SOLUTIONS MANUAL

for

MECHANICS OF SOLIDS

by

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CHAPTER 1

1a. **Moments about A**

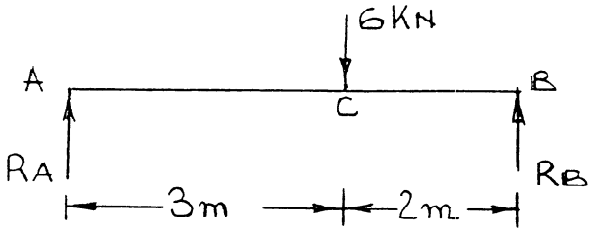
$R_B \times 5 = 6 \times 2$

$\underline{R_B = 2.4 \text{ kN}}$

Resolving vertically

$R_A + R_B = 6$

$\therefore \underline{R_A = 6 - 2.4 = 3.6 \text{ kN}}$



1b. **Moments about A**

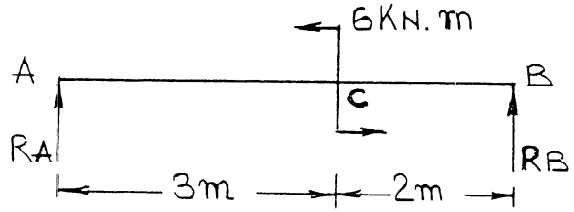
$R_B \times 5 + 6 = 0$

$\underline{R_B = -1.2 \text{ kN}}$

Resolving vertically

$R_A + R_B = 0$

$\underline{R_A = 1.2 \text{ kN}}$



2a. **Moments about A**

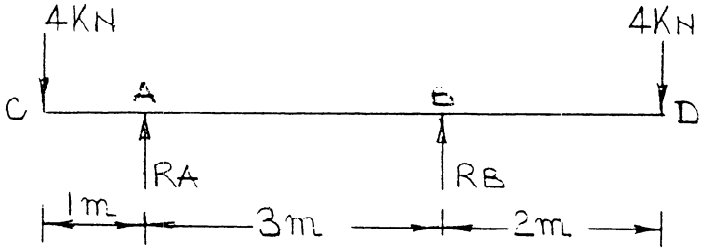
$R_B \times 3 + 4 \times 1 = 4 \times 5$

$R_B = 5.333 \text{ kN}$

Resolving vertically

$R_A + R_B = 4 + 4$

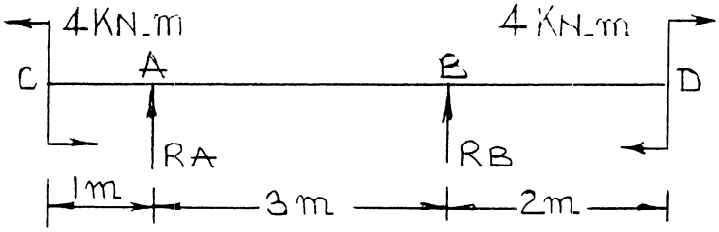
$R_A = 2.667 \text{ kN}$



2b. **Moments about A**

$R_B \times 3 = 4 - 4$

$\underline{R_B = 0}$

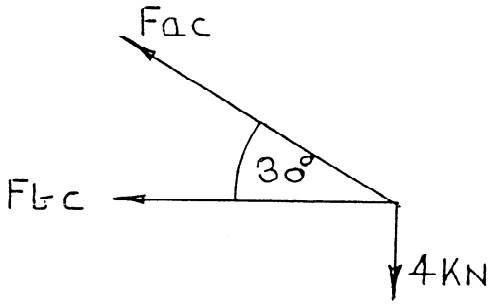


Resolving vertically

$R_A + R_B = 0$

$\underline{R_A = 0}$

3a. Assume unknown internal forces are in tension, and consider the equilibrium of joint C.



