Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20
Course Code: CIV 209
Course Name: STRUCTURAL ANALYSIS - II
Program & Sem: B. TECH (CIV) & V

Date: 27.09.2019
Time: 2:30PM to 3:30PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) *Write legibly and draw clear diagrams wherever required.*
(ii) *Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.*
(iii) *Scientific and non-programmable calculators are permitted.*

Part A [Memory Recall Questions]

Answer the Question. The Question carries ten marks **(1Qx10M=10M)**

1. Recall the Fixed End Moments for the beams shown in figures 1 & 2 below:

a.

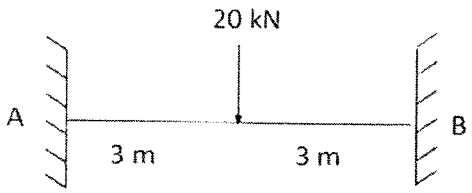


Figure 1

b.

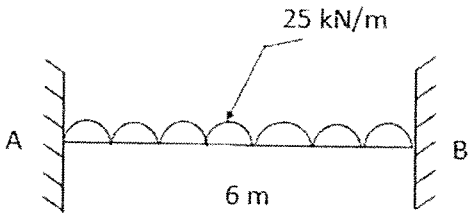


Figure 2

[5+5M]
(C.O.NO.1) [Knowledge]

Part B [Thought Provoking Questions]

Answer the Question. The Question carries fifteen marks. (1Qx15M=15M)

2. A beam is to be provided for a house. The load on the beam is shown in figure 3. Solve the given continuous beam by slope deflection method. Draw the Bending Moment Diagram (BMD) and Shear Force Diagram (SFD).
(C.O.NO.1) [Application]

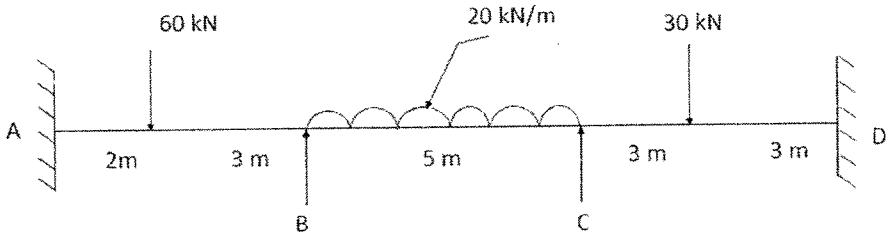


Figure 3

Part C [Problem Solving Questions]

Answer the Question. The Question carries fifteen marks. (1Qx15M=15M)

3. Solve the given frame shown in figure 4 by slope deflection method. Draw the Bending Moment Diagram (BMD). (C.O.NO.1) [Application]

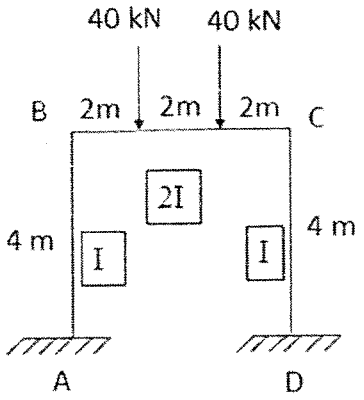


Figure 4

SCHOOL OF ENGINEERING

Semester: 5th

Course Code: CIV 209

Course Name: Structural Analysis – II

Branch & Sem: Civil, 5th

Date: 27 September 2019

Time: 1 hr 30 mins

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	CO1	Module – 1	5	5								10
2	CO1	Module – 1							15			15
3	CO1	Module – 1							15			15
	Total Marks		5	5					30			40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Dr. S B Anadinni]

Reviewers' Comments

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: 5TH

Course Code: CIV 209

Course Name. Structural Analysis – II

Branch & Sem: Civil, 5th

Date: 27 September 2019

Time: 1 hr 30 mins

Max Marks: 40

Weightage: 20%

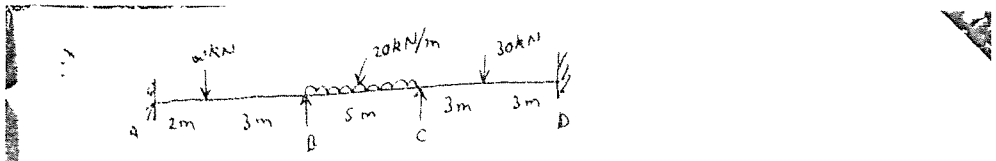
Part A (1Q x 10M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1a	$M_{FAB} = -\frac{WL}{8} = -\frac{20\times6}{8} = -15\,kNm$ $M_{FBA} = \frac{WL}{8} = \frac{20\times6}{8} = 15\,kNm$	5 marks	1 min

1b	$M_{FAB} = -\frac{WL^2}{12} = -\frac{25 \times 6^2}{12} = -75\,kNm$ $M_{FBA} = \frac{WL^2}{12} = \frac{25 \times 6^2}{12} = 75\,kNm$	5 marks	1 min

Part B

(1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
2	 Fixed End moments $M_{FAB} = -\frac{Wab^2}{L^2} = -\frac{60 \times 2 \times 3^2}{5^2} = -43.2\,kNm$ $M_{FBA} = +\frac{Wa^2b}{L^2} = \frac{60 \times 2^2 \times 3}{5^2} = 28.8\,kNm$ $M_{FBC} = -\frac{WL^2}{12} = -\frac{20 \times 5^2}{12} = -41.67\,kNm$ $M_{FCB} = \frac{WL^2}{12} = \frac{20 \times 5^2}{12} = 41.67\,kNm$ $M_{FCD} = -\frac{WL}{8} = -\frac{30 \times 6}{8} = -22.5\,kNm$ $M_{FDC} = \frac{WL}{8} = \frac{30 \times 6}{8} = 22.5\,kNm$ Slope deflection equations $M_{AB} = \frac{2EI}{5}[\theta_B] - 43.2 = 0.4EI(\theta_B) - 43.2 \rightarrow (1)$ $M_{BA} = \frac{2EI}{5}[2\theta_B] + 28.8 = 0.8EI(\theta_B) + 28.8 \rightarrow (2)$ $M_{BC} = \frac{2EI}{5}[2\theta_B + \theta_C] - 41.67 = 0.8EI(\theta_B) + 0.4EI(\theta_C) - 41.67 \rightarrow (3)$ $M_{CB} = \frac{2EI}{6}[2\theta_C + \theta_B] + 41.67 = 0.8EI(\theta_C) + 0.4EI(\theta_B) + 41.67 \rightarrow (4)$ $M_{CD} = \frac{2EI}{6}[2\theta_C] - 22.5 = 0.67EI(\theta_C) - 22.5 \rightarrow (5)$ $M_{DC} = \frac{2EI}{6}[\theta_C] + 22.5 = 0.33EI(\theta_C) + 22.5 \rightarrow (6)$	FEM's = 4 marks Final Moments = 4 marks BMD = 4 marks SFD = 3 marks	44 mins

