CHITTAGONG UNIVERSITY OF ENGINEERING & TECHNOLOGY

B. Sc. Engineering Level-1 Term-I, Final Examination 2020

Subject : Civil Engineering

Paper : Physics – I (Phy-101)

Time : 2 Hours 30 Minutes Full Marks : 150

Answer any TWO questions from EACH section. Use separate script for EACH section. The figures in the right margin indicate full marks. Use standard value if needed.

SECTION-A

Q.1. (a) Derive an expression for the total energy of a harmonic oscillator and show that it is a constant. (10)

(b) Prove that if at any stage of motion kinetic energy is suddenly increased by a blow in the ratio $(1+\beta):1$, the amplitude of the swing is increased in the ratio $\sqrt{1+\frac{\beta v^2}{a^2\omega^2}}:1$ (10)

Where, β is arbitrary constant a is the amplitude of original simple harmonic motion, ω is the angular frequency.

(c) Derive the relation between restoring force and potential energy. (7.5)

(d) If we dig a tunnel along a diameter of the earth and drop a body in it, show that it executes simple harmonic motion. Find its time period, if the radius of the earth is 6400km and g=9.8 m/s^2. (10)

Q.2. (a) Derive the differential equation of one dimensional wave motion. Which of the following are solutions of the one dimensional wave equation? (15)

i) $y = x^2 + v^2t^2$
ii) $y = x^2 - v^2t^2$
iii) $y = (x - vt)^2$
iv) $y = 7x - 10t$

(b) Show that the energy density of a plane progressive wave is given by $E = 2\pi^2n^2a^2\rho$, where the symbols have their usual meaning. (15)

(c) Derive a relation between phase velocity and group velocity. (7.5)

Q.3. (a) Discuss why two independent sources of light of the same wavelength cannot produce interference fringes. (6)

(b) Explain the formation of coherent sources in the case of Newton's rings arrangement. (6)

(c) Discuss briefly the interference phenomenon in a double slit experiment relation to the law of conservation of energy. (10)

(d) Derive an expression for fringe-width in case of Young's double slit experiment. (10)

(e) Calculate the fringe width of interference pattern produced in Young's double slit experiment with two slits 10^{-3}m apart on a screen 1m away. Wavelength of light is 5893 x 10^{-8} cm. (5.5)

SECTION-B

Q.4. (a) Define Young's modulus (Y), Bulk modulus (K), Modulus of rigidity (η) and Poisson ratio (σ). (6.5)

(b) Show that for a homogenous isotropic medium: (9+10)

i) $Y = 2\eta(1 + \sigma)$

ii) $K = \frac{Y}{3(1-2\sigma)}$

(c) Show that a shear is equivalent to an elongation strain and compression strain at right angles to each other. (6)

(d) An unabridged dictionary is 15cm thick and area of each page is 900cm^2. A force of 1kg parallel to the cover displaces it sideways 1.5cm. Find the shearing stress, shearing strain and rigidity modulus. (6)

Q.5. (a) Give an account of molecular theory of surface tension. (6)

(b) What is surface energy? Derive the relation between surface tension and surface energy. (6)

(c) Calculate the work done in spraying a drop of mercury of 1mm into one million identical drops all of the same size. Given that surface tension of mercury is 550 dynes/cm. (5.5)

(d) Derive an expression for the height h through which a liquid of surface tension T will rise in a capillary tube of radius r. Explain clearly from where the energy comes when the liquid rises against gravity in the capillary tube. What will happen if the length of the capillary tube is smaller than h? (10+5+5)

Q.6. (a) State and prove Bernoullis theorem for a liquid along a stream line. (10)

(b) A tank containing water has an orifice in one vertical scale. If the center of the orifice is 10 metres below the surface level in the tank, find the velocity of discharge, assuming no wastage of energy. (7.5)

(c) Write down the equation of motion of a forced oscillator being driven by an alternative force $F_0 \cos \omega t$. Explain the transient and steady state behavior of the forced oscillator. (20)

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