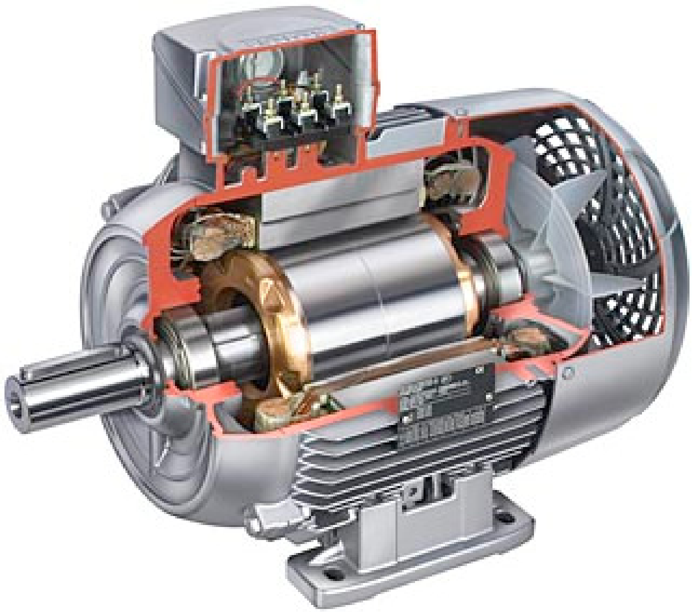
EEE 3352

Electromechanics & Electrical Machines



Lecture 6: Examples

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Examples:

6.1

A shunt generator has a field resistance of 60 Ω . When the generator delivers 6 kW, the terminal voltage is 120 V, while the generated EMF is 133 V. Determine the

(a) armature circuit resistance and

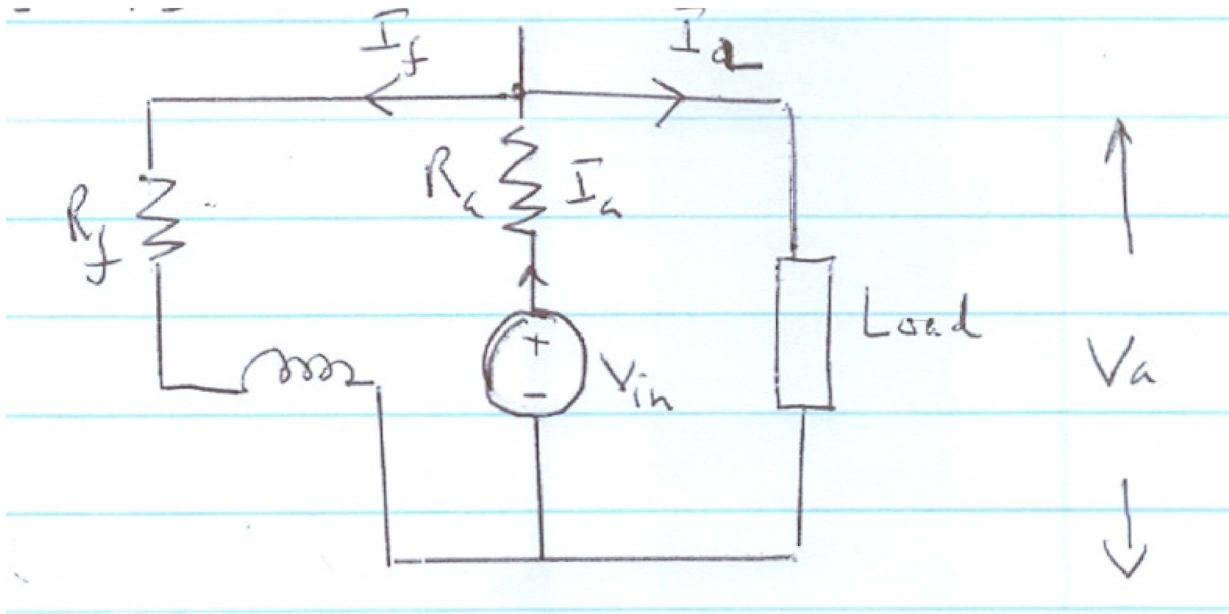
(b) EMF when the output is 2 kW and terminal voltage is 135 V

$R_f = 60\ \Omega$

$P = 6\ kW$

$V_a = 120\ V$

$V_{in} = 133\ V$



(a)

$$I_L = \frac{P}{V_a} = \frac{6\times10^3}{120} = 50\ \text{A}$$

$$I_f = \frac{V_a}{R_f} = \frac{120}{60} = 2\ \text{A}$$

$$I_a = I_f + I_L = 50 + 2 = 52\ \text{A}$$

$$R_a = \frac{V_{in} - V_a}{I_a} = \frac{133 - 120}{52} = 0.25\ \Omega$$

(b)

$V_a = 135\ V \quad ; \quad P_L = 2\ kW$

$$I_L = \frac{2\times10^3}{135} = 14.9\ A$$

$$I_f = \frac{135}{60} = 2.25\ A$$

$$I_a = I_f + I_a = 17.15\ A$$

$$V_{in} = V_a + I_a R_a = 135 + 17.15 \times 0.25\ A = \underline{\underline{139.3\ V}}$$

6.2

A DC motor operates at 1680 r/min when drawing 28 A from a 230-V supply. If the armature resistance is 0.25 Ω, and assuming all losses are neglected, calculate the

