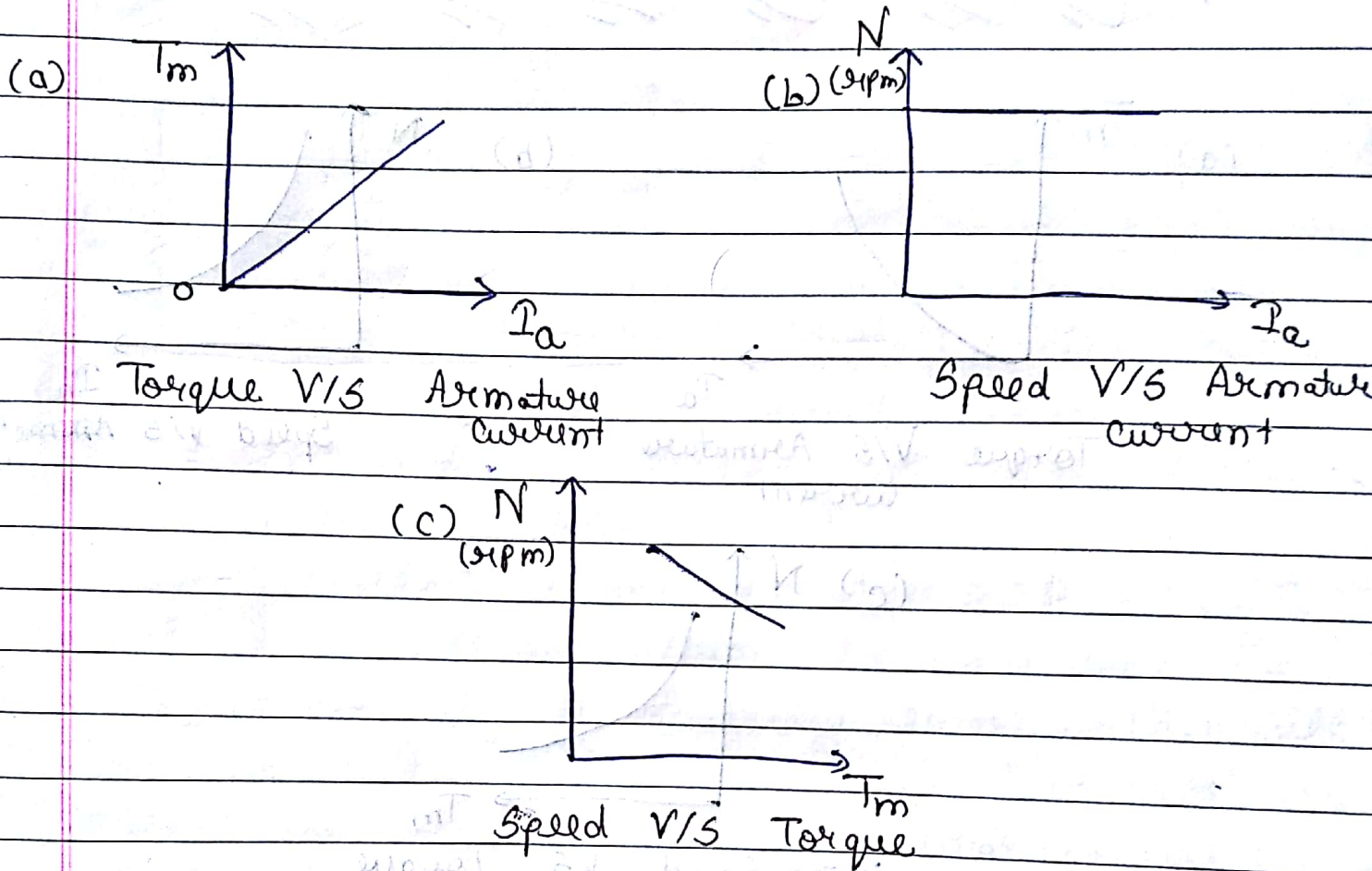


# For a shunt-wound DC motor -



From (6) & (7)

