**Code : ESC-205 (101304)**

**B.Tech 3rd Semester Special Exam., 2020**

**( New Course )**

ENGINEERING MECHANICS

*Time* : 3 hours          *Full Marks* : 70

*Instructions* :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are **NINE** questions in this paper.*

(iii) *Attempt **FIVE** questions in all.*

(iv) *Question No. **1** is compulsory.*

1. Choose the correct answer from the following (any *seven*) :          2×7=14

   (a) The moment axis, force and the perpendicular distance in the moment of the force calculation is lying in

      (i) two planes perpendicular to each other

      (ii) a single plane in the direction of the force

      (iii) a single plane in the direction of the perpendicular distance

      (iv) a single line in the direction of the force

   (b) If a force applied at any point in its line of action and is still creating the same moment about any fixed point say *P*, then the force is said to be

      (i) couple

      (ii) sliding vector

      (iii) slider couple

      (iv) couple slider

   (c) The resultant force acting in the couple is

      (i) zero

      (ii) infinite

      (iii) twice the magnitude of the single force

      (iv) half the magnitude of the single force

   (d) The net force of the body is zero that means the force are not being applied to the body at all and hence the body is in equilibrium.

      (i) The first part of the statement is false and other part is true

      (ii) The first part of the statement is false and other part is false too

      (iii) The first part of the statement is true and other part is false

      (iv) The first part of the statement is true and other part is true too

(e) A mass of 4 kg rests on a horizontal plane. The plane is gradually inclined until at an angle $\theta = 15°$ with the horizontal, the mass just begins to slide. What is the coefficient of static friction between the block and the surface?

(i) 0·814

(ii) 0·27

(iii) 1·5

(iv) 3·5

(f) To design the trusses which of the following rules is followed?

(i) All the loads are applied by the use of cables

(ii) The loads are applied at the joints

(iii) All the loads are not applied at the joints

(iv) The loads are not applied at all to the joints

(g) The centre of gravity is the ratio of

(i) the product of centroid and weight to the total weight

(ii) the addition of centroid and weight to the total weight

(iii) the subtraction of centroid and weight to the total weight

(iv) the product of centroid and weight to the total mass

(h) In the equation of virtual work which of the following forces is neglected?

(i) Reaction of any smooth surface with which the body is in contact

(ii) Reaction of a rough surface of a body which rolls on it without slipping

(iii) Reaction at a point or an axis, fixed in space, around which a body is constrained to turn

(iv) All of the above

(i) In elastic collisions

(i) only the total momentum of the colliding objects is conserved

(ii) only the total kinetic energy is conserved

(iii) both the momentum and total kinetic energy are conserved

(iv) neither momentum of the colliding bodies nor the total kinetic energy are recoverable

(j) D'Alembert's principle is used for

    (i) reducing the problem of kinetics to equivalent statics problem

    (ii) determining stresses in the truss

    (iii) stability of floating bodies

    (iv) designing safe structures

2. (a) Show that the algebraic sum of the resolved part of a number of forces in a given direction, is equal to the resolved part of their resultant in the same direction.   6

(b) The 30 N force $P$ is applied perpendicular to the portion $BC$ of the bent bar Fig. 1. Determine the moment of $P$ about point $B$ and about point $A$.   8
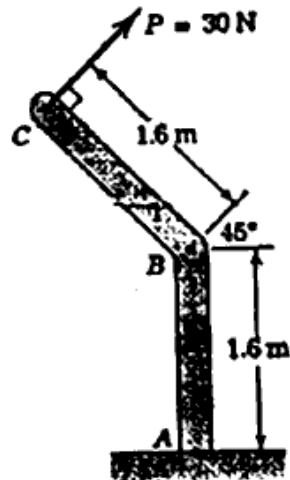


Fig. 1

3. (a) A string $ABCD$, attached to fixed points $A$ and $D$ has two equal weights of 1000 N attached to it at $B$ and $C$. The weights rest with the portions $AB$ and $CD$ inclined at angles as shown in Fig. 2. Find the tensions in the portions $AB$, $BC$ and $CD$ of the string, if the inclination of the portion $BC$ with the vertical is 120°.   6
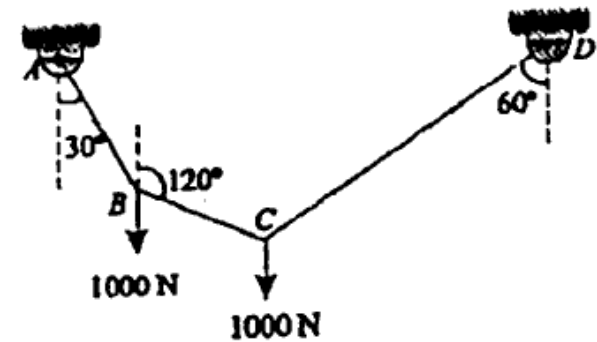