Resolving forces vertically

$F_{ac} \sin 30 = 4$

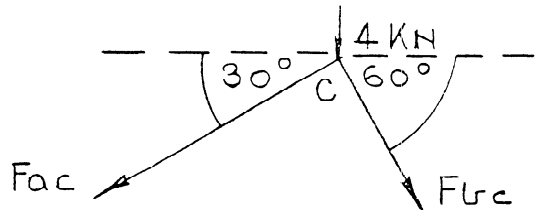
$\therefore F_{ac} = 8$ kN (tension)

Resolving forces horizontally

$F_{ac} \cos 30 + F_{bc} = 0$

$F_{bc} = -6.928$ (compression)

3b. Assume all unknown internal forces are in tension and consider the equilibrium of joint C.



Joint C

Resolving horizontally

$F_{ac} \cos 30 = F_{bc} \cos 60$

$F_{ac} = 0.5774\ F_{bc}$ 1

Resolving vertically

$4 + F_{ac} \sin 30 + F_{bc} \sin 60 = 0$

or $4 = -0.5\ F_{ac} - 0.866\ F_{bc}$ 2

Substitute 1 into 2

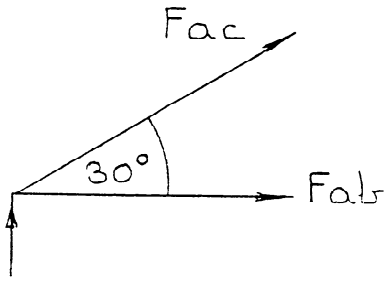
$4 = -0.2887\ F_{bc} - 0.866\ F_{bc}$

$\therefore F_{bc} = -3.464$ kN (compression) 3

Substitute 3 into 1

$F_{ac} = -2$ kN (compression) 4

Consider Joint A

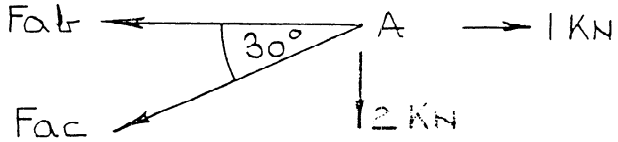


Resolve horizontally

$F_{ac} \cos 30 + F_{ab} = 0$

$F_{ab} = -F_{ac} \cos 30 = 1.732$ kN (tension)

4. Assume all unknown forces are in tension, and consider equilibrium of Joint A.



Resolving vertically

$F_{ac} \sin 30 = 2 = 0$

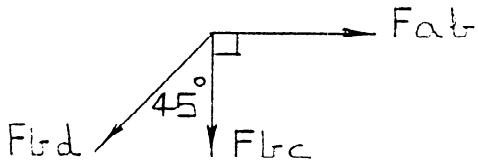
$F_{ac} = -4$ kN (compression)

Resolving horizontally

$F_{ab} + F_{ac} \cos 30 = 1$

$F_{ab} = 1 - 0.866\ F_{ac} = 4.464$ kN (tension)

Joint B



Resolving horizontally

$F_{bd} \cos 45 = F_{ab}$

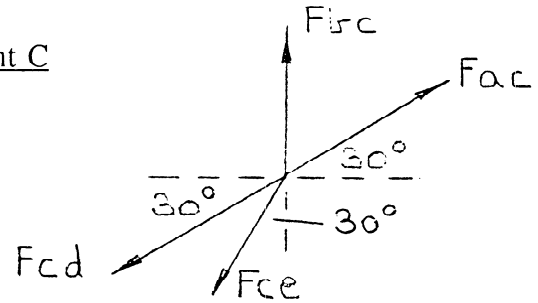
$F_{bc} = 6.31$ kN (tension)

Resolving vertically

$F_{bc} + F_{bd} \cos 45 = 0$

$F_{bd} = -4.464$ kN (compression)

