

**Q. 1 – Q. 5 carry one mark each.**

Q.1 The chairman requested the aggrieved shareholders to \_\_\_\_\_ him.

- (A) bare with      (B) bore with      (C) bear with      (D) bare

Q.2 Identify the correct spelling out of the given options:

- (A) Managable      (B) Manageable      (C) Mangaable      (D) Managible

Q.3 Pick the odd one out in the following:

13, 23, 33, 43, 53

- (A) 23      (B) 33      (C) 43      (D) 53

Q.4 R2D2 is a robot. R2D2 can repair aeroplanes. No other robot can repair aeroplanes.

Which of the following can be logically inferred from the above statements?

- (A) R2D2 is a robot which can only repair aeroplanes.  
(B) R2D2 is the only robot which can repair aeroplanes.  
(C) R2D2 is a robot which can repair only aeroplanes.  
(D) Only R2D2 is a robot.

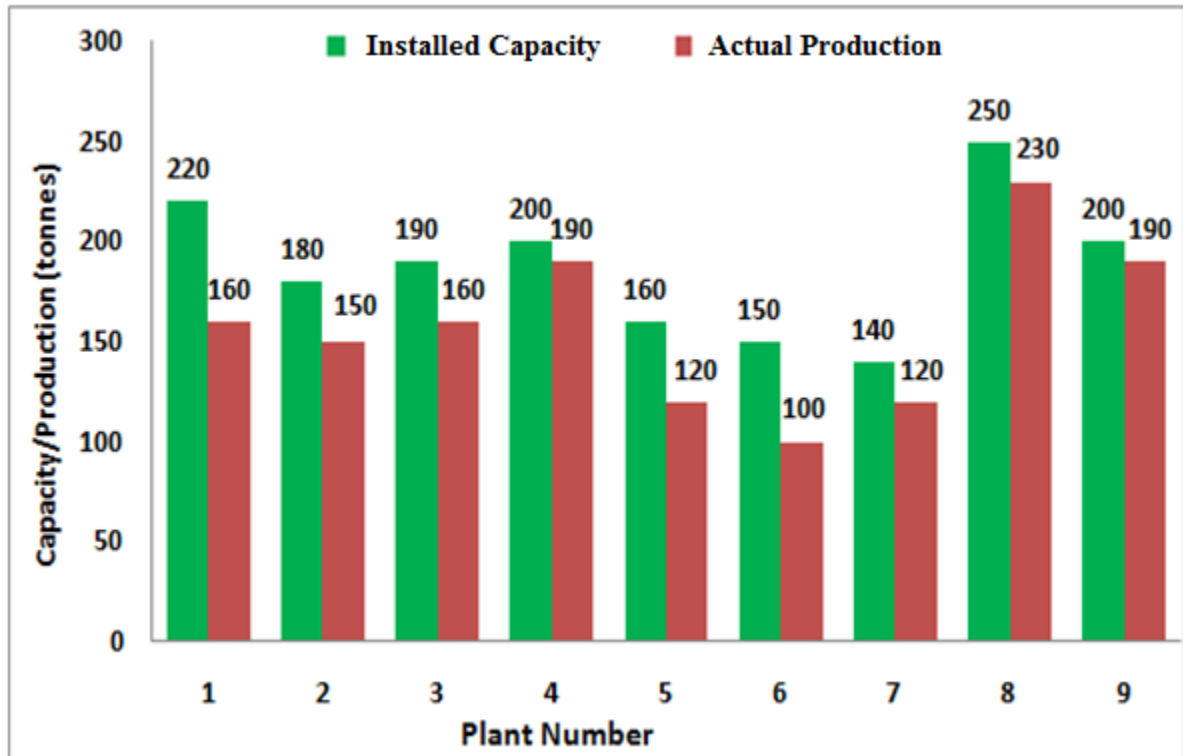
Q.5 If  $|9y-6|=3$ , then  $y^2 - 4y/3$  is \_\_\_\_\_.

- (A) 0      (B)  $+1/3$       (C)  $-1/3$       (D) undefined

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Q. 6 – Q. 10 carry two marks each.

