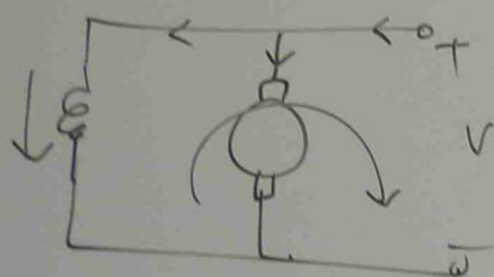
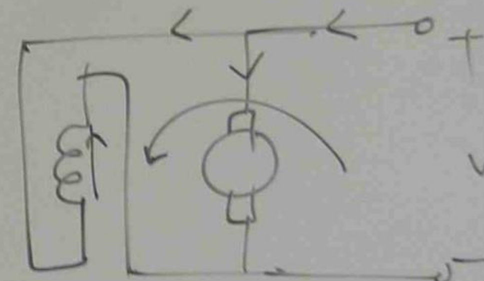
EFFECT OF CHANGING FLUX AND SPEED ON VOLTAGE

$$E_g \propto \phi N$$

$$\frac{E_{g1}}{E_{g2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$



DC MOTOR



BY CHANGING THE FIELD CONNECTION, MOTOR ROTATION DIRECTION CAN BE REVERSED.

pb MOTOR PARTICULARS → 3.75 KW, 230 V, 10 Amp, 1750 RPM

$R_a = 0.3\,\Omega$, BRUSH DROP = 2V ON LOAD.

CALCULATE (a) FULL LOAD TORQUE

(b) INITIAL RUSH OF ARMATURE CURRENT AND CORRESPONDING TORQUE AT THE INSTANT THE FIELD RESISTANCE IS INCREASING TO REDUCE THE FIELD FLUX TO 0.96 OF ORIGINAL VALUE

(c) FINAL ARMATURE CURRENT, SPEED AND POWER CONSUMPTION

(a)

$$\text{WATT} = \frac{2\pi N T}{60}$$

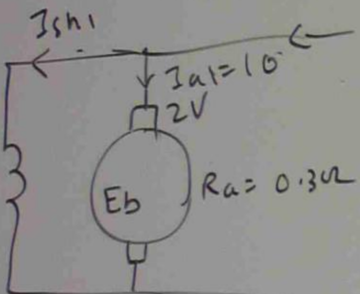
$$3.75\times10^3 = \frac{2\times3.1416\times1750\times T}{60}$$

$$T = \frac{3.75\times10^3\times60}{2\times3.1416\times1750} = 20.47\ \text{N-m}$$

(b)

$T = K\phi I_a$ motor torque

$$\frac{T_1}{T_2} = \frac{\phi_1 I_{a1}}{\phi_2 I_{a2}}$$



$$I_{FL} = \frac{\text{POWER}}{\text{VOLTAGE}}$$

$$= \frac{3750}{230}$$

$$= 16.3 \text{ Amp.}$$

$I_{sh_1} = 16.3 - 10 = 6.3$ Amp.

$$R_{BRUSH} = \frac{2V}{I_a} = \frac{2}{10} = 0.2\Omega$$

FIELD FLUX IS REDUCED

$$E_{b_1} = V - (I_a R_a + \text{BRUSH DROP})$$

$$= 230 - (10 \times 0.3 + 2)$$

$$= 225V$$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

$$\frac{225}{E_{b2}} = \frac{\phi_1 \times \cancel{N_1}}{0.96\phi_1 \times \cancel{N_2}}$$

$$E_{b2} = 0.96 \times 225$$

$$= 216V$$

$$E_{b2} = V - (I_{a2} R_a + \text{BRUSH DROP})$$

$$216 = 230 - (I_{a2} \times 3 + I_{a2} \times R_b)$$

$$216 = 230 - (I_{a2} \times 0.3 + I_{a2} \times 0.2)$$

$$0.5\, I_{a2} = 230 - 216 = 14$$

$$I_{a2} = \frac{14}{0.5} = 28 \text{ Amp.}$$

$$\frac{T_1}{T_2} = \frac{\phi_1 \, I_{a1}}{\phi_2 \, I_{a2}}$$

$$\frac{20.47}{T_2} = \frac{\phi_1}{0.96\phi_1} \times \frac{10}{28}$$

$$T_2 = \frac{20.47 \times 0.96 \times 28}{10}$$

$$= 55 \ N\text{-}m.$$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

$$\frac{225}{216} = \frac{\phi_1 \times 1750}{0.96\phi_1 \times N_2}$$

$$N_2 = \frac{216 \times 1750}{225 \times 0.96}$$

$$= 1750 \ RPM.$$

$$P = 2\pi N_2 T$$

$$= \frac{2 \times 3.1416 \times 1750 \times 55}{60}$$

$$= 10079 \ WATT$$

$$= 10.079 \ KW$$

7.46 KW, 230V, 1750 RPM SHUNT MOTOR.

ARMATURE RESISTANCE 0.35 Ω. SHUNT FIELD RESISTANCE 62.2 Ω.

