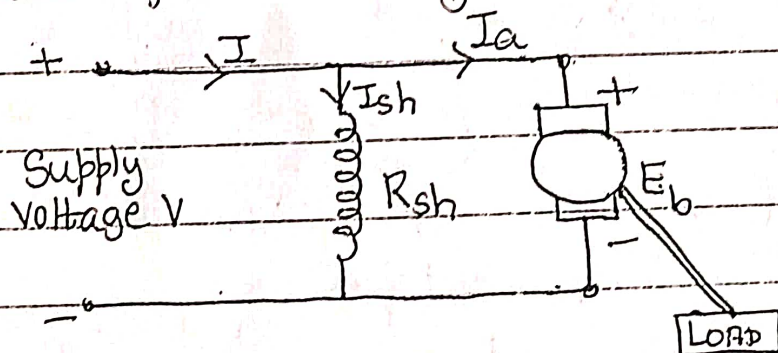


Types of DC Motors

- 1) DC series motor
- 2) DC shunt motor
- 3) Compound motors
- 4) separately excited dc motors

DC Shunt Motor

→ armature & field winding are connected in parallel



→ R_{sh} is always higher than that of R_a . No. of turns for the field winding is more than that of armature winding. The cross-sectional area of the wire used for the field

winding is smaller than that of the wire used for the armature winding.

$$\rightarrow I = I_a + I_{sh}$$

$$I_{sh} = \frac{V}{R_{sh}}$$

$$\rightarrow V = E_b + I_a R_a + V_{brush}$$

neglecting the drop across brushes

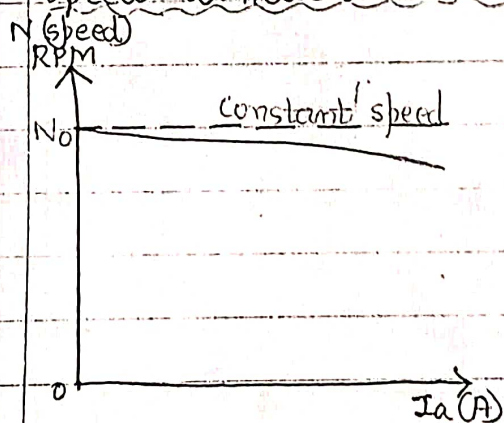
$$V = E_b + I_a R_a$$

\rightarrow Field current I_{sh} remains essentially constant. Hence flux produced also remains constant

$$\therefore \phi \propto I_{sh}$$

Shunt motor is also called as constant flux motors.

(i) Speed armature current characteristics:



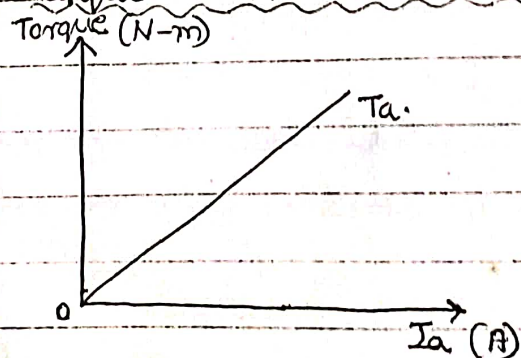
$$E_b = \frac{P \phi N Z}{60 A}$$

$$\therefore N = \frac{60 A E_b}{P \phi Z} = K \frac{E_b}{\phi} \quad (K = \text{const})$$

$$N \propto \frac{E_b}{\phi} \propto \frac{V - I_a R_a}{\phi}$$

as ϕ is const $N \propto (V - I_a R_a)$
with increase in load, I_a increases
and speed N decreases

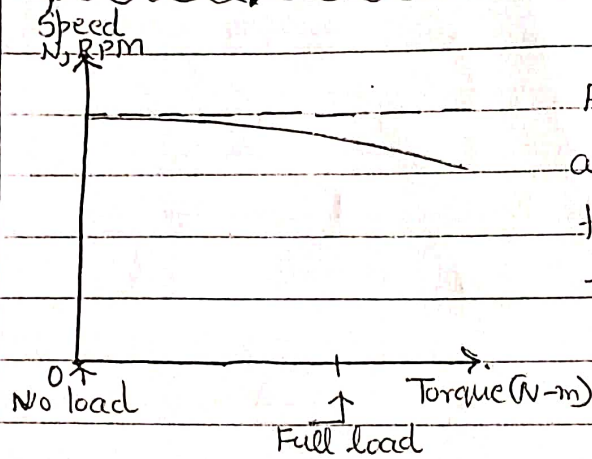
(ii) Torque - armature current characteristics



$$T \propto I_a$$

As the motor increases, I_a increases proportionally & the torque produced by the motor also increases linearly.