- Q.6 The following graph represents the installed capacity for cement production (in tonnes) and the actual production (in tonnes) of nine cement plants of a cement company. Capacity utilization of a plant is defined as ratio of actual production of cement to installed capacity. A plant with installed capacity of at least 200 tonnes is called a large plant and a plant with lesser capacity is called a small plant. The difference between total production of large plants and small plants, in tonnes is \_\_\_\_\_.



- Q.7 A poll of students appearing for masters in engineering indicated that 60 % of the students believed that mechanical engineering is a profession unsuitable for women. A research study on women with masters or higher degrees in mechanical engineering found that 99 % of such women were successful in their professions.

Which of the following can be logically inferred from the above paragraph?

- (A) Many students have misconceptions regarding various engineering disciplines.
- (B) Men with advanced degrees in mechanical engineering believe women are well suited to be mechanical engineers.
- (C) Mechanical engineering is a profession well suited for women with masters or higher degrees in mechanical engineering.
- (D) The number of women pursuing higher degrees in mechanical engineering is small.

- Q.8 Sourya committee had proposed the establishment of Sourya Institutes of Technology (SITs) in line with Indian Institutes of Technology (IITs) to cater to the technological and industrial needs of a developing country.

Which of the following can be logically inferred from the above sentence?

Based on the proposal,

- (i) In the initial years, SIT students will get degrees from IIT.
- (ii) SITs will have a distinct national objective.
- (iii) SIT like institutions can only be established in consultation with IIT.
- (iv) SITs will serve technological needs of a developing country.

- (A) (iii) and (iv) only. (B) (i) and (iv) only.  
(C) (ii) and (iv) only. (D) (ii) and (iii) only.

- Q.9 Shaquille O' Neal is a 60% career free throw shooter, meaning that he successfully makes 60 free throws out of 100 attempts on average. What is the probability that he will successfully make exactly 6 free throws in 10 attempts?

- (A) 0.2508 (B) 0.2816 (C) 0.2934 (D) 0.6000

- Q.10 The numeral in the units position of  $211^{870} + 146^{127} \times 3^{424}$  is \_\_\_\_\_.

END OF THE QUESTION PAPER

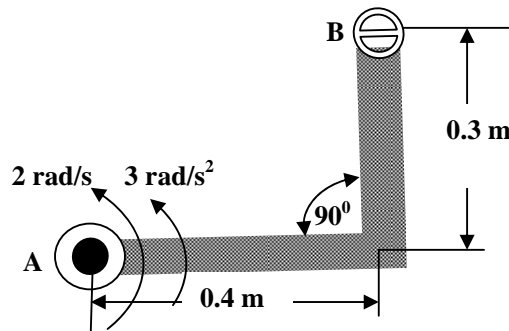
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**D : SOLID MECHANICS****Q. 1 – Q. 9 carry one mark each.**

Q.1 A single degree of freedom vibrating system has mass of 5 kg, stiffness of 500 N/m and damping coefficient of 100 N-s/m. To make the system critically damped

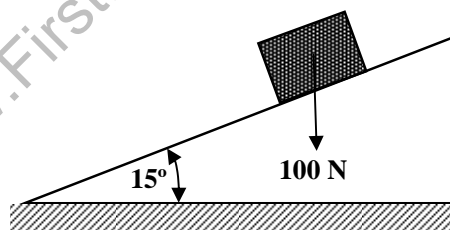
- (A) only the mass is to be increased by 1.2 times.
- (B) only the stiffness is to be reduced to half.
- (C) only the damping coefficient is to be doubled.
- (D) no change in any of the system parameters is required.

Q.2 A “L” shaped robotic arm AB is connected to a motor at end A and a magnetic gripper at B as shown in the figure. If the arm is rotating with an angular velocity of 2 rad/s and an angular acceleration of 3 rad/s<sup>2</sup>, the magnitude of the acceleration (in m/s<sup>2</sup>) of the end B is