Joint C



Resolving Horizontally

$F_{ac} \cos 30 = F_{cd} \cos 30 + F_{ce} \cos 60$

$F_{cd} = F_{ac} - 0.5774\ F_{ce}$

$F_{cd} = -4 - 0.5774\ F_{ce}$ 1

Resolving vertically

$F_{bc} + F_{ac} \sin 30 = F_{cd} \sin 30 + F_{ce} \sin 60$

$-4.464 - 2 = 0.5\ F_{cd} + 0.866\ F_{ce}$ 2

Substitute 1 into 2

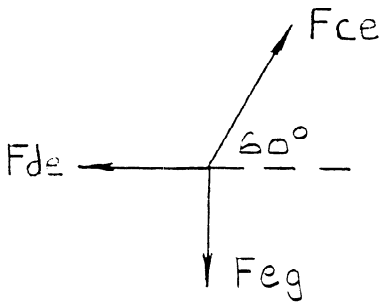
$-6.464 = -2 - 0.289\ F_{ce} + 0.866\ F_{ce}$

$F_{ce} = -7.737$ kN (compression) 3

Substituting 3 into 1

$F_{cd} = 0.467$ kN (tension)

Joint E



Resolving horizontally

$F_{ce} \cos 60 = F_{de}$

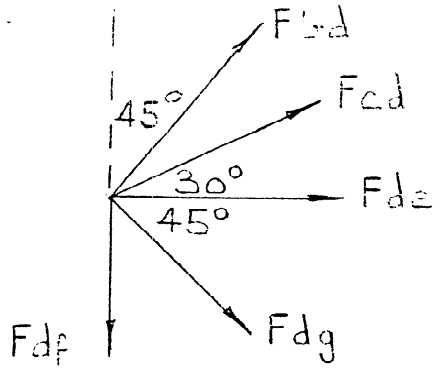
$F_{de} = -3.87$ (compression)

Resolving vertically

$F_{ce} \sin 60 = F_{eg}$

$F_{eg} = -6.7$ kN (compression)

Joint D



Resolving horizontally

$F_{bd} \cos 45 + F_{cd} \cos 30$

$+ F_{de} + F_{dg} \cos 45 = 0$

$6.31 \times 0.707 + 0.467 \times 0.866 - 3.87 + 0.707 F_{dg} = 0$

$F_{dg} = -1.41$ kN (compression)

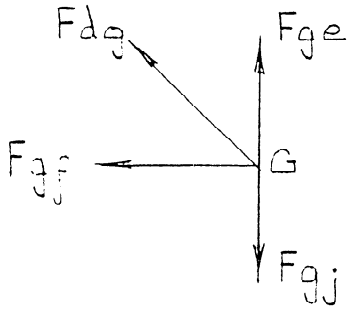
Resolving vertically

$F_{bd} \sin 45 + F_{cd} \sin 30 = F_{dg} \sin 45 + F_{df}$

$6.31 \times 0.707 + 0.467 \times 0.5 = -1.41 \times 0.707 + F_{df}$

$F_{df} = 5.7$ kN (tension)

Joint G



Resolving horizontally

$-F_{dg} \times 0.707 = F_{gf}$

$F_{gf} = 1.0$ kN (tension)

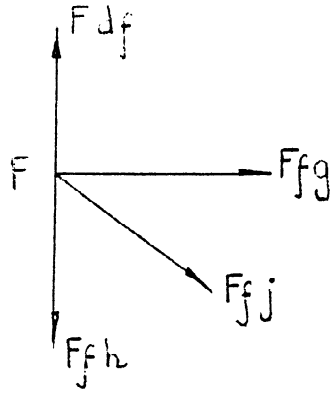
Resolving vertically

$F_{ge} + F_{dg} \times 0.707 = F_{gj}$

$-6.7 - 1.41 \times 0.707 = F_{gj}$

$F_{gj} = -7.7$ kN (compression)

Joint F



Resolving horizontally

$-F_{fj} \times 0.707 = F_{fg}$

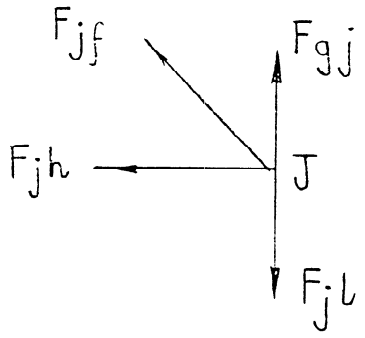
$\therefore F_{fj} = -1.41$ kN (compression)

