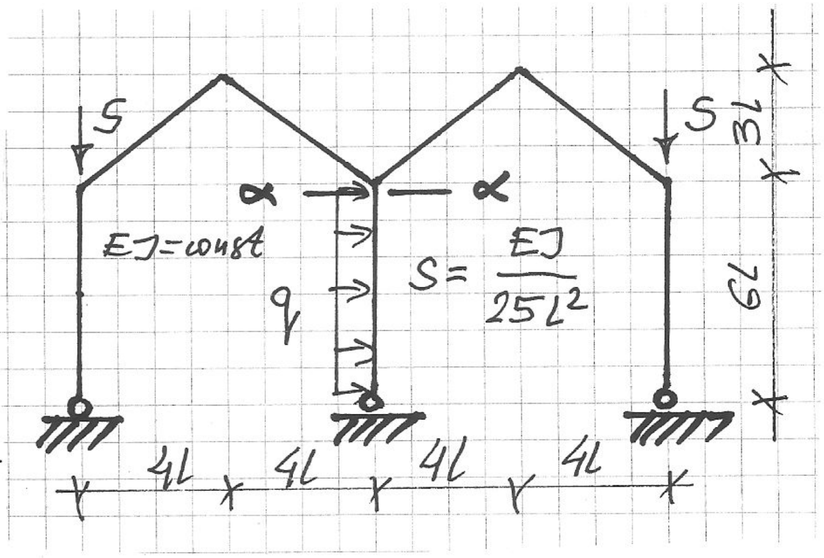
Egzamin pisemny z Mechaniki Konstrukcji II 29 XI 2014 r.

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

Zadanie 1

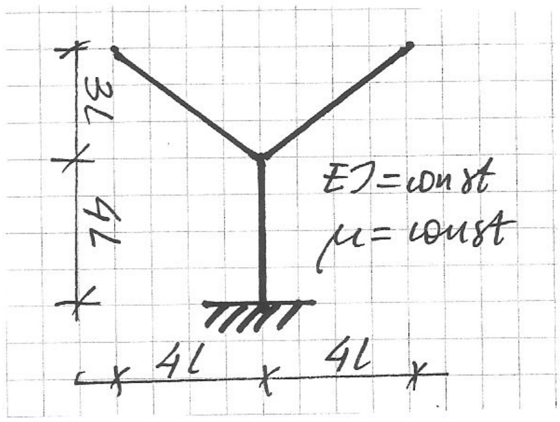
W danej ramie
z prętów niewydłużalnych,
EJ =const,
poddanej dużym siłom osiowym
i zginanej danym
obciążeniem bocznym
znaleźć
moment zginający M_α
w przekroju $\alpha - \alpha$.
(The given frame
(EA infinite, EJ =const) is subjected
to big axial forces and to the lateral load q.
Find M_α in the given section $\alpha - \alpha$.)



Zadanie 2

Zapisać równania określające
częstości drgań własnych
antysymetrycznych.

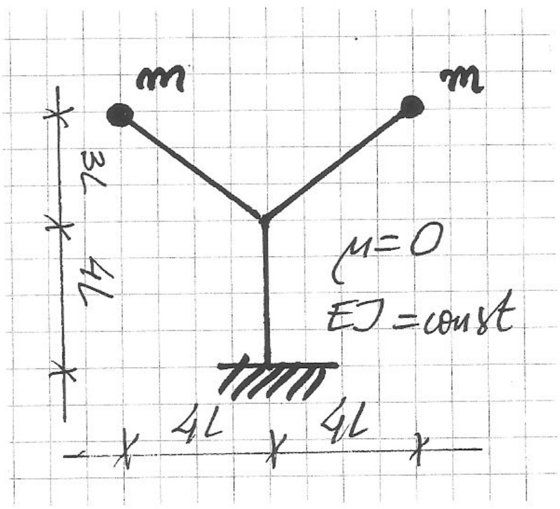
(Write down the formulae which determine
the eigenfrequencies
of skew-symmetric
eigenvibrations)



