

• ET - element de transfer

ET-P: proporcional

ET-I: integrator

ET-D: derivator

ET-PT1: proporcional cu temporizare de ordinul 1

ET-PID-T1: proporcional derivator cu temporizare de ordinul 1

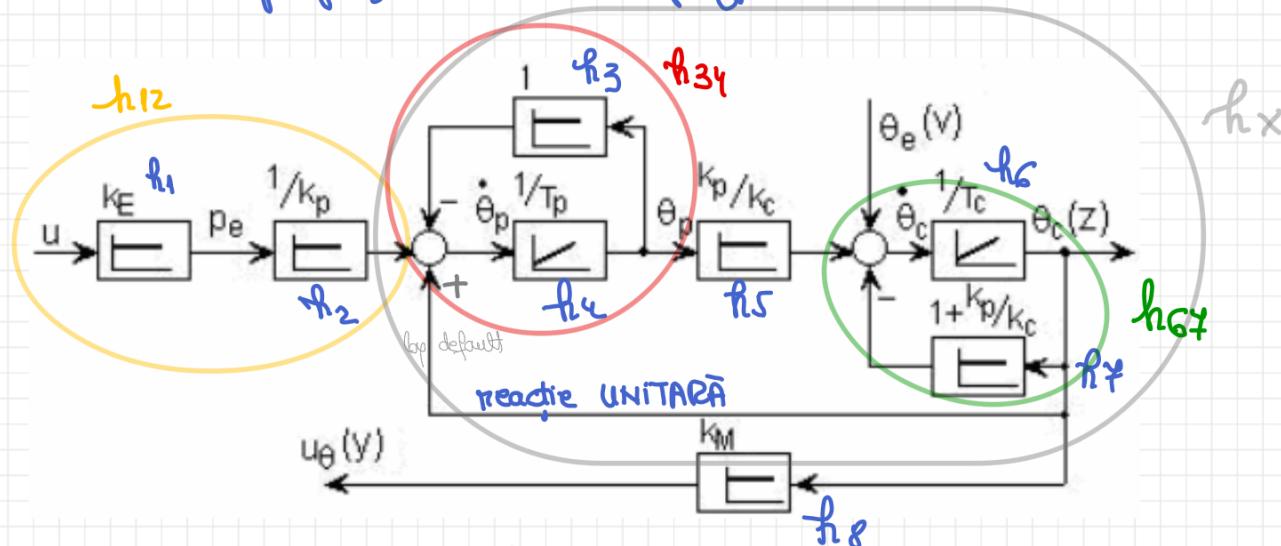
ET-DT1: derivator cu temporizare de ordinul 1

ET-PI: proporcional integrator

ET-PD: proporcional derivator

ET-PID: proporcional integrator derivator

ET-PT2: proporcional cu temporizare de ordinul 2



$$h_1(S) = K_E$$

$$h_5(S) = \frac{k_p}{k_c}$$

$$h_2(S) = 1/k_p$$

$$h_6(S) = \frac{1}{S T_c}$$

$$h_3(S) = 1$$

$$h_4(S) = \frac{1}{S T_p}$$

$$h_7(S) = 1 + \frac{k_p}{k_c}$$

$$h_8(S) = K_M$$

$$\cdot h_1, h_2 \rightarrow serie \Rightarrow h_{12} = h_1 \cdot h_2$$

$$\cdot h_3, h_4 \rightarrow reacție \Rightarrow h_{34} = \frac{h_4}{1 + h_3 \cdot h_4}$$

$$\cdot h_{34}, h_5 \rightarrow serie \Rightarrow h_{345} = \frac{h_4}{1 + h_3 h_4} \cdot h_5$$

$$\cdot h_6, h_7 \rightarrow \text{neutrie} \Rightarrow h_{67} = \frac{h_6}{1 + h_6 h_7}$$

$$\cdot h_3 h_5, h_6 h_7 \rightarrow \text{series} \Rightarrow h_{37} = \frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)}$$

$$\cdot h_3 h_5, 1, \text{neutrie} \Rightarrow h_x = \frac{h_3 h_5 h_6}{1 - h_3 h_5 \cdot 1} = \frac{\frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)}}{1 - \frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)}}$$

$\cdot h_1, h_x, h_8 \rightarrow \text{series}$

$$\Rightarrow H = h_1 \cdot h_x \cdot h_8 = h_1 \cdot h_2 \cdot \frac{\frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)}}{1 - \frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)}} \cdot h_8 =$$

$$= h_1 \cdot h_2 \frac{\frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)} - h_4 h_5 h_6}{\frac{h_3 h_5 h_6}{(1 + h_3 h_4)(1 + h_6 h_7)} - h_4 h_5 h_6} \cdot h_8$$

