Functions: Functions and their representation through table, graph and equation, combination and symmetry of Functions, different types of elementary functions like linear, quadric, polynomial , algebraic, transcendental functions, trigonometric, exponential, hyperbolic functions, piecewise defined functions,, inverse of a function, transformation of functions, interpreting graphs of functions using the concepts of calculus, Taylor's series expansion for elementary functions. scalar function vs vector function, Multivariable functions. **[3 Hours]**

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Index notation and summation convention, scalar and vector product and their physical significance, Product of vector of two, three and four vectors and representation in index notation using δ_{ij} and ε_{ijk}, Invariance of scalar product under rotation transformation. Scalar fields and vector fields. **[5 Hours]**

Vector Differentiation: Differentiation of a scalar and vector, Partial derivatives of functions with multiple variable - Product Rule, Quotient Rule, Power Rule, Chain Rule; Vector differential operator $\vec{\nabla}$ Gradient of a scalar field and its geometrical interpretation, normal and directional derivatives, Divergence and curl of a vector field and their physical significance. Del and Laplacian operators, Vector identities. **[7 Hours]**

SECTION 2: [15 Marks in the End Term Examination]

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals: Jacobian. infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **[5 Hours]**

Matrices: Types of matrices, rank of a matrix, Addition, substation, Multiplication of matrix, Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrix. Trace of a Matrix. Inner Product. Inverse of a matrix, Eigen-values and Eigenvectors, Cayley- Hamilton Theorem. **[10 Hours]**

SECTION 3: [15 Marks in the End Term Examination]

Ordinary Differential Equations: Formation of differential equations, first order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor, Applications to physics problems. Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complementary function, particular integral and general solution, Determination of particular integral using method of undetermined coefficients and method of variation of parameters, Cauchy-Euler equation, Initial value problems. Applications to problems.**[12 Hours]**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry **[3 Hours]**

5.0 DETAILED CONTENTS OF THE COURSE: PRACTICUM

Credit: 1 **Laboratory Work: 30 Hours**

In the practicum component, students gain hands-on experience in plotting mathematical curves both manually on graph paper and digitally using spreadsheet applications. Students investigate various functions, analyze their characteristics and errors, solve equations numerically, and prepare laboratory reports documenting calculations, graphs, observations, and results. This practicum enhances analytical, computational and problem-solving skills, effectively connecting theoretical concepts with practical applications.

In the practicum, the instructor has the flexibility to introduce additional exercises that directly correlate with and reinforce the topic discussed in the laboratory class. The suggestive activity and the laboratory work that is performed by the students are:

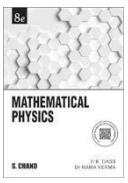
(A) Data Analysis using graphical plot in graph paper

1) To plot linear, quadratic, polynomial, algebraic, transcendental, trigonometric, exponential and hyperbolic functions on graph paper and study their characteristics.
2) To determine the roots of mathematical functions graphically by identifying the points of intersection of the curves with the x-axis.
3) To perform graphical differentiation and integration of functions, determine rates of change and areas under curves and interpret their physical significance.
4) To estimate the area under a curve graphically and compare it with analytical results.
5) To linearize nonlinear data using suitable graphical transformations and determine characteristic parameters from the resulting linear plots.
6) To apply interpolation and extrapolation techniques to graphical data for estimating unknown values within and beyond datasets
7) To analyze the convergence and accuracy of Taylor series approximations for logarithmic, exponential and trigonometric functions through graphical error analysis.
8) To calculate mean, standard deviation, and percentage error from experimental data and evaluate the accuracy, precision, and reliability of measurements.
9) To analyze the correlation between two variables using scatter plots and determine the best-fit line through graphical analysis.
10) To determine decay constants or growth parameters from exponential data using graphical methods and analyze the associated physical processes.