$$\omega_m T_m = E_b I_a$$

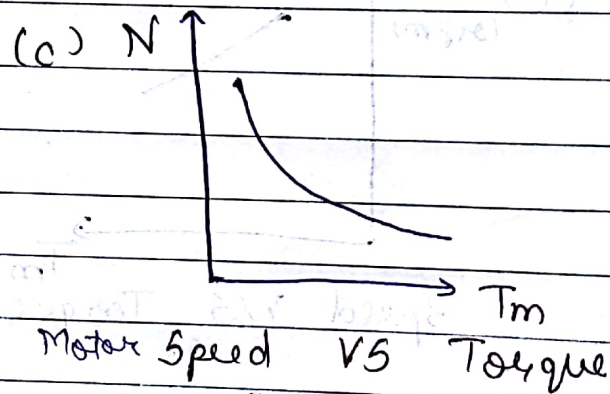
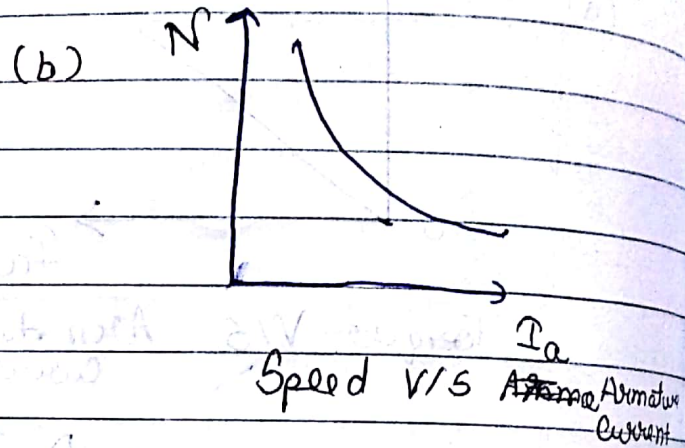
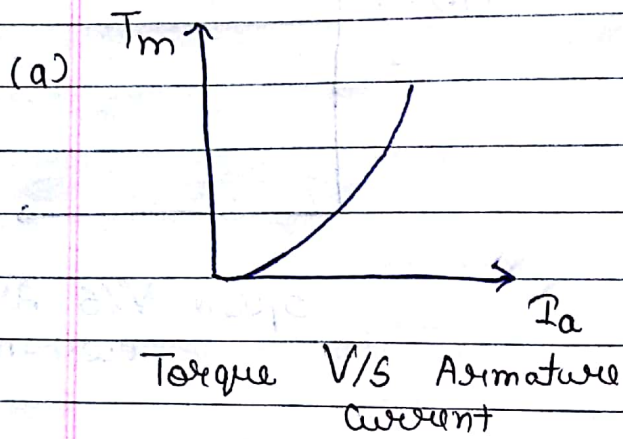
$$\Rightarrow T_m = \frac{E_b I_a}{\omega_m} = \frac{E_b I_a}{2\pi N} \times 60$$

$$\& E_b = \frac{\phi ZNP}{60 \times A}$$

Speed Regulation  $\rightarrow$

$$= \frac{(\text{No-load speed} - \text{Full-load speed})}{\text{Full-load speed}}$$

# For a series-wound DC motor :-



$$\phi \propto I_f \Rightarrow \phi \propto I_a$$

$$E_b = \frac{\phi ZNP}{60A} \quad [\Rightarrow E_b \propto I_a]$$

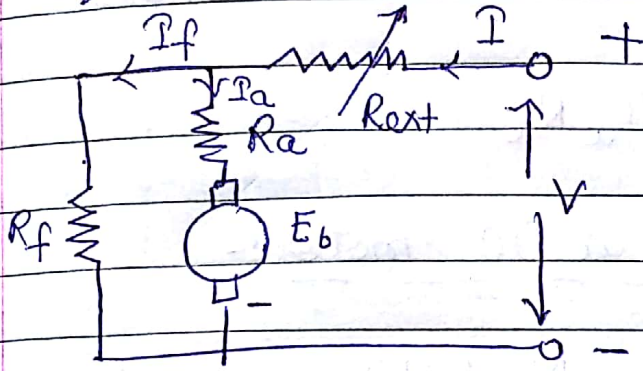
$$\omega_m T_m = E_b I_a$$

$$T_m \propto \frac{E_b I_a}{\omega_m}$$

$$T_m \propto I_a^2$$



\* The need for starter in a DC motor :-



When we apply an external Voltage 'V' to the motor, initially the motor speed  $N=0$ .

$$\text{Hence } E_b = \frac{\phi Z N P}{60 A} = 0$$

Hence, the armature current  $I_a = \frac{V - E_b}{R_a}$  is quite large (since the armature resistance  $R_a$  is generally small). This will damage the motor. We use "starter" to avoid this problem. Starter is nothing but a variable resistor  $R_{ext}$  put in series with the motor. Initially, we make  $R_{ext}$  quite high. As motor starts picking speed, we generally reduce  $R_{ext}$  and make it almost zero by the time the motor has picked up the full-speed.

