School of Engineering & Built Environment

African Leadership College, Mauritius

MEng/BEng(Hons)
In
Electrical Power Systems Engineering

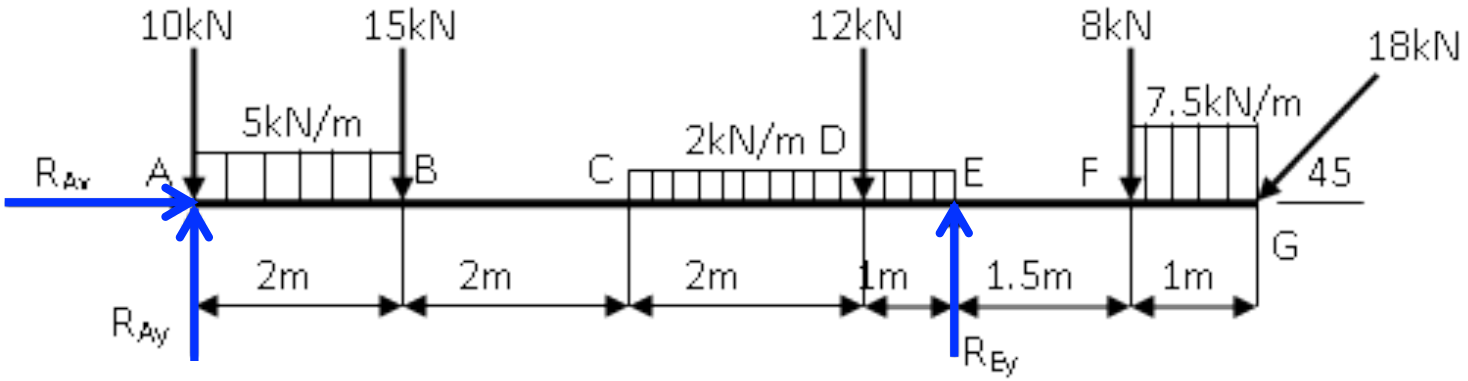
Module: Engineering Design & Analysis 2

Shear Force & Bending Moment Diagrams – Worked Example

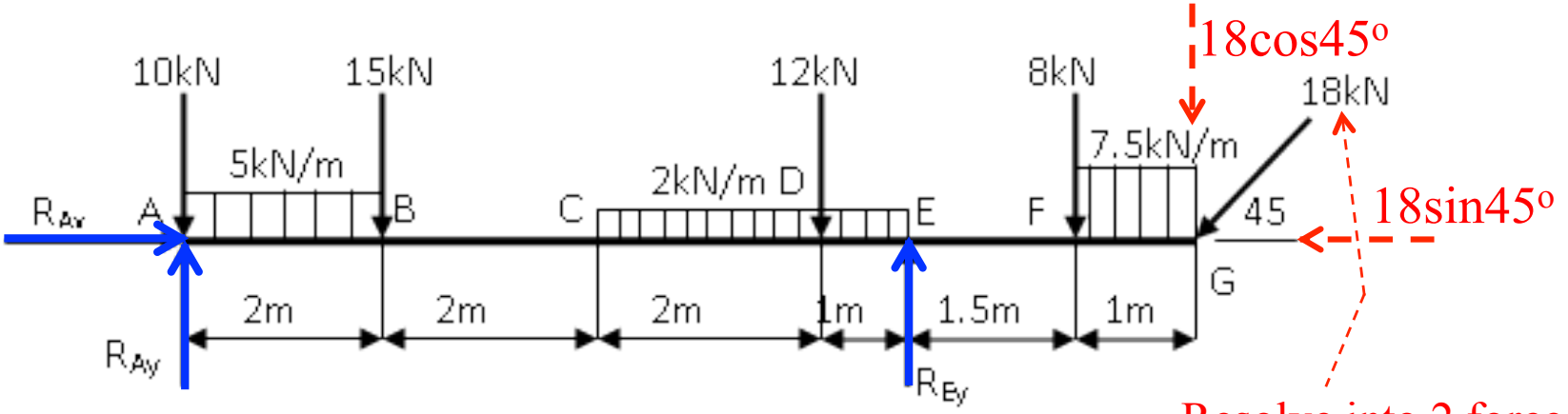
Shear Force & Bending Moments
Additional Worked Example

A beam is simply supported at A (by a pin) and E (by a knife edge) as shown in the figure and it carries various loads along its span.

i) Calculate the magnitude of the **reactions** at A and E.
ii) Draw the thrust diagram.
iii) Draw the shear force diagram.
iv) Draw the bending moment diagram.
v) State the magnitude and position of the maximum bending moment.
vi) Determine the position of contraflexure on the beam.



i) The pin support at A provides 2 force reactions (horizontal and vertical), and the knife edge at E provides a vertical reaction only.

