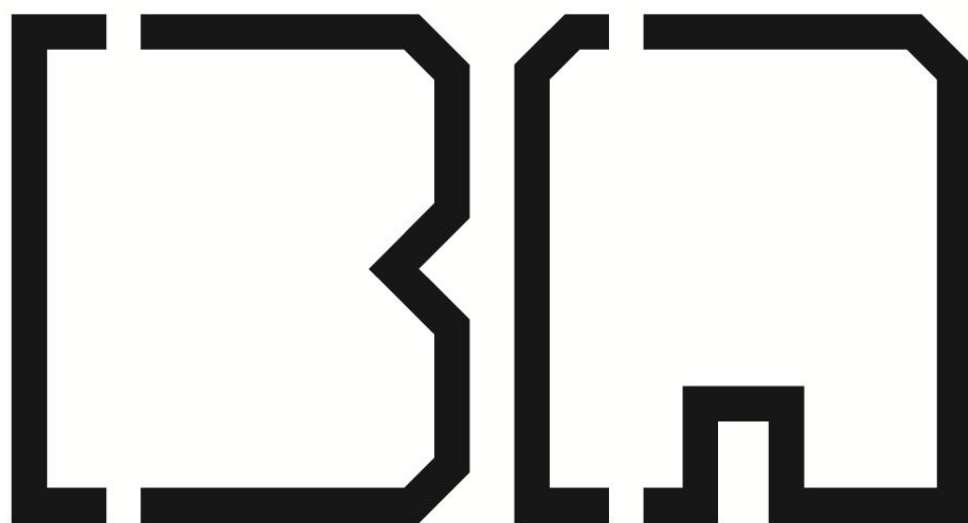


Politechnika Lubelska

Wydział Budownictwa i Architektury



Mechanika Budowli I

Projekt 3: Linia Wpływu

Wykonał:

.....

Sprawdził:

dr inż. Jakub Gontarz

PRZYKŁADOWY TEMAT

Student.....

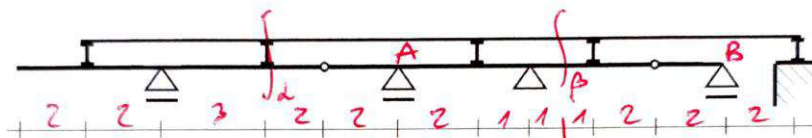
Grupa.....

Rok akademicki.....

ĆWICZENIE PROJEKTOWE nr 3 Z MECHANIKI BUDOWLI

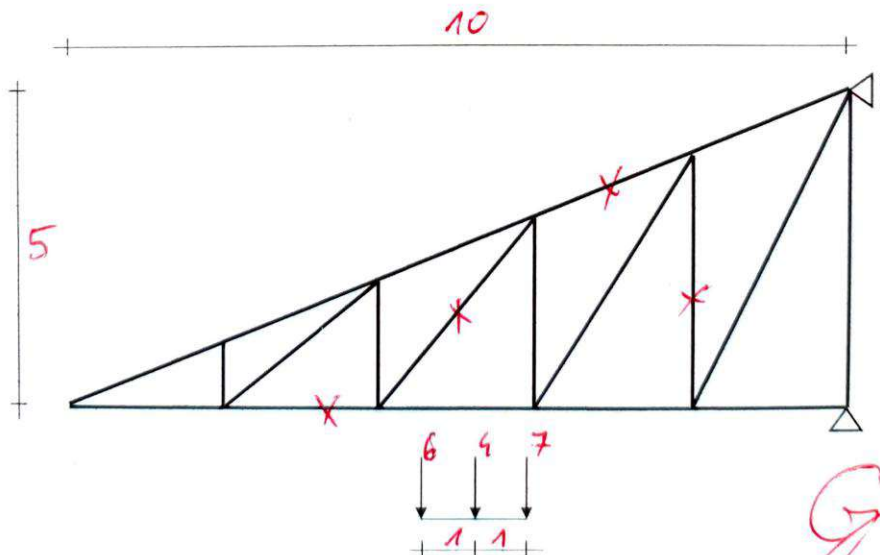
Zadanie 1.

Dla danej belki wyznaczyć linie wpływu reakcji i sił wewnętrznych: M_a , T_a , M_b , T_b . Wyznaczyć obwiednię momentów zginających przy obciążeniu jednostkowym w przedziale A-B.

