The Open University of Sri Lanka
BSc/BEd Degree Programme – Level 3
Final Examination - 2024/2025
Waves in Physics – PHU3202 / PHE3202

Date: 19th May 2025 **Time:** 01.30 pm – 03.30 pm

Answer only ANY FOUR (04) questions.

Useful physical constants

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

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

Note: Standard symbols have their usual meanings.

(01) (a) A simple pendulum bob is pulled away from its equilibrium position and then released to execute a simple harmonic motion.

(i) Write down an expression for the displacement, x, of the bob from its equilibrium position as a function of time t. Define the other physical quantities used in your expression.

(ii) Derive expressions for velocity, $v(t)$, and acceleration, $a(t)$, of the bob at any given time t.

(iii) Using Hooke's law and Newton's second law, derive an expression for the period, T, of the said simple harmonic motion.

(b) At $t = 0$, the displacement of a bob executing a periodic motion is – 8.50 cm, its velocity is – 0.92 m s^{-1} and the acceleration is 47.0 m s^{-2}. Determine the angular frequency, ω, and the frequency, f, of the periodic motion. (Consider $\pi = 22/7$)

(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 frequency (f_o) observed by a stationary observer when a source of sound (of frequency f) is moving away from him with a constant speed (v_s).

(c) An ambulance is moving away from a stationary observer with a constant speed while blowing a siren of frequency 3000 Hz. The frequency observed by the observer is 2800 Hz. Determine the speed of the ambulance 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 4 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) (a) Briefly describe the process of (i) generation (ii) transmission and (iii) reception of radio waves.

(b) The intensity of electromagnetic waves, at a point A at a distance r away from the source, is proportional to $1/r^2$. Compared to the intensity at A, estimate the fraction of the intensity at a distance $4r$ away from the source.

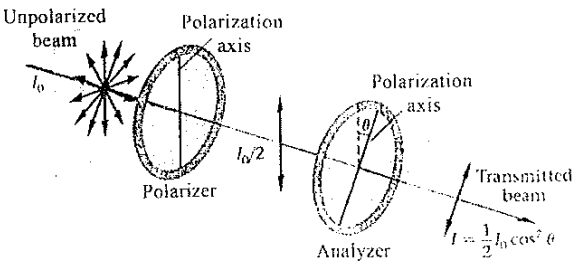
(c) A FM radio station broadcasts on a frequency of 102.1 MHz with a power of 45.26 kW.

(i) What is the wavelength of the radio waves produced by this station?

(ii) Estimate the intensity of the radio-waves that reaches a receiver at a distance of 20 km from the source. (Assume that the source radiates uniformly in all directions).

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

(b) As shown here, an unpolarized light is passing through a polarizer and then through an analyzer whose polarization axis is at an angle θ to the vertical.



Plot a 'θ' vs 'I/I_0' graph to show the variation of transmitted intensity with the angle θ varying from 0° to 360°.

(Draw the graph on a usual answer sheet given to you. Separate graph sheet ***will not be provided****. The graph need not be to the exact scale but use appropriate intervals and values for both x-axis and y-axis).*

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