

**KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY**

*Department of Mechanical Engineering*

B. Sc. Engineering 2nd Year 2nd Term Examination, 2018

ME 2211

(Mechanics of Solid)

Time: 3 Hours

Total Marks: 210

**N.B.:** i) Answer any THREE questions from each section in separate scripts.

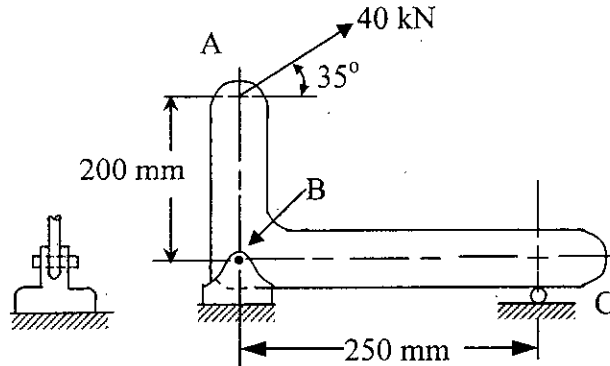
ii) Figures in the right margin indicate full marks.

iii) Assume reasonable data if missing any.

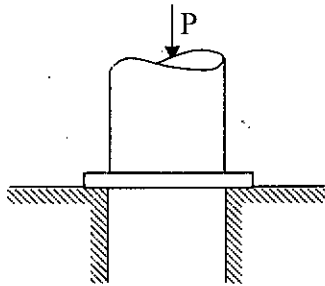
iv) Table 8-1 may be supplied on request.

**SECTION-A**

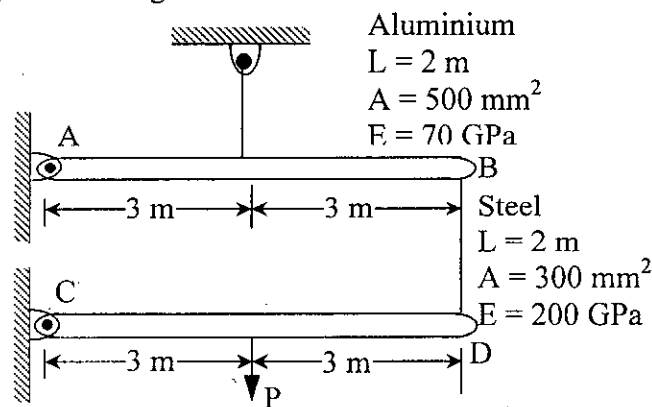
- 1(a) Compute the shearing stress in the pin at B for the member supported as shown in figure. 10  
The pin diameter is 20 mm.



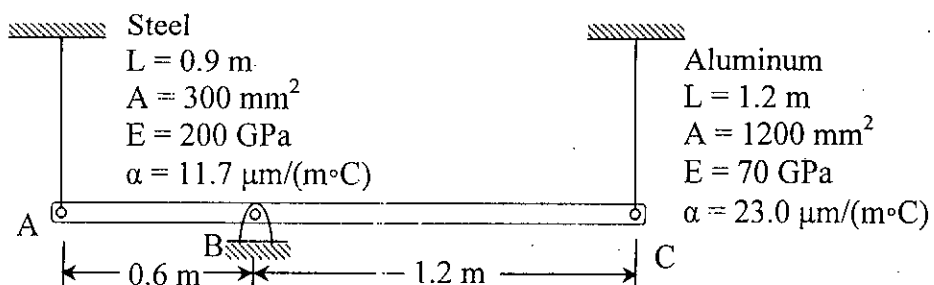
- 1(b) A hole is to be punched out of a plate having a shearing strength of 275 MPa as shown in figure. The compressive stress in the punch is limited to 50 MPa. (i) Compute the maximum thickness of the plate in which a hole 65 mm in diameter can be punched. (ii) If the plate is 6.5 mm thick, determine the diameter of the smallest hole that can be punched. 10



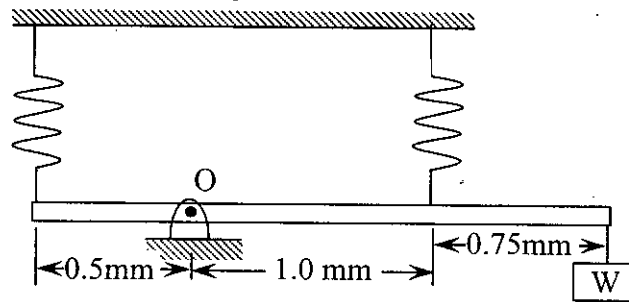
- 1(c) The rigid bars AB and CD shown in figure are supported by pins at A and C and the two rods. Determine the maximum force P that can be applied as shown; if its vertical movement is limited to 5 mm. Neglect the weight of all members. 15



