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ET-105(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) / BTCLEVI / BTMEVI / BTELVI / BTECVI / BTCSVI

Term-End Examination

00765

June, 2014

ET-105 (A) : PHYSICS

Time : 3 hours *Maximum Marks : 70*

Note : *All questions are* ***compulsory****. Symbols have their usual meanings. Assume missing data suitably, if any.*

1. Attempt any ***five*** of the following : *5×4=20*

(a) State the law of conservation of momentum. A bullet of mass 20 gm hits a ballistic pendulum, consisting of a wooden block of mass 5 kg suspended from a height of 2 m. The bullet delivers an impulsive force to the block. The block with the bullet in it rises through a height of 30 mm. Find the muzzle velocity of the bullet.

(b) What do you mean by 'precession' of angular momentum ? A circular disk rotates about its geometrical axis with angular speed ω. Its moment of inertia about this axis is I. Simultaneously, the axis itself rotates in a horizontal plane. If the torque τ acts on the system, find the precessional speed Ω.

(c) Is Lorentz force a conservative force ? Explain. A particle lying in the x-y plane is acted upon by a force of magnitude kr (where, $r = \sqrt{x^2 + y^2}$) directed towards the origin. Calculate the work needed to be done to move the particle from the origin to the point (1, 1) along the radius vector.

(d) Give the condition for constructive interference when light of wavelength λ is incident normally on a thin film of oil of thickness t and refractive index μ on a glass plate, for reflected light.

A thin film of oil of refractive index 1·4 floats on a glass plate of refractive index 1·5. The film thickness is 300 nm. Find the two longest wavelengths that are strongly reflected at normal incidence.

(e) What is a 'half-wave plate' ? What should be the thickness of quarter wave plate for a light of wavelength 5890 Å if $\mu_E = 1{\cdot}553$ and $\mu_0 = 1{\cdot}544$?

(f) Define the term 'dipole moment'. What is the value of electric potential due to a charge of one micro-coulomb at a distance of 5 cm from it ?

(g) What is the SI unit of capacitance ? Define it. Show that when a capacitor is charged, half the energy supplied by the battery is lost as heat during the charging.

(h) State Poynting theorem. For an electromagnetic wave E = 100 V/m, find the value of B, the energy density and the magnitude of Poynting vector.

2. Attempt any ***two*** parts of the following : *2×5=10*

(a) State Kirchhoff's rule for electrical network. Using Kirchhoff's rules, derive the condition for balance of a Wheatstone bridge circuit.

(b) State Gauss's theorem. Apply this theorem to obtain an expression for the electric field due to infinite plane sheet of charge.

(c) Twenty-seven spherical drops, each of radius 3 mm and carrying 10^{-12} C of charge are combined to form a bigger drop. Find the capacitance and the potential of the bigger drop.

3. Attempt any ***two*** parts of the following. *2×5=10*

(a) State Faraday's laws of electromagnetic induction. A conducting rod rotates with angular speed ω with one end at the centre and the other end at the circumference of a circular metallic ring of radius R, about an axis passing through the centre of the coil perpendicular to the plane of the coil. A constant magnetic field B parallel to the axis is present everywhere. Show that the e.m.f. (electromotive force) between the centre and the metallic ring is $\frac{1}{2} B\omega R^2$.

(b) State Ampere's law. Discuss its modification by Maxwell and hence explain displacement current. A parallel plate capacitor made of two circular plates, each of radius 10 cm and separated by 5 mm is being charged by a steady current of 0·2 A. What is the displacement current across the plates ?

(c) A radio station radiates a sinusoidal wave with an average total power of 50 kW. Assuming that the transmitter radiates equally in all directions above the ground, find the amplitudes of E_{max} and B_{max} detected by a satellite at a distance 100 km from the radio station transmitter antenna.

4. Attempt any ***two*** parts of the following. *2×5=10*

(a) Discuss Young's double slit experiment and show that the fringe width is independent of the order of the fringe. Show the intensity distribution by drawing a neat diagram.

(b) Why is diffraction of light not as common as that in sound ? Explain. Discuss diffraction of light in a single slit and obtain the condition for brightness and darkness. Show the intensity distribution using a neat diagram.

(c) A plano-convex lens of radius 3 m is placed on an optically flat glass plate and is illuminated by monochromatic light. The diameter of the 8th bright ring in the reflected system is $0{\cdot}72 \times 10^{-2}$ m. What is the wavelength of the used light ?

5. Attempt any ***two*** parts of the following. *2×5=10*

(a) What is 'double refraction' ? Explain how polarized light can be obtained using double refraction.

(b) What are 'phase shifters' ? Explain. What are 'half-wave plate' and 'quarter-wave plate' and how are these plates useful ? Discuss.

(c) What is a diffraction grating ? Find the highest order spectrum which can be seen with monochromatic light of wavelength 5000 Å by means of a diffraction grating with 5000 lines/cm.

6. Attempt any ***two*** parts of the following. *2×5=10*

(a) Starting with the equation of motion of a variable mass system, discuss the propulsion of rocket. Obtain the necessary condition to show that larger the exhaust speed, the better is the rocket propulsion.

(b) State Kepler's laws of planetary motion. Halley's Comet has a period of 76 years. Calculate the semi-major axis of the comet in units of the mean radius of the Earth's orbit around the Sun.

(c) A sphere of radius R and mass m rolls down, without slipping, an inclined plane which makes an angle θ to the horizontal. Show that the angular acceleration is given by

$$a_c = \frac{5}{7} g \sin \theta$$

Constants :

$\mu_0 = 4\pi \times 10^{-7}$ N/A^2

$\varepsilon_0 = 8{\cdot}85 \times 10^{-12}$ C^2/N-m^2

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ Nm^2/C^2

Mass of an electron = $9{\cdot}1 \times 10^{-31}$ kg

Charge on an electron = $1{\cdot}6 \times 10^{-19}$ C