Resolving vertically

$F_{df} = F_{fj} \times 0.707 + F_{fh}$

$F_{fh} = 5.7 + 1 = 6.7$ kN (tension)

Joint J



Resolving horizontally

$- F_{jf} \times 0.707 = F_{jh}$

$F_{jh} = 1.0$ kN (tension)

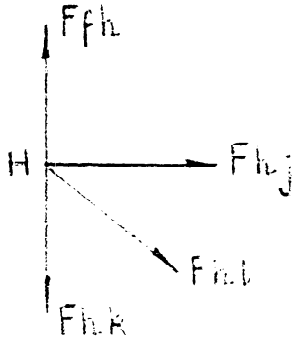
Resolving vertically

$F_{gj} + F_{jf} \times 0.77 = F_{jl}$

$- 7.7 - 1.41 \times 0.707 = F_{jl}$

$F_{jl} = -8.7$ kN (compression)

Joint H



Resolving horizontally

$F_{hl} \cos 45 = - F_{hj}$

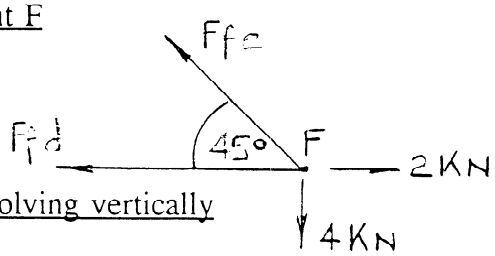
$\therefore F_{hl} = - 1.41$ kN(compression)

Resolving vertically

$F_{fh} = F_{hl} \times 0.707 + F_{hk}$

$\therefore F_{hk} = + 6.7 + 1 = 7.7$ kN (tension)

5. Joint F



Resolving vertically

$F_{fe} \times 0.707 = 4$

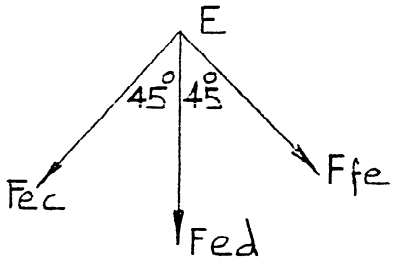
$F_{fe} = 5.658$ kN (tensile)

Resolving horizontally

$F_{fe} \times 0.707 + F_{fd} = 2$

$F_{fd} = 2 - 4 = 2$ kN (compressive)

Joint E



Resolving horizontally

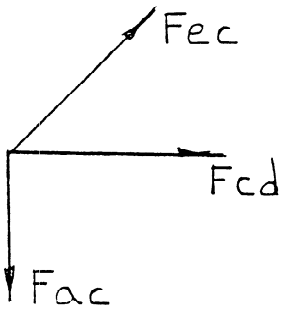
$F_{ec} = F_{fe} = 5.658$ kN (tensile)

Resolving vertically

$F_{ec} \times 0.707 + F_{fe} \times 0.707 + F_{ed} = 0$

$F_{ed} = -8$ kN (compressive)

Joint C



Resolving horizontally

$F_{ec} \times 0.707 + F_{cd} = 0$

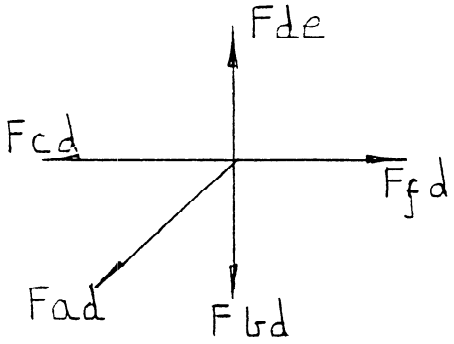
$F_{cd} = -4$ kN (compressive)

Resolving vertically

$F_{ec} \times 0.707 = F_{ac}$

$F_{ac} = 4$ kN (tensile)