iii) Equilibrium conditions

At 'B', $M_{BA} + M_{BC} = 0$

$0.8EI(\theta_B) + 28.8 + 0.8EI(\theta_B) + 0.4EI(\theta_C) - 41.67 = 0$

$1.6EI(\theta_B) + 0.4EI(\theta_C) = -12.87 \rightarrow (a)$

At 'C', $M_{CB} + M_{CD} = 0$

$0.8EI(\theta_B) + 0.4EI(\theta_B) + 41.67 + 0.67EI(\theta_C) - 22.5 = 0$

$0.4EI(\theta_B) + 1.47EI(\theta_C) = -19.17 \rightarrow (b)$

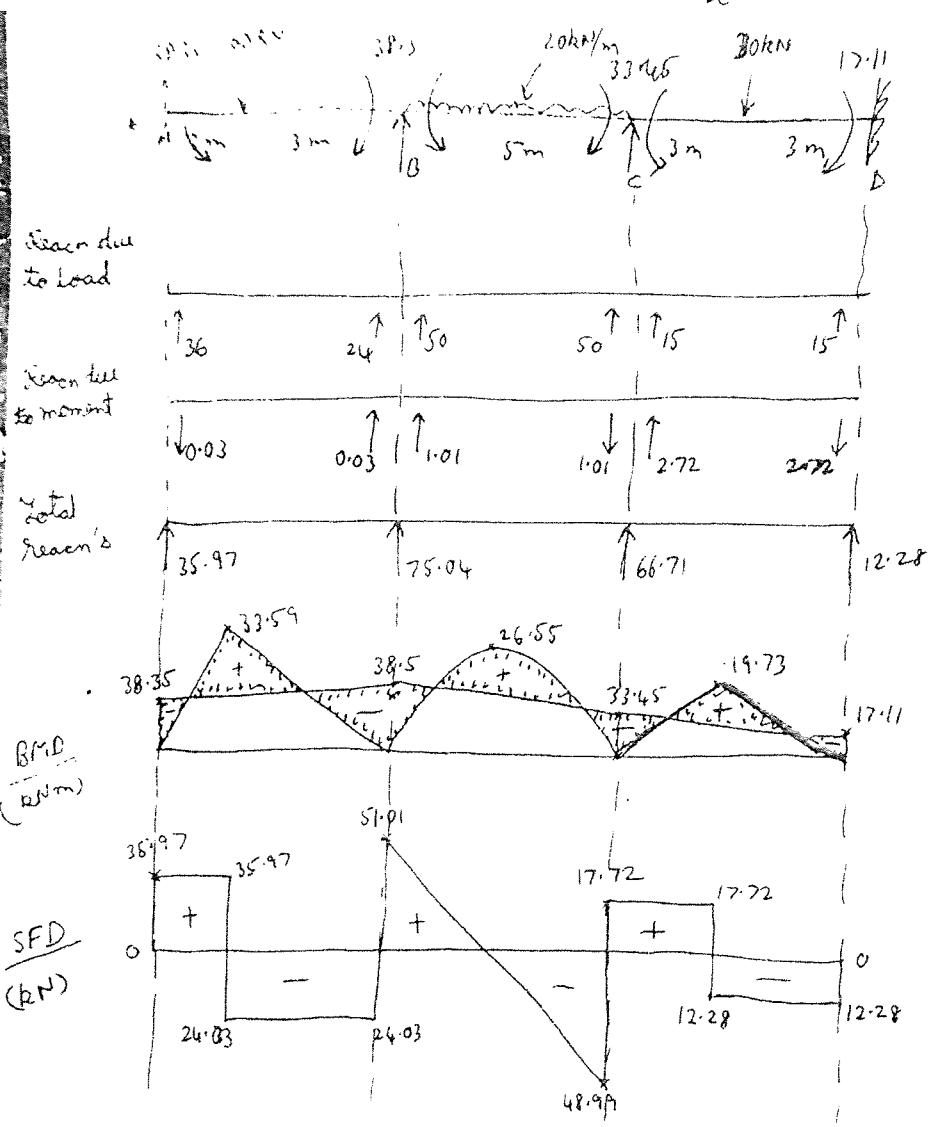
On solving (a) & (b) simultaneously, we get,

$\theta_B = 12.13/EI \qquad \theta_C = -16.34/EI$

iv) Final moments

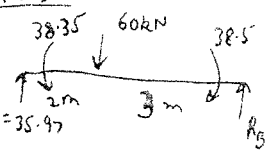
$M_{AB} = -38.35\ kNm \qquad M_{BC} = -38.50\ kNm \qquad M_{CD} = -33.45\ kNm$

$M_{BA} = 38.50\ kNm \qquad M_{CB} = 33.45\ kNm \qquad M_{DC} = 17.11\ kNm$



Max BM

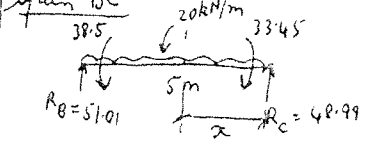
Span AB



$BM_{max} = 24.03 \times 3 - 38.5$

$= 33.59\ kNm$

Span BC



$BM_x = 48.99x - 33.45 - \frac{20x^2}{2}$

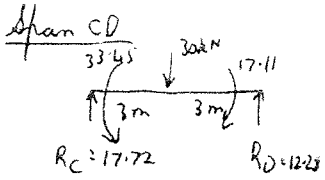
$\frac{dBM_x}{dx} = 0 \Rightarrow 48.99 - 20x = 0$

$x = 2.45\ m$

$\therefore BM_{max} = 48.99 \times 2.45 - 33.45 - \frac{20 \times 2.45^2}{2}$

$= 26.55\ kNm$

Span CD

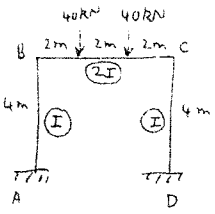


$BM_{max} = 12.28 \times 3 - 17.11$

$= 19.73\ kNm$

Part C

(1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
3	 i) Fixed end moments $M_{FAB} = M_{FBA} = M_{FCD} = M_{FDC} = 0$ $M_{FBC} = -\frac{Wab^2}{L^2} = -\left[\frac{40 \times 2 \times 4^2}{6^2} + \frac{40 \times 4 \times 2^2}{6^2}\right] = -53.33\ kNm$ $M_{FCB} = \frac{Wa^2b}{L^2} = \left[\frac{40 \times 2^2 \times 4}{6^2} + \frac{40 \times 4^2 \times 2}{6^2}\right] = 53.33\ kNm$ ii) Slope Deflection Equations $M_{AB} = \frac{2EI}{4}[\theta_B] = 0.5EI(\theta_B) \rightarrow (1)$ $M_{BA} = \frac{2EI}{4}[2\theta_B] = EI(\theta_B) \rightarrow (2)$ $M_{BC} = \frac{2E \times 2I}{6}[2\theta_B + \theta_C] - 53.33 = 1.33EI(\theta_B) + 0.67EI(\theta_C) - 53.33 \rightarrow (3)$ $M_{CB} = \frac{2E \times 2I}{6}[2\theta_C + \theta_B] + 53.33 = 1.33EI(\theta_C) + 0.67EI(\theta_B) + 53.33 \rightarrow (4)$ $M_{CD} = \frac{2EI}{4}[2\theta_C] = EI(\theta_C) \rightarrow (5)$ $M_{DC} = \frac{2EI}{4}[\theta_C] = 0.5EI(\theta_C) \rightarrow (6)$	FEM`s = 5 marks Final Moments = 5 marks BMD = 5 marks	44 mins

iii) Equilibrium conditions

At "B", $M_{BA} + M_{BC} = 0$

$$EI(\theta_B) + 1.33EI(\theta_B) + 0.67EI(\theta_C) - 53.33 = 0$$

$$2.33EI(\theta_B) + 0.67EI(\theta_C) = 53.33 \rightarrow (a)$$

At 'C', $M_{CB} + M_{CD} = 0$

$$1.33EI(\theta_C) + 0.67EI(\theta_B) + 53.33 + EI(\theta_C) = 0$$

$$0.67EI(\theta_B) + 2.33EI(\theta_C) = -53.33 \rightarrow (b)$$

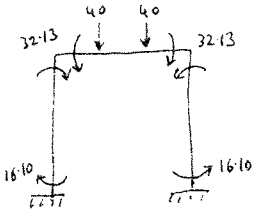
On solving (a) & (b) simultaneously, we get,