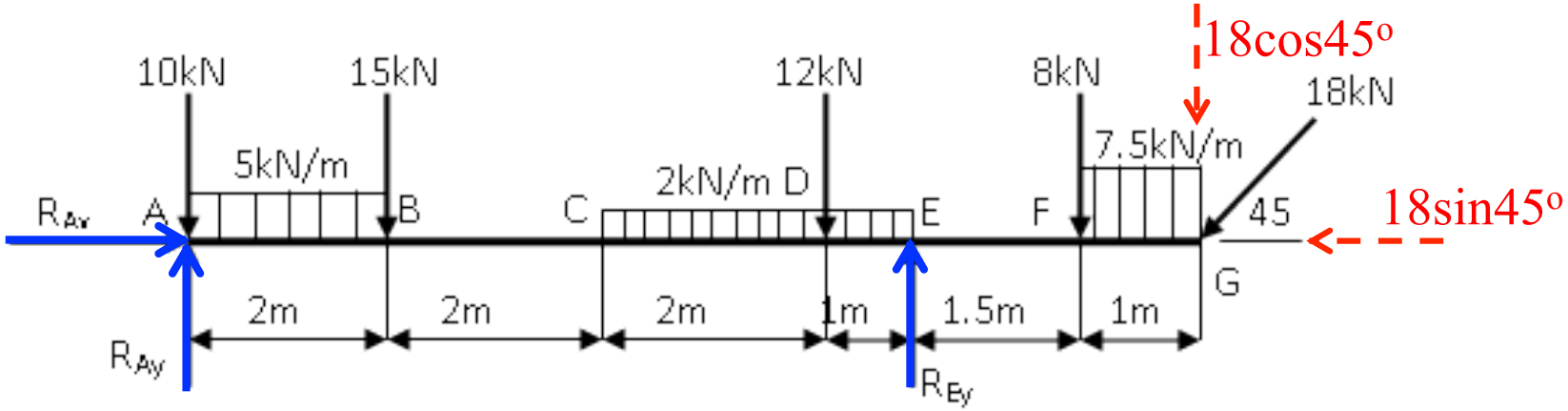


Applying 2D moment equilibrium about A:

$\sum M_A = o$:

$(5x2x1) + (15x2) + (2x3x5.5) + (12x6) - (7xR_E) + (8x8.5) + (7.5x1x9) + (18\cos 45^o x9.5) = 0$

