ET-105(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering)

00465

Term-End Examination

June, 2010

ET-105(A) : PHYSICS

Time : 3 hours *Maximum Marks : 75*

Note : *All questions are **compulsory**. Use of calculator is allowed.*

1. Answer ***any five*** of the following : **5x5=25**

(a) Explain the concept of centre of mass of a system of particles. Show that the total momentum of a system of particles is given by

$$\vec{P} = M\vec{v}_{cm}$$

where M is the total mass of the system and $\vec{v}_{cm}$ is the velocity of the centre of mass.

(b) Obtain an expression for the moment of inertia of a uniform rectangular bar of length *a*, width *b* and mass *M* about an axis perpendicular to its plane and passing through its centre.

(c) Name the types of wave fronts emerged from a point source of light and an infinitely long tube light. Show that the total average energy transported by a wave is proportional to the amplitude squared.

(d) State Gauss's law. Using this law, obtain an expression for the electric field due to an infinitely long charged rod at a distance r from its axis.

(e) A charged particle is moving with velocity $\vec{v}$ in a plane perpendicular to a uniform magnetic field $\vec{B}$. Obtain an expression for the time taken by the particle to complete one revolution of the circular trajectory.

(f) Derive an expression for the work done in charging the plates of a capacitor of capacitance C from neutral to charge Q. How does the capacitance of a capacitor change when a dielectric of dielectric constant K is filled between its plates ?

2. Answer ***any two*** of the following : **2x5=10**

(a) A bomb of mass 10 kg explodes into two pieces of masses 6 kg and 4 kg. The velocity of mass 6 kg is 8 m/s. Calculate the kinetic energy of mass 4 kg.

(b) A force $\vec{F} = 8\hat{i} + 5\hat{j} - 6\hat{k}$ acts on an object located at $\vec{r} = 4\hat{i} + 5\hat{j}$ with respect to origin O. Calculate the torque on the object.

(c) A 2 kilowatt motor is used to pump water from a well 20 m deep. Calculate the quantity of water pumped out per second.

3. Answer *any two* of the following : **2x5=10**

(a) A solid sphere of mass 2 kg is rolling without slipping on a table with linear speed of 0.5 m/s. Calculate its total kinetic energy.

(b) A body of mass 5 kg revolves around a circular path of radius 10 m. If it makes 10 revolutions per second, calculate its centripetal acceleration and centripetal force.

(c) A stone of 2 kg at the end of a 1 m long string is whirled in a vertical circle at constant speed of 5 m/s. Calculate the tension in the string when the stone is at the top of the circle.

4. Answer *any two* of the following : **2x5=10**

(a) A body of mass 0.5 kg at end of a spring executes SHM obeying the equation

$$x = 2 \times 10^{-2} \sin (8t - 0.6)$$

where x is in meters and t is in seconds. Calculate :

(i) the spring constant,

(ii) potential energy at the end of a swing, and

(iii) kinetic energy at the end of the swing.

(b) The fundamental frequency of a tube open at both ends is 500 Hz. If one end of the tube is closed, calculate the two lowest frequencies at which the tube will resonate.

(c) In a Young's double slit experiment, the wavelength of the light used is 500 nm and slit separation is 1.4 mm. Calculate the fringe width of the interference pattern obtained on a screen placed at 1.5 m from the slits. What is the angular separation of the first minimum ?

5. Answer *any two* of the following : 2x5=10

(a) Two point charges of $+9\mu C$ and $-25\ \mu C$ are placed 10 cm apart. Determine the position of the point where the resultant electric field is zero.

(b) In copper, the number of free electrons is $8.4 \times 10^{28}/m^3$. In a copper wire of cross-sectional area 2 mm^2, 0.5 A current is flowing. Calculate the drift velocity of electrons.

(c) Two charged particles, each of mass 20 g and each having charge $4 \times 10^{-2} C$ are kept at a distance of 20 cm and then released. Calculate the speeds of particles when the separation between them becomes very large.

6. Answer *any two* of the following : 2x5=10

(a) A 0.5 m long solenoid has 4 layers of windings with each layer having 500 turns. If 5A current flows in the solenoid, calculate the value of the magnetic field at its centre.

(b) A proton is projected in a plane perpendicular to a uniform magnetic field of 0.5 T. The kinetic energy of the proton is 2 MeV. Calculate the radius of its circular trajectory.

(c) A straight conductor wire is bent into a semi-circular arc of radius 4 cm. 10 A current is flowing in the arc in the clockwise direction. Determine the magnitude and direction of magnetic field at the centre of the arc.

Physical constants

$e = 1.6 \times 10^{-19}$ C

$\frac{1}{4\pi\epsilon_o} = 9 \times 10^9$ $C^2/(m^2N)$

$m_p = 1.67 \times 10^{-27}$ kg

$\frac{\mu_o}{4\pi} = 10^{-7}$ N/A^2

1 eV $= 1.6 \times 10^{-19}$ J