Egzamin z Mechaniki Konstrukcji (MK3 IPB), 5 II 2020 r.
studia stacjonarne

NAZWISKO, Imię			
nr albumu	grupa (IPB / BZ)	tryb studiów (ST / NST)	
ocena zadania 1	ocena zadania 2	ocena zadania 3	ocena egzaminu pisemnego

Zadanie 1.

Ułóż układ równań z niewiadomymi przemieszczeniami węzłów w ramie z rys. 1. (Fig. 1)

$$EJ = \text{const.}\ ,\ k = 0{,}1024\frac{EJ}{l^4}\ .$$

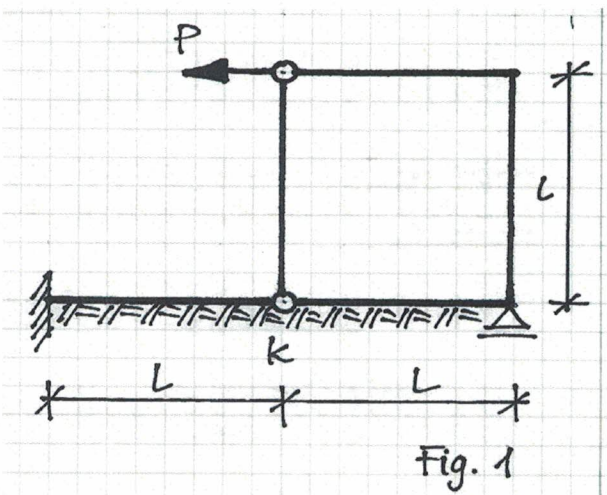

Fig. 1

Zadanie 2.

Ułóż układ równań z niewiadomymi przemieszczeniami węzłów w ramie z rys. 2. (Fig. 2)

$$EJ = \text{const.}\ ,\ k = 4\frac{EJ}{l^3}\ .$$

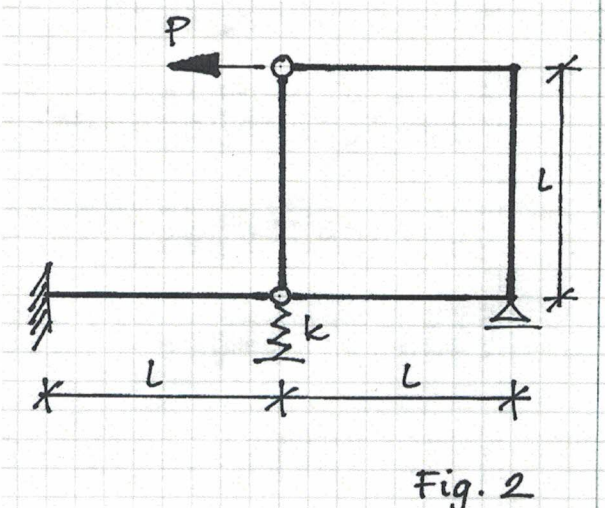

Fig. 2

Zadanie 3.

Korzystając z metody kondensacji statycznej, wyprowadź wzór określający moment przypodporowy w prawej podporze (utwierdzenie z suwakiem) pręta z rys. 3. (Fig. 3)

