UG — Math (D – 604) B
(Mech.)

2020

Time : 2 hours

Full Marks : 80

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

*Answer any **three** questions in which Q. No. 1 is compulsory.*

1. Answer **all** questions of the following : 2×10 = 20

(a) Write the expression for angle which resultant of forces along axes makes with the x-axis.

(b) If the forces P_1, P_2, P_3, P_4, P_5 and P_6 act along the sides of a regular hexagon taken in order, draw the figure.

(c) Prove that for a common catenary $y^2 = c^2 + s^2$ (in usual notations).

(d) Prove that $y = c \sec \psi$ for the common catenary.

(e) Define equilibrium.

(f) Define the angular velocity of a particle.

(g) Write the equation of motion of a particle whose acceleration varies as the distance from a fixed point and away from the fixed point.

(h) Explain Hook's Law.

(i) Prove that central orbit is a plane curve.

(j) Write the expresion of a complete oscillation of a particle in SHM.

(a) Find the equation of the resultant of a system of forces acting at different points of a rigid body. 15

(b) A light rigid wire in the form of an arc of a circle subtending an angle α at its centre and having two weights P and Q at its extremities, rest with the concavity downwards upon a horizontal table. Show that, if θ be the

inclination to the vertical of the radius to the end at which P is suspended, then

$$\tan\theta = \frac{Q\sin\alpha}{P + Q\cos\alpha}$$ 15

3. (a) Principle of virtual work for a system of coplanar forces acting at different points of a rigid body. 15

(b) Five weightless rods of equal length are joined together so as to form a rhombus ABCD with one diagonal BD. If a weight W is attached to C and the system be suspended from A, show that there is a thrust in BD equal to $W/\sqrt{3}$. 15

4. (a) Find the intrinsic equation of a common catenary. 15

(b) A heavy string hangs over two smooth pegs. The two ends of the string are free and the central portion hangs in a catenary. If the two pegs are on the same level and distance 2a

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apart, show that equilibrium of the string is impossible unless the length of the string is at least 2ae. 15

5. (a) Find the equation of the null plane of a point. 15

(b) Find the null point of the plane x + y + z = 0, for the forces (X, Y, Z, L, M, N). 15

6 (a) Find the Tangential and Normal Velocities Components. 15

(b) A particle describes an equiangular spiral $r = a\,e^{m\theta}$ with a constant velocity. Find the components of velocity and acceleration along the radius vector and perpendicular to it. 15

7. (a) Prove that the work done in stretching an elastic string is equal to the extension produced multiplied by the mean of the initial and final tension. 15

(b) A particle starts with a given velocity V and moves under a retardation equal to k times

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the space described Show that the distance traversed before it comes to rest is $\frac{V}{\sqrt{k}}$. 15

6. (a) Find the equation of central orbit in pedal form. 15

(b) A particle moves in an ellipse under a force which is always directed towards its focus Find the law of force and the velocity at any point of the path 15