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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

December, 2012

01712

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.*

1. Attempt *any five* of the following : **5x4=20**

(a) State the second law of motion and show that it may be written in the form : $\vec{F} = m\,\vec{a}$

(b) The coordinates of three masses of magnitudes 3, 4 and 5 units respectively are $(-7, 1)$, $(2, 6)$, $(5, -3)$. Find the centre of mass of the system.

(c) In plane polar coordinates, show that :

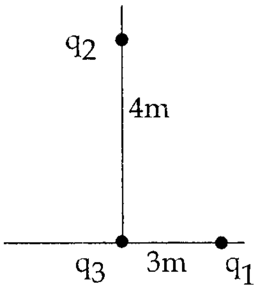
$$\frac{d\vec{r}}{dt} = \frac{dr}{dt}\,\hat{r} + r\,\omega\,\hat{\theta}.$$

(d) Show that the average potential energy of a harmonic oscillator of mass m is $\frac{1}{4} m\omega^2 A^2$, where A is the amplitude and ω is the angular frequency of the oscillator.

(e) Sketch the reflected waves in a composite string consisting of a lighter and a heavier string.

(f) State Coulomb's law in vector form. Sketch the electric lines of force due to a charge-Q.

(g) Three charges are located as shown. Their magnitudes are $q_1 = +3mC$, $q_2 = -2mC$ and $q_3 = +2mC$. Find the potential energy of charge q_3.



(h) Express the statement 'the field of magnetic induction $\vec{B}$ has zero divergence at all points' in an equation. What does the equation have to say about the nature of the magnetic lines of force ?

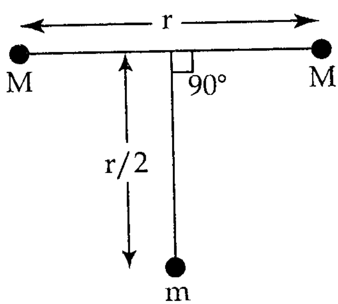
2. Attempt *any two* of the following : **2x5=10**

(a) Explain the existence of tension in a string at microscopic level.

A block of mass M is pulled by an inextensible uniform string by a force $\vec{T_0}$ applied at the free end of the string. If the mass of the string itself is m, calculate the tension at a point halfway along its length.

(b) Define angular momentum of a particle. How is it related to the torque acting on the particle ? A particle is projected with a velocity $\vec{v}_0$ at an angle θ to the horizontal. Find an expression for its angular momentum about the origin.

(c) Express the law of gravitation in a vector form. What indicates that the law is universal ? Calculate the gravitational force on the mass m in the following figure.



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

(a) Explain why finite angular displacement is not a vector. Does infinitesimal rotation behave like a vector ? What is the character of this vector ? Show that for a rigid body rotation about an axis fixed in space.

$$d\vec{r} = d\vec{\phi} \times \vec{r}$$

(b) Define a compound pendulum. Derive an expression for its time period.

(c) Derive an expression for the rotational kinetic energy of a rigid body. Show that it is possible to associate a part of the kinetic energy with the motion of particles about a parallel axis through the centre of mass and a second part with the rotation of the centre of mass itself about the axis of rotation of the rigid body.

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

(a) A particle is subjected to two simple harmonic motions of the same frequency but with a phase difference of π. Derive the equation of the trajectory of the particle and sketch it.

(b) Explains the terms phase velocity and group velocity. Show that in a dispersive medium

$$v_g = v_p - \lambda \frac{d\sqrt{p}}{d\lambda}$$

Can group velocity be larger than the velocity of light ?

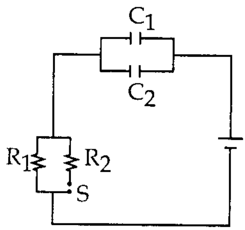
(c) Explain the working of a diffraction grating. A grating has 5000 lines/cm. Find the angular spread of the visible spectrum from 400 nm to 700nm.

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

(a) Define the dipole moment of an electric dipole. Sketch the field lines due to a dipole. Derive an expression for the electric field due to a dipole at a point far from the dipole.

(b) Write down Maxwell's equations. Derive $\vec{\nabla}.\vec{E} = \rho/\epsilon_0$, and discuss its physical significance.

(c) Derive the time constant of an RC circuit. Find the time constant of the circuit given below when the switch S is open. Will the time constant increase or decrease if switch S is closed.



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

(a) State and explain Ampere's law. Discuss an example of its validity.

(b) Explain the concept of velocity filter. Get the condition under which it works. Does the nature of charge affect its working ?

(c) Write down Maxwell equation. Using a three dimensional wave form, show that the $\vec{E}$ and $\vec{B}$ fields of an electromagnetic wave are normal to each other and both are normal to the direction of propagation of the wave.

Constants :

$$\frac{1}{4\pi\epsilon_0} = 9.0\times10^9\ Nm^2C^{-2},\ \mu_o = 4\pi\times10^{-7}\ Hm^{-1}$$