Second Semester Examination
2020/2021 Academic Session

July/August 2021

EAS254 – Structural Analysis

Duration : 3 hours

Please check that this examination paper consists of **SEVEN (7)** pages of printed material before you begin the examination.

Instructions: This paper contains **FIVE (5)** questions. Anwser **ALL** questions.

All questions **MUST BE** answered on a new page.

1. (a). Determine the vertical displacement at point C for the truss shown in **Figure 1** if two concentrated loads of P_1 are applied vertically downward at points G and I and a concentrated load of P_2 is applied vertically downward at point H. The cross-sectional area of each member is given in parentheses (mm^2) and the modulus of elasticity is 200 GPa. Consider the axial deformation only and the values of all applied loads are given in **Table 1**. Use the method of virtual work.

[14 marks]

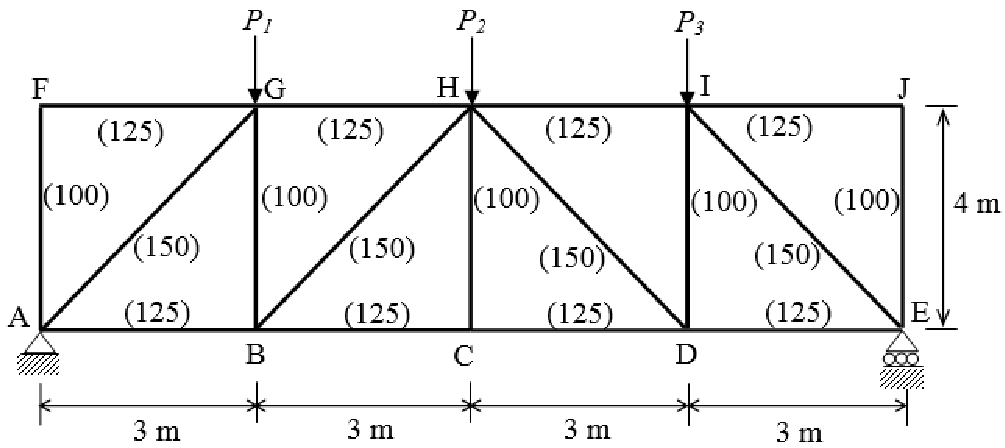

Figure 1

Table 1

Last digit of index number	P_1 (kN)	P_3 (kN)	Second last digit of index number	P_2 (kN)
0	7.5	7.5	0	32.5
1	10	10	1	35
2	12.5	12.5	2	37.5
3	15	15	3	40
4	17.5	17.5	4	42.5
5	20	20	5	45
6	22.5	22.5	6	47.5
7	25	25	7	50
8	27.5	27.5	8	52.5
9	30	30	9	55

Note: If your index number is 50038, use P_1 = 27.5 kN, P_2 = 40 kN and P_3 = 27.5 kN.

(b) Determine the vertical displacement at point C of the same truss as shown in **Figure 1** without the applied loads of P_1, P_2 and P_3 but due to temperature increase of 55^{o}C in member AG, member BH is 10 mm too short and member DH is 6 mm too long. The coefficient of thermal expansion of the member is $1.08\times10^{-5}/^oC$. Use the method of virtual work.

[6 marks]

2. **Figure 2** shows a beam carrying a uniformly distributed load of 20 kN/m on span ABC, a triangular load varying from 20 kN/m to 0 kN/m on span CD and an inclined point load of 25 kN at mid span BC. Supports A and D are fixed, whereas supports B and C are pinned. *EI* is constant for the beam.

(a) Compute the internal moments at the joints of the beam by using the moment distribution method. Fixed end moment is given in the **Appendix**.

[13 marks]

(b) Draw the bending moment diagram and the qualitative deflected shape for the beam.

[5 marks]

(c) Without any calculation, sketch the new bending moment diagram and the deflected shape if supports A and D are changed to pinned supports.

[2 marks]

