B.Sc. Engg. (CEE)/ 4th Sem. 12th May, 2023 (Group B: Morning

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Summer Semester: 2021-2022**
Course No.: CEE 4413 **Full Marks: 150**
Course Title: Mechanics of Solids II **Time: 3 hours**

There are **6 (Six)** Questions. **Answer all Questions.** Except question 1 and 6, all other questions carry equal marks. 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) Sketch a single-span cable supported (suspended) bridge showing different parts. Identify the locations(s) of potential maximum tensile force and minimum tensile force on the main cable. Give an example each for loading cases which result parabolic and catenary shapes of cable. (3+2+2 [CO PO1

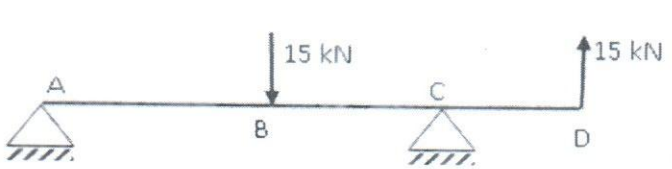
(b) Why do civil engineering structures generally use rivets in place of threaded bolts? Also, why do we use throat of weld dimension during weld-strength calculation? (5 [CO PO1

(c) Explain why failure envelope of a cohesionless material is usually linear. What are the assumptions of Euler's theory for buckling? (8 [CO PO1

2(a) Find deflection of the point at 1/3 length from the left support of a 10m-span simply supported beam. The beam has the following loading function: $P(x)=25\sin(2\pi x/10)$ kN/m, where x is the distance of a point on beam from left support. EI constant. Use any method. (15 [CO PO2

(b) The length of an aluminum (E = 70 GPa) column, pin-supported on both ends, is L = 2.2 m. It is under axial compressive load P. The column cross section is a solid square of width, b = 200 mm. (i) Find the value of P if it is half of the buckling load. (ii) During a fire exposure, fire reduces column dimension as a function of fire exposure time, $b_{damaged}=(200-t/10)$ mm; where t=fire duration in minutes. Estimate the time when the critical buckling load of the damaged column will be just lower than P. (13 [CO PO2

3(a) An 9-meter beam has two loads acting on it as shown on Figure 1. Find deflection at point D using moment-area method. E = 200 kN/mm^2. I = 4000 × 10^4 mm^4. AB=BC=CD=3m. (15 [CO PO2

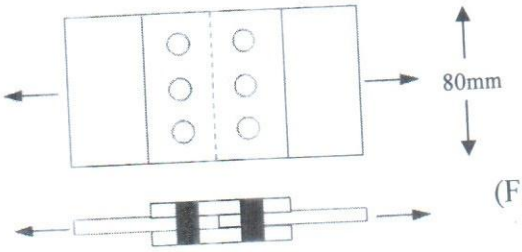


(Figure 1)

(b) A bottom-end closed hollow steel tube of 4-mm thickness and 500-mm inner diameter will be used as a steel-encased concrete column after being filled with concrete. Now, when concrete is poured into the tube, it has a slurry-like consistancy and provides lateral pressure on the tube wall due to hydrostatic pressure ($P = \rho gh$). Concrete has a density of ρ=2400 kg/m^3. If the allowable maximum tensile stress of steel is 100 MPa, what should be the concrete filling height (h) before the tube bursts at the bottom? Consider hoop-stress only. (13 [CO PO2

4(a) A concentrated load of 30 kip is acting at midspan of a 20-ft simply supported beam, which is additionally loaded over the whole span with uniformly distributed load of 3 kip/ft. E=29000 ksi and I=250 in^4. Find mid-span deflection using either virtual work method or singularity function. (15) [CO2 PO2]

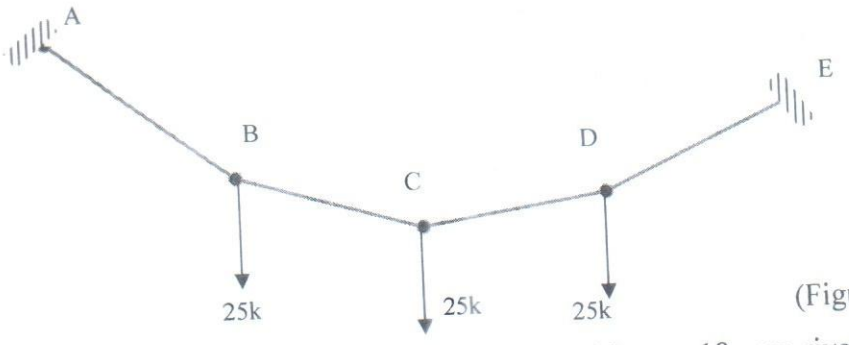
(b) A single riveted lap joint with two cover plates is used to connect plates 12 mm thick and 80 mm wide as seen in Figure 2. If 10 mm diameter rivets are used at 25 mm pitch (3 on each side of the joint), determine the strength of joint. Cover plate dimensions are 8-mm in thickness and 80 mm in width. Working stress in shear in rivets= 100 N/mm^2 (MPa). Working stress in bearing in rivets=300 N/mm^2 (MPa). Working stress in axial tension in plates and cover plates=156 N/mm^2. Check for all possible failure types. (13) [CO3 PO2]



(Figure 2)

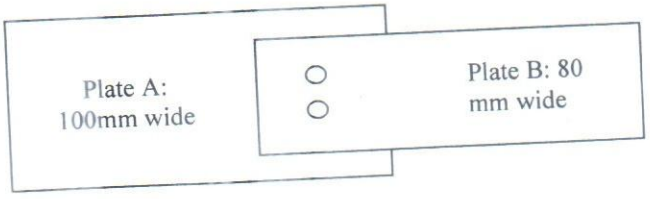
5(a) A cantilever beam of 10 ft length is loaded with a uniformly distributed downward load of 600 lb/ft over the whole span and an upward concentrated load of P at the tip of cantilever. Find the value of P if the deflection at the tip of the cantilever is zero. Use any method. (15 [CO PO2

(b) A cable (Figure 3) has the following coordinates: Support (A): (10,10), point B: (22,-5), point C: (34,-11), point D: (46, -8) and Support (E): (58, 1) (unit is in Feet). Downward load P_B= P_C = P_D= 25 kip. Find the forces in the cable segments AB, BC, CD, DE. If the maximum allowable stress in cable 40 ksi, compute the required cross section area of the cable. (1 [CO PO



(Figure 3)

6. A lap joint, as shown in Figure 4, is connected with two 18 mm rivets. Plates are 10 mm thick. Working stress in shear in rivets= 80 N/mm^2 (MPa). Working stress in bearing in rivets=250 N/mm^2 (MPa). Working stress in axial tension in plates =156 N/mm^2. (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 125 N/mm^2. ([C P



(Figure 4)