The Open University of Sri Lanka
BSc/BEd Degree Programme – Level 3
Final Examination - 2023/2024
Waves in Physics – PHU3202/PHE3202

Date: 23rd March 2024 Time: 09.30 am – 11.30 am

Answer only ANY FOUR (04) questions.

Useful physical constants

Speed of sound in air = 350 m s^{-1}

Speed of electromagnetic waves in vacuum = 3×10^8 m s^{-1}

Note: Standard symbols have their usual meanings.

(01) A simple pendulum is constructed by suspending an object of mass m with a light string of length l from a rigid ceiling. The pendulum is set to execute simple harmonic motion by releasing the object after displacing it through a small angle θ.

(a) Draw a free body force diagram of the pendulum when the object is displaced by the angle θ, and label its parts.

(b) Write the expressions for (i) the force along the string and (ii) the restoring force.

(c) Derive the equation for the period (T) of oscillations of the simple pendulum.

(d) State three assumptions *(other than the ones already stated above)* made in deriving the above equation for T.

(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 *Doppler Effect* in sound with an example.

(b) Derive an expression for the observed frequency (f_o) when a source of sound is moving with a constant speed (v_s) towards a stationary observer.

(c) A train is approaching a stationary observer with a constant speed while blowing a horn of frequency 1900 Hz. The frequency observed by the observer is 2100 Hz. Determine the speed of the train in km h^{-1}.

(04) (a) Most surfaces reflect a portion of the sound falling on them. What could happen to the remaining (unreflected) portion of the sound?

(b) Name two acoustic phenomena caused by the reflection of sound.

(c) A man stationed between two parallel cliffs fires a single gunshot. He hears the first echo after 3 seconds and the next echo after 6 seconds. What is the distance between the two cliffs?

(d) State three (03) requisites for good acoustics of an auditorium.

(05) Using Maxwell's equations, it can be shown that the ratio of the maximum electric field strength to the maximum magnetic field strength of an electromagnetic wave in a medium is equal to the speed of the electromagnetic wave in that medium.

(a) Calculate the maximum electric field strength in an electromagnetic wave that has a maximum magnetic field strength of 4.00×10^{-4} T.

(b) Compute the wavelength of the electromagnetic waves emitted by an LC oscillator – antenna system with $L = 0.1$ μH and $C = 2.0$ pF?

(c) Briefly describe the terms Permittivity and Permeability.

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

(b) When a beam of unpolarized light passes through two linear polarizers whose polarization axes are at an angle θ with each other, the transmitted intensity I of the emerging light 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. For which angle θ, the transmitted intensity will be maximum?

(c) Two linear polarizers P_1 and P_2 are placed with their polarizing axes perpendicular to each other. A beam of unpolarized light of intensity I_m is incident on P_1. A third linear polarizer P_3 is kept in between P_1 and P_2 such that its polarizing axis makes an angle 45° with that of P_1. Determine the intensity of the light emerging through P_2.

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