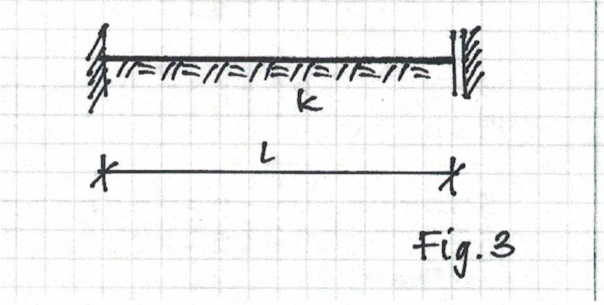

Fig. 3

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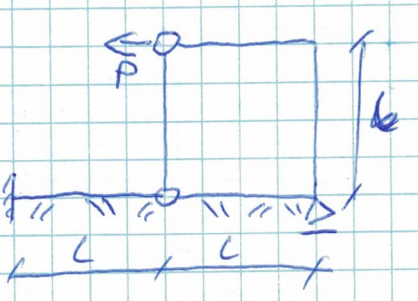
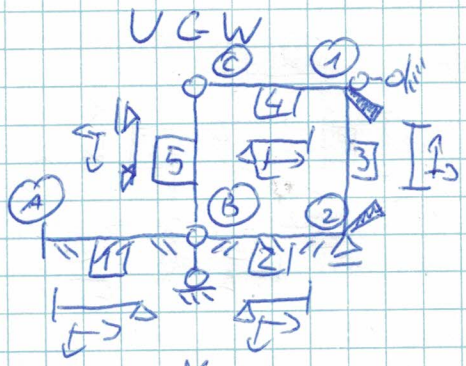
Zadanie 1



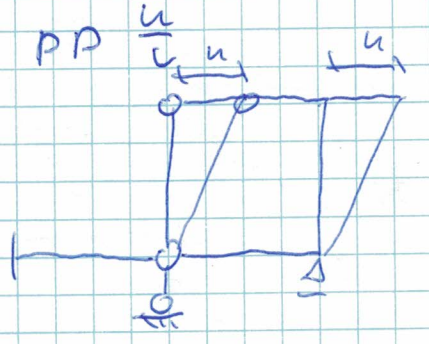


$q_1 = \begin{bmatrix} q_1 \\ q_2 \\ \frac{u}{L} \\ \frac{v}{L} \end{bmatrix}$ Pręt 5 - krotony

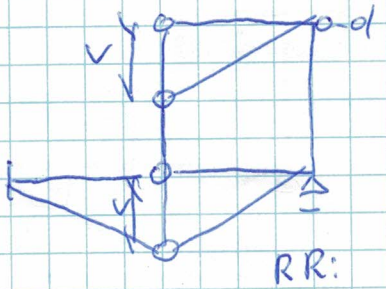
$\lambda_1 = \lambda_2 = 0{,}4$

$\lambda_3 = \lambda_4 = \lambda_5 = 0$

PP $\frac{u}{L}$



PP $\frac{v}{L}$



Pręt	*w	w*	u	λ
1	0	v	0	0,4
2	v	0	0	0,4
3	0	u	0	0
4	v	0	u	0
5	-u	0	v	0

RR:

$$\begin{cases} \bar{\Phi}_1^3 + \bar{\Phi}_1^4 = 0 \\ \bar{\Phi}_2^2 + \bar{\Phi}_2^3 = 0 \\ -(\bar{W}_1^3 \bar{u}) - P\bar{u} = 0 \Rightarrow W_1^3 = -P \\ -\left[\bar{W}_B^1 \bar{v} + \bar{W}_B^2 \bar{v} + W_C^4 \bar{v}\right] = 0 \Rightarrow \bar{W}_B^1 + W_B^2 + W_C^4 = \end{cases}$$

$$\bar{\Phi}_1^3 = \frac{EJ}{L}\left[2q_2 + 4q_1 - 6\frac{u}{L}\right] \quad \bar{\Phi}_1^4 = \frac{EJ}{L}\left[3q_1 + 3\frac{v}{L}\right]$$

$$\bar{\Phi}_2^2 = \frac{EJ}{L}\left[3{,}002\, q_2 + 2{,}996\frac{v}{L}\right] \quad \bar{\Phi}_2^3 = \frac{EJ}{L}\left[4q_2 + 2q_1 - 6\frac{u}{L}\right]$$

$$\bar{W}_1^3 = \frac{EJ}{L^2}\left[-6q_1 - 6q_2 + 12\frac{u}{L}\right] \quad \bar{W}_B^1 = \frac{EJ}{L^2}\left[3{,}024\frac{v}{L}\right]$$

