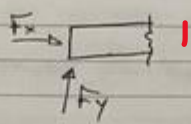


77%

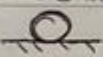
STRUCTURES EXAM    14/01/22    BRETT THOMAS

a) Pin Support - 2 Reaction forces

 2

 1

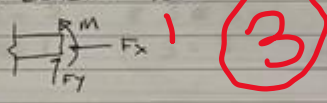
Roller Support - 1 Reaction force

 2

 1

Fixed Support - 3 Reaction forces

 6

 3

b) See above

c) Determinate Structures can be analysed using basic Equilibrium equations. This analysis the unknown reactions are found for the further determination of stresses.

Indeterminate structures cannot be analysed by using basic equilibrium equations. extra conditions are required like use of moment distribution method, slope deflection method etc! 2

d) Summation of horizontal forces <sup>must</sup> be equal to zero.

$\sum H = 0$  2

Summation of vertical forces must be equal to zero

$\sum V = 0$  2

BRETT THOMAS 1807835 structures exam all to the fkajbckja ckqn cn ad sakdv akdc kasd visa visadjviadj vias vis vksfn isf vsf vs fv

d) Summation of moments must be equal to zero.

$$\sum m = 0$$

e) for statically determinate structures -  $r = 3n$

if  $r > 3n$  the structure is statically indeterminate

where  $n$  = total number of parts of the structure

$r$  = total number of unknown reactive force and moment components



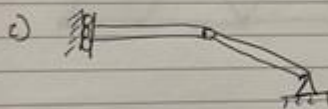
$$r = 3$$

$$n = 1$$

$$3 \neq 3 \times 1$$

$$3 = 3$$

determinate



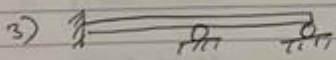
$$r = 6$$

$$n = 2$$

$$6 = 3 \times 2$$

$$6 = 6$$

determinate



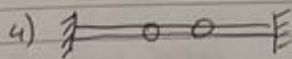
$$r = 5$$

$$n = 1$$

$$5 \neq 3 \times 1$$

$$5 > 3$$

indeterminate to the 2nd degree



$$r = 10$$

$$n = 3$$

$$10 \neq 3 \times 3$$

$$10 > 9$$

indeterminate to the first degree

g) Frame structures have a combination of beam, column and slab to resist the lateral and gravity loads. These structures are used to overcome the large moments developing due to applied loading

g) The basic classifications are Rigid frame structure and Braced frame structure. <sup>2</sup>

h) Over rigid truss has more members than the required  
under rigid truss has less members than the required

i) the equation for calculating the truss to see if it is rigid is

$$m = 2j - 3$$

$m = \text{members}$

$j = \text{joints}$

J. i



Warren truss

$$m = 2j - 3$$

$$11 = 2 \times 7 - 3$$

$$11 = 11 \text{ Rigid}$$

ii Pratt truss

iii Howe truss

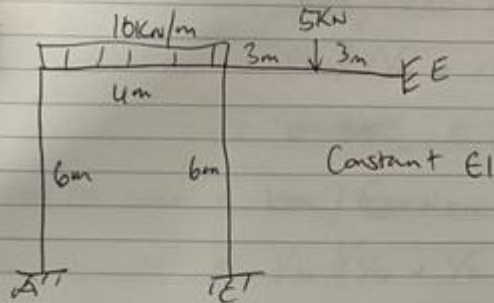
iv K truss

v Fink truss

Q - 40

### Section B

Q3



Calc the distribution factors

$$AB(K_{AB}) = EI/L = 1/6$$

$$BD(K_{BD}) = EI/L = 1/4$$

$$\begin{aligned} \text{DST factor BA} \text{ \&Oslash; } \text{FBA} &= K_{AB} / (K_{AB} + K_{BD}) \\ &= 1/6 / (1/6 + 1/4) \\ &= 0.4 \end{aligned}$$

$$\begin{aligned} \text{DST factor BD} &= K_{BD} / (K_{AB} + K_{BD}) \\ &= 1/4 / (1/6 + 1/4) \\ &= 0.6 \end{aligned}$$

$$CD = K_{CD} = EI/L = 1/6$$

$$DE = K_{DE} = EI/L = 1/6$$

$$\begin{aligned} \text{DST factor DB} \text{ \&Oslash; } \text{FDB} &= K_{BD} / (K_{BD} + K_{CD} + K_{DE}) \\ &= 1/4 / (1/4 + 1/6 + 1/6) \\ &= 0.42 \end{aligned}$$

