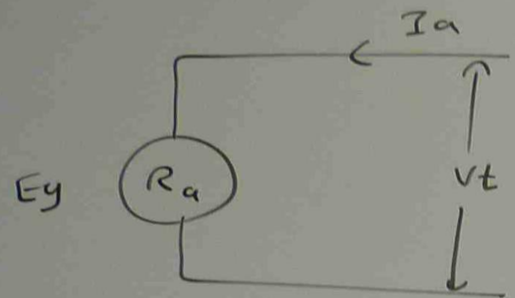
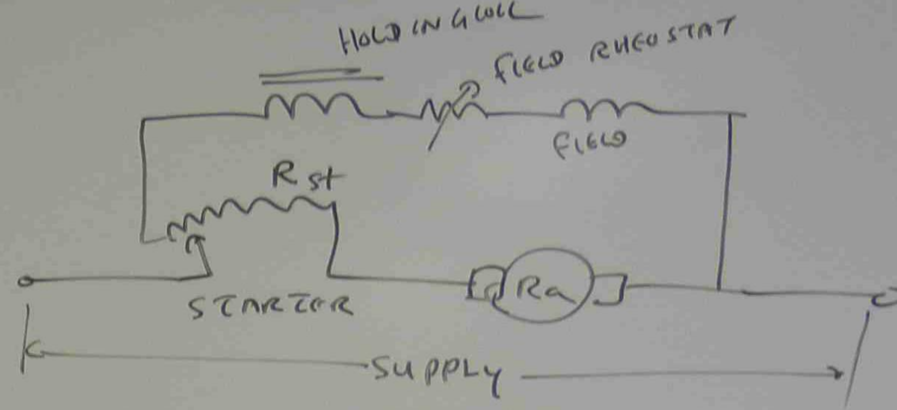
DC MOTOR STARTERS

CIRCUIT ANALYSIS



$$E_g = V_t - I_a R_a$$

$$I_a = \frac{V_t - E_g}{R_a}$$



$$I_a = \frac{V_t - E_g}{R_a + R_{st}}$$

$$E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$$

E_g = BACK EMF
ϕ = FLUX
Z = ARMATURE CONDUCTORS
N = SPEED
P = NO. OF POLES
a = NO. OF ARMATURE PARALLEL PATHS.

AT STARTING TIME, N IS SMALL AS IT STARTS FROM ZERO SPEED.

ACCORDING TO $E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$, E_g IS SMALL.

STARTING CURRENT $I_a = \frac{V_t - E_g}{R_a}$ IS LARGE.

LARGE STARTING CURRENT NEEDS TO BE LIMITED BY STARTING RESISTOR.

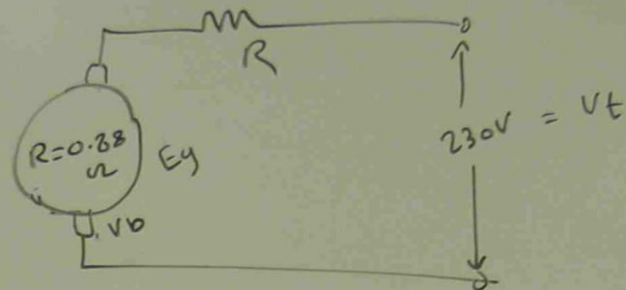
---

pb THE ARMATURE OF A 230V SHUNT MOTOR HAS A RESISTANCE OF $0.88\,\Omega$ AND TAKES 28.2 AMP AT FULL LOAD.

(a) IF I_a IS NOT TO EXCEED 150% OF NORMAL FULL LOAD CURRENT AT STARTING, CALCULATE STARTING RESISTANCE

(b) DETERMINE I_a IF NO STARTING RESISTANCE IS INSERTED. ASSUME BRUSH DROP 3V.

EED.