$$W_B^2 = \frac{EJ}{L^2}\left[2{,}996\, q_2 + 3{,}024\frac{v}{L}\right] \quad \bar{W}_C^4 = \frac{EJ}{L^2}\left[3q_1 + 3\frac{v}{L}\right]$$

$$\frac{EJ}{L}\begin{bmatrix} 4+3 & 2 & -6 & 3 \\ 2 & 4+3{,}002 & -6 & 2{,}996 \\ -6 & -6 & 12 & 0 \\ 3 & 2{,}996 & 0 & 3+2\cdot 3{,}024 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ \frac{u}{L} \\ \frac{v}{L} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -PL \\ 0 \end{bmatrix}$$

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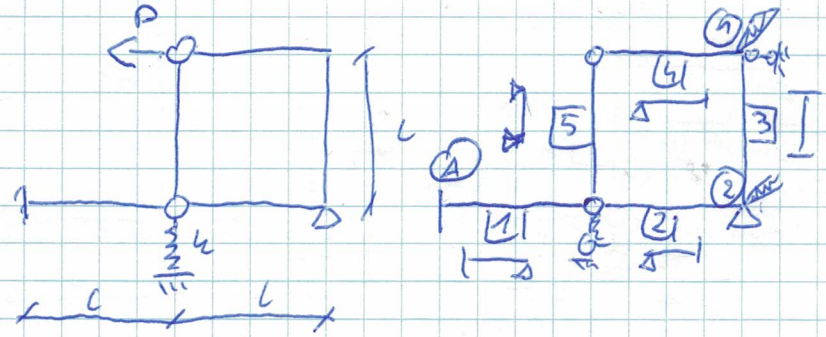
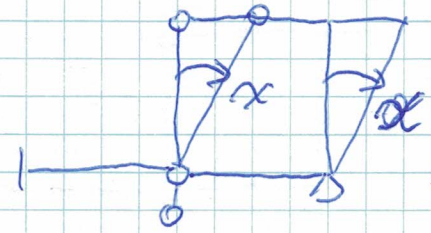
Zadanie 2 v GW

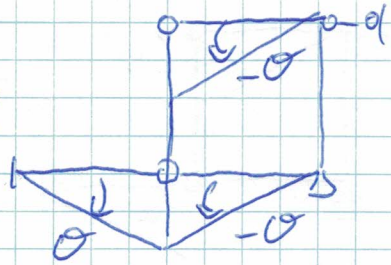


$q_i = \begin{bmatrix} u_1 \\ u_2 \\ \chi \\ \vartheta \end{bmatrix}$ Pręt 5 - kinematyczny

PP χ:



PP ϑ



$\Delta u = -\vartheta l$

$Q = k \Delta u = -4 \frac{EJ}{l^2} \vartheta$

RR:

$$\begin{cases} \bar{\Phi}_1^3 + \bar{\Phi}_1^4 = 0 \\ \bar{\Phi}_2^2 + \bar{\Phi}_2^3 = 0 \\ (\bar{\Phi}_2^3 + \bar{\Phi}_1^3)\bar{\chi} - Pl\bar{\chi} = 0 \Rightarrow -\bar{\Phi}_1^3 - \bar{\Phi}_2^3 = -Pl \\ \bar{\Phi}_4^1\bar{\vartheta} + \bar{\Phi}_2^2(-\bar{\vartheta}) + \bar{\Phi}_1^4(-\bar{\vartheta}) + Q\bar{\vartheta}l = 0 \quad -\bar{\Phi}_4^1 + \bar{\Phi}_2^2 + \bar{\Phi}_1^4 + 4\frac{EJ}{l} = 0 \end{cases}$$

$$\frac{EJ}{l}\begin{bmatrix} 3+4 & 2 & -6 & 3 \\ 2 & 4+3 & -6 & 3 \\ -4-2 & -2-4 & -12 & 0 \\ 3 & 3 & 0 & 3+3+3+4 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ \chi \\ \vartheta \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -Pl \\ 0 \end{bmatrix}$$