Zadanie 3

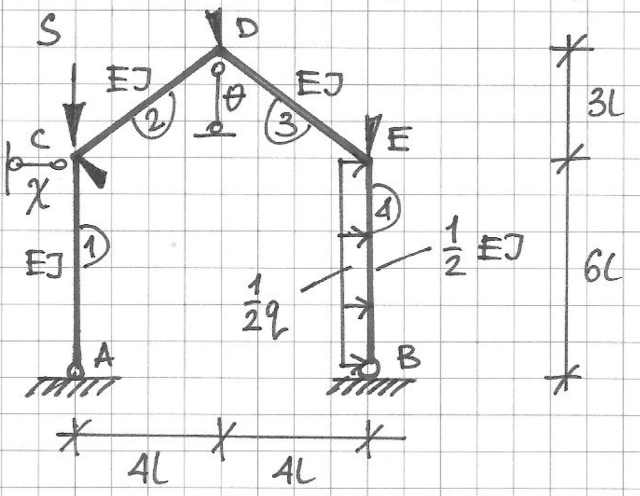
Dana jest rama z prętów nieważkich
o stałej sztywności na zginanie
z dwiema masami punktowymi.
Zapisać równania
określające częstości drgań własnych.

(The given frame is made of weightless bars
of constant bending stiffness,
with two masses concentrated
at two nodes.
Write down equations
which make it possible
to compute
the eigenfrequencies.)



Egzamin z MK 2, 29 XI 2014, zadanie 1

Schemat zredukowany do połowy ramy, geometrycznie wyznaczalny

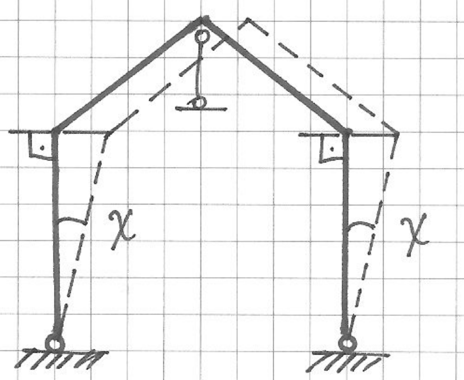


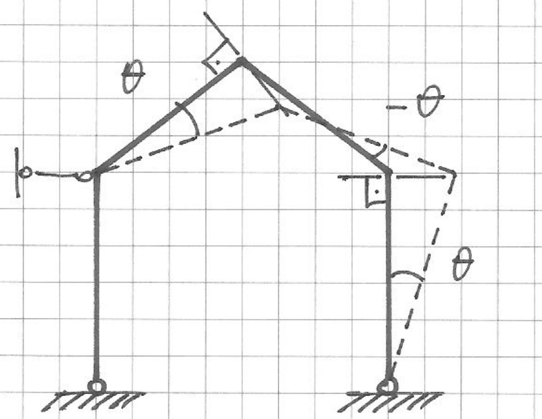
$$q = \begin{bmatrix} \varphi_C \\ \varphi_D \\ \varphi_E \\ \chi \\ \theta \end{bmatrix}$$

$S^{(1)} = S$

$\sigma^{(1)} = 1{,}2$

Plany przesunięć:





Równania równowagi:

$$\Phi_C^{(1)} + \Phi_C^{(2)} = 0$$

$$\Phi_D^{(2)} + \Phi_D^{(3)} = 0$$

$$\Phi_E^{(3)} + \Phi_E^{(4)} = 0$$

$$\Phi_C^{(1)} \cdot \bar{\chi} + \Phi_E^{(4)} \cdot \bar{\chi} + \frac{1}{2} q \cdot 6l \cdot 3l \cdot \bar{\chi} + S \cdot 6l \cdot \chi \cdot \bar{\chi} = 0$$

$$\left[\Phi_C^{(2)} + \Phi_D^{(2)}\right] \cdot \bar{\theta} + \left[\Phi_D^{(3)} + \Phi_E^{(3)}\right] \cdot (-\bar{\theta}) + \Phi_E^{(4)} \cdot \bar{\theta} + \frac{1}{2} q \cdot 6l \cdot 3l \cdot \bar{\theta} = 0$$

Wzory transformacyjne:

$$\Phi_C^{(1)} = \frac{EJ}{6l}\left[\alpha'(1,2)(\varphi_C - \chi)\right]$$

$$\Phi_C^{(2)} = \frac{EJ}{5l}\left[4\varphi_C + 2\varphi_D - 6\theta\right]$$

$$\Phi_D^{(2)} = \frac{EJ}{5l}\left[2\varphi_C + 4\varphi_D - 6\theta\right]$$

$$\Phi_D^{(3)} = \frac{EJ}{5l}\left[4\varphi_D + 2\varphi_E + 6\theta\right]$$

$$\Phi_E^{(3)} = \frac{EJ}{5l}\left[2\varphi_D + 4\varphi_E + 6\theta\right]$$

$$\Phi_E^{(4)} = \frac{EJ}{12l}\left[3(\varphi_E - \chi - \theta)\right] + \frac{1}{8}\cdot(6l)^2\cdot\frac{1}{2}q$$

