

ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO

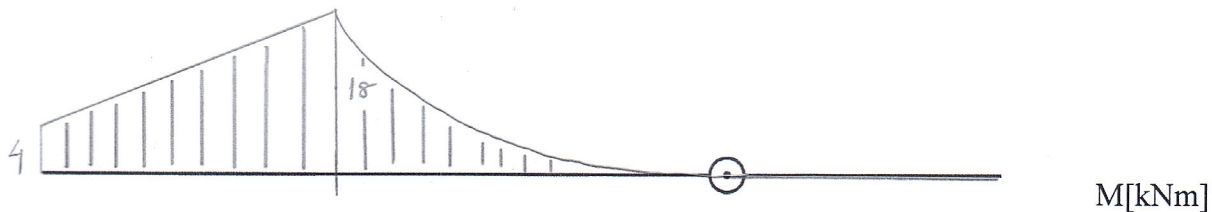
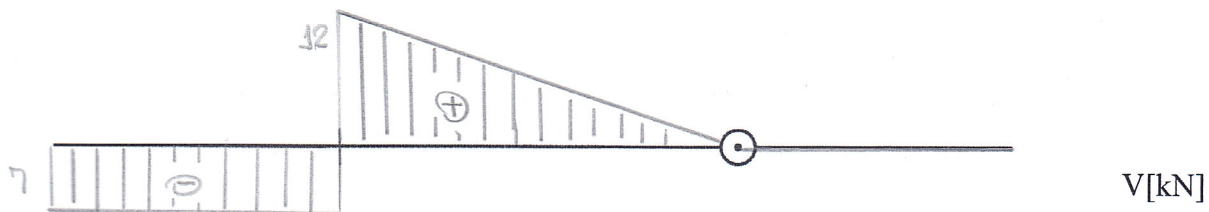
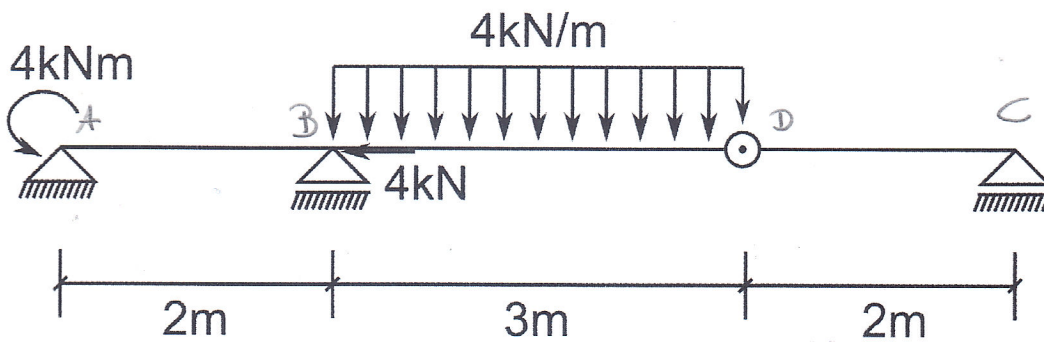
Departamento de Engenharia de Estruturas e Geotécnica

PEF – 3202 – Introdução à Mecânica dos Sólidos (08/04/2015)

Nome: GABARITO nUSP: _____

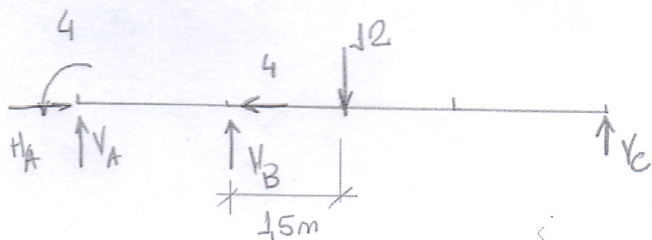
Questão 1

Encontre as reações de equilíbrio e trace os diagramas para a viga Gerberda figura 1.