$\mathbf{R_E = 57.3\ kN}$

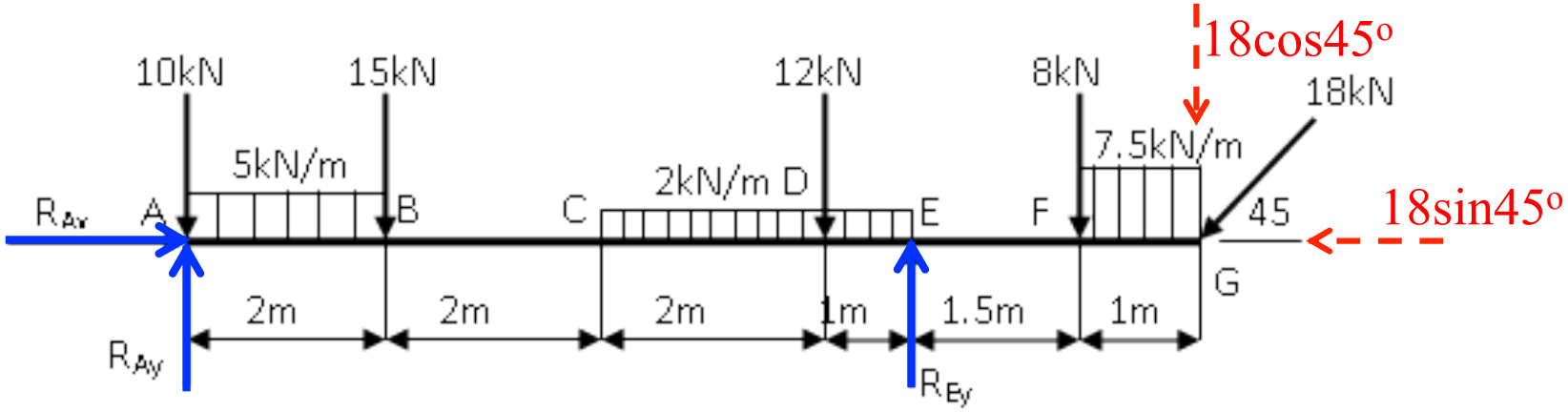


Applying 2D force equilibrium in Y-direction:

$$\sum F_y = o$$

$$R_{Ay} - 10 - (5x2) - 15 - (2x3) - 12 + 57.3 - 8 - (7.5x1) - (18\cos 45^o) = 0$$

$$\therefore \quad \mathbf{R_{Ay} = 23.9\ kN}$$



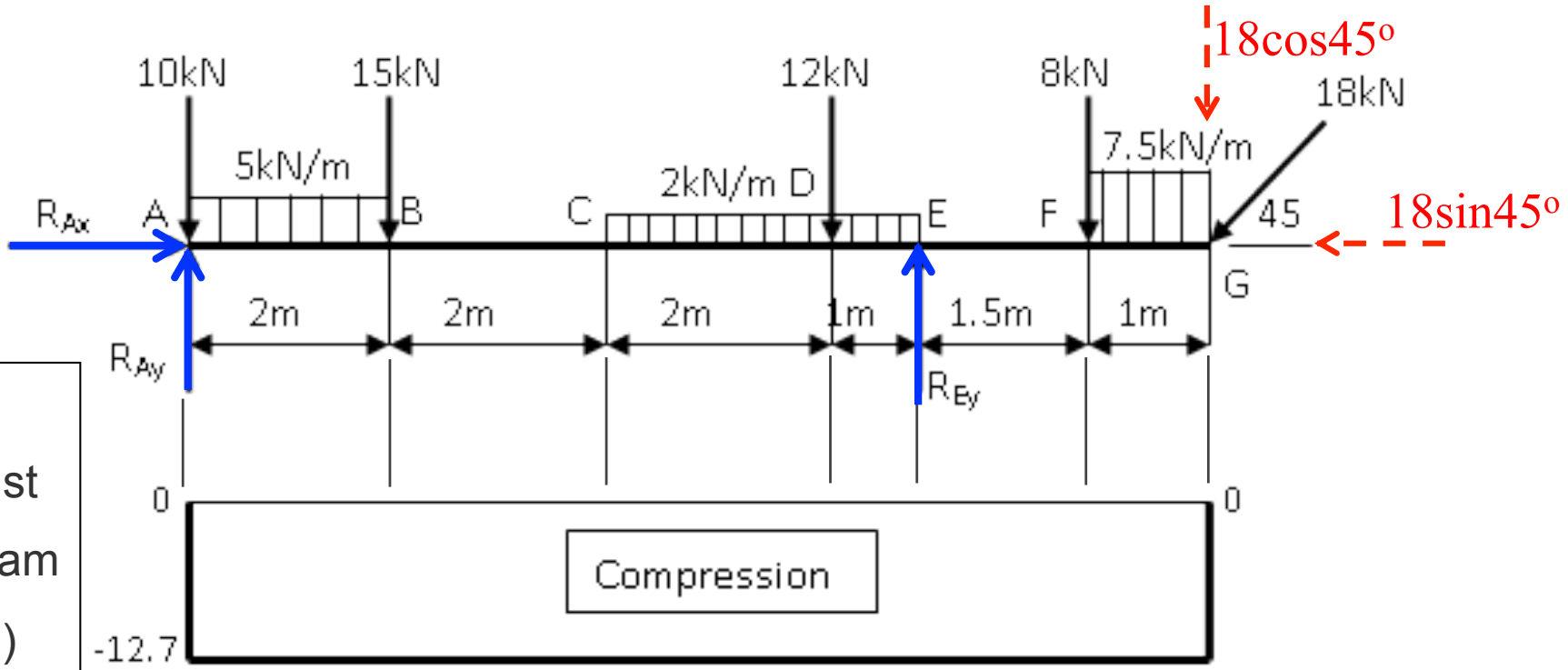
Applying 2D force equilibrium in X-direction:

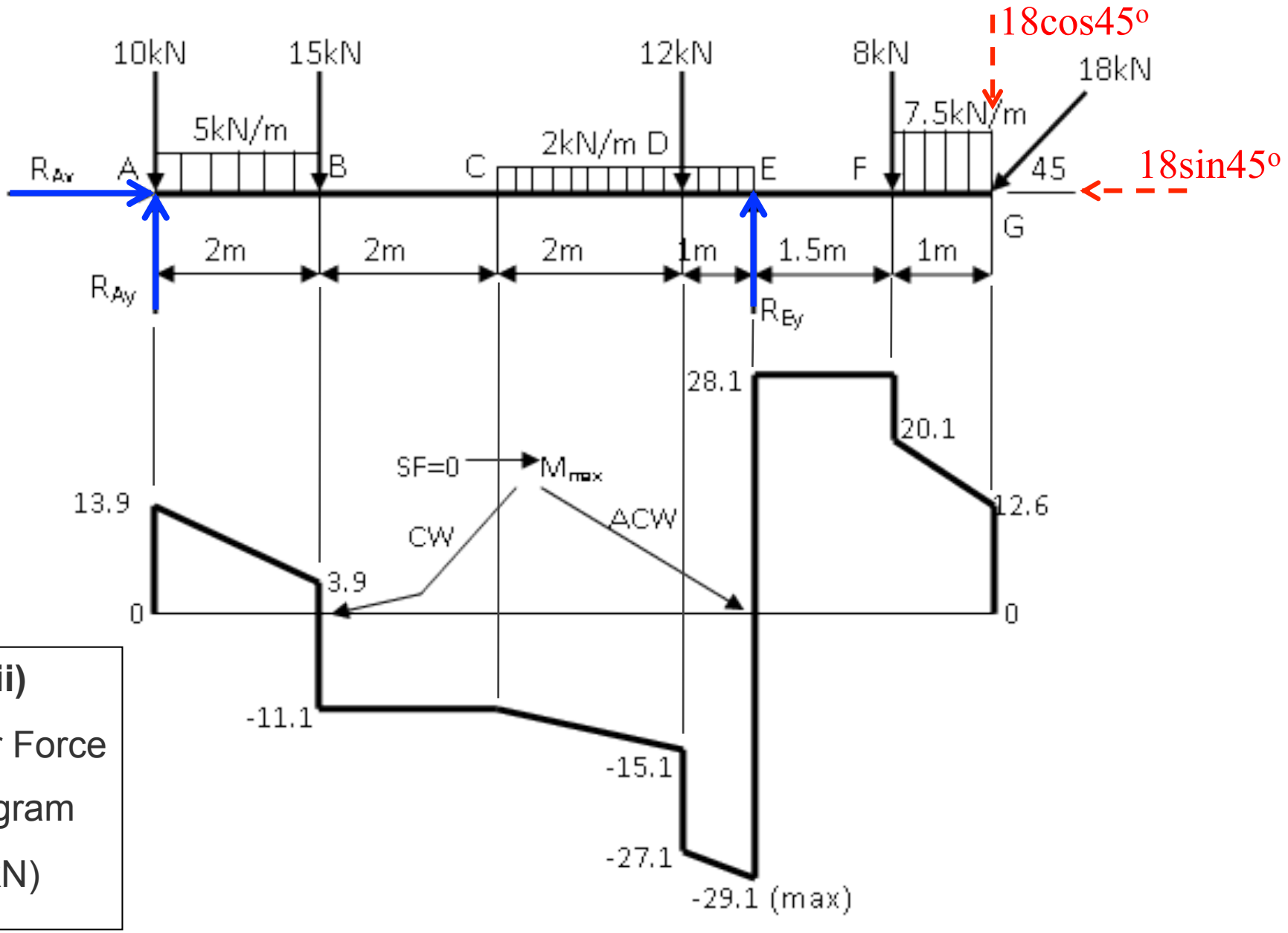
$$\sum F_x = o$$

$R_{Ax} - (18\sin 45^o) = 0$ ⇒ **$R_{Ax} = 12.7$ kN**

ii)

