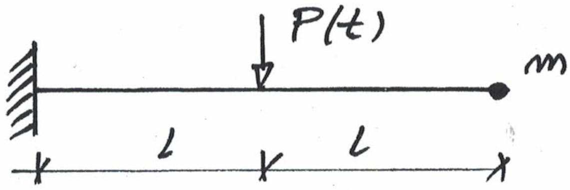
Egzamin pisemny z Mechaniki Konstrukcji II, 25 czerwca 2025 r.

Imię i NAZWISKO				
Prowadzący ćwiczenia, nr grupy				
ocena zadania 1	ocena zadania 2	ocena zadania 3	ocena egz. pis.	Ocena Ostateczna
				Data

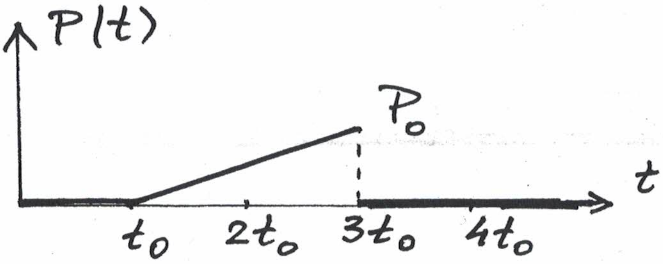
Zadanie 1

Dana jest nieważki pręt o z masą skupioną na końcu, obciążony jak na rysunku. Obciążenie zmienia się w czasie zgodnie z podanym wykresem. Warunki początkowe są jednorodne. Zapisać równania określające przemieszczenie pionowe masy w chwili $t=4t_o$.

(Given is a cantilever: a massless bar with a concentrated mass at its end, loaded as shown in the figure. The load varies in time according to the given plot. The initial conditions are homogeneous. Write down equations which determine the vertical displacement of the mass at the time instant $t=4t_o$.



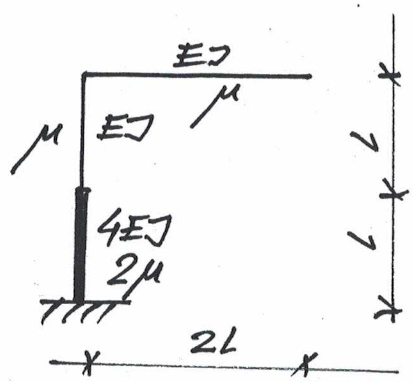
$EJ = const,\ \mu = 0,$
$EA = \infty$



Zadanie 2

Dana jest rama jak na rysunku. Zapisać równania określające częstości drgań własnych.
(Given is a frame, cf the figure.
Write down equations
which determine the eigenfrequencies).

$EA = \infty$



Zadanie 3

3.1 Wyprowadzić równania opisujące ugięcie belki prostej pryzmatycznej przy obecności dużej siły ściskającej
3.2 Naszkicować wyprowadzenie równania transformacyjnego na moment w lewym końcu pręta
(3.1 Derive the equations modeling deflection of a straight prismatic beam in the presence of a big compression force.
3.2 Write down the equations from which one can derive the slope deflection equation for the left end moment)

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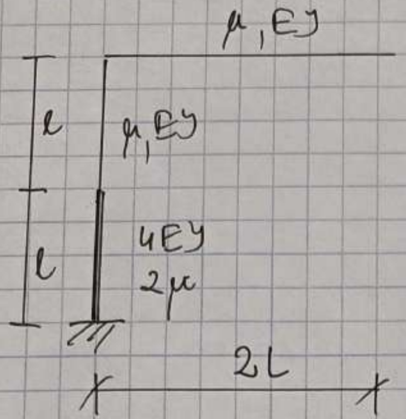
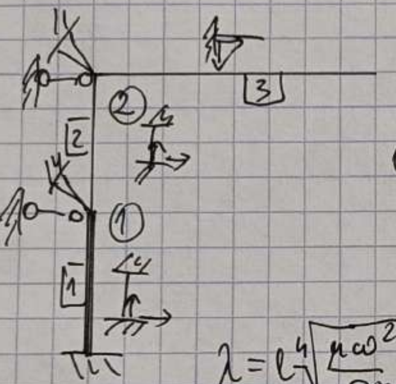
ZAD. 2.

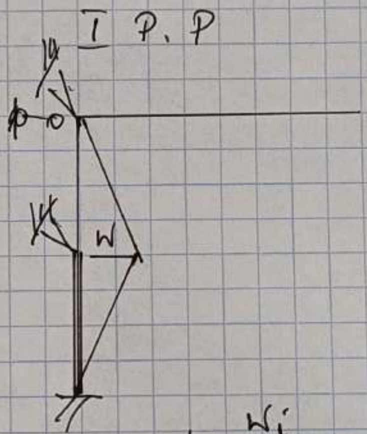




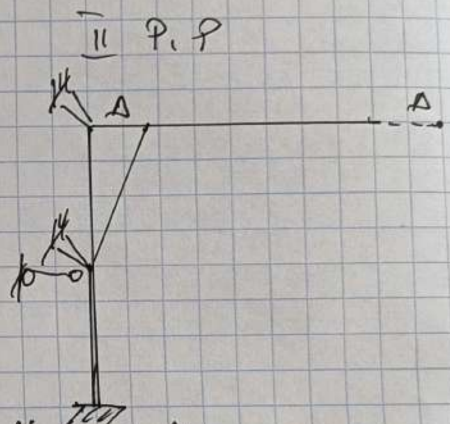
MGW

$$\lambda = l\sqrt[4]{\frac{\mu\omega^2}{EJ}} \qquad q = \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \frac{w}{l} \\ \frac{\Delta}{l} \end{bmatrix}$$