$\bar{\Phi}_1^3 = \frac{EJ}{l}[4u_1 + 2u_2 - 6\chi]$ $\bar{\Phi}_1^4 = \frac{EJ}{l}[3u_1 + 3\vartheta]$

$\bar{\Phi}_2^2 = \frac{EJ}{l}[3u_2 + 3\vartheta]$ $\bar{\Phi}_2^3 = \frac{EJ}{l}[2u_1 + 4u_2 - 6\chi]$

$\bar{\Phi}_4^1 = \frac{EJ}{l}[-3\vartheta]$

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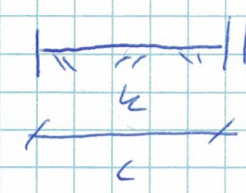
Zadanie 3



$\lambda = L\sqrt[4]{\frac{\xi}{4EJ}}$

Dla skrócenia zapisu:

$\delta(\lambda) \to \delta \quad \vartheta(\lambda) \to \vartheta \quad \xi(\lambda) \to \xi$

$\gamma(\lambda) \to \gamma \quad \alpha(\lambda) \to \alpha \quad \beta(\lambda) \to \beta$

$\overline{W}^* = 0 \qquad W^* = -\frac{EJ}{L^2}\left[\delta^* \varphi + \vartheta \varphi^* + \xi \frac{w^*}{L} - \gamma \frac{w^*}{L}\right]$

$\frac{w^*}{L} = \frac{\delta}{\gamma}^* \varphi + \frac{\vartheta}{\gamma} \varphi^* + \frac{\xi}{\gamma} \frac{w^*}{L}$

$\overline{W}^* = \frac{EJ}{L^2}\left[\vartheta^* \varphi + \delta \varphi^* + \gamma \frac{w^*}{L} - \xi\left(\frac{\delta}{\gamma}^* \varphi + \frac{\vartheta}{\gamma} \varphi^* + \frac{\xi}{\gamma} \frac{w^*}{L}\right)\right]$

$= \frac{EJ}{L^2}\left[\left(\vartheta - \frac{\xi \cdot \delta}{\gamma}\right)^* \varphi + \left(\delta - \frac{\xi \vartheta}{\gamma}\right) \varphi^* + \left(\gamma - \frac{\xi^2}{\gamma}\right) \frac{w^*}{L}\right]$

$\overline{\Phi}^* = \frac{EJ}{L}\left[\alpha^* \varphi + \beta \varphi^* + \vartheta \frac{w^*}{L} - \delta\left(\frac{\delta}{\gamma}^* \varphi + \frac{\vartheta}{\gamma} \varphi^* + \frac{\xi}{\gamma} \frac{w^*}{L}\right)\right] =$

$= \frac{EJ}{L}\left[\left(\alpha - \frac{\delta}{\gamma}\right)^* \varphi + \left(\beta - \frac{\delta \vartheta}{\gamma}\right) \varphi^* + \left(\vartheta - \frac{\delta \xi}{\gamma}\right) \frac{w^*}{L}\right]$

$\Phi^* = \frac{EJ}{L}\left[\beta^* \varphi + \alpha \varphi^* + \delta \frac{w^*}{L} - \vartheta\left(\frac{\delta}{\gamma}^* \varphi + \frac{\vartheta}{\gamma} \varphi^* + \frac{\xi}{\gamma} \frac{w^*}{L}\right)\right] =$

$= \frac{EJ}{L}\left[\left(\beta - \frac{\vartheta}{\gamma}\delta\right)^* \varphi + \left(\alpha - \frac{\vartheta^2}{\gamma}\right) \varphi^* + \left(\delta - \frac{\vartheta \xi}{\gamma}\right) \frac{w^*}{L}\right]$