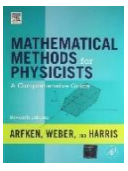
(B) Numerical Computation

1) To solve Algebraic and Transcendental equation graphically and numerical techniques using Bisection, Newton Raphson, False position and Secant methods though calculator/spreadsheet.
2) To Solve the system of quadratic equation like $\alpha = \tan tan\, \alpha$, $I = I_0\left[\frac{\sin sin\, \theta}{\alpha}\right]^2$
3) Determine the inverse of and matrices using cofactor method
4) To solve a linear system of four/five different equations using the matrix inverse method.
5) To Solve linear systems of four/five different equations using Gauss elimination method.
6) To Solve a system of four/five different equations using the Gauss-Jordan elimination method.
7) To Solve a system of four/five different equations using the various LU-decomposition methods.
8) To perform matrix factorizations and determine eigenvalues and eigenvectors for linear systems.
9) To fit a curve to a data set using various mathematical and computational methods,.
10) o analyse the convergence, accuracy and errors of numerical methods in solving equations.

6.0 TEXT BOOKS

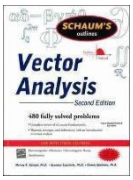


Name: Mathematical Physics
Author:H.K. Dass and R. Verma
Edition:8th Ed. (2022)
Publisher: S. Chand & Company.
ISBN: 978-9352837229

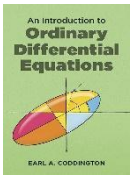


Name: Mathematical Methods for Physicists,
Author: G.B. Arfken, H.J. Weber, F.E. Harris
Edition:7thEdn
Publisher: Elsevier
ISBN:978-9381269558

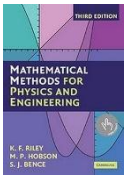
7.0 REFERENCE BOOKS AND MATERIALS



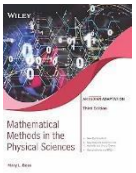
Name: Schaum's Outline of Vector Analysis
Author: Spiegel Murray
Edition:2nd Ed (2009).
Publisher: McGraw-Hill Education, India
ISBN: 978-0071615457



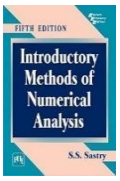
Name: An introduction to ordinary differential equations,
Author:E.A. Coddington
Edition:23 March 2012
Publisher: Dover Publications
ISBN:978-0486131832



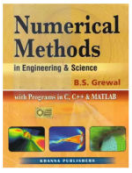
Name: Mathematical Methods for Physics and Engineering
Author: Ken F. Riley, Mike P. Hobson, Stephen J. Bence
Edition: Third edition (1 January 2018)
Publisher: Cambridge University Press;
ISBN:978-0521139878



Name: Mathematical Methods in the Physical Sciences
Author: Mary L. Boas; Abhinav P. Singh; K. Mondal; Maheshwary; S. Anand
Edition:3rd Ed. (2023)
Publisher: Wiley India Private Limited
ISBN: 978-9354644252



Name: Introductory Methods of Numerical Analysis
Author:S.S.Sastry
Edition:5th Ed.
Publisher: Prentice Hall India Learning Private Limited
ISBN:978-8120345928



Name: Numerical Methods in Engineering & Science
Author:B. S. Grewal
Edition:10th Ed.
Publisher: Khanna Publishers
ISBN: 9788174092489

8.0 MAPPING OF CLO TO PLO

The CLO and their mapping with the PLO of B.Sc. in Physics (Hons.) are specified in the table below

Course Learning Outcomes	Programme Learning Outcomes (PLOs)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	H	M	H	–	H	–	L	–	M	L	–	M	L	M	H
CLO2	H	M	H	–	H	–	L	–	M	L	–	M	L	M	H
CLO3	H	M	H	–	H	–	L	–	M	M	–	M	L	M	H
CLO4	H	M	H	–	H	–	L	–	L	L	–	M	L	M	H
CLO5	H	M	H	–	H	M	L	–	M	M	–	M	L	M	H
CLO6	M	M	M	–	M	M	M	–	H	L	–	M	M	H	M

8.0 ASSESSMENT SCHEME

Assessment shall be conducted on a continuous basis throughout the semester to evaluate the student's attainment of the course learning outcomes through various academic activities appropriate to the nature of the course. The evaluation shall take into account the student's conceptual understanding, analytical ability, practical skills, academic performance, participation, and overall progress. The distribution of marks for the assessment shall be as follows:

Component	% of Marks		
	Internal Assessment	End Term Examination	Total
Theory	25	45	70
Practicum	10	20	30

ASSESSMENT OF PRACTICUM:

The assessment of the practicum shall comprise Continuous Internal Assessment and an End-Term Examination. The Continuous Internal Assessment shall evaluate the student's laboratory performance, practical skills, conceptual understanding, regularity, participation and progress throughout the semester.