$$\varphi_C = 25{,}635\ \frac{ql^3}{EJ}$$

$$\varphi_D = -9{,}087\ \text{—''—}$$

$$\varphi_E = 10{,}715\ \text{—''—}$$

$$\chi = 53{,}374\ \text{—''—}$$

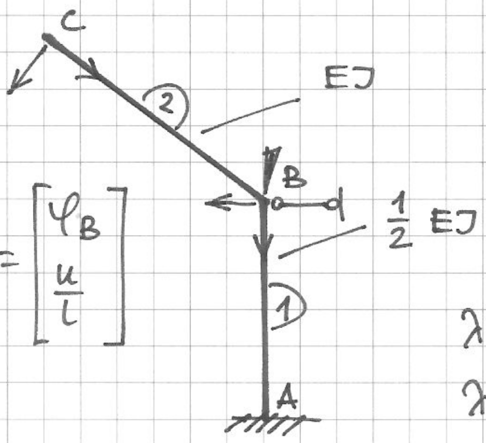
$$\theta = 3{,}661\ \text{—''—}$$

$$M_\alpha = 2\cdot\Phi_E^{(4)} = -18{,}660\ ql^2$$

Egzamin z MK2, 29 XI 2014, zadanie 2

Schemat zredukowany do połowy ramy, geometrycznie wyznaczalny

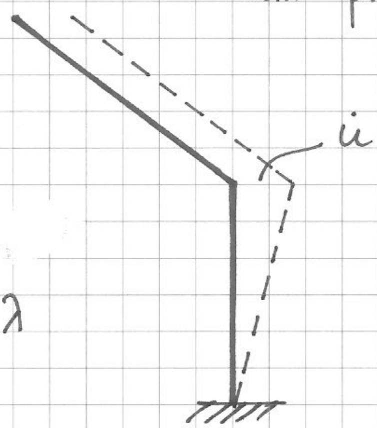
Plan prędkości



$$q = \begin{bmatrix} \varphi_B \\ \frac{u}{l} \end{bmatrix}$$

$$\lambda^{(1)} = \frac{4}{\sqrt[4]{2}}\lambda$$

$$\lambda^{(2)} = 5\lambda$$



$$w_B^{(1)} = -u \qquad w_A^{(1)} = 0 \qquad u^{(1)} = 0$$

$$w_B^{(2)} = -\frac{3}{5}u \qquad u^{(2)} = \frac{4}{5}u$$

Równania równowagi:

$$\Phi_B^{(1)} + \Phi_B^{(2)} = 0$$

$$W_B^{(1)} \cdot w_B^{(1)} + W_B^{(2)} \cdot w_B^{(2)} - B_{\parallel}^{(2)} \cdot u^{(2)} = 0$$

Wzory transformacyjne i siły bezwładności

$$\Phi_B^{(1)} = \frac{EJ}{8l}\left[\alpha(\lambda^{(1)})\varphi_B - \vartheta(\lambda^{(1)})\frac{u}{4l}\right]$$

$$\Phi_B^{(2)} = \frac{EJ}{5l}\left[\alpha''(\lambda^{(2)})\varphi_B + \vartheta''(\lambda^{(2)})\frac{3u}{25l}\right]$$

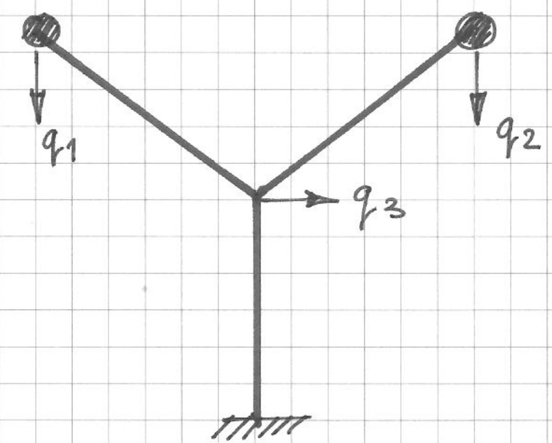
$$W_B^{(1)} = \frac{EJ}{32l^2}\left[\vartheta(\lambda^{(1)})\varphi_B - \gamma(\lambda^{(1)})\frac{u}{4l}\right]$$

$$W_B^{(2)} = -\frac{EJ}{25l^2}\left[\vartheta''(\lambda^{(2)})\varphi_B + \gamma''(\lambda^{(2)})\frac{3u}{25l}\right]$$

$$B_{\parallel}^{(2)} = \omega^2 \cdot \mu \cdot 5l \cdot \frac{4}{5}u = \frac{EJ}{l^2}(4\lambda^4)\frac{u}{l}$$