(a)

$$I_{st} = \frac{V_t - (E_g + V_b)}{R_a + R}$$

$$\frac{150}{100} \times 28.2 = \frac{230 - (0+3)}{0.88 + R}$$

$$0.88 + R = \frac{227 \times 100}{150 \times 28.2}$$

$$R = \frac{227 \times 100}{150 \times 28.2} - 0.88 = 4.55\,\Omega$$

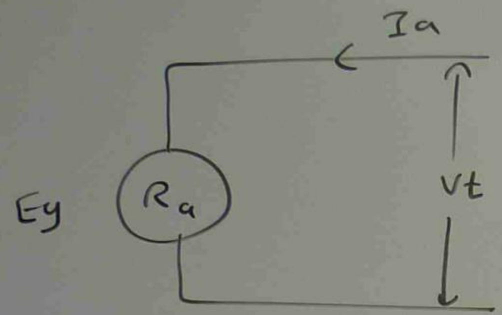
(b)

$$I_{st} = \frac{V_t - (E_g + V_b)}{R_a} = \frac{230 - (0+3)}{0.88} = \frac{227}{0.88}$$

$$= 277 \text{ Amp.}$$

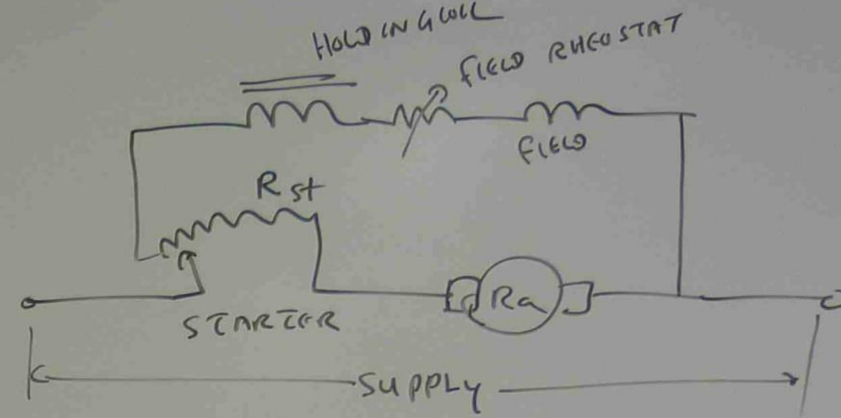
DC MOTOR STARTERS

CIRCUIT ANALYSIS



$$E_g = V_t - I_a R_a$$

$$I_a = \frac{V_t - E_g}{R_a}$$



$$I_a = \frac{V_t - E_g}{R_a + R_{st}}$$

$$E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$$

E_g = BACK EMF

ϕ = FLUX

Z = ARMATURE CONDUCTORS

N = SPEED

P = NO. OF POLES

a = NO. OF ARMATURE PARALLEL PATHS.

AT STARTING TIME, N IS SMALL AS IT STARTS FROM ZERO SPEED.

ACCORDING TO $E_g = \frac{\phi Z N}{60} \times \frac{P}{a}$, E_g IS SMALL.

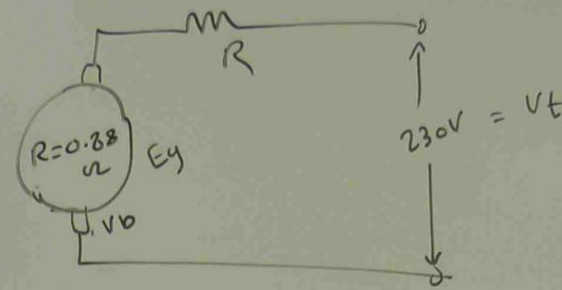
STARTING CURRENT $I_a = \frac{V_t - E_g}{R_a}$ IS LARGE.

LARGE STARTING CURRENT NEEDS TO BE LIMITED BY STARTING RESISTOR.

pb THE ARMATURE OF A 230V SHUNT MOTOR HAS A RESISTANCE OF 0.33 Ω AND TAKES 28.2 AMP AT FULL LOAD.

(a) IF I_a IS NOT TO EXCEED 150% OF NORMAL FULL LOAD CURRENT AT STARTING, CALCULATE STARTING RESISTANCE

(b) DETERMINE I_a IF NO STARTING RESISTANCE IS INSERTED. ASSUME BRUSH DROP 3V.