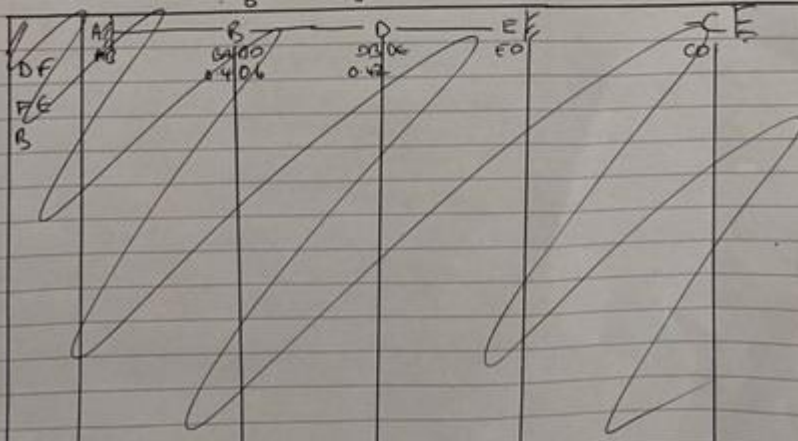
$$\begin{aligned}\text{DIST FACTOR DC } DF_{DC} &= K_{CD} / (K_{BD} + K_{CD} + K_{CE}) \\ &= 1/6 / (1/4 + 1/6 + 1/6) \\ &= \cancel{0.285} \quad 0.29\end{aligned}$$

$$\begin{aligned}\text{DIST FACTOR DE } DF_{DE} &= K_{DE} / (K_{BD} + K_{CD} + K_{CE}) \\ &= 1/6 / (1/4 + 1/6 + 1/6) \\ &= \cancel{0.285} \quad 0.29\end{aligned}$$

Calc fixed end moment.

$$\begin{aligned}FEM_{BD} &= W \times L \times L / 12 = \\ &= 10 \times 4 \times 4 / 12 = \cancel{13.33} \quad 13.2\end{aligned}$$

$$FEM_{DE} = \frac{PL}{8} = \frac{5 \times 6}{8} = 3.75 \text{ kN}$$

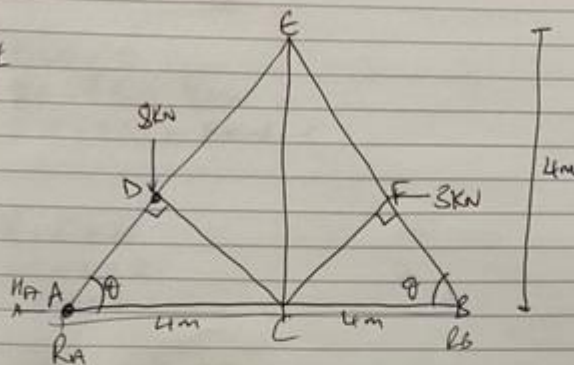


|      | Ans  | <sup>2</sup> B <sub>1</sub> B <sub>2</sub> D |       | B <sub>3</sub> D <sub>2</sub> C |              | C <sub>2</sub> C | <sup>DE</sup> E <sub>2</sub> D |       | E <sub>2</sub> E |
|------|------|----------------------------------------------|-------|---------------------------------|--------------|------------------|--------------------------------|-------|------------------|
| OP   | 0    | 0.4                                          | 0.6   | 0.42                            | 0.29         | 0                | 0.29                           | 0     | 1                |
| FEM  | 0    | 0                                            | -3.3  | 13.3                            | 0            | 0                | -3.75                          | 3.75  |                  |
| 60kN | 0    | 5.32                                         | 7.98  | -4.01                           | -2.77        | 0                | -2.77                          | 0     | 1                |
| CO   | 2.66 | 0                                            | -2    | 3.99                            | 0            | 1.39             | 0                              | 1.385 |                  |
| B    | 0    | 0.8                                          | 1.2   | -1.68                           | 1.16         | 0                | -1.16                          | 0     | 1                |
| CO   | 0.4  | 0                                            | 0.84  | 0.6                             | 0            | <del>-0.58</del> | 0                              | -0.58 |                  |
| B    | 0    | 0.34                                         | 0.5   | 0.25                            | 0.17         | 0                | 0.17                           | 0     | 1                |
|      | 0.17 | 0                                            | 0.125 | -0.25                           | 0            | <del>-0.09</del> | 0                              | -0.09 |                  |
|      | 0    | 0.05                                         | 0.00  | 0.11                            | 0.07         | 0                | 0.07                           | 0     |                  |
|      | 3.23 | 1                                            | 6.51  | 6.795                           | <u>-1.49</u> | -4.03            | 0.72                           | -0.02 | 0                |
|      |      |                                              |       | <u>-12.73</u>                   | 1.9          |                  |                                |       | (7x)             |

Q3 - 16

## Section C

Q4



Support reactions at A and B.

using  $\sum M = 0$

$$\begin{aligned}
 RB \times (4+4) - (3 \times 2) - (8 \times 2) &= 0 \\
 8RB - 6 - 16 &= 0 \\
 8RB &= 22 \\
 RB &= 2.75 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 RA \times (4+4) + (3 \times 2) + 8 \times 6 &= 0 \\
 8RA + 6 + 48 &= 0 \\
 8RA &= -54 \\
 RA &= -6.75 \text{ kN}
 \end{aligned}$$

