

is compulsory.

The figures in the right-hand margin indicate marks.

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

A. Choose the correct answer of the following questions : 2×10

(a) The necessary and sufficient conditions that a system of coplanar forces be in equilibrium if

(i) $X \neq 0, Y = 0, G = 0$

~~(ii)~~ $X = 0, Y \neq 0, G = 0$

(iii) $X = 0, Y = 0, G \neq 0$

(iv) $X = 0, Y \neq 0, G \neq 0$

(Turn Over)

(b) If the equation of a st. line is

$$x \cos \alpha + y \sin \alpha = p.$$

then the equation of line of action of single resultant is

(i) $xY + yX = G$

(ii) $xY - yX = G$

(iii) $xY - yX = 0$

(iv) $xY + yX = 0$

(c) If a heavy body rests on a fixed body, the equilibrium is stable if

(i) $\frac{1}{h} < \frac{1}{R} + \frac{1}{r}$

(ii) $\frac{1}{h} > \frac{1}{R} + \frac{1}{r}$

(iii) $\frac{1}{h} = \frac{1}{R} - \frac{1}{r}$

(iv) $\frac{1}{h} = \frac{1}{R} + \frac{1}{r}$

(3)

(d) The pitch of the wrench is

(i) $K + R$

(ii) $\frac{K}{2R}$

(iii) $\frac{K}{R}$

(iv) $\frac{R}{K}$

(e) The equation of common catenary in cartesian co-ordinates is

(i) $y = c \sinh\left(\frac{x}{c}\right)$

(ii) $y = c \tan \psi$

(iii) $y = c \cosh\left(\frac{x}{c}\right)$

(iv) $y = c \tanh\left(\frac{x}{c}\right)$

(4)

(f) The frequency of S.H.M. $\frac{\theta^2}{\alpha} = -\omega^2$ is

(i) $\frac{2}{T^2}$

(ii) $\frac{1}{T^2}$

(iii) $\frac{1}{T}$

(iv) $\frac{T}{2}$

where T is the periodic time.

(g) Radial acceleration of a moving particle in polar co-ordinates is

(i) $\frac{dr}{dt} - r\left(\frac{d\theta}{dt}\right)^2$

(ii) $\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2$

(iii) $\frac{d^2r}{dt^2} - r^2\left(\frac{d\theta}{dt}\right)^2$

(iv) $\frac{dr}{dt} + r\left(\frac{d\theta}{dt}\right)^2$

(5)

- (h) Differential equation of central orbit in pedal form is

$$(i) \quad P = \frac{h^2}{p} \cdot \frac{d\phi}{dr}$$

$$(ii) \quad P = \frac{h^2}{p} \cdot \frac{d\phi}{dr}$$

$$(iii) \quad P = \frac{h^2}{p^2} \cdot \frac{d\phi}{dr}$$

$$(iv) \quad P = \frac{h}{p} \cdot \frac{d\phi}{dr}$$

- (i) If a particle moves in a path so that its acceleration is always directed to a fixed point and equal to $\frac{\mu}{(\text{distance})^2}$. Then for elliptic orbit

$$(i) \quad V^2 = \mu \left(\frac{2}{r} + \frac{1}{a} \right)$$

(6)

$$(II) \quad V^2 = \mu \left(\frac{2}{r} - \frac{1}{a} \right)$$

$$(III) \quad V^2 = \mu \left(\frac{1}{r} - \frac{1}{a} \right)$$

$$(IV) \quad V^2 = \mu \left(\frac{1}{r} + \frac{1}{a} \right)$$

- (j) If M and m be the masses of the sun and the planet respectively and d be the distance between the sun and the planet. Then acceleration of the planet relative to the sun is

$$(i) \quad \frac{Y(M+m)}{d}$$

$$(ii) \quad \frac{Y(M-m)}{d}$$

$$(iii) \quad \frac{Y(M+m)}{d^2}$$

$$(iv) \quad \frac{Y(M^2 - m^2)}{d^2}$$

where Y is any constant.

(7)

(a) Answer all questions :

2 × 5

- (i) State converse of the principle of virtual work.
- (ii) Define Poinsot's central Axis.
- (iii) Define Catenary.
- (iv) Define Screw.
- (v) Define Null line and Null plane.

(b) Answer both questions :

5 × 2

- (i) Find the relation between x and ψ of a common catenary.
- (ii) A hemisphere rests in equilibrium on a sphere of equal radius. Show that the equilibrium is stable or unstable according to the flat and curved surface of hemisphere is in contact.

3. (a) Answer all questions :

2 × 5

(i) Define simple Harmonic motion.

(ii) Define Hooke's law for elastic string.

(iii) Define central orbit

(iv) Define Apse.

(v) State Kepler's third law.

(b) Answer both questions :

5 × 2

- (i) A point moves in a plane curve so that its tangential and normal accelerations are equal and the tangent rotates with constant angular velocity. Find the path.
- (ii) Find the law of force towards the pole under which the curve $r(1 + \cos 2\theta) = 2a$ can be described.

(a) If a system of coplanar forces acting upon a rigid body, keep the body in equilibrium and the body is given a small virtual displacement, consistent with geometrical conditions of the system, then prove that the algebraic sum of virtual work done of the forces is zero.

10

(b) A uniform beam of length $2a$ rests against a smooth vertical plane over a smooth peg at a distance b from the plane. If θ be the inclination of the beam to the vertical. Show that

$$\sin^3 \theta = \frac{b}{a}.$$

10

(9)

5. (a) Find the intrinsic equation of common catenary.

10

(b) Find the equation of central axis of any given system of forces.

10

6. (a) If equal forces act along the co-ordinates axes and the line

$$\frac{x-\alpha}{l} = \frac{y-\beta}{m} = \frac{z-\gamma}{n}.$$

Find the resultant wrench and the equation of the central axis.

10

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

10

7. (a) Prove that the period of simple Harmonic motion is independent of amplitude.

10

(b) 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 its initial and final tension.

10