F → Flexi T → theory N → not mention.
M → mam
S →

16-17

1 (a) → theory
(b) → Flexi
2 (a) → T
(b) → F/N.
3 (a) → F/N
(b) → F
4 (a) → S
5 (a) → M
(b) → M
6 (a) → M
(b) → M
7 (a) → M
(b) → S
8 (a) → S
(b) → S

S → 4
F → 4
M → 5

15-16

1 (a) → M
(b) → M
2 (a) S
(b) S
3 (a) S
(b) M
4 (a) M
(b) S
5 (a) F
(b) F
6 (a) F
(b) F
7 (a) F
(b) 8
8 (a) N
(b) S

S → 5
F → 5
M → 4

14-15

1 (a) F
(b) F
2 (a) F
(b) F
3 (a) S
(b) S
4 (a) S
(b) → T
5 (a) T
(b) M
6 (a) M
(b) M
7 (a) S
(b) F
8 (a) S
(b) S

S → 6
F → 5
M → 3

13-14

1 (a) M
(b)
2 → F
3 → M
4 → F
5 → M
6 → F
7 → M
8 → S
9 → S
10 → S
11 → S
12 → S
13 → S
14 → F

S → 6
F → 4
M → 4

13-14

12-13

1 (a) M
(b)
2 (a) M
(b) S
3 (a) S
(b) S
4 (a) S
5 (a) F
(b) F/T
6 (a) F
(b) F
7 (a) F
(b) F
8 F.

S → 4
F → 6
M → 2

11-12

1 (a) F
(b) S
2 (a) F
(b) S
3 (a) N
(b) S
4 → S
5 (a) M
(b) F
6 (a) Scope
(b) M
7 (a) M
8 (a) Scope
(b)

S → 4
F → 3
M → 3

11 12
10 11
8 9

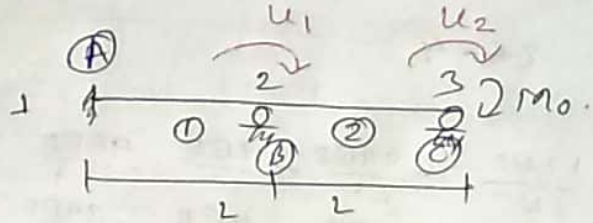
Nothing is certain.

Beam problem

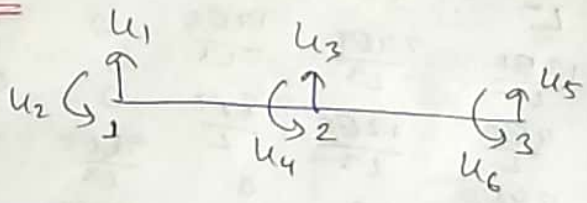
2016-17

8(a)

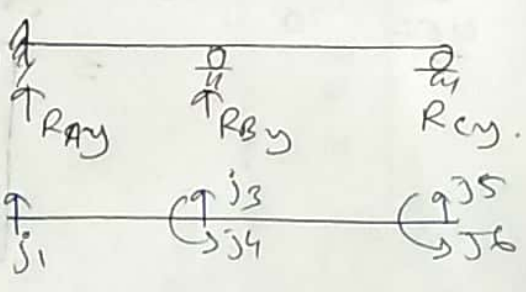
→ Normal matl



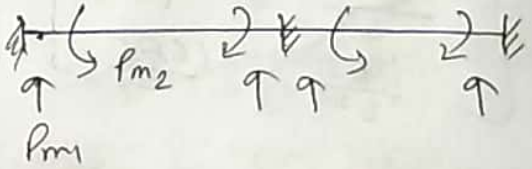
Here



$$P_j = \begin{bmatrix} P_{j1} \\ P_{j2} \\ P_{j3} \\ P_{j4} \\ P_{j5} \\ P_{j6} \end{bmatrix} = \begin{bmatrix} R_{Ay} \\ M_A \\ R_{By} \\ 0 \\ R_{cy} \\ 0 \end{bmatrix}$$



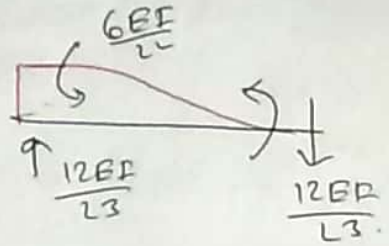
if there was any load on Beam.



