No. of Printed Pages : 7

ET-105(A)

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

Term-End Examination

00955

June, 2017

ET-105(A) : PHYSICS

Time : 3 hours *Maximum Marks : 70*

Note : *All questions are* ***compulsory****. Symbols have their usual meanings. Use of scientific calculator is permitted. Assume missing data suitably, if any.*

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

(a) State Newton's first law of motion. Why is it called the law of inertia ? If a number of forces are acting on a body, what is the condition that these forces will not change the state of motion of the body ?

(b) Show that only an infinitesimal rotation can be regarded as a vector.

(c) Define a simple harmonic motion. Displacement of a particle is given as

$$x = 0{\cdot}05 \cos (2t + 0{\cdot}5\pi).$$

Obtain the amplitude and the initial phase of the velocity of the particle.

(d) State Gauss' law. Depict the variation of the electric field due to a uniformly charged sphere from the centre of the sphere to a point outside its surface.

(e) State the value of the divergence of $\vec{B}$. What does this value imply ?

Can $\vec{A} = \hat{i}\, xy^2 - \hat{j}\, yza + \hat{k}\, a^2z$

represent a field of magnetic induction ?

(f) A particle is projected with an initial speed v_0 at an angle θ to the vertical. Find its angular momentum about the origin. What is its direction ?

(g) Describe the polarization state of the following wave :

$$\vec{E} = \hat{j}\, E_0 \sin(kx + \omega t) + \hat{k}\, E_0 \sin\left(kx + \omega t - \frac{\pi}{4}\right)$$

(h) Explain how charge carriers drift in a conductor. A current of 1 A passes through a copper wire of radius of cross-section 1 mm. Find the drift velocity of electrons in the wire if the number density of charges in copper is $8{\cdot}5 \times 10^{28}/m^3$.

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

(a) Define torque. Show that it is equal to the rate of change of angular momentum of a system of particles.

(b) Show that the power delivered by a machine is $P = \vec{F} \cdot \vec{v}$.

A 100 kg mass is being pulled up a 30° incline with a uniform speed of 1 m/s using a rope. If the coefficient of friction between the surfaces of the mass and the incline is 0·5, find the power delivered by the force which is pulling the rope.

(c) State Kepler's laws governing the motion of planets. Show that the second law is a consequence of the conservation of angular momentum. Calculate the semi-major axis of a comet (in AU) having a period of 64 years.

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

(a) A thin homogeneous circular disc is suspended like a compound pendulum. Find the distance of the point from the centre of the disc such that the oscillations about this point have the minimum time period.

(b) State and establish the work energy theorem for a system of particles undergoing an arbitrary motion.

(c) A wheel of radius 0·25 m rolls without slipping on a plane surface so that its centre moves with a speed of 10 m/s along x-direction. Find its angular velocity and indicate the sense of rotation of the wheel.

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

(a) A particle is undergoing displacement given by

$$y = A \cos (\omega t + \phi).$$

Calculate its velocity and acceleration. Show displacement, velocity and acceleration graphically on the same graph.

(b) Derive an expression for the velocity of sound waves in a medium of bulk modulus B. For an ideal gas undergoing adiabatic process, show that

$$B = \gamma P,$$

where γ is the adiabatic index and P is the pressure of the gas.

(c) Distinguish between group velocity and phase velocity of a wave motion.

If λ_0 is the wavelength of light in vacuum and μ is the refractive index of the medium,

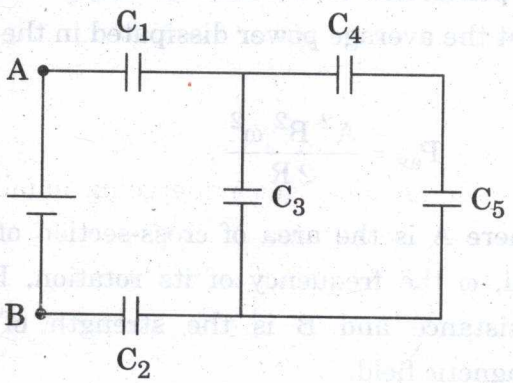
show that

$$\frac{1}{v_g} = \frac{1}{v} - \frac{\lambda_0}{c}\,\frac{d\mu}{d\lambda_0},$$

where v_g and v denote group and phase velocities.

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

(a) In the circuit shown below, all capacitors have value 6 μF each. Calculate the equivalent capacitance of the circuit between A and B.



(b) Derive the resistance of a spherical shell of outer radius r_1 and inner radius r_2. The conductivity of the material of the shell is σ.

(c) Plot the trajectory of a point charge in an electric field provided by two parallel plates.

An electric dipole of moment $\vec{p}$ is placed in an electric field $\vec{E}$. Find the torque exerted on the dipole.

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

(a) Derive an expression for moment of intertia of a uniform circular plate of radius R and mass M along an axis passing through the centre and perpendicular to the plane.

(b) A coil is rotating about one of its diameters in a uniform magnetic field directed perpendicular to the axis of rotation. Show that the average power dissipated in the coil is

$$P_{av} = \frac{A^2 B^2 \omega^2}{2R},$$

where A is the area of cross-section of the coil, ω the frequency of its rotation, R its resistance and B is the strength of the magnetic field.

(c) Find the trajectory of a charged particle released from the origin in the crossed $\vec{E}$ and $\vec{B}$ given by

$$\vec{E} = E\hat{j}, \quad \vec{B} = B\hat{k}.$$

Constants :

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

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ N\text{-}m^2/C^2$

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