Example 3.6

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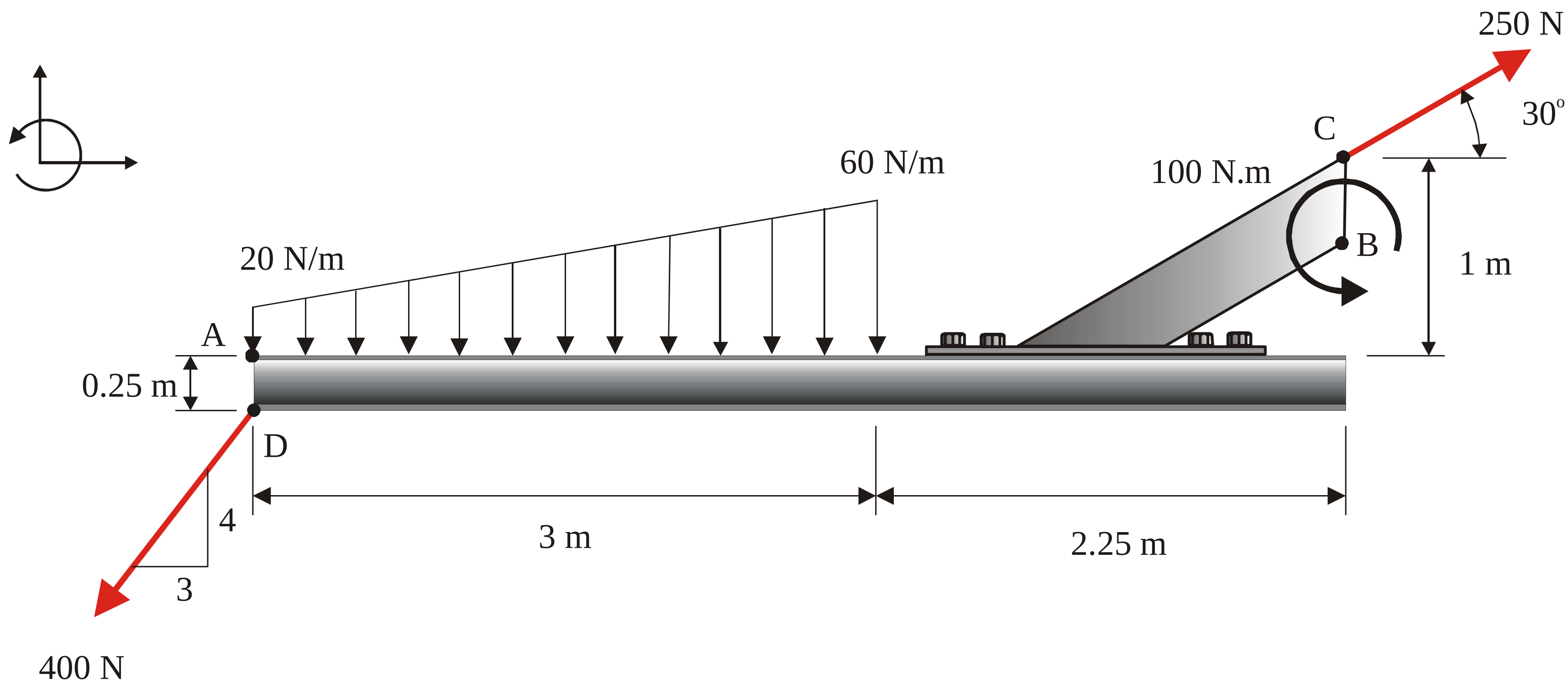
Example 3.6:

A distributed load that varies from 20 N/m to 60 N/m is applied to a beam as shown in the figure. A 400 N force is applied at Point D. A 100 N.m couple-moment and a 250 N force act on a bracket that is attached by bolts to the beam.

Determine:

a)The equivalent force-couple at point A, and

b)The magnitude and direction of the minimum force applied at point C that will produce the same moment about point A.



Convert the Distributed Load on the beam to two point loads.

For the rectangular portion of the distributed load:

