Birla Institute of Technology & Science, Pilani
Hyderabad Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2021-2022
Course Handout Part-I

Date: 28/09/2021

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*:** Sashideep Gutti
Instructors: P. K. Thiruvikraman, Kannan Ramaswamy, Asrarul Haque, Harihara Venkataraman, and Swastik Bhattacharya

***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, harmonic oscillator with and without damping, 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 in text book problems as well as in situations from real life.
2. Ability to judiciously select suitable coordinate systems in solving problems in Mechanics.
3. Ability to apply Newton's laws to planetary motion and calculate the trajectories of satellites in simple situations.
4. Ability to analyze and understand oscillatory mechanical systems which are coupled.
5. Ability to identify and apply the phenomena of Interference and Diffraction in certain well known experiments in Optics.

Lecture Number	Learning Objectives	Topics to be covered	Suggested Chapter/Section
1-3	To understand the kinematical concepts in plane polar coordinates and use them to solve simple problems.	Motion in Plane Polar Co-ordinates	1.6-1.9 (TB1)
4-6	Understand torque equation and conservation of angular momentum	Torque equation, Angular momentum	CHAP 6 (TB1)
7-12	To understand the concept of central force motion and its manifestations in the motion of planets and satellites.	Central force motion, Energy diagrams, planetary motion, Kepler's laws	9.1-9.7 (TB1)
13-14	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)
15-16	Damped harmonic oscillator	Lightly damped, heavily damped, and critically damped oscillations, Q factor	10.2 (TB1)
17-18	Forced harmonic oscillator	Undamped forced oscillator, resonance, forced damped oscillator, Q factor	10.3-10.4 (TB1)
19-21	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)
22-25	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 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. 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, Newton's rings (Lab manual)	Chapter 8 (TB2) Pages: 253-259,267-274, 280-298

Evaluation Scheme:

S. No.	Evaluation Component (Online)	Duration	Weightage (%)	Date & Time	Nature of Component
1	Mid semester Test	90 mins.	35		Open Book
2	Quizzes *	50 mins.	25		Open Book
3	Comprehensive Examination	2 hours.	40		Open Book

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

Consultation Hour: To be put up in the Google Classroom.

Announcements: Announcements will be put in Google Classroom.

Make up Policy: Make up for *Mid-semester examination* and *Comprehensive examination will be given* in exceptional circumstances.

Instructor-in-Charge – PHYF111