B.Sc. Eng.ME/IPE/2nd Sem. Date:29 May 2024

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination
Course Number: PHY 4213
Course Title: Waves and Oscillation, Geometrical Optics and wave mechanics

Summer Semester: 2022-2023
Full Marks: 150
Time: 3 Hours

Please answer according to the order of the questions. Answer all the **6 (Six)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

1.a) List five differences between free and forced oscillation. (5) (CO1) (PO1)

b) Define transverse and longitudinal wave motions along with examples. (5) (CO1) (PO1)

c) Define concave and convex lens. State the characteristic features distinguishing the image formation by convex and concave lenses. (5) (CO1) (PO1)

2. a) Formulate the differential equation of motion of a particle executing forced vibrations in a resisting medium. Explain the physical meaning of each term and each constant in the equation. Solve the equation and obtain the condition for resonance amplitude. (15) (CO2) (PO2)

b) Discuss analytically the formation of stationary waves and explain how the characteristics change with distance. (6+9) (CO2) (PO2)

c) i)Two thin convex lens L_1 and L_2 of focal lengths f_1 and f_2 respectively, are placed coaxially in contact. An object is placed at a point beyond the focus of L_1. Draw a ray diagram to show the image formation by the combination and hence derive the expressions for the focal lengths of combined system.
ii) Explain what is mean by power of a lens and how to find out the power of a lens using lens maker's formula. (10+5) (CO2) (PO2)

3. a) The equation for displacement of a point on a damped oscillator is given by $y = 5e^{-0.25t} sin\frac{\pi}{2}t$ meter. Find the velocity of the oscillating point at t = T/4 and T, where T is the time period of oscillation. (5) (CO3) (PO2)

b) A plane progressive wave train of frequency 400 cycles per second has a phase velocity of 480 m/sec. How far apart are the two points 30 degree out of phase? What is the phase difference between two displacements at a given point at times 10^{-3} sec apart? (5) (CO3) (PO2)

c) Consider the combination of a convex lens and a concave lens with a focal length of 5 and 10 cm, respectively, in contact. Compute the equivalent focal length and position of image for an object 18 cm from the combination. (5) (CO3) (PO2)

4. a) Describe the important characteristics of fermions and bosons? (5) (CO1) (PO1)

b) Define acoustics. Describe the important factors to improve the acoustics of an auditorium. (5) (CO1) (PO1)

c) List the differences between a compound microscope and a polarizing microscope. Describe the principle on which a polarizing microscope works. (5) (CO1) (PO1)

5. a) i) Explain what is thermodynamic probability. Discuss the distribution of n distinguishable particles into k compartments of unequal size each one of which is further subdivided into g cells of equal priori probability. (7+8) (CO2) (PO2)
ii) What were the flaws in determining the specific heat of a solid according to Einstein? How Einstein made corrections to the law of Dulong-Petit by incorporating the average energy per oscillator? Derive Einstein's specific heat formula based on the corrections.

b) (i) Explain what is reverberation and derive Sabine's reverberation formula. Draw a schematic diagram of a proper auditorium taking into account all the acoustic factors. (8+7) (CO2) (PO2)
(ii) Describe how would you determine the absorption coefficient according to Sabine's method. Explain how the absorption coefficients of different materials vary with the frequencies.

c) (i) Discuss the construction and working of a Nicole's prism. What are O- rays and E-rays? Draw the rays identifying the o and e-rays as it passes through a Nicols prism. Which ray obeys the Snell's law of reflection and refraction? (7+8) (CO2) (PO2)
(ii) Name different types of polarizing materials used in a polarizer. A beam of light is said to be unpolarized, plane-polarized or circularly polarized; how would you choose about using them in an experimentally.

6. a) Determine the Fermi energy in copper on the assumption that each copper atom contributes one free electron to the electron gas assuming that a copper atom has single 4s electron outside the closed inner shell (density of copper is 8.94×10^3 kg/m^3 and its atomic mass is 63.5 u). (5) (CO3) (PO2)

b) A room having the dimensions 6 x 4 x 5 meters. Calculate the mean free-path of the sound wave in the room and the number of reflections made per second by the sound wave with the walls of the room (velocity of sound in air =350 m/s). (5) (CO3) (PO2)

c) Compute the angle of incidence at which the light reflected from water will be completely polarized. Does this angle depend on the wavelength of the light? (3+2) (CO3) (PO2)