00285

The Open University of Sri Lanka
Department of Physics
BSc Degree Programme – Level 3
Final Examination - 2020/2021

Course Code:	**PHU3202 / PHE3202**
Course Title:	**Waves in Physics**
Date:	**13.03.2022**
Time:	**01:30 pm to 03:30 pm**
Duration:	**2 Hours**

GENERAL INSTRUCTIONS TO CANDIDATES

- Read all instructions carefully before answering the questions.
- Unless specified, standard symbols have their usual meanings.
- This question paper consists of **06 Essay type questions** in 03 pages.
- Answer **only ANY FOUR (04)** questions.
- Non-programmable calculators are allowed.
- Write your answers in the answer book / single sheets provided at the examination hall.
- Question / section numbers should clearly be written against relevant answers.
- Write your **Index Number** in the spaces provided in the answer book / single sheets.
- Also write all other details requested in the answer book.
- Having any form of unauthorized documents / mobile phones in your possession is a punishable offense.

Answer only ANY FOUR (04) questions.

(01) Consider an object of mass m, executing harmonic motion with an amplitude x_m and frequency f. The displacement of the object at any instant of time, t, is given by,

$x = x_m \cos(\omega t + \varphi)$, where ω is the angular frequency and φ is the phase angle.

(a) Show that the kinetic energy, K, of the object at any instant of time can be given by,

$$K = \frac{1}{2} m\omega^2 (x_m^2 - x^2)$$

(b) Show that the potential energy, P, of the object at any instant of time can be given by,

$$P = \frac{1}{2} m\omega^2 x^2$$

(c) Find the total energy of the object in terms of m, f, and x_m.

(02) (a) What are Lissajous figures?

(b) Construct Lissajous figures for the following cases:

(i) Two sine waves of equal frequency, in phase.

(ii) Two sine waves of equal frequency, 180 degrees out of phase.

(iii) Two sine waves of equal frequency, 90 degrees out of phase.

(iv) Two sine waves, in phase, the frequency of horizontal wave is twice the frequency of vertical wave.

(03) (a) Briefly explain the phenomenon of Doppler Effect in sound.

(b) Derive an expression for the observed frequency, f', when a source emitting a sound at frequency, f_s, is moving with a velocity v_s away from a stationary observer hearing that sound.

(c) (i) Write down a general expression for the observed frequency, f'', when the source and the observer are moving with the velocities v_s and v_o respectively.

(ii) Two trains on two adjacent tracks cross each other and move away from each other, with train A has a speed of 126 km h^{-1} and train B has a speed of 90 km h^{-1}. Train A blows its horn at a frequency of 500 Hz. What is the frequency heard by the driver of the train B. [Consider speed of sound in air as 350 m s^{-1}]

(04) (a) Define 'sound intensity' and state the SI unit for the sound intensity.

(b) A source generates 1.0 Wm^{-2} at a distance of 5 m at a frequency of 1.0 kHz. The source spreads the sound waves uniformly in all the directions and none reflects from any objects in that region. Assuming the speed of sound as 350 m s^{-1} and the density of air as 1.21 kg m^{-3}, calculate the following:

(i) The sound intensity at a distance of 25.0 m from the source.

(ii) The displacement amplitude and the pressure amplitude at a distance of 5.0 m from the source.

(c) Show that if the first sound is twice as intense as the second sound, the first one has a sound level of about 3 dB higher.

(05) (a) Briefly describe, with the help of suitable sketch, the generation of electromagnetic waves in the region of radio waves using a *LC* oscillator.

(b) Briefly describe the terms Permittivity and Permeability.

(c) What is the maximum strength of the B-field in an electromagnetic wave that has a maximum E-field strength of 1000 V m^{-1}? [Consider speed of light as 3×10^8 m s^{-1}]

(06) (a) State the three common types of polarization and explain each of them briefly with the help of suitable sketches.

(b) In an experiment conducted with two polarizing sheets, the transmitted intensity I of the emerging radiation is found to vary according to the formula, $I = I_m \cos^2 \theta$, where I_m is the maximum value of the transmitted intensity and θ is the angle between the planes of polarization of the two polarizing sheets.

(i) When will you get the maximum value for the transmitted intensity?

(ii) A beam of polarized light is sent through two polarizing sheets. The polarizing direction of the first sheet is at an angle ω to the direction of vibration of the light. The polarizing direction of the second sheet is perpendicular to that direction of vibration. If a fraction of 0.10 of the incident intensity is transmitted by the two sheets, what is ω?

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