- (A) 2.0
- (B) 2.5
- (C) 5.0
- (D) 6.0

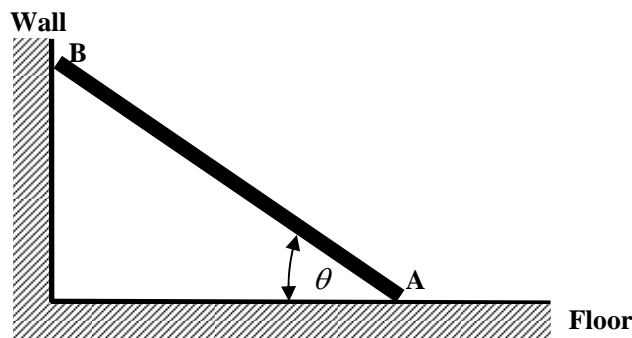
Q.3 A block of weight 100 N is in static equilibrium on an inclined plane which makes an angle 15° with the horizontal. The coefficient of friction between the inclined plane and the block is 0.3. The magnitude of friction force (in N) acting on the block is \_\_\_\_\_



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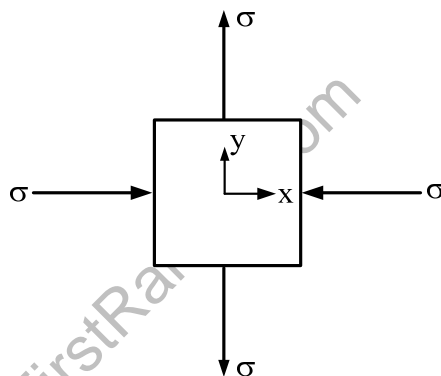
Solid Mechanics

- Q.4 The lower end A of the rigid bar AB is moving horizontally on the floor towards right with a constant velocity of 5 m/s and the point B is sliding down the wall. The magnitude of the velocity of point B at the instant  $\theta = 30^\circ$  is



- (A) zero (B) 4.34 m/s (C) 7.25 m/s (D) 8.66 m/s

- Q.5 The state of plane stress at a point in a body is shown in the figure. The allowable shear stress of the material of the body is 200 MPa. According to the maximum shear stress theory of failure the maximum permissible value of  $\sigma$  (in MPa) is \_\_\_\_\_



- Q.6 For a slender steel column of circular cross-section the critical buckling load is  $P_{cr}$ . If the diameter of the column is doubled (keeping other material and geometrical parameters same), then the critical buckling load of the column is

- (A)  $P_{cr}/16$  (B)  $8 P_{cr}$  (C)  $2 P_{cr}$  (D)  $16 P_{cr}$

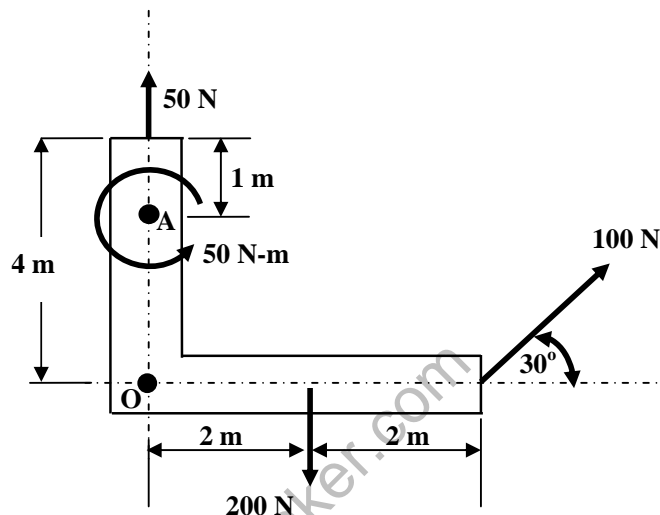
- Q.7 A closed thin cylindrical pressure vessel having an internal diameter of 1000 mm and a thickness of 10 mm is subjected to an internal pressure of 4 MPa. The maximum shear stress (in MPa) induced in the cylinder is \_\_\_\_\_ (neglect the radial stress).

