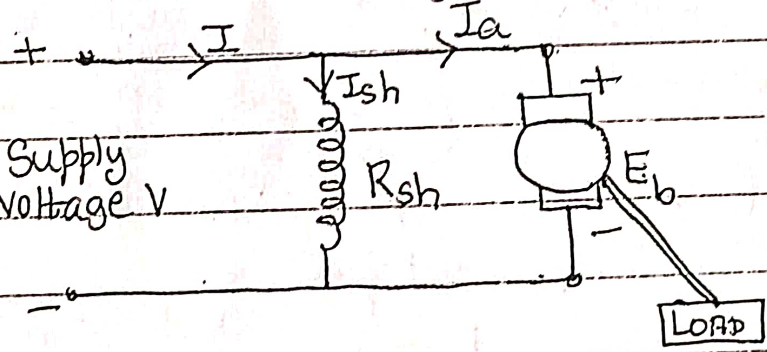
Types of DC Motors

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.

→ $I = I_a + I_{sh}$

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

→ $V = E_b + I_a R_a + V_{Brush}$

neglecting the drop across brushes

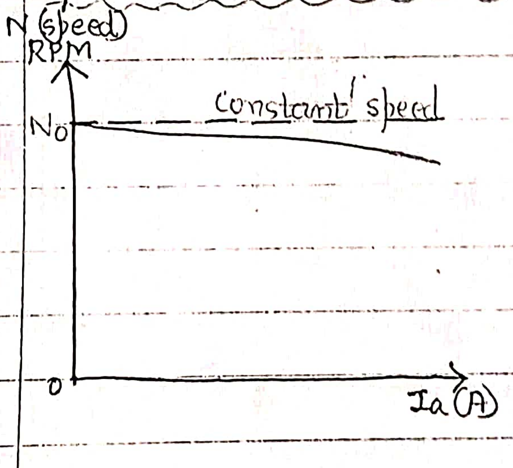
$V = E_b + I_a R_a$

→ 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:



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

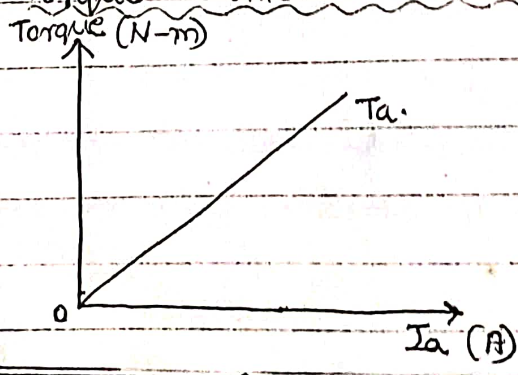
$\therefore N = \frac{60A\,E_b}{P\phi Z} = K\frac{E_b}{\phi}$ (K = const)

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

as ϕ is const $N \propto (V - I_a R_a)$

with increase in load, I_a increases and speed N decreases.

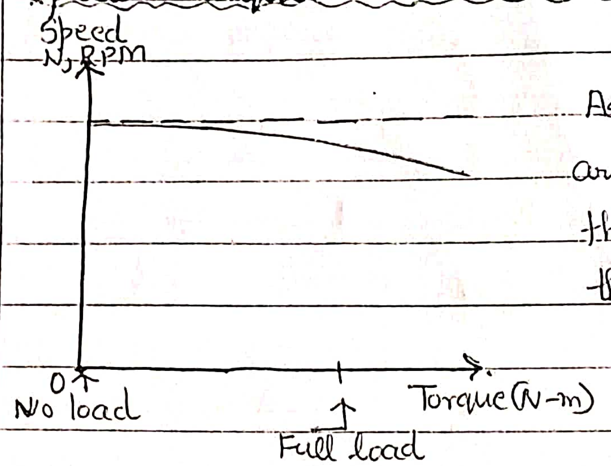
(ii) Torque - armature current characteristics.



