# SOLUTIONS TO TUTORIAL EXAMPLES

# CHAPTER 14

**Note:** The 'cut lines' referred to in the solutions below are illustrated on the diagrams at the end of this section.

## Question 1

All angles are tan-1(3/2) = 56.3° to the horizontal.

Sin 56.3° = 0.832, cos 56.3° = 0.555

***Member CD***

Cut along line 1–1.

Resolving vertically for the whole frame to the left of this cut line, it can be seen that the vertical component of the force in member CD near end C (upwards) will be equal to the 48 kN (downwards) force.

$F_{CD}$ sin 56.3° = 48
$F_{CD}$ = 48/0.832 = 57.6 kN (compression).

***Member DE***

Cut along line 2–2.

Resolving vertically for the whole frame to the left of this cut line, it can be seen that the force in member DE near end D (upwards) will be equal to the 48 kN (downwards) force.

$F_{DE}$ = 48 kN (tension).

***Member EG***

Cut along line 3–3, then take moments about F for the whole frame to the left of this cut line. Assume the force in member EG near to end E acts to the right.

($F_{EG}$ × 3 m) = (48 kN × 3 m) + (48 kN × 6 m)
$3F_{EG}$ = 432
$F_{EG}$ = 432/3 = 144 kN (tension).

***Member GH***

Calculate the reaction at K, $R_K$. Assume $R_K$ acts downwards.

Taking moments about F for whole frame:

$(R_K \times 4\ m) = (48\ kN \times 3\ m) + (48\ kN \times 6\ m)$
$4R_K = 432$
$R_K = 432/4 = 108\ kN$ (downwards).

Cut along line 4–4, then resolve vertically for the whole frame to the right of this cut line. By inspection, the force in member GH near to end H acts upwards.

The vertical component of the force in member GH near end H (upwards) will be equal to the 108 kN (downwards) force.

$F_{GH} \sin 56.3° = 108$
$F_{GH} = 108/0.832 = 129.8\ kN$ (tension).

## Question 2

All angles are tan-1(5/6) = 39.8° to the horizontal.

Sin 39.8° = 0.640, cos 39.8° = 0.768

***Member BE***

Cut along line 5–5, then resolve vertically for the whole frame to the right of this cut line. By inspection, the force in member BE near to end E acts upwards.

The vertical component of the force in member BE near end E (upwards) will be equal to the sum of the downward external forces to the right of the cut line.

$F_{BE} \sin 39.8° = (20 + 20) = 40$
$F_{BE} = 40/0.640 = 62.5\ kN$ (tension).

***Member BF***

Cut along line 6–6, then resolve vertically for the whole frame to the right of this cut line. By inspection, the force in member BF near to end B acts upwards.

$F_{BF} = (20 + 20 + 20) = 60\ kN$ (compression).

## Question 3

All angles are tan-1(6/8) = 36.9° to the horizontal.

Sin 36.9° = 0.6, cos 36.9° = 0.8

Cut along line 7–7.

***Member CD***

Resolve vertically for the whole frame to the left of cut line 7–7. By inspection, the force in member CD near end C acts downwards. The vertical component of the force in member CD near end C (downwards) will be equal to the 120 kN (upwards) external force.

$F_{CD}$ sin 36.9° = 120
$F_{CD}$ = 120/0.6 = 200 kN (compression).

***Member BC***

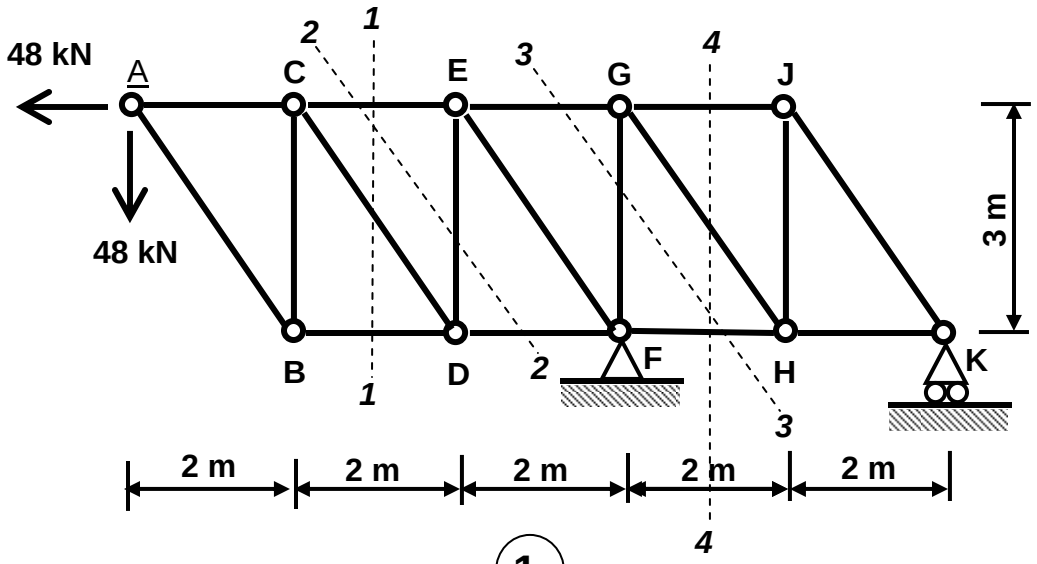
Take moments about point D for the part of the frame to the left of cut line 7–7, assuming the force in member BC at C acts to the right:

(120 kN × 16 m) = (24 kN × 6 m) + ($F_{BC}$ × 6 m)
6$F_{BC}$ = 1776
$F_{BC}$ = 1776/6 = 296 kN (tension).

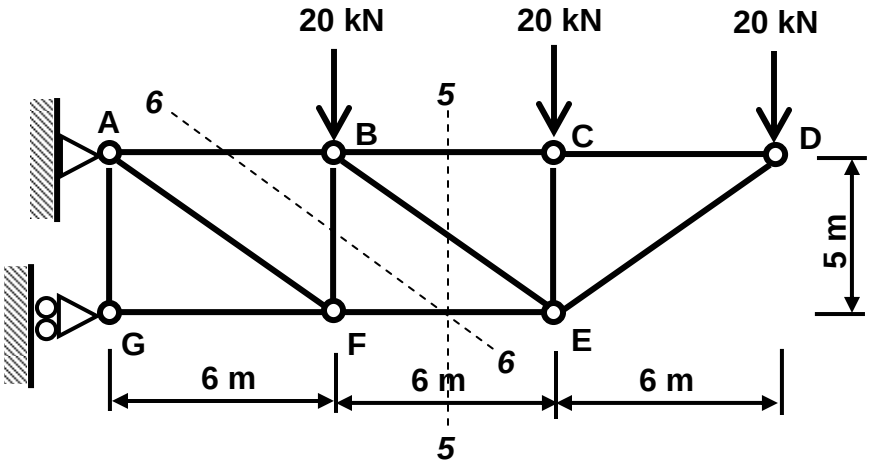
***Member DE***

Take moments about point C for the part of the frame to the left of cut line 7–7, assuming the force in member DE at E acts to the left:

(FDE × 6 m) + (24 kN × 12 m) = (120 kN × 8 m)
6FDE = 672
FDE = 672/6 = 112 kN (compression).


48 kN
A
C
E
G
J
48 kN
3 m
B
D
F
H
K
1
2
3
4
2 m
2 m
2 m
2 m
2 m

1


20 kN
20 kN
20 kN
A
B
C
D
5 m
G
F
E
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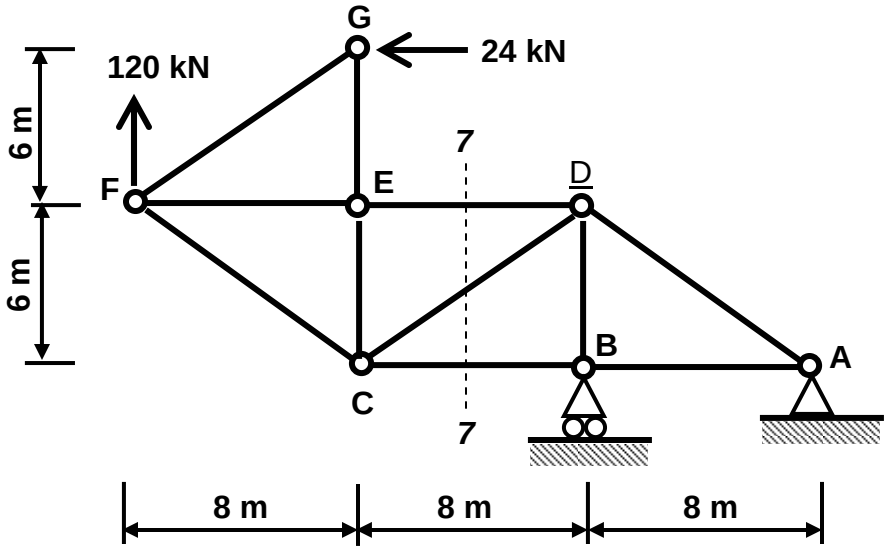
6 m
6 m
5
6

2


G
24 kN
120 kN
6 m
6 m
F
E
D
7
B
A
C
7
8 m
8 m
8 m

3