- Q.8 A solid circular shaft subjected to pure torsion develops a maximum torsional shear stress of 120 MPa. Keeping the torsional moment same, if the diameter of the shaft is doubled then the maximum shear stress (in MPa) induced in the shaft is \_\_\_\_\_

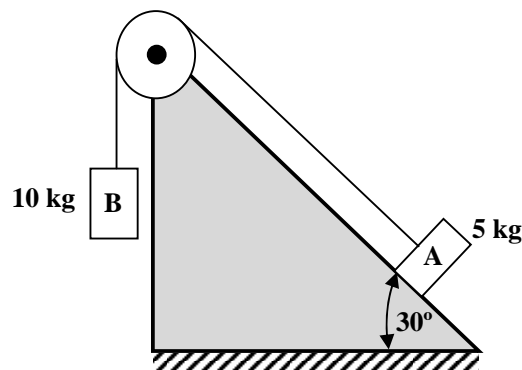
- Q.9 On a single straight track, a vehicle of mass 500 kg moving with a velocity of 25 m/s strikes another vehicle of mass 250 kg moving with a velocity 10 m/s in the same direction. After the impact, if both the vehicles stick together, the common velocity (in m/s) with which both the vehicles will move together is \_\_\_\_\_

**Q. 10 – Q. 22 carry two marks each.**

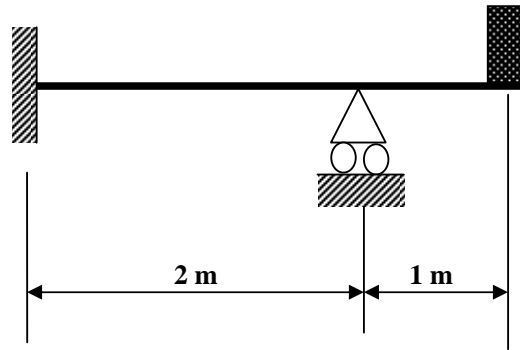
- Q.10 A system with three forces and a concentrated moment at A is shown in the figure. The system is replaced by an equivalent force system with a single force and a single couple at point 'O'. The magnitude (in N-m) of the equivalent couple at 'O' is \_\_\_\_\_



- Q.11 A block A on a smooth inclined plane is connected to block B as shown in the figure using an inextensible cord which pass over a mass-less and friction-less pulley. Initially, the block B is constrained to be at rest. If the constraint on block B is released, the magnitude of velocity (in m/s) of the block 'B' after 2 seconds from its release is \_\_\_\_\_ (assume  $g = 10 \text{ m/s}^2$ ).

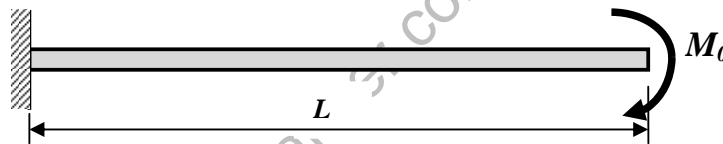


- Q.12 The vibrating system shown in the figure carries a mass of 10 kg at the free end, where the static deflection is 1 mm. This system is to be replaced by an equivalent vibrating spring mass system having equivalent mass of 2 kg (assume  $g = 10 \text{ m/s}^2$ ). The natural frequency (in rad/s) and the stiffness (in kN/m) of the equivalent system respectively are



- (A) 10 and 20 (B) 20 and 100 (C) 100 and 20 (D) 1000 and 20

- Q.13 A beam having flexural rigidity  $EI$  and length  $L$  is subjected to a concentrated end moment  $M_0$  as shown in the figure. For  $EI = 4 \times 10^3 \text{ N-m}^2$ ,  $L = 1 \text{ m}$  and  $M_0 = 8 \text{ kN-m}$ , the strain energy stored (in kN-m) in the beam and the rotation (in rad) at the free end respectively are

