Birla Institute of Technology & Science, Pilani
Hyderabad Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2023-2024
Course Handout Part-I

Date: 11-8-2023

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regarding the course.

***Course Number* : PHY F111**
***Course Title* : MECHANICS, OSCILLATIONS & WAVES**
***Instructor-in-Charge* :** P.K.THIRUVIKRAMAN
Instructors : Prasant Samantray, Sankar Davuluri, Rickmoy Samanta, Subhadeep Roy, Asrarul Haque
***Course Description*: "**Mechanics, Oscillations, and Waves" serves as a fundamental course in physics for science and engineering. This course, consisting of a series of lectures coupled with several demonstrations, provides a good, sound, working knowledge of the following topics: polar coordinates, angular momentum, central force motion, harmonic oscillator, coupled oscillations, waves and wave equation.

Scope & Objective: Newtonian mechanics, the oldest branch of physics, is rather robust and possesses a very solid foundation**.** The phenomena of oscillations and waves have always been intriguing and are ubiquitous in the world around us. A course on "Mechanics, Oscillations, and Waves" is indispensable to understand other branches of science and engineering and serves as one of the stepping stones for scientific, engineering and medical research and development. The wide-ranging spectrum of subject matter of this course provides a foundation for advanced level physics courses. The objective of this course is to develop good physics problem-solving skills by building a deep conceptual understanding of the subject.

***Text Books*:**
1. An Introduction to Mechanics, by D. Kleppner and R. Kolenkow, Cambridge University Press, Second edition 2021.
2. French, Anthony P French, Vibrations and Waves, CBS, 2003.

Reference Books:
1. The Physics of Vibrations & Waves, by H. J. Pain, 6th edition, John Wiley & Sons, Inc., 2005.
2. Physics Vol I & II, Halliday/Resnick/Krane 5th Edition, John Wiley, 2003.
3. Berkeley Physics Course Volume I, Tata-McGraw Hill.
4. Berkeley Physics course volume III, Tata-McGraw Hill
4. Feynman lectures on Physics, Vol I, Addison-Wesley

Learning Outcomes:

1. Ability to draw free body diagrams with knowledge of constraints and forces and solve the equation of motion.
2. Application of Newton's laws to planetary motion.
3. Ability to analyze and understand oscillatory mechanical systems which are coupled.
4. To understand Interference and diffraction phenomena

Lecture Number	Learning Objectives	Topics to be covered	Suggested Chapter/Section
1	Introduction	The Spirit of Newtonian Mechanics	CLASS NOTE
2-3	Vectors and Kinematics	Velocity and Acceleration, Motion in Plane Polar Coordinates	1.7-1.11 (TB1)
4-8	To understand the concept of Angular Momentum and to study	Angular Momentum, Torque, Fixed axis rotation, Physical	7.1-7.9 (TB1)

	rotation of a rigid body about a fixed axis	Pendulum	
9-14	Understand Central Force Motion	Central force motion, Energy diagrams, planetary motion, Kepler's laws	10.1-10.6 (TB1)
15-16	Calculate frequency of small oscillations for arbitrary potentials	Introduction and review of SHM, Energy diagrams, Small oscillations in a bound system	5.5-5.7, 11.1-11.2 (TB1)
17-18	Damped harmonic oscillator	Lightly damped, heavily damped, and critically damped oscillations, Q factor	11.3 (TB1)
19-20	Forced harmonic oscillator	Undamped forced oscillator, resonance, forced damped oscillator, Q factor	11.4-11.6 (TB1)
21-23	To learn how vibrations can be combined to give more general vibrations leading to beats.	Superposed vibrations in 1D, two superposed vibrations of equal and unequal frequencies, beats, Lissajous figures	Chapter 2 – pages 19-39 (TB2)
24-25	To analyze the behavior of undamped coupled harmonic oscillators. Define normal modes and describe how they may be combined.	Coupled oscillators, normal modes, forced coupled oscillators	Chapter 5 (TB2) Pages: 119-135
26-28	To find the normal modes of coupled pendulums. To determine the motion of coupled pendulums from their initial conditions.	Matrix method for finding normal mode frequencies, matrices, eigenvalues and eigenvectors	Class notes
29-32	To learn how to set up the wave equation. To learn how a normal mode of vibration of a stretched string is describable as a combination of two progressive waves. To find the total energy associated with one complete wavelength of a sinusoidal wave on a stretched string.	The free vibrations of stretched string, Progressive Waves, the energy in a mechanical wave, phase and group velocity	Chapter 6 – TB2 (Pages: 161-170) Chapter 7 (Pages: 201-212) – TB2
33-34	To distinguish between particle and wave/phase velocity.	Superposition of waves, energy in mechanical wave	Pages 213-215, 230-234, 237-242 (TB2)
35-40	To describe interference from multiple sources. Study diffraction grating and diffraction by a single and double slit.	Reflection of wave pulses, Interference from two and more than two sources, diffraction grating, diffraction by a single slit	Chapter 8 (TB2) Pages: 253-259,267-274, 280-298

Evaluation Scheme:

S. No.	Evaluation Component	Duration	Weightage (%)	Date & Time	Nature of Component
1	Mid semester Test	90 mins.	35		Open Book
2	Quizzes *	50 mins.	20		Closed book
3	Comprehensive Examination	3 hours.	45		Closed Book

** Two quizzes will be conducted and the best performance will be considered. No make-up for the quiz.*

Chamber Consultation Hour: To be announced in class.

Notices: Notices will be sent by email.

Make up Policy: Make up for *Mid sem* and *Compre exam* only for exceptional circumstances.

Instructor-in-Charge – PHYF111