Gabarito - Questão 1

DCL:



Reações de apoio:

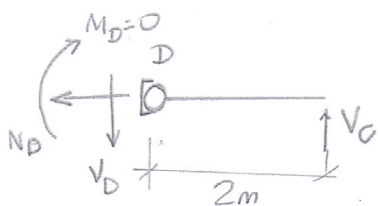
$$\sum F_x = 0 \Rightarrow H_A - 4 = 0 \Rightarrow \boxed{H_A = 4 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow V_A + V_B + V_C = 12$$

$$\sum M_A = 0 \Rightarrow 4 + V_B \cdot 2 - 12 \cdot 3,5 + V_C \cdot 7 = 0$$

$$2V_B + 7V_C + 4 - 42 = 0 \Rightarrow 2V_B + 7V_C = 38$$

Fazendo o corte na articulação:



$$\sum M_D = 0 \Rightarrow 2 \cdot V_C = 0 \Rightarrow \boxed{V_C = 0}$$

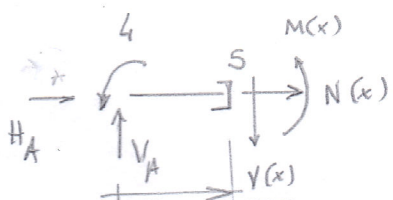
Logo:

$$2V_B = 38 \Rightarrow \boxed{V_B = 19 \text{ kN}}$$

$$V_A = 12 - V_B - V_C \Rightarrow \boxed{V_A = -7 \text{ kN}}$$

Traçando os diagramas:

Trecho 1 ($0 < x < 2\text{m}$):



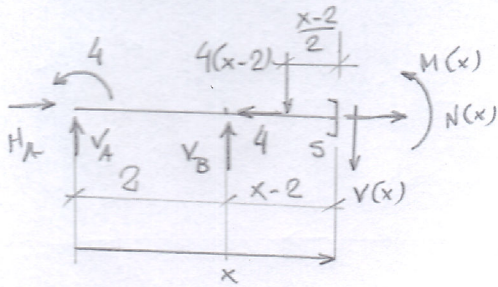
$$\sum F_x = 0 \Rightarrow H_A + N(x) = 0 \Rightarrow \boxed{N(x) = -4 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow V_A - V(x) = 0 \Rightarrow \boxed{V(x) = -7 \text{ kN}}$$

$$\sum M_S = 0 \Rightarrow 4 + M(x) - V_A x = 0 \Rightarrow$$

$$\boxed{M(x) = -4 - 7x}$$

Trecho 2 (2m < x < 5m):



$$\sum F_x = 0 \Rightarrow H_A - 4 + N(x) = 0 \Rightarrow \boxed{N(x) = 0}$$

$$\sum F_y = 0 \Rightarrow V_A + V_B - 4(x-2) - V(x) = 0$$

$$V(x) = 4(x-2) + V_A + V_B = -4x + 8 + 7 + 19$$

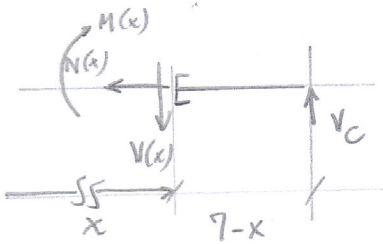
$$\boxed{V(x) = 20 - 4x}$$

$$\sum M_S = 0 \Rightarrow 4 + M(x) - V_A x - V_B(x-2) + 4(x-2)\frac{(x-2)}{2} = 0$$

$$M(x) + 4 + 7x - 19(x-2) + 2(x^2 - 4x + 4) = 0 \Rightarrow M(x) + 4 + 7x - 19x + 38 + 2x^2 - 8x + 8 = 0$$

$$\boxed{M(x) = -2x^2 + 20x - 50}$$

Trecho 3 (5m < x < 7m):



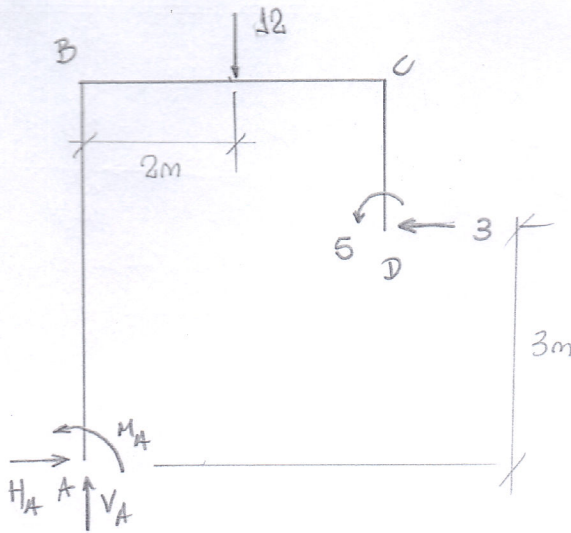
$$\sum F_x = 0 \Rightarrow \boxed{N(x) = 0}$$

$$\sum F_y = 0 \Rightarrow V(x) = V_C \Rightarrow \boxed{V(x) = 0}$$

$$\sum M_S = 0 \Rightarrow -M(x) + V_C(7-x) = 0 \Rightarrow \boxed{M(x) = 0}$$

Gabarito - Questão 2

DCL



Reações de apoio:

