



**LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034**

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

**FIFTH SEMESTER – NOVEMBER 2016**

**MT 5506/MT 4501 – MECHANICS - I**

Date: 16-11-2016

Dept. No.

Max. : 100 Marks

Time: 09:00-12:00

**PART – A**

Answer ALL questions:

(10 x 2 = 20 marks)

1. State parallelogram law of forces.
2. What is the magnitude of and direction of the resultant of two forces  $\vec{P}$  and  $\vec{Q}$  when  $\vec{P}$  and  $\vec{Q}$  are perpendicular.
3. Define unlike parallel forces.
4. Define torque of a force.
5. State triangle law of velocities.
6. Define angular velocity and angular acceleration.
7. Define Newton's laws of motion.
8. State the principle of conservation of linear momentum.
9. Write down the velocity of projectile.
10. State Newton's experimental laws.

**PART – B**

Answer any FIVE questions:

(5 x 8 = 40 marks)

11. State and prove Lami's theorem.
12. A weight W hangs by a string and is drawn aside by a horizontal force until the string makes an angle  $60^\circ$  with the vertical. Find the horizontal force and the tension in the string.
13. Two unlike parallel forces P and Q ( $P > Q$ ) set at A and B respectively. Show that if the directions of P be reversed, the resultant is displaced through the distance  $\frac{2PQ}{P^2 - Q^2} AB$ .
14. State and prove Varignon's theorem on moments.
15. A and B describe concentric circles of radii a and b with speeds u and v, the motion being the same way round. If the angular velocity of either w.r.t the other is zero, prove that the line joining them subtends at the centre an angle whose cosine is  $\frac{au + bv}{av + bu}$ .
16. 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  $\frac{1}{2}(g + f)t(t + 2t')$ .
17. 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.
18. A particle is to be projected from a point P so as to pass through another point Q. Show that the product of the two times of flight from P to Q with a given velocity of projection is  $\frac{2}{g} PQ$ .

PART – C

Answer any TWO questions:

(2 x 20 = 40 marks)

19. a) Two weights P and Q are suspended from a fixed point O by strings OA and OB and are kept apart by a light rod AB. If the strings OA and OB make angles  $\alpha$  and  $\beta$  with the rod, show that the angle  $\theta$  which the rod makes with the vertical is given by  $\tan \theta = \frac{P + Q}{Q \cot \beta - P \tan \alpha}$ . (10)

b) A square board ABCD of side  $a$  is fixed in a vertical plane with two of its sides horizontal. A string of length  $\ell (> 4a)$  passes over four smooth pegs at the angular points of the board and through a ring at weight W which is below the lower horizontal side of the board. Prove that the tension in the string is  $\frac{W(\ell - 3a)}{2\sqrt{\ell^2 - 6a\ell + 8a^2}}$ . (10)

20. a) A straight rod PQ of length  $2a$  and weight  $W$  rests on smooth horizontal pegs R and S at the same level at a distance apart. If two weights  $P$  and  $Q$  are suspended from P and Q respectively, show that when the reactions at R and S are equal, the distance PR is given by  $\frac{a(1 + 3q - p)}{2(1 + q + p)}$ . (10)

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  $\mu_1, \mu_2$  respectively and  $\mu_1 > \tan \alpha > \mu_2$ , where  $\alpha$  is the inclination of the plane with the horizon, prove that  $\tan \alpha = \frac{\mu_1 W_1 + \mu_2 W_2}{W_1 + W_2}$ , of both particles are on the point of moving down the plane. (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. (10)

b) 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. (10)

22. a) Show that the greatest height which a particle with initial velocity  $u$  can reach on a vertical wall at a distance  $a$  from the point of projection is  $\frac{u^2}{2g} - \frac{a^2 g}{2u^2}$ . (10)

b) Two smooth spheres of masses  $m_1$  and  $m_2$ , moving with velocities  $\mu_1$  and  $\mu_2$  respectively in the direction of the line of centres, impinge directly. Discuss the motion. (10)

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