UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: November 2017

Module Number: CE4203 **Module Name**: **Structural Analysis II**

[Time: Three Hours]

[Answer all questions, each question carries twelve marks]

All Standard Notations denote their regular meanings

Q1. a) Explain what is meant by 'plastic moment capacity' and plastic region in relation to a beam.

[2.5 Marks]

b) A portal frame shown in Fig. Q1 is loaded as shown. Plastic moments are also indicated in the same Figure. It is required to carry out a plastic analysis.

(i) Determine the degree of kinematic indeterminacy and identify number of independent mechanisms.

[1.0 Mark]

(ii) Write work equations for all possible mechanisms

[3.5 Marks]

(iii) Hence determine the collapse mechanism and its relation to the load.

[2.5 Marks]

(iv) Calculate and show that there is a statically admissible structure for the failure condition.

[2.5 Marks]

Q2. a) Compare 'Action Diagram' and 'Influence Line'.

[2.5 Marks]

b) A continuous beam shown in Fig. Q2 is subjected to the loading systems shown in part (c) below. Determine the influence lines for;

(i) Support reactions at A

[2.5 Marks]

(ii) Bending moment at E

[2.5 Marks]

(iii) Shear force at E

[2.5 Marks]

c) Determine the maximum bending moment at E, when

(i) A distributed load of intensity 4 kN/m and length 12m long traverses the beam.

[1.0 Mark]

(ii) A distributed load of intensity 6 kN/m and 3m long traverses the beam.

[1.0 Mark]

Q3. A machine component made out of cast iron has tensile strength of 400 N/mm², compressive strength of 1200 N/mm², modulus of elasticity of 225 kN/mm², and poison's ratio of 0.2.

Determine the safety factor for each of the four cases of loading as shown in Fig. Q3. You are required to use Mohr's modified shear stress theory as the failure criterion. Note that all the stresses are given in N/mm².

[4x3.0 marks]

Q4. a) A pin-ended strut of flexural rigidity *EI* and length *L* carries an axial load *P*. Using the first principles, determine the buckling load.

[3.0 marks]

b) A beam of length 0.9m is supported on two pin-ended struts as shown in Fig. Q4. The beam AB is installed in such a way that it can only be moved in the vertical direction but not allow to sway. The strut AC has a length of 2m with rectangular shape cross section with the size of 40 mm x 20 mm. The strut BD has a length of 1.2m of circular cross section having diameter of 20mm.
Determine the maximum load the system could carry. Take the modulus of elasticity of all the components as 20 kN/mm².

[9.0 Marks]

Q5. a) A suspension cable supported at its ends and subjected to a uniformly distributed load of w_o/unit length span 'L' distance with dip 'd'. If the cable is parabolic in shape and supported at the same level, show that:

Horizontal component of the tension force (*H*) in the cable at any point is given by $H = \frac{w_0 L^2}{8d}$

Maximum tension force (T_{max}) in the cable is occurred at the supports and it is given by $T_{\max} = \frac{w_0 L}{8d}\sqrt{L^2 + 16d^2}$

[5.0 Marks]

b) A suspension bridge is built across a river in the suburb of Galle town to facilitate passenger movements as shown in Fig. Q5. The girder beam ABC which supports the passage of the bridge contain a hinge at the center B. The beam is hanged to the main cable in parabolic shape by equally space hangers. Determine the maximum and the minimum tension force in the cable, and tension force in the hangers.

[7.0 Marks]

