B.Sc. Eng.EEE/2nd Sem. Date:14 May 2024

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination — Summer Semester: 2022-2023
Course Number: PHY 4221 — Full Marks: 150
Course Title: Engineering Physics II — 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) Describe the characteristics of a particle under simple harmonic motion. (5) (CO1) (PO1)

b) Formulate the expression for the energy density of a plane progressive wave and show that though both potential and kinetic energies of waves depend on position and time, its energy density is independent of either. (15) (CO2) (PO2)

c) Suppose in a spring-mass system the block has mass m =2.72 $\times 10^5$ kg and is designed to oscillate at a frequency of 10.0 Hz and with amplitude, x_m of 20.0 cm. Calculate the total mechanical energy E of the spring–block system and the block's speed as it passes through the equilibrium point? (05) (CO3) (PO2)

2. a) List five differences between mechanical and non-mechanical wave motion along with examples. (5) (CO1) (PO1)

b) Consider the formation of a stationary wave in a one end fixed string and discuss the resultant vibration of a particle on that string. Describe the positions where nodes and antinodes can be observed. (8+7) (CO2) (PO2)

c) A train of simple harmonic waves is travelling in a gas along the positive x-direction, with an amplitude of 2 cm, velocity of 300 m/sec and frequency 400 Hz. Compute the displacement and particle velocity at a distance of 4 cm from the origin after an interval of 5 secs. (05) (CO3) (PO2)

3. a) State the working principle of a thermocouple and name its different types. (5) (CO1) (PO1)

b) Considering a cylinder with a piston filled with a gas, with ρ being the density of the gas molecules, illustrate Newton's formula and Laplace's correction for speed of sound through the gas. (15) (CO2) (PO2)

c) Calculate the wavelengths of sounds at the extremes of the audible range, 20 and 20,000 Hz, in 30.0 °C air. (05) (CO3) (PO2)

4. a) Define Miller indices, and describe the procedure employed in determination of the h, k and l index numbers. (5) (CO1) (PO1)

b) (i) Explain the crystal structure of NaCl, and clarify whether it exhibits an FCC or BCC structure. (7+8) (CO2) (PO2)

(ii) Show that the volume of a unit cell for a triclinic Bravais lattice system is given by the formula:

$V = abc \times \sqrt{1 - cos^2\alpha - cos^2\beta - cos^2\gamma + 2\cos\alpha\cos\beta\cos\gamma}$.

Here, the symbols have their usual meanings.

c) Calculate the angle between two crystal directions, $[111]$ and $[\bar{1}\bar{1}1]$, for a cubic structure. (05) (CO3) (PO2)

5. a) State the postulates of special theory of relativity. (5) (CO1) (PO1)

b) Formulate the relativistic equation relating the total energy of a particle to its invariant mass and momentum. (15) (CO2) (PO2)

c) Show with mathematical argument whether a massless particle can exist or not. (05) (CO3) (PO2)

6. a) Write down the actual experimental observations/results of photoelectric effect. (5) (CO1) (PO1)

b) Discuss Compton's theory to show that $\Delta\lambda = \frac{h}{mc}(1 - cos\varphi)$, where the symbols have their usual meanings. (10+5) (CO2) (PO2)

c) X-rays of wavelength 10.0 pm are scattered from a target electron. Calculate (i) the wavelength of the x-rays scattered through 45° and (ii) the maximum wavelength present in the scattered x-rays. (3+2) (CO3) (PO2)