LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **MATHEMATICS**

FIFTH SEMESTER – **NOVEMBER 2017**

MT 5510 – STATICS

Date: 08-11-2017 Dept. No. Max. : 100 Marks

Time: 09:00-12:00

PART – A

Answer ALL questions. **(10 × 2 = 20)**

1. Let **F** be a force acting at a point O. Find the components of **F** along the direction OX which makes an angle α with **F** and OY which makes an angle β with **F**.
2. State triangular law of forces.
3. Define moment of a force.
4. Define a couple.
5. Give an example of a body where the centre of mass is not necessarily a point of the body.
6. What is meant by centre of gravity of a compound body?
7. Define unstable equilibrium.
8. State equation of virtual work.
9. Define span of a catenary.
10. What is a suspension bridge?

PART – B

Answer any FIVE questions **(5 × 8 = 40)**

11. Two forces of magnitude P and Q (P>Q) act on a particle and the angle between the forces is α. If the magnitudes of the forces are interchanged, show that the resultant turns through the angle $2\tan^{-1}\left(\frac{P-Q}{P+Q}\tan\frac{\alpha}{2}\right)$.
12. State and prove Lami's theorem.
13. A heavy carriage wheel of weight W and radius r is to be dragged over an obstacle of height h by a horizontal force of magnitude F applied to the centre of the wheel. Show that F must be greater than $\frac{W\sqrt{2rh-h^2}}{r-h}$.
14. Find the centre of gravity of a thin uniform triangular lamina.
15. Find the resultant of two like parallel forces.

16. A uniform rod of length 2a rests in equilibrium against a smooth vertical wall and upon a smooth peg at a distance b from the wall. If in the position of equilibrium the rod is inclined at an angle θ with the wall, show that $\sin\theta = (\frac{b}{a})^{\frac{1}{3}}$.

17. Derive Cartesian equation of the catenary.

18. A uniform chain of length *l* is to be suspended from two points A and B, in the same horizontal line so that either terminal tension is n times that at the lowest point. Show that the span AB must be $\frac{l}{\sqrt{n^2-1}}\log(n+\sqrt{n^2-1})$.

PART – C

Answer any TWO questions. **(2 × 20 = 40)**

19 (a) Discuss the equilibrium of a heavy particle on a smooth inclined plane.

(b) State and prove Varignon's theorem of moments. **(10+10)**

20 (a) Two strings AB and AC are knotted at A, where a weight W is attached. If the weight hangs freely and in the position of equilibrium, with BC horizontal, AB: BC : CA = 2:4:3 , show that the tensions in the strings are $\frac{7W}{2\sqrt{15}}$ and $\frac{11}{4\sqrt{15}}$.

(b) Two rough particles connected by a light string rest on an inclined plane. If their weights and corresponding coefficients of friction are W_1, W_2 and μ_1, μ_2 respectively and $\mu_1 > \tan\alpha > \mu_2$ where α is the inclination of the plane with the horizon, prove that $\tan\alpha = \frac{\mu_1 W_1 + \mu_2 W_2}{W_1 + W_2}$, if both particles are on the point of moving down the plane. **(10+10)**

21 (a) Find the centre of gravity of the segment of a sphere of radius a cut off by a plane at distance c from the centre,

(b) A string of length *l* hangs between two points not in the same vertical line and the tangents at the end points are inclined at an angle α and β with the horizontal. Show that the height of one extremity above the other is $\frac{l \sin\frac{\alpha+\beta}{2}}{\cos\frac{\alpha-\beta}{2}}$, the two extremities being on the same side of the vertex of the catenary. **(10+10)**

22 (a) A rod lies in equilibrium with its ends on two smooth planes inclined at an angle α,β to the horizontal, the planes intersecting in a horizontal line. Show that the inclination of the rod to the horizontal is $\tan^{-1}(\frac{\sin(\alpha\sim\beta)}{2\sin\alpha\sin\beta})$.

(b) State and prove the principle of virtual work for a system of coplanar forces acting on a rigid body. **(10+10)**

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