ADELAIDE UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING
FINAL EXAMINATION FOR THE DEGREE OF B.E
#4958: STRUCTURAL ANALYSIS & DESIGN
JUNE, 2001

TIME ALLOWED: 3 HOURS & 10 MINUTES

- **You are advised to devote the first 10 minutes to read the paper and plan your approach.**
- Answer all SIX questions. Part A (70 marks), Part B (30 marks).
- All questions carry unequal marks
- Use separate Booklets for Part A and Part B
- Open books open notes examinations. The use of notes, textbooks, and programmable calculating devices is permitted in the examination room
- Appropriate engineering assumptions may be made for inadequate data.

PART A (USE SEPARATE BOOKLET FOR THIS PART)

QUESTION 1 (a).

A dockyard crane may be considered to be a plane pin-jointed frame as shown in the following figure. Determine the support reactions and the forces in the members of the framework by Maxwell's graphical construction method only. Write down the magnitude of the force with the appropriate sign (+ve) for tension and (-ve) for compression for each member.

[10 marks]

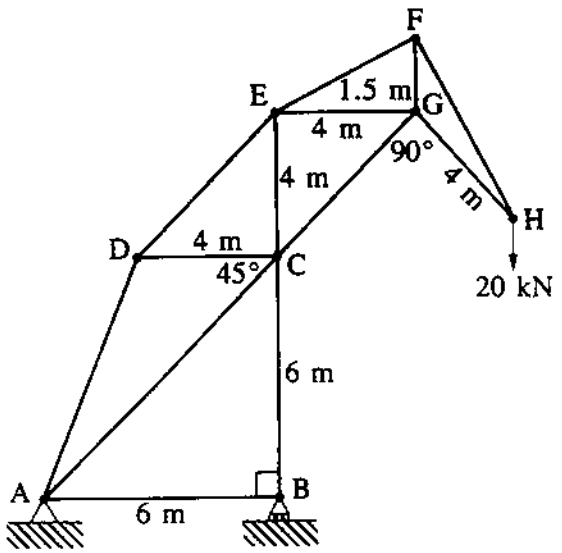

Figure : Q 1(a). Dockyard Crane Pin-jointed Frame.

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Question 1(b).

Calculate the force in member BL in the pin-jointed framework shown in the following figure. You may use the "Method of Sections" or any other suitable method to calculate the force in the member BL.

[8 marks]

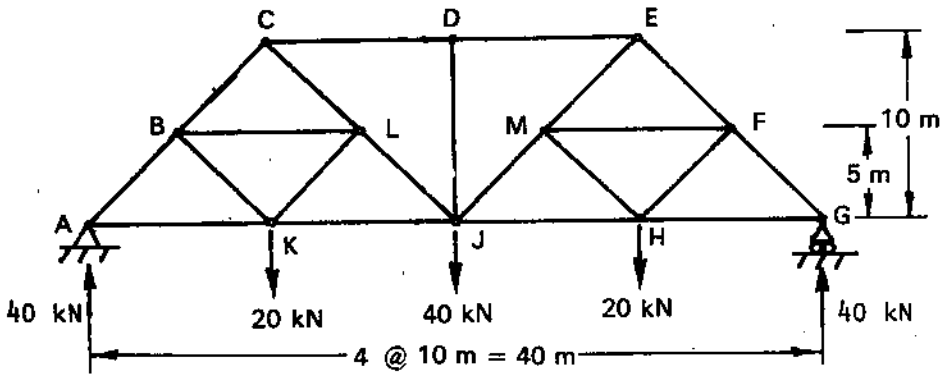

Figure Q1(b).

Question 2.

A "Launching Truss" is used in bridge construction to carry beams across the completed spans and place them on the piers, which provide support for the new span. Two critical loading conditions exist. The first is when the truss is about to reach the next pier. The second is when the truss is supporting the weight of the beam before placing it. The two cases are shown schematically in the following diagram 2 (a) and 2 (b) respectively. The truss weight (T) may be considered as the single resultant shown in the diagrams for the calculation of reactions. For member forces the weight must be distributed to the bottom joints giving (T/8) for intermediate joints and (T/16) at each end.