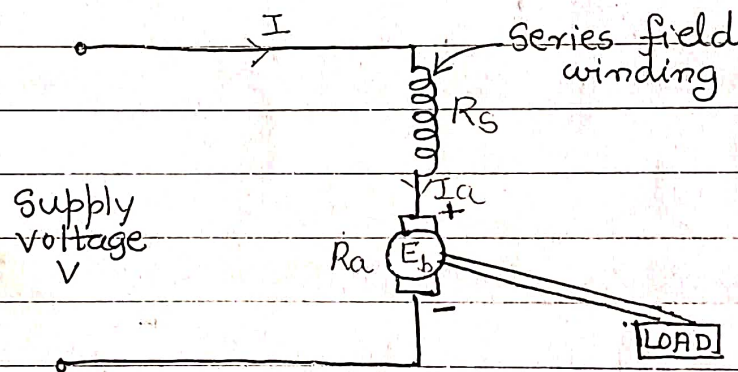
(ii) Speed - Torque characteristics



As torque is proportional to the armature current, the nature of this characteristics is same as that of the speed - armature current characteristics.

DC Series Motor:

→ armature & field windings are connected in series with each other.



→ R_s is much smaller as compared to R_a .

→ $I = I_s = I_a$

→ $V = E_b + I_a R_a + I_a R_s + \text{Brush drop}$

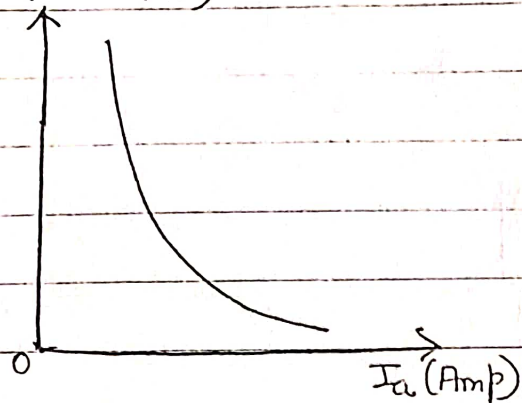
neglecting brush drop we get

$$V = E_b + I_a (R_a + R_s)$$

→ Flux is proportional to the field current,
But since field is same as armature current
 $\therefore \phi \propto I_a$

(i) Speed - armature current characteristics

Speed N (RPM)



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

$$E_b = V - I_a(R_a + R_s) \quad \& \quad \phi \propto I_a$$

$$\therefore N \propto \frac{V - I_a(R_a + R_s)}{K I_a}$$

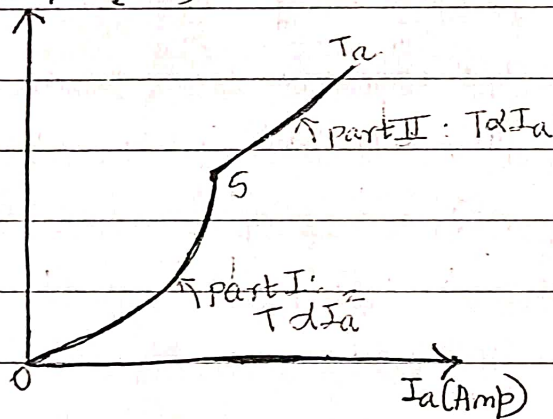
Since R_a & R_s are small and

$$E_b = V = \text{constant}$$

$$N \propto \frac{1}{I_a}$$

(ii) Torque - armature current characteristics

Torque (N-m)



$$T \propto \phi I_a$$

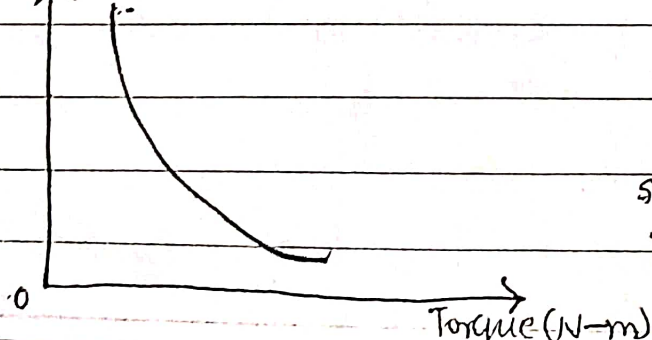
$$\text{But } \phi \propto I_a \quad \therefore T \propto I_a^2$$

Part I: Torque is proportional to the square of armature current.

Part II: At point S, saturation of the field electromagnet may occur. There is no change in flux even there is a change in field current. Hence torque produced is directly proportional to the armature current.

(iii) Speed - Torque characteristics

Speed N (RPM)



$$T \propto I_a^2 \quad \text{and} \quad N \propto \frac{1}{I_a}$$

$$I_a \propto \sqrt{T} \quad \therefore N \propto \frac{1}{\sqrt{T}}$$

speed decreases with increase in the value of torque.

DC Motor Applications:

Shunt Motor

→ A constant speed motor having its starting torque 30% to 40% more than its rated torque.

→ Such a motor can be used for.

- (i) machine tools such as lathe machines, drilling machines, milling machines.
- (ii) printing machinery.
- (iii) paper machines.
- (iv) centrifugal & reciprocating pumps.
- (v) blowers & fans.

Series Motor

→ develops a very high starting torque and it has adjustable varying speed. Therefore, for any load which needs high starting torque, series motor is the only suitable drive.

- (i) used for electric trains
- (ii) diesel-electric locomotives
- (iii) cranes
- (iv) hoists
- (v) trolley cars & trolley buses
- (vi) rapid transit systems.
- (vii) conveyors etc.