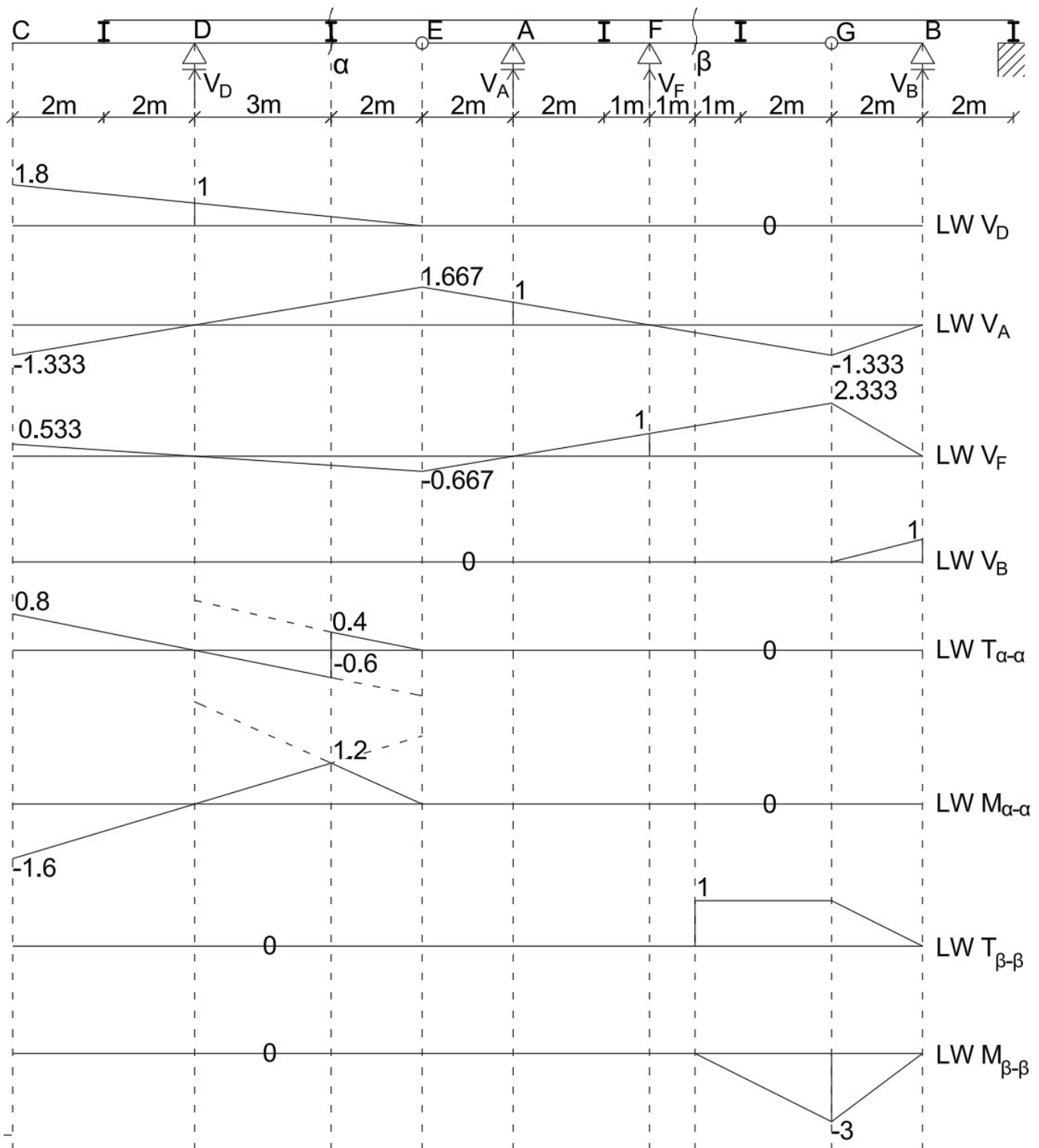


Zadanie 2.

Wyznaczyć linie wpływu reakcji i sił wewnętrznych w oznaczonych prętach oraz ich ekstremalne wielkości przy zadanym obciążeniu.



Zadanie 1: Belka



Obliczenia:

