

# MAMT-05/MSCMT-05/MAT-202

**December - Examination 2025**  
**M.A./M.Sc. (Previous) Examination**  
**MATHEMATICS**  
**(MECHANICS)**  
**Paper : MAMT-05/MSCMT-05/MAT-202**

[Time: 3 Hours]

[Maximum Marks: 80]

**Note :-** The question paper is divided into three Sections A, B and C. Write answers as per the given instructions. Use of non-programmable scientific calculator is allowed in this paper.

**Section-A**

**8×2=16**

**(Very Short Answer Type Questions)**

**Note :-** Answer **all** the questions. As per the nature of the question delimit your answer in one word, one sentence or maximum up to **30** words. Each question carries **2** marks.

1. (i) Write M.I. of a uniform rod of mass M and length 2a about an axis through an extremity and perpendicular to it.
- (ii) What do you mean by an axis of spontaneous rotation?
- (iii) Define the Invariable line.
- (iv) Explain conservative system.
- (v) What is the degree of freedom of a single particle moving in space at any time t?
- (vi) Define stream function and its physical significance.
- (vii) Define strength of a source.
- (viii) Write down the Bernoulli's equation for the unsteady, irrotational motion of an incompressible fluid.

**Section-B**

**4×8=32**

**(Short Answer Type Questions)**

**Note :-** Answer **any four** questions. Each answer should not exceed **200** words. Each question carries **8** marks.

2. Deduce the general equations of motion of a rigid body from D' Alembert's Principle when forces are finite.
3. A uniform solid cylinder is placed with its horizontal on a plane. Whose inclination to the horizon is  $\alpha$ . Show that the least coefficient of friction between it and the plane, so that it may roll and not slide is  $\frac{1}{3} \tan \alpha$ .
4. A straight uniform rod of mass m, is placed at right angles to a smooth plane of inclination  $\alpha$  with one end in contact with it, the rod is then released. Show that when its inclination to the plane is  $\phi$ , the reaction of the plane will be -

$$mg \frac{3(1-\sin\phi)^2+1}{(3\cos^2\phi+1)^2} \cos \alpha$$

5. Prove that when a body moves under the action of a system of conservative forces, the sum of its kinetic and potential energies is constant throughout the motion.
6. A circular plate is turning in its own plane about a point A on its circumference. Suddenly A is freed and point B, also on the circumference, fixed show that the plate will be reduced to rest if the arc AB is one third of the circumference.
7. A circular disc, of radius a, has a thin rod pushed through its centre perpendicular to its plane, the length of the rod being equal to the radius of the disc. Show that the system can not spin with the rod vertical unless the angular velocity is greater than  $\sqrt{\frac{20g}{a}}$
8. For a two-dimensional flow the velocities at a point in the fluid may be expressed in the Eulerian coordinates by  $u = x + y + 2t$  and  $v = 2y + t$ . Determine the Lagrange coordinate as function of the initial position  $x_0$  and  $y_0$  and the time t.
9. Deduce Lagrange's Equations from Hamilton's Principle.

**Section-C**

**2×16=32**

**(Long Answer Type Questions)**

**Note :-** Answer **any two** questions. You have to delimit your each answer maximum up to **500** words. Each question carries **16** marks.

10. A rod, of length 2a is suspended by a string, of length l, attached to one end; if the string and rod revolve about the vertical with uniform angular velocity, and their inclinations to the vertical be  $\theta$  and  $\phi$  respectively, show that -

$$\frac{3l}{a} = \frac{(4\tan\theta - 3\tan\phi)\sin\phi}{(\tan\phi - \tan\theta)\sin\theta}$$

11. If initially the axis of the top is horizontal and it is set spinning with angular velocity  $w$  in a horizontal plane, prove that the axis will start to rise if  $nC w > mgh$  and that, when  $nC w = 2 mgh$ , the axis will rise to an angular distance  $\cos^{-1}\left(\frac{Aw}{nc}\right)$ , provided  $Aw < nC$ , and will there be at instantaneous rest. A, C and n have their usual meanings.

12. A particle moves in a straight line with central acceleration  $\mu$ , x between two points  $x_0$  and  $x_1$ , in the prescribed  $t_1 - t_0$ . Show that -

$$\frac{\sqrt{\mu}[(x_1^2 + x_0^2) \cos(t_1 - t_0) \sqrt{\mu} - 2x_1 x_0]}{2\sin(t_1 - t_0)\sqrt{\mu}}$$

13. If the lines of motion are curves on the surface of spheres all touching the plane of xy at the origin O, then prove that the equation of continuity is -

$$r \sin \theta \frac{\partial \rho}{\partial t} + \frac{\partial(\rho v)}{\partial \phi} + \sin \theta \frac{\partial(\rho u)}{\partial \theta} + (\rho u)(1 + 2 \cos \theta) = 0$$

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