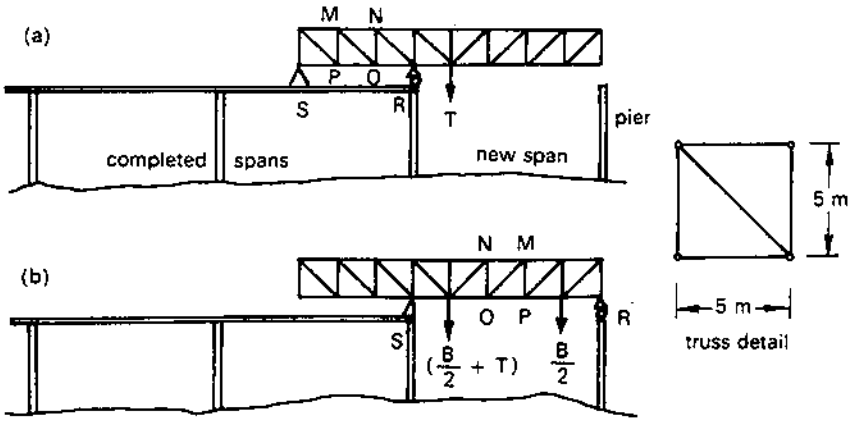

Figure Q.2

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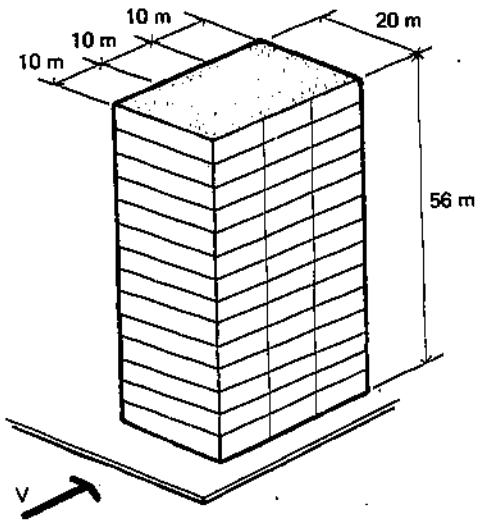
The truss weight T and the beam weight B are both 1000 kN, the span length is 25m and the standard panel of the truss is as shown. Determine the reactions at R and S in both cases, and also calculate the forces in members MN, MO and PO.

[18 marks].

Question 3.

(a). Determine the base shear force V for the 14 storey commercial building as shown in the following figure. It is located in the area where the seismic zone coefficient Z = 1.0 and the characteristic site frequency, T_s has been determined as 2.0 seconds. It has a separate core system to carry the full lateral load and a moment resisting frame designed for 25% of these loads. A typical floor (and the roof) has a dead–load value of 10 kN/m^2, which includes an allowance for all structural members. The seventh floor has some heavy mechanical equipment, so the average dead load for that floor is 13 kN/m^2.



(b). Determine the lateral forces that act at levels 1, 3 and 5 for the 14-storey building shown above.

You may base your calculations on SEAC Code (Structural Engineers Association of California Code) , ANSI Code or any other suitable Code.

[18 marks].

Please see next page.....

Question 4.

For the two-bar truss system shown in the following figure determine the displacement in the y–direction of node 1and the axial force in each element. A force of P=1000 kN is applied at node 1 in the positive y-direction while node 1 settles an amount δ =50 mm in the negative x-direction. Let E=210 GN/m^2 and area A=6.00x10^{-4} m^2 for each element. The lengths of the elements are shown in the figure. [16 marks]

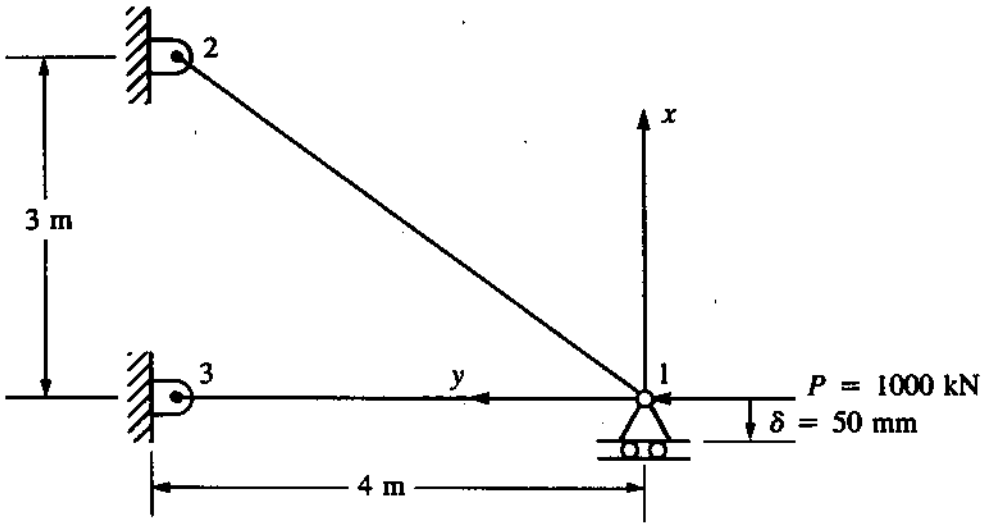


Figure:Q4 A two-bar truss system

PART B: (USE SEPARATE BOOKLET FOR THIS PART)

Question 5.

a) The ratio of mix water to cement (W/C) has the greatest influence on both the strength and durability of concrete. What is the effect of reducing the W/C on strength and durability? Explain. **[4 marks]**

b) You are asked to do a preliminary design of a braced 4 meter high column that is fixed to the foundation at its base and must carry a factored axial compressive load of 1100 kN. It can be assumed that the unbalanced bending moment is neglible and the top of the column is a pin type connection. Determine whether the minimum longitudinal reinforcement is adequate if, for architectural reasons, the cross-section must be 2 meters wide and 600 mm thick. 32 MPa concrete is to be used. **[7 marks]**

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Question 6.

a) You have been asked to determine whether a cantilevered Reinforced Concrete balcony on a flat located near the beach front is adequate. The slab is 160 mm thick and the primary reinforcement consists of Y16 bars spaced at 150 mm. The concrete strength is 40 MPa and the clear cover to the primary reinforcement was found to be 24 mm. Calculate the safe bending moment capacity (ie. ϕM_u in units of kNm/m width). Comment on the durability of the balcony. **[15 marks]**

b) Is the behaviour of the balcony described in part a) ductile? Give reasons for your answer. Briefly explain what influences the ductility of a reinforced concrete structure and why ductility is important. **[4 marks]**

End of Examination paper.