In the End-Term Examination, each student shall be assigned four or five laboratory tasks, depending on their weightage, selected randomly from the department-approved list of experiments. The student shall complete the assigned tasks within the stipulated time, submit a laboratory report, and appear for a viva voce examination. The final assessment shall be based on the student's performance in the assigned experiments, the quality of the laboratory report, performance in the viva voce examination and the Laboratory Notebook maintained throughout the semester.

PHY 1201004MC: MECHANICS

NCrF Level:	4.5	
Programme:	Four Year Undergraduate Programme	**Semester:** Second
Course Category:	Minor Course	
Credits (L – T – P):	3- 0-1	
Credit Hours:	Theory: 45 Hours, Practical 30 Hours	
Prerequisite:	Class XI & XII (NCrF Level 3.0 & 3.5) Physics & Mathematics	

1.0 COURSE OBJECTIVES

The course is to develop a comprehensive understanding of the fundamental principles of mechanics as well as basic properties of matter like elasticity, viscosity and surface tension. Additionally, the course aims to enhance critical thinking and problem-solving skills and to apply these principles to practical and real-world problems. The objectives of the Course are to:

- Provide a comprehensive understanding of particle dynamics, reference frames, collisions, and centre-of-mass motion for the analysis of physical systems.
- Develop the ability to apply the principles of translational and rotational dynamics, including the determination of moments of inertia for various mass distributions and rigid body motion.
- Introduce the concepts of gravitation, Kepler's laws, and orbital mechanics to explain the motion of planets, satellites, and other celestial bodies, along with their practical applications.
- Equip students with practical skills to investigate the mechanical properties of matter, including elasticity, viscosity, surface tension, torsion, and bending, while promoting the safe use of laboratory instruments, accurate data analysis, and scientific report writing.

2.0 COURSE LEARNING OUTCOMES

After completing this course, students will be able to,

CLO	Outcomes
CLO1:	Explain inertial and non-inertial frames, apply Galilean transformations, analyze center-of-mass motion, conservative forces, and collision dynamics in mechanics.
CLO2:	Apply principles of special relativity to explain Lorentz transformations, relativistic effects, velocity addition, and mass-energy equivalence phenomena
CLO3:	Understand the analogy between translational and rotational dynamics along with the of moment of inertia as well as to calculate moment of inertia for different mass distributions
CLO4:	Analyze central-force motion through effective potential concepts, orbital stability, Kepler's laws, planetary motion, and artificial satellite dynamics.
CLO5:	Analyze the theoretical foundations of elastic properties, fluid flow and surface phenomena, and relate their underlying principles to physical systems.
CLO6:	Demonstrate proficiency in using laboratory measuring instruments safely to study mechanics and properties of matter and prepare clear, structured scientific reports.

3.0 SKILLS TO BE LEARNED

- To solve problems related to linear and rotational motion
- To solve practical problems related to elasticity, viscosity and surface tension. n
- Use of various types of measuring instruments used in Physics Laboratories.

- Art of scientific report wringing of laboratory work.