4

5.24594

Section C Q4

$$\sum V = 0$$

$$V_A + V_B = 8 \text{ kN}$$

$$2.75 + 5.25 = 8 \text{ kN} \quad \checkmark$$

$$\sum H = 0$$

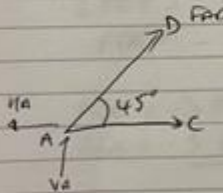
$$H_A + 3 = 0$$

$$H_A = -3$$

$$R_A = \sqrt{V_A^2 + H_A^2}$$

$$= \sqrt{2.75^2 + 3^2}$$

$$R_A = 4.06 \text{ kN}$$



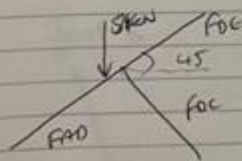
$$\text{using } \sum F_y = 0$$

$$F_{AD} \sin 45^\circ + V_A = 0$$

$$0.707 F_{AD} + 5.25 = 0$$

$$F_{AD} = -7.42 \text{ kN} \quad (\text{C})$$

What AC



$$\text{using } \sum F_x = 0$$

$$8 - F_{DE} \sin 45^\circ + F_{DC} \sin 45^\circ - F_{AD} \sin 45^\circ = 0$$

$$8 - 0.707 F_{DE} + 0.707 F_{DC} - 7.42 \times 0.707 = 0$$

$$2.75 - 0.707 F_{DE} + 0.707 F_{DC} = 0$$

$$F_{AD} \cos 45^\circ + F_{DC} \cos 45^\circ + F_{DE} \cos 45^\circ = 0$$

$$7.42 \times 0.707 + 0.707 F_{DC} + 0.707 F_{DE} = 0$$

$$5.25 + 0.707 F_{DC} + 0.707 F_{DE} = 0$$

Q4 Cont

$$\frac{5.25-8}{\sin 45} + \frac{F_{DE} \sin 45}{\sin 45} = \frac{F_{DC} \sin 45}{\sin 45} = 0$$

$$F_{DE} - F_{DC} = 2.75$$

$$F_{DE} - F_{DC} = 3.89 \quad (1)$$

$$\sum H F = 0$$

$$F_{AD} \cos 45 + F_{DE} \cos 45 + F_{DC} \cos 45 = 0$$

$$F_{DE} + F_{DC} = -7.42 \quad (2)$$

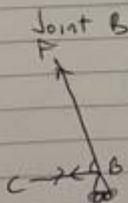
$$\text{Add } (1) + (2)$$

$$2F_{DE} = -3.53$$

$$F_{DE} = -1.77 \text{ kN}$$

$$F_{DC} = -3.89 - 1.77$$

$$F_{DC} = -5.66 \text{ kN}$$



$$\sum V_B = 0$$

$$P_B + F_{BF} \sin 45 = 0$$

$$F_{BF} = 2.75$$

$$\sin 45$$

$$F_{BF} = 3.89 \text{ kN}$$

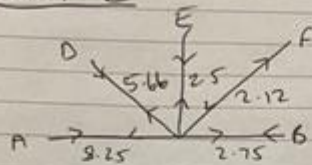
$$\sum H_B = 0$$

$$P_{BC} + F_{BF} \sin 45 = 0$$

$$F_{BC} = -3.89 \sin 45$$

$$F_{BC} = 2.75 \text{ kN}$$

Joint C



$$\sum M_F = 0$$

$$-8.25 + (5.66 \cos 45^\circ \times 2.75) = 0$$

$$F_{EC} \cos 45^\circ = 8.25 - 5.66 \cos 45^\circ - 2.75$$

$$F_{EC} = \frac{8.25 - (5.66 \cos 45^\circ) - 2.75}{\cos 45^\circ}$$

$$F_{EC} = 2.12 \text{ (T)}$$

$$\sum F = 0$$

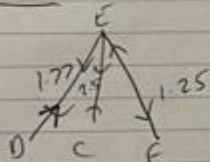
$$-5.66 \sin 45^\circ + F_{EC} + 2.12 \sin 45^\circ = 0$$

$$F_{EC} = \frac{(5.66 \sin 45^\circ) - (2.12 \sin 45^\circ)}{\sin 45^\circ}$$

$$F_{EC} = 2.5 \text{ T}$$

③

Joint E



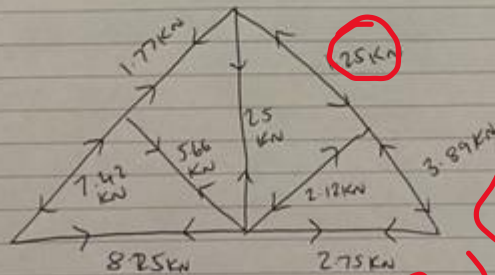
$$\sum M_F = 0$$

$$1.77 \cos 45^\circ + F_{EF} = 0$$

$$F_{EF} = -1.77 \cos 45^\circ$$

$$F_{EF} = 1.25 \text{ (C)}$$

$\cos 45^\circ$



2.5 kN

④

④ - 21