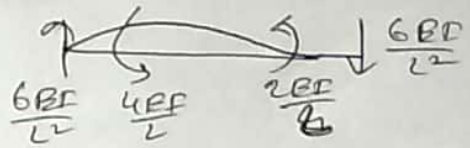
$$P_m = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

for member-1

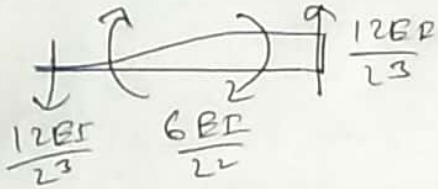
$u_1 = 1$



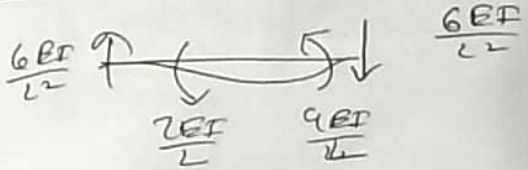
$u_2 = 1$



$u_3 = 1$



$u_4 = 1$



$$P_j = P_m + KU$$

$$\begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} \frac{12EI}{L^3} & \frac{6EI}{L^2} & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{4EI}{L} & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{2EI}{L} & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{Bmatrix}$$

$$\Rightarrow \begin{bmatrix} R_{AY} \\ M_A \\ R_{BY} \\ 0 \end{bmatrix}$$

maybe global matrix

220

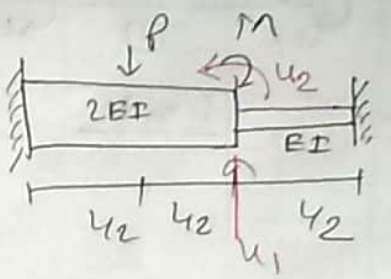
5-16 No beam Gebbal.

14-15 No beam.

Computer application.

13-14

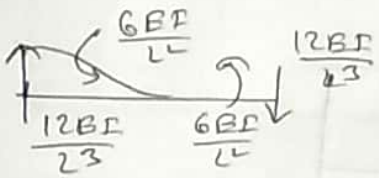
(12)



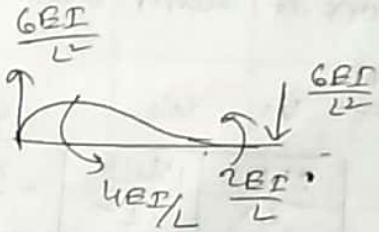
Single beam member.

Beam-1

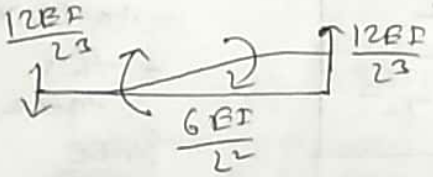
$u_1 = 1$



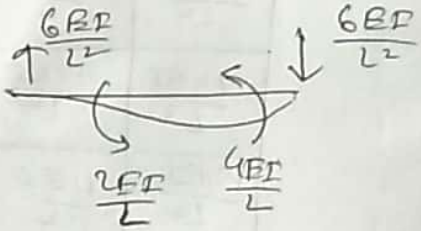
$u_2 = 1$



$u_3 = 1$



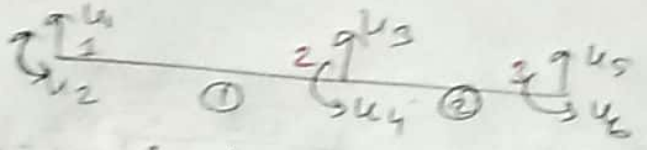
$u_4 = 1$



u_1	u_2	u_3	u_4
$\frac{12EI}{L^3}$	$\frac{6EI}{L^2}$	$-\frac{12EI}{L^3}$	$\frac{6EI}{L^2}$
$\frac{6EI}{L^2}$	$\frac{4EI}{L}$	$-\frac{6EI}{L^2}$	$\frac{2EI}{L}$
$-\frac{12EI}{L^3}$	$-\frac{6EI}{L^2}$	$\frac{12EI}{L^3}$	$-\frac{6EI}{L^2}$
$\frac{6EI}{L^2}$	$\frac{2EI}{L}$	$-\frac{6EI}{L^2}$	$\frac{4EI}{L}$

Stiffness matrix for Beam-1

For two span beam



Member	i-node	j node	L	I	E
1	1	2	L	2I	E
2	2	3	L/2	I	E

Based on derived length and rigidity. Stiffness matrix of beam becomes.

