(6 pages)

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B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2023

Fifth Semester

Mathematics – Core

STATICS

(For those who joined in July 2017–2020 only)

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

1. The resultant of two forces, P, Q acting along the same line and in the opposite direction is ————

(a) $\sqrt{P^2+Q^2}$ (b) PNQ

(c) P^2+Q^2 (d) $P+Q$

2. If the resultant of two forces acting at a point with magnitudes 3,5 is a force with magnitude 7, then the angle between them is ————

(a) 30° (b) 45°

(c) 60° (d) 90°

3. If the line of action of the force passes through a point, then the moment of that force about that point becomes ————

(a) twice (b) zero

(c) half (d) infinity

4. The moment of force $\bar{F}$ about a point O is ————

(a) $\bar{r}.\bar{F}$ (b) $\bar{r}\times\bar{F}$

(c) $\bar{F}\times\bar{r}$ (d) $\bar{r}\bar{F}$

5. If three forces acting on a rigid body are in equilibrium then they must be ————

(a) coplanar (b) perpendicular

(c) not parallel (d) not coplanar

6. If three faces are in equilibrium, and two of them meet at O, then the thrid force ———— O.

(a) is perpendicular to

(b) passes through

(c) does not pass through

(d) is coplanar to

7. The coefficient of friction is equal to ————

(a) FR (b) R/F

(c) F/R (d) $\tan^{-1}\lambda$

8. Friction is ———— force

(a) active (b) passive

(c) zero (d) resultant

9. The cartesian equation of a catenary is ————

(a) $y = c\sinh\left(\frac{x}{c}\right)$

(b) $y = c\cos\left(\frac{x}{c}\right)$

(c) $y = c\sin\left(\frac{x}{c}\right)$

(d) $y = c\cosh\left(\frac{x}{c}\right)$

10. The cartesian equation of the catenary shows symmetry about ————

(a) x–axis (b) y–axis

(c) both x and y axis (d) none

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) State and prove Lami's theorem.

Or

(b) State and prove converse of the triangle of forces.

12. (a) Three like parallel forces acting at the vertices of a triangle, have magnitudes proportional to the opposite sides. Show that their resultant passes through the incentre of the triangle.

Or

(b) Find the conditions of equlibrium of three coplanar parallel forces.

13. (a) State and prove three coplanar forces theorem.

Or

(b) The altitude of a right cone is 'h' and the radius of its base is 'a'. A string is fastened to the vertex and to a point on the circumference of the circular base and is then put over a snooth peg, the cone rests with its axis horizontal. Show that the length of the string is $\sqrt{h^2+4a_2}$.

14. (a) A particle of weight 30 kgs resting on a rough horizontal plane is just on the point of motion when acted on by horizontal forces of 6 kg wt and 8 kg wt at right angles to each other. Find the coefficient of friction between the particle and the plane and the direction in which the friction acts.

Or

(b) Find the relation between the coefficient of friction and the angle of friction.

15. (a) Show that if a long claim is thrown over two smooth pegs and is in equilibrium, the free ends must reach the directrix of the catenary formed by it.

Or

(b) Describe the geometrical properties of a common catenary.

SECTION C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Two beads of weights w and w^1 can slide on a smooth circular wire in a vertical plane. They are connected by a light string which subtends an angle 2β at the centre of the circle when the beads are in equilibrium on the upper half of the wire. Prove that the inclination of the string to the horizontal is given by $\tan\alpha = \frac{w \sim w^1}{w + w^1} \tan\beta$.

Or

(b) Derive an analytic expression for the resultant of two forces acting at a point. Discuss its special cases also.

17. (a) Find the resultant of two like parallel forces acting on a rigid body.

Or

(b) State and prove Varigon's theorem of moments.

18. (a) A beam of weight W hinged at one end is supported at the other end by a string so ghat the beam and the string are in a vertical plane and make the same angle θ with the horizon. Show that the reaction at the hinge is $\frac{W}{4}\sqrt{8 + Co\sec^2\theta}$.

Or

(b) A uniform beam of length 1 and weight W hangs from a fixed point by two strings of lengths a and b. Prove that the inclination of the rod to the horizon is $\sin^{-1}\left(\frac{a^2 - b^2}{l\sqrt{2(a^2 + b^2 - l)}}\right)$. Find also the tension of the strings.

19. (a) A weight can be supported on a rough inclined plane by a force P acting along the plane or by a force Q acting horizontally. Show that the weight is $\frac{PQ}{\sqrt{Q^2 \sec^2\lambda - P^2}}$ where λ is the angle of friction.

Or

(b) Find the conditions for the equilibrium of a body on a rough inclined plane under a force parallel to the plane.

20. (a) A uniform chain of length 2l hangs over two small smooth pegs in the same horizontal line and at a distance 2a apart. Show that if h is the sag in the middle, the length of either part of the chain that hangs vertically is $h + l - 2\sqrt{2hl}$.

Or

(b) Derive the equations of the common catenary.