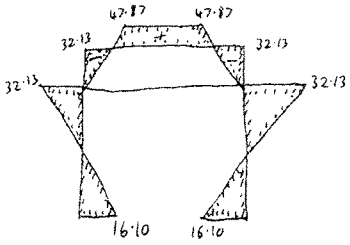
$\theta_B = 32.13/EI$ $\theta_C = -32.13/EI$

iv) Final moments

$M_{AB} = 16.10\,kNm$ $M_{BC} = -32.13\,kNm$ $M_{CD} = -32.13\,kNm$

$M_{BA} = 32.13\,kNm$ $M_{CB} = 32.13\,kNm$ $M_{DC} = -16.10\,kNm$





Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20 | **Date**: 16.11.2019

Course Code: CIV 209 | **Time**: 2:30 PM to 4:00 PM

Course Name: STRUCTURAL ANALYSIS - II | **Max Marks**: 40

Program & Sem: B. TECH (CIV) & V | **Weightage**: 20%

Instructions:

(i) Write legibly and draw clear diagrams wherever required.
(ii) Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.
(iii) Scientific and non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries two marks. **(5Qx2M=10M)**

1. In moment distribution method, the relative stiffness for a beam with a far end fixed support is

a. I/L
b. I/E
c. 3I/4L
d. AEI/L

(C.O.NO.2) [Knowledge]

2. The fixed end moment for a fixed beam with central point load is

a. WL/16
b. WL/12
c. $WL^2/12$
d. WL/8

(C.O.NO.2) [Knowledge]

3. In moment distribution method, the relative stiffness for a beam with an overhang is

a. I/L
b. I/E
c. 3I/4L
d. 0

(C.O.NO.2) [Knowledge]

4. In moment distribution method, the moment shared with the continuous or fixed support is

a. 100%
b. 25%
c. 50%
d. 75%

(C.O.NO.2) [Knowledge]

5. In moment distribution method, the relative stiffness for a beam with a far end pinned support is

a. I/L
b. I/E
c. 3I/4L
d. AEI/L

(C.O.NO.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer the Question. The Question carry fifteen marks. (1Qx15M=15M)

6. A beam is to be provided for a house. The load on the beam is shown in figure 1. Solve the given continuous beam by moment distribution method. Draw the Bending Moment Diagram (BMD) and Shear Force Diagram (SFD). EI is constant

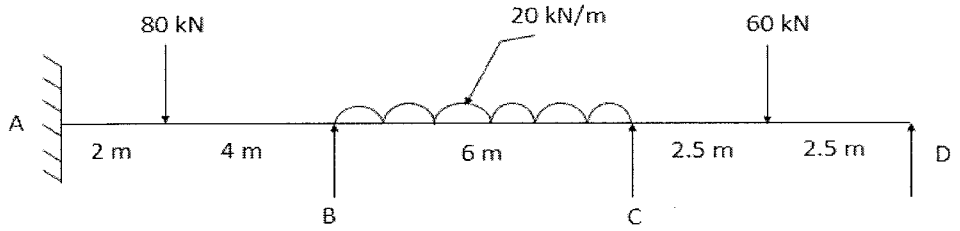


Figure 1

(C.O.NO.2) [Application]

Part C [Problem Solving Questions]

Answer the Question. The Question carry fifteen marks. (1Qx15M=15M)

7. Solve the given frame shown in figure 2 by moment distribution method. Draw the Bending Moment Diagram (BMD).

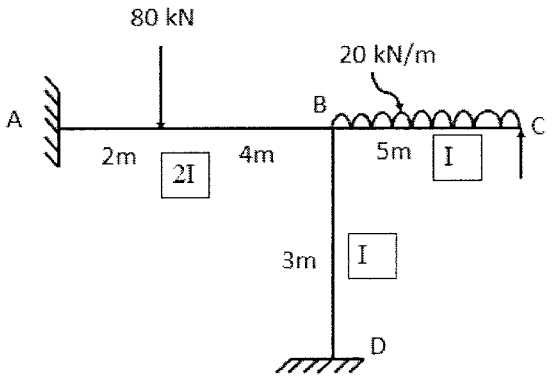


Figure 2

(C.O.NO.2) [Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 5th

Course Code: CIV 209

Course Name: Structural Analysis – II

Branch & Sem: Civil, & 5th

Date: 16 November 2019

Time: 1 hr 30 mins

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (%age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	CO2	Module – 2	2									2
2	CO2	Module – 2	2									2
3	CO2	Module – 2	2									2
4	CO2	Module – 2	2									2
5	CO2	Module – 2	2									2
6	CO2	Module – 2							15			15
7	CO2	Module – 2							15			15
	Total Marks		10						30			40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60% of the questions must be such that even a below average students must be able to attempt, about 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines. [Name of faculty]

Reviewer's Comments:

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: 5TH

Course Code: CIV 209

Course Name: Structural Analysis – II

Branch & Sem: Civil, & 5th

Date: 16 November 2019

Time: 1 hr 30 mins

Max Marks: 40

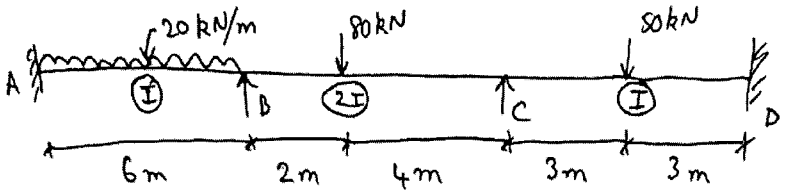
Weightage: 20%

Part A (5Q x 2M = 10 Marks)

