

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination

Summer Semester: 2022-2023

Course No.: CEE 4413

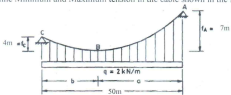
Full Marks: 150

Course Title: Mechanics of Solids II

Time: 3 hours

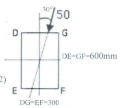
There are 6 (Six) Questions. Answer all Questions. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning. Assume reasonable values for any missing information.

- 1(a) Prove that the minimum cable tension is at the lowest point of a parabolic cable and maximum cable tension is at one of the supports. (5) [CO1 PO1]
- (b) Why do civil engineering structures generally use rivets in place of threaded bolts? Also, why do we use throat of weld dimension during weld-strength calculation? (5) [CO1 PO1]
- (c) Discuss the differences between ductile and brittle materials in terms of their failure modes and applications in civil engineering. (5) [CO1 PO1]
- (d) Develop a correlation between hoop and longitudinal stress in a thin-walled cylindrical pressure vessel. (5) [CO1 PO1]
- 2(a) Determine the deflection at a point 1/4 length from the left support of a simply supported beam with a span of 12m. The beam has a varying load  $P(x) = x^2 - 3x$  kN/m where x is the distance from the left support. EI is constant. Use any method. (15) [CO2 PO2]
- (b) Determine Minimum and Maximum tension in the cable shown in the following Figure 1. (13) [CO3 PO2]



(Figure 1)

- 3(a) A uniformly distributed load of 50 kN works at an angle of 30° with the vertical axis of the beam as seen in Figure 2. The beam has 25m span which is simply supported at two ends. E=20000 MPa. Measure maximum (tensile and compressive) stresses. (15) [CO2 PO2]



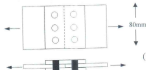
(Figure 2)

(13)  
[CO3  
PO2]

- (b) A steel compression rod is a 5m long tube with an outer diameter of 60 mm and a wall thickness of  $t = 10$  mm, pin connected at both ends. Determine critical buckling load if it acts on the top of the rod. What will be the critical buckling load if both ends are welded to make it fixed?  $E = 210$  GPa.

- 4(a) A single riveted lap joint with two cover plates is used to connect plates 12 mm thick and 80 mm wide as seen in Figure 3. If 10 mm diameter rivets are used at 25 mm pitch (3 on each side of the joint), determine the strength of joint. Cover plate dimensions are 8-mm in thickness and 80 mm in width. Working stress in shear in rivets =  $100$  N/mm<sup>2</sup> (MPa). Working stress in bearing in rivets =  $300$  N/mm<sup>2</sup> (MPa). Working stress in axial tension in plates and cover plates =  $156$  N/mm<sup>2</sup>. Check for all possible failure types.

(15)  
[CO3  
PO2]



(Figure 3)

- (b) A hollow cylindrical steel industrial boiler has a circular cross-section, diameter of 2 m, wall thickness of 10 mm, and height of 3 m (when unpressurized) as seen in Figure 1. For steel,  $E = 200$  GPa, Yield Strength = 480 MPa, and Poisson's ratio  $\nu = 0.30$ . If the cylinder contained pressure is 600 kPa, determine the change in length and diameter of the cylinder from its unpressurized (unloaded) state.

(13)  
[CO3  
PO2]

5. A lap joint, as shown in Figure 4, is connected with two 14 mm dia rivets. Plate A is 8 mm and Plate B is 12 mm thick. Working stress in shear in rivets =  $80$  N/mm<sup>2</sup> (MPa). Working stress in bearing in rivets =  $250$  N/mm<sup>2</sup> (MPa). Working stress in axial tension in plates =  $156$  N/mm<sup>2</sup>. (i) Find the strength of the joint. (ii) If it is decided that the rivets will be removed and Plate B will be fillet welded to plate A, what should be the length of weld for maintaining previous capacity as found in Case (i)? Allowable stress in the weld is  $130$  N/mm<sup>2</sup>.

(28)  
[CO3  
PO2]



(Figure 4)

6. Determine the maximum allowable force on a single cover butt joint used to connect two flat plates as shown in Figure 5; Plate A has 220 mm width and 8 mm thickness while plate C has 180 mm width and 12 mm thickness. Thickness of cover plate B is 16 mm and width is 150 mm. Rivet spacing is 60 mm side-by-side and 40 mm row by row. Rivet diameter is 16 mm and hole diameter is 17 mm. Tearing, shearing and bearing strength are 150, 200 and 150 N/sq.mm, respectively.

(18)  
[CO3  
PO2]



(Figure 5)