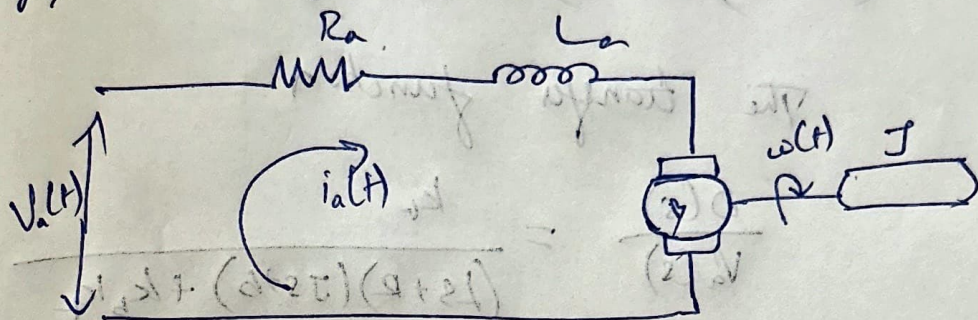


## Electro-mechanical system

converts electrical energy into mechanical energy.



$V_a(t)$  — armature voltage  $\rightarrow$  i/p

$\omega(t)$  — motor speed  $\rightarrow$  o/p

dynamic equations of DC motor is given as

$$L \frac{di_a(t)}{dt} + R i_a(t) + k_b \omega(t) = V_a(t)$$

$$J \frac{d\omega(t)}{dt} + b \omega(t) - k_t i_a(t) = 0$$

apply Laplace transform

$$Ls i_a(s) + R i_a(s) + k_b \omega(s) = V_a(s)$$

$$Js \omega(s) + b \omega(s) - k_t i_a(s) = 0$$

$$\Rightarrow (Ls + R) i_a(s) + k_b \omega(s) = V_a(s) \rightarrow \textcircled{1}$$

$$\Rightarrow (Js + b) \omega(s) - k_t i_a(s) = 0 \rightarrow \textcircled{2}$$

find  $i_a(s)$  from equation  $\textcircled{2}$

$$i_a(s) = \frac{(Js + b) \omega(s)}{k_t} \rightarrow \textcircled{3}$$

Substitute  $\textcircled{3}$  in  $\textcircled{1}$  equation

$$(Ls + R) \frac{(Js + b) \omega(s)}{k_f} + R k_b \omega(s) = V_a(s)$$

$$(Ls + R)(Js + b)\omega(s) + k_b k_f \omega(s) = k_f V_a(s)$$

The transfer function

$$\frac{\omega(s)}{V_a(s)} = \frac{k_f}{(Ls + R)(Js + b) + k_b k_f}$$

$\omega(t) \leftarrow$  angular velocity  
 $\omega(0) \leftarrow$  initial angular velocity  
 $\omega(0) \leftarrow$  initial angular velocity  
 $\omega(0) \leftarrow$  initial angular velocity

$$(1) \omega(t) = (1) \cos t + (1) \sin t + \frac{(1) \sin t}{1}$$

$$0 = (1) \sin t + (1) \cos t + \frac{(1) \cos t}{1}$$

$$(2) \omega(t) = (2) \cos t + (2) \sin t + (2) \sin t$$

$$0 = (2) \sin t + (2) \cos t + (2) \cos t$$

$$(3) \omega(t) = (3) \cos t + (3) \sin t + (3) \sin t$$

$$(4) \omega(t) = (4) \cos t + (4) \sin t + (4) \sin t$$

$$(5) \omega(t) = (5) \cos t + (5) \sin t + (5) \sin t$$

$$(6) \omega(t) = (6) \cos t + (6) \sin t + (6) \sin t$$