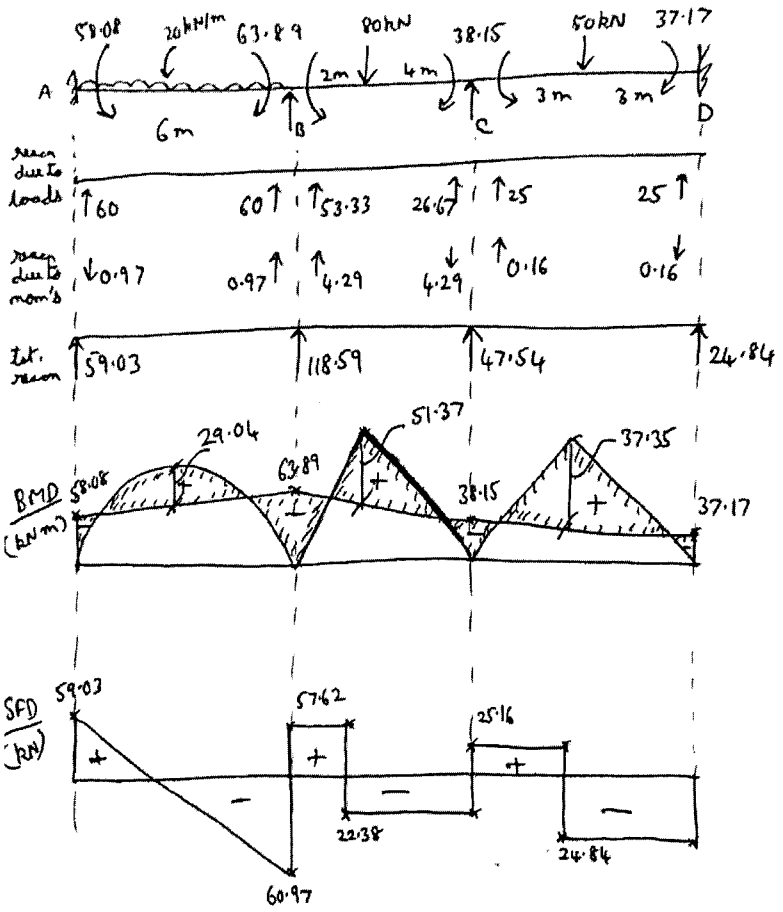
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	A	2 marks	2 mins
2	A	2 marks	2 mins
3	D	2 marks	2 mins
4	A	2 marks	2 mins
5	C	2 marks	2 mins

Part B (1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

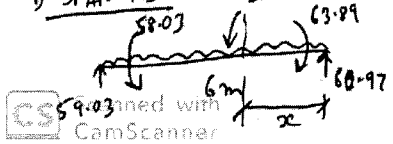
6	 i) Fixed End Moments [FEM] $M_{F_{AB}} = M_{F_{BA}} = \mp \frac{WL^2}{12} = \mp \frac{20\times6^2}{12} = \mp 60\,kNm$ $M_{F_{BC}} = -\frac{Wab^2}{L^2} = -\frac{80\times2\times4^2}{6^2} = -71.11\,kNm$ $M_{F_{CB}} = +\frac{Wa^2b}{L^2} = +\frac{80\times2^2\times4}{6^2} = +35.56\,kNm$ $M_{F_{CD}} = M_{F_{DC}} = \mp \frac{WL}{8} = \mp \frac{50\times6}{8} = \mp 37.5\,kNm$ ii) Distribution Factor [DF] Joint | member | k | Σk | D.F = $k/\Sigma k$ B | BA | $I/L = I/6 = 0.167I$ | $0.5I$ | 0.33 BC | $I/L = 2I/6 = 0.333I$ | 0.67 C | CB | $I/L = 2I/6 = 0.333I$ | $0.5I$ | 0.67 CD | $I/L = I/6 = 0.167I$ | 0.33 iii) MOMENT DISTRIBUTION TABLE [MDT] AB | 0.33 BA | 0.67 BC | 0.67 CB | 0.33 CD | DC -60 | +60 | -71.11 | 35.56 | -37.5 | +37.5 | FEM's 1.84 ← | 3.67 | 7.44 | 1.30 | 0.64 → | 0.32 | BAL | | 0.65 → | 3.72 | | | C.O. -0.11 ← | -0.21 | -0.44 | -2.49 | -1.23 → | -0.62 | BAL | | -1.25 → | -0.22 | | | C.O 0.21 ← | 0.41 | 0.84 | 0.15 | 0.07 → | 0.04 | BAL | | 0.08 → | 0.42 | | | C.O. -0.02 ← | -0.03 | -0.05 | -0.28 | -0.14 → | -0.07 | BAL | | -0.04 → | -0.03 | | | C.O. Scanned with CamScanner	15 marks FEMs = 2 marks DF's = 2 marks MDT = 3 marks BMD = 3 marks SFD = 2 marks Steps = 3 mark	40 mins

0·05		0·09		0·02	0·01		BAL
-58·08	63·89	-63·89	38·15	-38·15	37·17		FINAL MOMENTS
↺	↻	↺	↻	↺	↻		



MAX BM

i) SPAN AB



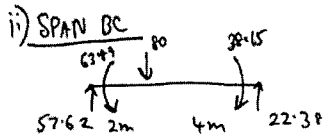
$BM_x = 60.97x - 63.89 - 20\frac{x^2}{2}$

$\frac{dBM_x}{dx} = 0 \Rightarrow 60.97 - 20x = 0$

$x = 3.05m$

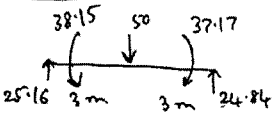
$BM_{max} = 29.04\ kNm$

ii) SPAN BC



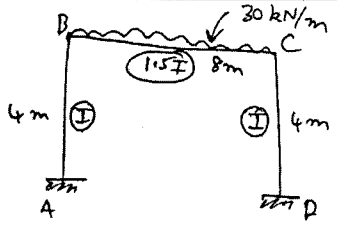
$BM_{max} = 22.38 \times 4 - 38.15 = 51.37\ kNm$

iii) SPAN CB



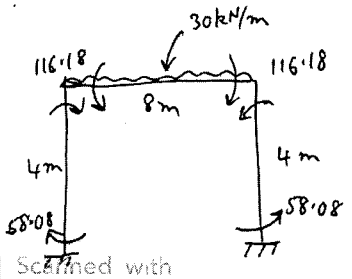
$BM_{max} = 24.84 \times 3 - 37.17 = 37.35\ kNm$

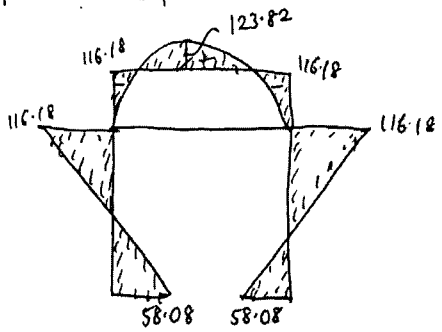
Part C (1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	 i) Fixed end moments $M_{F_{AB}} = M_{F_{BA}} = M_{F_{CD}} = M_{F_{DC}} = 0$ $M_{F_{BC}} = M_{F_{CB}} = \mp \frac{WL^2}{12} = \mp \frac{30 \times 8^2}{12} = \mp 160\ kNm$ ii) Distribution factors Joint | members | k | Σk | $DF = k/\Sigma k$ B | BA | $I/L = I/4 = 0.25I$ | $0.44I$ | 0.57 BC | $I/L = 1.5I/8 = 0.19I$ | 0.43 C | CB | $I/L = 1.5I/8 = 0.19I$ | $0.44I$ | 0.43 CD | $I/L = I/4 = 0.25I$ | 0.57 Scanned with	15 marks FEMs = 2 marks DF's = 2 marks MDT = 5 marks BMD = 3 marks Steps = 3 mark	40 mins

iii) Moment distribution table

	0.57	0.43	0.43	0.57		
AB	BA	BC	CB	CD	DC	
0	0	-160	+160	0	0	FEM's
	91.20	68.80	-68.80	-91.20		BAL
45.60		-34.40	34.40		-45.60	C.O
	19.61	14.79	-14.79	-19.61		BAL
9.81		-7.4	7.40		-9.81	C.O
	4.22	3.18	-3.18	-4.22		BAL
2.11		-1.59	1.59		-2.11	C.O
	0.91	0.68	-0.68	-0.91		BAL
0.46		-0.34	0.34		-0.46	C.O.
	0.19	0.15	-0.15	-0.19		BAL
0.10		-0.08	0.08		-0.1	C.O
	0.05	0.03	-0.03	-0.05		BAL
58.08	116.18	-116.18	116.18	-116.18	-58.08	FINAL MOMENTS





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Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20
Course Code: CIV 209
Course Name: STRUCTURAL ANALYSIS - II
Program & Sem: B.Tech (CIV) & V

Date: 23 December 2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Write legibly and draw clear diagrams wherever required.
(iii) Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.
(iv) Scientific and non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer the following question. The question carries 10 marks. (1Qx10M=10M)

1. Calculate the fixed moment for the beams shown in figures 1 to 5. [5Q*2M=10M]

i.

