FIRST SEMESTER 2019-20
COURSE HANDOUT

Date: 26.07.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : PHY F111

Course Title : Mechanics Oscillations and Waves
Instructor-in-Charge : Kaushar Vaidya
Instructor(s) : Rishikesh Vaidya, D. Bandyopadhyay, Niladri Sarkar
Tutorial/Practical Instructors: Tapomoy G. Sarkar, Amol Holkundkar, Srijata Dey, Kaushar Vaidya, Subhashish Gangopadhyay, Rakesh Choubisa, Madhukar Mishra, Biswanath Layek, D. Bandyopadhyay

1. Course Description: The first half of the course deals with the applications of Newton's laws to the systems of particles and the study of linear and rotational motion using polar coordinates and physics of non-inertial reference frames. The second half deals with oscillatory motion, coupled oscillations and waves. There will be three lecture hours and one tutorial hour per week. Whereas the lectures would mostly focus on concepts and illustrative examples tutorial hour will be used to discuss representative problems from the chapters. Tutorial will follow the lectures as closely as possible.

2. Scope and Objective of the Course: Mechanics Oscillations and Waves is a foundation course in Physics that is mandatory for all the first degree students.

3. Text Books:
(a) An Introduction to Mechanics by Kleppner & Kolenkow, Tata McGraw-Hill Indian Edition, 1999

(b) Vibrations and waves, by A.P. French, CBS Publishers and Distributors, Inc., first Indian edition 1987.

4. Reference Books:

(a) Physics, Vol.1, by Halliday, Resnick, & Krane, 5th Edition, John Wiley & Sons, Inc., 2002

(b) The Physics of Waves and Oscillations by N K Bajaj, Tata McGraw-Hill 1984.

5. Course Plan:

Topics from Text Book 1 (T1) : Kleppner & Kolenkow			
Module Number	**Lecture session/Tutorial Session.**	**Reference**	**Learning Outcome**
1. Foundations of Newtonian Mechanics and Polar Coordinates.	**L1:** Critical overview of Newton's laws **L2:** Introduction to motion in plane polar coordinates **L3:** Illustrative examples on polar coordinates	**T1** Section 1.9 in Chapter 1; Chapter 2 and problems related to polar coordinates in Chapter 2.	**1.** Critical appreciation of Newton's laws **2.** Given a motion of a body involving circular geometry identify the radial and tangential components of forces and draw a free body diagram. **3.** Solve second order linear differential equation with constant coefficients through simple guess work.
2. Momentum	**L4:** Extended systems and motion of center of mass **L5:** Conservation of momentum its applications and impulse **L6:** Mass varying systems and their applications	**T1** Chapter 3	**1.** Description of an extended system (discrete or continuous) in terms of motion of center of mass. **2.** Formulating momentum conservation (when applicable) with appropriate velocity components referring to inertial systems. **3.** Formulating and solving the equation of motion of a mass varying system.
3. Work and Energy	**L7:** Work energy theorem and concept of potential energy **L8**: Conservative and non-conservative forces. **L9:** Physics from energy diagrams	**T1** Chapter 4 (except section 4.14 and problems related to section 4.14)	**1.** Application of work energy theorem for conservative systems. **2.** Calculation of power for non-conservative system **3.** Constructing energy diagrams and extracting

	L10: Oscillatory systems and stability analysis		physical insights. **4.** Stability analysis and finding frequency of small oscillations.
4. Angular Momentum and Fixed Axis Rotation	**L11:** Angular Momentum and Torque in a fixed axis rotation **L12:** Momentum of inertia and dynamics of pure rotation. **L13:** Dynamics of Rotation and translation **L14:** Conservation of Angular Momentum **L15:** Angular Oscilllations and stability analysis	**T1** Chapter 6	**1.** Finding angular momentum and torque about various choices of fixed axis. **2.** Examining and exploiting conservation of angular momentum to find quantity of interest. **3.** Solving problems involving rotational and translational motion about fixed axis. **4.** Finding frequency of small angular oscillations.
5. Non-inertial Frames	**L16:** Galilean transformations, uniformly accelerated frames and pseudo forces **L17:** Principle of equivalence **L18:** Physics of tides **L19:** Physics in rotating coordinate system **L20:** Illustrative problems	**T1** Chapter 8	**1.** Learning to formulate and solve a problem from both inertial and non-inertial reference frames. **2.** Understanding the relevance of non-inertial frames, principle of equivalence and their connection to physics of tides.

Topics from Text Book 2 (T2) : A.P. French			
6. The Free Vibrations of Physical System.	**L21:** Simple harmonic motion (SHM) for different physical systems **L22:** SHM equation **L23:** The decay of free vibrations **L24:** Effect of very large damping	**T2** Chapter 3	**1.** Finding angular frequency of different oscillating systems. **2.** Solving SHM equation using complex exponential. **3.** How the free vibrations get modified by including the dissipative effects. **4.** Calculating the quality and amplitude of damped systems.
7. Forced Oscillator and Resonance	**L25:** Undamped oscillator with harmonic forcing **L26:** Forced oscillator with damping **L27:** Effect of varying the resistive term **L28:** Power absorbed by a driven oscillator **L29:** Velocity and power resonance	**T2** Chapter 4	**1.** Distinguish between natural and driving frequencies. **2.** Finding the amplitude of a forced oscillator as a function of driving frequency. **3.** Finding average and maximum power input to maintain the oscillations.
8. Coupled Oscillators and Normal Modes	**L30:** Two coupled pendulums **L31:** Normal coordinates, Normal modes, normal frequencies. **L32:** Illustrative problems **L33:** Forced oscillations of two coupled oscillators **L34:** Many coupled oscillators	**T2** Chapter 5	**1.** Finding equation of motion of coupled free systems. **2.** Calculation of normal mode frequencies. **3.** Finding equation of motion of coupled forced systems **4.** Determining normal modes and their frequencies for N coupled oscillators.

9. Normal Modes of Continuous Systems	**L35:** The free oscillations of stretched strings **L36:** Normal modes of a stretched string, forced oscillations of a stretched string	**T2** Chapter 6	**1.** Calculating linear density of a uniform sting **2.** Finding the permitted frequencies for the free vibrations in strings. **3.** Finding the driving frequency for the amplitude resonance of vibrating string.
10. Progressive Waves	**L37:** Progressive waves in one dimension **L38:** Superposition, motion of wave pulses of constant shape **L39:** Phase and group velocity **L40:** Energy and its transportation by a wave	**T2** Chapter 7	**1.** Identifying different types of waves. **2.** Distinguish particle, phase and group velocities in wave motion. **3.** Applying the relationship between phase velocity and group velocity. Finding the energy transported by a wave.

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	90 Min.	30	<TEST_1>	Open
Comprehensive Examination	3 h	45	<TEST_C>	Closed
Tutorial Tests	20 min.	25	TBA	Closed

7. Chamber Consultation Hour: To be announced in the tutorial class.

8. Notices: Notices and solutions will be displayed only on **Nalanda site.** If required sometime on **PHYSICS or FDIII** notice board.

9. Make-up Policy: Very strict: Make up for tests will be given only to genuine cases. No makeup for tutorials/quiz.

10. Note (if any):

Instructor-in-charge
Course No.