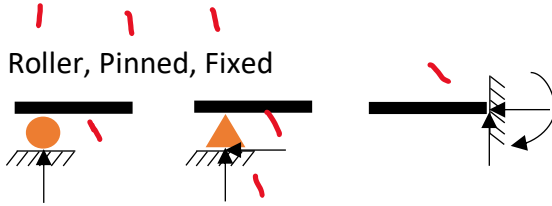


80%

Exam

a & b) Roller, Pinned, Fixed



7

c) A structure is Determinate if the 3 equilibrium equations are sufficient to find stresses and reactions. Also, when the number of unknown reactions equals $3 \times$ structural parts (beam parts). Indeterminate structures are not capable of being analysed with the basic equations of equilibrium; further conditions are required. Also, when the number of unknown reactions is greater than $3 \times$ structural parts (beam parts).

2

d) The net external force on the system must be zero in the Horizontal (H) and Vertical (V) directions.

$$\Sigma H=0, \Sigma V=0$$

The net sum of the rotational forces (moments) must be zero

$$\Sigma M=0$$

6

e) r: unknown reaction force and moment components, n: structural parts

$$R=3n \text{ (Determinate)}$$

$$R>3n \text{ (Indeterminate)}$$

$$R<3n \text{ (Unstable)}$$

4

f) f1. $R=3, n=1$

$$3=3(1), \text{ statically determinate}$$

f2. $R=6, n=2$

$$6=3(2), \text{ statically determinate}$$

f3. $R=5, n=1$

$$5=3(1)$$

$$5-3=2, \text{ statically indeterminate to the second degree}$$

6

f4. $R=10, n=3$

$$10=3(3)$$

$$10-9=1, \text{ statically indeterminate to the first degree}$$

g)

- A framed structure is a self-supporting combination of columns, beams and slabs to resist lateral and gravity loads.
- Rigid and Brace frame

3

h) An under-rigid truss is one in which the number of members is not sufficient to maintain the stability of the structure under external loading. An over-rigid truss is where the number of members exceed the number required.

Under Rigid: $m < 2j - 3$

Over Rigid: $m > 2j - 3$

2

i) $m = 2j - 3$

Where, m = number of members, j = number of joints

Rigid: $m = 2j - 3$

Under Rigid: $m < 2j - 3$

Over Rigid: $m > 2j - 3$

3

j) Warren truss, Pratt truss, Howe truss, K-truss, Fink truss

5

Q1 - 28

Section B
Question 2

Stiffness $\frac{EI}{L}$

$$K_{AB} = \frac{2}{4} = 0.5$$

$$K_{BC} = \frac{1}{6}$$

$$K_{CD} = \frac{3}{8}$$

5

Distribution Factor (DF) = $\frac{K}{\sum K}$

$$DF_{BA} = \frac{0.5}{0.5 + \frac{1}{6}} = 0.75$$

$$DF_{BC} = \frac{\frac{1}{6}}{0.5 + \frac{1}{6}} = 0.25$$

$$DF_{CB} = \frac{\frac{1}{6}}{\frac{1}{6} + \frac{3}{8}} = 0.31$$

$$DF_{CD} = \frac{\frac{3}{8}}{\frac{1}{6} + \frac{3}{8}} = 0.69$$

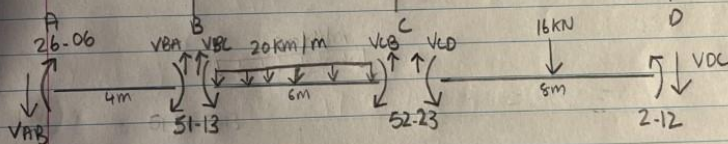
Fixed End Moments (FEM)

$$FEM_{BC} = \frac{wL^2}{12} = \frac{20 \times 6^2}{12} = 60 \text{ kNm}$$

2

$$FEM_{CD} = \frac{Pl}{8} = \frac{16 \times 8}{8} = 16 \text{ kNm}$$

	A	B	C	D		
DF	0	0.75	0.25	0.31	0.69	0
FEM	0	0	60	-60	18	-16
BAL		-45	-15	13.64	30.36	
COM	-22.5		6.82	-7.5		15.18
BAL		-5.12	-1.71	2.33	5.18	
COM	-2.56		1.17	-0.86		2.59
BAL		-0.88	-0.29	0.27	0.59	
COM	-0.44		0.14	-0.15		0.3
BAL		-0.11	-0.04	0.05	0.1	
COM	-0.56		0.03	-0.02		0.05
BAL		-0.02	$-\frac{3}{400}$	$\frac{31}{5000}$	$\frac{69}{5000}$	
(Fixed) Moment	-26.06	-51.13	51.13	-52.23	52.23	-2.12



$$M_B \downarrow \quad 51.13 + 26.06 - V_{AB} \times 4 = 0$$

$$V_{AB} = \frac{77.19}{4} = 19.3 \text{ kN}$$

$$M_A \downarrow \quad 26.06 + 51.13 - V_{BA} \times 4 = 0$$

$$V_{BA} = 19.3 \text{ kN}$$

$$M_{B2} \downarrow \quad -51.13 + (20 \times 6 \times 3) + 52.23 - V_{CB} \times 6 = 0$$

$$V_{CB} = 60.18 \text{ kN}$$

$$M_{C1} \downarrow \quad 52.23 - (20 \times 6 \times 3) - 51.13 + V_{BC} \times 6 = 0$$