(a) NO LOAD CURRENT IS 7.7 AMP. FULL LOAD EFFICIENCY 86 %. BRUSH DROP 3 VOLT AT FULL LOAD

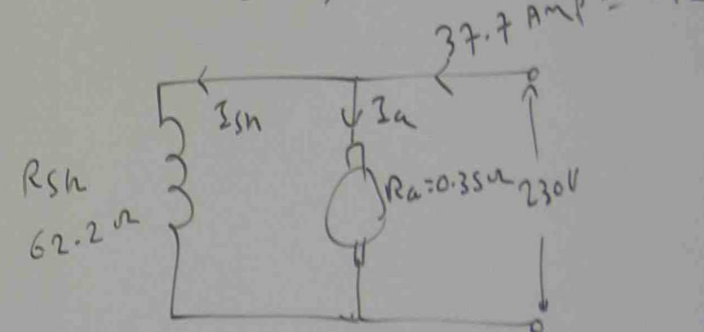
CALCULATE % REGULATION

) A 2.65 Ω RESISTANCE IS PLACED IN SERIES WITH ARMATURE CIRCUIT, CALCULATE NEW SPEED, % REGULATION, % POWER LOSS IN SERIES RESISTANCE IN RESPECT OF TOTAL POWER INPUT.

(a) $$I_{FL} = \frac{\text{OUTPUT POWER}}{\text{VOLTAGE} \times \text{EFFICIENCY}}$$

$$= \frac{7.46 \times 10^3}{230 \times 0.86}$$

$$= 37.7 \text{ Amp.}$$



$$I_{sh} = \frac{V}{R_{sh}} = \frac{230}{62.2} = 3.7 \text{ Amp.}$$

$$I_a = I_{FL} - I_{sh} = 37.7 - 3.7 = 34 \text{ Amp}$$

$N_{FL} = 1750\ RPM$ $\qquad I_{aFL} = 34\ Amp$

$N_{NL} = ?$ $\qquad I_{aNL} = I_{NL} - I_{sh\,NL}$

$= 7.7 - 3.7$

$= 4\ Amp.$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

$$\frac{V - (I_{aFL} \times R_a + BRUSH\ DROP)}{V - (I_{aNL} R_a + BRUSH\ DROP)} = \frac{\phi_1 N_1}{\phi_2 N_2} \qquad \phi_1 = \phi_2$$

$$\frac{230 - (34 \times 0.35 + 3)}{230 - (4 \times 0.35 + 3)} = \frac{\cancel{\phi_1} N_1}{\cancel{\phi_2} N_2}$$

$$\frac{215.1}{225.6} = \frac{1750}{N_2}$$

$$N_2 = 1750 \times \frac{225.6}{215.1} = 1850\ RPM$$

$N_2 \Updownarrow N_{NL}$

$$\%\ SPEED\ REGULATION = \frac{N_{NL} - N_{FL}}{N_{FL}} \times 100$$

$$= \frac{1850 - 1750}{1750} \times 100$$

$$= 5.7\%$$

(b)

$$E_{b_3} = V - (I_a R_a + \text{BRUSH DROP})$$

$$= 230 - [34(0.35 + 2.65) + 3]$$

$$= 125\,V$$

$$\frac{E_{b2}}{E_{b3}} = \frac{\cancel{\phi_2} N_2}{\cancel{\phi_3} N_3}$$

$$\frac{225.6}{125} = \frac{1850}{N_3}$$

$$N_3 = \frac{1850 \times 125}{225}$$

$$= 1020\,RPM$$

$$\%\,REG = \frac{N_{NL} - N_3}{N_3} \times 100$$

$$= \frac{1850 - 1020}{1020} \times 100$$

$$= 81.3\%$$

$$2.65\Omega \text{ power loss} = I_a^2 \times 2.65$$

$$= 34^2 \times 2.65 = 3060\,W$$

$$\%\text{ of power input} = \frac{3060}{V_T \times I_{FL}} \times 100$$

$$= \frac{3060}{230 \times 37.7} \times 100 = 39.2\%$$

7.46 KW, 230V, 1750 RPM SHUNT MOTOR.

ARMATURE RESISTANCE 0.35Ω. SHUNT FIELD RESISTANCE 62.2Ω.