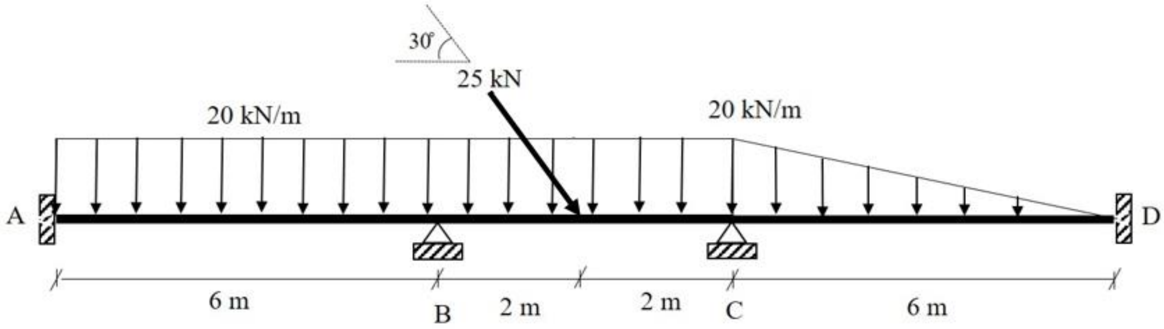

Figure 2

3. **Figure 3** shows a beam carrying point loads of 10 kN along span ABC at certain distance. Meanwhile, span CD carries a uniformly distributed load of 3 kN/m and a point load of 8 kN acting at 30° from the horizontal plane at overhang portion of span DE. Support A is fixed and supports B, C and D are pinned. The moment of inertia of spans AB, BC, CD and DE are *3I*, *2I*, *1.5I* and *I*, respectively. *E* is constant for the beam. Compute the internal moments at the joint of the beam by using the slope deflection method. Fixed end moment is given in the **Appendix.**

[20 marks]

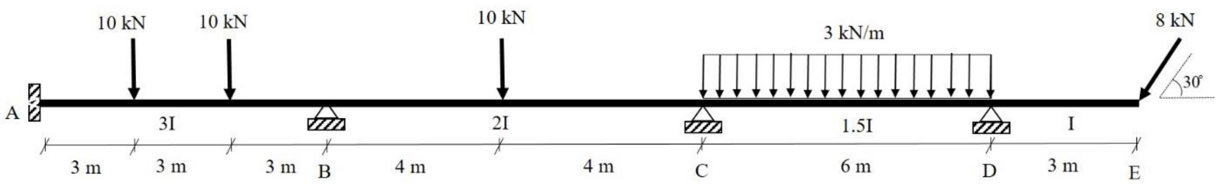

Figure 3

4. A two-span continuous steel beam as shown in **Figure 4** supports uniformly distributed loads of 3 kN/m, 10 kN/m and 7 kN/m along spans AD, DB and BC, respectively and a concentrated load of 40 kN at D. The continuous beam is supported by a pin at A and rollers at B and C. The spans AB and BC of the beams have the second moment of area of 79100 cm^4 and 57100 cm^4, respectively. The Young's modulus of the steel beam is 200 GN/m^2.

   (a). Determine the reaction forces at all supports A, B and C of the continuous beam using the method of least work.

   [17 marks]

   (b). Consider initial settlement of 50 mm at the support that was chosen as redundant in part (a), calculate the new reaction forces at all supports.

   [3 marks]

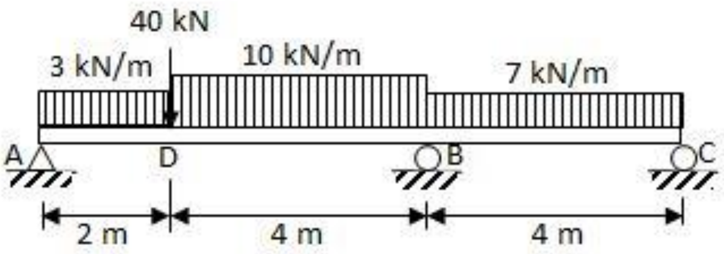

Figure 4

5. **Figure 5** shows a rigid-jointed frame carrying the working loads. If the collapse load factor is 1.35, determine the required plastic moment capacity (M_p) for the frame. Consider all possible mechanisms. The values of w_1, w_2, P_1, H_1 and H_2 are given in **Table 2**.

   [20 marks]

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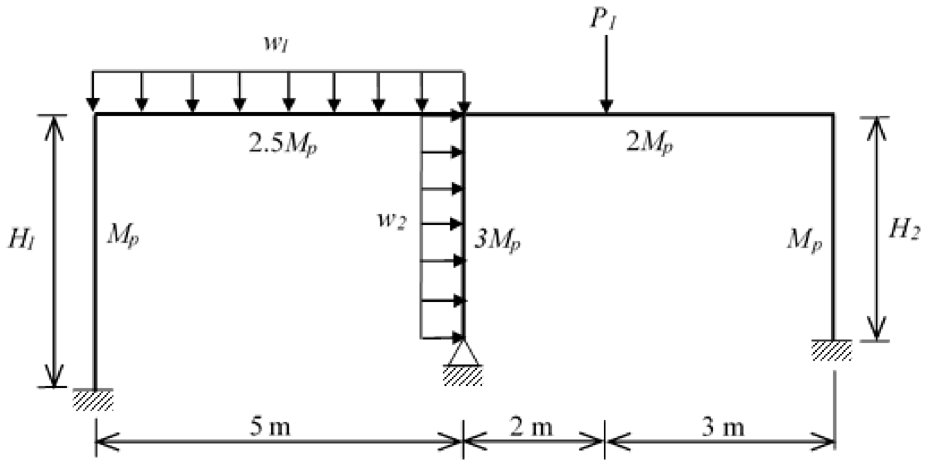

