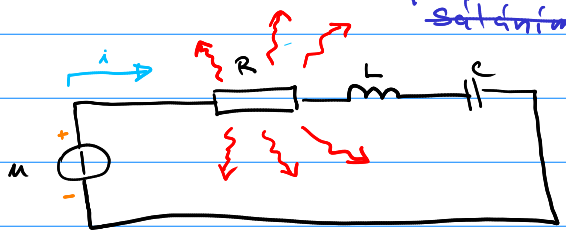
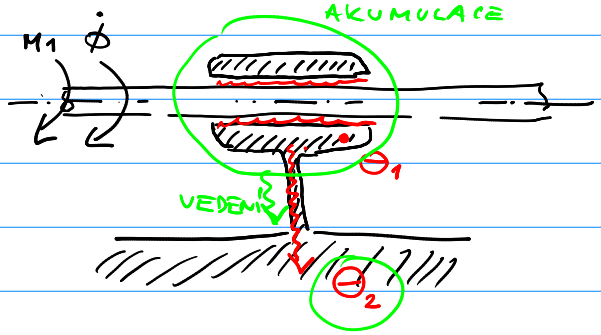
MODELOVÁNÍ TEPELNÝCH SYSTÉMŮ POMOCÍ VAZEBNÍCH GRAFŮ

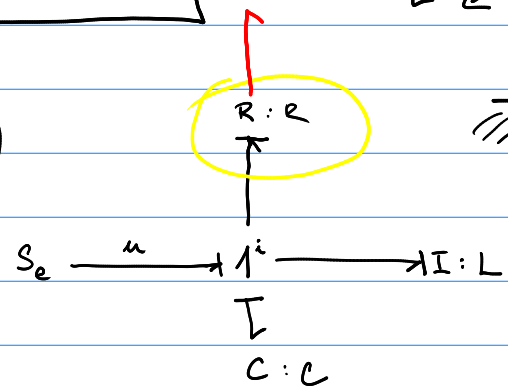
(A3B35MSD 2014/15)

- buď práce nebo přenos tepla
- přenos tepla: — vedením
  ~~prouděním~~
  ~~sáláním~~

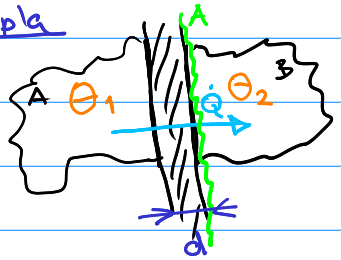




$$R = R_0\left(1 + \alpha \cdot (T - T_0)\right)$$



Vedení tepla



$\Theta_1 > \Theta_2$

Θ... teplota $[\Theta] = K$

$\dot{Q}$ ... tepelný tok (heat flow, flux) $[\dot{\Theta}] = \frac{J}{s} = K$

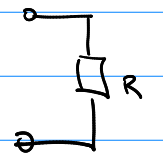
Q ... teplo $[Q] = J$

Fourier:

$$\dot{Q} = H \cdot (\Theta_1 - \Theta_2) = \frac{\Theta_1 - \Theta_2}{R}$$

H ... tepelná vodivost

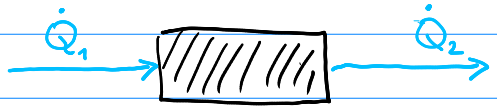
$$H = \frac{A}{d} \cdot \lambda$$



$i_R = G \cdot u_R$

$i_R = \frac{u_R}{R}$

Akumulace tepla



$\dot{Q}_1 > \dot{Q}_2$

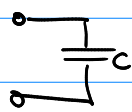
$$\dot{Q} = \dot{Q}_1 - \dot{Q}_2$$

C ... tepelná kapacita

$$Q = C \cdot \Theta$$

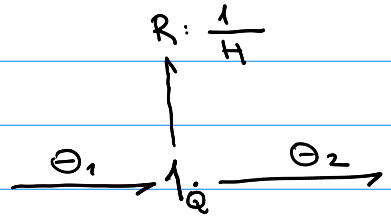
c ... měrná tep. kapacita

$$C = m \cdot c$$

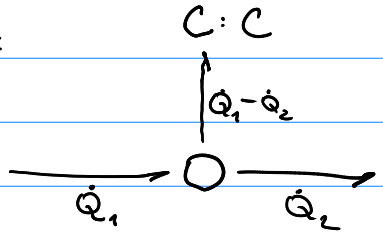


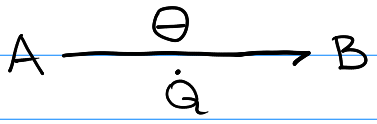
$q = C \cdot u$

Vedení:



Akumul.:





$[\Theta] = K$

$[\dot{Q}] = \frac{J}{s} = W$

$[\Theta \cdot \dot{Q}] = K \cdot W$

⇓

PSEUDO-VAZ. GRAFY

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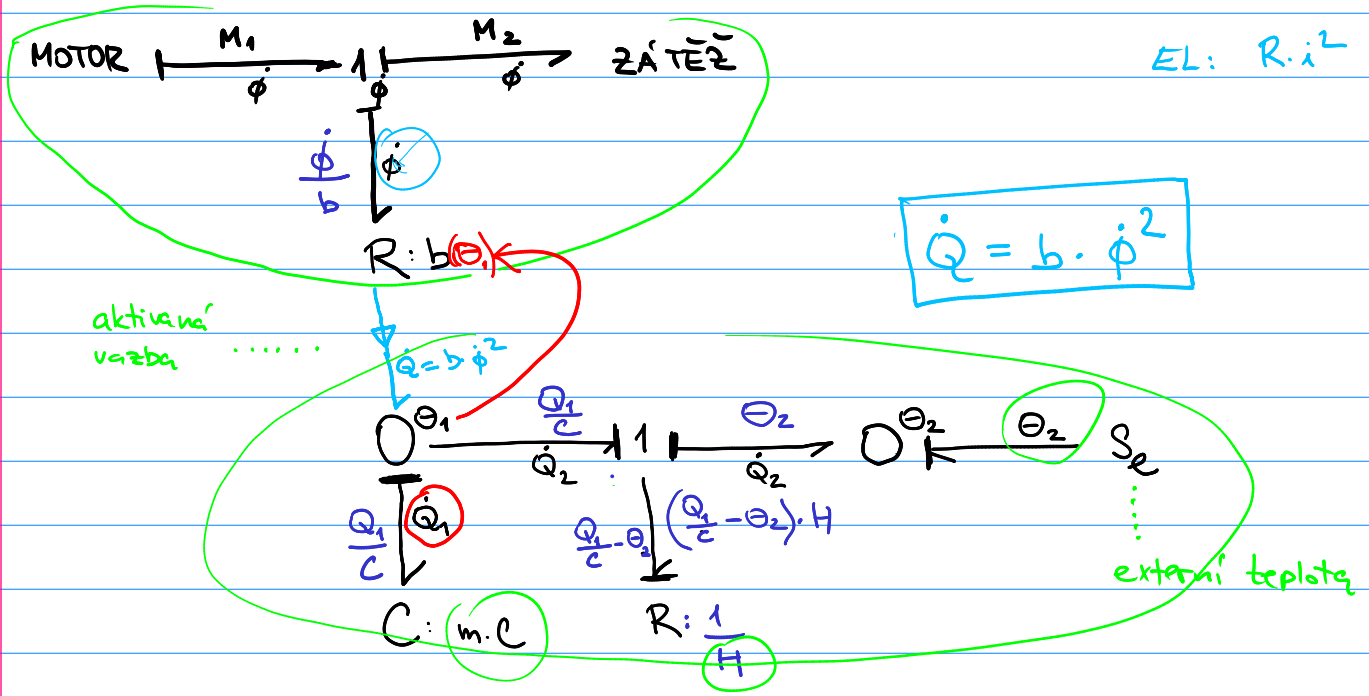
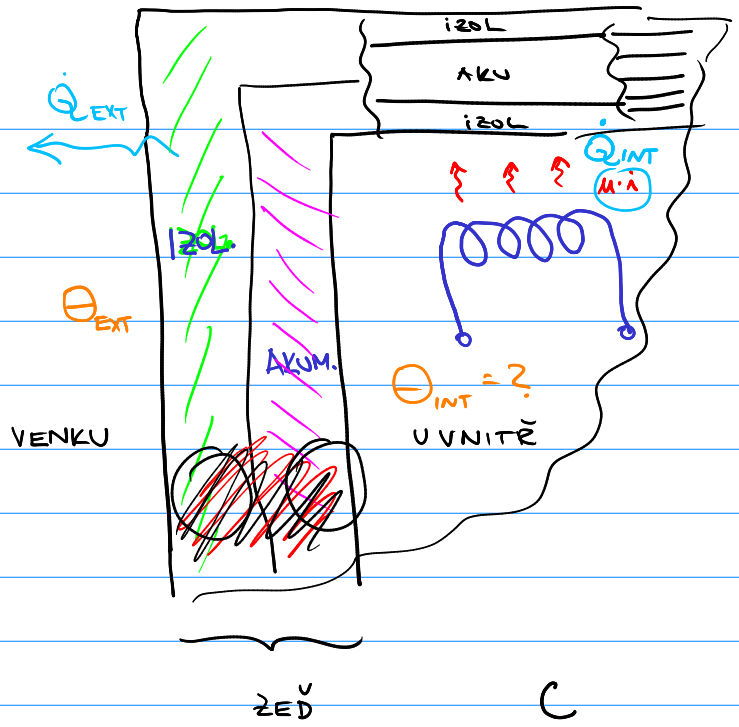
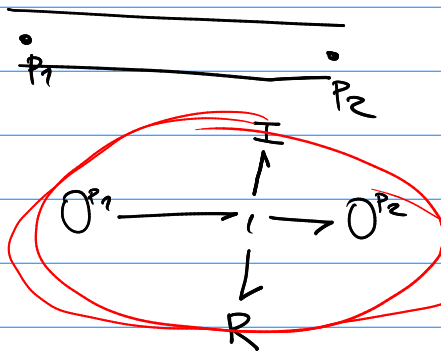
Nekompatibilita s jinými fyzikálními doménami

