M.Sc. DEGREE (FIVE YEAR INTEGRATED) I SEMESTER EXAMINATION
IN PHOTONICS
DECEMBER 2003

CEL 1101 MECHANICS AND WAVE PHENOMENA

Time: 3 Hours Maximum Marks: 50

PART - A
(Answer ***ANY FIVE*** questions)
(Each question carries ***TWO*** marks)

(5 x 2 = 10)

I. (i) The speed of an automobile is uniformly reduced from 60 km/hr to 30 km/hr at a distance of 60 m. Find the magnitude and direction of the acceleration.

(ii) The position of two identical particles are $\left(2\hat{i}+3\hat{j}+4\hat{k}\right)m$ and $\left(-\hat{j}-2\hat{k}\right)m$ respectively. Find the centre of mass.

(iii) Find the magnitude and direction of the acceleration in uniform circular motion.

(iv) State the conditions for a body to be in equilibrium.

(v) With examples explain the connection between symmetry and conservation laws.

(vi) A particle executing a simple harmonic motion has zero displacement at t = 0 and has maximum displacement of when $t = \frac{\pi}{10}s$. Find the angular frequency.

(vii) Give a short account of dispersion of waves in a medium.

PART - B

(Answer *ALL* questions)
(Each question carries *EIGHT* marks)

(5 x 8 = 40)

II. (a) Show that the path of a projectile is a parabola.

(b) A rifle with muzzle velocity 500 m/s shoots a bullet at a small target 50 m away. How high above the target must the gun be aimed so that the bullet will hit the target?

OR

III. (a) Prove work energy theorem. Explain it with an example.

(b) A particle experience a force $\vec{F} = f\left(x\hat{i} + y\hat{j} + z\hat{k}\right)$. Find the corresponding potential energy function $V(x, y, z)$. Obtain the work done in moving the system from the point (0, 0, 0) to $b(\hat{i} + \hat{j} + \hat{k})$ where f and b are constants.

IV. (a) A body of 0.2 kg. mass makes an elastic collision with another body at rest and continues to move in the original direction but with half its original speed. What is the mass of the struck body?

(b) A steel ball of mass 0.5 kg. is dropped from a height of 4 m onto a horizontal steel slab. The collision is elastic, and the ball rebounds to its original height. Calculate the impulse delivered to the ball and the average force on the ball if the ball is in contact with the slab for 0.002s.

OR

V. (a) Define the angular momentum $\vec{\ell}$ and torque $\vec{\tau}$ of a particle and show that $\frac{d\vec{\ell}}{dt} = \vec{\ell}\vec{\tau}$. Show that the angular momentum is conserved if the force acting onthe particle $\vec{F} = f\left(x\hat{i} + y\hat{j} + z\hat{k}\right)$ where f is a constant.

Contd.....3

V. (b) A small object of mass 0.01 kg is attached to a light string which passes through a hollow tube. The object is set in rotation in a circle of radius 20 cm. with a speed of 5 cm/s. The radius of the circle is reduced to 10 cm. by pulling down the string. Find the new speed and the work done. You can neglect the effect of gravity.

VI. (a) State Kepler's Laws of planetary motion. Explain the origin of the law of equal areas.

(b) A satellite of mass 3000 kg is moving in a circular orbit of radius 600 km. determine its speed and period.

OR

VII. (a) State and explain the law of universal gravitation. Obtain the expression for the gravitational potential energy.

(b) Consider the earth to be a homogeneous sphere of radius R. Determine the acceleration due to gravity at a depth D from the Earth's surface.

VIII. (a) State Hooks law. Find the corresponding equation of motion and show that it execute a simple harmonic motion.

(b) A harmonic oscillator of mass 0.2 kg. has a maximum displacement of 0.2 m and its kinetic energy in the mean position is 0.2J. Find the frequency of oscillations.

OR

IX. (a) What is a damped oscillator? Obtain its equation of motion. Comment on the solution when the damping is small.

(b) A simple pendulum has a maximum angular displacement of 1°. When in the mean position its angular speed is 10°/s. Find the length of the pendulum.

Contd.....4

X. (a) Obtain the expression for the wave speed in a stretched string.

(b) By considering the superposition of two waves explain the phenomena of interference.

OR

XI. (a) What is Doppler effect? Obtain the expression for the Doppler shift in sound waves when

(i) observer at rest and source moving.

(ii) observer moving and source at rest.

(b) Explain the beat phenomenon.

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