Figure 5

Table 2

Last digit of index number	w_1 (kN/m)	P_1 (kN)	Second last digit of index number	w_2 (kN/m)	H_1 *(m)*	H_2 *(m)*
0	2.5	15	0	7	4.5	3.5
1	3	20	1	6.5	5	4
2	3.5	25	2	6	5.5	4.5
3	4	30	3	5.5	6	5
4	4.5	35	4	5	6.5	5.5
5	5	40	5	4.5	7	6
6	5.5	35	6	4	6	7
7	6	30	7	3.5	5.5	6.5
8	6.5	25	8	3	5	6
9	7	20	9	2.5	4.5	5.5

Note: If your index number is 50038, use w_1 = 6.5 kN/m, w_2 = 5.5 kN/m, P_1 = 25 kN, H_1 = 6 m and H_2 = 5 m.

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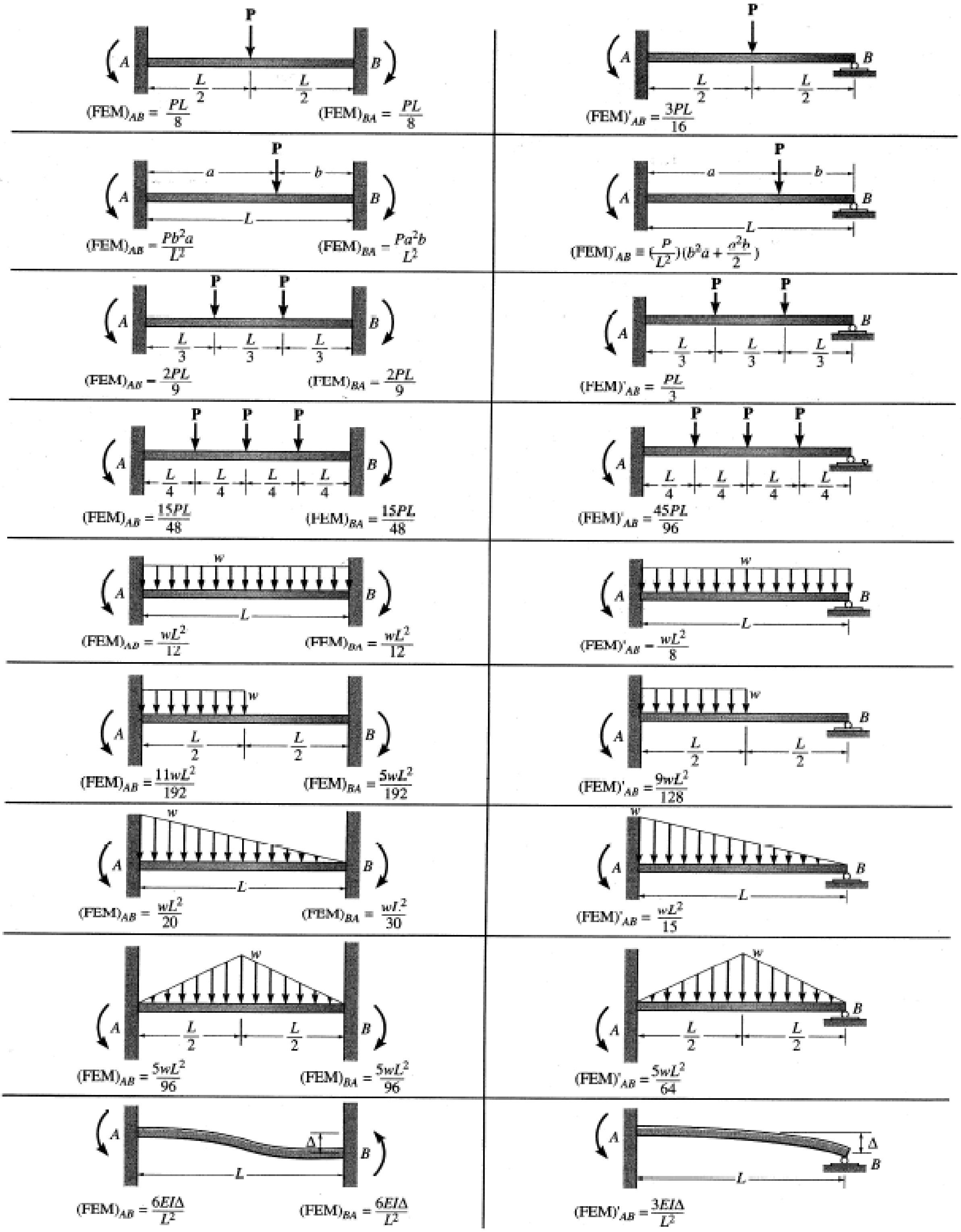
APPENDIX



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