

**INDIAN INSTITUTE OF TECHNOLOGY PATNA**  
**DEPARTMENT OF MECHANICAL ENGINEERING**  
**END-SEMESTER EXAMINATION, B.TECH SEMESTER –II, DATE: 26-04-2018**  
**ENGINEERING MECHANICS – I (ME 102)**

Max. Marks: 35

Time duration: 3 hrs.

Note: 1. Attempt all questions

2. Missing data, if any, may suitably be assumed

1. (a) Calculate the magnitude of the force in member PR and the support reaction at R for the truss shown in Fig. 1. Comment on the nature of the force acting in member PR. (Marks: 3)

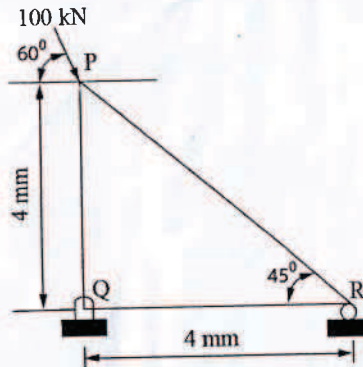
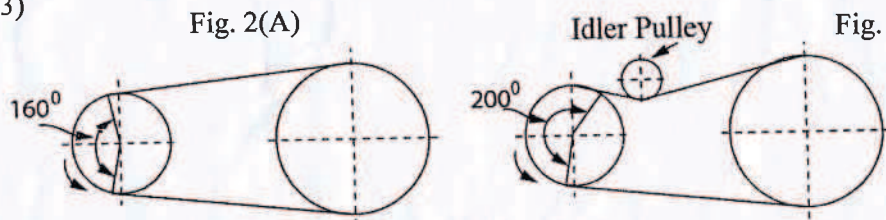


Fig. 1

- (b) A belt drive shown in Fig. 2 (A) has an angle of wrap of  $160^\circ$  on the smaller pulley. Adding an idler as shown in Fig. 2 (B) increases the wrap angle to  $200^\circ$ . The slack side tension is the same in both cases and the centrifugal force is negligible. By what percentage is the torque capacity of the belt drive increased by adding the idler? (Use coefficient of friction  $(\mu = 0.3)$ ). (Marks: 3)



- (c) A wardrobe (mass 100 kg, height 4 m, width 2 m, depth 1 m), symmetric about the Y-Y axis, stands on a rough level floor as shown in the Fig. 3. A force P is applied at mid-height on the wardrobe so as to tip it about point Q without slipping. What are the minimum values of the force (in newton) and the static coefficient of friction  $\mu$  between the floor and the wardrobe, respectively? (Marks: 3)

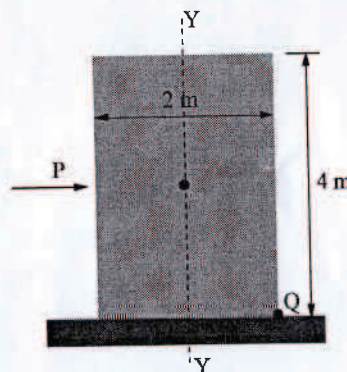


Fig. 3

1. (a) Derive the torsion formula for circular shaft with the proper diagram showing the variation of stress profile. (Marks: 4)  
 (b) Maximum shear stress developed on the surface of a solid circular shaft under pure torsion is 240 MPa. Calculate the maximum shear stress if the shaft diameter is doubled corresponding to the same torque. (Marks: 3)

2. Calculate the state of stresses at point 'A' for a given Fig. 4. Also, draw the representative volume element showing the state of stresses at point 'A'. (Marks: 6)

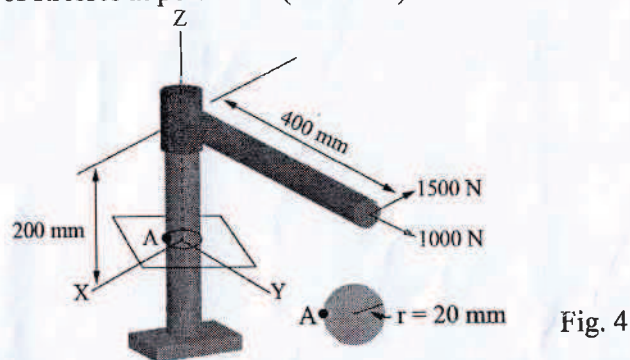


Fig. 4

3. (a) The 2-D stress system is shown in Fig. 5, find the stress components when it is inclined at  $30^\circ$  clockwise. Draw the Mohr's circle showing the stress co-ordinates. What is the value of radius of Mohr's circle? (Marks: 4)

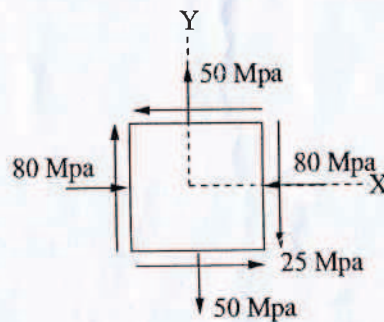


Fig. 5

- (b) The state of stress at a point on an element is shown in Fig. 6 (A). The same of stress is shown in another coordinate system in Fig. 6 (B). What is the component of  $(\tau_{xx}, \tau_{yy}, \tau_{xy})$ . (Marks: 3)

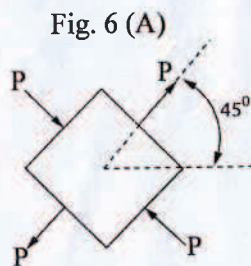


Fig. 6 (A)

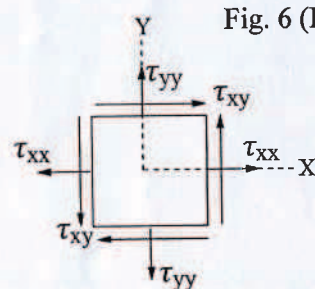


Fig. 6 (B)

4. For the cantilever beam with the shown loadings and cross-section, determine the absolute maximum bending stress in the beam. Draw the stress profile about the neutral axis. What is the value of stress at the junction of flange and web (location P shown in Fig. 7). (Marks: 6).

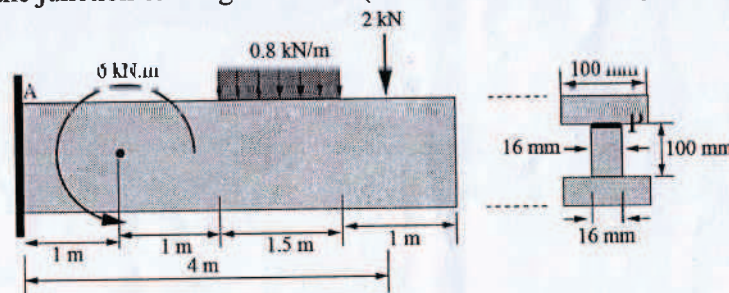


Fig. 7