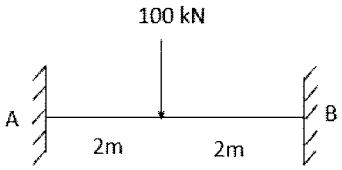


Figure 1

ii.

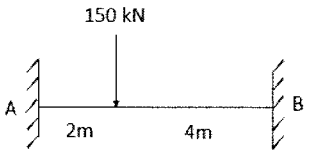


Figure 2

iii.

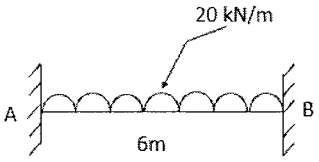
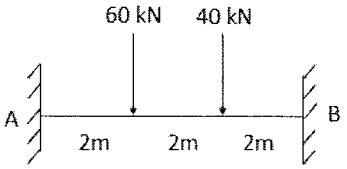


Figure 3

iv.



. Figure 4

v.

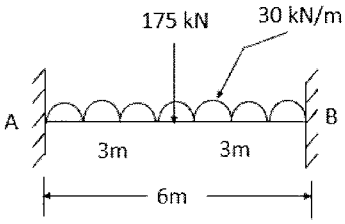


Figure 5

(C.O.No.1, C.O.No.2, C.O.No.3, C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries 15 marks. (2Qx15M=30M)

2. A beam is subjected to various loading on a project by an engineer. The loading is as shown in figure 6. Analyse the beam using slope deflection method and draw the bending moment diagram and shear force diagram. (C.O.No.1) [Application]

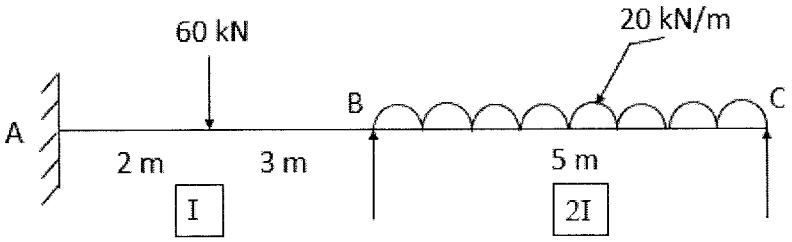


Figure 6

3. A beam is to be erected in the auditorium. The details of the loading and support conditions of beam are shown in figure 7. Analyse the beam using Kani's Method and draw the Shear Force Diagram and Bending Moment Diagram. (C.O.No.3) [Application]

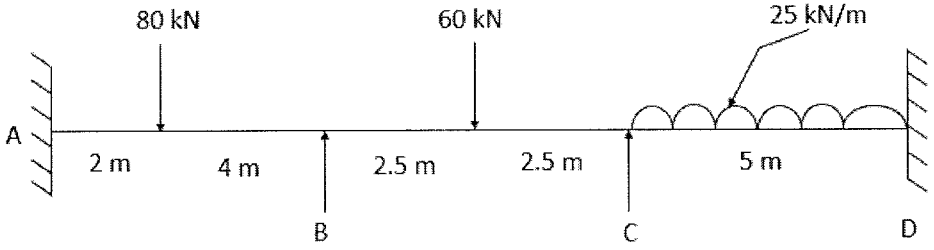


Figure 7

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries 20 marks. (2Qx20M=40M)

4. Analyse the frame shown in figure 8 by Kani's Method and draw the bending moment diagram. (C.O.No.3) [Application]

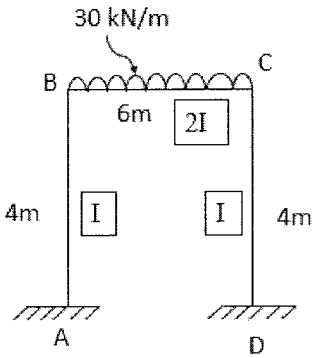


Figure 8

5. Analyse the beam shown in figure 9 by either flexibility matrix **or** stiffness matrix method and draw the shear force diagram and bending moment diagram. (C.O.NO. 4) [Application]

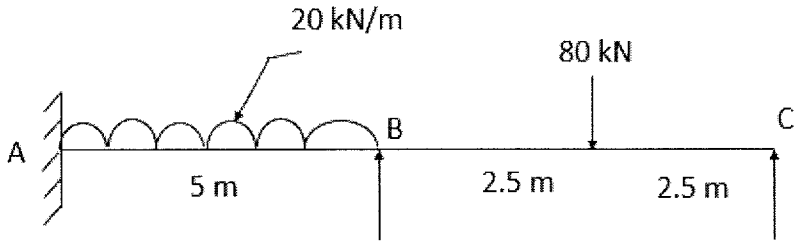


Figure 9

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	CO 1, CO 2, CO 3, CO 4	MODULE 1 MODULE 2 MODULE 3 MODULE 4	10			10
2	CO 1	MODULE 1			15	15
3	CO 3	MODULE 3			15	15
4	CO 3	MODULE 3			20	20
5	CO 4	MODULE 4			20	20
	Total Marks		10		70	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: Odd Sem. 2019-20
Course Code: CIV 209
Course Name: STRUCTURAL ANALYSIS - II
Program & Sem: B.TECH & 5TH

Date: 23.12.2019
Time: 9:30AM to 12:30AM
Max Marks: 80
Weightage: 40%

Part A

(1Q x 10M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	(i) a) $M_{F_{AB}} = -\frac{WL}{8} = -\frac{100\times4}{8} = -50\ kNm$ $M_{F_{BA}} = +\frac{WL}{8} = +\frac{100\times4}{8} = +50\ kNm$ b) $M_{F_{AB}} = -\frac{Wab^2}{L^2} = -\frac{150\times2\times4^2}{6^2} = -133.33\ kNm$ $M_{F_{BA}} = +\frac{Wa^2b}{L^2} = +\frac{150\times2^2\times4}{6^2} = +66.67\ kNm$ c) $M_{F_{AB}} = -\frac{WL^2}{12} = -\frac{20\times6^2}{12} = -60\ kNm$ $M_{F_{BA}} = +\frac{WL^2}{12} = +\frac{20\times6^2}{12} = +60\ kNm$ d) $M_{F_{AB}} = -\frac{Wab^2}{L^2} = -\left[\frac{60\times2\times4^2}{6^2} + \frac{40\times4\times2^2}{6^2}\right] = -71.11\ kNm$ $M_{F_{BA}} = +\frac{Wa^2b}{L^2} = +\left[\frac{60\times2^2\times4}{6^2} + \frac{40\times4^2\times2}{6^2}\right] = +62.22\ kNm$ e) $M_{F_{AB}} = -\frac{WL}{8} - \frac{WL^2}{12} = -\frac{175\times6}{8} - \frac{30\times6^2}{12} = -221.25\ kNm$ $M_{F_{BA}} = +\frac{WL}{8} + \frac{WL^2}{12} = +\frac{175\times6}{8} + \frac{30\times6^2}{12} = +221.25\ kNm$	2M EACH 5 * 2M = 10M	20 mins