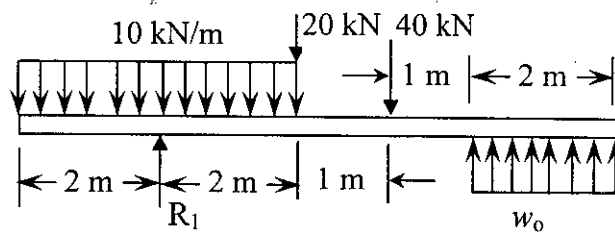
- 2(a) The rigid bar ABC is pinned at B and attached to the two vertical rods as shown. Initially the bar is horizontal and the vertical rods are stress free. Determine the stress in the aluminum rod if the temperature of the steel rod I decreased by 40°C. Neglect the weight of the bar ABC. 18



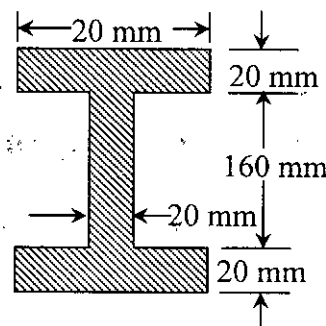
- 2(b) A rigid bar pinned at point O, is supported by two identical springs as shown. Each spring consists of 20 turns of 20 mm diameter wire having a mean diameter of 150 mm. Determine the maximum load W that may be supported if the shearing stress in the springs is limited to 140 MPa. Neglect the mass of the rigid bar. 17



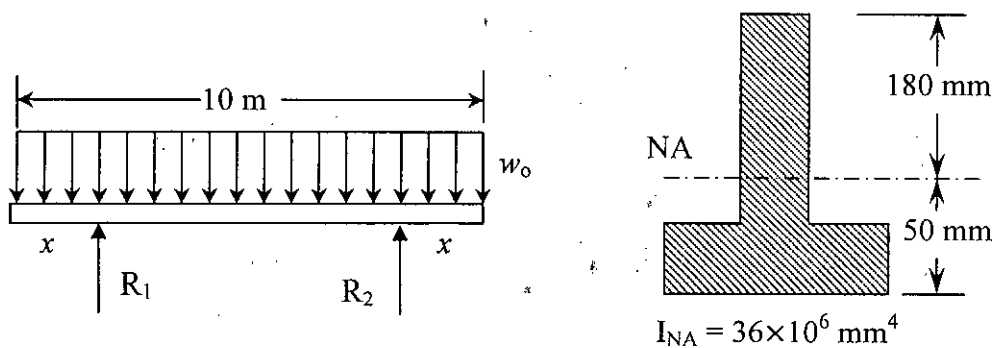
- 3(a) Draw the shear and moment diagrams for the beam as shown. Also mention the numerical values at all change of loading positions and at all points of zero shear. 17



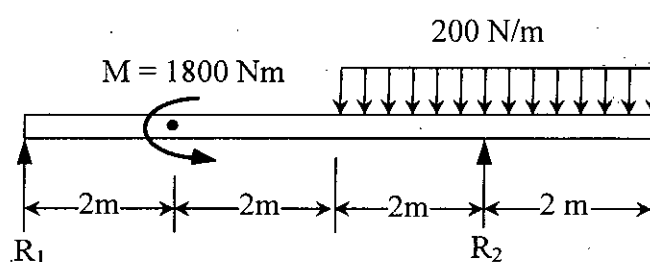
- 3(b) Determine the maximum and minimum shearing stress in the web of the wide-flange section in figure if  $V = 100$  kN. Also, compute the percentage of vertical shear carried only by the web of the beam. 18



- 4(a) A cast iron beam 10 m long and supported as shown in figure, carries a uniformly distributed load of intensity  $w_0$  (including its own weight). The allowable stresses are  $\sigma_t \leq 120$  MPa and  $\sigma_c \leq 80$  MPa. Determine the maximum safe value of  $w_0$  if  $x = 1.0$  m. 18

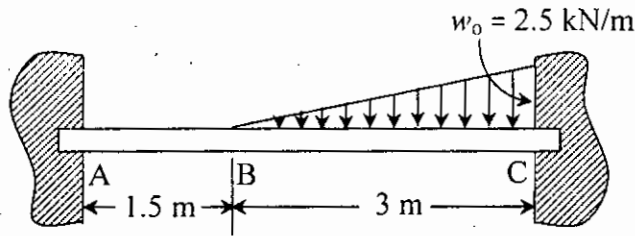


- 4(b) Determine the value of  $EIy$  midway between the supports for the beam loaded as shown in figure. 17

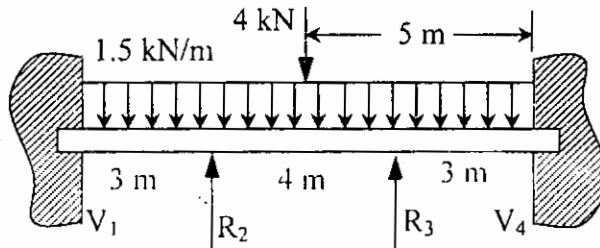


**SECTION-B**

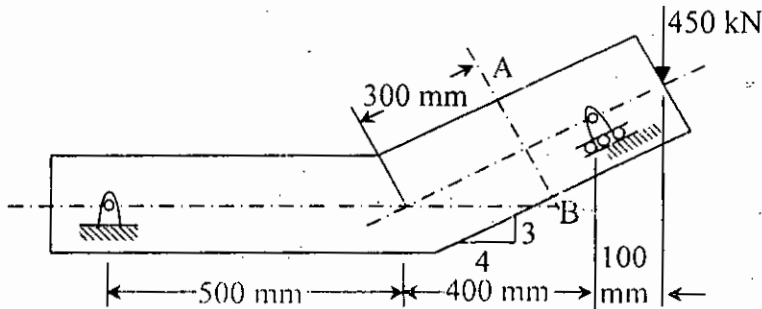
- 5(a) Determine the end shears and end moments for the restrained beam as shown in figure. Also sketch the shear and moment diagrams. 17