Joint D



Resolving horizontally

$F_{fd} = F_{cd} + F_{ad} \times 0.707$

$F_{ac} = 2.828$ kN (tensile)

Resolving vertically

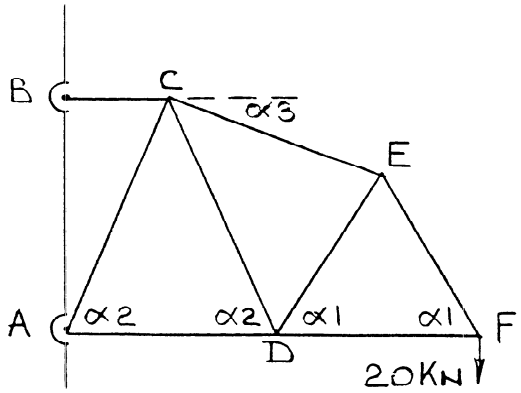
$F_{de} = F_{bd} + F_{ad} \times 0.707$

$F_{bd} = -8 - 2 = -10$ kN (compressive)

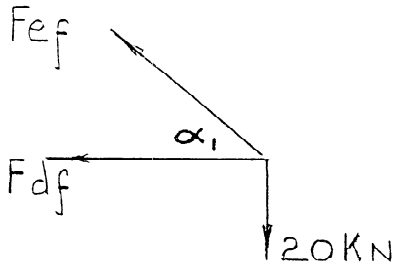
6. $\alpha_1 \tan^{-1} 3 = 71.565°$

$\alpha_2 = \tan^{-1} 4 = 75.964°$

$\alpha_3 = \tan^{-1} (½) = 26.565°$



Joint F



Resolving vertically

$F_{ef} \sin \alpha_1 = 20$

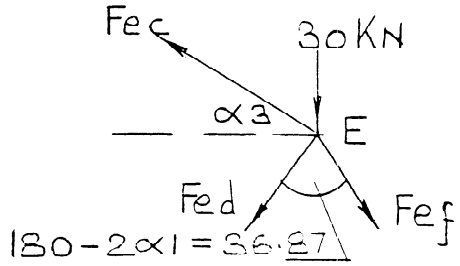
$F_{cf} = 21.08$ (tensile)

Resolving horizontally

$F_{df} + F_{ef} \cos \alpha_1 = 0$

$F_{df} = -6.667$ kN (compressive)

Joint E



Resolving vertically

$F_{ec} \sin \alpha_3 = 30 + (F_{ed} + F_{ef}) \cos (18.435°)$

$0.447\ F_{ec} = 30 + 0.949\ F_{ed} + 20$

$F_{ec} = 111.86 + 2.123\ F_{ed}$ ——— 1

Resolving horizontally

$F_{cc} \cos \alpha_3 + F_{ed} \sin (18.435) = F_{ef} \sin (18.435)$

$0.894\ F_{ec} + 0.316\ F_{ed} = 6.667$ ——— 2

Substitute 1 into 2

$0.894\ (111.86 + 2.123\ F_{ed}) + 0.316\ F_{ed} = 6.667$

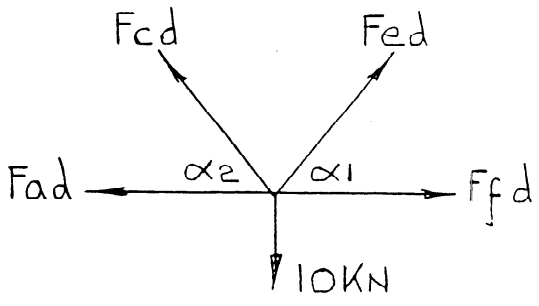
$100 + 2.214\ F_{ed} = 6.667$

$F_{ed} = -42.16$ kN (compressive) ——— 3

Substituting 3 into 1

$F_{ec} = 22.36$ kN (tensile)

Joint D



Resolving horizontally

$F_{ad} + F_{cd} \cos \alpha_2$

$= F_{fd} + F_{cd} \cos \alpha_1$