Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐

Question Paper Code : 10405

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Second Semester

Common to Civil, Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Rubber and Plastics Technology, Materials Science and Engineering, Manufacturing Engineering, Mechatronics Engineering, Industrial Engineering, Industrial and Management Engineering, Environmental Engineering, Geoinformatics, Mechanical and Automation Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology and Textile Chemistry

ME 2151 / 113201 / ME 25 / 10122 ME 205 / 080120002 / CE 1151 — ENGINEERING MECHANICS

(Regulation 2008)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   State Lame's Theorem.

2.   What is the difference between a resultant force and equilibrant force?

3.   What is meant by free-body diagram of a rigid body?

4.   Write the conditions of equilibrium of a system of parallel forces acting in a plane.

5.   Define radius of gyration with respect to x-axis of an area.

6.   State parallel axis theorem with simple sketch.

7.   A body moves along a straight line so that its displacement from a fixed point on the line is given by $s = 3t^2 + 2t$. Find the velocity and acceleration at the end of 3 seconds.

8.   A particle of mass 10 kg falls vertically from a height of 100 m from ground. What is the change in potential energy when it has reached a height of 50 m?

9.   When do we say that the motion of a body is impending?

10. How do, at any given instant, the velocity and acceleration of different points of a rigid body vary when it is undergoing translation?

11. (a) (i) The truck shown is to be towed using two ropes. Determine the magnitudes of forces F_A and F_B acting on each rope in order to develop a resultant force of 950 N directed along the positive X-axis. (8)
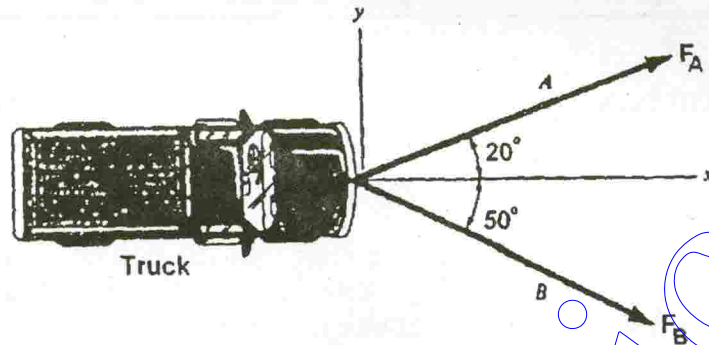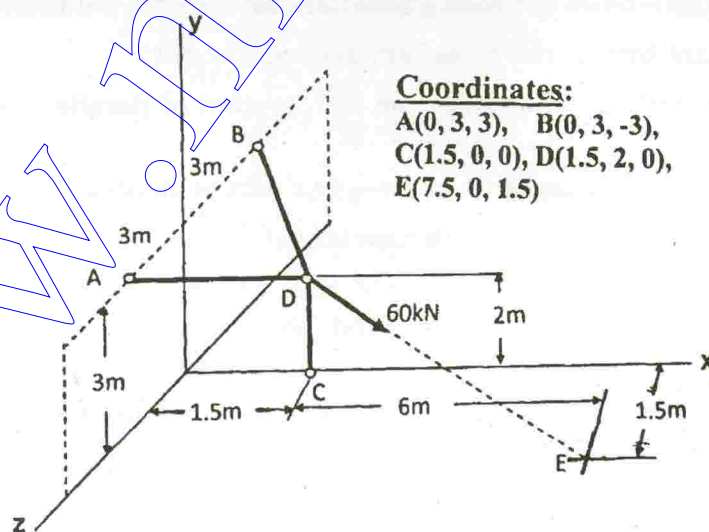

