2022

Time : 3 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 **four** *questions in which Q. No. 1 is compulsory.*

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

(a) Define Resultant and its components.

(b) State Triangle law of forces.

(c) Forces are called concurrent when their lines of action meet in :

(i) One point

(ii) Two points

(iii) Plane

(iv) Perpendicular planes

(d) Write the equation of virtual work.

(e) State principle of virtual work.

(f) The cartesian equation of a catenary contains :

(i) S and C

(ii) x, y, and c

(iii) x and y

(iv) None of these

(g) Define S. H. M. . Write down its periodic time and frequency.

(h) Define Simple Pendulum ?

(i) Define Central Orbit and Central Force.

(j) Define inverse square law.

2. (a) Find the resultant of a system of coplanar forces acting on a rigid body. 10

(b) Three forces P, Q, R act along the sides of the triangle formed by the lines x + y = 1, y – x = 1 and y = 2. Find the equation of the line of action of the resultant. 10

3. (a) State and prove the converse of the principle of virtual work. 10

(b) The middle point of the opposite side of a jointed quadrilateral are connected by light rods of lengths ℓ and ℓ'. If T and T′ be the tensions is these rods. Prove that

$$\frac{T}{\ell}+\frac{T'}{\ell'} = 0.$$ 10

4. (a) Find the intrinsic equation of the catenary. 10

(b) If T be tension at any point P of a catenary and T_0 that of the lowest point C, prove that $T^2 - T_0^2 = W^2$, W being the weight of the arc CP of the catenary. 10

5. (a) Find the equation of the central axis of any given system of forces. 10

(b) Two forces P and Q acts along the lines $y = 0, z = 0$ and $x = 0, z = a$ respectively. As the forces vary, show that the surface generated by the axis of their equivalent wrench is $(x^2 + y^2) z = ay^2$. 10

6. A particle starts from rest a distance 'a' from a fixed point O on a straight line, and moves with an acceleration which is directed towards O and varies as the distance from O. Investigate the motion and prove that the motion is oscillatory about O. 20

7. (a) Define Hook's law and prove that the work done against the tension in stretching a light elastic string is equal to the product of its extension and the mean of the initial and final tensions. 10

(b) Find the work done in extending an elastic light string to double its natural length. 10

8. (a) Find the differential equation of a central orbit in Pedal form. 10

(b) Find the law of force towards the pole under which the following curves are described :

(i) $r^n \cos n\theta = a^n$

(ii) $r^2 = a^2 \cos 2\theta$ 10

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