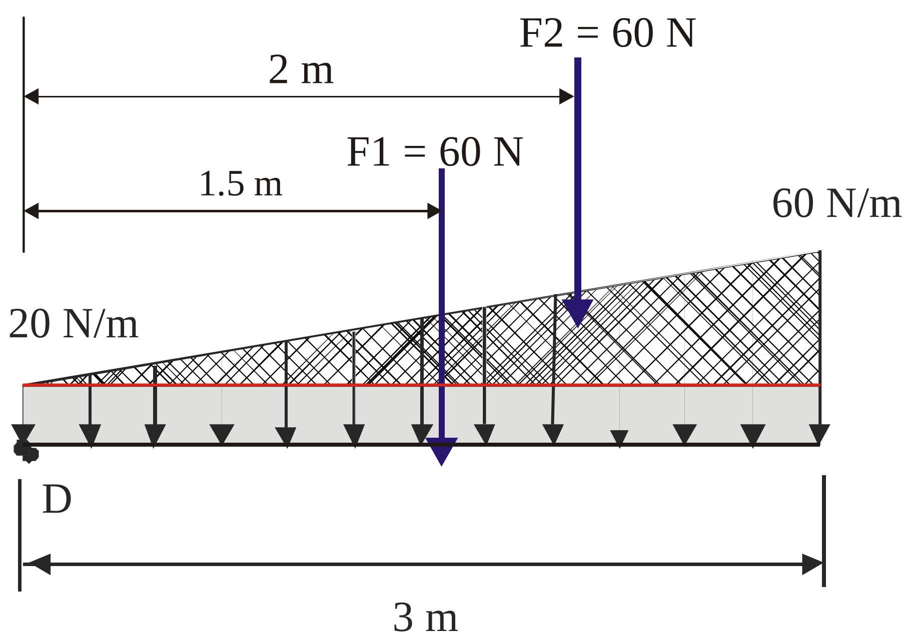
$$F_1 = 20\, {}^{N}\!/\!{}_{m}\,(3m) = 60N$$

Acting at 1.5 m

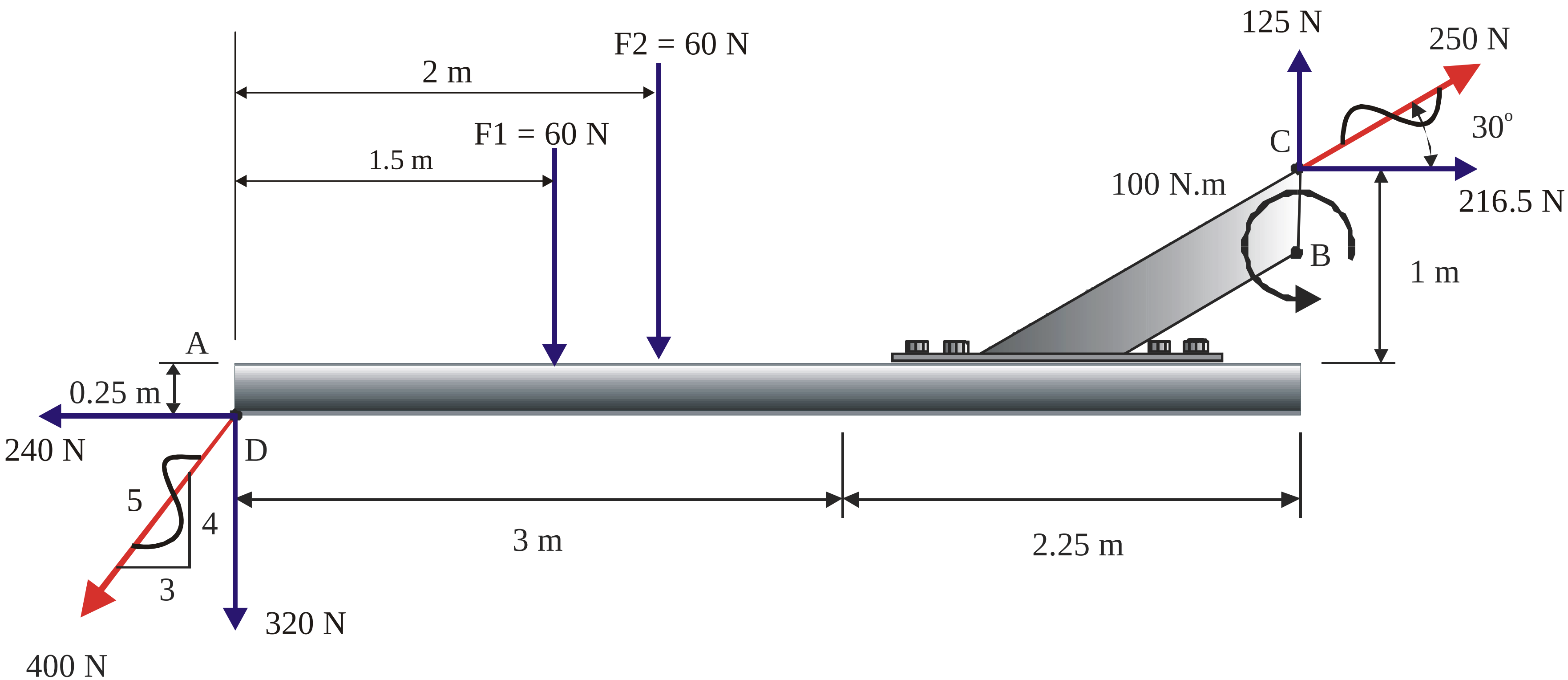
For the triangular portion of the distributed load:

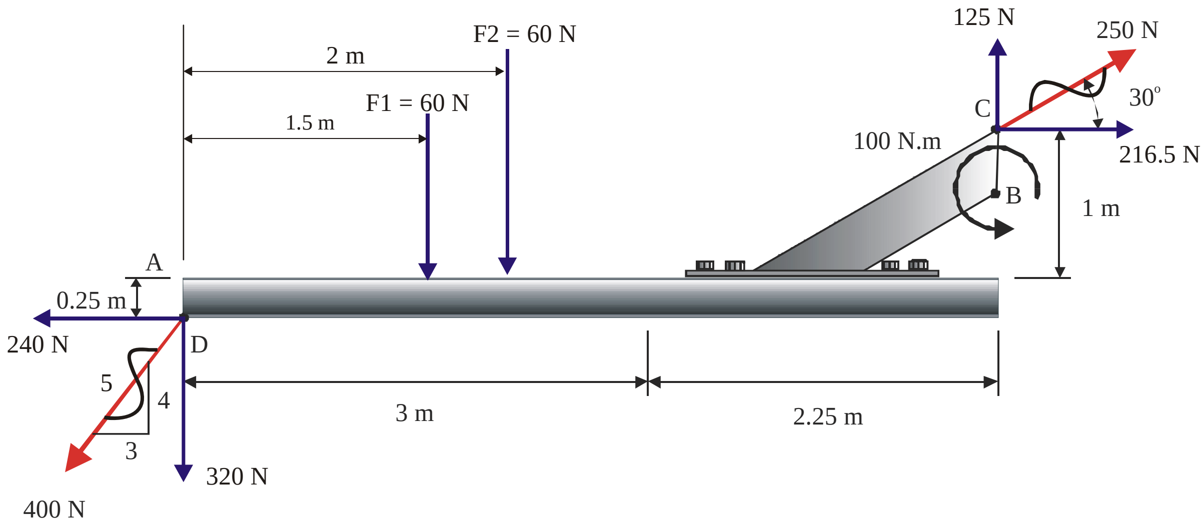
$$F_2 = (60\, {}^{N}\!/\!{}_{m} - 20\, {}^{N}\!/\!{}_{m})\frac{(3m)}{2} = 60N$$

Acting at $3 - \frac{1}{3}(3) = 2$ m from point D.



We convert the sloping forces at C and D to their rectangular components:





$$R_x = \sum F_x \rightarrow = -240 + 216.5 = -23.5\text{N}$$

$$\therefore \mathbf{R_x} = 23.5\text{N} \leftarrow$$

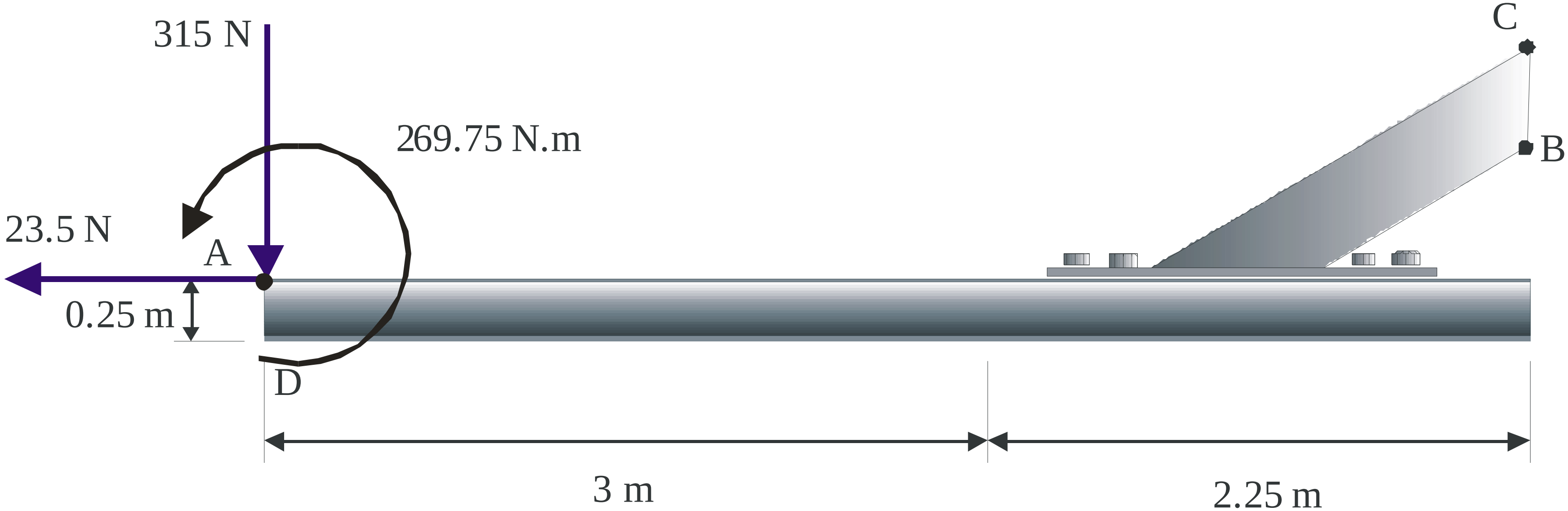
$$R_y = \sum F_y \uparrow = -320 - 60 - 60 + 125 = -315\text{N}$$