(ii) Determine the magnitude and angle θ of F so that particle P, shown in figure, is in equilibrium. (8)
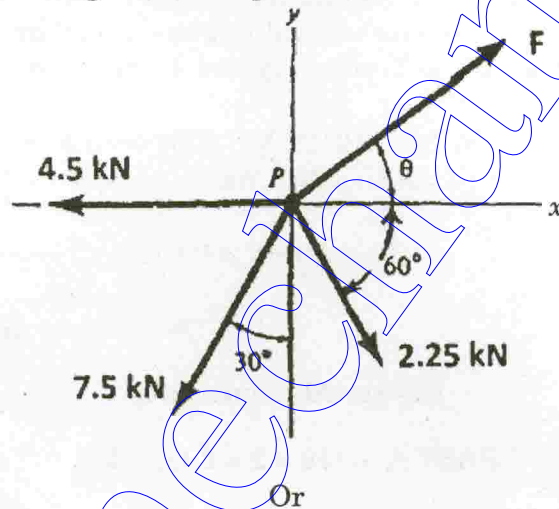

Or

(b) In the figure shown, three wires are joined at D.

Coordinates:
A(0, 3, 3), B(0, 3, -3),
C(1.5, 0, 0), D(1.5, 2, 0),
E(7.5, 0, 1.5)

Two ends A and B are on the wall and the other end C is on the ground. The wire CD is vertical. A force of 60 kN is applied at 'D' and it passes through a point E on the ground as shown in figure. Find the forces in all the three wires. (16)

12. (a) (i) A force $(10i + 20j - 5k)N$ acts at a point $P(4, 3, 2)$ m. Determine the moment of this force about the point $Q(2, 3, 4)$ m in vector form. Also find the magnitude of the moment and its angles with respect to x, y, z axes. (8)
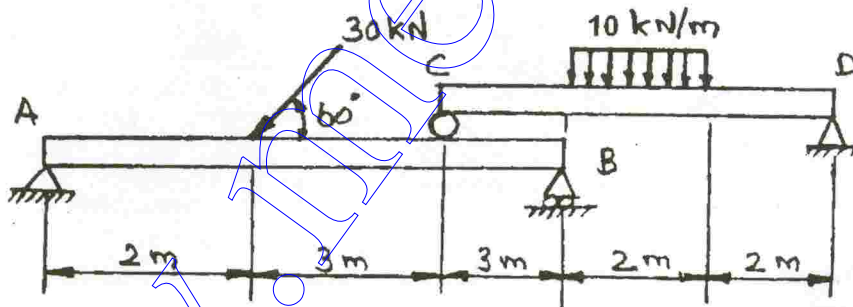
(ii) A plate $ABCD$ in the shape of a parallelogram is acted upon by two couples, as shown in the figure.
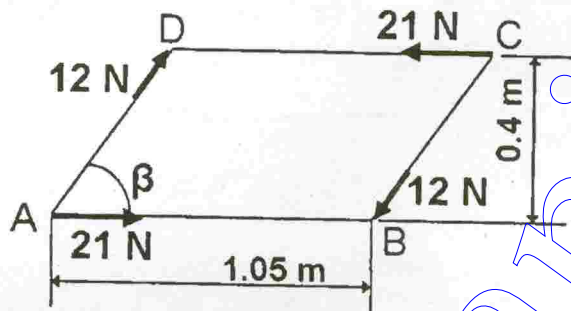
Determine the angle β if the resultant couple is 1.8 N.m clockwise. (8)

Or

(b) Two beams AB and CD are shown in figure. A and D are hinged supports. B and C are roller supports.

(i) Sketch the free body diagram of the beam AB and determine the reactions at the supports A and B. (9)

(ii) Sketch the free body diagram of the beam CD and determine the reactions at the supports C and D. (7)

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13. (a) (i) Derive, from first principles, the second moment of area of a circle about its diametral axis. (6)

(ii) For the section shown in figure below, locate the horizontal and vertical centroidal axes. (10)
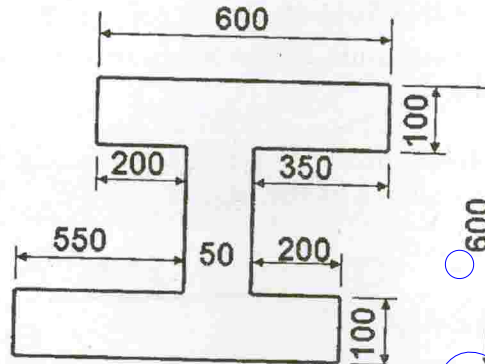
Or