Beam 1

u_1	u_2	u_3	u_4
$\frac{24EI}{L^2}$	$\frac{12EI}{L^2}$	$-\frac{24EI}{L^3}$	$\frac{12EI}{L^2}$
$\frac{12EI}{L^2}$	$\frac{8EI}{L}$	$-\frac{12EI}{L^2}$	$\frac{4EI}{L}$
$-\frac{24EI}{L^3}$	$-\frac{12EI}{L^2}$	$\frac{24EI}{L^3}$	$-\frac{12EI}{L^2}$
$\frac{12EI}{L^2}$	$\frac{4EI}{L}$	$-\frac{12EI}{L^2}$	$\frac{8EI}{L}$

→ Previous table × 2 = this table since 2I

Beam 2

u_1	u_2	u_3	u_4
$\frac{96EI}{L^3}$	$\frac{24EI}{L^2}$	$-\frac{96EI}{L^3}$	$\frac{24EI}{L^2}$
$\frac{24EI}{L^2}$	$\frac{8EI}{L}$	$-\frac{24EI}{L^2}$	$\frac{4EI}{L}$
$-\frac{96EI}{L^3}$	$-\frac{24EI}{L^2}$	$\frac{96EI}{L^3}$	$-\frac{24EI}{L^2}$
$\frac{24EI}{L^2}$	$\frac{4EI}{L}$	$-\frac{24EI}{L^2}$	$\frac{8EI}{L}$

Here $L = L/2$

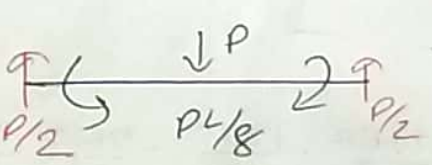
Beam-1

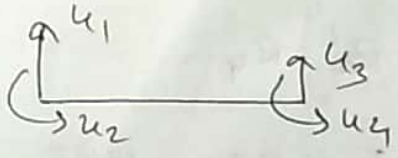
global stiffness matrix

$\frac{24EI}{L^3}$	$\frac{12EI}{L^2}$	$-\frac{24EI}{L^3}$	$\frac{12EI}{L^2}$		
$\frac{12EI}{L^2}$	$\frac{8EI}{L}$	$-\frac{12EI}{L^2}$	$\frac{4EI}{L}$		
$-\frac{24EI}{L^3}$	$-\frac{12EI}{L^2}$	$\frac{24EI}{L^3}+\frac{96EI}{L^3}$	$-\frac{12EI}{L^2}+\frac{24EI}{L^2}$	$-\frac{96EI}{L^3}$	$-\frac{24EI}{L^2}$
$\frac{12EI}{L^2}$	$\frac{4EI}{L}$	$-\frac{12EI}{L^2}$ $\frac{24EI}{L^2}$	$\frac{8EI}{L}+8EI/L$	$-\frac{24EI}{L^2}$	$\frac{4EI}{L}$
		$-\frac{96EI}{L^3}$	$\frac{24EI}{L^3}$	$\frac{96EI}{L^3}$	$-\frac{24EI}{L^2}$
		$\frac{24EI}{L^2}$	$\frac{4EI}{L}$	$-\frac{24EI}{L^2}$	$\frac{8EI}{L}$