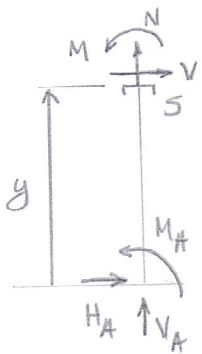
$$\sum F_x = 0 \Rightarrow H_A - 3 = 0 \Rightarrow \boxed{H_A = 3 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow V_A - 12 = 0 \Rightarrow \boxed{V_A = 12 \text{ kN}}$$

$$\sum M_A = 0 \Rightarrow M_A - 12 \cdot 2 + 5 + 3 \cdot 3 = 0 \Rightarrow M_A - 24 + 5 + 9 = 0 \Rightarrow \boxed{M_A = 10 \text{ kNm}}$$

Traçando os diagramas:

Barra AB ($0 \text{ m} < y < 3 \text{ m}$):

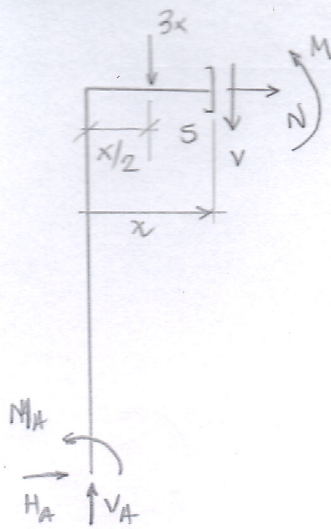


$$\sum F_x = 0 \Rightarrow V + H_A = 0 \Rightarrow \boxed{V = -3 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow N + V_A = 0 \Rightarrow \boxed{N = -12 \text{ kN}}$$

$$\sum M_S = 0 \Rightarrow M + M_A + H_A y = 0 \Rightarrow \boxed{M = -10 - 3y}$$

Bano BC ($0 < x < 4m$):



$$\sum F_x = 0 \Rightarrow H_A + N = 0 \Rightarrow \boxed{N = -3 \text{ kN}}$$

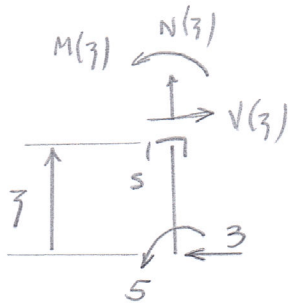
$$\sum F_y = 0 \Rightarrow V_A - 3x - V(x) = 0 \Rightarrow \boxed{V(x) = 12 - 3x}$$

$$\sum M_S = 0 \Rightarrow M + M_A - V_A x + H_A \cdot 5 + 3x \cdot \frac{x}{2} = 0$$

$$M(x) + 10 - 12x + 15 + \frac{3}{2}x^2 = 0$$

$$\boxed{M(x) = -1,5x^2 + 12x - 25}$$

Bano CD ($0 < z < 2m$):



$$\sum F_x = 0 \Rightarrow V(z) - 3 = 0 \Rightarrow \boxed{V(z) = 3 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow \boxed{N(z) = 0}$$

