

UNIVERSITY OF MADRAS
M.Sc. DEGREE PROGRAMME IN PHYSICS
 SYLLABUS WITH EFFECT FROM 2023-2024

Paper-2 - CLASSICAL MECHANICS AND RELATIVITY	I YEAR - FIRST SEMESTER
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
429C1B	CLASSICAL MECHANICS AND RELATIVITY	Core				4	5	75

Pre-Requisites
Knowledge of fundamentals of mechanics, Foundation in mathematical methods.
Learning Objectives
<ul style="list-style-type: none"> ➤ To understand fundamentals of classical mechanics. ➤ To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. ➤ To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. ➤ To discuss the theory of small oscillations of a system. ➤ To learn the relativistic formulation of mechanics of a system.

UNITS	Course Details
UNIT I: PRINCIPLES OF CLASSICAL MECHANICS	Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.
UNIT II: LAGRANGIAN FORMULATION	D’Alembert’s principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood’s machine (iii) projectile motion.
UNIT III: HAMILTONIAN FORMULATION	Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton’s canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.
UNIT IV: SMALL OSCILLATIONS	Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.

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UNIT V: RELATIVITY	Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein’s mass-energy relation – Minkowski’s space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations
UNIT VI: PROFESSIONAL COMPONENTS	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	<ol style="list-style-type: none"> 1. H. Goldstein, 2002, <i>Classical Mechanics</i>, 3rd Edition, Pearson Edu. 2. J. C. Upadhyaya, <i>Classical Mechanics</i>, HimalayaPublishing. Co.New Delhi. 3. R. Resnick, 1968, <i>Introduction to Special Theory of Relativity</i>, Wiley Eastern, New Delhi. 4. R. G. Takwala and P.S. Puranik, <i>Introduction to Classical Mechanics –Tata – McGraw Hill</i>, New Delhi, 1980. 5. N. C. Rana and P.S. Joag, <i>Classical Mechanics - Tata McGraw Hill</i>, 2001
REFERENCE BOOKS	<ol style="list-style-type: none"> 1. K. R. Symon, 1971, <i>Mechanics</i>, Addison Wesley, London. 2. S. N. Biswas, 1999, <i>Classical Mechanics</i>, Books & Allied, Kolkata. 3. Gupta and Kumar, <i>Classical Mechanics</i>, KedarNath. 4. T.W.B. Kibble, <i>Classical Mechanics</i>, ELBS. 5. Greenwood, <i>Classical Dynamics</i>, PHI, New Delhi.
WEB SOURCES	<ol style="list-style-type: none"> 1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf 2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html 3. https://nptel.ac.in/courses/122/106/122106027/ 4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/ 5. https://www.britannica.com/science/relativistic-mechanics

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COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the fundamentals of classical mechanics.	K2
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K3, K5
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K4, K5
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K2, K3
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) and program specific outcomes (PSO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2