Part B

(2Q x 15M = 30 Marks)

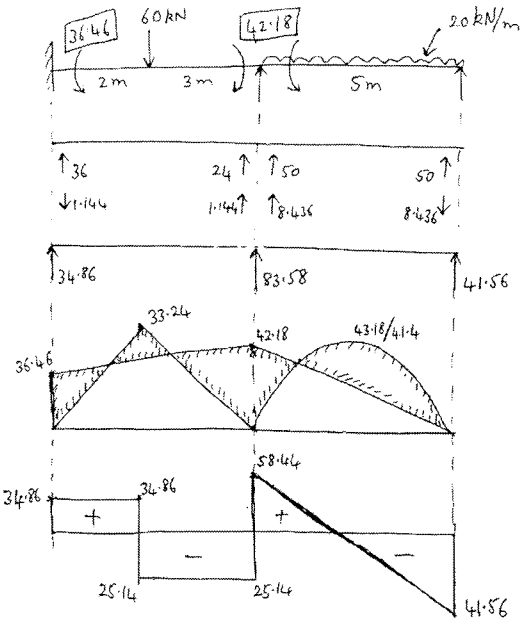
Q No	Solution	Scheme of Marking	Max. Time required for each Question

2	i) Fixed End Moments $M_{F_{AB}} = \frac{-wab^2}{L^2} = \frac{-60\times2\times3^2}{5^2} = -43.2\ kNm$ $M_{F_{BA}} = +\frac{Wa^2b}{L^2} = \frac{60\times2^2\times3}{5^2} = +28.8\ kNm$ $M_{F_{BC}} = M_{F_{CB}} = \mp\frac{WL^2}{12} = \mp\frac{20\times5^2}{12} = \mp 41.67\ kNm$ ii) Slope deflection equations $M_{AB} = M_{F_{AB}} + \frac{2EI}{L}[2\theta_A + \theta_B - \frac{3\psi}{L}]$ $M_{AB} = -43.2 + 0.4EI\theta_B \rightarrow (1)$ $M_{BA} = +28.8 + 0.8EI\theta_B \rightarrow (2)$ $M_{BC} = -41.67 + 1.6EI\theta_B + 0.8EI\theta_C \rightarrow (3)$ $M_{CB} = +41.67 + 1.6EI\theta_C + 0.8EI\theta_B \rightarrow (4)$ iii) Equilibrium Conditions At 'B', $M_{BA} + M_{BC} = 0$ $28.8 + 0.8EI\theta_B - 41.67 + 1.6EI\theta_B + 0.8EI\theta_C = 0$ $2.4EI\theta_B + 0.8EI\theta_C = 12.87 \rightarrow (a)$ At 'C', $M_{CB} = 0$ $41.67 + 1.6EI\theta_C + 0.8EI\theta_B = 0$ $0.8EI\theta_B + 1.6EI\theta_C = -41.67 \rightarrow (b)$ On solving simultaneously, $\theta_B = \frac{16.85}{EI}$ $\theta_C = -\frac{34.47}{EI}$	FEM=4M SDM=3M EQ COND=1M FM=2M BMD=3M SFD=2M	40 mins

iv) Final Moments

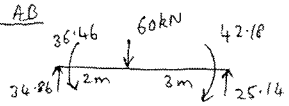
$M_{AB} = -36.46\ kNm$ $M_{BC} = -42.18\ kNm \approx -42.28\ kNm$