(a)

$$I_{st} = \frac{V_t - (E_g + V_b)}{R_a + R}$$

$$\frac{150}{100} \times 28.2 = \frac{230 - (0+3)}{0.88 + R}$$

$$0.88 + R = \frac{227 \times 100}{150 \times 28.2}$$

$$R = \frac{227 \times 100}{150 \times 28.2} - 0.88 = 4.55\,\Omega$$

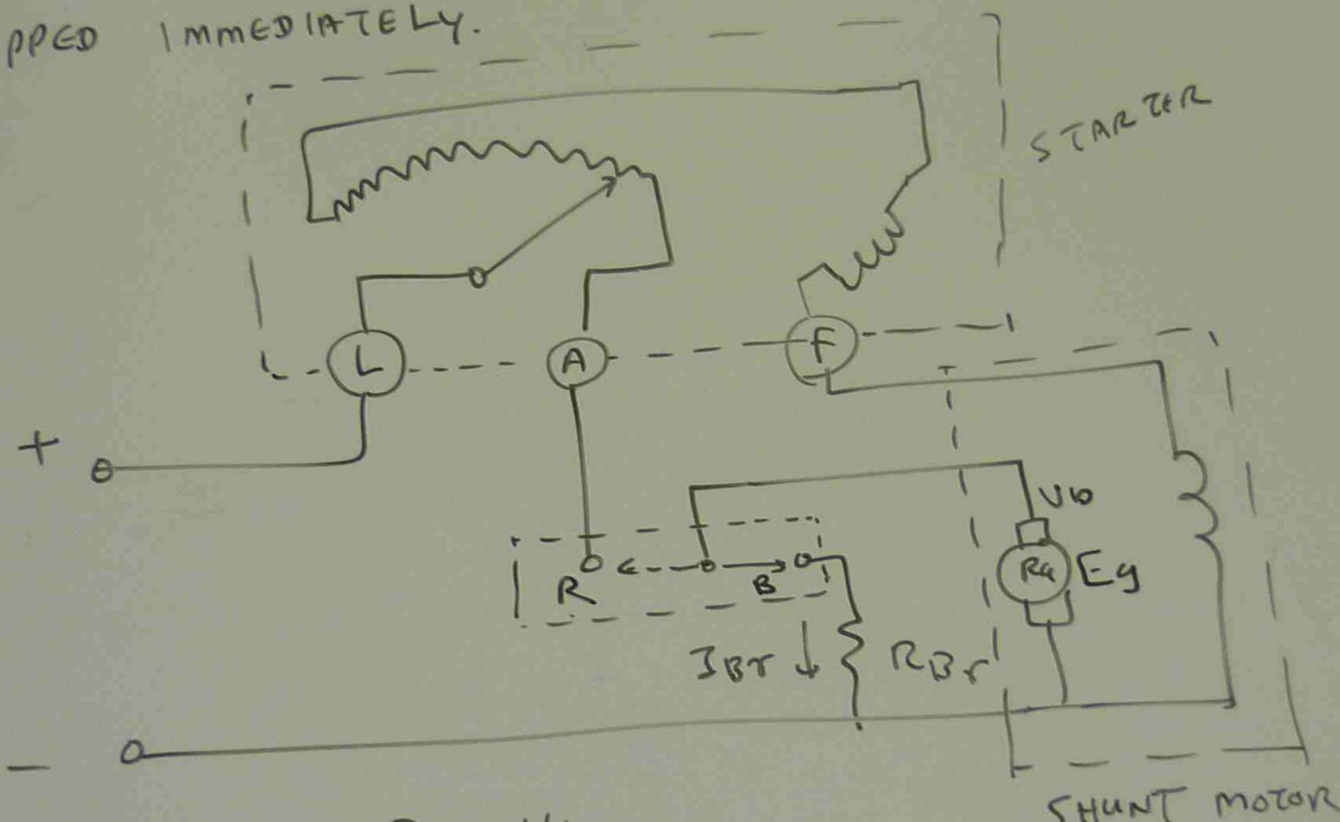
(b)

$$I_{st} = \frac{V_t - (E_g + V_b)}{R_a} = \frac{230 - (0+3)}{0.88} = \frac{227}{0.88}$$

$$= 257 \text{ Amp.}$$

DYNAMIC BRAKING

WHEN THE STOP SWITCH IS PRESSED, THE ENERGY STORED IN MOTOR ARMATURE IS DISSIPATED IN DYNAMIC BRAKING RESISTOR. THEREFORE, THE MOTOR IS STOPPED IMMEDIATELY.



