LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **MATHEMATICS**

SIXTH SEMESTER – **JULY 2025**

UMT 6503 – MECHANICS

Date: 11-07-2025 Dept. No. Max. : 100 Marks

Time: 10:00 AM - 01:00 PM

	SECTION A - K1 (CO1)	
	Answer ALL the Questions -	**(10 x 1 = 10)**
1.	**Answer the following**	
a)	State Triangle law of forces.	
b)	What do we mean by the moment of a force about a point?	
c)	Write Newton's second law of motion.	
d)	Define the angle of projection.	
e)	State Routh's rule.	
2.	**Fill in the blanks**	
a)	When a number of forces act on a body and keep it at rest, the forces are said to be in …….	
b)	The algebraic sum of the moments of any number of coplanar forces about any point on the line of action of their resultant is ……	
c)	The weight of a mass of 1 gram is equal to ……. Dynes	
d)	……. is the path which the particle describes.	
e)	The moment of inertia of a thin uniform rod of length 2a is ……	
	SECTION A - K2 (CO1)	
	Answer ALL the Questions	**(10 x 1 = 10)**
3.	**MCQ**	
a)	The resolved part of a force F in its own direction is (i) F (ii) $-F$ (iii) 0 (iv) vanished	
b)	The magnitude of the resultant of two like parallel forces is (i) always 0 (ii) their difference (iii) their sum (iv) their product	
c)	The coefficient of friction μ is defined as (i) F. R (ii) F/R (iii) F − R (iv) R/F	
d)	If a projectile is thrown with the velocity u, then the maximum horizontal range reached by it is (i) u^2/g (ii) 2u/g (iii) g^2u (iv) gu^2	
e)	When m is the mass of a particle and r is its perpendicular distance from a given line, the quantity mr^2 is called (i) centre of gravity (ii) centrifugal force (iii) an energy (iv) moment of inertia	
4.	**True or False**	
a)	The algebraic sum of the resolved parts of a number of forces in any direction is equal to the resolved part of the resultant in the opposite direction.	
b)	If two couples whose moments are equal and opposite, act in the same plane upon a rigid body, then they balance one another.	
c)	When the force acting on a particle is zero in a certain direction, the momentum in that direction will vary at every instant.	
d)	The direction of projection for maximum range bisects the angle between the vertical and the inclined plane.	
e)	The moment of inertia of a uniform circular ring of radius 'a' about its diameter is $3Ma^2/2$.	

SECTION B - K3 (CO2)	
Answer any TWO of the following	**(2 x 10 = 20)**
5.	State and prove Lami's theorem.
6.	ABC is an equilateral triangle of side a: D, E, F divide the sides BC, CA, AB respectively in the ratio 2: 1. Three forces each equal to P act at D, E, F perpendicularly to the sides and outward from the triangle. Prove that they are equivalent to a couple of moment $\frac{1}{2}Pa$.
7.	A mass of 20kg falls 500cm from rest and then penetrates to a depth of 50cm into the sand before coming to rest. Find the average thrust of the sand.
8.	A body is projected with a velocity of 98 metres per sec in a direction making an angle $\tan^{-1} 3$ with the horizon; show that it rises to a vertical height of 441 metres and that its time of flight is about 19 secs. Find also horizontal range through the point of projection ($g = 9.8\, metres/\sec^2$).
SECTION C – K4 (CO3)	
Answer any TWO of the following	**(2 x 10 = 20)**
9.	$ABCDEF$ is a regular hexagon and at A, act forces represented $\overline{AB}$, $2\overline{AC}$, $3\overline{AD}$, $4\overline{AE}$ and $5\overline{AF}$. Show that the magnitude of the resultant is AB. $\sqrt{351}$ and that it makes an angle $\tan^{-1}\left(\frac{7}{\sqrt{3}}\right)$ with AB.
10.	State and prove Varignon's theorem of moments.
11.	Two particles of masses m_1 and m_2 are connected by a light in extensible string passing over a light smooth fixed pulley. If $m_1 > m_2$, determine the resulting motion of the system and the tension in the string.
12.	If h and h' be the greatest heights in the two paths of a projectile with a given velocity for a given range R, prove that $R = 4\sqrt{hh'}$.
SECTION D – K5 (CO4)	
Answer any ONE of the following	**(1 x 20 = 20)**
13.	(a) Two beads of weights w and w' can slide on a smooth circular wire in a vertical plane. They are connected by a light string which subtends an angle 2β at the centre of the circle when the beads are in equilibrium on the upper half of the wire. Prove that the inclination of the string to the horizontal is given by $\tan\alpha = \frac{w\sim w'}{w+w'}\tan\beta$. (b) Two like parallel forces P and Q act on a rigid body at A and B respectively. If Q be changed to $\frac{P^2}{Q}$, show that the line of action of the resultant is the same as it would be if the forces were simply interchanged.
14.	(a) Two particles of masses m_1 and m_2 are connected by a light inextensible string passing over a light smooth pulley placed at the top of a smooth inclined plane of inclination α to the horizon; m_1 is hanging freely and m_2 is lying on the inclined plane, the portion of the string on the inclined plane being parallel to the inclined plane. If m_1 descends, find the resulting motion and the tension in the string. (b) State and prove the perpendicular axes theorem on moment of inertia.
SECTION E – K6 (CO5)	
Answer any ONE of the following	**(1 x 20 = 20)**
15.	(a) ABC is a given triangle. Forces P, Q, R acting along the lines OA, OB, OC are in equilibrium. If O is the circumcentre of the triangle, show that $P: Q: R = a^2(b^2 + c^2 - a^2): b^2(c^2 + a^2 - b^2): c^2(a^2 + b^2 - c^2)$. (b) Derive the resultant of two unlike and unequal parallel forces acting on a rigid body.
16.	(a) Show that the path of a projectile is a parabola. (b) Discuss and derive the moment of inertia of a uniform elliptic lamina about its axes.

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