$$\text{LW } V_D: \quad C: 1 \cdot \frac{9}{5} = 1.8$$

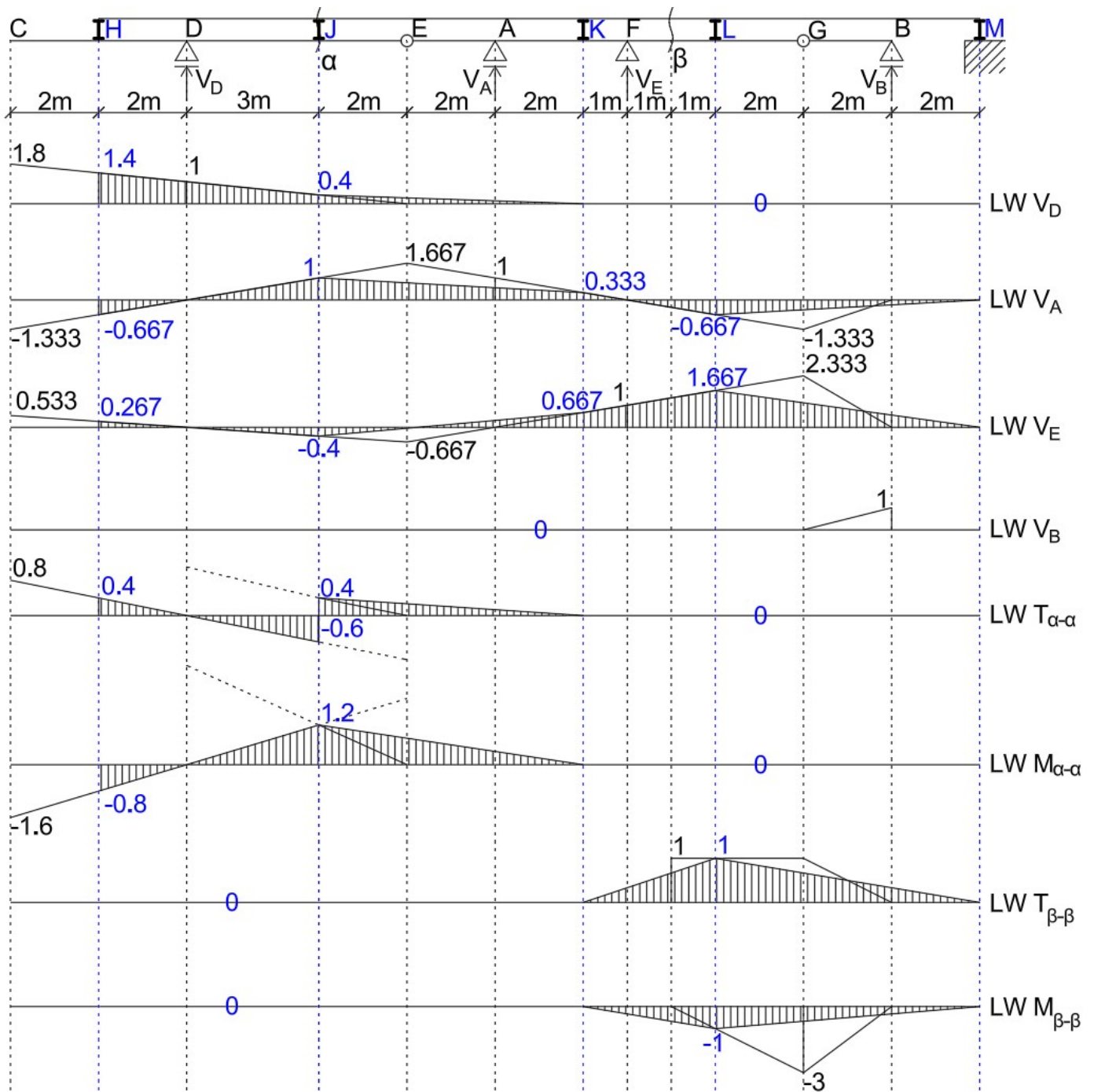
$$\text{LW } V_A: \quad E: 1 \cdot \frac{5}{3} = 1.667 \quad A: 1.667 \cdot \frac{-4}{5} = -1.334 \quad G: 1 \cdot \frac{-4}{3} = -1.333$$

$$\text{LW } V_F: \quad E: 1 \cdot \frac{-2}{3} = -0.667 \quad A: -0.667 \cdot \frac{-4}{5} = 0.534 \quad G: 1 \cdot \frac{7}{3} = 2.333$$

$$\text{LW } T_{\alpha-\alpha}: \quad -1 \cdot \frac{3}{5} = -0.6 \quad 1 \cdot \frac{2}{5} = 0.4 \quad C: -0.6 \cdot \frac{-4}{3} = 0.8$$

$$\text{LW } M_{\alpha-\alpha}: \quad 2 \cdot \frac{3}{5} = 1.2 \quad C: 1.2 \cdot \frac{-4}{3} = -1.6$$