$$I_{br} = \frac{E_g - V_b}{R_{br} + R_a}$$

pb THE BRAKING CURRENT OF A 12.5 KW 230V 58 Amp MOTOR SERIES WOUND, TOTAL ARMATURE AND FIELD RESISTANCE 0.28 Ω IS TO BE LIMITED TO 1.75 TIMES MOTOR FULL LOAD RATING. CALCULATE THE VALUE OF THE DYNAMIC BRAKING RESISTOR. ASSUME Eg IS 94% OF RATED VOLTAGE AND BRUSH DROP IS 3V.

$I_{br} = 1.75\, I_{FL} = 1.75 \times 58$

$E_g = 0.94 \times 230$ ✓

$R_a = 0.28\,\Omega$ $\quad V_b = 3V$

$R_{br} = ?$

$$I_{br} = \frac{E_g - V_b}{R_{br} + R_a}$$

$$R_{br} + R_a = \frac{E_g - V_b}{I_{br}}$$

$$R_{br} = \frac{E_g - V_b}{I_{br}} - R_a$$

$$= \frac{0.94 \times 230 - 3}{1.75 \times 58} - 0.28$$

$$= 1.82\,\Omega$$

ACCELERATION TIME CONSIDERATION

$$t = \frac{\Delta N \ (2\pi I)}{60\,T} \quad \underline{\underline{sec}}$$

t = TIME (sec)

ΔN = CHANGE IN SPEED (RPM)

I = MOMENT OF INERTIA $N-m\,s^{-2}$

T = TORQUE (N - m)

IT IS REQUIRED THAT THE MOTOR IS TO HAVE THE SUITABLE PERFORMANCE AT THE STARTING TO ENSURE THAT THE TORQUE PRODUCED BY CHOSEN MOTOR IS CAPABLE OF ACCELERATING THE ASSOCIATED SYSTEM.

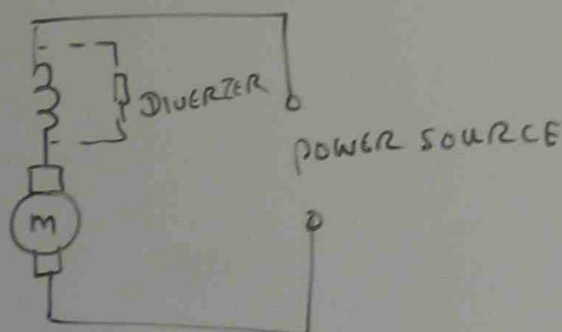
THE TORQUE PRODUCED UNDER THE RESTRICTION OF CURRENT LIMITING RESISTOR MUST HAVE APPROPRIATE VALUE TO PREVENT THE DAMAGE.