I p.p



II p.p



				w_i	w_k	u
$l^{(1)} = l$	$4E$	2μ	$\lambda^{(1)} = l\sqrt[4]{\frac{2\mu\omega^2}{4EJ}} = \frac{1}{\sqrt[4]{2}}\lambda$	0	w	0
$l^{(2)} = l$	EJ	μ	$\lambda^{(2)} = \lambda$	w	Δ	0
$l^{(3)} = 2l$	EJ	μ	$\lambda^{(3)} = 2l\sqrt[4]{\frac{\mu\omega^2}{EJ}} = 2\lambda$	0	0	Δ

1) $\Sigma M_1 = 0 \Rightarrow \phi_1^{(1)} + \phi_1^{(2)} = 0$

2) $\Sigma M_2 = 0 \Rightarrow \phi_2^{(2)} + \phi_2^{(3)} = 0$

3) i 4) $W_1^{(1)} \cdot \bar{w} + W_1^{(2)} \cdot w + W_2^{(2)} \cdot \bar{\Delta} - B_{11}^{(3)} \cdot \bar{\Delta} = 0$

3) $\bar{w} = 1 \wedge \bar{\Delta} = 0 \Rightarrow W_1' + W_1^{(2)} = 0$

4) $\bar{w} = 0 \wedge \bar{\Delta} = 1 \Rightarrow W_2^{(2)} - B_{11}^{(3)} = 0$

$$B_{11}^{(3)} = \mu \cdot 2l \cdot \omega^2 \cdot \Delta = \mu \cdot 2l \cdot \frac{\lambda^4 EJ}{\mu l^4} \cdot \Delta =$$

$$= \frac{EJ}{l^2} \; 2\lambda^4 \cdot \frac{\Delta}{l}$$

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ZAD. 2. c.d.

wzory transf.

$$\phi_1^{(1)} = \frac{4EJ}{l}\left[\alpha\left(\frac{1}{\sqrt[4]{2}}\lambda\right)\cdot\varphi_1 - \vartheta\left(\frac{1}{\sqrt[4]{2}}\lambda\right)\cdot\frac{w}{l}\right]$$

$$W_1^{(1)} = -\frac{4EJ}{l^2}\left[\vartheta\left(\frac{1}{\sqrt[4]{2}}\lambda\right)\varphi_1 - \gamma\left(\frac{1}{\sqrt[4]{2}}\lambda\right)\frac{w}{l}\right]$$

$$\phi_2^{(2)} = \frac{EJ}{l}\left[\alpha(\lambda)\varphi_2 + \beta(\lambda)\varphi_1 + \delta(\lambda)\frac{w}{l} - \vartheta(\lambda)\frac{\Delta}{l}\right]$$

$$\phi_1^{(2)} = \frac{EJ}{l}\left[\alpha(\lambda)\varphi_1 + \beta(\lambda)\varphi_2 + \vartheta(\lambda)\frac{w}{l} - \delta(\lambda)\frac{\Delta}{l}\right]$$

$$W_2^{(2)} = -\frac{EJ}{l^2}\left[\delta(\lambda)\cdot\varphi_1 + \vartheta(\lambda)\cdot\varphi_2 + \varepsilon(\lambda)\cdot\frac{w}{l} - \gamma(\lambda)\cdot\frac{\Delta}{l}\right]$$

$$W_1^{(2)} = \frac{EJ}{l^2}\left[\vartheta(\lambda)\cdot\varphi_1 + \delta(\lambda)\varphi_2 + \gamma(\lambda)\frac{w}{l} - \varepsilon(\lambda)\frac{\Delta}{l}\right]$$

$$\phi_2^{(3)} = \frac{EJ}{2l}\left[\alpha''(2\lambda)\cdot\varphi_2\right]$$

$$\overbrace{\frac{EJ}{l}\begin{bmatrix} 4\alpha\left(\frac{1}{\sqrt[4]{2}}\lambda\right)+\alpha(\lambda) & \beta(\lambda) & -4\vartheta\left(\frac{1}{\sqrt[4]{2}}\lambda\right)+\vartheta(\lambda) & -\delta(\lambda) \\ \beta(\lambda) & \alpha(\lambda)+\frac{\alpha''(2\lambda)}{2} & \delta(\lambda) & -\vartheta(\lambda) \\ -4\vartheta\left(\frac{1}{\sqrt[4]{2}}\lambda\right)+\vartheta(\lambda) & \delta(\lambda) & 4\gamma\left(\frac{1}{\sqrt[4]{2}}\lambda\right)+\gamma(\lambda) & -\varepsilon(\lambda) \\ -\delta(\lambda) & -\vartheta(\lambda) & -\varepsilon(\lambda) & \gamma(\lambda)-2\lambda^4 \end{bmatrix}}^{\mathbb{K}(\lambda)} \cdot$$

$$\cdot\begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \frac{w}{l} \\ \frac{\Delta}{l} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\det \mathbb{K}(\lambda) = 0 \Rightarrow \lambda_1 = \ldots$$