# Program : M.A./M.Sc. (Mathematics)
# M.A./M.Sc. (Previous) Question Bank-2015
# Paper Code:MT-05
## Section-A (Very Short Answer type Questions)

1).Define moment of Inertia. (p.2)

2).Define compound pendulum (p.43)

3).Define instantaneous axis of rotation. (p.145)

4).Define degree of freedom. (p.204)

5).What is principle of energy? (p.210)

6).Define steady motion of a Top. (p.242)

7).Define compressibility. (p.272)

8).Define unsteady fluid flow. (p.273)

9) Write moment of Inertia of a solid ellipsoid of mass M and length of axes 2a, 2b and 2c about the axis OX. (p.8)

10).Write formula for time period of simple pendulum of length l. (p.44)

11).What is the locus of invariable line? (p.156)

12).Write principle of conservation of Angular Momentum under Impulsive forces.(p.189)

13).In which system, all generalized co-ordinates are independent to each other? (p.204)

14).Define density. (p.271)

15).Define steady flow of fluid. (p.273)

16).What is Barotropic fluid flow? (p.274)

## (Section-B)

1).Find M.I. of a uniform rectangular lamina of mass M and sides of length 2a, and 2b

about a line through its centre and parallel to sides 2a,2b and perpendicular to its plane. (p.5)

2).Find the length of simple equivalent pendulum in case of circular disc when the axis is horizontal and a tangent to it. (p.49)

3).A body moves under no forces about a point O, the principal moments of inertia at O being 6A, 3A and A. Initially the angular velocity of the body has components $w_1$=n, $w_2$=0, $w_3$=3n about the principal axes. Show that at any later time

$W_2 = -\sqrt{5}n \tanh(\sqrt{5}nt)$ and ultimately the body rotates about mean axis. (p.158)

4).State and prove principle of conservation of angular momentum under finite forces. (p,181)

5).Two equal rods AB and BC, each of length l, smoothly jointed at B, are suspended from A and oscillates in a vertical plane through A. Show that the periods of normal oscillations are $\frac{2\pi}{n}$, where $n^2 = \left(3 \pm \frac{6}{\sqrt{7}}\right)\frac{g}{l}$. (p.219)

6).Find the stream lines and path lines of the particles of the velocity field:

$u = \frac{x}{1+t}, v = y$ and w=0 . (p.290)

7).Show that $\frac{x^2}{a^2}f(t) + \frac{y^2}{b^2}\phi(t) + \frac{z^2}{c^2}\psi(t) = 1$, where $f(t).\phi(t).\psi(t) = 1$ is a possible form of the boundary surface. (p.334)

8).In the case of the two-dimensional fluid motion produce by a source of strength m placed at a point S outside a rigid circular disc of radius a whose centre is O. Show that the velocity of slip o f the fluid in contact with the disc is greatest at the points where the line joining S to the ends diameter at right angles to OS cut the circle and prove that its magnitude at these points is $\frac{2m.OS}{(OS^2-a^2)}$.

(p.415)

9) Derive the equation of motion of translation. (p.13)

10).Find the change in kinetic energy due to action of impulse. (p.133)

11).If the earth be regarded as a solid of revolution, whose principal moments of inertia at its centre of gravity are A,A,C. Show that its axis of rotation describes a cone of very small angle about the axis of the figure in period $\frac{A}{C-A}$ siderial days. (p.175)

12).Show that when a body moves under the action of a system of conservative forces, the sun of its kinetic and potential energies is constant throughout the motion. (p.195)

13).When the axis of a symmetrical top is stationary and the spin is large and equal to n, a blow $J$ is applied perpendicular to the axis at a distance $d$ from the fixed point. Prove that the maximum angular deflection of the axis approximately $2\tan^{-1}\{\frac{Jd}{Cn}\}$ ,C being the moment of inertia of the top about its axis of symmetry.