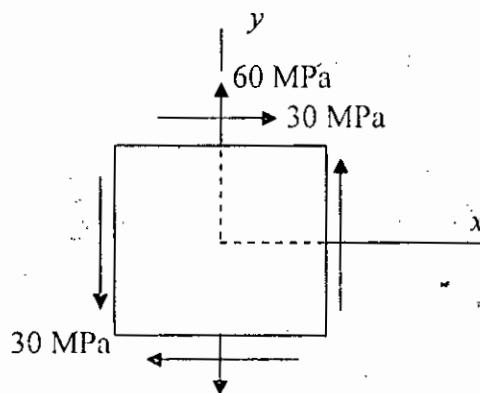
- 5(b) For the continuous beam shown in figure, determine the moments over the supports. Also, draw the shear diagram and compute the maximum positive bending moment. 18



- 6(a) The bent steel bar shown in figure is 200 mm square. Determine the normal stresses at A and B. 17



- 6(b) For the state of stress shown in figure, determine the principal stresses and the maximum in-plane shearing stress. Show all results on complete sketches of different elements. 18

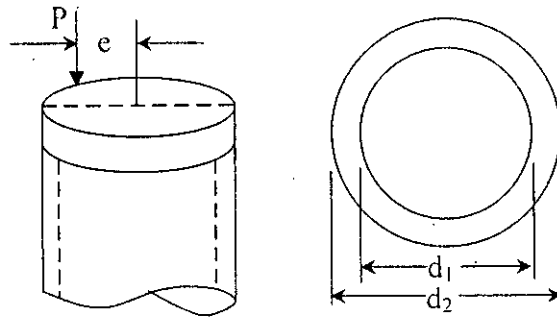


- 7(a) What is slenderness ratio? Discuss the limitation of Euler's formula of critical load for long columns. 05

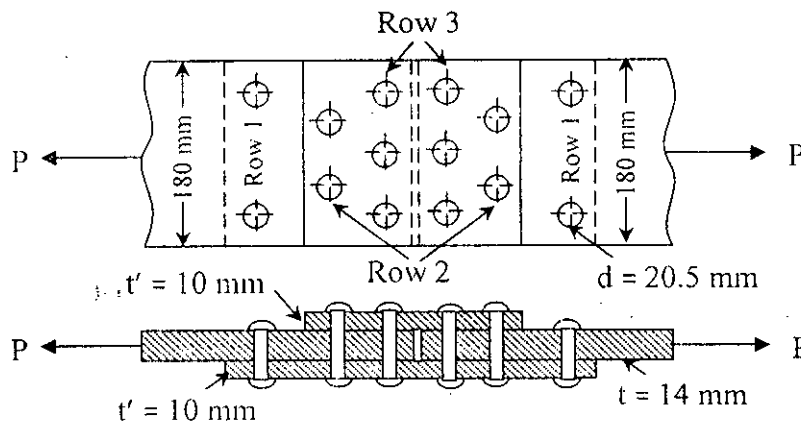
- 7(b) Derive the expressions of critical load for long column and show that critical load of a fixed ended long column is four times the load of a hinge ended column. Also, discuss the limitations of Euler formula. 16

7(c) A pinned-end column with length  $L = 2.1$  m is constructed of steel pipe ( $E = 210$  GPa) 14  
 having inside diameter 60 mm and outside diameter 68 mm. A compressive load 10 kN  
 acts with eccentricity 30 mm.

- (i) What is the maximum compressive stress in the column?
- (ii) If the allowable stress in the steel is 50 MPa, then what is the maximum permissible length of the column?



8(a) A repeating section 180 mm long of a riveted triple-row butt joint of the pressure type is 18  
 illustrated in the figure. The rivet hole diameter is 20.5 mm, the thickness of each main  
 plate is 14 mm, the thickness of each cover plate is 10 mm. The ultimate stress in shear,  
 bearing and tension are respectively 300 MPa, 650 MPa and 400 MPa. Using a factor of  
 safety of 5, determine the strength of a repeating section, the efficiency of the joint, and  
 the maximum internal pressure that can be carried in a 1.5 m diameter boiler for which  
 this joint is the longitudinal seam.



8(b) A plate is lapped over and welded to a gusset plate as shown in figure. 17  
 (i) Determine the size of the fillet welds to be specified using  $\tau = 145$  MPa through  
 the throats of the welds.  
 (ii) What maximum value of  $P$  can be applied vertically downward, if 8 mm welds are  
 used?

