Online Lecture 3

EEE4231:Control system Section: A

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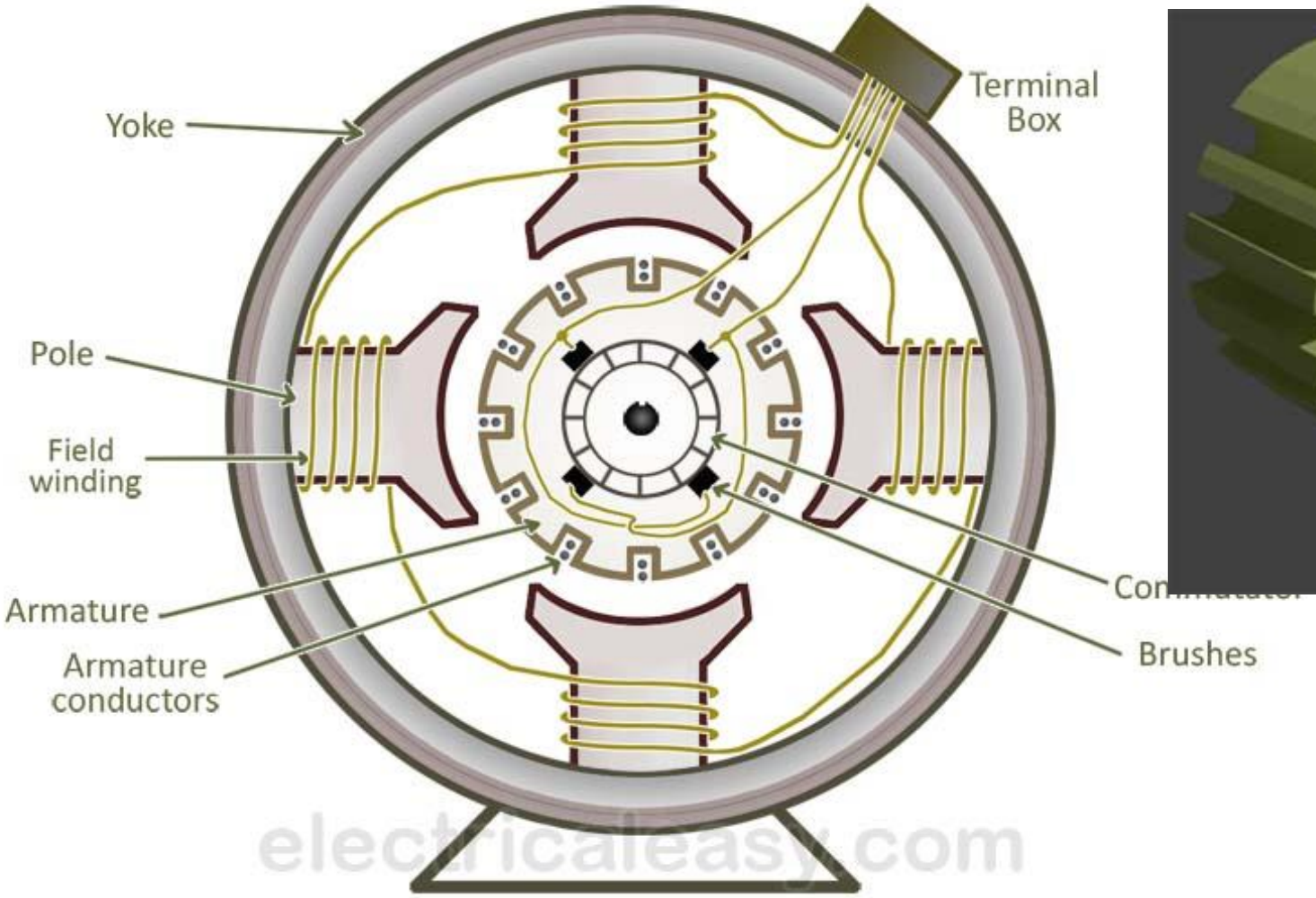
Contents:

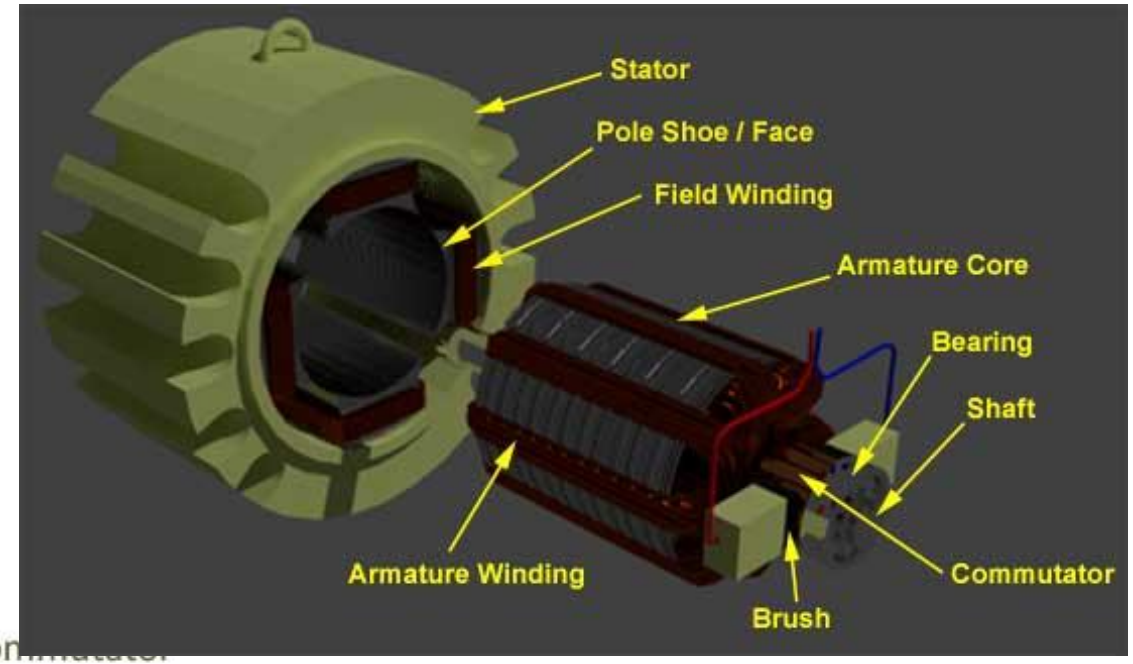
- Objective of todays lecture.
- Overview on DC machine as background study
- Transfer function of DC motor
- Thyristor control DC motor(shunt type)
- Learning outcomes

Objectives of todays lecture

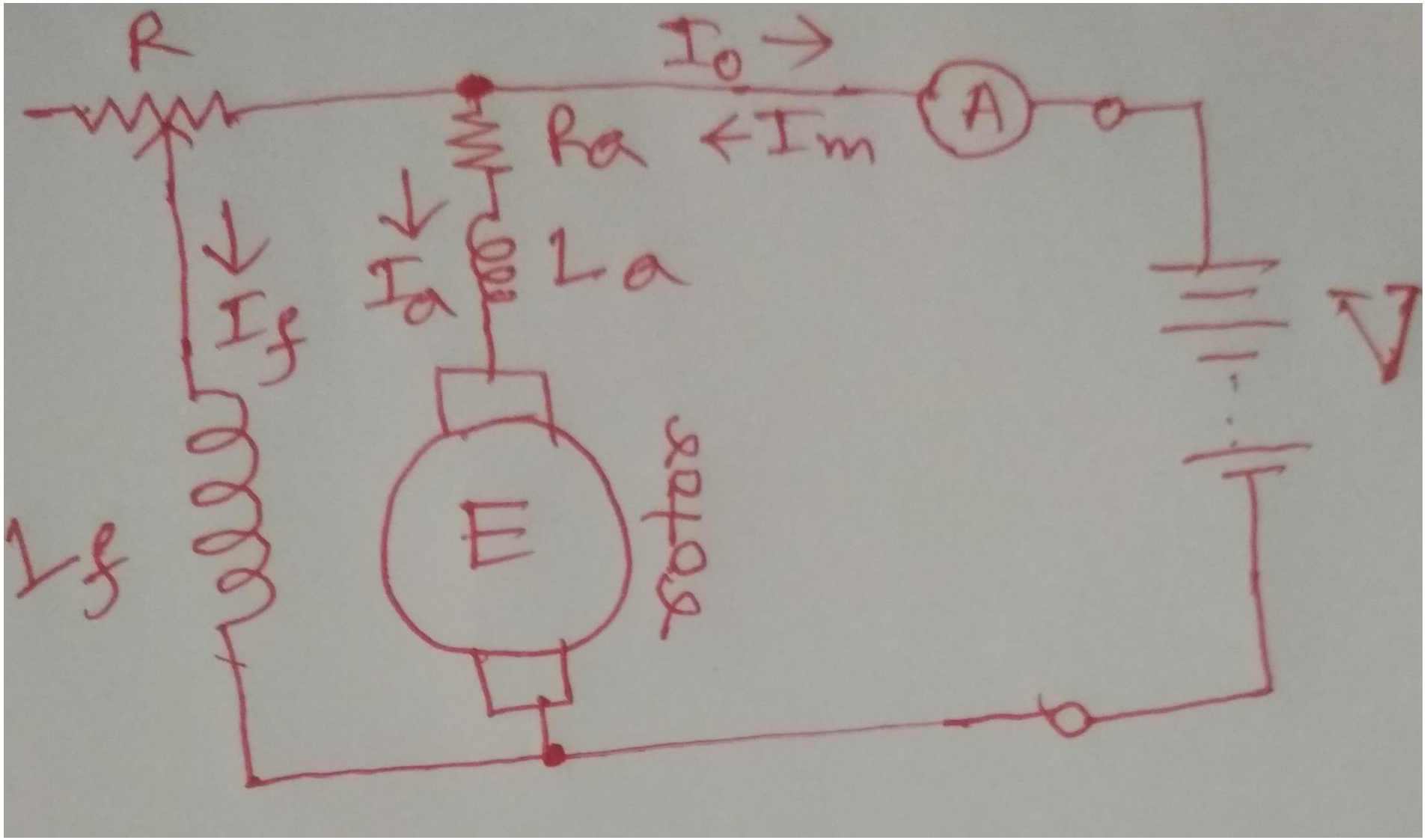
- To deduce transfer function of DC motor
- To understand speed control of DC motor (shunt type) using thyristor (possibly next lecture)