(b) (i) Calculate the centroidal polar moment of inertia of a rectangular section with breadth of 100 mm and height of 200 mm. (4)

(ii) Find the moment of inertia of the shaded area shown in figure about the vertical and horizontal centroidal axes. The width of the hole is 200 mm. (12)
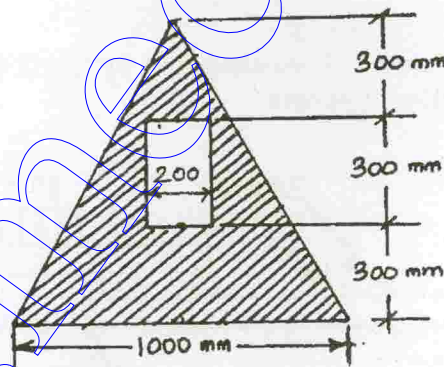
14. (a) A ball is projected with an initial velocity of u at an angle of α with the horizontal.

(i) Derive the expressions for x and y positions of the ball in terms of time t. Also derive the expressions for the time of flight, maximum height attained and horizontal range. (10)

(ii) If the initial velocity is 10 m/s and $\alpha = 45°$, find the time of flight, maximum height attained and horizontal range. (6)

Or

(b) A ball of mass 1 kg moving with a velocity of 6 m/s strikes another ball of mass 2 kg moving with a velocity of 2 m/s at the instant of impact the velocities of the two balls are parallel and inclined at 30° to the line joining their centers as shown in the figure.
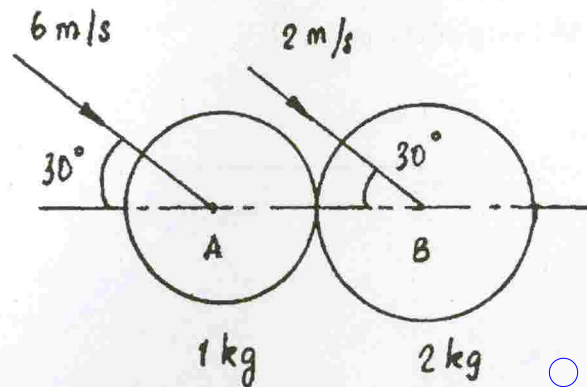

If the coefficient of restitution is 0.5, find the velocity and the direction of the two balls after impact. Also calculate the loss in kinetic energy due to impact and the percentage of loss. (16)

15. (a) (i) A block weighing 36 N is resting on a rough inclined plane having an inclination of 30°. A force of 12 N is applied at an angle of 10° up the plane and the block is just on the point of moving down the plane. Determine the coefficient of friction. (8)

(ii) A flat belt develops a tight side tension of 2000 N during power transmission; the coefficient of friction between pulley and belt is 0.3; the angle of lap on smaller pulley is 165° and the belt speed is 18 m/s. Determine the power that can be transmitted, if the belt is assumed to be perfectly elastic and without mass. (8)

Or

(b) (i) A rigid body is undergoing general plane motion. Write down the relationship of the velocities of two points *A* and *B* on it and explain. (6)

(ii) An automobile travels to the right at a constant speed of 72 km/h. The diameter of the wheel is 560 mm.
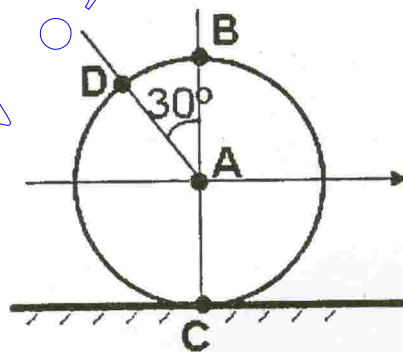
Determine the magnitude and direction of the following :

(1) Angular velocity of the wheel.   (2)

(2) Velocity of the point B.   (2)

(3) Velocity of the point C.   (2)

(4) Velocity of the point D.   (4)

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