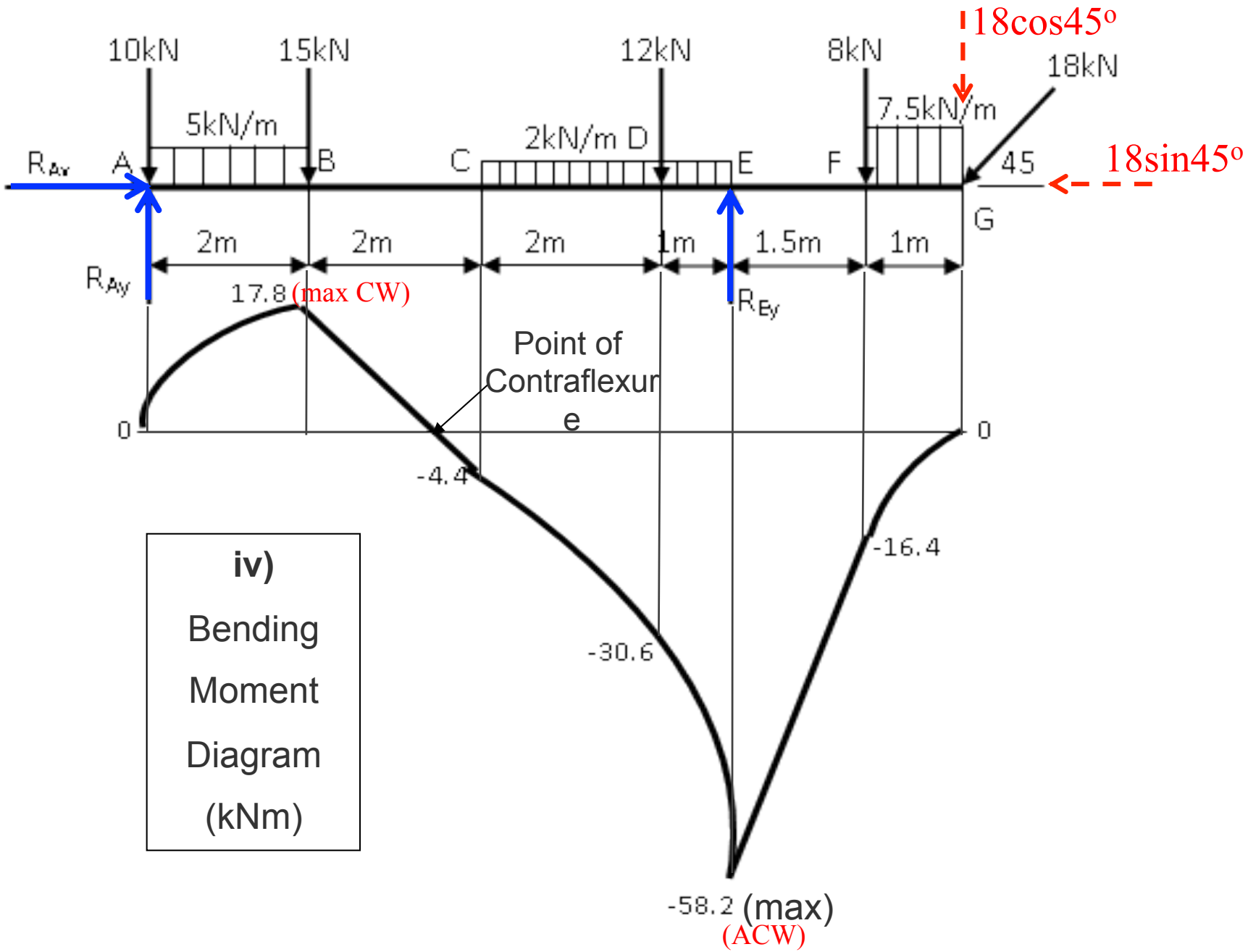
Thrust Diagram (kN)