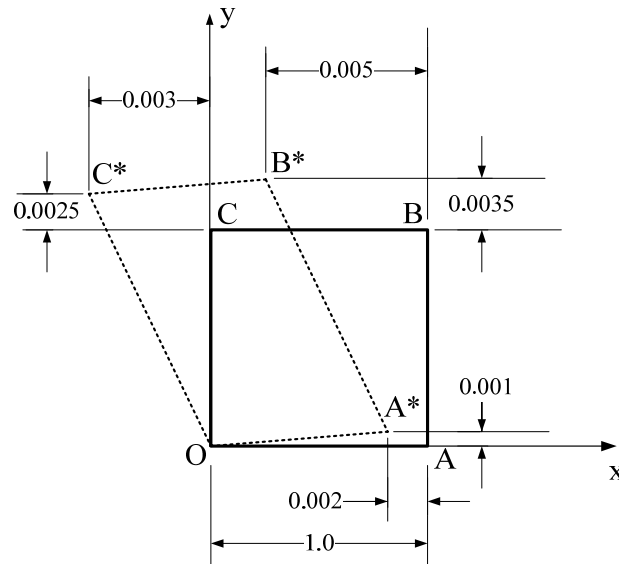


- (A) 8.00 and 0.02 (B) 8.00 and 2.00 (C) 8.00 and 0.04 (D) 0.80 and 2.00

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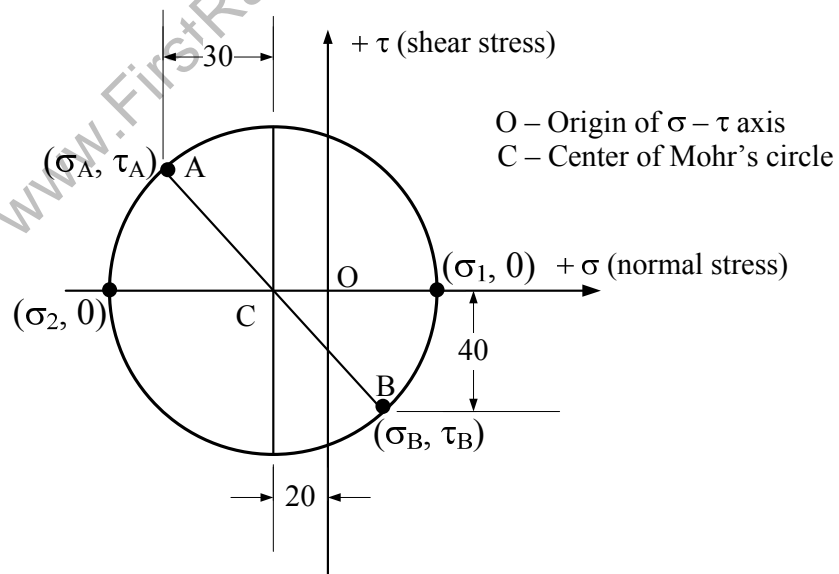
Solid Mechanics

- Q.14 At a point 'O' on a metal sheet a square OABC of a unit side length is drawn. The square undergoes a small uniform elastic deformation and deforms to OA\*B\*C\* (dashed lines) as shown in the figure. All dimensions are in mm and the figure is not to scale. The normal strains  $\epsilon_x$ ,  $\epsilon_y$  and shear strain  $\gamma_{xy}$  developed in the square respectively are



- (A)  $-0.0020$ ,  $0.0025$  and  $0.0020$  (B)  $0.0020$ ,  $-0.0025$  and  $-0.0020$   
(C)  $0.0025$ ,  $-0.0020$  and  $0.0020$  (D)  $-0.0020$ ,  $0.0025$  and  $-0.0020$

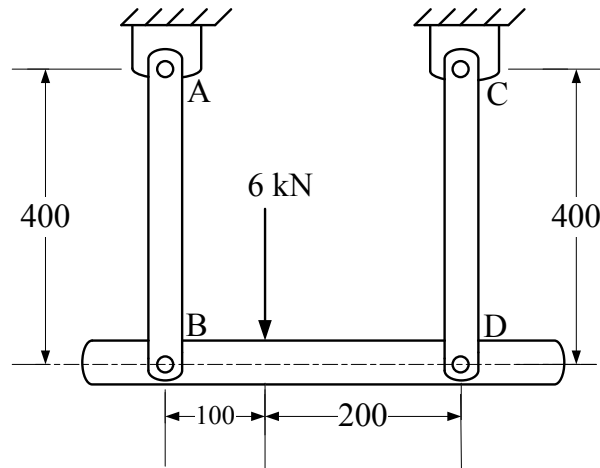
- Q.15 Mohr's circle for the state of plane stress at a point is shown in the figure. Unit of stress is MPa and the circle is drawn not to scale. Which one of the following options (stress values in MPa) is true?