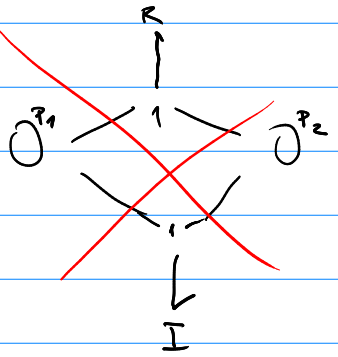


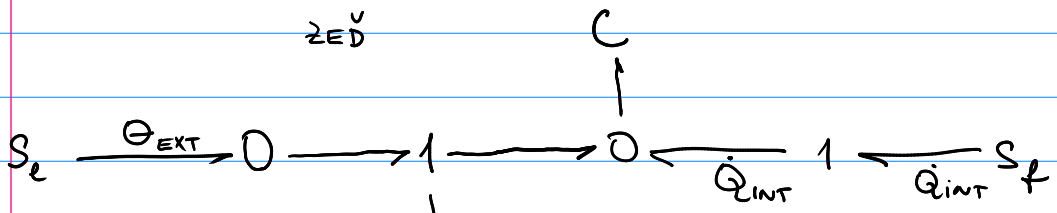
EL: $R \cdot i^2$

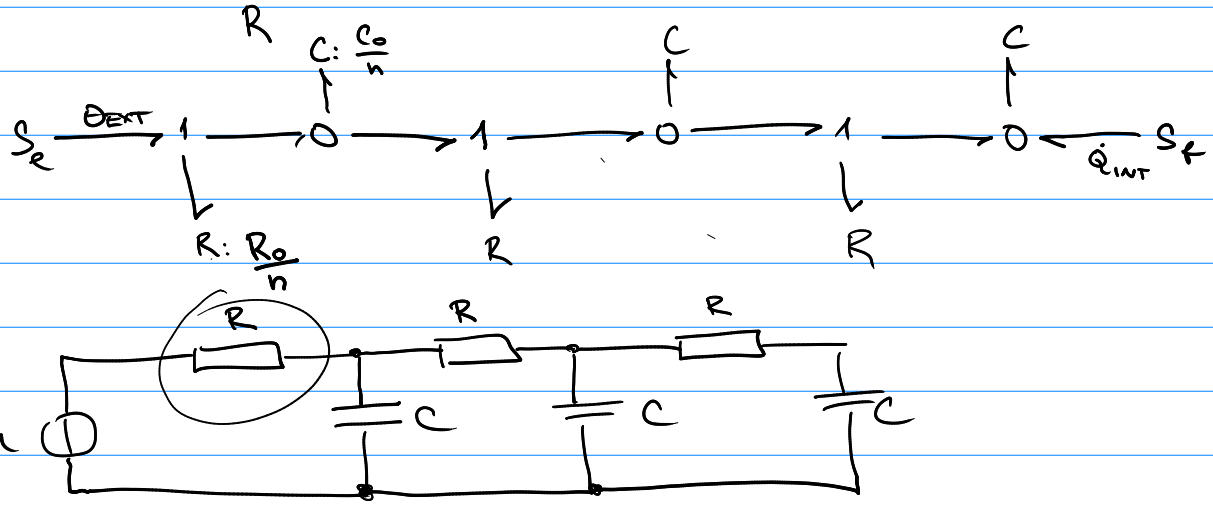
$\dot{Q} = b \cdot \dot{\phi}^2$











RYZÍ VAZEBNÍ GRAFY

$$\xrightarrow[\dot{S}]{\Theta}$$

$$[\dot{S}] = \left[\frac{\dot{Q}}{\Theta}\right] = \frac{W}{K} = \frac{\frac{J}{s}}{K}$$

změna entropie

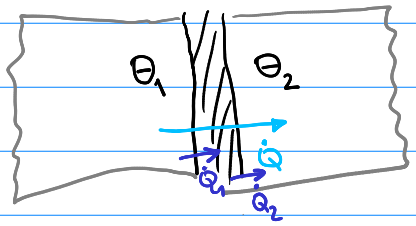
$$dS = \frac{dQ}{\Theta}$$

$$\dot{S} = \frac{\dot{Q}}{\Theta}$$

S ... entropie

$\dot{S}$ ... tok entropie

$$\frac{dS}{dt} = \frac{\frac{dQ}{dt}}{\Theta} \quad / \cdot dt$$

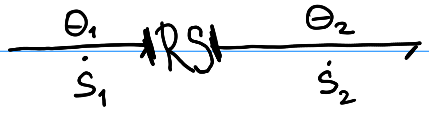


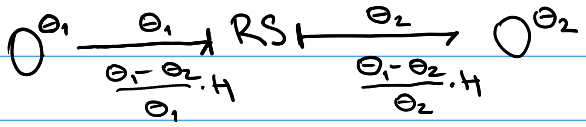
$\Theta_1 > \Theta_2$

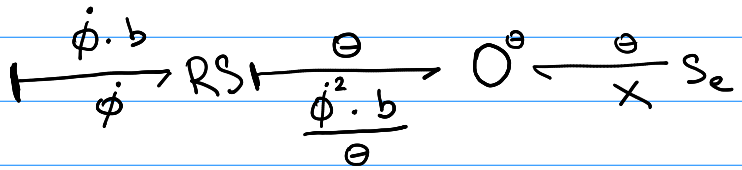
$\dot{Q}_1 = \Theta_1 \cdot \dot{S}_1 = \dot{Q}_2 = \Theta_2 \cdot \dot{S}_2 = \dot{Q}$

