STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2019-20 & thereafter)

SUBJECT CODE : 19MT/MC/PM65

B. Sc. DEGREE EXAMINATION, APRIL 2023
BRANCH I – MATHEMATICS
SIXTH SEMESTER

COURSE : MAJOR CORE
PAPER : PRINCIPLES OF MECHANICS
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

ANSWER ALL QUESTIONS. **(10 × 2 = 20)**

1. Define : Force.
2. State : Lami's theorem.
3. State the Triangle law of forces.
4. Define : Couple.
5. Define : moment of a force about a point.
6. State the law of kinetic friction.
7. Define : Friction.
8. What is the intrinsic equation of the common catenary?
9. Show that $y^2 = c^2 + s^2$ for a common catenary.
10. Define : Moment of inertia of a mass about a line.
11. State the Theorem of Perpendicular Axes.
12. Write the moment of inertia of a circular ring of radius a about a diameter.

SECTION –B

ANSWER ANY FIVE QUESTIONS. **(5 × 8 = 40)**

13. Three forces P, Q, R acting at O are in equilibrium. The angle between P and Q is double the angle between R and P. Show that $R^2 + PQ = Q^2$, using Lami's theorem.
14. A rod whose centre of gravity divides it into two parts a and b is placed inside a smooth sphere. Show that if θ be its inclination to the horizon in the position of equilibrium and 2α be the angle subtended by the rod at the centre of the sphere, then $tan\theta = \frac{b-a}{b+a}\, tan\alpha$.
15. A solid cone of height h and semi-vertical angle α is placed with its base against a vertical wall and is supported by a string attached to its vertex and to a point in the wall. Show that the greatest possible length of the string is $h\sqrt{1 + \frac{16tan^2\alpha}{9}}$.
16. A ladder rests in limiting equilibrium with its lower end on a rough horizontal plane and the other end against a rough vertical wall. The centre of gravity divides the ladder into two portions of lengths a and b. Find the position of limiting equilibrium.

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17. Derive the cartesian equation of the common catenary.
18. A particle falls under gravity in a medium whose resistance varies as the square of the velocity. Discuss the motion and find the relation between velocity and displacement.
19. Find the moment of inertia of a circular plate of radius a about a tangent line.

SECTION –C

ANSWER ANY TWO QUESTIONS. **(2 × 20 = 40)**

20. (a) The resultant of two forces P and Q acting at an angle θ is R; that of the forces $2P$ and Q acting at the same angle is 2R and the resultant of forces P and $2Q$ acting at $(180^0 - \theta)$ is $2R$. Prove that $P : Q : R = \sqrt{6} : \sqrt{2} : \sqrt{5}$.

    (b) A body of weight W is in equilibrium on a rough inclined plane of angle α ($\neq \lambda$) under the action of a force P upwards at an angle θ to the line of greatest slope, in a vertical plane through the line of greatest slope. If the body is on the point of moving up the inclined plane, find P if the equilibrium is limiting and λ is the angle of friction. (10 + 10)

21. (a) State and prove Varignon's Theorem.

    (b) Two like parallel forces P and Q $(P > Q)$ act at points A and B of a rigid body. If P and Q are interchanged, show that the point of the resultant is displaced by $\frac{P-Q}{P+Q}AB$ (10 + 10)

22. (a) A uniform chain of length $2l$ 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 $\frac{2l}{\sqrt{n^2-1}}\log_e(n+\sqrt{n^2-1})$.

    (b) Find the moment of inertia of a thin uniform rod of length $2a$ and mass M about a line through one end and perpendicular to it. (10 + 10)