$$= \frac{h_1 h_2 h_4 h_5 h_6 h_8}{(1 + h_3 h_4)(1 + h_6 h_7) - h_4 h_5 h_6}$$

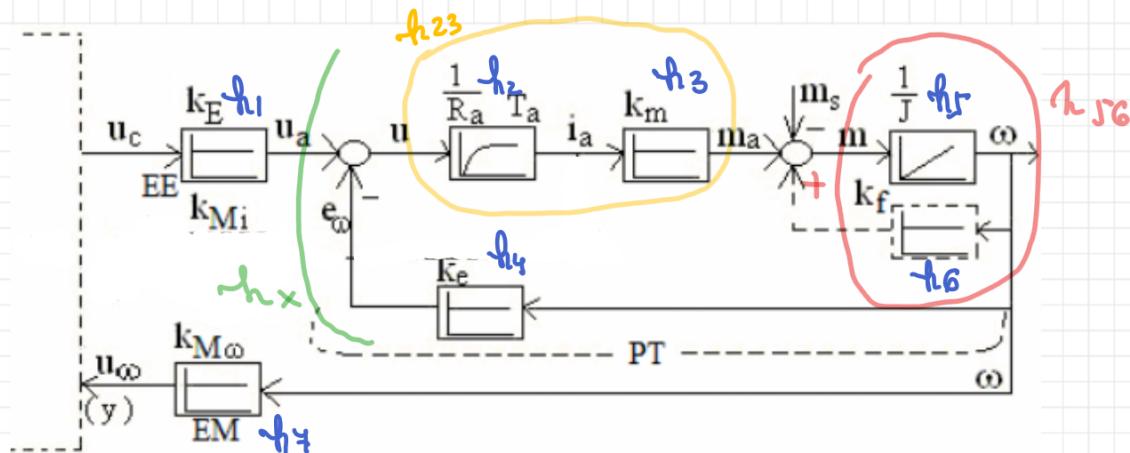
$$= \frac{\frac{K_E \cdot \frac{1}{K_p} \cdot \frac{1}{S_{Tp}} \cdot \frac{K_p}{K_C} \cdot \frac{1}{S_{Tc}} \cdot K_M}{(1 + \frac{1}{S_{Tp}}) \left[1 + \frac{1}{S_{Tc}} \cdot (1 + \frac{K_p}{K_C}) \right] - \frac{1}{S_{Tp}} \cdot \frac{K_p}{K_C} \cdot \frac{1}{S_{Tc}}}}{=} =$$

$$= \frac{\frac{K_E \cdot \frac{1}{K_p} \cdot \frac{1}{S_{Tp}} \cdot \cancel{\frac{K_p}{K_C}} \cdot \cancel{\frac{1}{S_{Tc}}} \cdot K_M}{(S_{Tp} + 1) \cdot \frac{1}{S_{Tp}} \cdot \frac{1}{S_{Tc} \cdot K_C} [S_{Tc} \cdot K_C + K_C + K_p] - \frac{K_p}{S^2 T_p T_c \cdot K_C}}}{=} =$$

$$= \frac{\frac{K_E \cdot K_M}{(S_{Tp} + 1)(S_{Tc} K_C + K_C + K_p) - K_p}}{=} =$$

$$= \frac{\frac{K_E \cdot K_M}{S^2 T_p T_c K_C + S_{Tp} K_C + S_{Tp} K_p + S_{Tc} K_C + K_C + K_p - K_p}}{=} =$$

$$= \frac{k_E \cdot k_M}{S^2 \cdot T_p T_c \cdot k_C + S(T_p k_C + T_c k_P + T_c k_C) + k_C}$$



$$h_1 = k_E$$

$$h_2 = \frac{1}{R_a} \quad h_4 = k_e$$

$$h_5 = \frac{1}{Sj}$$

$$h_6 = k_f$$

$$h_x = k_{M\omega}$$

$$\bullet h_2, h_3 \rightarrow \text{serie} : h_{23} = h_2 \cdot h_3$$

$$\bullet h_5, h_6 \rightarrow \text{reactie} : h_{56} = \frac{h_5}{1 - h_5 \cdot h_6}$$

$$\bullet h_{23}, h_{56} \rightarrow \text{serie} \Rightarrow h_{26} = \frac{h_2 h_3 h_5}{1 - h_5 \cdot h_6}$$

$$\bullet h_{26}, h_4 \rightarrow \text{reactie} \Rightarrow h_x = \frac{h_{26}}{1 + h_{26} \cdot h_4} = \frac{\frac{h_2 h_3 h_5}{1 - h_5 \cdot h_6}}{1 + \frac{h_2 h_3 h_5 \cdot h_4}{1 - h_5 \cdot h_6}}$$

$$= \frac{h_2 h_3 h_5}{1 - h_5 h_6 + h_2 h_3 h_4 h_5}$$

$$\bullet h_1, h_x, h_7 \rightarrow \text{serie} \rightarrow H = \frac{h_1 \cdot h_2 \cdot h_3 \cdot h_5 \cdot h_7}{1 - h_5 h_6 + h_2 h_3 h_4 h_5}$$

$$\begin{aligned}
 &= \frac{k_E \frac{1}{R_a} \cdot k_m \cdot \frac{1}{Sg} \cdot k_{MW}}{1 - \frac{1}{Sg} \cdot k_f + \frac{1}{R_a} \cdot k_m \cdot k_e \cdot \frac{1}{Sg}} = \\
 &= \frac{\frac{k_E \cdot k_m \cdot k_{MW}}{(1+S\cdot T_a) \cdot Sg \cdot R_a}}{\frac{1}{R_a \cdot Sg \cdot (1+S\cdot T_a)} \left(R_a Sg (1+S\cdot T_a) - R_a k_f (1+S\cdot T_a) + k_m \cdot k_e \right)} = \\
 &= \frac{k_E \cdot k_m \cdot k_{MW}}{R_a Sg + S^2 R_a J T_a - R_a k_f - S \cdot T_a \cdot R_a k_f + k_m \cdot k_e} = \\
 &= \frac{k_E \cdot k_m \cdot k_{MW}}{S^2 R_a J T_a + S(R_a J - T_a R_a k_f) - R_a k_f + k_m \cdot k_e}
 \end{aligned}$$