Birla Institute of Technology and Science-Pilani
K. K. Birla Goa Campus
Second Semester 2023-2024
Course Handout (Part II)

Date: July 22, 2024

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 and Waves (MOW)

Instructors:

Instructor	Email id (***@goa.bits-pilani.ac.in)	VOIP	Office
Aabhaas Vineet Mallik	aabhaasm	892	CC-214
Arnab Roy	arnabr	875	D-316
Arun V. Kulkarni	avkbits	309	D-320/23
Radhika Vathsan	radhika	411	D-320/15
Ram Shanker Patel (IC)	rsp	294	D-320/6
Swastibrata Bhattacharyya	swastibratab	365	CC-111
Yuriy Petenev	yuriyp	428	CC-212

Text Books:

1. An introduction to mechanics, Daniel Kleppner & Robert Kolenkow, Second Edition, CUP.
2. Vibrations and waves, A. P. French, CBS Publishers.

Reference Books:

1. Berkeley physics course, Vol. I, and III, Addison Wesley.
2. Classical Dynamics, Thornton & Marion

Course overview:

This is a course on intermediate level mechanics that is built upon the mechanics concepts you have learned in high school physics. The topics that will get covered include: damped oscillator under forcing, motion of coupled oscillators, wave phenomenon, collisions, motion in non-inertial frames and rigid body dynamics. In the process we shall be looking at various physical systems where these concepts are relevant. You will also be exposed to new mathematical ideas like Fourier series and tensors that come along as we study these topics.

Course outcomes: Some of the expected take aways from the course are

- Learn how to apply laws of mechanics to understand various physical phenomena.
- Exposure to mathematical topics such as ordinary differential equations, partial differential equations, Fourier series, polar coordinate systems, vector calculus and tensors.
- An ability to formulate and solve physics problems using the theory learned.
- Build a sense for units and magnitudes of various physical quantities involved.
- Engage in collaborative learning and working.

Evaluation scheme:

Sr. No.	Evaluation components	Tentative duration	Weightage	Date and time	Type of test
1	**Attendance**		6 %		
2	**Online Quizzes (4, best 3 to be considered)**	30 min each	24 %	Q1: 27-08-2024 ** Q2: 17-09-2024 Q3: 22-10-2024 Q4: 12-11-2024 Tuesday 12:15 - 1:30 pm	Closed book
3	**Midsemester Exam**	90 mins	30%	04-10-2024, Friday, 09.30 - 11.00 am	Open (one A4 sheet)
4	**Comprehensive exam**	180 mins	40%	04-12-2024, Thursday, FN	Open (one A4 sheet)

** Quiz dates are tentative, we shall be finalizing it by Aug 10, 2024

General Instructions:

- All announcements and notices will be shared on the course webpage in Quantaaws. Students are requested to check their BITS email and course webpage on a regular basis.
- Any discrepancies in attendance should be addressed to the section instructor without delay.
- Consultation Hours, when required, will be announced in the class by the respective section instructor. Any student from any section can meet instructors of other sections (within their stipulated consultation hours) provided that the student has other engagements during the consultation hour of the corresponding section instructor.
- Students are encouraged to interact with the faculty in person during the class or specified consultation hours. Email communications for doubt clearance are not encouraged, and this option should only be exercised in unavoidable situations.
- Students can post their queries in the discussion forum on the course webpage. The queries will be answered by one of the instructors at the earliest.

Lecture Plan (tentative):

Lecture topic no.	Topics	Reference
Module 1 (Polar coordinates)		
1	Complex number. Differential equations. Cartesian and polar coordinates. Cartesian to polar transformation.	KK 1.10, 1.11
2	Velocity and acceleration in polar coordinates. Examples and applications.	KK 1.11, 2.10
Module 2 (Energy)		
3	Translational and rotational potential energies, PE diagrams	KK chapter 5
Module 3 (Angular momentum and fixed-axis rotation)		
4	Review of angular momentum. Rotation about a fixed axis. Moment of inertia of simple objects.	KK chapter 7
5	Torque and conservation of angular momentum. Motion involving both translation and rotation.	KK chapter 7
Module 4 (Central force)		
6	Central forces	KK chapter 10
Module 5 (Rigid body dynamics)		

7	Vector nature of angular velocity and momentum,	KK Chapter 8
8	MI Tensor: various cases of point particles as well as rigid body	KK Chapter 8
9	Gyroscope: stability and precession.	KK chapter 8
10	Examples of gyroscopic motion: gyrocompass.	KK chapter 8
Module 6 (Effect of Rotating frame)		
11	Physics in a rotating coordinate system.	KK chapter 9.5
12	Velocity and acceleration in rotating and inertial frames.	KK chapter 9.5.3
Module 7 (SHM and superposition)		
13	Review of SHM. Rotating vector and complex representation. Examples with one degree of freedom. Small oscillations.	APF chapter 1,2
Module 8 (Free, damped and forced oscillations)		
14	Damped vibration: types of damping. Q factor and energy.	APF chapter 3
15	Forced damped oscillation. Amplitude resonance. Transient and steady-state solutions.	APF chapter 4
16	Forced damped oscillation: energy and power. Resonance.	APF chapter 4
Module 9 (Coupled oscillations and normal modes)		
17	Two coupled oscillators: equations of motion. Normal modes. Superposition of normal modes.	APF chapter 5
18	N coupled oscillators: normal modes. Large N limit.	APF chapter 5
19	Normal modes of continuous system. Transverse vibration of a stretched string.	APF chapter 6

Module 10 (Fourier analysis)		
20	Introduction to Fourier analysis. Examples: plucked and struck string.	APF chapter 6
21	Fourier series: applications and examples.	APF chapter 6
Module 11 (Wave motion)		
22	Traveling and stationary waves. Wave equation.	APF chapter 7
23	Wave pulses. Group and phase velocity.	AP chapter 7
24	Energy in a mechanical wave. Energy transported by a wave.	APF chapter 7

* **KK:** Kleppner & Kolenkow

* **APF:** A. P. French

Instructor-in-charge
PHY F111