$T \propto I_a$

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

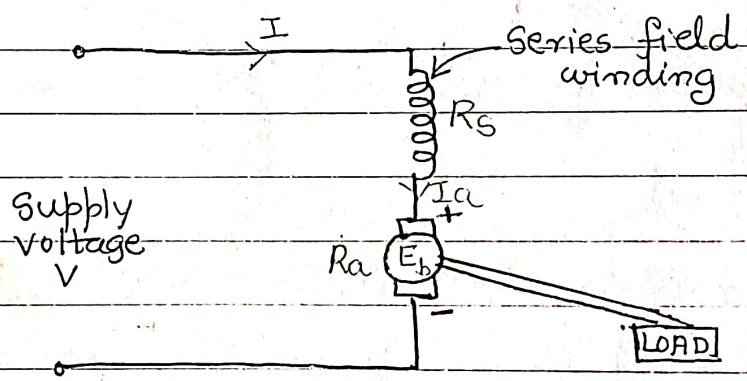
(iii) Speed - Torque characteristics



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.

→ $I = I_S = I_a$

→ $V = E_b + I_aR_a + I_aR_S +$ Brush drop.

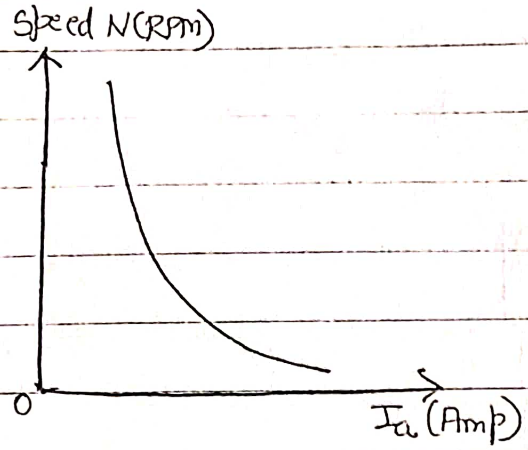
neglecting brush drop we get

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

→ 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



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

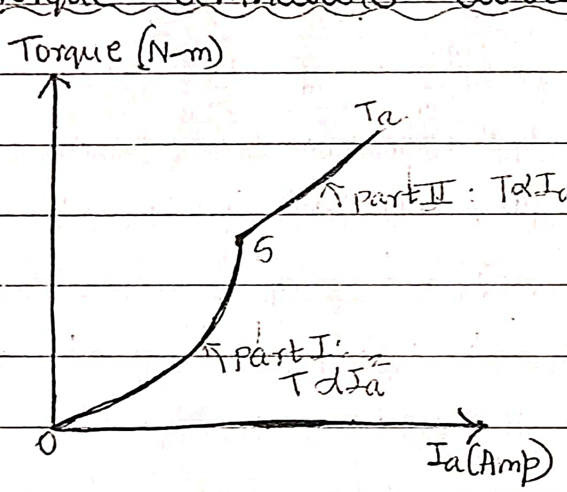
$E_b = V - I_a(R_a + R_s)$ & $\phi \propto I_a$.

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

Since R_a & R_s are small and
$E_b = V =$ constant

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

(ii) Torque – armature current characteristics



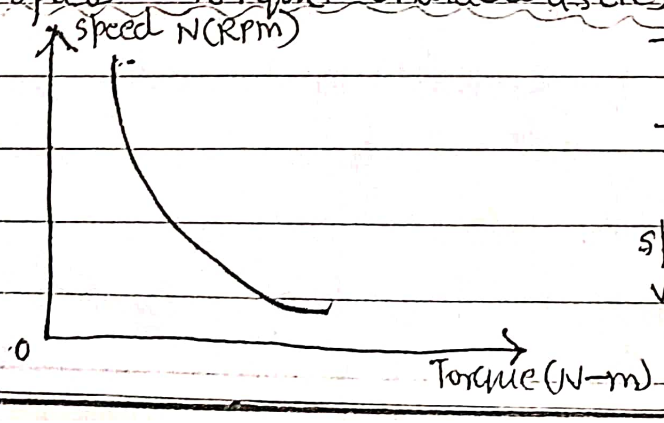
$$T \propto \phi I_a$$

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



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

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

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) conveyers etc.