# Speed Control →

$$\text{Speed } (N) \propto \frac{E_b}{\phi}$$

(i) By changing  $\phi$  :

(Field or flux control method)

$$\phi \propto I_f$$

$$\Rightarrow \phi = K I_f$$

[K → constant of prop.]

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(ii) By change  $E_b$  :  
(Armature control method)

$$E_b = V - I_a R_a$$

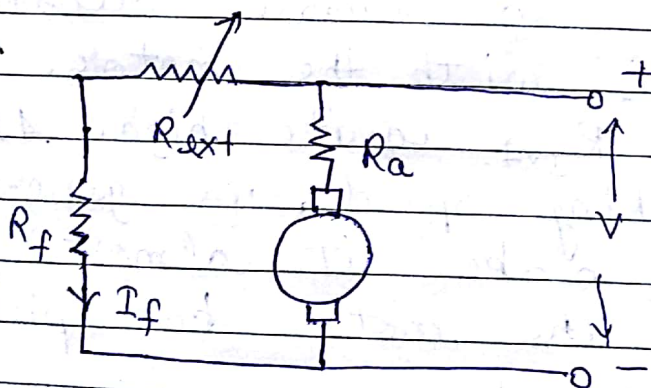
# Speed control of a DC motor:-

$$\text{Since, } N \propto \frac{E_b}{\phi} \quad \text{--- (1)}$$

We can change  $N$  by "Armature control" method or "Field Control" method.  
(flux)

(a) Shunt Wound motor  $\Rightarrow$

(i) Flux Control method  $\rightarrow$



$I_f$  changes with  $R_{ext}$ .

& Since  $\phi \propto I_f$

$\therefore \phi$  changes with  $R_{ext}$ .

Field current ( $I_f$ ) is given by -

$$I_f = \frac{V}{R_f + R_{ext}} \quad \text{--- (2)}$$

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# Flux & Armature Control Methods → Principal methods

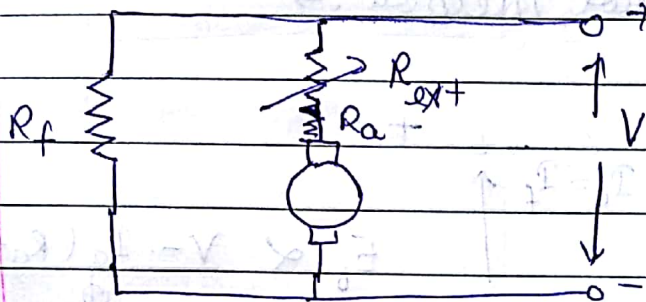
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$$\phi = K I_f \quad \text{--- (2)}$$

$$\therefore N \propto \frac{1}{\phi} \Rightarrow N \propto \frac{1}{I_f} \Rightarrow N \propto R_{ext.}$$

(ii) Armature Control method :-



$$N \propto \frac{V - I_a R_a}{\phi} \quad \text{--- (3)}$$

$$N \propto \frac{V - I_a (R_a + R_{ext})}{\phi} \quad \text{--- (4)}$$

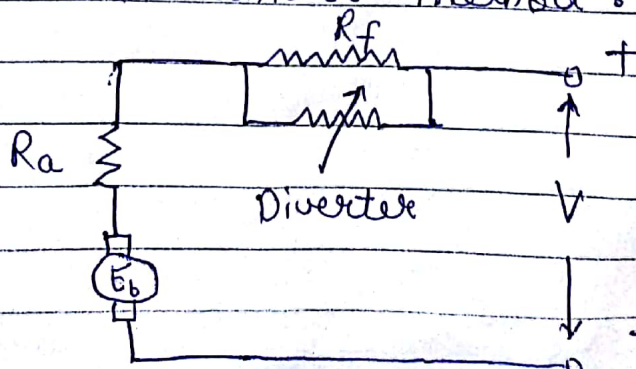
$\phi \rightarrow \text{Constant}$

(iii) Voltage Control method :-

external Voltage is not provided to control  $I_f$ .

(b) Series-Wound DC motor  $\Rightarrow$

(i) Flux-Control method :-



Diverter  $\rightarrow R_{ext}$

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

Diverter can ~~be~~ have varied resistance per  
"continuous control" or "tapped-control"  
(Discrete values)

(ii) Armature Control method :->

