UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: January 2022

Module Number: CE4204 **Module Name: Structural Analysis II**

[Three Hours]

[Answer **all questions**. Each question carries 12 marks]

All Standard Notations denote their regular meanings

Q1. a) Explain the load transferring mechanism of a suspension bridge. You may use neat sketches to support your answer.

[2 Marks]

b) A suspension bridge with two parallel cables has been constructed over a wide river. The bridge cables slung between two piers 100 m apart and carries a load of 25 kN/m over entire span. The tops of the piers are at the same level and the cables at their lowest point sags 10 m below the piers top level. The backstays are inclined 30° to the horizontal and are anchored to the cable through a frictionless pulley. The height of the piers is 15 m. Consider the given load is factored design load.

i.) Calculate the maximum tension in a cable for the above loading.

[3 Marks]

ii.) What is the force in a backstay?

[1 Mark]

iii.) Determine horizontal force, vertical force and the maximum bending moment acting on a pier.

[6 Marks]

Q2. a) A three-pinned parabolic arch carries a uniformly distributed load throughout its span. Show that the bending moment at any cross section is zero.

[4 Marks]

b) A symmetrical three-pinned parabolic arch bridge spans 36 m with central rise 8 m. The arch is subjected to a uniformly distributed load of 40 kN/m over its left half of the span, due to equipment use for repairing work of the bridge. Neglecting the effect of self-weight of the bridge;

i.) Determine the bending moment at a distance of 10 m from the left support.

[2 Marks]

ii.) Determine the shear force and the normal thrust for the same section given in Part (i).

[2 Marks]

iii.) Determine the location and the magnitude of the maximum bending moment.

[4 Marks]

Q3. a) What is meant by an influence line? Briefly explain the uses of influence line diagrams.

[2 Marks]

b) Draw the influence line diagram for a simply supported beam of span 10m and hence determine the maximum positive shear developed at a point 2.5m away from the left hand support, due to:

i.) a concentrated moving load of 5 kN, and

ii.) a uniform moving load of 3 kN/m.

[4 Marks]

c) A series of wheel loads having magnitudes 5kN, 9kN and 6kN spaced 3m centre to centre, cross over a simply supported girder of span 10m. If loads move from left to right and 6kN load leading, find the position and the absolute maximum bending moment which may occur anywhere in the girder.

[6 Marks]

Q4. a) A hollow circular cantilever bar is loaded by a force 3 kN that has an eccentricity 50 mm as shown in Figure Q4. The bar is made of a ductile material having yield strength of 300 MPa. The bar is 100 mm long with outer and inner diameters equal to 30 mm and 20 mm respectively. Assume that transverse shear can be neglected. Determine the Factor of Safety for yielding at the point **A**, according to the following failure theories.

i.) Maximum Principal Stress Theory

ii.) Maximum Shear Stress Theory

iii.) Maximum Shear Strain Energy Theory

[8 Marks]

b) For the above hollow circular section, calculate the elastic moment capacity, plastic moment capacity, and shape factor.

[4 Marks]

Q5. a) Briefly discuss the three important criteria in plastic analysis to identify the correct load factor.

[2 Marks]

b) Explain the "basic collapse mechanisms" in related to plastic analysis of frame structures.

[2 Marks]

c) A portal frame (ABCD) is shown in Figure Q5. Frame supports a vertical load, 50 kN, at the centre of the beam BC. Member AB is subjected to a to a uniformly varying load of intensity zero at the support A and 10 kN/m at the node B. Plastic moment capacity of the beam (BC) and columns (AB, CD) are 150 kNm and 75 kNm respectively. Determine;

i.) The collapse load factor for each basic collapse mechanisms.

ii.) The collapse load factor for portal frame and sketch the bending moment diagram for corresponding collapse mechanism.

[8 Marks]

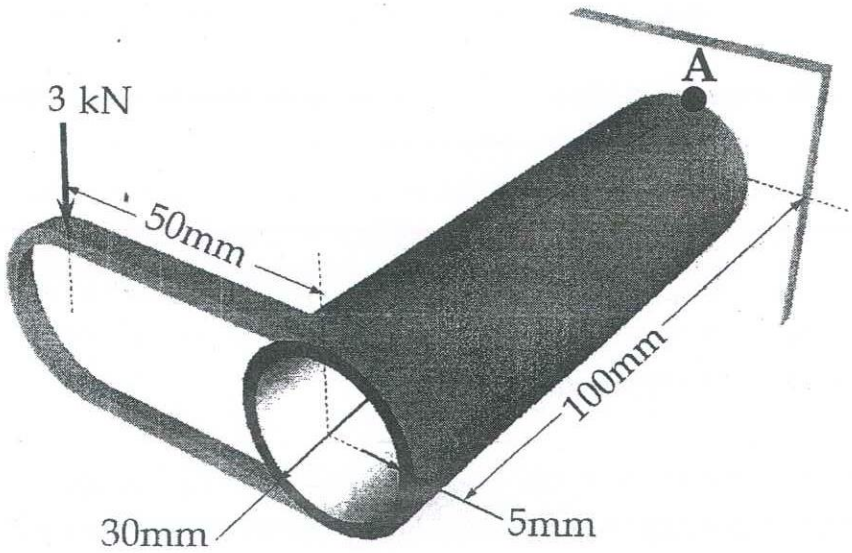

Figure Q4

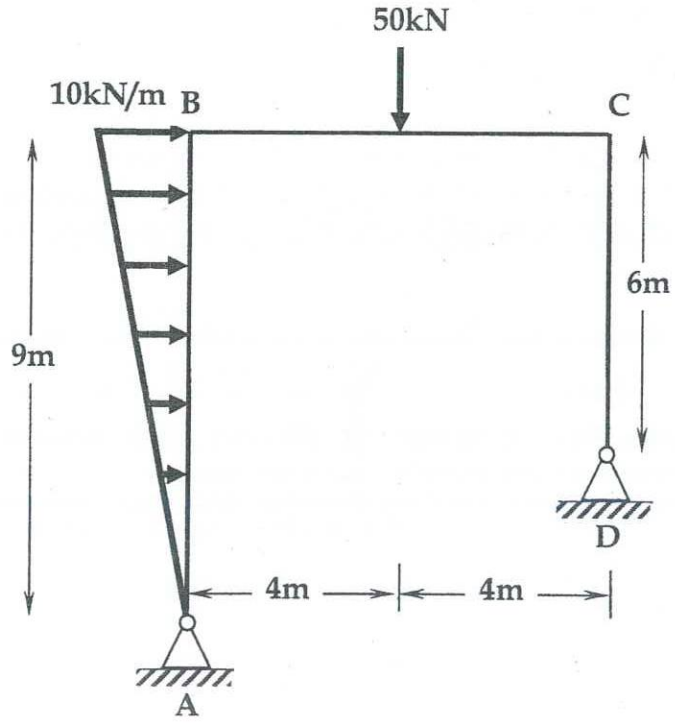

Figure Q5