(8 pages) **Reg. No. :** .....

Code No. : 30424 E **Sub. Code : CMMA 53**

B.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2024.

Fifth Semester

Mathematics — Core

STATICS

(For those who joined in July 2021- & 2022 only)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)
Answer ALL questions.

Choose the correct answer :

1. If two forces P and Q are at right angles to each other, then the resultant force is ————

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

(c) $\sqrt{P^2-Q^2}$ (d) $P \sim Q$

2. A force has no resolved part in its ———— direction.

(a) parallel (b) perpendicular

(c) own (d) all

3. A couple is the effect of two ———— forces.

(a) like parallel

(b) coplanar

(c) unlike parallel

(d) unlike, equal parallel

4. If the line of action of a force passes through the point O, then the moment of that force about the point is ————

(a) positive (b) negative

(c) zero (d) not defined

5. Three coplanar forces P, Q, R are in equilibrium and are parallel. Which of the following is true?

(a) P and Q from a couple

(b) P, Q, R are like parallel forces only

(c) One must be proportional to distance between other two

(d) Atleast one must be in opposite direction of other two

6. Let P, Q and R be coplanar forces acting on a rigid body. If it is in equilibrium, which of the following cannot be true?

(a) P and Q – like parallel

(b) P and Q – unlike parallel

(c) P and Q – couple forces

(d) P, Q, R – like parallel

7. The maximum value of function is ————

(a) μ/R (b) μ

(c) μR (d) R/μ

8. When one body in contact with another is in equilibrium, then the friction exerted is called ————

(a) limiting friction (b) statical friction

(c) dynamical friction (d) passive friction

9. The intrinsic equation of the catenary is ————

(a) $s = c\tan\psi$ (b) $s = c\sin\psi$

(c) $s = c\cos\psi$ (d) $s = c\sec\psi$

10. Which of the following is true in a catenary?

(a) $s^2 = y^2 + c^2$ (b) $y^2 = c^2 + s^2$

(c) $y^2 = s^2 - c^2$ (d) $y^2 = c^2 - s^2$

PART B — ($5 \times 5 = 25$ marks)

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

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

Or

(b) $ABCDEF$ is a regular hexagon and at A, act forces represented by $\overline{AB}, 2\overline{AC}, \overline{3AD}, 4\overline{AE}$ and $5\overline{AF}$. Show that the magnitude of the resultant is $AB.\sqrt{351}$ and that it makes an angle $\tan^{-1}\left(\frac{7}{\sqrt{3}}\right)$ with AB.

12. (a) A uniform circular plate is supported horizontally at three points A, B, C of its circumference. Show that the pressure on the supports in the ratio $\sin 2A : \sin 2B : \sin 2C$.

Or

(b) Find the resultant of two unlike and unequal parallel forces acting on a rigid body.

13. (a) A uniform sold hemisphere of weight W rests with its curved surface on a smooth horizontal plane. A weight to is suspended from a point on the rim of the hemisphere. If the plane base of the rim is inclined to the horizontal at an angle θ, prove that $\tan\theta = \frac{8w}{3W}$.

Or

(b) A uniform beam of length l 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 $\sin^{-1}\left(\frac{a^2-b^2}{l\sqrt{2(a^2+b^2)-l^2}}\right)$.

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) Two particles P and Q each of weight W on two equally rough inclined planes CA and CB of the same height, placed back to back are connected by a light string which passes over the smooth top edge C of the planes. Show that if the particles are on the point of slipping, the difference of the inclinations of the planes is double the angle of friction.

15. (a) The span of a suspension bridge is 100 metres and the sag at the middle of the chain is 10 metres, if the total load on each chain is 750 quintals, find the greatest tension in each chain and tension at the lowest point.

Or

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

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) Two beads of weight w and w^{-1} cam 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 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 $\tan\alpha = \frac{w \sim w'}{w+w'}\tan\beta$.

Or

(b) E is the middle point of the side CD of a square ABCD. Force $16, 20, 4\sqrt{5}, 12\sqrt{2}$ Kg.wt. act along AB, AD, EA, CA in the directions indicated by the order of the letters. Show that they are in equilibrium.

17. (a) Forces P, Q, R act along the sides BC, AC, BA respectively of an equilateral triangle. If their resultant is a force parallel to BC through the centroid of the triangle, prove that $Q = R = 1/2P$.

Or

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

18. (a) A heavy uniform rod of length 2a, rests partly within and partly without a smooth hemispherical bowl of radius r, fixed with its rim horizontal. If α is the inclination of the rod to the horizon, show that $2r\cos 2\alpha = a\cos\alpha$. Also calculate the reactions at the extremities show also that the length of the rod should lie between $4r$ and $2r\sqrt{2/3}$ in order that it may rest in equilibrium thus.

Or

(b) A uniform rod of length $2l$ rests with its lower end in contact with a smooth vertical wall. It is supported by a string of length a, one end of which is fastened to a point in the wall and the other end to a point in the rod at a distance b from its lower end. If the inclination of the string to the vertical be θ, show that $\cos^2\theta = \dfrac{b^2(a^2-b^2)}{a^2l(2b-l)}$.

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

Or

(b) 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 $\dfrac{PQ}{\sqrt{Q^2\sec^2\lambda - P^2}}$ where λ is the angle of friction.

20. (a) A telegraph wire stretched between two poles at a distance 'a' feet apart sags n feet in the middle. Prove that the tension at the ends is approximately $w\left(\dfrac{a^2}{8n}+\dfrac{7n}{6}\right)$ where w is the weight of unit length of wire.

Or

(b) Derive the equation of the common catenary.
