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MT-505

Mechanics-I

M.A/M.Sc. Mathematics (MAMT/MSCMT-20)

IstSemester, Examination, June 2022

Time: 2 Hours Max. Marks:40

Note: This paper is of Forty (40) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein.

SECTION – A

(Long-answer – type questions)

Note: Section 'A' contains Five (05) long-answer-type questions of Ten (10) marks each. Learners are required to answer any Two (02) questions only.

(2×10=20)

P.T.O.

1. From a uniform sphere of radious a, a spherical sector of vertical angle 2α is removed. Show that the moment of inertia of the remainded of mass M about the axis of symmetry is

$$\frac{1}{5}Ma^2(1+\cos\alpha)(2-\cos\alpha).$$

2. 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 inclination to the vertical be α and β respectively, show that

$$\frac{3l}{a}=\frac{(4\tan\alpha-3\tan\beta)\sin\beta}{(\tan\beta-\tan\alpha)\sin\alpha}$$

3. A thin uniform rod has one end attached to a smooth hinge and is allowed to fall from a horizontal position. Show that the horizontal strain on the hinge is greatest when the rod is inclined at an angle of 45^0 to the vertical and that the vertical strain is then 11/8 times the weight of the rod.

P.T.O.

4. A uniform rod is held in a vertical position with one end resting upon a perfectly rough table and when released rotates about the end in contact with the table. Discuss the motion.
5. The kinetic energy of a rigid body, moving in any manner, is at any instant equal to the kinetic energy of the whole mass, supposed to be collected at its centre of inertia and moving with it, together with the kinetic energy of the whole mass relative to its centre of inertia.

SECTION – B

(Short – answer – type questions)

Note: Section 'B' contains Eight (08) short–answer type questions of Five(5) marks each. Learners are required to answer any Four (04) questions only. (4×5 = 20)

1. Find the moment of inertia of a right circular cylinder about its axis.

P.T.O.

2. State and prove D' Alembert's principle.

3. A solid homogeneous cone of height h and vertical angle 2α oscillates about a horizontal axis through its vertex. Show that the length of the simple equivalent pendulum is

$$\frac{1}{5} h (4 + \tan^2\alpha).$$

4. A heavy circular disc is revolving in a horizontal plane about the centre which is fixed. An insect of mass $1/n^{th}$ that of the disc walk from the centre along a radius and then flies away. Show that the final angular velocity is n/n+2 times the original angular velocity of the disc.

5. An equilateral triangular lamina is rotating in its plane with uniform angular velocity about an axis through one vertex. If this vertex is released and one of the other vertices fixed. Show that the new angular velocity is 1/5 of its former value.

P.T.O.

6. A particle Q moves on a smooth horizontal circular wire of radius, which is free to rotate about a vertical axis through a point O, distance c from the centre C. If the angle QCO = θ, Show that $a\ddot{\theta} + \acute{\omega}(a - c\cos\theta) = c\omega^2 \sin\theta$

Where ω is the angular velocity of the wire.

7. Find the time of oscillation of a compound pendulum, consisting of a rod of mass m and length a carrying at one end a sphere of mass m_1 and diameter 2b, the other end of the rod being fixed.

8. Obtain the direction cosines of a set of principal axes at O, one of the corner of the cube.
