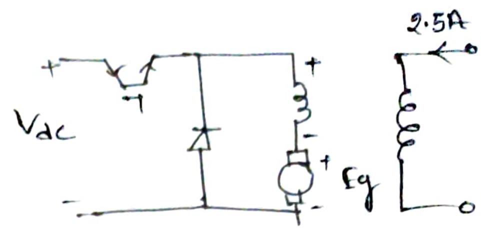
1. Given data:

DC seperately excited motor



$V_{dc} = 600V$

$R_a = 0.05\Omega$

$K_t = 1.527$ V/A rad/sec

$I_a = 250$ A

$I_F = 2.5$ A

$d = 0.6$

a) Input power from source = ?

b) Rin of the dc source-DC converter = ?

c) Motor speed = ?

d) Torque = ?

$V = dV_{dc}$

$= 0.6 \times 600$

$V = 300V$

$V = I_a R_a + E_b$

$360 = 250(0.05) + E_b$

$360 = 12.5 + E_b$

$E_b = 360 - 12.5$

$E_b = 347.5$

a) Assume, loss free DC-DC converter

then, $V_{in} I_{in} = V \times I_a$

$$P_{in} = 360 \times 250$$

$$= 90\,KW$$

b) $$R_{in} = \frac{V_{in}}{I_{in}}$$

$$I_{in} = \frac{P_{in}}{V_{in}} = \frac{90 \times 10^3}{600}$$

$$I_{in} = 150$$

$$R_{in} = \frac{600}{150}$$

$$R_{in} = 4\,\Omega$$

c) Motor speed $= \dfrac{E_b}{K_b I_F}$ $\left\{ K_b \times I_F = K = 3.8175 \right\}$

$$= \frac{347.5}{2.5 \times 1.527}$$

$$= 91.028 \text{ rad/sec}$$

$$= 869.25 \text{ rpm}$$

d) Developed torque,

$$\omega_m = \frac{V}{K} - \frac{R_a}{K^2} T$$

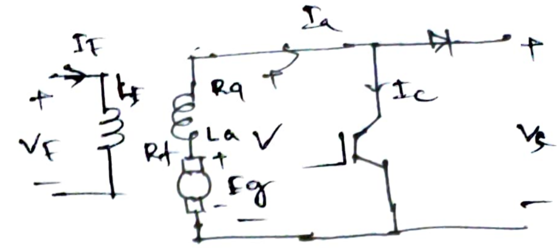
$$\Rightarrow 91.028 = \frac{360}{3.8175} - \frac{0.05}{3.8175^2}(T)$$

$$\Rightarrow T = 3.274\,(3.8175)^2 / 0.05$$

$$\therefore T = 954.421 \text{ N-m}$$

2. Given data

Regenerative Breaking



ckt diagram

Dc series motore

$V_s = 600V$

$R_a = 0.02\Omega$

$R_f = 0.03\Omega$

$K_v = 15.27$ mV/A rad/sec

$I_a = 250$ A

$d = 0.6$

a) Avg voltage accross the converter = ?

b) Power gen to the dc supply = ?

c) Eq. resistance of motore acts as a gen = ?

d) motor speed = ?

From the figure, it looks like a boost converter

a) V is the voltage accross the converter

$$\left\{ V_o = \frac{1}{1-d} V_{in} \right.$$

Here, $V_o = V_s$

$V_{in} = V$

$V = V_s(1-d)$

$= 600(1-0.6)$

$= 240$

b) Gen power $= E_g I_a$

$$E_g I_a = 252.5 \times 250$$

$$= 63.125 \text{ kW}$$

c) Eq. resistance $= \frac{V}{I_a} = \frac{240}{250} = 0.96\Omega$

d) Motor speed, $w_m \Rightarrow$

$$V = E_g - (I_a R_a + I_a R_{sc})$$

$$240 = E_g - 250(0.02 + 0.03)$$

$$E_g = 240 + 250(0.05).$$

$$E_g = 252.5V$$

$$\text{Speed} = \frac{E_g}{K}$$

$$K = K_b I_a = 15.27 \times 10^{-3} \times 250 \quad V\ rad/sec$$

$$= 3.817 \quad V/rad/sec$$

$$\text{Speed} = \frac{252.5 V}{3.817 \ V/rad/sec}$$

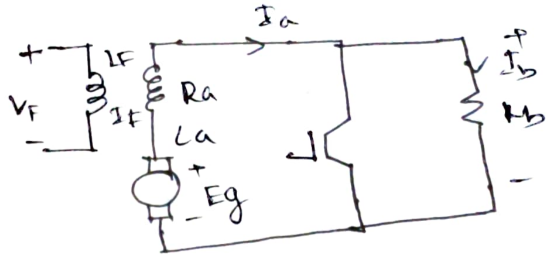
$$= 66.15 \text{ rad/sec}$$

$$= 631.68 \text{ rpm}$$

3. Given data

Rheostat Breaking

Dc seperately excited Motor



$R_a = 0.05\,\Omega$

$R_b = 5\,\Omega$

$K_v = 1.527$ V/A rad/sec

$I_F = 1.5$ A

$I_a = 150$ A

$d = 0.4$

$K = K_v I_F$

$= 1.527 \times 1.5$

$= 2.29$ V rad/sec

$I_b = I_a(1-d)$ as per boost converter topology

$i_b = 150(1-0.4)$

$= 90$ A

$V_b = i_b \times R_b$

$= 90 \times 5 = 450$ V

$V = 450(1-0.4)$

$= 270$ V

$E_g = V + I_a R_a$

$= 270 + (250 \times 0.05)$

$E_g = 282.5V$

a) Voltage acrross converter = 270V

b) Power dissipated in $R_b = i_b^2 R_b$

$= 90^2 \times 5$

$= 40.5 kW$

c) Eq. Resistance $= \frac{270}{150}$

$= 1.8 \Omega$

d) Motor speed ; $\omega_m = \frac{E_g}{k}$

$= \frac{282.5}{2.29}$

$= 123.36$ rad/sec

$= 1178.02$ rpm

4. Given data:

$V_{in} = 24V$

$f_s = 1KHz$

$d = ?$

Speed ⇒ 0 to 1 pu

load = 2 pu

Motor details:

1 hp ; 10V, 2500 rpm

$\eta = 78.5\%$, $R_a = 0.01\Omega$

$L_a = 0.002 H$

$K_b = 0.03019$ V rad/sec

chopper drop voltage = 1V

1st quadrant

Normalized values,

$V_b = 10V$ (Base)

V_n(normalized voltage) $= \frac{V_s}{V_b} = \frac{24-1}{10} = 2.5$ pu

$\omega_{m1} = \frac{2500 \times 2\pi}{60} = 261.79$ rad/sec

$I_{an} = \frac{O/P}{V_b \times \eta} = \frac{1 \times 746}{10 \times 0.785} = 95A = I_b$(base)

$$R_{au} = \frac{I_b R_a}{V_b} = \frac{95 \times 0.001}{10}$$

$$= 0.095 \, pu$$

$$T_{eq} = 2 \, pu$$

Duty cycle

$$\because \omega_m = \frac{d v}{k} - \frac{R}{k^2} T$$

Here, $K = 1 pu$

$$d = \frac{T_{eq} R_{au} + \omega_m}{V_n}$$

$$d_{min} = \frac{2 * 0.095 + 0}{2.3}$$

$$= 0.0826$$

$$d_{max} = \frac{2 \times 0.095 + 1}{2.3} = 0.517$$

So, Range of duty $\Rightarrow$ $0.0826 \le d \le 0.517$