



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

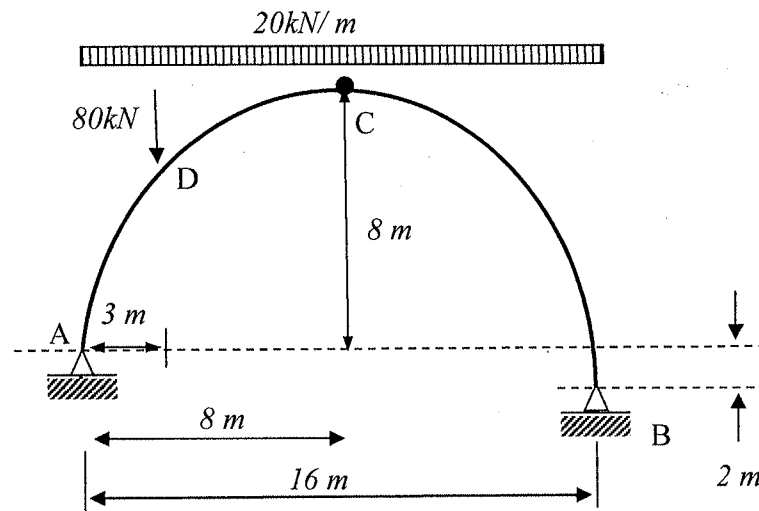
Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: CVX7343 Bridge Engineering
Academic Year	: 2024/25
Date	: 08 th February 2026
Time	: 1400-1700 hrs
Duration	: 3 hours

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) Briefly describe three types of arch bridges with sketches. (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 16 m and 8m, respectively. It is subjected to a uniformly distributed load and one concentrated load as shown in the Figure Q1.

**Figure Q1**

- Determine the mathematical expression for the geometry of the arch (4 Marks)
- Determine the support reactions at A and B (4 Marks)
- Determine the bending moment and the shear force at the point D. (4 Marks)
- Determine the internal forces at the point C. (3 Marks)
- Propose a suitable construction material to be used for the construction of this arch bridge by giving logical reasons. (2 Marks)

QUESTION 2

- (i) Describe the load transfer mechanism of suspension bridges. (4 Marks)
- (ii) A cable of a uniform cross section is used to hang three concentrated loads as shown in Figure Q2.
- Determine support reactions at A and B. (4 Marks)
 - Determine the cable deflections at C and E (y_c and y_e). (4 Marks)
 - Determine cable tension in AC, CD, DE and EB sections. (6 Marks)
 - Determine the design diameter of the cable so that there is a factor of safety against yielding is 3.0. (You can assume the yield strength of cable material as 235 N/mm^2) (2 Marks)

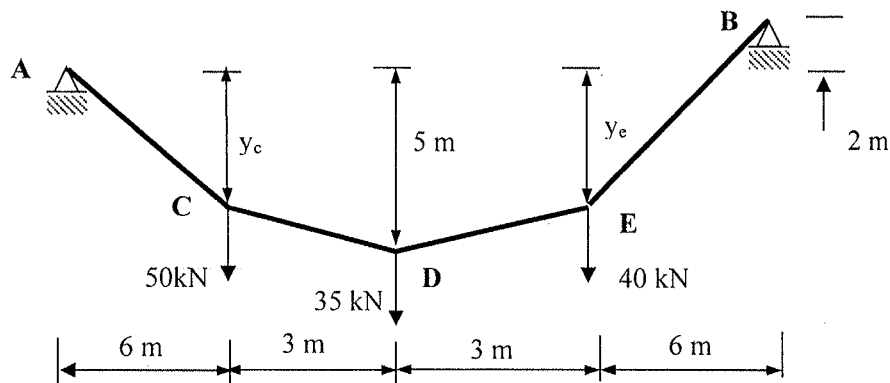


Figure Q2

QUESTION 3

- (i) Describe the differences between through bridge, semi through bridge and underslung bridge. (3 Marks)
- (ii) A pin-jointed truss is loaded as shown in Figure Q3. Determine member forces using the method of sections and method of joints. (12 Marks)
- (iii) Describe the difference between Warren truss with Pratt truss (3 Marks)