$M_{BA} = 42.28\ kNm$ $M_{CB} = 0$



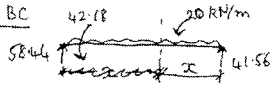
MAX BM

SPAN AB



$BM_{max} = 25.14 \times 3 - 42.18 = 33.24\ kNm$

SPAN BC

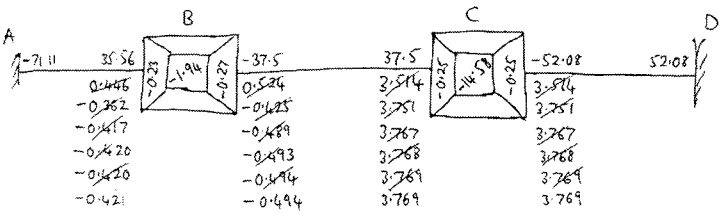


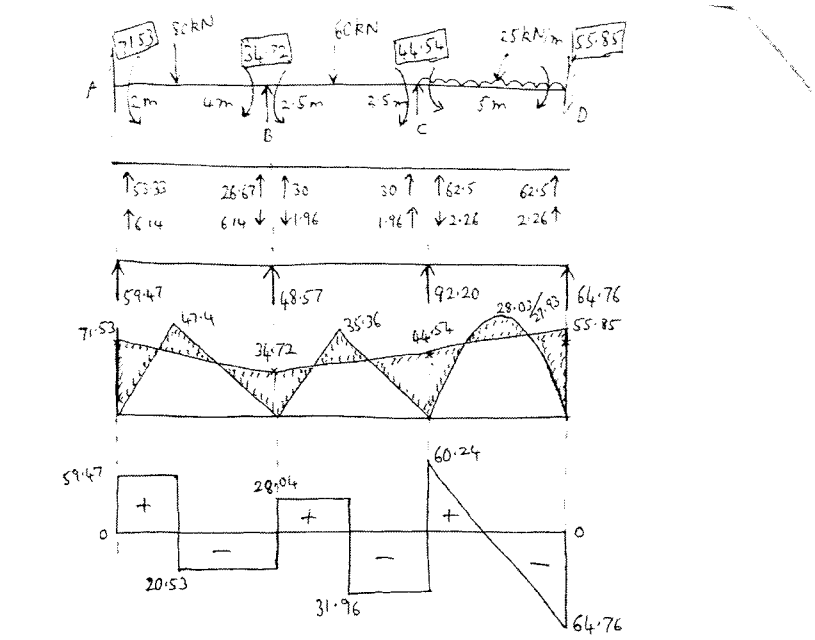
$BM_{x-x} = 41.56x - 20\frac{x^2}{2}$

$\frac{dM}{dx} = 41.56 - 20x = 0$

$x = 2.08\ m$

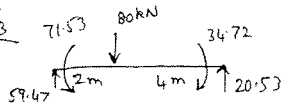
$BM_{max} = 43.18\ kNm / 41.4\ kNm$

3	i) Fixed End Moment $M_{F_{AB}} = -\frac{Wal^2}{L^2} = -\frac{80\times2\times4^2}{6^2} = -71.11\ kNm$ $M_{F_{BA}} = \frac{Wa^2b}{L^2} = +\frac{80\times2^2\times4}{6^2} = +35.56\ kNm$ $M_{F_{BC}} = M_{F_{CB}} = \mp\frac{WL}{8} = \mp\frac{60\times5}{8} = \mp 37.5\ kNm$ $M_{F_{CD}} = M_{F_{DC}} = \mp\frac{WL^2}{12} = \mp\frac{25\times5^2}{12} = \mp 52.08\ kNm$ ii) Rotation factors Joint | Member | k | Σk | RF = $-\frac{1}{2}\left(\frac{k}{\Sigma k}\right)$ B | BA | I/L = I/6 = 0.167I | 0.367 I | −0.23 BC | I/L = I/5 = 0.2I | | −0.27 C | CB | I/L = I/5 = 0.2I | 0.4 I | −0.25 CD | I/L = I/5 = 0.2I | | −0.25 iii) Kani's Method  iv) Final Moments $M_{AB} = M_{F_{AB}} + 2[\text{Near moments}] + [\text{Far moments}]$ $M_{AB} = -71.11 + 2(0) + -0.421 = -71.53\ kNm$ $M_{BA} = 35.56 + 2(-0.421) + 0 = 34.72\ kNm$ $M_{BC} = -37.5 + 2(-0.494) + 3.769 = -34.72\ kNm$ $M_{CB} = 37.5 + 2(3.769) - 0.494 = 44.54\ kNm$ $M_{CD} = -52.08 + 2(3.769) + 0 = -44.54\ kNm$ $M_{DC} = 52.08 + 2(0) + 3.769 = 55.85\ kNm$	FEM=4M RC=2M KANI ITER=3M FM=1M BMD=3M SFD=2M	40 mins



MAX BM

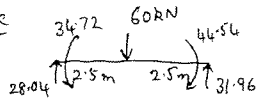
SPAN AB



$BM_{max} = 20.53 \times 4 - 34.72$

$= 47.4\ kNm$

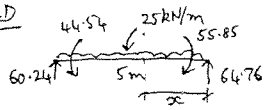
SPAN BC



$BM_{max} = 31.96 \times 2.5 - 44.54$

$= 35.36\ kNm$

SPAN CD



$BM_x = 64.76\,x - 25\frac{x^2}{2} - 55.85$

$\frac{dM_x}{dx} = 64.76 - 25x = 0$

$x = 2.59\ m$

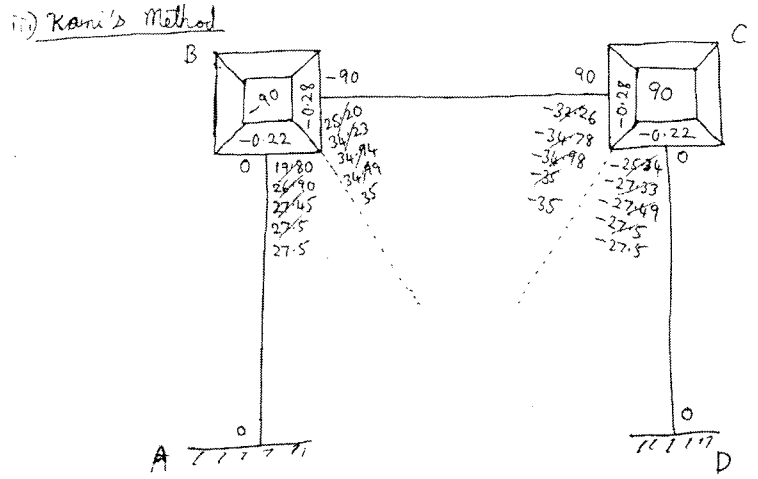
$BM_{max} = 28.03\ kNm / 27.93$

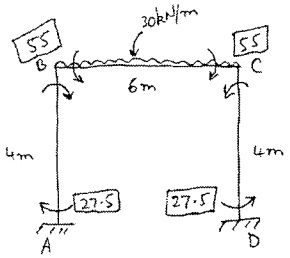
Part C

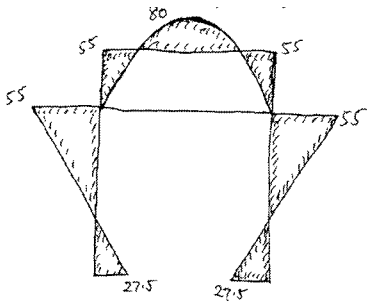
(2Q x 20M = 40Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
4	i) Fixed End Moments $M_{F_{AB}} = M_{F_{BA}} = M_{F_{CD}} = M_{F_{DC}} = 0$ $M_{F_{BC}} = M_{F_{CB}} = \mp \frac{WL^2}{12} = \mp \frac{30 \times 6^2}{12} = \mp 90\ kNm$ ii) Rotational Factors Joint | Members | k | Σk | R.F = $-\frac{1}{2}\left(\frac{k}{\Sigma k}\right)$ B | BA | I/L = I/4 = 0.25I | 0.58 I | −0.22 BC | I/L = 2I/6 = 0.33I | | −0.28 C | CB | I/L = 2I/6 = 0.33I | 0.58I | −0.28 CD | I/L = I/4 = 0.25I | | −0.22	FEM=4M RC=4M KANI ITER=4M FM=4M BMD=4M	40 mins

iii) Kani's Method







iv) Final moments

$$M_{AB} = M_{FAB} + 2[\text{Near moments}] + [\text{Far moments}]$$

$M_{AB} = 0 + 2(0) + 27.5 = 27.5\ kNm$

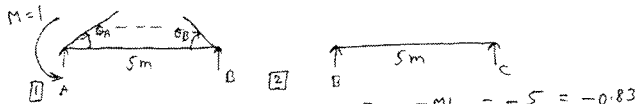
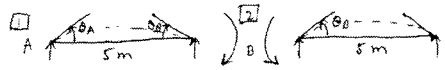
$M_{BA} = 0 + 2(27.5) + 0 = 55\ kNm$

