The Open University of Sri Lanka
The Department of Physics
BSc Degree Programme – Level 3
Final Examination - 2019/2020

Course Code:	**PHU3202 / PHE3202 / PYU1162 / PYE3162**
Course Title:	**Waves in Physics**
Date:	**27.01.2021**
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 04 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 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) (a) Write down an expression for the displacement of a particle, executing simple harmonic motion, as a function of time t. Define the physical quantities used in your equation.

(b) One end of a light spring with spring constant k is attached to a rigid ceiling and hangs vertically. A mass m is fixed to the lower end of the spring. Prove that when displaced vertically and released, the mass executes simple harmonic motion of period,

$$T = 2\pi\sqrt{\frac{m}{k}}$$

(c) An object of mass 800 g is attached to the lower end of a spring which is suspended vertically from a rigid support. As a result the spring is stretched downward through a distance 2 cm from the earlier equilibrium position. Find the value of the spring constant. (Consider g = 10 N kg^{-1}).

(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, frequency of horizontal wave twice frequency of vertical wave.

(03) (a) State **three** differences between the electromagnetic waves and the sound waves.

(b) The relationship between speed of sound wave in a medium and rate of change of pressure with the density of the medium can be given by the expression,

$$v_s = \sqrt{\frac{dp}{d\rho}}.$$

For an ideal gas, show that the speed (v) of sound can be given by the equation,

$$v = \sqrt{\frac{\gamma kT}{m}},$$

where, γ is ratio of specific heat capacities, k is Boltzmann's constant, T is absolute temperature and m is mass of a molecule. (Assume that no heat is added or removed from the system during the compression and rarefaction of the gas).

(c) Displacement of sound wave is given by the equation,

$$X(x,t) = 6.0\ \text{nm}\cos\{3.6\ \text{m}^{-1}x - 1200\ \text{s}^{-1}t\}$$

Find the (i) maximum displacement, (ii) frequency (f) and (iii) the speed of the sound wave. (Consider $\pi = 3$).

(04) (a) Briefly explain the Doppler Effect in sound.

(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 whistle of frequency 900 Hz. The observed frequency by the observer is 973.05 Hz. Determine the speed of the train in km h^{-1}.
(Consider the speed of sound in air as 333 m s^{-1}).

(05) (a) Does a wire connected to a battery emit electromagnetic waves? Briefly explain your answer.

(b) Prove that the intensity, I, of an electromagnetic wave can be given by the expression,

$$I = \frac{1}{2}\varepsilon_0 cE^2.$$

where ε_0 is the permittivity of free space, c is the speed of light, and E is the maximum electric field strength.

(c) A FM radio station broadcasts on a frequency of 101 MHz with a power of 50,000 W

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

(ii) Estimate the average intensity of the wave at a distance of 30 km from the transmitting antenna. Assume that the antenna radiates equally on all directions.

(06) (a) The intensity of a beam of unpolarized light drops down when it passes through

(i) a coloured glass and

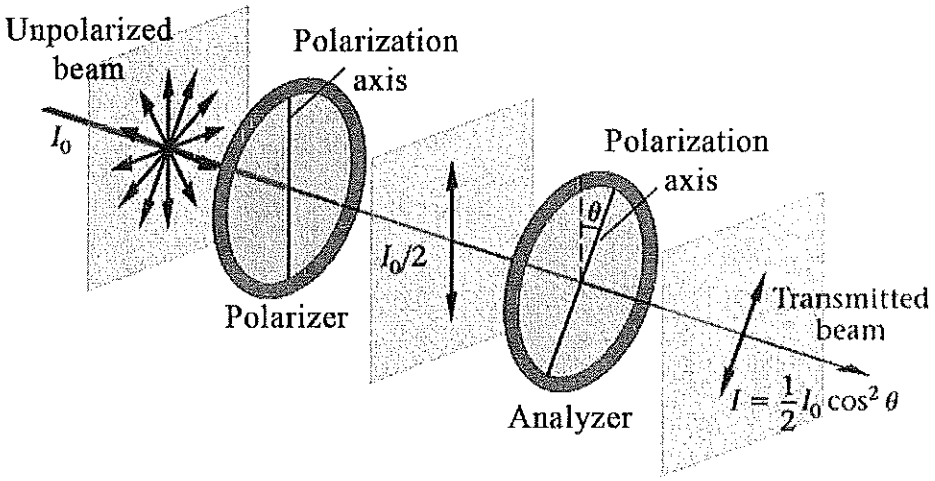
(ii) a polarizer.

Explain the happening at each of the two situations.

(b) Explain the main three types of polarization of light with the help of suitable sketches.

(c) As shown below, 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, Graph need not be to the exact scale but use appropriate intervals and values for both x-axis and y-axis Separate graph sheet will not be provided).



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