



Date: 30-10-2018  
Time: 09:00-12:00

Dept. No.

Max. : 100 Marks

**PART-A**

**Answer all the questions**

(10 × 2 = 20)

1. State parallelogram law of forces.
2. State Triangle of forces.
3. Define couple.
4. Define moment of a force.
5. Define the centre of gravity of a body.
6. Find the centre of gravity of a compound body.
7. State the Hooke's Law.
8. Define neutral equilibrium.
9. Define Catenary.
10. Define span and sag.

**PART-B**

**Answer any FIVE questions**

(5 × 8 = 40)

11. State and prove Lami's theorem.
12. A weight is supported on a smooth plane inclined at the angle  $\alpha$  with the horizon, by a string inclined to the vertical at the angle  $\beta$ . If the inclination of the plane is increased to  $\gamma$  and the inclination of the string with the vertical is unaltered, the tension in the string is doubled in supporting the weight. Prove that  $\cot \alpha - 2 \cot \gamma = \cot \beta$ .
13. Find the resultant of two unlike and unequal parallel forces acting on a rigid body.
14. A uniform rod  $AB$  of length  $2a$  and weight  $W$  is resting on two pages  $C$  and  $D$  in the same level at a distance  $d$  apart. The greatest weights that can be placed at  $A$  and  $B$  without tilting the rod are  $W_1$  and  $W_2$  respectively. Show that  $\frac{W_1}{W + W_1} + \frac{W_2}{W + W_2} = \frac{d}{a}$ .
15. Find the centroid of the arc of the catenary  $y = c \cosh \frac{x}{c}$  which is included between the lines  $x = 0$  and  $x = a$ .

16. State and prove the principle of virtual work for a system of coplanar forces acting on a rigid body.
17. 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  $\frac{1}{\sqrt{n^2 - 1}} \log(n + \sqrt{n^2 - 1})$ .
18. Discuss stability of a body with one fixed point.

### PART-C

Answer any TWO questions

(2 × 20 = 40)

19. (a) State and prove Polygon Law of Forces.
- (b) Two weights  $P$  and  $Q$  are suspended from a fixed point  $O$  by strings  $OA$  and  $OB$  and are kept apart by a light rod  $AB$ . If the strings  $OA$  and  $OB$  make angles  $\alpha$  and  $\beta$  with the rod, show that the angle  $\theta$  which the rod makes with the vertical is given by  $\tan \theta = \frac{P + Q}{Q \cot \beta - P \tan \alpha}$ . (10+10)
20. (a) State and prove Varignon's theorem on moments.
- (b) Two like parallel forces  $P$  and  $Q$  ( $P > Q$ ) act at  $A$  and  $B$  respectively. If the magnitude of the forces are interchanged, show that the point of application of the resultant on  $AB$  will be displaced through the distance  $\frac{P - Q}{P + Q} \cdot AB$ . (15+5)
21. (a) Find the centre of gravity of the area enclosed by the parabolas  $y^2 = ax$  and the circle  $x^2 = by$ , ( $a > 0, b > 0$ ).
- (b) Find the centre of gravity of a uniform hollow right circular cone. (10+10)
22. (a) 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  $\alpha$  and  $\beta$  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.
- (b) Derive the Cartesian equation of the catenary. (10+10)

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