Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2024-2025

Course Handout Part-I

Date: 06-01-2025

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 **:** TANAY NAG

Instructors : Meenakshi V, Rickmoy Samanta, Subhadeep Roy, Suvadip Das, Debanjan Polley, Manabendra Kuiri

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. Physics Vol I & II, Halliday/Resnick/Krane 5th Edition, John Wiley, 2003.
2. Introduction to Classical Mechanics by David Morin (Cambridge University Press).
3. Berkeley Physics Course Volume I, Tata-McGraw Hill.
4. Berkeley Physics course volume III, Tata-McGraw Hill
5. 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	Vectors and Kinematics	Velocity and Acceleration, Motion in Plane Polar Coordinates	1.7-1.11 (TB1)
3-6	To understand the concept of Angular Momentum and to study rotation of a rigid body about a fixed axis	Angular Momentum, Torque, Fixed axis rotation, Physical Pendulum	7.1-7.9 (TB1)
7-10	Understand Central Force Motion	Central force motion, Energy diagrams, planetary motion, Kepler's laws	10.1-10.6 (TB1)
11	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)
12-13	Damped harmonic oscillator	Lightly damped, heavily damped, and critically damped oscillations, Q factor	11.3 (TB1)
14-15	Forced harmonic oscillator	Undamped forced oscillator, resonance, forced damped oscillator, Q factor	11.4-11.6 (TB1)
16	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)
17-20	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, N-coupled oscillators, Demonstration of normal modes	Chapter 5 (TB2) Pages: 119-141
21-22	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
23-25	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
26-27	To distinguish between particle and wave/phase velocity.	Superposition of waves, energy in mechanical wave, Demonstration of wave propogation	Pages 213-215, 230-234, 237-242 (TB2)

Evaluation Scheme:

S. No.	Evaluation Component	Duration	Weightage (%)	Date & Time	Nature of Component
1	Mid semester Test	90 mins.	35	04/03 11.30 - 01.00PM	Open Book
2	Classroom participation (5 Exit tests for lectures)		10		Open book
3	Surprise quizzes (5 Exit tests for tutorials)		10		Open book
4	Comprehensive Examination	3 hours.	45	03/05FN	Closed Book

Minimum marks for valid grade: 30 % of A grade cutoff or 40 % of median marks of the class, whichever is lower. Those below the minimum will be awarded "Not Cleared" (NC).

Details about the "classroom participation/ exit tests" component :

- ***5 exit tests in lecture (classroom participation evaluation) + 5 surprises quizzes (exit tests) in tutorials will be conducted. Best of 8 out of 10 will be evaluated. However, we have to conduct altogether 10 such exit tests for reasons beyond our control.***

- ***Students should register in CANVAS through the link sent to their BITS emails. Exit tests will be conducted digitally through the CANVAS platform. Please bring mobile/laptop to participate in the exit tests.***

- *Chamber Consultation Hour:* Saturday 11 am to 1 pm, D-323.
- *Notices:* Notices will be posted on CANVAS platform.
- *Make up Policy:* **No make up for classroom participation/exit tests**. Make up for *Mid sem* and *Compre exams are* only possible under emergency circumstances and prior permission with appropriate evidence is required.

- **Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-Charge – PHYF111