Fig. 2

(b) Enunciate any two principles of equilibrium.   3

(c) State and prove Lami's theorem.   5

4. (a) Define the terms 'centre of gravity'. How would you find out the centre of gravity of a section, with a cut out hole?   6

(b) Find the moment of inertia of the lamina with a circular hole of 30 mm diameter about the axis AB as shown in Fig. 3.  8
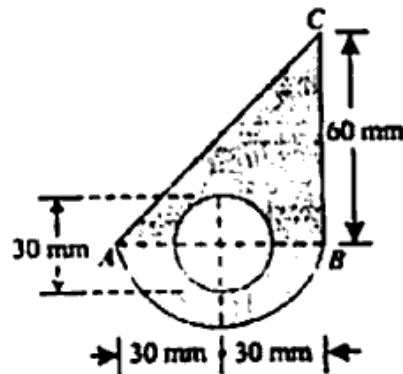


Fig. 3

5. (a) A load of 1·5 kN, resting on an inclined rough plane, can be moved up the plane by a force of 2 kN applied horizontally or by a force 1·25 kN applied parallel to the plane. Find the inclination of the plane and the coefficient of friction.  7

(b) What is the difference between angle of friction and angle of repose?  3

(c) A load of 2·5 kN is to be raised by a screw jack with mean diameter of 75 mm and pitch of 12 mm. Find the efficiency of the screw jack; if the coefficient of friction between the screw and nut is 0·075.  4

6. (a) A truss of 5 m span and 2·5 m height is subjected to wind load as shown in Fig. 4. Find the reactions at the two supports A and E.  9
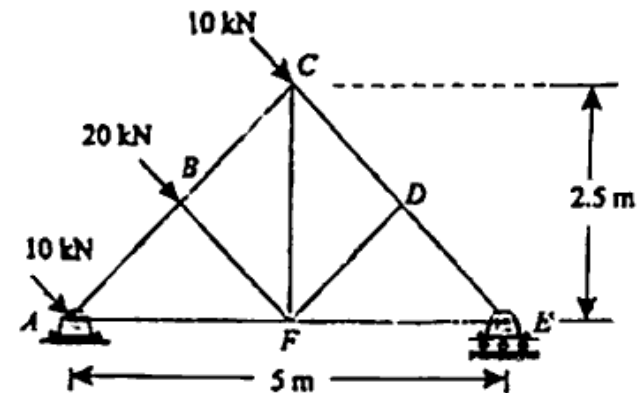


$15\sqrt{2}$    Fig. 4
$5\sqrt{2}$

(b) A simply supported beam AB of span 5 m is loaded as shown in Fig. 5. Find the reactions at A and B.  5



$R_A + R_B = 12$

$R_A \times 5 + 5 \times 4$    Fig. 5
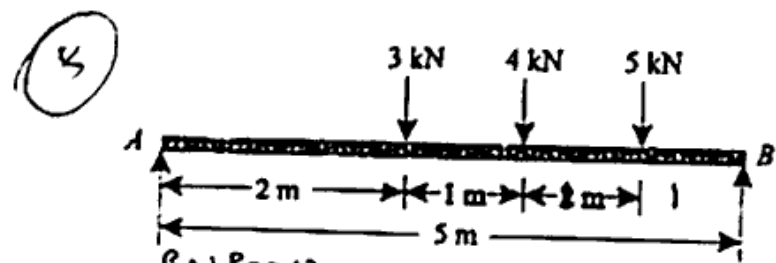$- 4 \times 3 - 3 \times 2 = 0$

$R_B - 20 - 12 - 6$    ( Continued )

**7.** (a) State the principle of virtual work. 3

(b) A simply supported beam *AB* of span 4 m is subjected to a point load of 10 kN at a distance of 1·5 m from *A*. Using the principle of virtual work, determine the reactions at the two supports. 6

(c) A stone is dropped from the top of a tower 50 m high. At the same time, another stone is thrown upwards from the foot of the tower with a velocity of 25 m/s. When and where the two stones cross each other? 5

**8.** (a) Explain the dynamic equilibrium of a rigid body in plane motion. 4

(b) Two bodies of masses 45 kg and 30 kg are hung to the ends of a rope, passing over a frictionless pulley. With what acceleration the heavier mass comes down? What is the tension in the string? 5

(c) A truck of mass 1·5 tonnes is running at a speed of 54 km per hour. Find its kinetic energy. If the resistance to the motion is 100 N, find how far the truck will run before it stops. 5

**9.** (a) What is meant by centre of oscillation? Describe its importance. 4

(b) A spiral spring hung up at one end, and carrying a mass of 7 kg at the other is made to vibrate. Find the period of oscillation, if the spring is found to extend 10 mm for each 0·5 kg of mass. 4

(c) What is a compound pendulum? Derive an expression for the time period of a compound pendulum. 6

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