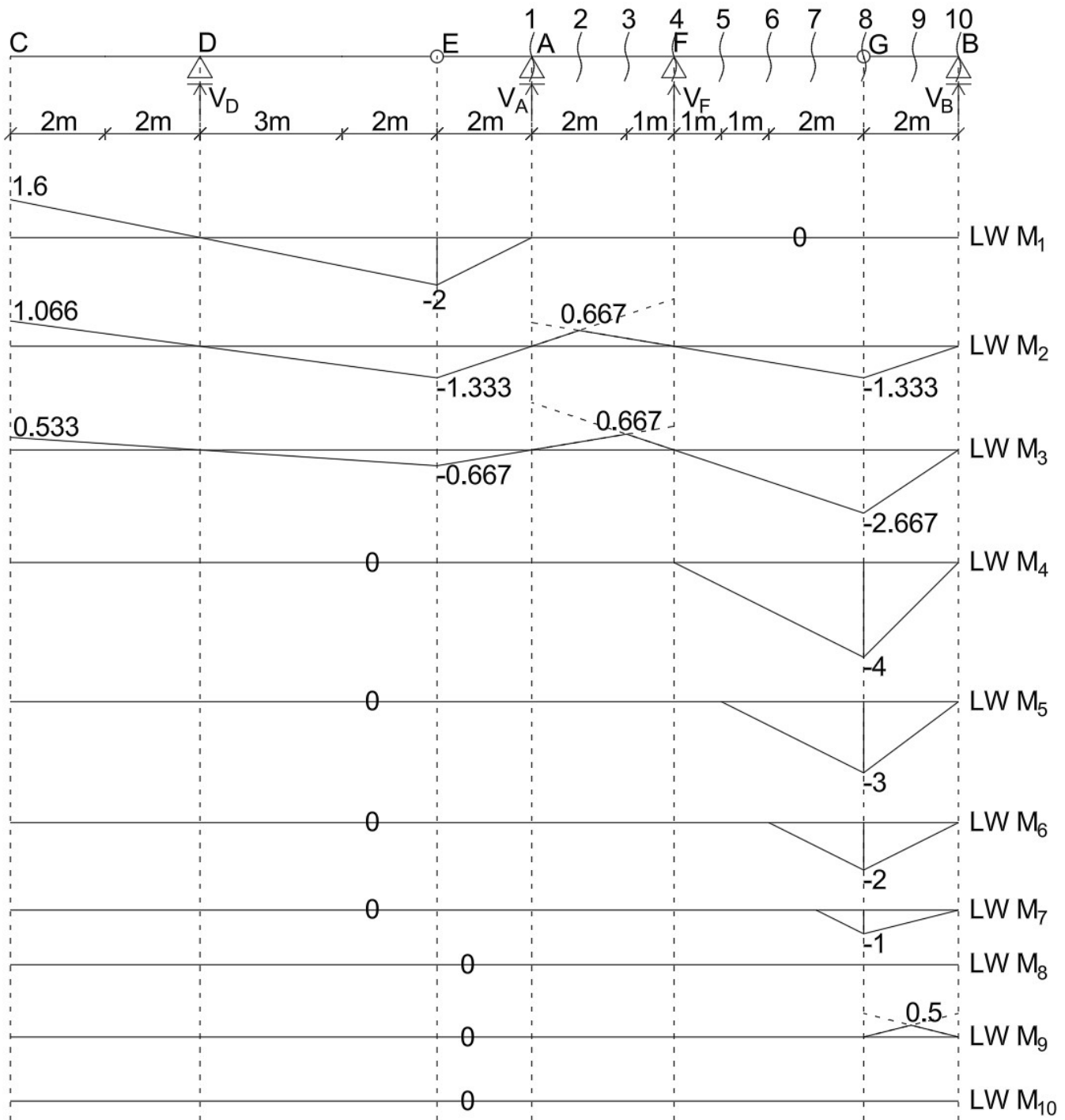
Uwzględnienie belki pośredniej:



Obliczenia:

$$\begin{aligned}
 \text{LW } V_D: & \quad H: 1.8 \cdot \frac{7}{9} = 1.4 & \quad J: 1.8 \cdot \frac{2}{9} = 0.4 \\
 \text{LW } V_A: & \quad H: -1.333 \cdot \frac{2}{4} = -0.667 & \quad J: 1.667 \cdot \frac{3}{5} = 1 & \quad K: 1 \cdot \frac{1}{3} = 0.333 & \quad L: -1.333 \cdot \frac{2}{4} = -0.667 \\
 \text{LW } V_E: & \quad H: 0.533 \cdot \frac{2}{4} = 0.267 & \quad J: -0.667 \cdot \frac{3}{5} = -0.4 & \quad K: 1 \cdot \frac{2}{3} = 0.667 & \quad L: 2.333 \cdot \frac{5}{7} = 1.667 \\
 \text{LW } T_{\alpha-\alpha}: & \quad H: 0.8 \cdot \frac{2}{4} = 0.4 \\
 \text{LW } M_{\alpha-\alpha}: & \quad H: -1.6 \cdot \frac{2}{4} = -0.8 \\
 \text{LW } M_{\beta-\beta}: & \quad H: -3 \cdot \frac{1}{3} = -1
 \end{aligned}$$

Obwiednia:



Obliczenia:

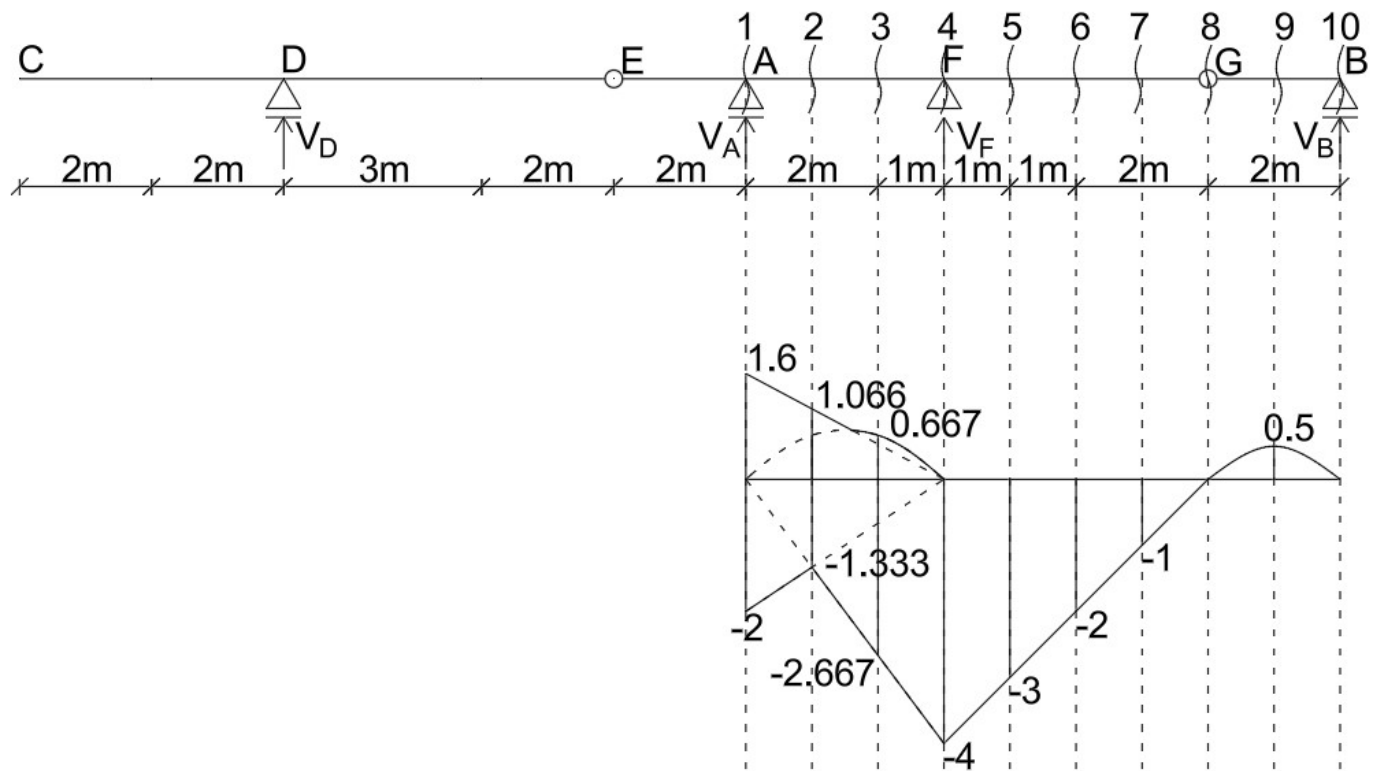
$$\text{LW M1: } C: -2 \cdot \frac{-4}{5} = 1.6$$

$$\text{LW M2: } 2: 1 \cdot \frac{2}{3} = 0.667 \quad E: 0.667 \cdot \frac{-2}{1} = -1.334 \quad C: -1.333 \cdot \frac{-4}{5} = 1.066 \quad G: 0.667 \cdot \frac{-4}{2} = -1.334$$