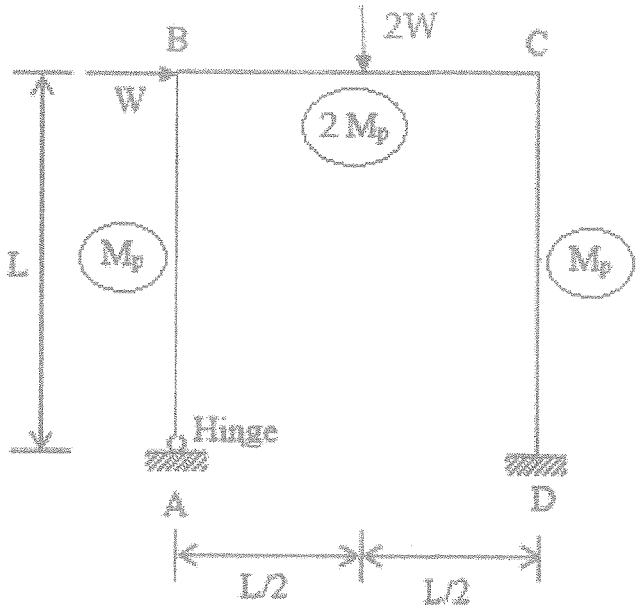

Fig. Q1

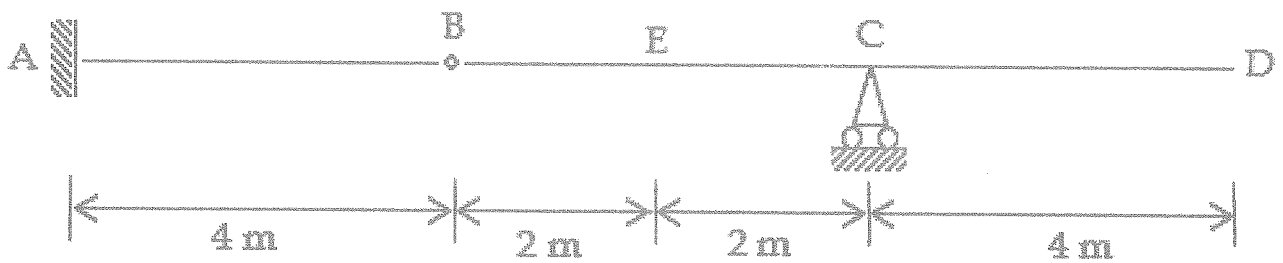

Fig. Q2

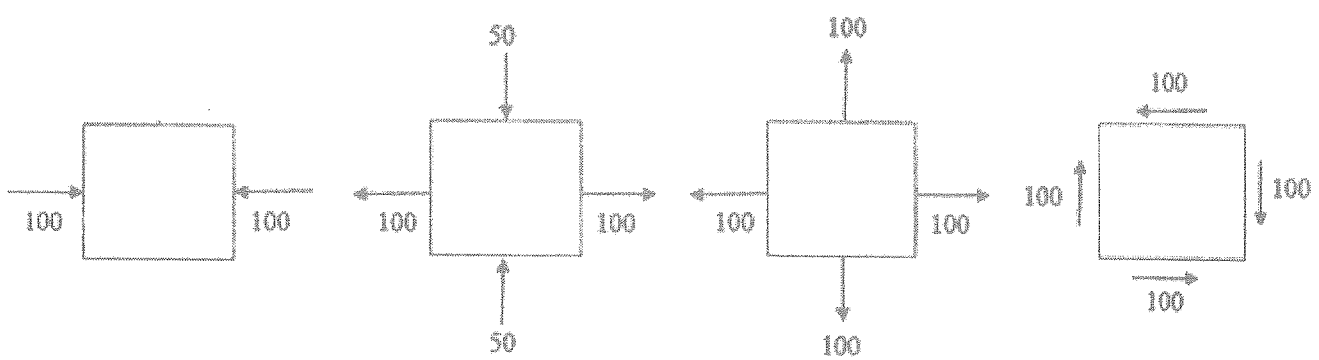

Fig Q3

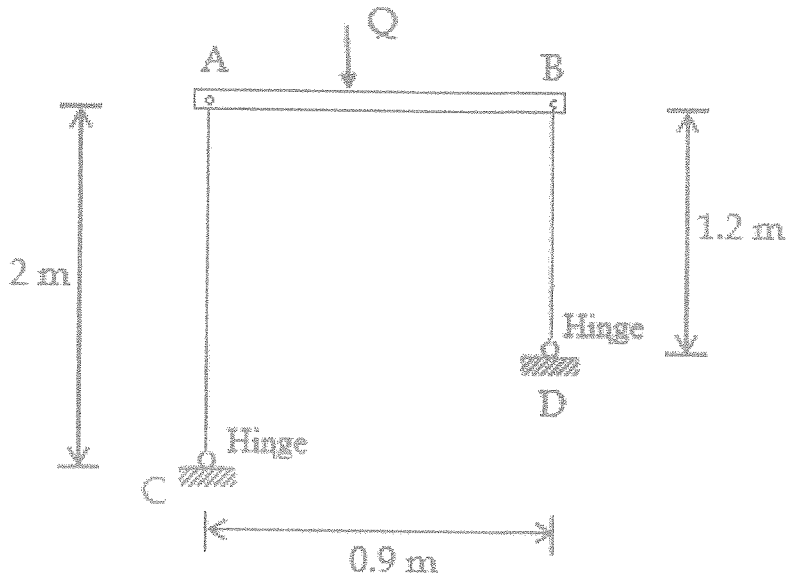
Q
A
B
2 m
1.2 m
Hinge
D
Hinge
C
0.9 m

Fig. Q4

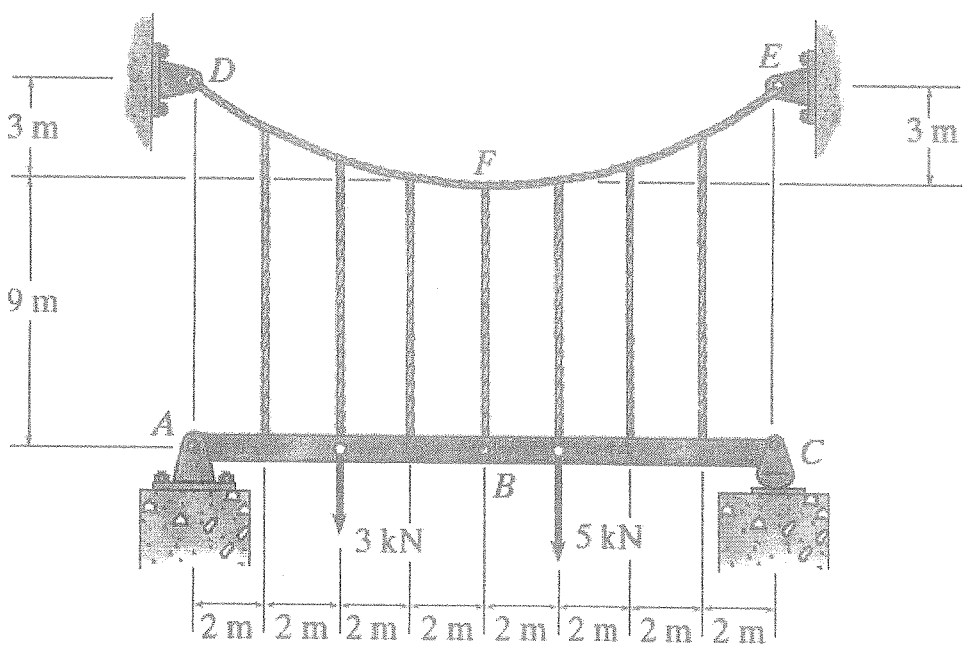
D
E
3 m
3 m
F
9 m
A
C
B
3 kN
5 kN
2 m
2 m
2 m
2 m
2 m
2 m
2 m
2 m

Fig. Q5