4.0 DETAILED CONTENTS OF THE COURSE: THEORY

Credit: 3 **Classroom Teaching: 45 Hours**

SECTION 1: [15 Marks in the End Term Examination]

Frame of reference: Inertial frames - Galilean transformations and Galilean invariance, Non-inertial frames - Rotating frame of reference, centrifugal force, coriolis force and its applications. **[5 Hours]**

Conservation Laws Center of mass: Conservative force, force as negative gradient of potential, Potential energy curve, Centre of mass of discrete and continuous objects. Equation of motion of center of mass, L-frame and C-frame, elastic and inelastic collisions in the center of mass of laboratory frames. **[7 Hours]**

Special Theory of Relativity: Postulates of Special Theory, Lorentz transformations (deduction not necessary), relativity in simultaneity, Time dilation & Length contraction, Velocity addition theorem, variable mass (deduction not necessary), Mass-Energy Equivalence Principle. **[5 Hours]**

SECTION 2: [15 Marks in the End Term Examination]

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical). Application of parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation **[8 Hours]**

Central Force Motion (Newtonian Approach): General features of motion under central force, Two-body problem - Reduction to a one-body problem and its solution, f effective potential energy and stability of orbits for central potentials of the form kr^n for n=2 and -1 using energy diagram, nature of for n=-2, Kepler's problem, Kepler's laws for planetary motion, orbit for artificial satellites. **[7 Hours]**

SECTION 3: [15 Marks in the End Term Examination]

Elasticity: Relation between the three elastic constants, Poison's ratio, Twisting torque on a Wire, Torsional pendulum, Bending of beam and cantilever **[6 Hours]**

Kinematics and Dynamics of Fluids : steady and unsteady flow, Equation of continuity and conservation of mass in fluid flow. Euler's equation of motion for an ideal fluid and its physical significance. Bernoulli's theorem, applications to fluid flow through pipes **[6 Hours]**

Surface Tension: Pressure difference across a curved surface, expression for excess pressure inside a spherical drop and spherical shop bubble, Jaeger's method and Ferguson method. **[3 Hours]**

5.0 DETAILED CONTENTS OF THE COURSE: PRACTICUM

Credit: 1 **Laboratory Work: 30 Hours**

The practicum begins with training in fundamental laboratory measurement techniques essential for scientific investigations. Students then perform experiments on motion and material properties, analyse data to determine physical quantities, follow standard laboratory procedures, and prepare concise reports presenting methodology, results, analysis, and conclusions.

In this component of the course, the teacher has the flexibility to introduce additional activities/experiments that directly correlate with and reinforce the theoretical concepts covered in the course curriculum. The suggested experiments are grouped into the following sections and their objectives may be modified or refined in accordance with the assigned academic weightage and laboratory requirements.

PART 1: LABORATORY ACTIVITY AND SKILLS:

1) Use of Vernier callipers for measuring the diameter of small spherical and cylindrical objects, the internal diameter and depth of a cylindrical vessel such as a beaker.
2) use of a screw gauge for determining the diameter of a given wire, the thickness of a thin sheet.

3) To use a sextant for measuring the angular elevation and hence determining the height of a building or tall structure.
4) To use a travelling microscope for the accurate measurement of small linear separations
5) To determine the radius of curvature of a spherical surface using a spherometer**.**

PART 2: SUGGESTIVE EXPERIMENTS:

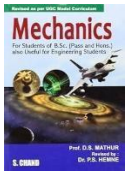
(A) Mechanics:

1) To study the relation between the limiting frictional force and the normal reaction and hence determine the coefficient of friction between two contacting surfaces.
2) To study the component of gravitational force acting along an inclined plane and verify its dependence on sin θ by graphical analysis.
3) To determine the centre of mass of a system of discrete masses and of a continuous body having cylindrical or spherical symmetry by experimental methods.
4) To verify the law of conservation of mechanical energy using a spring–mass system.
5) To determine the effective length of a second's pendulum by constructing L–T and L–T^2 graphs using a simple pendulum.
6) To determine the acceleration due to gravity (g) using a bar pendulum/ Kater's pendulum.
7) To determine the moment of inertia of a flywheel about its axis of rotation.
8) To determine the moment of inertia of a rigid body using a torsional pendulum.
9) To determine the moment of inertia of a given body using an inertia table.