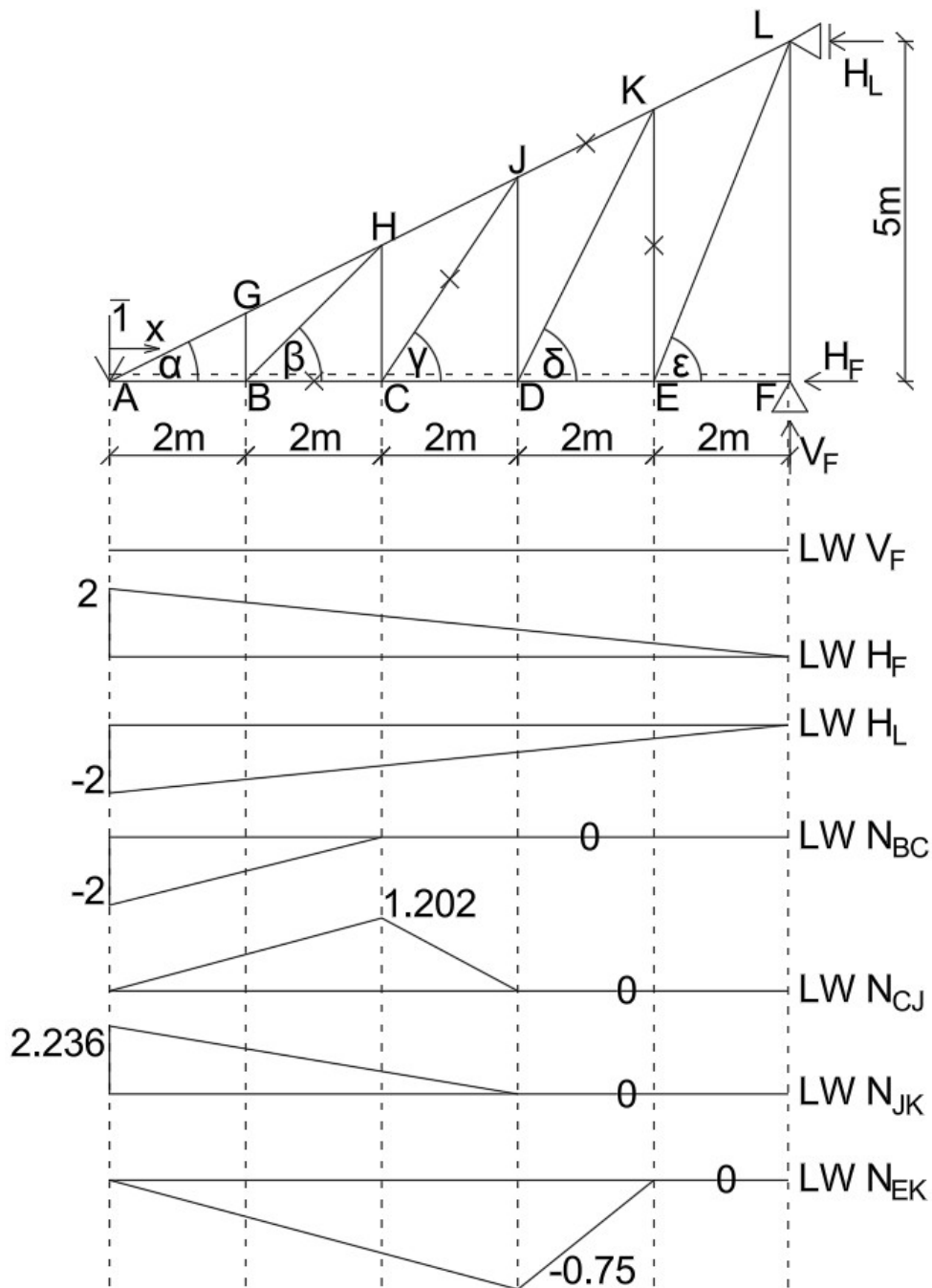
$$\text{LW M3: } 3: 1 \cdot \frac{2}{3} = 0.667 \quad E: 0.667 \cdot \frac{-2}{2} = -0.667 \quad C: -0.667 \cdot \frac{-4}{5} = 0.534 \quad G: 0.667 \cdot \frac{-4}{1} = -2.668$$

$$\text{LW M9: } 9: 1 \cdot \frac{1}{2} = 0.5$$

Obwiednia M [m]



Zadanie 2: Kratownica



Obliczenia:

LW V_F : $x \in (0; 10) \text{ m}$

$$\sum Y = V_F - 1 = 0 \quad V_F := 1$$

LW H_F : $x \in (0; 10) \text{ m}$

$$\sum M_L = -1 \cdot (10 \text{ m} - x) + H_F \cdot 5 \text{ m} = 0 \quad H_F(x) := \frac{1 \cdot (10 \text{ m} - x)}{5 \text{ m}}$$

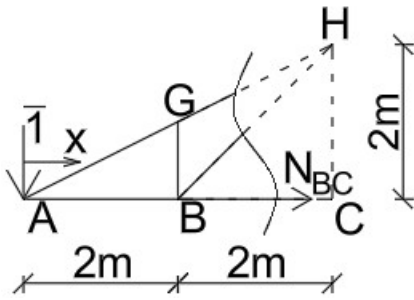
$$H_F(0 \text{ m}) = 2 \quad H_F(10 \text{ m}) = 0$$

LW H_L : $x \in (0; 10) \text{ m}$

$$\sum X = -H_F - H_L = 0 \quad H_L(x) := -H_F(x)$$

$$H_L(0 \text{ m}) = -2 \quad H_L(10 \text{ m}) = 0$$

Pręt BC:



$$x \in (0; 2) \text{ m}$$

$$\Sigma M_H = -1 \cdot (4 - x) - N_{BC} \cdot 2 = 0$$

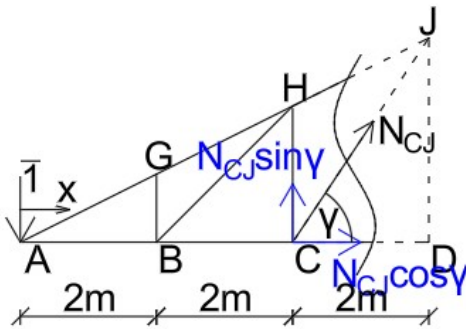
$$N_{BC}(x) := \frac{-1 \cdot (4 \text{ m} - x)}{2 \text{ m}} \quad N_{BC}(0 \text{ m}) = -2 \quad N_{BC}(2 \text{ m}) = -1$$

$$x \in (4; 10) \text{ m}$$

$$\Sigma M_H = -N_{BC} \cdot 2 = 0$$

$$N_{BC} := 0$$

Pręt CJ:



$$x \in (0; 4) \text{ m}$$

$$\Sigma M_A = 1 \cdot x - N_{CJ} \cdot \sin \gamma \cdot 4 = 0$$

$$N_{CJ}(x) := \frac{1 \cdot x}{\sin \gamma \cdot 4 \text{ m}} \quad N_{CJ}(0 \text{ m}) = 0 \quad N_{CJ}(4 \text{ m}) = 1.202$$

