LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIFTH SEMESTER – **NOVEMBER 2013**

MT 5506/MT 4501 - MECHANICS - I

Date: 07/11/2013 Dept. No. Max. : 100 Marks
Time: 9:00 - 12:00

PART – A

Answer ALL the questions. Each question carries equal marks: (10 x 2 = 20 marks)

1. What is the resolved part of a force $\vec{F}$.
   (i) along the direction of the force?
   (ii) Perpendicular to the direction of the force?
2. State converse of the triangle law of forces.
3. Define moment of a force.
4. Define a couple.
5. State Newton's third law of motion.
6. Define the angle of friction and cone of friction.
7. State the principle of conservation of momentum.
8. Define coefficient of restitution.
9. Define (i) trajectory (ii) horizontal range in the context of a projectile.
10. Define limiting velocity.

PART – B

Answer any FIVE questions. Each question carries equal marks: (5 x 8 = 40 marks)

11. State and prove Lam's theorem.
12. A uniform plane lamina in the form of a rhombus, one of whose angle is 120° is supported by two forces of magnitudes P and Q applied at the centre in the direction of the diagonals so that one side is horizontal. Show that if $P > Q$, $P^2 = ZQ^2$.
13. State and prove Varignon's theorem on moments.
14. Equal weights P and P are attached to two strings A C P and B C P passing over a smooth peg C. AB is a heavy beam of weight W whose centre of gravity is 'a' feet from A and 'b' feet from B. Show that AB is inclined to the horizon at the angle $\tan^{-1}\left\{\frac{a-b}{a+b}\tan\left(\sin^{-1}\frac{W}{2P}\right)\right\}$.
15. A heavy rod ACDB where AC = a and DB = b rests horizontally upon two smooth pegs C and D. If a load P is applied at A, it will just distribute the equilibrium. If CD = c, prove that the weight of the rod is $\frac{Pa+ab}{c}$.

16. Find the resultant of two like and unlike parallel forces.

17. A particle projected upwards under the action of gravity in a resisting medium where the resistance varies as the square of the velocity. Discuss the motion.

18. A particle is projected from a point in a smooth fixed horizontal plane with a velocity μ at an elevation α. Show that the particle ceases to rebound from the plane at the end of time $\left(2u\sin\alpha / g(1-e)\right)$ and that the total horizontal distance described in this period is $\left\{u^2 \sin 2\alpha / g(1-e)\right\}$.

PART – C

Answer any TWO questions. Each question carries equal marks: (2 x 20 = 40 marks)

19. a) The angle between two forces of magnitudes P + Q and P – Q is 2α and the resultant of forces makes and angle θ with the lisutor of the angle between the forces. Show that the P tan θ = Q tan α.

b) O is the circum centre of the Δ ABC. Forces of magnitudes P, Q and R acting respectively along $\overrightarrow{OA}, \overrightarrow{OB}$ and $\overrightarrow{OC}$ are in equilibrium. Prove that

$$\frac{P}{a^2\left(b^2+c^2-a^2\right)}=\frac{Q}{b^2\left(c^2+a^2-b^2\right)}=\frac{R}{c^2\left(a^2+b^2-c^2\right)}.$$ (10 +10)

20. a) Find the resultant of two like parallel forces P and Q and determine the position of the point of application.

b) A ladder which stands on a horizontal ground leaning against a vertical wall is so loaded that its centre of gravity is at the distance a and b lower and upper ends respectively. Show that if the ladder is in limiting equilibrium, its inclination θ to the horizontal is given by $\tan\theta=\frac{a-b\mu\mu^1}{(a+b)\mu}$, μ, μ^1 being the coefficient of friction between the ladder and the ground wall respectively. (12+8)

21. a) Derive the equation of the path of a projectile in Cartesian form.

b) A particle is projected in a vertical plane at an angle α to the horizontal from the foot of a plane whose inclination to the horizon in 45°. Show that the particle will strike the plane at right angles if $\tan\alpha = 3$. (10 + 10)

22. Two smooth spheres of masses m_1 and m_2 moving with velocities u_1 and u_2 impinge directly. Obtain (i) the motion after impact.
(ii) the impulse imparted to each sphere due to impact.
(iii) the change in K. E. due to impact. (20)

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