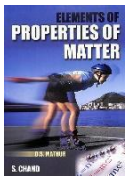
(B) Properties of Matter:

1) To determine Young's modulus of a material by bending of a beam (uniform and non-uniform).
2) To determine the rigidity modulus of a wire by static torsion method.
3) To determine the Young's Modulus of a Wire by Optical Lever Method
4) To determine rigidity modulus and moment of inertia using a torsional pendulum.
5) To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6) To determine Young's Modulus, Rigidity Modulus and Poisson ratio of a wire by Searle's method.
7) To study bending moment and deflection in a cantilever.
8) To determine the coefficient of viscosity of a liquid by Poiseuille's method.
9) To determine the surface tension of water by capillary rise method and verification of Jurin's Law.
10) To verify Stokes' law and hence to determine the coefficient of viscosity of a liquid.
11) To determine the Reynolds number and study the transition from laminar to turbulent flow.
12) Determination of Surface Tension of a liquid-by-liquid drop method.
13) To determine surface tension of a liquid by Jaeger's method.

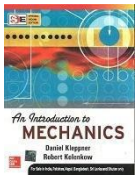
6.0 TEXT BOOKS



Name: Mechanics
Author: D.S. Mathur
Edition: 2000
Publisher: S. Chand & Company Ltd.
ISBN: 978-8121905992



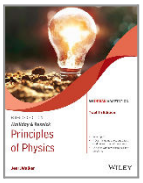
Name: Properties of Matter
Author: D.S. Mathur
Edition: 2010
Publisher: S. Chand & Company Ltd.
ISBN: 978-8121908153



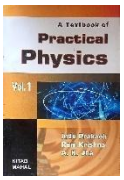
Name: Mechanics
Author: D. Kleppner, R.J. Kolenkow
Edition: 2017
Publisher: McGraw Hill Education
ISBN: 978-0070647787

7.0 REFERENCE BOOKS AND MATERIALS

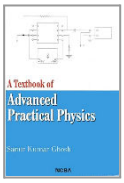
Name: Mechanics, Berkeley Physics, vol.1
Author: C.Kittel, W.Knight
Edition: 2nd Ed.
Publisher: McGraw-Hill Education, India
ISBN: 978-0070702134



Name: Fundamentals of Physics
Author: David Halliday, Robert Resnick, Jearl Walker
Edition: 12th Ed.
Publisher: Wiley
ISBN: 978-9357460835



Name: A textbook of Practical Physics
Author: Indu Prakash, Rama Krishna, A.K. Jha
Edition: 2011
Publisher: Kitab Mahal
ISBN: 978-8122504163



Name: A Textbook of Advanced Practical Physics
Author: Samir Kumar Ghosh
Edition: 2008
Publisher: New Central Book Agency
ISBN: 978-8173812439

6.0 MAPPING OF CLO TO PLO

The CLO and their mapping with the PLO of B.Sc. in Physics (Hons.) are specified in the table below

Course Learning Outcomes	Programme Learning Outcomes (PLOs)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CLO6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

8.0 ASSESSMENT SCHEME

Assessment shall be conducted on a continuous basis throughout the semester to evaluate the student's attainment of the course learning outcomes through various academic activities appropriate to the nature of the course. The evaluation shall take into account the student's conceptual understanding, analytical ability, practical skills, academic performance, participation, and overall progress. The distribution of marks for the assessment shall be as follows:

Component	% of Marks		
	Internal Assessment	End Term Examination	Total
Theory	25	45	70
Practicum	10	20	30

ASSESSMENT OF PRACTICUM:

The assessment of the practicum shall comprise Continuous Internal Assessment and an End-Term Examination. The Continuous Internal Assessment shall evaluate the student's laboratory performance, practical skills, conceptual understanding, regularity, participation and progress throughout the semester.

In the End-Term Examination, each student shall be assigned one or two laboratory tasks, depending on their weightage, selected randomly from the department-approved list of experiments. The student shall complete the assigned tasks within the stipulated time, submit a laboratory report, and appear for a viva voce examination. The final assessment shall be based on the student's performance in the assigned experiments, the quality of the laboratory report, performance in the viva voce examination and the Laboratory Notebook maintained throughout the semester.