$M_{BC} = -90 + 2(35) - 35 = -55\ kNm$

$M_{CB} = 90 + 2(-35) + 35 = 55\ kNm$

$M_{CD} = 0 + 2(-27.5) + 0 = -55\ kNm$

$M_{DC} = 0 + 2(0) - 27.5 = -27.5\ kNm$

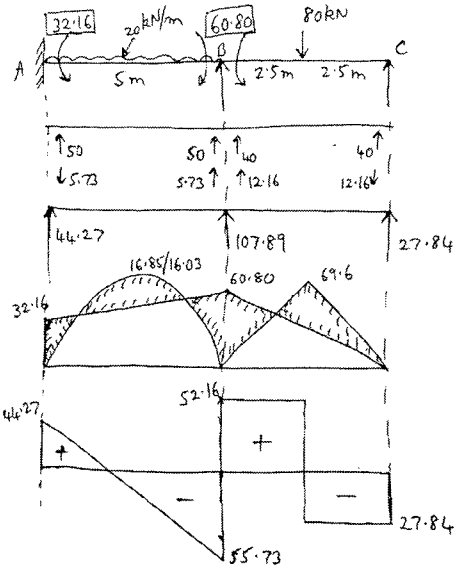
5	i) Degree of redundancy No. of unknowns = 4 $[M_A, V_A, M_B, V_C]$ no. of equilibrium eqns = 2 $[\Sigma V=0 \& \Sigma M=0]$ 2 The continuous beam is "2" degree redundant Take "M_A" & "M_B" as redundants ii) Basic determinate beam Separating the beam into basic determinate beams  $\Delta_{L_A} = \frac{WL^3}{24EI} = \frac{20\times5^3}{24EI} = \frac{104.17}{EI}$ $\Delta_{L_B} = \frac{WL^3}{24EI} + \frac{WL^2}{16EI} = \frac{20\times5^3}{24EI} + \frac{80\times5^2}{16EI} = \frac{229.17}{EI}$ $\Delta_L = -\frac{1}{EI}\begin{bmatrix}104.17\\229.17\end{bmatrix}$ iii) Flexibility matrix Removing all external loads and applying unit hogging moment at the redundants separately.  $F_{11} = -\frac{ML}{3EI} = \frac{-5}{3EI} = -\frac{1.67}{EI}$ $F_{21} = \frac{-ML}{6EI} = \frac{-5}{6EI} = \frac{-0.83}{EI}$  $F_{12} = \frac{-ML}{6EI} = \frac{-5}{6EI} = \frac{-0.83}{EI}$ $F_{22} = -\frac{ML}{3EI} - \frac{ML}{3EI} = \frac{-5}{3EI} - \frac{5}{3EI} = \frac{-3.33}{EI}$	RED=1M BDM=5M FM=5M BMD=5M SFD=4M	40 mins

$$[F] = -\frac{1}{EI}\begin{bmatrix} 1.67 & 0.83 \\ 0.83 & 3.33 \end{bmatrix}$$

$$[R] = [F]^{-1}\{[\Delta] - [\Delta_L]\}$$

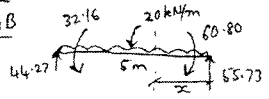
$$\begin{bmatrix} M_A \\ M_B \end{bmatrix} = -EI\begin{bmatrix} 1.67 & 0.83 \\ 0.83 & 3.33 \end{bmatrix}^{-1}\left\{[0] - \frac{1}{EI}\begin{bmatrix} 106.17 \\ 229.17 \end{bmatrix}\right\}$$

$M_A = 32.16\ kNm$ $\quad M_B = 60.80\ kNm$



MAX BM

SPAN AB



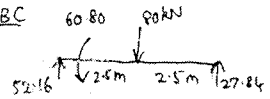
$$BM_x = 55.73x - 60.80 - 20\frac{x^2}{2}$$

$$\frac{dM_x}{dx} = 55.73 - 20x = 0$$

$$x = 2.79\ m$$

$$BM_{max} = 16.85\ kNm / 16.03$$

SPAN BC



$$BM_{max} = 27.84 \times 2.5 = 69.6\ kNm$$

i) Fixed End Moments

$$M_{F_{AB}} = M_{F_{BA}} = \mp \frac{WL^2}{12} = \mp \frac{20 \times 5^2}{12} = \mp 41.67 \text{ kNm}$$

$$M_{F_{BC}} = M_{F_{CB}} = \mp \frac{WL}{8} = \mp \frac{80 \times 5}{8} = \mp 50 \text{ kNm}$$

ii) Net moments

Taking 'θ_B' & 'θ_C' as redundants.

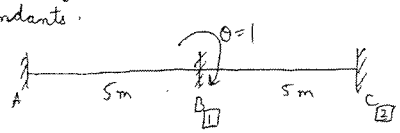
$$P_{L_B} = M_{BA} + M_{BC} = 41.67 - 50 = -8.33 \text{ kNm}$$

$$P_{L_C} = M_{CB} = 50 \text{ kNm}$$

$$[P_L] = \begin{bmatrix} -8.33 \\ 50 \end{bmatrix}$$

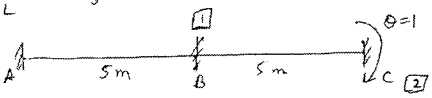
iii) Stiffness Matrix

Removing all external loads and applying unit rotation at the redundants.



$$K_{11} = \frac{4EI\theta}{L} + \frac{4EI\theta}{L} = \frac{4EI}{5} + \frac{4EI}{5} = 1.6EI$$

$$K_{21} = \frac{2EI\theta}{L} = \frac{2EI}{5} = 0.4EI$$



$$K_{12} = \frac{2EI\theta}{L} = \frac{2EI}{5} = 0.4EI$$

$$K_{22} = \frac{4EI\theta}{L} = \frac{4EI}{5} = 0.8EI$$

$$[K] = EI \begin{bmatrix} 1.6 & 0.4 \\ 0.4 & 0.8 \end{bmatrix}$$

$$[R] = [K]^{-1} \{[P] - [P_L]\}$$

$$\begin{bmatrix} \theta_B \\ \theta_C \end{bmatrix} = \frac{1}{EI} \begin{bmatrix} 1.6 & 0.4 \\ 0.4 & 0.8 \end{bmatrix}^{-1} \left\{ [0] - \begin{bmatrix} -8.33 \\ 50 \end{bmatrix} \right\}$$

$$\theta_B = \frac{23.81}{EI} \qquad \theta_C = \frac{-74.4}{EI}$$

iv) Final Moments

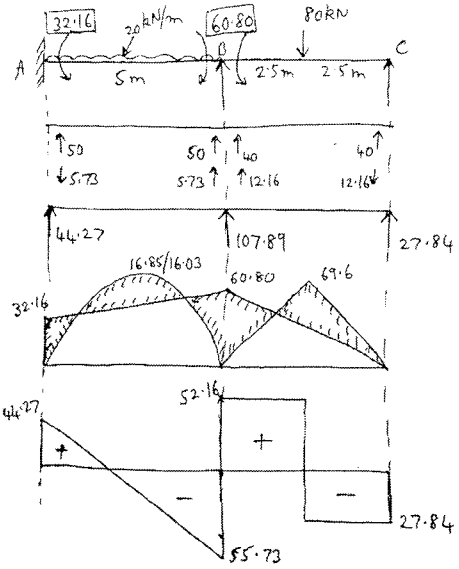
$$M_{AB} = M_{F_{AB}} + \frac{2EI}{L}\left[2\theta_A + \theta_B - \frac{3\delta}{L}\right]$$

$$M_{AB} = -32.15 \text{ kNm} \qquad M_{BC} = -60.72 \text{ kNm}$$

$$M_{BA} = 60.72 \text{ kNm} \qquad M_{CB} = 0$$

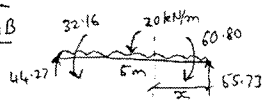
FEM=4M
NM=2M
STIFF=5M
FM=4M
BMD=3M
SFD=2M

40 mins



MAX BM

SPAN AB



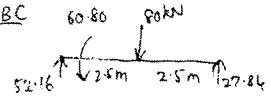
$BM_x = 55{\cdot}73\,x - 60{\cdot}80 - 20\frac{x^2}{2}$

$\frac{dM_x}{dx} = 55{\cdot}73 - 20x = 0$

$x = 2{\cdot}79$ m

$BM_{max} = 16{\cdot}85$ kNm / 16·03

SPAN BC



$BM_{max} = 27{\cdot}84 \times 2{\cdot}5 = 69{\cdot}6$ kNm