a) NO LOAD CURRENT IS 7.7 AMP. FULL LOAD EFFICIENCY 86%. BRUSH DROP 3 VOLT AT FULL LOAD

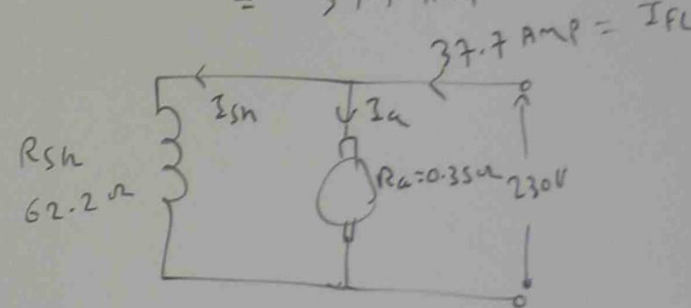
CALCULATE % REGULATION

) A 2.65Ω RESISTANCE IS PLACED IN SERIES WITH ARMATURE CIRCUIT, CALCULATE NEW SPEED, % REGULATION, % POWER LOSS IN SERIES RESISTANCE IN RESPECT OF TOTAL POWER INPUT.

(a) $$I_{FL} = \frac{\text{OUTPUT POWER}}{\text{VOLTAGE} \times \text{EFFICIENCY}}$$

$$= \frac{7.46 \times 10^3}{230 \times 0.86}$$

$$= 37.7 \text{ Amp.}$$



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$$I_a = I_{FL} - I_{sh} = 37.7 - 3.7 = 34 \text{ Amp}$$

$N_{FL} = 1750\,RPM$ $\quad I_{aFL} = 34\,Amp$

$N_{NL} = ?$ $\quad I_{aNL} = I_{NL} - I_{sh\,NL}$

$= 7.7 - 3.7$

$= 4\,Amp.$

$$\frac{E_{b1}}{E_{b2}} = \frac{\phi_1 N_1}{\phi_2 N_2}$$

$$\frac{V - (I_{aFL} \times R_a + \text{BRUSH DROP})}{V - (I_{aNL} R_a + \text{BRUSH DROP})} = \frac{\phi_1 N_1}{\phi_2 N_2} \qquad \phi_1 = \phi_2$$

$$\frac{230 - (34 \times 0.35 + 3)}{230 - (4 \times 0.35 + 3)} = \frac{\cancel{\phi_1} N_1}{\cancel{\phi_2} N_2}$$

$$\frac{215.1}{225.6} = \frac{1750}{N_2}$$

$$N_2 = \frac{1750 \times 225.6}{215.1} = 1850\,RPM$$

N_{NL}

$$\%\text{ SPEED REGULATION} = \frac{N_{NL} - N_{FL}}{N_{FL}} \times 100$$

$$= \frac{1850 - 1750}{1750} \times 100$$

$$= 5.7\%$$

Amp

(b)

$$E_{b_3} = V - (I_a R_a + \text{BRUSH DROP})$$

$$= 230 - [34(0.35 + 2.65) + 3]$$

$$= 125\,V$$

$$\frac{E_{b2}}{E_{b3}} = \frac{\cancel{\phi_2} N_2}{\cancel{\phi_3} N_3}$$

$$\frac{225.6}{125} = \frac{1350}{N_3}$$

$$N_3 = \frac{1350 \times 125}{225}$$

$$= 1020\,RPM$$

$$\%\,REG = \frac{N_{NL} - N_3}{N_3} \times 100$$

$$= \frac{1350 - 1020}{1020} \times 100$$

$$= 61.3\%$$

$$2.65\,\Omega \text{ power loss} = I_a^2 \times 2.65$$

$$= 34^2 \times 2.65 = 3060\,W$$

$$\%\text{ of power input} = \frac{3060}{V_T \times I_{FL}} \times 100$$

$$= \frac{3060}{230 \times 37.7} \times 100 = 37.2\%$$