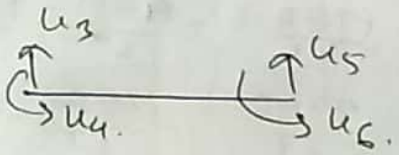
Beam-2

for member-1





member-2



$$P_m = \begin{Bmatrix} P/2 \\ PL/8 \\ P/2 \\ -PL/8 \\ 0 \\ 0 \end{Bmatrix}$$

$$P_m + Ku = P_j$$

$$\begin{Bmatrix} P/2 \\ PL/8 \\ P/2 \\ -PL/8 \\ 0 \\ 0 \end{Bmatrix} + \begin{bmatrix} \frac{24EI}{L^3} & \frac{12EI}{L^2} & -\frac{24EI}{L^3} & \frac{12EI}{L^2} & 0 & 0 \\ \frac{12EI}{L^2} & \frac{8EI}{L} & -\frac{12EI}{L^2} & \frac{4EI}{L} & 0 & 0 \\ -\frac{24EI}{L^3} & -\frac{12EI}{L^2} & \frac{120EI}{L^3} & \frac{12EI}{L^2} & -\frac{96EI}{L^3} & \frac{24EI}{L^2} \\ \frac{12EI}{L^2} & \frac{4EI}{L} & \frac{12EI}{L^2} & \frac{16EI}{L} & -\frac{24EI}{L^2} & \frac{4EI}{L} \\ 0 & 0 & -\frac{96EI}{L^3} & -\frac{24EI}{L^2} & \frac{96EI}{L^3} & -\frac{24EI}{L^2} \\ 0 & 0 & \frac{24EI}{L^2} & \frac{4EI}{L} & -\frac{24EI}{L^2} & \frac{8EI}{L} \end{bmatrix} \cdot \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \end{Bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ -M \\ 0 \\ 0 \end{bmatrix}$$

$R_1' = R_3 \quad R_2' = R_4$

$$\begin{Bmatrix} P/2 \\ -PL/8 \\ P/2 \\ PL/8 \\ 0 \\ 0 \end{Bmatrix} + \begin{bmatrix} -\frac{24EI}{L^3} & -\frac{12EI}{L^2} & \frac{120EI}{L^3} & \frac{12EI}{L^2} & -\frac{96EI}{L^3} & \frac{24EI}{L^2} \\ \frac{12EI}{L^2} & -\frac{4EI}{L} & \frac{12EI}{L^2} & \frac{16EI}{L} & -\frac{24EI}{L^2} & \frac{4EI}{L} \\ \frac{24EI}{L^3} & \frac{12EI}{L^2} & -\frac{24EI}{L^3} & \frac{12EI}{L^2} & 0 & 0 \\ \frac{12EI}{L^2} & \frac{8EI}{L} & -\frac{12EI}{L^2} & \frac{4EI}{L} & 0 & 0 \\ 0 & 0 & -\frac{96EI}{L^3} & -\frac{24EI}{L^2} & \frac{96EI}{L^3} & -\frac{24EI}{L^2} \\ 0 & 0 & \frac{24EI}{L^2} & \frac{4EI}{L} & -\frac{24EI}{L^2} & \frac{8EI}{L} \end{bmatrix} \cdot \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \end{Bmatrix}$$

$$= \begin{bmatrix} 0 \\ -M \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

col → 1 ⇔ 3 2 ⇔ 4

$$\begin{Bmatrix} P/2 \\ -PL/8 \\ P/2 \\ \frac{PL}{8} \\ 0 \\ 0 \end{Bmatrix} + \begin{bmatrix} \frac{120EI}{L^3} & \frac{12EI}{L^2} & -\frac{24EI}{L^3} & -\frac{12EI}{L^2} & -\frac{96EI}{L^3} & \frac{24EI}{L^2} \\ \frac{12EI}{L^2} & \frac{16EI}{L} & \frac{12EI}{L^3} & -\frac{4EI}{L} & -\frac{24EI}{L^3} & \frac{4EI}{L} \\ -\frac{24EI}{L^3} & \frac{12EI}{L^2} & \frac{24EI}{L^3} & \frac{12EI}{L^3} & 0 & 0 \\ -\frac{12EI}{L^2} & \frac{4EI}{L} & \frac{12EI}{L^3} & \frac{8EI}{L} & 0 & 0 \\ -\frac{96EI}{L^3} & -\frac{24EI}{L^2} & 0 & 0 & \frac{96EI}{L^3} & -\frac{24EI}{L^2} \\ \frac{24EI}{L^2} & \frac{4EI}{L} & 0 & 0 & -\frac{24EI}{L^3} & \frac{8EI}{L} \end{bmatrix} \begin{Bmatrix} u_3 \\ u_4 \\ u_1 \\ u_2 \\ u_5 \\ u_6 \end{Bmatrix}$$

$$= \begin{bmatrix} 0 \\ -M \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$\therefore$

$$\begin{Bmatrix} P/2 \\ -PL/8 \end{Bmatrix} + \begin{bmatrix} \frac{120EI}{L^3} & \frac{12EI}{L^2} \\ \frac{12EI}{L^2} & \frac{16EI}{L} \end{bmatrix} \begin{Bmatrix} u_3 \\ u_4 \end{Bmatrix} = \begin{bmatrix} 0 \\ -M \end{bmatrix}$$