Overview of DC machine





Overview continued



continued

EMF equation:

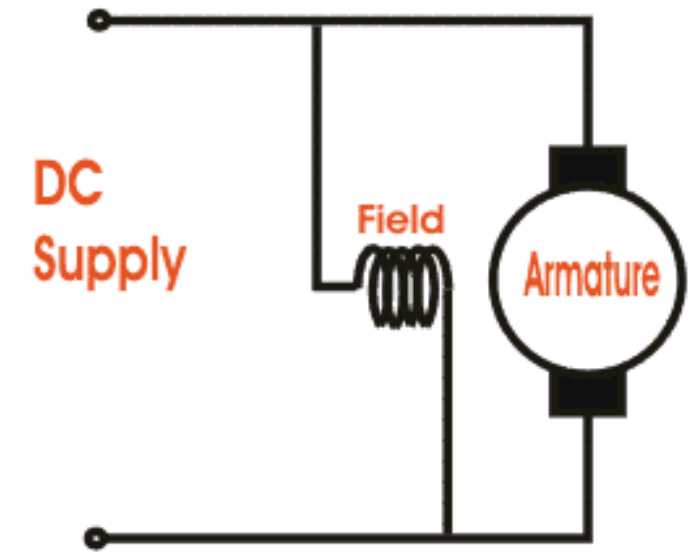
$E = V + I_a R_a$(as generator)

$E = V - I_a R_a$(as motor)