(p.252)

14).The velocity field at a point in fluid is given as $\vec{q} = \frac{x}{y}\hat{\imath} + y\hat{\jmath} + 0.\hat{k}$ ,obtain path lines.

(p.288)

15).Derive the equation of continuity in vector form by Euler's method. (p.299)

16).Show that ellipsoid $\frac{x^2}{a^2k^2t^4} + kt^2\left(\frac{y^2}{b^2} + \frac{z^2}{c^2}\right) = 1$ is a possible form of the boundary surface of a liquid at time t.

**(Section-C)**

1).A solid homogenous cone of height h and vertical angle $2\alpha$ ,oscillates about a horizontal axis through its centre. Show that the length of the simple equivalent pendulum is

$\frac{h}{5}(4 + tan^2\alpha)$. (p.52)

2).Two equal cylinders each of mass m are bound together by an elastic string whose tension is T and roll with their axes horizontal down a rough plane of inclination α. Show that their acceleration is

$\frac{2}{3}g\sin\alpha\left[1-\frac{2\mu T}{mg\sin\alpha}\right]$, where μ is the coefficient of friction between the cylinders.

(p.98)

3).A uniform thin circular disc is set rotating with an angular velocity ω about an axis through the centre making an angle $i$ with the normal. Prove that the semi-vertical angle θ of the cone described by the axis of disc is given by $\tan\theta=\frac{1}{2}\tan i$ .

If ω be angular velocity, prove that above cone is described in period $\frac{2\pi}{\omega\sqrt{1+3cos^2 i}}$ .(p.173)

4).Determine the stream line if the velocity of an incompressible fluid at the point $(x,y,z)$ is given by $\left(\frac{3xz}{r^5},\frac{3yz}{r^5},\frac{3z^2-r^2}{r^5}\right)$, where $r^2=x^2+y^2+z^2$. (p.288)

5).Two unequal masses M and M' rest on two rough planes inclined at angles α and $\beta$ to the horizon, they are connected by a fine string passing over a small pulley of mass m and radius a, which is placed at the common vertex of two planes, show that the acceleration of either mass is $g[M(\sin\alpha-\mu\cos\alpha)-M'(\sin\beta+\mu'\cos\beta)]\div\left[M+M'+m\frac{k^2}{a^2}\right]$, where μ and μ' are the coefficients of friction of two planes, k is the radius of gyration of the pulley about its axis and mass M moves downwards.

(p.33)

6).A rigid body, symmetrical about an axis, so that B=A, is supported at its centre of gravity which is fixed and only forces that have moments about the C.G. are equivalent to a retarding frictional couple, proportional to the angular velocity and acting in a plane at right angles to the instantaneous axis. Assuming C>A, prove that equations of motion can be integrated in the form $\omega_1=\alpha e^{-C\lambda t/A}\sin\left(\frac{\sigma}{\lambda}e^{-\lambda t}+\epsilon\right)$, $\omega_2=\alpha e^{-C\lambda t/A}\cos\left(\frac{\sigma}{\lambda}e^{-\lambda t}+\epsilon\right)$, $\omega_1=ne^{-\lambda t}$

where n, $\alpha,\sigma$ are constants, $\sigma=\frac{n(C-A)}{A}$ and $\lambda$ is a constant defined by a constant couple.

(p.145)

7).If initially the axis of the top is horizontal and it is set spinning with angular velocity ω in a horizontal plane prove that the axis will start to rise if nCω >mgh and that ,when nCω =2mgh, the axis will rise to an angular distance $\cos^{-1}\frac{A\omega}{nC}$, provided that Aω<nC and will there be at instantaneous rest. A, C and n have their usual meanings. (p.248)

8).Show that if the velocity potential of an irrotational fluid motion is equal to $A(x^2+y^2+z^2)^{-3/2}z\tan^{-1}\left(\frac{y}{x}\right)$, the lines of flow will be on the series of the surface $(x^2+y^2+z^2)=C^{2/3}(x^2+y^2)^{2/3}$ (P.311)