ITMO

TEST 2

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Preliminary

The test consists of 10 questions with answers (5 points max)

You have 1 attempt.

Any new attempt gives you 0,5-point penalty.

In the case of anonymous answer (like «Name – 1, HDU ID – 1 ……»)
ALL students will receive 0,5-point penalty for each case.

All questions are in this presentation.
Form with answers can be filled here:

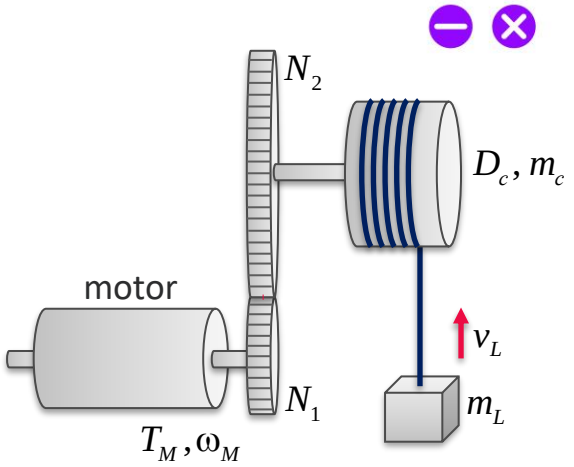
https://forms.yandex.ru/u/67cdd0b0eb61469181a62610/

Question 1

Consider the follows mechanical system:

T_M – the torque of the motor
ω_M – the velocity of the motor
N_1 – number of teeth of the first gear
N_2 – number of teeth of the second gear
D_c – diameter of the cylinder
m_c – mass of the cylinder
m_L – mass of the load
v_L – speed of the load

$N_1 = 5$
$N_2 = 15$
$D_c = 0.2\ m$
$m_c = 50\ kg$
$v_L = 0.25\ m/s$
$m_L = 200\ kg$



Find the equivalent inertia of the mass m_L converted to the motor side

a) $J_{Le} \approx 2\ kg \cdot m^2$

b) $J_{Le} \approx 0.67\ kg \cdot m^2$

c) $J_{Le} \approx 0.28\ kg \cdot m^2$

d) $J_{Le} \approx 18\ kg \cdot m^2$

e) $J_{Le} \approx 0.22\ kg \cdot m^2$

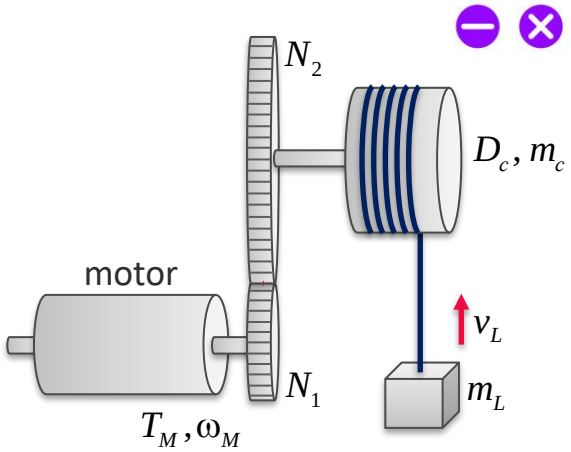
f) not enough data to answer

Question 2

Consider the follows mechanical system:

T_M – the torque of the motor
ω_M – the velocity of the motor
N_1 – number of teeth of the first gear
N_2 – number of teeth of the second gear
D_c – diameter of the cylinder
m_c – mass of the cylinder
m_L – mass of the load
v_L – speed of the load

$N_1 = 15$
$N_2 = 60$
$D_c = 0.3\ m$
$m_c = 20\ kg$
$v_L = 0.4\ m/s$
$m_L = 150\ kg$



Find the torque of the motor that is needed to lift the load of mass *m* with the speed *v*

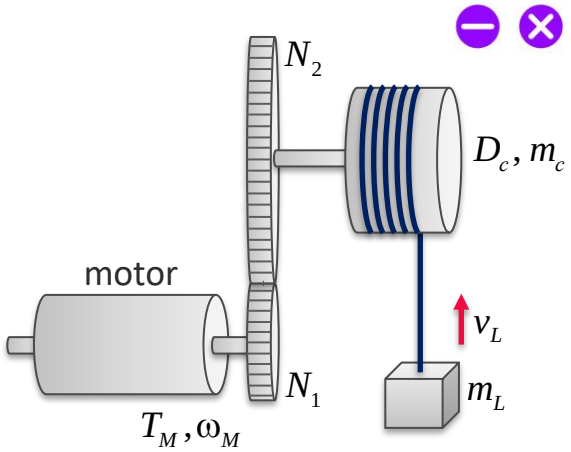
a) $T_M \approx 220.7\ Nm$
b) $T_M \approx 13.8\ Nm$
c) $T_M \approx 1.4\ Nm$
d) $T_M \approx 55.2\ Nm$
e) $T_M \approx 3.4\ Nm$
f) not enough data to answer

