Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part-I

Date: 11/3/2022

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 : Souri Banerjee, Subramanya Bhima Sankar Davuluri

***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, rigid body motion, central force motion, Special theory of Relativity, 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, Tata McGraw-Hill Edition, 2007.
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 3, Tata-McGraw Hill
4. Feynman lectures on Physics, Vol I

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	Chapter in the Text Book
1	Introduction	The Spirit of Newtonian Mechanics	CLASS NOTE
2-4	Vectors and Kinematics	Velocity and Acceleration, Motion in Plane Polar Co-ordinates	1.6-1.9 (TB1)
5-8	To understand the concept of	Angular Momentum, Torque,	6.1-6.7 (TB1)

	Angular Momentum and to study rotation of a rigid body about a fixed axis	Fixed axis rotation, Physical Pendulum	
9-13	Understand Central Force Motion	Central force motion, Energy diagrams, planetary motion, Kepler's laws	9.1-9.7 (TB1)
14-15	Calculate frequency of small oscillations for arbitrary potentials	Introduction and review of SHM, Energy diagrams, Small oscillations in a bound system	4.8-4.10, 10.1 (TB1)
16-17	Damped harmonic oscillator	Lightly damped, heavily damped, and critically damped oscillations, Q factor	10.2 (TB1)
18-19	Forced harmonic oscillator	Undamped forced oscillator, resonance, forced damped oscillator, Q factor	10.3-10.4 (TB1)
20-22	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)
23-26	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
27-29	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
30-33	To learn how to set up 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
34-35	To distinguish between particle and wave/phase velocity.	Superposition of waves, energy in mechanical wave	Pages 213-215, 230-234, 237-242 (TB2)
36-40	To describe interference from multiple sources. Define diffraction grating. Study diffraction by a single 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	02/05 3.30 to 5.00pm	Open Book
2	Quizzes *	50 mins.	25		Closed book
3	Comprehensive Examination	2 hours.	40	22/06 FN	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 displayed on the **physics department** notice board and on **CMS** website.

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

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