Roll No. ... ...

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B. Sc. 3rd Semester (Mathematics) Examination – November, 2014

STATICS

Paper : BM-233

Time : Three Hours] *[Maximum Marks : 40*

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt ***five*** questions in all, selecting ***one*** from each Unit. Question No. **9** is ***compulsory***.

Q. No. 1 to 8 carry 7 marks each. ($4 \times 7 = 28$)

Q. No. 9 caryy 2 marks for each part. ($6 \times 2 = 12$)

UNIT – I

1. (a) A string of length l is fastened to two points A, B at the same level and at a distance 'a' apart. A ring

of weight W can slide on the string and a horizontal force P is applied to it such that it is in equilibrium vertically below B. Show that $P = \frac{aW}{l}$ and tension of the string is $\frac{W(l^2 + a^2)}{2l^2}$.

(b) ABC is a triangle and O is a point in the plane of triangle A force R acts along AO. Resolve R into two force parallel to it and cutting at B and C respectively, where

(i) O is the incentre of ΔABC.

(ii) O is the circumcentre of ΔABC.

2. (a) Forces of magnitude P, 2P, - 3P, 4P, 5P and - 9P act respectively along the sides taken in order of a regular hexagon. Prove that they reduce to a resultant force acting through the centre of the hexagon. Find the magnitude and direction of resultant.

(b) Force λBC, μCA, υAB act respectively along the sides BC, CA, AB of a triangle ABC. Show that if $\lambda = \mu = \upsilon$, the system reduces to a couple and if $\lambda + \mu + \upsilon = 0$, the resultant passes through the centroid of the triangle.

UNIT – II

3. (a) One end of a uniform rod is attached to a hinge and the other end is supported by a string attached to the extremity of the rod; the rod and the string are inclined at the same angle θ to the horizontal. If W be the weight of the rod, show that the reaction at the hinge is $\frac{1}{4}W\sqrt{8+\text{cosec}^2\theta}$. Also find tension of the string.

(b) Find Centre of Gravity of a Right Circular Solid Cone.

4. (a) Two bodies of weights W_1 and W_2 are placed on an inclined plane and are connected by a light string which coincides with a line of greater slope of the plane. If the coefficient of friction between the bodies and the plane be respectively μ_1 and μ_2 and $\mu_1 > \tan\alpha > \mu_2$ prove that if they are both on the point of slipping then $\tan\alpha = \frac{\mu_1 W_1 + \mu_2 W_2}{W_1 + W_2}$.

(b) A ladder whose C.G. divides it into two portions of lengths 'a' and 'b' rests with one end on a rough horizontal floor and the other end against a rough vertical wall. If the coefficient of friction at the floor and wall be μ and μ', show that the inclination of the ladder to the floor, when the equilibrium is limitting, is $\tan^{-1}\frac{a-b\mu\mu'}{\mu(a+b)}$.

UNIT – III

5. (a) A string of length a, forms the shorter diagonal of a rhombus formed of four uniform rods, each of length 'b' and weight 'W', which are hinged together. If one of the rod is supported in a horizontal position. Prove that the tension of the string is $\frac{2w(2b^2-a^2)}{b\sqrt{4b^2-a^2}}$.

(b) A heavy elastic string, whose natural length $2\pi a$ is placed round a smooth cone whose axis is vertical and whose semi-vertical angle is α. If W be the weight and λ be the modulus of elasticity of the

string, prove that it will be in equilibrium when in the form of a circle whose radius is $a\left[1+\frac{W\cot\alpha}{2\pi\lambda}\right]$.

6. (a) A force P acts along the axis of x and another nP along the generator of cylinder $x^2 + y^2 = a^2$. Show that the central axis lies on the cylinder $n^2(nx - z)^2 + (1 + n^2)^2 y^2 = n^4a^2$.

(b) OA, OB, OC are edges of a cube of side a and OO', AA', BB', CC' are its diagonals. Forces equal to P, $2P$, $3P$, $4P$ act along OB', $O'A$, BC and $C'A'$. Reduce the system to a force through O and a couple about an axis through O.

UNIT – IV

7. (a) The axis of two given wrenches intersect at right angles. Their intensities are X and Y and their pitches are Px and Py. If the pitches are given, find the locus of the central axis.

(b) Find the null point of the plane $x + y + z = 0$ for the force system $(X, Y, Z; L, M, N)$.

8. (a) A body consisting of a cone of a hemisphere on the same base, rests on a rough horizontal table, hemisphere being in contact with the table. Show that the greatest height of the cone, so that the equilibrium may be stable, is $\sqrt{3}$ times the radius of hemisphere.

(b) A heavy uniform rod rests with one end against a smooth vertical wall and with a point in its length resting on a smooth peg. Find the position of equilibrium and show that it is unstable.

UNIT – V

9. (i) Resultant of two forces P and V act at right angle to P. Show that the angle between the forces is $\cos^{-1}\left(-\frac{P}{V}\right)$.

(ii) What is the difference between tension and thrust and write the gravitational units of force in C.G.S. and S.I. system.

(iii) Define wrench and screw.

(iv) Define centre of gravity of a uniform triangular lamina.

(v) If the upper body has a plane force in contact with the lower body of radius R then write the conditions when equilibrium is stable and when unstable.

(vi) State law of limiting friction.
