LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – MATHEMATICS

FIFTH SEMESTER – APRIL 2010

MT 5506/MT 4501 - MECHANICS - I

Date & Time: 27/04/2010 / 1:00 - 4:00 Dept. No. Max. : 100 Marks

PART – A

Answer ALL the questions. **(10 x 2 = 20 marks)**

1. Define coplanar and non-coplanar forces.
2. Define equilibrium of forces.
3. State the law of parallelogram of forces.
4. Define transtion motion and rotation.
5. Define moment or a torque.
6. Define angular velocity.
7. Define conservation of linear momentum.
8. Define angle of friction.
9. Define time of flight of a projectile and write down it's value.
10. Define oblique impact.

PART – B

Answer any FIVE questions **(5 x 8 = 40 marks)**

11. State and prove Lami's theorem.
12. A non uniform rod AD rests on two supports B and C at the same level where AB=BC=CD. If a weight p is hung from A or a weight q is hung from D, the rod just tilts. Show that the weight of the rod is p+q and that the centre of gravity of the rod divides AD in the ratio 2p+q: p+2q.
13. Three equal strings of no sensible weight are knotted together to form an equilateral triangle ABC and a weight W is suspended from A. If the triangle and the weight be supported with BC horizontal by means of two strings at B and C each at an angle 135^o with BC, show that the tension in BC is $\frac{W}{6}(3-\sqrt{3})$.
14. A ladder which stands on a horizontal ground leaning against a vertical wall is so loaded that its centre of gravity is at the distances 'a' and 'b' from the lower and upper ends respectively. Show that if the ladder is in limiting equilibrium, its inclination θ to the horizontal is given by $\tan\theta = \frac{a-b\mu\mu'}{(a+b)\mu}$ where μ and μ' are the coefficients of friction between the ladder and the ground and the wall respectively.
15. A particle is dropped from an aeroplane which is rising with acceleration f and 't' seconds after this, another stone is dropped. Prove that the distance between the stones at time 't'' after the second stone is dropped is $\frac{1}{2}(g+f)(t+2t')t.$
16. Show that when masses P and Q are connected by a string over the edge of a table, the tension is the same whether P hangs and Q is on the table or Q hangs and P is on the table.

17. If 't' be the time in which a projectile reaches a point P in its path and 't'' ; the time from P till it reaches the horizontal plane through the point of projection, show that the height of P above the horizontal plane is $\frac{1}{2}\partial tt'$.

18. A ball A impinges directly on an exactly equal and similar ball B lying on a smooth horizontal table. If e is the coefficient of restitution, prove that after impact, the velocity of B is to that of A as (1+e) : (1-e).

PART – C

Answer any TWO questions **(2 x 20 = 40 marks)**

19. a) State and prove Varignon's theorem on moments.

b) A system of forces in the plane of ΔABC is equivalent to a single force at A, acting along the internal bisector of the angle BAC and a couple of moment G. If the moments of the system about B and C are respectively G_2 and G_3, prove that (b+c) $G = bG_2 + cG_3$. (10+10)

20. a) One end of a uniform rod is attached to a hinge and the other end is supported by a string attached to the extremity of the rod. The rod and the string are inclined at the same angle θ to the horizontal. Show that the action at the hinge is $\frac{W}{4}\sqrt{9+\cot^2\theta}$.

b) Two rough particles connected by a light string rest on an inclined plane. If their weights and corresponding coefficients of friction are W_1, W_2 and μ_1, μ_2 respectively and $\mu_1 > \tan\alpha > \mu_2$, where α is the inclination of the plane with the horizon, prove that $\tan\alpha = \frac{\mu_1 W_1 + \mu_2 W_2}{W_1 + W_2}$, if both particles are on the point of moving down the plane. (10+10)

21. a) Two particles of masses m_1 and m_2 ($m_1 > m_2$) are connected by means of a light inextensible string passing over a light, smooth, fixed pulley. Discuss the motion.

b) A string passes over a fixed smooth pulley and to one end there is attached a mass m_1 and to the other a smooth light pulley over which passes another string with masses m_2 and m_3, at the ends. If the system is released form rest, show that m_1 will not move if $\frac{4}{m_1} = \frac{1}{m_2} + \frac{1}{m_3}$. (10+10)

22. a) Prove that the path of projectile is a parabola.

b) A,B,C are three small smooth spheres of masses m, 2m and m respectively, lying in a straight line on a smooth horizontal table. A is projected along the line ABC with velocity u. If the coefficient of restitution be 0.5 in each case, show that after B strikes C, the velocities of A,B,C are in the ratio 0:1:2 and that there are no further impacts. (10+10)

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