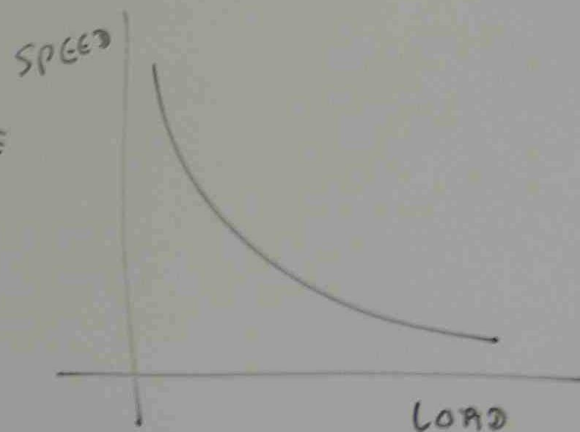
CHARACTERISTICS OF DC MOTORS

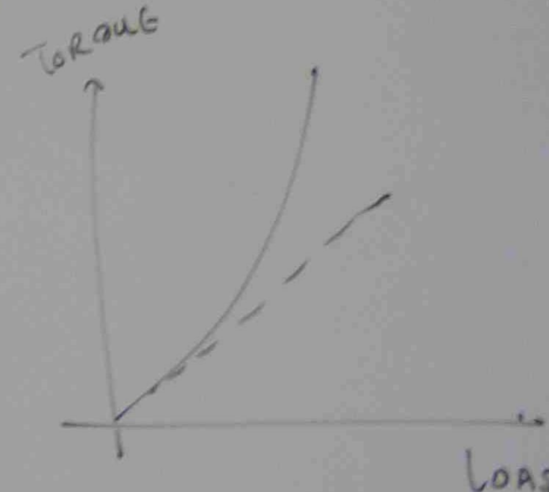
SERIES MOTOR

THE SERIES EXCITED MOTOR IS USED FOR IT'S GOOD STARTING TORQUE CHARACTERISTICS

Eg. TRAMS, ELEVATORS, CRANES, STARTER MOTORS

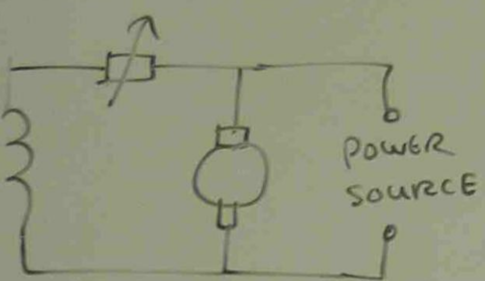


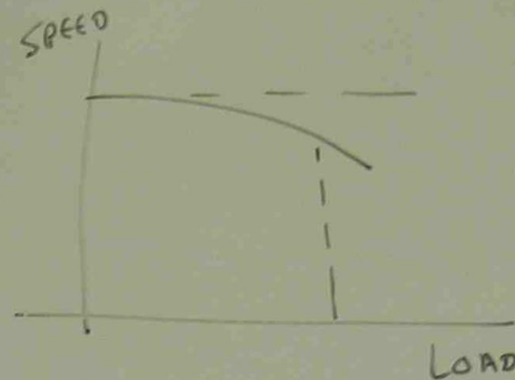


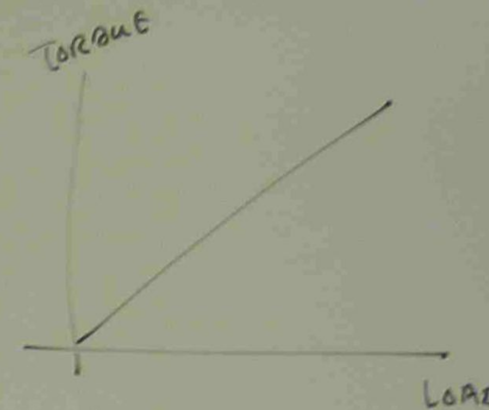


SHUNT MOTOR

THE SHUNT EXCITED MOTOR IS USED FOR IT'S FAIRLY CONSTANT SPEED CHARACTERISTICS

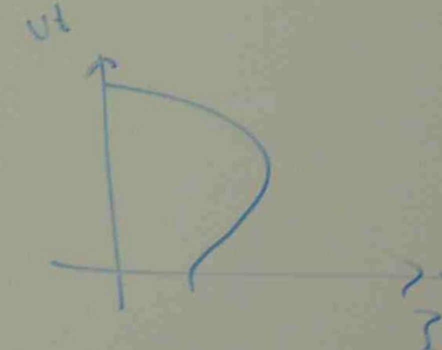






DIFFERENTIAL

$\phi_{sh} - \phi_{se}$



COMPOUND MOTOR

THE CUMULATIVELY COMPOUNDED MOTOR COMBINES THE CHARACTERISTICS OF BOTH THE SERIES AND SHUNT MOTORS. APPLICATIONS ARE PUNCHES, SHEARS, ROLLING MILLS.