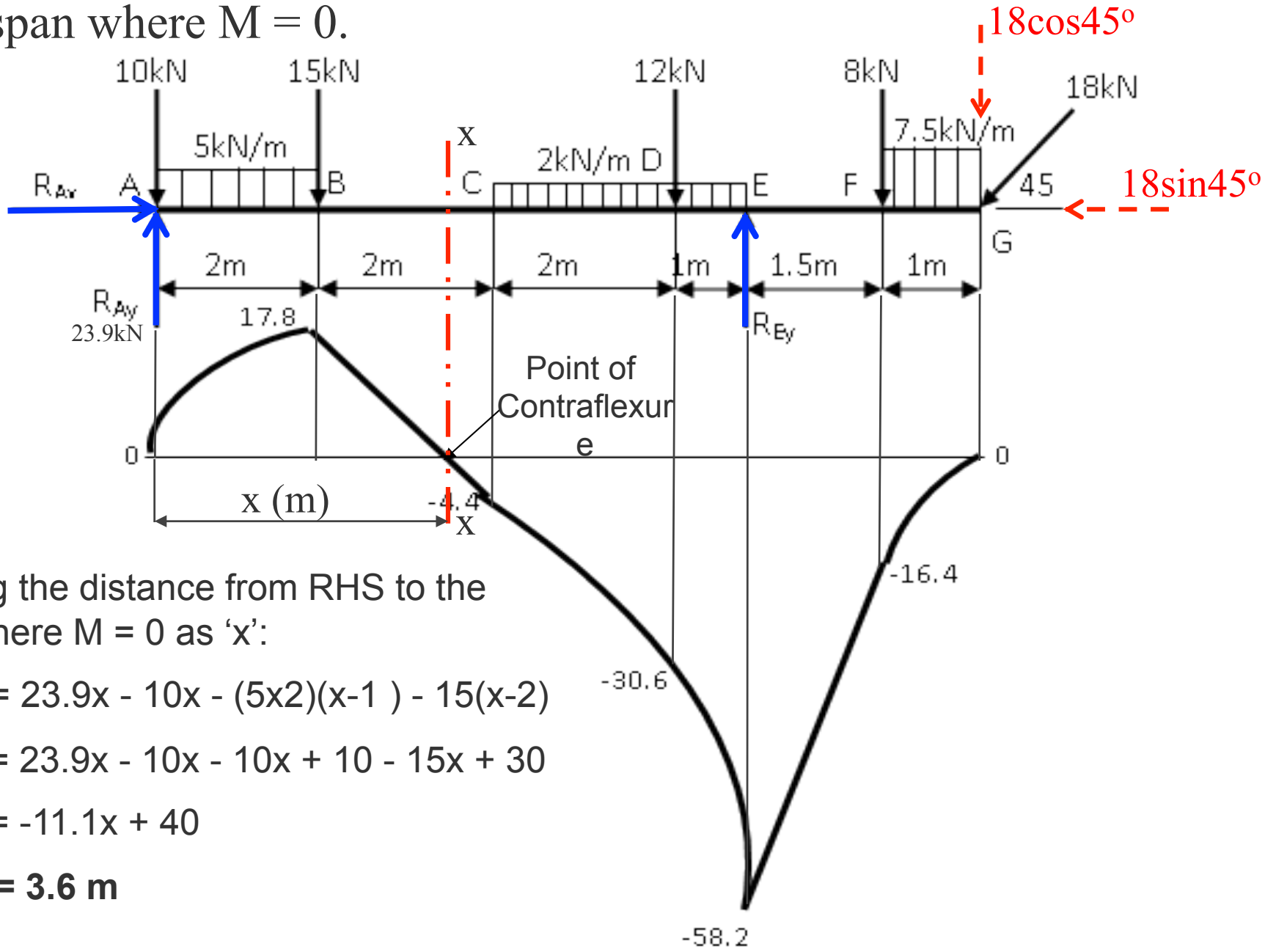


iii)

Shear Force Diagram (kN)


10kN
15kN
12kN
8kN
18cos45°
18kN
5kN/m
2kN/m
7.5kN/m
18sin45°
45
A
B
C
D
E
F
G
2m
2m
2m
1m
1.5m
1m
17.8 (max CW)
Point of Contraflexure
0
0
-4.4
-16.4
-30.6
-58.2 (max)
(ACW)
iv)
Bending Moment Diagram (kNm)

v) The point of contraflexure (or inflexion) occurs at the point along the beam span where M = 0.



Defining the distance from RHS to the point where M = 0 as 'x':

$M_x = 0 = 23.9x - 10x - (5x2)(x-1) - 15(x-2)$

$= 23.9x - 10x - 10x + 10 - 15x + 30$

$= -11.1x + 40$

i.e., **x = 3.6 m**