2026

MATHEMATICS

(Major)

Paper : MAT4200304MJ

(Mechanics)

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions.

1) **Answer the following questions :** **1×8=8**

a) State the converse of the triangle of forces.

b) Can moment of a couple be zero? Give the reason.

c) Find the frequency of a simple harmonic motion.

d) State Varignon's theorem.

e) State Newton's second law of motion.

f) What is the S.I. unit of energy and power?

g) Let the forces P and Q with given magnitude acting at a point at an angle α. Find the cosine of the angle when resultant is greatest.

h) Define moment of a force about a point.

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2) **Answer the following questions (any six) :** **2×6=12**

a) State Parallelogram of forces.

b) State the modification of the triangle of forces.

c) If the resultant of two forces acting on a particle be at right angle and its magnitude be one-third of the magnitude of the other, then show that the ratio of the larger force to the smaller force is $3 : 2\sqrt{2}$.

d) Prove that the algebraic sum of the moments of the forces forming a couple about any point in their plane is a non-zero constant and equal to the moment of the couple.

e) Two men have to carry a block of stone of weight 70 kg on a light plank. How must the block be placed so that one of the men should bear the weight 10 kg more than the other?

f) Define simple harmonic motion.

g) The law of motion in a straight line being $s = \frac{vt}{2}$. Prove that the acceleration is constant.

h) An impulse I changes the velocity of a particle of mass m from v_1 to v_2. Show that the kinetic energy gained is $\frac{1}{2}I(v_1 + v_2)$.

i) Define coefficient and angle of friction.

j) State equilibrium of three coplanar forces.

3) Answer the following questions (any four) : **5×4=20**

a) Prove that the algebraic sum of the resolved parts of any two forces acting at a point, along any direction, is equal to the resolved part of their resultant, in the same direction.

b) A body of mass 1 kg is suspended by two strings, 7 and 24 cm long, their other ends being fastened to the extremities of a rod of length 25 cm. If the rod be so held that the body hangs immediately below its middle point, then find the tensions of the strings.

c) State and prove polygon of forces.

d) What is friction? State the laws of Statical friction and the law of Dynamical friction.

e) The velocity of a particle along perpendicular to the radius vectors are λr and $\mu\theta$. Find the path and show that the acceleration along a perpendicular to the radius vector are $(\lambda^2 r - \frac{\mu^2\theta^2}{r})$ and $(\lambda + \frac{\mu}{r})\mu\theta$

f) A shot of mass is fixed from a gun of mass M with a velocity u relative to the gun. Find the actual velocity of the shot of gun just after firing.

A bullet of mass m moving with velocity u strikes the mass M which in force to move in the direction of motion of the bullet and embedded in it. Show that a portion $\frac{M}{M+m}$ of the kinetic energy is lost.

h) A narrow uniform plank 6 m long weighing 50 kg is supported in a horizontal position on two posts, one 1.5 m from one end and the other 2.5 m from the other end of the plank. A boy weighing 30 kg walks on it starting from the latter post towards the corresponding end. Find how far it is safe for him to walk. What are the reactions of the posts when he is farthest from the starting point without upsetting the plank?

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4) Answer the following questions (any two) : **10×2=20**

a) i. Find the CG of a uniform arc of a quadrant of the circle $x^2 + y^2 = a^2$ in the positive quadrant.

ii. Find the CG of an arc of a quadrant of the asteroid $x = a\cos^3\phi$, $y = a\sin^3\phi$ in the first quadrant.

b) Derive the resultant of two unlike(unequal) parallel forces.

c) Derive the radial and transverse of components of velocity and acceleration.

d) Show that for a single particle in a conservative field of force the sum of the kinetic and potential energies is constant.

e) State and prove Lami's theorem.

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