Question 3

Consider the follows mechanical system:

T_M – the torque of the motor
ω_M – the velocity of the motor
N_1 – number of teeth of the first gear
N_2 – number of teeth of the second gear
D_c – diameter of the cylinder
m_c – mass of the cylinder
m_L – mass of the load
v_L – speed of the load

$N_1 = 10$
$N_2 = 50$
$D_c = 0.4\ m$
$m_c = 25\ kg$
$v_L = 0.5\ m/s$
$m_L = 300\ kg$



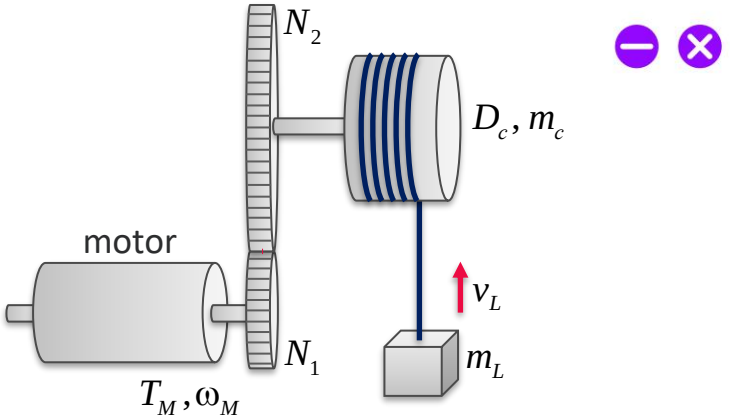
Find the full inertia of the load converted to motor side (assume the inertia of motor's shaft and inertias of gears are equal to zero)

a) $J_e \approx 0.02\ kg \cdot m^2$
b) $J_e \approx 0.48\ kg \cdot m^2$
c) $J_e \approx 0.5\ kg \cdot m^2$
d) $J_e \approx 12.02\ kg \cdot m^2$
e) $J_e \approx 0.98\ kg \cdot m^2$
f) not enough data to answer

Question 4

Consider the follows mechanical system:

T_M – the torque of the motor
ω_M – the velocity of the motor
N_1 – number of teeth of the first gear
N_2 – number of teeth of the second gear
D_c – diameter of the cylinder
m_c – mass of the cylinder
m_L – mass of the load
v_L – speed of the load

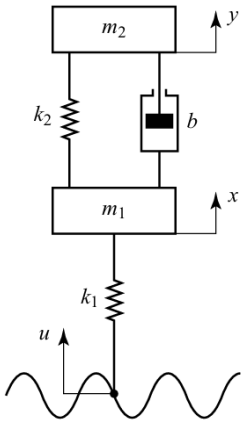


How will change the power of the motor if the number of teeth of the second gear (N_2) increases twice but speed of the load (v_L) will stay the same?

a) increases twice
b) decreases twice
c) increases 4 times
d) decreases 4 times
e) doesn't change
f) not enough data to answer

Question 5

Consider the follows mechanical system:



Choose the right differential equation for m_2

a) $m_2\ddot{y} = k_2(y - x) + b(\dot{y} - \dot{x})$

b) $m_2\ddot{y} = -k_1(u - x) - b(\dot{y} - \dot{x})$

c) $m_2\ddot{y} = -k_2(y - x) - b(\dot{y} - \dot{x}) + u$

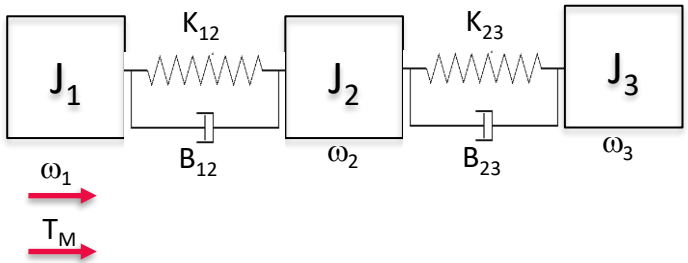
d) $m_2\ddot{y} = -k_2(y - x) - b(\dot{y} - \dot{x})$

e) $m_2\ddot{y} = -k_2(y - x)$

f) $m_2\ddot{y} = k_1(u - x)$

Question 6

Consider the follows mechanical system:



Choose the right differential equation for J_2

a) $J_2 \frac{d\omega_2}{dt} = T_{s12} + b_{12}(\omega_1 - \omega_2) - T_{s23} - b_{23}(\omega_2 - \omega_3) - T_{L2},$

b) $J_2 \frac{d\omega_2}{dt} = T_{s12} - b_{12}(\omega_1 - \omega_2) - T_{s23} + b_{23}(\omega_2 - \omega_3) - T_{L2},$

c) $(J_1 + J_2)\frac{d\omega_2}{dt} = T_{s12} + b_{12}(\omega_1 - \omega_2) - T_{s23} - b_{23}(\omega_2 - \omega_3) - T_{L2},$

d) $J_2 \frac{d\omega_2}{dt} = -T_{s12} + b_{12}(\omega_1 - \omega_2) + T_{s23} - b_{23}(\omega_2 - \omega_3) - T_{L2},$

e) $J_2 \frac{d\omega_2}{dt} = T_{s12} + b_{12}(\omega_1 + \omega_2) - T_{s23} - b_{23}(\omega_2 + \omega_3) - T_{L2},$

f) $(J_2 + J_3)\frac{d\omega_2}{dt} = T_{s12} + b_{12}(\omega_1 - \omega_2) - T_{s23} - b_{23}(\omega_2 - \omega_3) - T_{L2},$

Question 7

Consider the mechanical system, that is described by the follows differential equations:

$$\begin{cases} 0.05\dfrac{d\omega_1}{dt} = T_M - T_{S12} - 2(\omega_1 - \omega_2) - 3, \\ \dfrac{dT_{s12}}{dt} = 500(\omega_1 - \omega_2) \\ 0.2\dfrac{d\omega_2}{dt} = T_{s12} + 2(\omega_1 - \omega_2) - 1. \end{cases}$$

Calculate the resonant frequency of the mechanical system

a) 111.8 rad/s

b) 55.9 rad/s

c) 17.8 rad/s

d) 4.5 rad/s

e) 223.6 rad/s

f) not enough data to answer

Question 8

Consider the mechanical system, that is described by the follows differential equations:

$$\begin{cases} J_1 \dfrac{d\omega_1}{dt} = T_M - T_{S12} - b_{12}(\omega_1 - \omega_2) - T_{L1}, \\ \dfrac{dT_{s12}}{dt} = K_{12}(\omega_1 - \omega_2) \\ J_2 \dfrac{d\omega_2}{dt} = T_{s12} + b_{12}(\omega_1 - \omega_2) - T_{L2}. \end{cases}$$

How will resonant frequency change if load torque T_{L2} increases twice

a) increases twice

b) decreases twice

c) increases 4 times

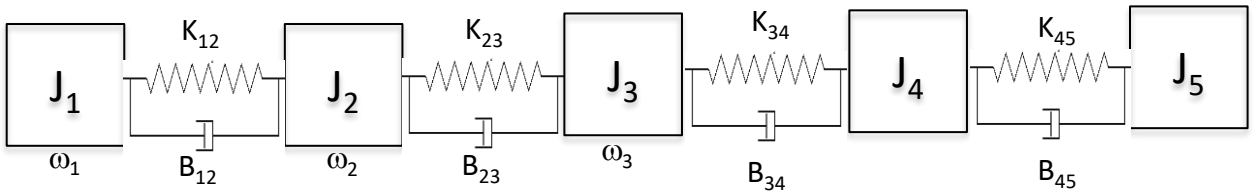
d) decreases 4 times

e) doesn't change

f) not enough data to answer

Question 9

How many differential equations of the first order we need to describe the dynamic behavior of the velocities of the follows mechanical system:



a) 5

b) 7

c) 9

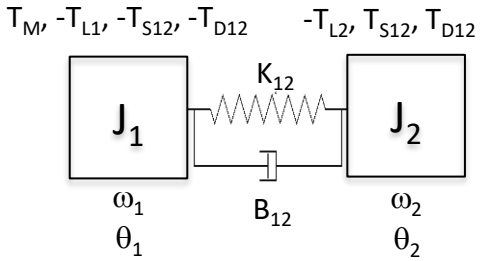
d) 3

e) 1

f) not enough data to answer

Question 10

Consider the follows mechanical system:



How will change the resonant frequency of the system if K_{12} decreases twice

a) increases twice

b) decreases twice

c) doesn't change

d) decreases $\sqrt{2}$ times

e) increases $\sqrt{2}$ times

f) not enough data to answer

THANK YOU
FOR YOUR TIME!

ITMO more than a UNIVERSITY