$\dot{S}_1 = \frac{\dot{Q}}{\Theta_1} = \frac{\Theta_1 - \Theta_2}{\Theta_1} \cdot H$

$\dot{S}_2 = \frac{\dot{Q}}{\Theta_2} = \frac{\Theta_1 - \Theta_2}{\Theta_2} \cdot H$







$\Theta \cdot \frac{dS}{dt} = \frac{dQ}{dt} \quad / \cdot dt$

$\Theta \cdot dS = dQ = C \cdot d\Theta$

$dS = C \cdot \frac{1}{\Theta} \cdot d\Theta$

$\downarrow \int dt$

$S(t) - S(t_0) = C \cdot \ln \frac{\Theta(t)}{\Theta(t_0)}$

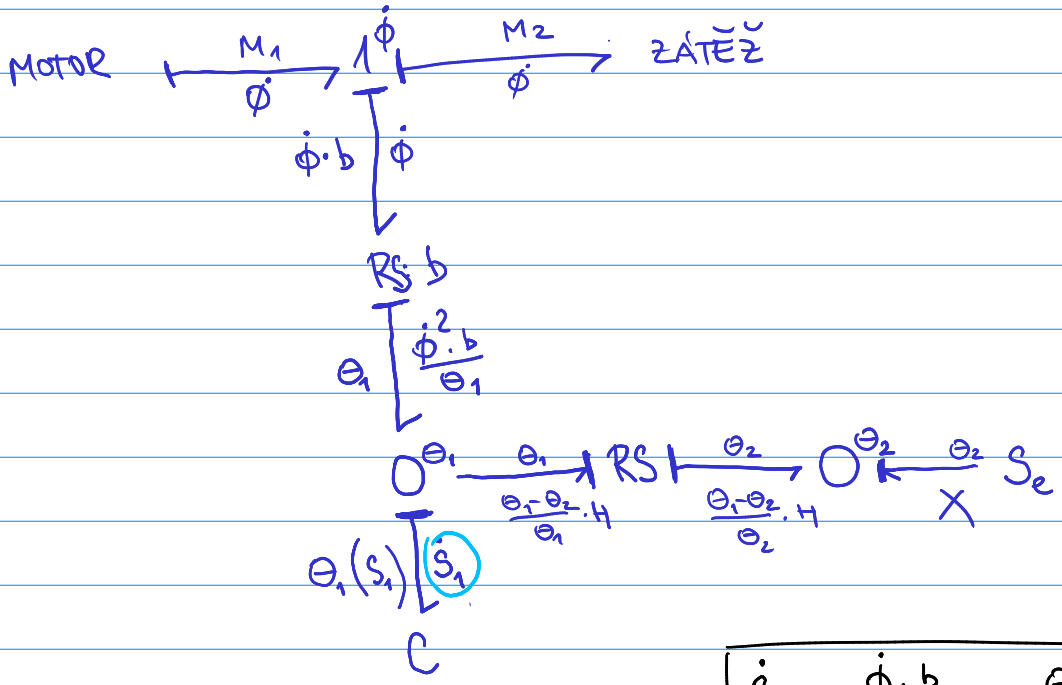
$\frac{S(t) - S(t_0)}{C} = \ln \frac{\Theta(t)}{\Theta(t_0)}$

$\frac{\Theta(t)}{\Theta(t_0)} = e^{\frac{S(t) - S(t_0)}{C}}$

primerjaj s: $\Theta(t) = \frac{1}{C} \cdot Q(t)$

$\Theta(t) = \Theta(t_0) \cdot e^{\frac{S(t) - S(t_0)}{C}}$

$S(t_0) = 0$



$$\dot{S}_1 = \frac{\dot{\phi} \cdot b}{\Theta_1} - \frac{\Theta_1 - \Theta_2}{\Theta_1} \cdot H$$

$$\Theta_1(t) = \Theta_1(t_0) \cdot e^{\frac{S_1(t)}{C}}$$

$$\Theta_1(t) = \Theta_1(t_0) \cdot e^{\frac{S_1(t)}{C}}$$