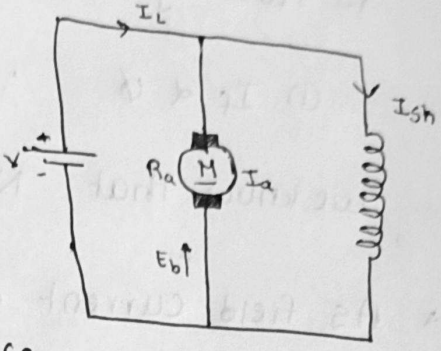
Unit-6 :- Speed control of DC shunt motor

$$E_b = \frac{ZN\phi P}{60A}$$

$E_b \propto N\phi$

$$N \propto \frac{E_b}{\phi} = \frac{V - I_aR_a}{\phi}$$



If the armature resistance is very small, then $N \approx \frac{V}{\phi}$

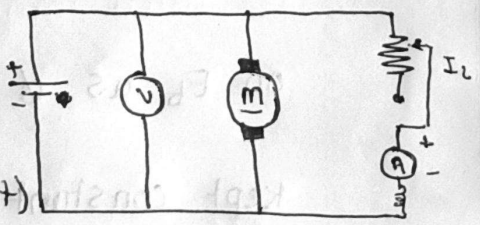
$\therefore N \propto \frac{E_b}{\phi} \approx \frac{V}{\phi}$

* $V - I_aR_a - E_b = 0$
* $E_b = V - I_aR_a$

* If flux decreases speed increases and vice versa you can control the speed by varying flux or by changing voltage at armature {field / flux control method}
* we can also control speed by controlling voltage at armature - {Armature voltage control method (or) voltage control}

a) Field control method (or) Flux control :-

* As we Initially rheostat is kept at minimum, so the actual current I_f (field current) passes through field winding



As there is no resistance. As we increase

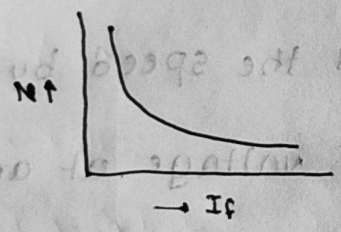
the value of rheostat increase the current that is flowing through rheostat decreases.

(i) $I_f \propto \phi$ ∵ flux also decreases

we know that $N \propto \frac{1}{\phi}$

* As field current decrease, flux also decreases. As flux decreases speed of DC shunt motor increases. { As rheostat ↑ → speed ↑

* This method is used for above rated speed

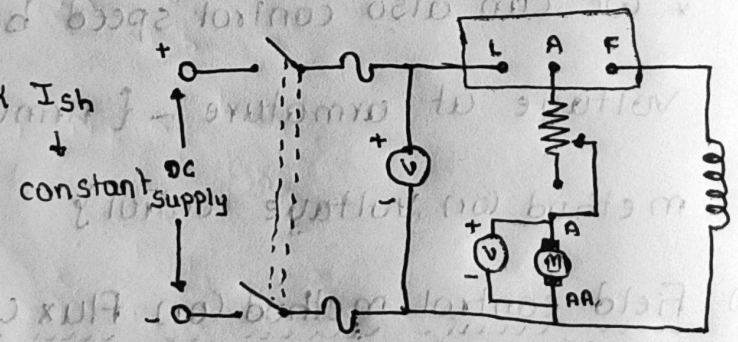


b) Armature voltage control method:-

$N \propto \frac{E_b}{\phi} \propto I_{sh}$

↓

constant



In this method speed of motor only depends on E_b as ϕ is constant field winding is kept constant.

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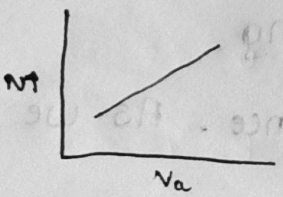


* So if E_b changes speed also changes
* fastly if we keep rheostat at minimum supply voltage is equal to voltage measured at motor.
* If we increase the rheostat then the voltage measured at motor seen in voltage decreases i.e if rheostat increase voltage decreases in armature motor (E_b) By using rheostat E_b can be change and $E_b \propto N$.
* This method is used for below rated speed.
* A 250 V Dc shunt motor has a shunt field resistance of 200Ω. and armature resistance of 0.3Ω. For a given load, motor runs at 1500 RPM drawing a current of 22A from the supply. If the resistance of 150Ω is added in series with field winding, finding the new armature current and the speed. Assume the load torque is constant and magnitization curve is linear.