$$\sum M_S = 0 \Rightarrow 5 + M(z) - 3z = 0$$

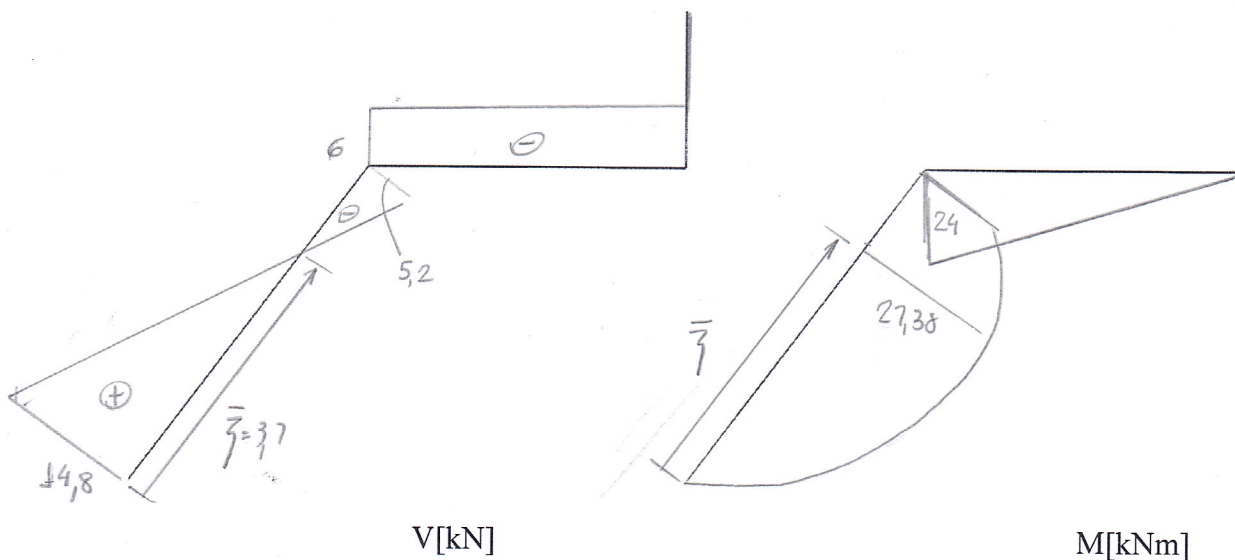
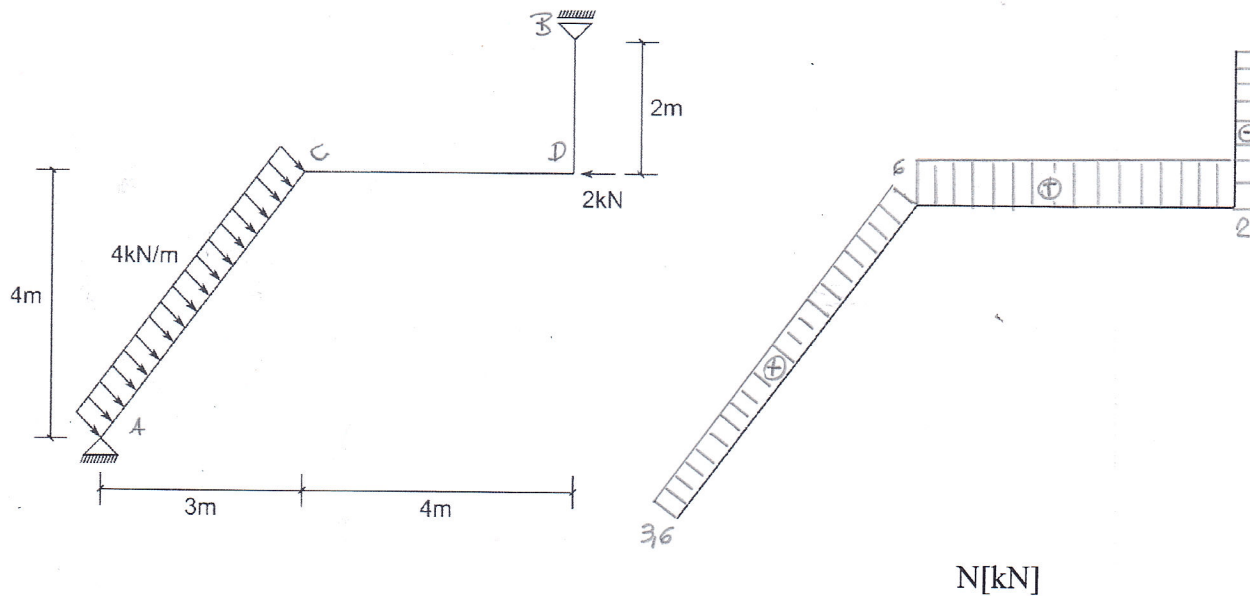
$$\boxed{M(z) = 3z - 5}$$

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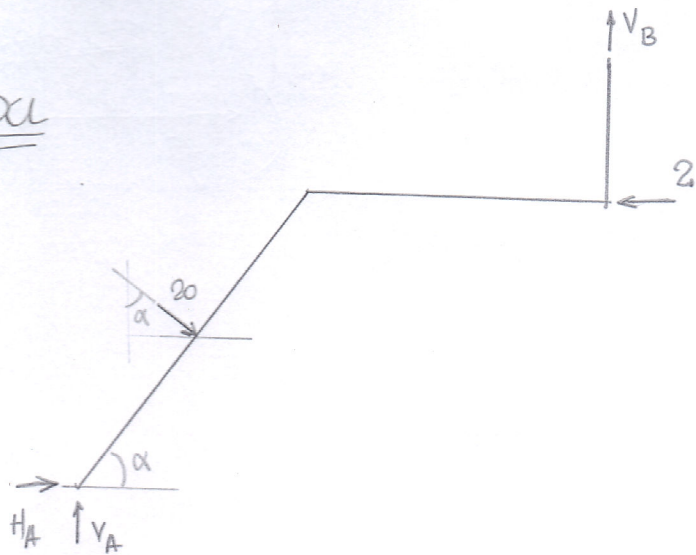
Questão 3

Encontre as reações de equilíbrio e trace os diagramas para a viga poligonal da figura 3.