(a) no-load speed

(b) developed power under loaded conditions

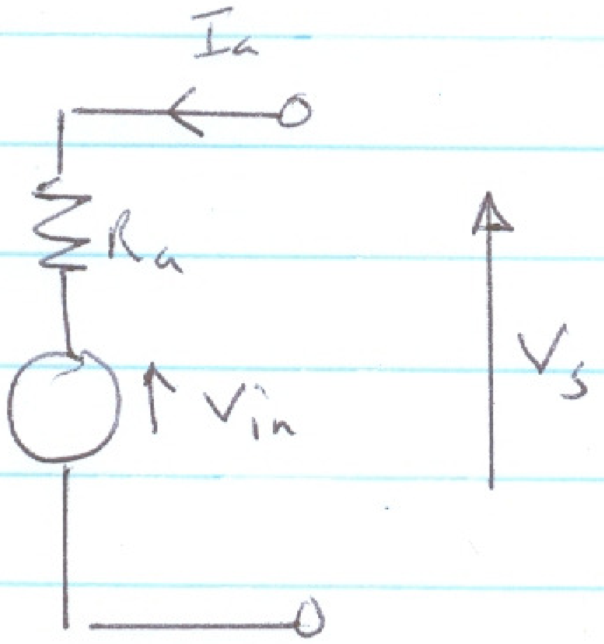
(c) torque developed under the given load

$n = 1680$ r/min

$I_a = 28$ A

$V_s = 230$ V

$R_a = 0.25\ \Omega$



Assume :

- seperately excited
- ϕ is constant

(a)

$I_L = I_{a_1} = 28A$; $n_1 = 1680\ r/min$

$V_{in_1} = V_a - I_{a_1}R_a = 230 - 28 \times 0.25 = 223\ V$

$V_{in_1} = k n_1 \phi = 1680\ k\phi \Rightarrow k\phi = \frac{223}{1680} = 0.1327$

At no-load, $I_{a_2} = 0$, $V_{in_2} = V_a = 230\ V$

$V_{in_2} = k\phi n_2 \Rightarrow 230 = k\phi n_2$

$$n_2 = \frac{230}{0.1327} = 1733\ r/min$$

(b)

$$P = V_{in} I_a = 223 \times 28 = 6244 \text{ W}$$

(c)

$$P = \omega T = 2\pi n T$$

$$T = P / 2\pi n = \frac{6244}{2\pi (1680/60)} = 35.5 \text{ Nm}$$

6.4

A 240-V shunt motor runs at 800 r/min when the armature current at no-load

the armature and field circuit resistance are 0.4 and 160 Ω, respectively

calculate the required resistance to be placed in series with the field to increase the speed to 950 r/min when armature current is 20 A

$V_s = 240\,V$

$n_1 = 800$ r/min

$n_2 = 950$ r/min

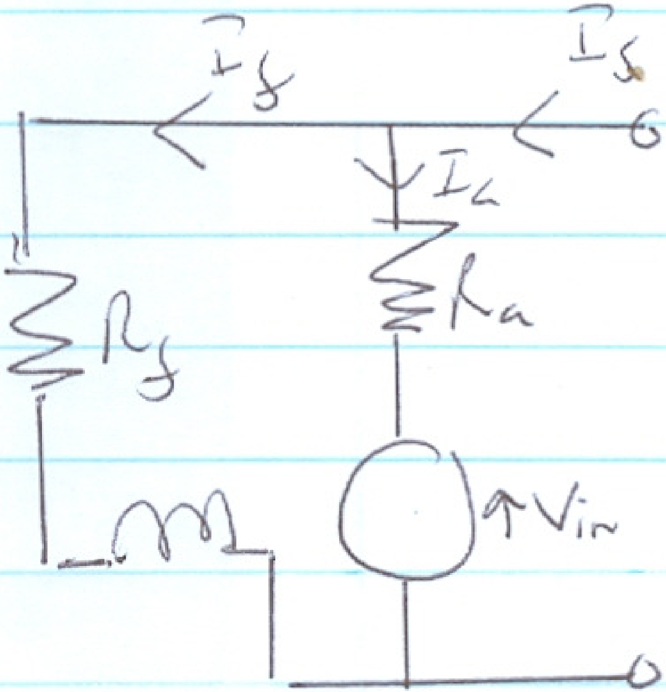
$I_a = 20$ A

$R_f = 160\,\Omega$

$R_a = 0.4\,\Omega$

$P(W + F + F_e) = 0$

$\phi \propto I_f$



Case 1, no-load, $I_a = 0$

$$V_{in_1} = 240 = k_e n_1 \phi$$

$$k_e \phi_1 = 240/800 =$$

$$I_{f_1} = \cancel{240}\ \frac{V_s}{R_f} = \frac{240}{160} = 1.5\,A$$

Case 2, new R_f.

$$V_{in_2} = V_s - I_a R_a = 240 - 20 \times 0.4 = 232$$

$$V_{in_2} = k_e \phi_2 n_2 = k_e \phi_2 \times 950$$

$$\phi_2 = \phi_1 \frac{I_{f2}}{I_{f1}}$$ ~~with~~

$$232 = k_e \phi_1 \frac{I_{f2}}{I_{f1}} \times 950 = \frac{240}{800} \times \frac{I_{f2}}{1.5} \times 950$$

$$I_{f_2} = 1.221 \text{ A}$$

$$R_{ex} + 160 = \frac{240}{1.221} = 197\ \Omega$$

$$R_{ex} = 37\ \Omega$$