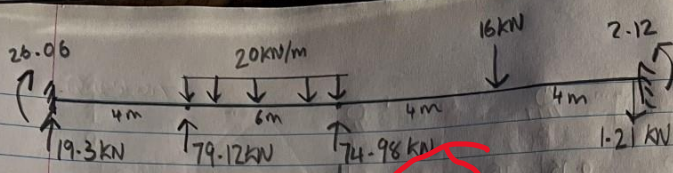
$$V_{BC} = 59.82 \text{ kN}$$

$$M_{D1} \downarrow \quad -2.12 - (16 \times 4) + V_{CD} \times 8 - 52.23 = 0$$

$$V_{CD} = 14.8 \text{ kN}$$

$$M_{D2} \downarrow \quad -52.23 + (16 \times 4) - 2.12 + V_{DL} \times 8 = 0$$

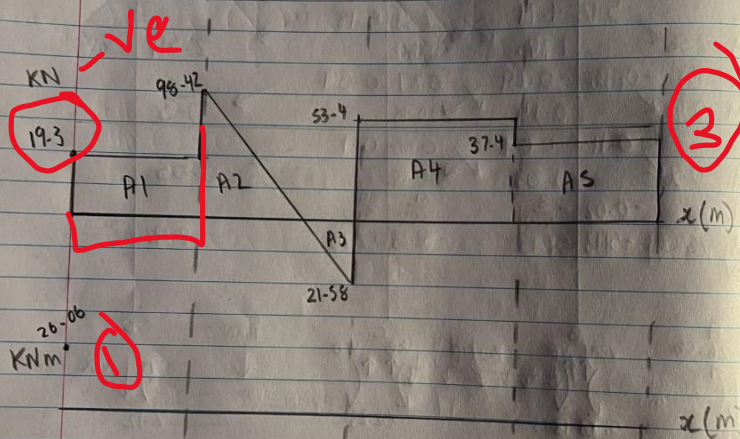
$$V_{DL} = 1.21 \text{ kN}$$



$$V_A = 19.3$$

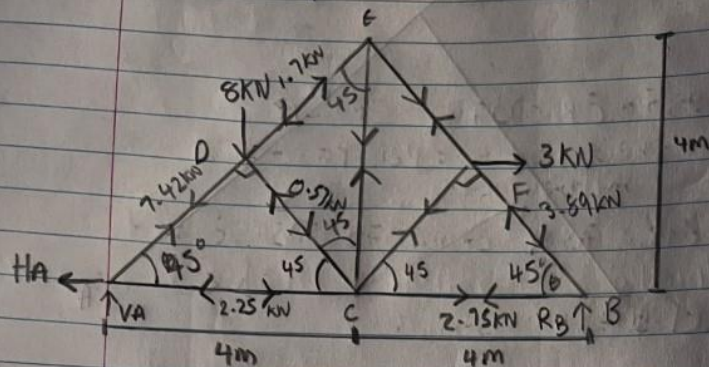
$$V_B = 19.3 + 59.82$$

$$V_C = 60.18 + 14.8$$



② — 24

Question 4



$$\tan \theta = \frac{4}{4} \quad (1)$$

$$\theta = 45^\circ$$

$$\sum H = 0$$

$$-H_A + 3 = 0$$

$$H_A = 3 \text{ kN}$$

$$\sum M_A \downarrow (8 \times 2) + (3 \times 2) - R_B \times 8 = 0$$

$$R_B = 2.75 \text{ kN}$$

$$\sum V = 0$$

$$V_A + R_B = 8$$

$$V_A = 5.25 \text{ kN}$$

Joint A

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

$$F_{AD} = \frac{5.25}{\sin 45}$$

$$F_{AD} = 7.42 \text{ kN (T)}$$

$$F_{AC} + F_{AD} \cos 45 - H_A = 0$$

$$F_{AC} = -7.42 \cos 45 + 3$$

$$F_{AC} = -2.25 \text{ kN}$$

$$F_{AC} = 2.25 \text{ (C)}$$

$$8.25$$

Joint D

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

$$0.707 F_{DE} - 0.707 F_{DC} + 0.707 F_{AD} - 8 = 0$$

$$0.707 F_{DE} - 0.707 F_{DC} + 5.24 - 8 = 0$$

$$0.707 F_{DE} - 0.707 F_{DC} - 2.76 = 0$$

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

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

(1) into (2)

$$1.414 F_{DE} + 2.49 = 0$$

$$F_{DE} = \frac{-2.49}{1.414} = -1.7$$

$$F_{DE} = 1.7 \text{ kN (C)}$$

(3)

$F_{DC} =$

$$0.707 (-1.7) + 0.707 F_{DC} + 5.25 = 0$$

$$F_{DC} = \frac{-4.05}{0.707}$$

$$F_{DC} = -0.57 \text{ ? } 5.7$$

$$F_{DC} = 0.57 \text{ (C)}$$

Joint B

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

$$F_{BF} = \frac{-2.75}{\sin 45} = -3.89 \text{ kN}$$

$$F_{BF} = 3.89 \text{ kN (C)}$$

$$F_{BC} + F_{BF} \cos 45$$

$$F_{BC} = 2.75 \text{ (T)}$$

(4)
4-17