ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc. (Physics Sc. Electronics)						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
VI	(32227626)	Classical Dynamics	05	01	00	06
Teacher/Instructor(s)		Pawan Kumar Singh				
Session		2021-22				

Course Objective: The objective of this course is to develop and enhance the understanding amongst the students about the Classical Mechanics by using the Lagrangian and Hamiltonian Approach to solve the different physics problems.

Course Learning Outcomes: It is expected that after the completion of this course students can imagine and be capable to solve the classical mechanics problems. I am sure they will develop understanding regarding the physics behind the various phenomena occurring around them in the environment.

Lesson Plan:

Unit No.	Learning Objective	No. of Lectures	Topics to be covered
1.	Learn the basics and background of Classical dynamics with solving different physical problems	14	1.Review of Newtonian Mechanics(03) 2. Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field(01) 3.Magnetic field- gyroradius and gyro-frequency, motion in crossed electric and magnetic fields(01) 4.Degrees of freedom of a system(02) 5.Generalized coordinates and velocities(01) 6.Hamilton's Principle(01) 7.Lagrangian and Lagrange's equations of motion of one- dimensional simple harmonic oscillators(01) 8. Falling body in uniform gravity. Cyclic coordinates (01) 9.Problems Practices (03)

2.	Learn the basics of small amplitude oscillations, stable equilibrium and solve the different physical problems for nomal modes, frequencies and coordinates	10	1.Minima of potential energy and points of stable equilibrium (02) 2.small amplitude oscillations about the minimum (01) 3.normal modes of longitudinal simple harmonic oscillations (maximum 3 masses connected by 4 springs) (02) 4. Kinetic energy (T) and potential energy (V) in terms of normal co-ordinates(02) 5. T and V matrices: finding eigen-frequencies and eigen-vectors using these matrices (01) 6. Practice problems (02)
3.	Detail learning about theory of relativity, four space and related problems	35	1.Postulates of Special Theory of Relativity (03). 2.Lorentz Transformations(02) 3. Minkowski space(02) 4.The invariant interval, light cone and world lines(02) 5.Space-time diagrams(03) 6. Time-dilation, length contraction, simultaneity(03) 7.Four-vectors: space-like, time-like and light-like. Four-displacement [$X\mu = (ct, r)$], 4-velocity [$U\mu = \gamma(c, u)$], 4-acceleration ($A\mu$). Metric tensor ($g\mu\nu$ or $g\mu\nu$) and alternating tensor (abcd abcd $\in$ or $\in$) and their properties(05) 8.Four-momentum [$P\mu = (E/c, p)$] and energy-momentum relation (02) 9.Concept of four-force ($F\mu$).(02) 10.Transformation Laws of Four-force.Norms : $X\mu X\mu$, $U\ \mu U\mu$, $A\ \mu A\mu$, $F\mu\ F\mu$ (02) 11.Orthogonal relations:$U\ \mu A\mu = 0$, $P\mu\ F\mu = 0$(02) 12.Conservation of four-momentum(02) 13. Lagrangian and Hamiltonian of a relativistic free particle (02) 14.Practice problems (03)
4.	Learning about fluid dynamics and related problems	05	1.Density ρ and pressure P in a fluid(01) 2. an element of fluid and its velocity(01) 3.continuity equation and mass conservation, stream-lined motion, laminar flow(01) 4.Poiseuille‟s equation for flow of a liquid through a pipe (01) 5. Practice problems (01)

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment	Class test: 2hrs	(10+05+10)=25
	• Quiz		
	• **Class Test (10 marks)**		

	• **Attendance (05 marks)** • **Assignment (10 marks)**		
2.	End Semester Examination	3 hr	75

Details of the Course		
Unit	**Contents**	**Contact Hours**
I	Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field-gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Degrees of freedom of a system, Generalized coordinates and velocities. Hamilton's Principle, Lagrangian and Lagrange‟s equations of motion of one-dimensional simple harmonic oscillators, falling body in uniform gravity. Cyclic coordinates. Canonical momenta & Hamiltonian. Hamilton‟s equations of motion. Comparison of Newtonian, Lagrangian and Hamiltonian mechanics. Applications of Hamiltonian mechanics: Hamiltonian for a simple harmonic oscillator, solution of Hamilton‟s equations for simple harmonic oscillations (1-D), particle in a central force field – conservation of angular momentum and energy.	25
II	Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, small amplitude oscillations about the minimum, normal modes of longitudinal simple harmonic oscillations (maximum 3 masses connected by 4 springs). Kinetic energy (T) and potential energy (V) in terms of normal co-ordinates. T and V matrices: finding eigen-frequencies and eigen-vectors using these matrices.	10
III	Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction, simultaneity Four-vectors: space-like, time-like and light-like. Four-displacement [$X\mu = (ct, r)$], 4-velocity [$U\mu = \gamma(c, u)$], 4-acceleration ($A\mu$). Metric tensor ($g\mu\nu$ or $g\mu\nu$) and alternating tensor (abcd abcd $\in$ or $\in$) and their properties. Four-momentum [$P\mu = (E/c, p)$] and energy-momentum relation. Concept of four-force ($F\mu$). Transformation Laws of Four-force.Norms : $X\mu X\mu$, $U\ \mu U\mu$, $A\ \mu A\mu$, $F\mu\ F\mu$. Orthogonal relations:$U\ \mu A\mu = 0$, $P\mu\ F\mu = 0$.Conservation of four-momentum. Lagrangian and Hamiltonian of a relativistic free particle.	35
IV	Fluid Dynamics: Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille‟s equation for flow of a liquid through a pipe.	05
	Total	**75**

Suggested Books:		
Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/Reprint**
1	Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3 rdEdn. 2002,Pearson Education.	2002
2	Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.	1976
3	Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press	2015
4	Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.	
5	Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press	2010
6	Classical Mechanics, Tai L. Chow, CRC Press.	
7	Classical mechanics , J, C. Upadhaya	
Mode of Evaluation:	Internal Assessment and End Semester Exam	