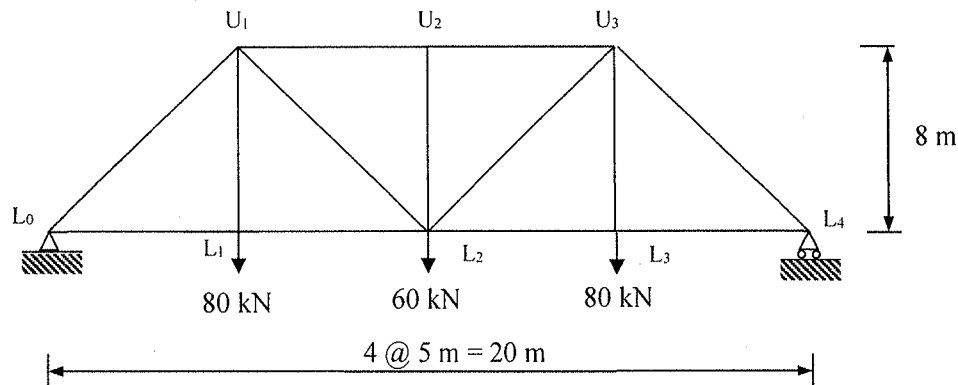


Figure Q3

- (iv) Explain the functions of wind bracing and sway bracing in steel truss bridges (2 Marks)

QUESTION 4

- (i) Write short notes on following topics.

- (a) Segmental bridge construction (2 Marks)
- (b) Load Models in AASHTO code (2 Marks)
- (c) Normal loading and abnormal loading on bridges (2 Marks)

- (ii) Explain how torsional stiffness is increased in box girder bridges. (3 Marks)

- (iii) Two electrical resistance strain gauges (ϵ_1 and ϵ_2) are attached to a steel foot bridge pier 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 $550\mu\epsilon$ (micro strains) while strain gauge 2 (ϵ_2) experienced -350 (negative 350) $\mu\epsilon$. Steel has an elastic modulus of 200 GPa. The geometry of the section is shown in Figure Q4. Determine axial load and bending moment of the section. (11 Marks)

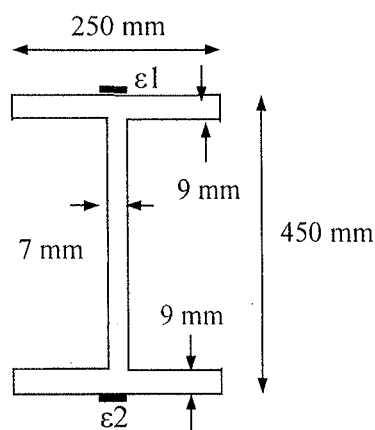


Figure Q4

QUESTION 5

- (i) Discuss the importance of Ultra Low Cycle Fatigue in bridge fatigue damage assessments. (4 Marks)
- (ii) A bridge member is subjected to six loading cases per day 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/ Per day	No of Cycles to Failure from S-N curve
1	80	25	7	4.5×10^6
2	100	25	10	3.5×10^6
3	120	20	9	1.5×10^6
4	50	15	6	11×10^6
5	140	30	12	1.0×10^6
6	60	30	5	5.0×10^6

Table Q5

- (a) Determine stress ratio, mean stress, stress range and stress amplitude for each load Cases. (4 Marks)
- (b) Determine damage accumulation after 30 years of service using Miner's rule. (5 Marks)
- (c) Determine remaining fatigue life after 30 years of service (3 Marks)
- (d) Discuss one shortcoming of Miner's rule in bridge engineering applications. (4 Marks)

QUESTION 6

- (i) Briefly explain the difference between "bow-string arch bridges" over conventional arch bridges in structural engineering point of view. (4 Marks)
- (ii) Briefly explain the limitations of reinforced concrete deck bridges. (6 Marks)
- (iii) Iron and steel have been used for bridge construction from the beginning of 19th century. Describe different types of iron and steel used for bridge construction highlighting their respective mechanical properties. (5 Marks)
- (iv) Briefly explain how the failure triggered in Minnesota bridge failure of USA. (5 Marks)