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RR-0881

Third Year B. Sc. Examination

March / April – 2010

Mathematics Mechanics

(Can Course)

[Old Course]

Time : **3** Hours] [Total Marks : **70**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **T. Y. B. Sc.**

Name of the Subject :

☛ **Mathematics Mechanics (OLD) [CAN]**

☛ Subject Code No. : **0 8 8 1** ☛ Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) **All** questions are **compulsory**.

(3) Digits to **right** indicate marks.

(4) Non-programmable **calculator** is allowed.

1 Do as directed : **10**

(1) If $\vec{v} = x^2 + y^2 + z^2 + x$ at what points in space the grad v parallel to Z–axis ?

(2) When is the system of forces called equipollent and plane equipollent ?

(3) Forces of magnitude 2 and 3 acts parallel to X-axis at points (1,2) and (2,3) respectively. Reduce them to a force at the origin and a couple.

(4) Prove that the work done by a couple of moment N in an infinitesimal rotation $\delta\theta$ is $N.\delta\theta$.

(5) State the laws of static and kinetic friction.

2 (a) Explain the following terms with illustration : 4

(i) scalar field

(ii) vector field

(b) A particle is in equilibrium under three forces. Two of them act at right angle to one another, one being double the other. If the third force has the magnitude 10 lb wt, then find, magnitude of other two by Lamy's theorem. 4

(c) A particle travels along a straight line with constant acceleration. Prove that $s = ut + \frac{1}{2}at^2$, $v = u + at$, $v^2 = u^2 + 2as$ where s is the distance covered from the instant t=0, u is the initial velocity, v is the final velocity and a is the acceleration. 4

OR

2 (a) Define a couple, moment of a couple and show that two couples in a fundamental plane are plane equipollent if they have the same moment. 4

(b) Prove that any force system in a fundamental plane can be reduced either to a single force or to a couple. 4

(c) A force of fixed magnitude R and variable inclination θ to the X-axis, acts in a plane Oxy at a fixed point (a,b). Find its moment about origin as a function of θ. Obtain the value of θ for which is maximum. 4

3 (a) Define mass centre of system of particles and prove that every system has a unique mass centre. 4

(b) A light ladder is supported on a rough floor and leans against a smooth wall. How far up the ladder can a man climb without slipping taking place. 4

(c) Prove that the potential of a thin spherical shell at any external point is the same as if the whole mass is concentrated at its centre. 4

OR

3 (a) Find the mass centre of a cubical box with no lid, the sides and bottom being made of the same thin material. 4

(b) Find the mass centre of a wire bent into the form of an isosceles right angle triangle. 4

(c) A ladder leans against a smooth wall, the lower end resting on a rough floor for which the coefficient is 1/4. Find the inclination of a ladder to the vertical if it is just at the point of slipping. 4

4 (a) Define terms : 4

Instantaneous centre, space centrode and body centrode.

(b) A particle moves in an elliptical path with a constant speed. At what points is the magnitude 4

(i) maximum and

(ii) minimum ?

(c) Consider a particle moving on a circle of radius r with a speed v proportional to time t. Prove that the tangential component of its acceleration is constant and normal component varies at t^2. 4

OR

4 (a) Obtain the radial and transverse components of velocity and acceleration of a particle moving in a plane. 4

(b) Define a Hodograph. Show that the hodograph of a particle with acceleration constant in magnitude and direction, is a straight line described with a constant speed. 4

(c) Consider a particle moving on a circle of a radius r with constant speed v. Prove that the acceleration is directed towards the centre with magnitude v^2/r. *4*

5 (a) Define the linear momentum and angular momentum of a particle. Prove that the rate of change of angular momentum of a particle about a fixed point in the plane is equal to the moment of the force about that point. 4

(b) Define the kinetic energy and prove that the rate of increase in kinetic energy is equal to the rate of working of the force. 4

(c) A bead of mass m slides on a smooth wire in the form of a parabola with axis vertical and vertex downward. If it starts from rest position at an end of latus rectum $4p$, find the speed with which it passes through the vertex. 4

OR

5 (a) Prove that rate of change of angular momentum relative to mass centre is equal to a moment of the external forces about the mass centre. 4

(b) Prove that the rate of change of linear momentum of a system is equal to the vector sum of the external forces. 4

(c) A particle of mass m, moving freely in a vertical plane under gravity, is at a height h, above the ground and has a speed v, at a certain instant. Find its speed when it strikes the ground, using the principle of energy. 4

6 (a) In usual notations prove that the time period of the simple pendulum is given by $T = 2\pi\sqrt{l/g}$ where l is the length, g is the gravitational acceleration. 4

(b) Define a damped oscillator. Obtain an equation of a damped oscillator and hence obtain its general solution. 4

(c) A stone is thrown with a velocity 80 feet/second, inside a tunnel which is 15 feet high. Find the maximum distance traveled by the stone. 4

OR

6 (a) Show that the motion of a simple pendulum is simple harmonic. 4

(b) Show that the path of a projectile is parabolic. 4

(c) A ball is thrown with in initial velocity 90 feet/second to strike an object at a distance of 120 feet and at a height of 40 feet above the ground. At what angle should the ball be thrown (Neglect the air resistance and height above the ground of the point of projection). 4