Gabarito - Questão 3

DCU



$$\cos \alpha = 0,6$$

$$\sin \alpha = 0,8$$

Reações de apoio:

$$\sum F_x = 0 \Rightarrow H_A + 20 \cdot \sin \alpha - 2 = 0 \Rightarrow H_A + 16 - 2 = 0 \Rightarrow \boxed{H_A = -14 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow V_A - 20 \cdot \cos \alpha + V_B = 0 \Rightarrow V_A + V_B = 12$$

$$\sum M_A = 0 \Rightarrow -20 \cdot 2,5 + 2 \cdot 4 + V_B \cdot 7 = 0 \Rightarrow 7V_B - 50 + 8 = 0 \Rightarrow 7V_B = 42 \Rightarrow \boxed{V_B = 6 \text{ kN}}$$

$$V_A = 12 - V_B \Rightarrow \boxed{V_A = 6 \text{ kN}}$$

Trazendo os diagramas:

Barras AC ($0 \text{ m} < z < 5 \text{ m}$):

$$\sum F_z = 0 \Rightarrow N(z) + H_A \cos \alpha + V_A \sin \alpha = 0 \Rightarrow N(z) - 14 \cdot 0,6 + 6 \cdot 0,8 = 0$$

$$N(z) - 8,4 + 4,8 = 0 \Rightarrow \boxed{N(z) = 3,6 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow -V(z) - 4z - H_A \sin \alpha + V_A \cos \alpha = 0$$

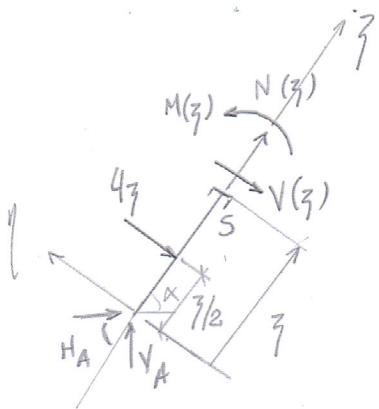
$$V(z) = -4z + 14 \cdot 0,8 + 6 \cdot 0,6 \Rightarrow V(z) = -4z + 11,2 + 3,6$$

$$\boxed{V(z) = 14,8 - 4z}$$

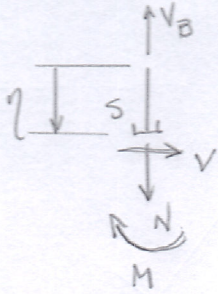
$$\sum M_S = 0: M(z) + H_A \sin \alpha \cdot z - V_A \cos \alpha \cdot z + 4z \cdot \frac{z}{2} = 0$$

$$M(z) - 11,2z - 3,6z + 2z^2 = 0$$

$$\boxed{M(z) = 14,8z - 2z^2}$$



Bone BD ($0m < y < 2m$):

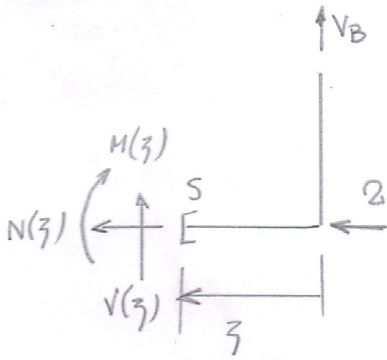


$$\sum F_x = 0 \Rightarrow \boxed{V(x) = 0}$$

$$\sum F_y = 0 \Rightarrow V_B - N(x) = 0 \Rightarrow \boxed{N(x) = 6 \text{ kN}}$$

$$\sum M_S = 0 \Rightarrow -M = 0 \Rightarrow \boxed{M(x) = 0}$$

Bone CD ($0m < z < 4m$):



$$\sum F_x = 0 \Rightarrow -N(z) - 2 = 0 \Rightarrow \boxed{N(z) = -2 \text{ kN}}$$

$$\sum F_y = 0 \Rightarrow V(z) + V_B = 0 \Rightarrow \boxed{V(z) = -6 \text{ kN}}$$

$$\sum M_S = 0 \Rightarrow -M(z) + V_B z = 0 \Rightarrow \boxed{M(z) = 6z}$$