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MT-505

Mechanics-I

MA/MSC Mathematics (MAMT/MSCMT)

1st Semester Examination, 2022 (Dec.)

Time : 2 Hours] **[Max. Marks : 35**

Note : This paper is of Thirty Five (35) 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 Nine and Half (9½) marks each. Learners are required to answer any Two (02) questions only. (2×9½=19)

1. To show that the motion of a body about its centre of inertia is the same as it would be if the centre of inertia were fixed and the same forces acted on the body.

2. Define Compound pendulum. To Show that the time of complete oscillation of compound pendulum is $2\pi\sqrt{\frac{k^2}{gh}}$, where k is the radius of gyration of the body a fixed axis and h is distance of the centre of inertia of the body from the fixed axis.

3. A uniform solid cylinder is placed with its axis horizontal on a plane, whose inclination to the horizon is α, 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. State and prove Principal of conservation of Angular Momentum.

5. To derive the Lagrange's equations of motion in generalized coordinates for a harmonic dynamical system under finite forces.

SECTION–B

(Short Answer Type Questions)

Note : Section 'B' contains Eight (08) short answer type questions of Four (04) marks each. Learners are required to answer any Four (04) questions only. (4×4=16)

1. A uniform Circular board, of mass M and radius a, is placed on a perfectly smooth horizontal plane and free to rotate about a vertical axis through its centre; a man of mass M', walks round the edge of the board whose upper surface is rough enough to privent his slipping : when he has walked completely round the board to his starting point, show that M' board has turned through an angle $\frac{M'}{M + 2M'} 4\pi$.

2. Prove that the K.E. of a rigid body, moving in any manner is at any instant equal to 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.

3. Define Integrals of Energy and Angular Momentum. Prove that, if a rectaengular parallelepiped (edges $2a$, $2a$, $2b$) rotates about its centre of gravity, its angular velocity about one principal axis is constant and about the other principal axes is periodic, the period being to the period about the first mentioned principal axis as $(b^2 + a^2)$: $(b^2 - a^2)$.

4. To deduce the Euler's Dynamical Equations of motion.

5. Show that in free motion of body with an axis of symmetry (C) about its C.G. If n denotes the spin about the axis C and $\varnothing$ denotes the Euler's third angle then $A\dot{\varnothing} = (\dot{A} - C)n$.

6. A circular board is placed on smooth horizontal plane, and a boy runs round the edge of it at a uniform rate, what is the motion of the board?

7. Define the following :

(a) Moment of Inertia.

(b) Principle of Conservation of Energy.

8. A uniform circular board, of mass M and radius *a*, is placed on a perfectly smooth horizontal plane and free to rotate about a vertical axis through its centre; a man of mass M', walks round the edge of the board whose upper surface is rough enough to privent his slipping: when he has walked completely round the board to his starting point, show that board has turned through an angle $\frac{M'}{M + 2M'} 4\pi$.