$E \propto N_r \emptyset$

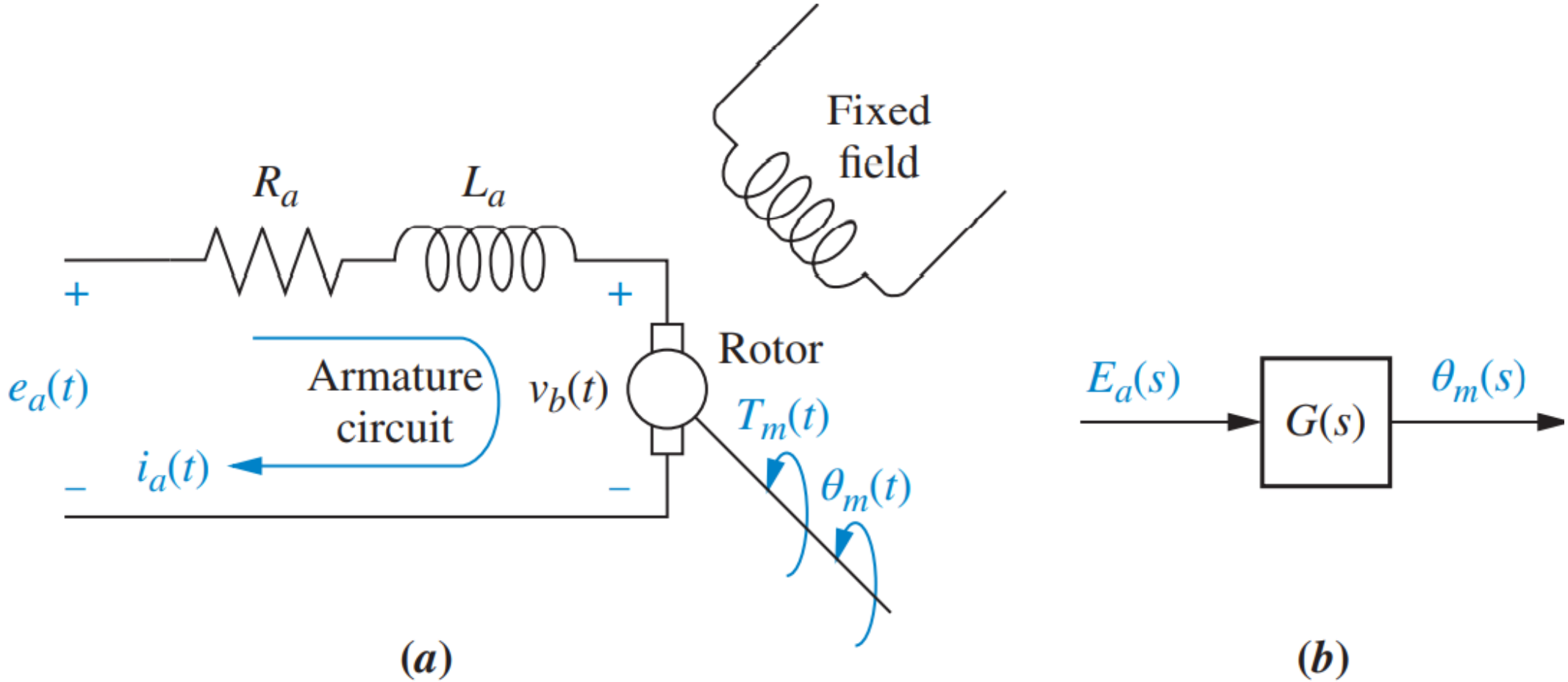
$T \propto I_a \emptyset$

$N_r \propto \frac{V}{\emptyset}$



Shunt Excited DC Motor

Transfer function G(s) of DC motor



2.35 DC motor: **a.** schematic;[12] **b.** block diagram

Continued

$$v_b(t) = k_b \frac{d\theta_m(t)}{dt}$$
$$V_b(s) = k_b s\theta_m(s)$$

Using KVL in Fig.2.35

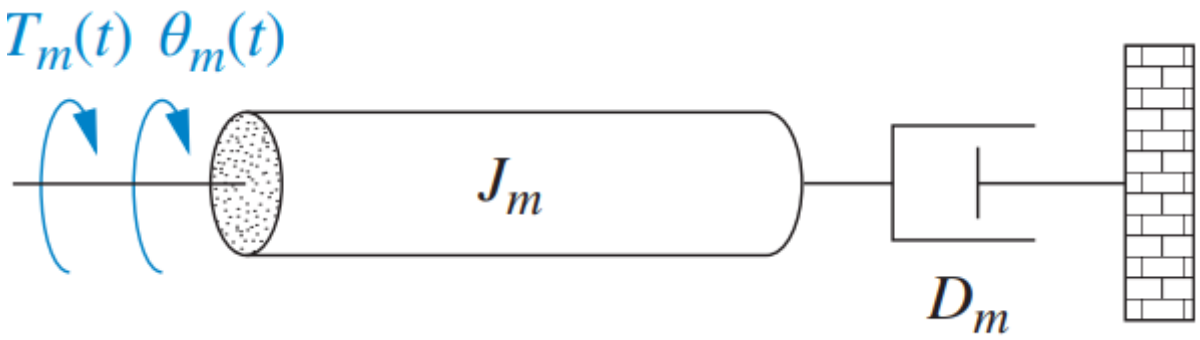
$$e_a(t) - i_a R_a - L_a \frac{di_a(t)}{dt} - v_b(t) = 0$$

Using Laplace transformation with zero initial condition

$$R_a I_a(s) + L_a s I_a(s) + V_b(s) = E_a(s)$$

The torque developed by the motor is proportional to the armature current; thus,

$$T_m(s) = K_t I_a(s)$$



$$T_m(s) = (J_m s^2 + D_m s)\theta_m(s) \tag{2.150}$$

Substituting Eq. (2.150) into Eq. (2.149) yields

$$\frac{(R_a + L_a s)(J_m s^2 + D_m s)\theta_m(s)}{K_t} + K_b s\theta_m(s) = E_a(s) \tag{2.151}$$

Transfer function DC motor (continued)

simplification, the desired transfer function, $\theta_m(s)/E_a(s)$, is found to be

$$\frac{\theta_m(s)}{E_a(s)} = \frac{K_t/(R_a J_m)}{s\left[s + \frac{1}{J_m}\left(D_m + \frac{K_t K_b}{R_a}\right)\right]} \tag{2.153}$$

hough the form of Eq. (2.153) is relatively simple, namely

$$\frac{\theta_m(s)}{E_a(s)} = \frac{K}{s(s+\alpha)} \tag{2.154}$$

END