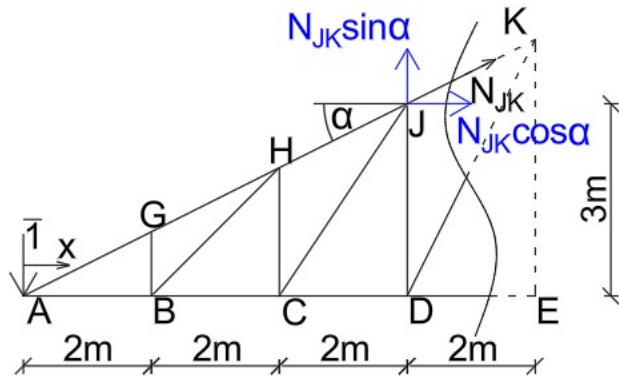
$$x \in (6; 10) \text{ m}$$

$$\Sigma M_A = -N_{CJ} \cdot \sin \gamma \cdot 4 = 0$$

$$N_{CJ} := 0$$

$$\sin \gamma := \frac{3}{\sqrt{3^2 + 2^2}} = 0.832$$

Pręt JK:



$$x \in (0; 6) \text{ m}$$

$$\Sigma M_D = -1 \cdot (6 - x) + N_{JK} \cdot \cos \alpha \cdot 3 = 0$$

$$N_{JK}(x) := \frac{1 \cdot (6 \text{ m} - x)}{\cos \alpha \cdot 3 \text{ m}}$$

$$N_{JK}(0 \text{ m}) = 2.236 \quad N_{JK}(6 \text{ m}) = 0$$

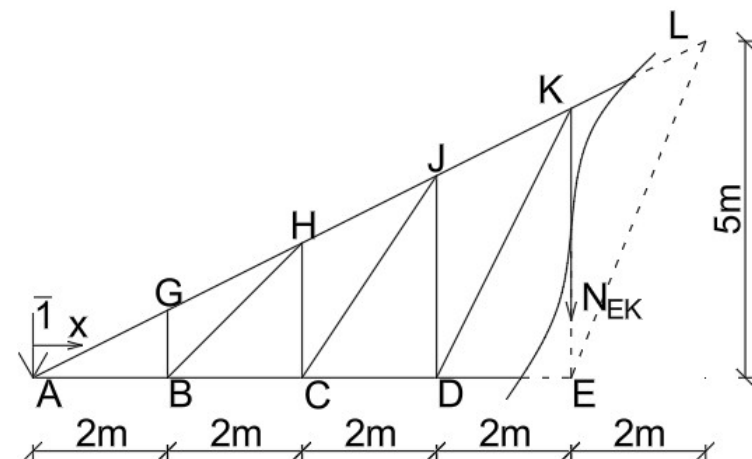
$$x \in (8; 10) \text{ m}$$

$$\Sigma M_D = N_{JK} \cdot \cos \alpha \cdot 3 = 0$$

$$N_{JK} := 0$$

$$\cos \alpha := \frac{2}{\sqrt{2^2 + 1^2}} = 0.894$$

Pręt EK:



$$x \in (0; 6) \text{ m}$$

$$\Sigma M_A = 1 \cdot x + N_{EK} \cdot 8 = 0$$

$$N_{EK}(x) := \frac{-1 \cdot x}{8 \text{ m}}$$

$$N_{EK}(0 \text{ m}) = 0 \quad N_{EK}(6 \text{ m}) = -0.75$$

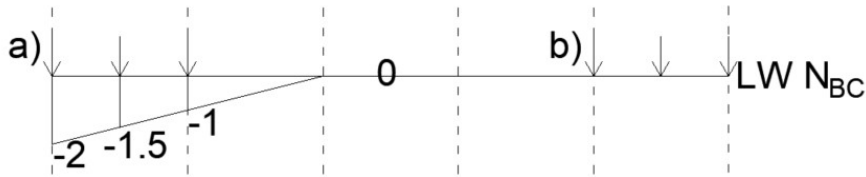
$$x \in (8; 10) \text{ m}$$

$$\Sigma M_A = N_{EK} \cdot 8 = 0$$

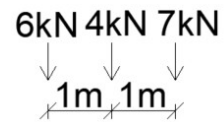
$$N_{EK} := 0$$

Obliczenie wartości minimalnych i maksymalnych:

LW NBC:



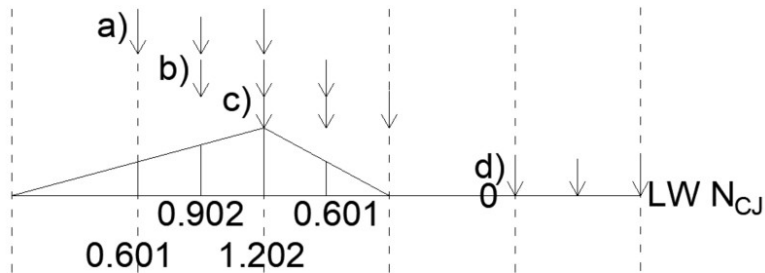
Układ sił:



a) $N_{BC.min} := -2 \cdot 6 \text{ kN} - 1.5 \cdot 4 \text{ kN} - 1 \cdot 7 \text{ kN} = -25 \text{ kN}$

b) $N_{BC.max} := 0 \cdot 6 \text{ kN} + 0 \cdot 4 \text{ kN} + 0 \cdot 7 \text{ kN} = 0 \text{ kN}$

LW NCJ:



a) $N_{CJ.max.a} := 0.601 \cdot 6 \text{ kN} + 0.902 \cdot 4 \text{ kN} + 1.202 \cdot 7 \text{ kN} = 15.628 \text{ kN}$

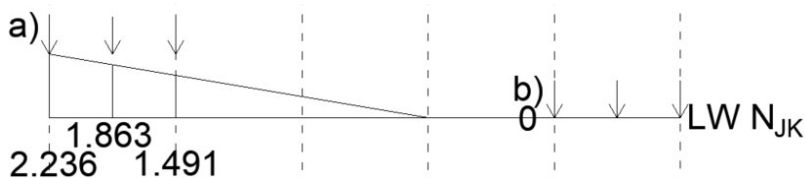
b) $N_{CJ.max.b} := 0.902 \cdot 6 \text{ kN} + 1.202 \cdot 4 \text{ kN} + 0.601 \cdot 7 \text{ kN} = 14.427 \text{ kN}$

c) $N_{CJ.max.c} := 1.202 \cdot 6 \text{ kN} + 0.601 \cdot 4 \text{ kN} + 0 \cdot 7 \text{ kN} = 9.616 \text{ kN}$

$N_{CJ.max} := N_{CJ.max.a} = 15.628 \text{ kN}$

d) $N_{CJ.max} := 0 \cdot 6 \text{ kN} + 0 \cdot 4 \text{ kN} + 0 \cdot 7 \text{ kN} = 0 \text{ kN}$

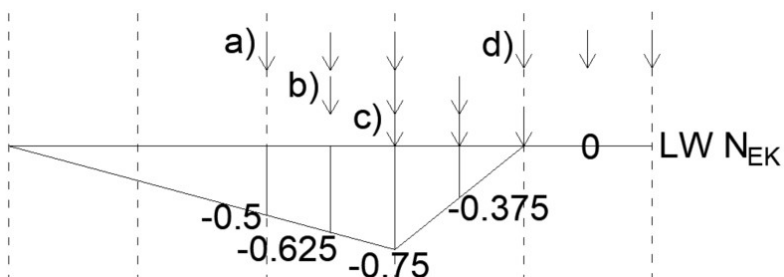
LW NJK:



a) $N_{JK.max} := 2.236 \cdot 6 \text{ kN} + 1.863 \cdot 4 \text{ kN} + 1.491 \cdot 7 \text{ kN} = 31.305 \text{ kN}$

b) $N_{JK.min} := 0 \cdot 6 \text{ kN} + 0 \cdot 4 \text{ kN} + 0 \cdot 7 \text{ kN} = 0 \text{ kN}$

LW NEK:



a) $N_{EK.min.a} := -0.5 \cdot 6 \text{ kN} - 0.625 \cdot 4 \text{ kN} - 0.75 \cdot 7 \text{ kN} = -10.75 \text{ kN}$

b) $N_{EK.min.b} := -0.625 \cdot 6 \text{ kN} - 0.75 \cdot 4 \text{ kN} - 0.375 \cdot 7 \text{ kN} = -9.375 \text{ kN}$

c) $N_{EK.min.c} := -0.75 \cdot 6 \text{ kN} - 0.375 \cdot 4 \text{ kN} - 0 \cdot 7 \text{ kN} = -6 \text{ kN}$

$N_{EK.min} := N_{EK.min.a} = -10.75 \text{ kN}$

d) $N_{EK.max} := 0 \cdot 6 \text{ kN} + 0 \cdot 4 \text{ kN} + 0 \cdot 7 \text{ kN} = 0 \text{ kN}$