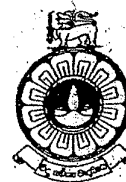


The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering



Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: CVX7343 Bridge Engineering
Academic Year	: 2023/24
Date	: 16 th February 2025
Time	: 1330-1630hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

QUESTION 1

- (i) "Masonry arches are one of most durable bridges in the world". Logically explain above statement. (3 Marks)
- (ii) A three hinged parabolic arch bridge of uniform cross section is loaded as shown in Figure Q1. C is an internal hinge. Arch span and crest height are 18 m and 8m, respectively. It is subjected to a uniformly distributed load and one concentrated load as shown in the Figure.

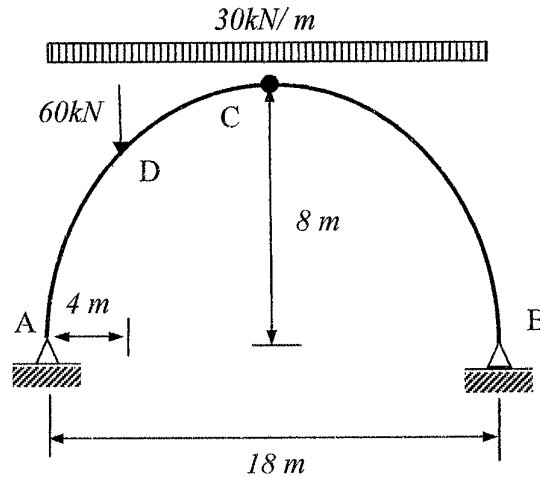


Figure Q1

- a) Determine the mathematical expression for the geometry of the arch. (4 Marks)
- b) Determine the support reactions at A and B. (4 Marks)
- c) Determine the location and magnitude of maximum bending moment. (6 Marks)
- d) Briefly explain material selection for above arch bridge construction. (3 Marks)

QUESTION 2

- (i) Describe the basic difference between suspension bridges and cable stayed bridges. (4 Marks)
- (ii) A cable of a uniform cross section is used to hang three concentrated loads as shown in Figure Q2 (not to scale)
 - (a) Determine support reactions at A and B. (4 Marks)
 - (b) Determine the cable deflections at C and E (y_c and y_e). (4 Marks)
 - (c) Determine cable tension in AC, CD, DE and EB sections. (8 Marks)

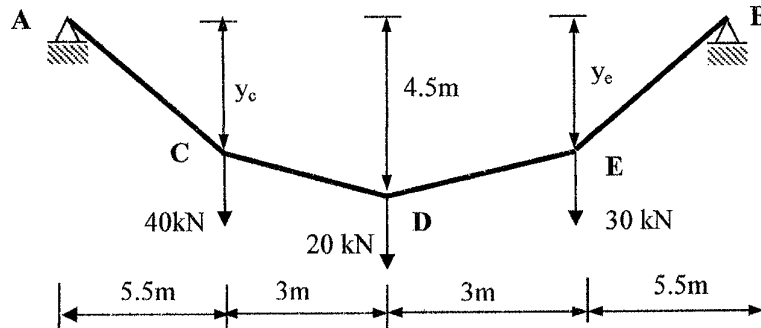


Figure Q2

QUESTION 3

- (i) Describe how the internal forces and deflections of real trusses vary from pin-jointed truss analysis results (3 Marks)
- (ii) A pin-jointed truss is loaded as shown in Figure Q3. Determine member forces using the method of joints. (8 Marks)