$$\therefore \mathbf{R_y} = 315\text{N} \downarrow$$

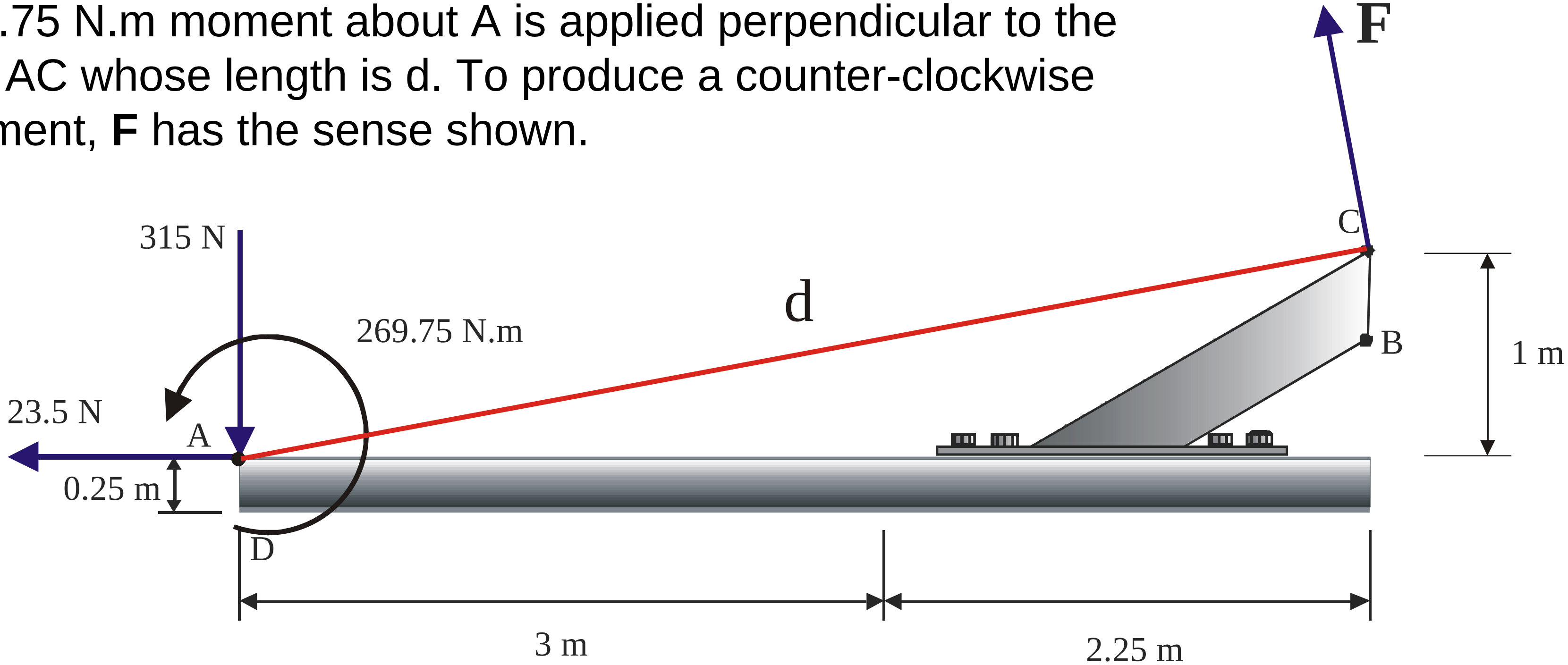
$$M_{AR} \circlearrowleft = -240(0.25) - 60(1.5) - 60(2) + 125(5.25) - 216.5(1) + 100 = +269.75\text{N.m}$$

$$\therefore \mathbf{M_{AR}} = 269.75\text{N.m} \circlearrowleft$$

Equivalent Force-Couple at A



The minimum force, **F** applied at C to produce the same 269.75 N.m moment about A is applied perpendicular to the line AC whose length is d. To produce a counter-clockwise moment, **F** has the sense shown.



$$d = \sqrt{5.25^2 + 1^2} = 5.344\text{m}$$

$$M = Fd$$

$$269.75 = F(5.344)$$

$$F = 50.47\text{N}$$

$$\therefore \mathbf{F} = 50.47\text{N}$$