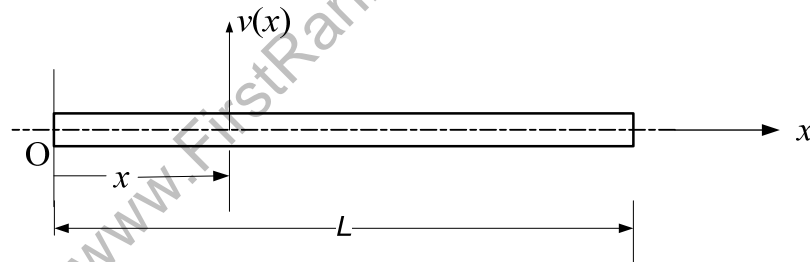
- (A)  $\sigma_A = -50$ ,  $\sigma_B = 10$ ,  $\sigma_1 = 30$ ,  $\sigma_2 = -70$  (B)  $\sigma_A = -50$ ,  $\sigma_B = 20$ ,  $\sigma_1 = 30$ ,  $\sigma_2 = -50$   
(C)  $\sigma_A = -30$ ,  $\sigma_B = 30$ ,  $\sigma_1 = 30$ ,  $\sigma_2 = -10$  (D)  $\sigma_A = -20$ ,  $\sigma_B = 10$ ,  $\sigma_1 = 50$ ,  $\sigma_2 = -30$



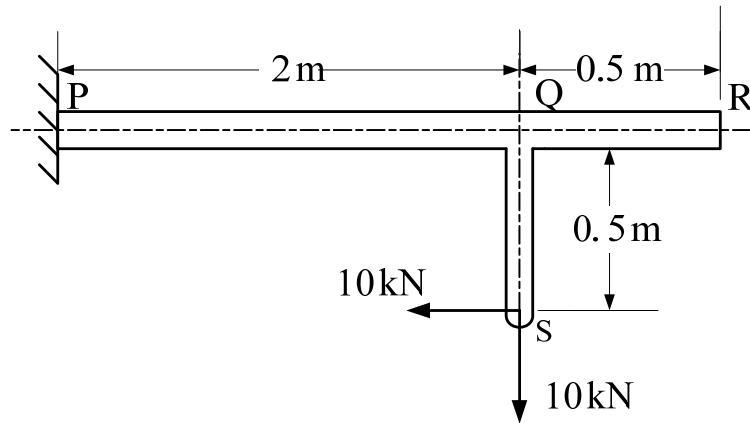
- Q.16 As shown in the figure, links AB and CD support the rigid member BD. Links AB and CD are made of aluminum alloy ( $E = 100 \text{ GPa}$ ) and each has a cross-sectional area of  $100 \text{ mm}^2$ . All the members are pin connected and all the dimensions are in mm. Neglecting the weights of the members, the elongation (in mm) of the link AB is \_\_\_\_\_



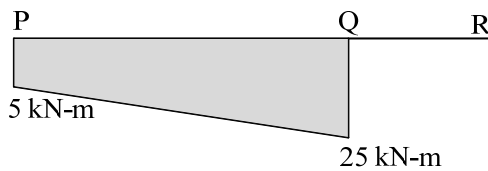
- Q.17 Figure shows an elastic beam of constant flexural rigidity  $EI$  and length  $L$ . The transverse deflection  $v(x)$  for the beam is represented by the equation  $v(x) = M_0(x^3 - x^2L)/(4EIL)$ , where  $M_0$  is the applied couple. If  $L = 100 \text{ mm}$  and  $M_0 = 100 \text{ N-mm}$ , then the magnitude of the shear force (in N) at the middle of the beam (at  $x = L/2$ ) is \_\_\_\_\_



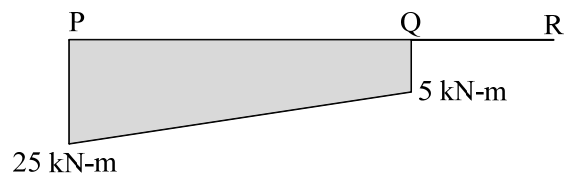
- Q.18 Which one of the following represents the correct bending moment diagram of the beam PQR loaded as shown in the figure?



