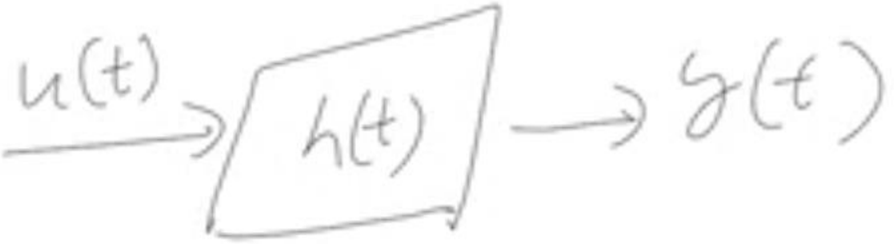
Transfer function



$$TF = \frac{Y(s)}{U(s)} = \mathcal{L}\, h(t)$$

All initial conditions are zero

2.00
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Electrical ckt

$$x_1 \triangleq v_C$$

$$x_2 = i_L$$

$R = 10\,\Omega$

$L = 0.0045\,H$

$C = 0.03\,F$

$$\frac{dx_1}{dt} = -\frac{1}{RC}x_1 + \frac{1}{C}x_2$$

$$\frac{dx_2}{dt} = -\frac{1}{L}x_1 + \frac{1}{L}v_s$$

$$\frac{dx_1}{dt} = -3.33\,x_1 + 33.3\,x_2$$

$$\frac{dx_2}{dt} = -222.2\,x_1 + 222.2\,v_s$$

$$s\,X_1(s) = -3.33\,X_1(s) + 33.3\,X_2(s) \;\checkmark\Rightarrow\; X_2(s) = \frac{s+3.33}{33.3}\,X_1(s)$$

$$s\,X_2(s) = -222.2\,X_1(s) + 222.2\,V_s(s)$$

$$\frac{s(s+3.33)}{33.3}\,X_1(s) = -222.2\,X_1(s) + 222.2\,V_s(s)$$

$$TF = \frac{Y(s)}{V_s(s)} = \frac{X_1(s)}{V_s(s)} = \frac{7400}{s^2+3.33s+7400}$$

3.00
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TF of a DC Motor

$$\frac{dx_1}{dt} = -\frac{B}{J}x_1 + \frac{K_T}{J}x_2, \qquad x_1 \triangleq \omega, \quad x_2 \triangleq i_a$$

$$\frac{dx_2}{dt} = -\frac{R_a}{L_a}x_2 - \frac{K_b}{L_a}x_1 + \frac{1}{L_a}v_a$$

$B = 0.1$, $J = 1.2$, $K_T = 0.8 \ \text{N-m/A}$, $K_b = 1.6 \ \frac{\text{V.rad}}{\text{sec}}$

$L_a = 0.045\,H$, $R_a = 20\,\Omega$

$y(t) = \omega = x_1$

$$TF = \frac{Y(s)}{V_a(s)} = \frac{X_1(s)}{V_a(s)} = ?$$

$T_M = K_T i_a$

$e_b = K_b \omega$

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$$\frac{dx_1}{dt} = -0.0833\, x_1 + 0.667\, x_2$$

$$\frac{dx_2}{dt} = -444.4\, x_2 - 35.55\, x_1 + 22.2\, V_a$$

$$sX_1(s) = -0.0833\, X_1(s) + 0.667\, X_2(s)$$

$$X_2(s) = \frac{s + 0.0833}{0.667}\, X_1(s)$$

$$sX_2(s) = -444.4\, X_2(s) - 35.55\, X_1(s) + 22.2\, V_a(s)$$

$$(s + 444.4)\, X_2(s) = -35.55\, X_1(s) + 22.2\, V_a(s)$$

$$\left[\frac{(s+0.0833)(s+444.4)}{0.667}+35.55\right]X_1(s)$$

$$=22.2\,V_a(s)$$

$$TF=\frac{X_1(s)}{V_a(s)}=\frac{Y(s)}{V_a(s)}=\frac{14.8}{(s+0.0833)(s+444.4)+23.7}$$