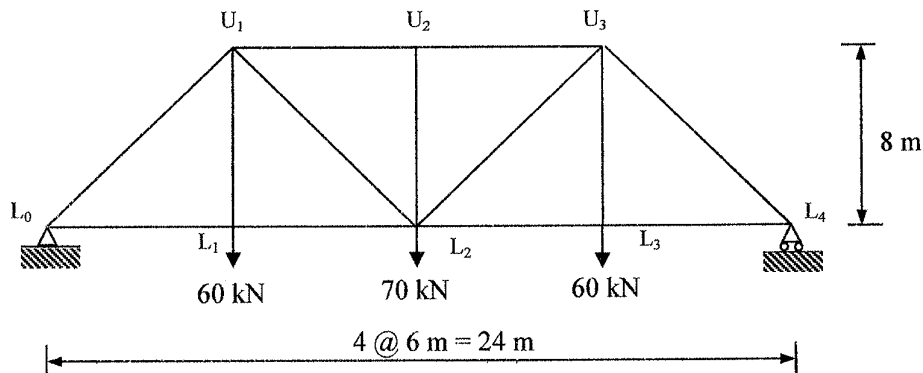


Figure Q3

- (iii) Describe the reasons for using steel as a material for railway bridge construction. (9 Marks)

QUESTION 4

- (i) Write short notes on following topics.
- (a) The bolt and rivet connections (2 Marks)
 - (b) Load Models in Euro codes (BS EN 1992-1-2 Action on Bridges) (2 Marks)
 - (c) HA loading and HB loadings (2 Marks)
- (ii) Explain the “null method” used in static strain measurements. (6 Marks)
- (iii) Two electrical resistance strain gauges (ϵ_1 and ϵ_2) are attached to a steel column in parallel direction to the length of the column to measure its axial load and bending moment. During load application, it was found that the strain gauge 1 (ϵ_1) experienced a strain of $450\mu\epsilon$ (micro strains) while strain gauge 2 (ϵ_2) experienced -400 (negative 400) $\mu\epsilon$. Steel has an elastic modulus of 210 GPa. The geometry of the section is shown in Figure Q4. Determine axial load and bending moment of the section.

(8 Marks)

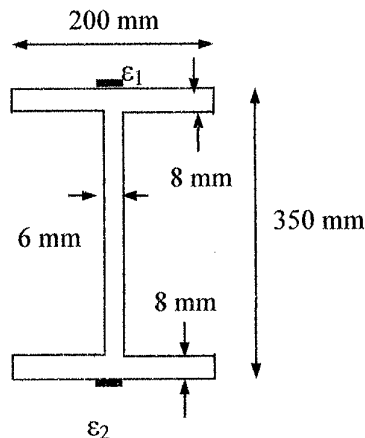


Figure Q4

QUESTION 5

- (i) Discuss the difference between High Cycle Fatigue and Low Cycle Fatigue with emphasis on bridge engineering applications. (6 Marks)
- (ii) A bridge member is subjected to six loading cases as shown in following Table. The bridge material is an old form of iron with yield strength of 175 MPa and endurance limit of 30 MPa.

Load Case	Maximum Stress (MPa)	Minimum Stress (MPa)	No of applied Load Cycles	No of Cycles to Failure from S-N curve
1	80	25	15000	4.5×10^6
2	100	25	75000	3.5×10^6
3	120	20	40000	1.5×10^6
4	50	15	90000	11.0×10^6
5	140	30	20000	1.0×10^6
6	60	30	30000	5.0×10^6

- (a) Determine mean stress, stress range and stress amplitude of load cases. (5 Marks)
- (b) Determine damage accumulation using the Miner's rule. (5 Marks)
- (iii) Discuss one shortcoming of Miner's rule in bridge engineering applications. (4 Marks)

QUESTION 6

- (i) Briefly explain the difference between arch bridges over tie arch bridges in structural engineering point of view. (4 Marks)
- (ii) Briefly explain how corrosion affects to condition deteriorations of reinforced concrete deck bridges. (6 Marks)
- (iii) "Forensic investigations of bridge failures have contributed immensely to present understanding of bridge performance under different loading scenarios". Discuss above statement giving a few bridge failures in other countries than Sri Lanka (Donot get examples from Sri Lanka). (5 Marks)
- (iv) Briefly explain similarities between Paragastota bridge failure and Keppettigala bridge failure. (5 Marks)