Egzamin z MK2, 29 XI 2014, zadanie 3

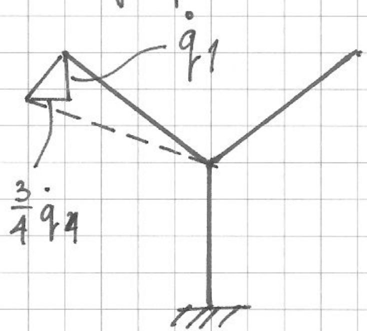
Współrzędne Lagrange'a

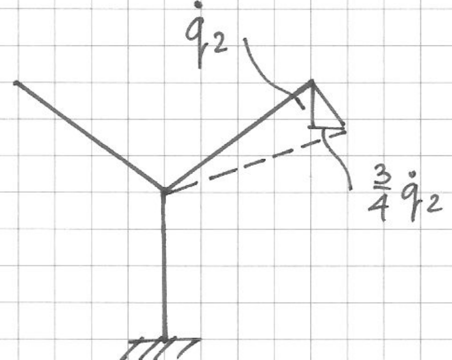


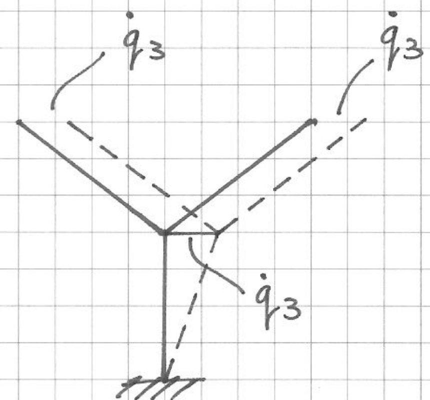
$$\mathbf{q} = \begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix}$$

$\mathbf{a}$ – amplituda $\mathbf{q}$

Plany prędkości



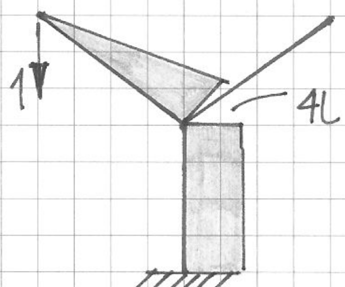




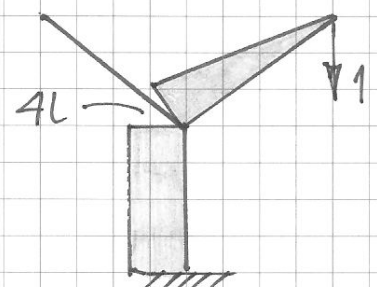
Energia kinetyczna:

$$2E_k = m\left[\dot{q}_1^2 + \left(\dot{q}_3 - \tfrac{3}{4}\dot{q}_1\right)^2\right] + m\left[\dot{q}_2^2 + \left(\dot{q}_3 + \tfrac{3}{4}\dot{q}_2\right)^2\right] = \mathbf{q}^T \mathbb{M} \mathbf{q}$$

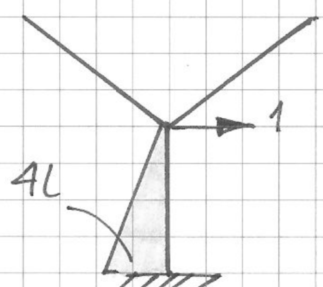
$$\mathbb{M} = \begin{bmatrix} \frac{25}{16} & 0 & -\frac{3}{4} \\ 0 & \frac{25}{16} & \frac{3}{4} \\ -\frac{3}{4} & \frac{3}{4} & 2 \end{bmatrix} m$$



M_1



M_2



M_3

$$\mathbb{D} = \begin{bmatrix} 90,667 & -64 & -32 \\ -64 & 90,667 & 32 \\ -32 & 32 & 21,333 \end{bmatrix} \frac{L^3}{EJ} \qquad \mathbb{I} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\det \left(\mathbb{I} - \omega^2 \mathbb{D} \mathbb{M} \right) = 0 \rightarrow \omega_1, \omega_2, \omega_3$$