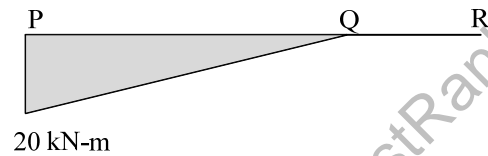
(A)



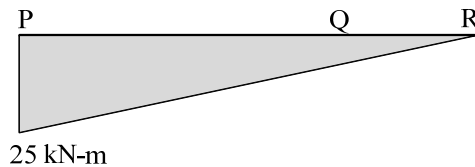
(B)



(C)



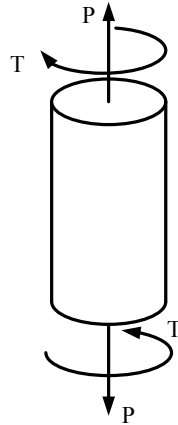
(D)



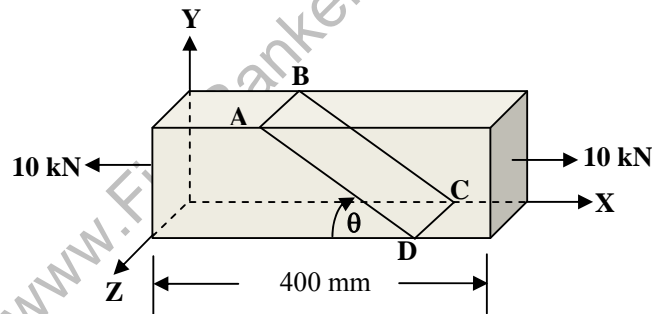
- Q.19 A point in a body is subjected to plane state of stress in XY plane. If  $\sigma_x = 140$  MPa,  $\sigma_y = 60$  MPa and the major principal stress is 150 MPa, the magnitude of the in-plane shear stress  $\tau_{xy}$  (in MPa) is

(A) 75 (B) 30 (C) 40 (D) 70

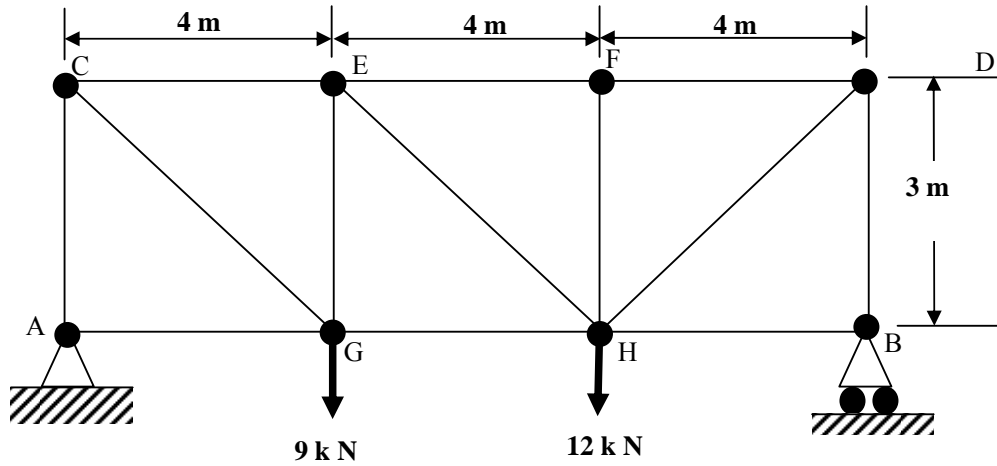
- Q.20 A 40 mm diameter rotor shaft of a helicopter transmits a torque  $T = 0.16 \pi$  kN-m and a tensile force  $P = 24 \pi$  kN. The maximum tensile stress (in MPa) induced in the shaft is \_\_\_\_\_. Use the value of  $\pi = 3.1416$ .



- Q.21 A wooden block of length 400 mm, width 50 mm and depth 100 mm is subjected to uniaxial load as shown in the figure. An inclined plane ABCD is shown which makes an angle  $\theta$  with the XZ plane and the line CD is parallel to the Z-axis. The normal stress on the plane ABCD is  $\sigma_{n1}$  when  $\theta = 30^\circ$  and the normal stress on the plane ABCD is  $\sigma_{n2}$  when  $\theta = 120^\circ$ . The value of  $\frac{\sigma_{n2}}{\sigma_{n1}}$  is \_\_\_\_\_



Q.22 For the truss shown in the figure, which one of the following statements is true?



- (A) AG is the only zero force member.
- (B) AG and BH are the only two zero force members.
- (C) AG, BH and HF are zero force members.
- (D) AG, BH, HF and GC are zero force members.

**END OF THE QUESTION PAPER**