A $V = 250\Omega$

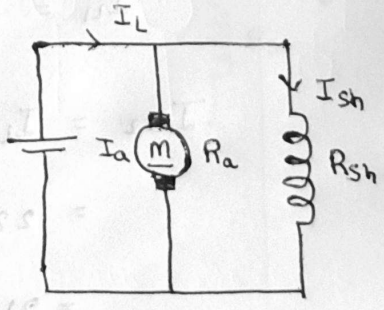
$R_{sh} = 200\Omega$

$R_a = 0.3\Omega$

$N_1 = 1500$ RPM

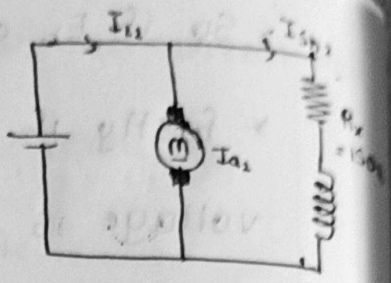
$I_L = 22A$

$R_x = 150\Omega$



case (i)

$$I_{sh1} = \frac{V}{R_{sh1}} = \frac{250}{200} = 1.25A$$



$I_L = 22A$

$I_{a1} = I_{L1} - I_{sh1} = 22 - 1.25$

$= 20.75A$

$E_{b1} = V - I_{a1} R_{a1}$

$= 250 - (20.75)(0.3)$

$= 243.77V$

$$I_{sh2} = \frac{V}{R_{sh} + R_x} = \frac{250}{200+150} = \frac{250}{350} = 0.71A$$

$T \propto \phi I_a$

$\phi \propto I_{sh}$

$\therefore T \propto I_a I_{sh}$

$$N \propto \frac{E_b}{\phi} \; ; \; N \propto \frac{E_b}{I_{sh}}$$

$$N_1 \propto \frac{E_b}{I_{sh1}} \; ; \; N_2 \propto \frac{E_{b2}}{I_{sh2}}$$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b2}} \times \frac{I_{sh1}}{I_{sh2}}$$

As load torque is constant

$I_{L1} = I_{L2} = 22A$

$I_{a2} = I_{L2} - I_{sh2}$

$= 22 - 0.71$

$= 21.28$

$E_{b2} = 250 - 21.98(0.3)$

$= 243.616\ V$

$$N_2 = N_1 \left[\frac{E_{b2}}{E_{b1}}\right]\left[\frac{I_{sh_1}}{I_{sh_2}}\right]$$

$$= 1500\left[\frac{243.616}{243.77}\right]\left[\frac{1.25}{0.71}\right]$$

$= 2640\ RPM$

Q. A 250V 10HP Dc shunt motor with R_a is 0.4Ω and R_{sh} is 100Ω, runs at 1000 RPM on full load efficiency on full load is 80%. if the speed is to be raised 1400 RPM keeping load as constant, Determine the extra resistance to be added in field circuit. Assume 1 HP is 735.5 W.

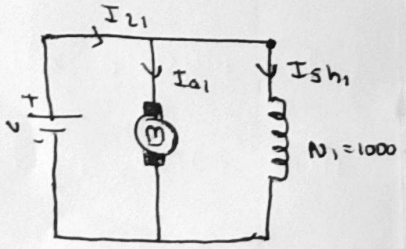
A 10 HP,

$= 10 \times 735.5$

$= 7355\ W$

Efficiency = 85%.

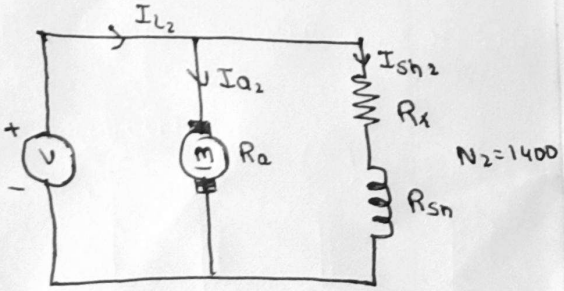
$= 0.85$



$R_a = 0.4\Omega$

$R_{sh} = 100\Omega$

$N_1 = 1000\ RPM$



$P = VI_L$

$I_L = P/V = 7355$

$$\text{Efficiency} = \frac{O/P}{I/P} = 0.85$$

$$I/p = \frac{o/p}{0.85} = \frac{7355}{0.85} = 8652.94$$

$$VI_L = 8652.94$$

$$I_{L1} = \frac{8652.9}{250} = \underline{\underline{34.61A}}$$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}\left(\frac{I_{Sh1}}{I_{Sh2}}\right)$$

* $I_{Sh1} = \frac{V}{R_{Sh}} = \frac{250}{100} = 2.5A.$