Electrical Machine

CH[1]

1- $\tau = r F \sin\theta$ [N.m]

2- $\tau = J\alpha$ ∴ التسارع الزاوي × نصف قطر الدوران

3- $\omega = \tau\theta$ [J]

4- $P = \frac{dw}{dt} = Fv = \tau\omega$ [w]

5-

6- $H = Ni/L_c$

7- $B = \mu H$ [T] or [webber / m^2]

8- $\Phi = BA = \frac{\mu N i A}{L_c}$ [T.m^2 or webber]

9- $F = Ni = R\Phi$

10- $R = \frac{l_c}{\mu A}$ [Ω]

11-

12- $e_{ind} = N\, d\Phi/dt$ [V]

13- $e_{ind} = d\lambda/dt$ $\lambda = N\Phi$

14- core loses = Eddy current loss + Hysteresis loss

15- $F = ilB\sin\theta$

16- $e_{ind} = (V \times B)\cdot l$ (VBl sinθ)

17-

18- $i = [(V_B - e_{ind})/R]$

19- $V_{ss} = [V_B/BL]$ [m.s]

20- $V_{ss}' = \frac{V_B - F_{ind}/R}{LB}$

21- $\frac{}{LB}$

22- $i' = \frac{F_{load}}{LB}$ $e_{ind} = V_B - iR$

23- $P_{conv} = P_{out} = e_{ind}' i' = F_{ind} V_{ss}'$

24- $\eta = [e_{ind}/V_B] \times 100\%$

25- $F_{app} = F_{ind} = ilB$ (21)

26- end CH(1)

27-

28- $\Sigma\tau = J\alpha$ when $\alpha = 0$

29- in generator $\tau_{app} = \tau_{ind} + \tau_{loss}$

30-

31- motor $\tau_{ind} = \tau_{load} + \tau_{loss}$

$\frac{V_p}{V_s} = \frac{I_s}{I_p} = a$

$P_{in} = V_p I_p \cos\theta_p$

$P_{out} = V_s I_s \cos\theta_s$

$S_{in} = V_p I_p^* = V_s I_s^* = S_{out}$

$Z = \frac{V}{I}$

$Z_L' = a^2 Z_L$

$P_{loss} = (I_L)^2 R_{line}$

$PF = \cos\theta = P_{oc}/V_{oc} I_{oc}$

$VR = \frac{V_{nL} - V_L}{V_L} \times 100\%$

$\eta = P_{out}/(P_{out} + P_{loss})$

$e_{ind} = K\Phi\omega$

$\tau_{ind} = K\Phi i \sin\theta$

$\tau_{ind} = K B_{coil} \times B_s \sin\theta$

$B_{net} = 1.5 B_m$

$n_m = 120 f_e / p$ [rpm]

$E_A = K\Phi\omega \doteq \frac{V_T}{\frac{V_T}{\sqrt{3}}}$ Δ, Y connections

$\tau = k B_R B_{net} \sin\delta$

$V_\phi = E_A - jX_s A - R_A I_A$

$I_A \cos\theta = E_A \sin\delta / X_s$

$P_{out} = \frac{3 V_\phi E_A \sin\delta}{X_s}$

$\tau_{ind} = \frac{3 V_\phi E_A \sin\delta}{X_s \omega_m}$

$P = \frac{}{} S_p (f_{s1} - f_{fc})$

For Generator

$P_{conv} = \tau_{ind} \omega_m$

ch6

$n_s = \frac{120 f_e}{P}$

$S = \frac{n_s - n_m}{n_s}$

$n_m = [1 - S] n_s$

$f_r = S f_e$

$\tau_{load} = \frac{P_{out}}{\omega_m}$

$P_{in} = 3 V_\phi I_\phi \cos\theta$

$P_{scl} = 3 I_1^2 R_1$ [stator]

$P_{core} = \frac{3 E_1^2}{R_c}$

$P_{AG} = P_{in} - P_{scl} - P_{core}$

$= 3 I_2^2 \frac{R_2}{S}$

$P_{RCL} = 3 I_2^2 R^2 = S P_{AG}$

$P_{conv} = P_{AG} - P_{RCL}$

$= (1 - S) P_{AG}$

$P_{out} = P_{conv} - P_{Fow} - P_{strag}$

$\tau_{ind} = \frac{P_{conv}}{\omega_m} = \frac{P_{AG}}{\omega_s}$

$\tau_{load} = \frac{P_{out}}{\omega_m}$

ch7

$E_A = K \phi \omega$

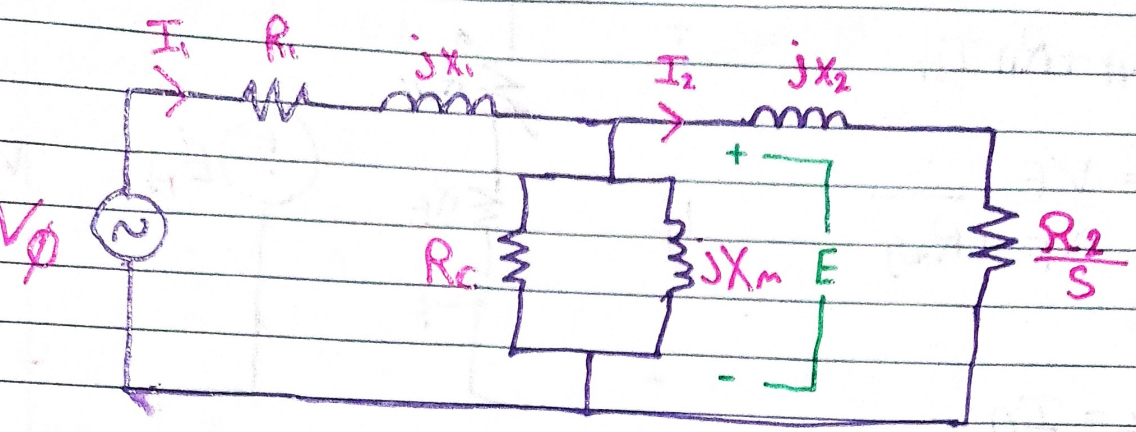
$\tau_{ind} = K \phi I_A$

ch8

$SR = \frac{\omega_{nL} - \omega_{fL}}{\omega_{fL}}$

$I_A = \frac{V_T - E_A}{R_A + R_{in}}$

Per Phase equivalent circuit an induction motor



R_1 : Stator
R_2 : Rotor
R_c : Core losses

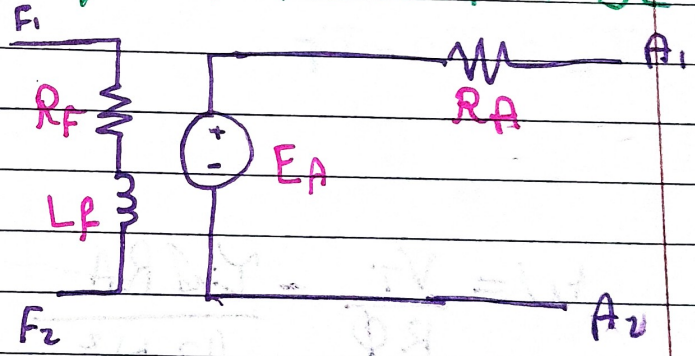
X_1 : Stator
X_2 : Rotor
X_m : magnetizing induction

Dc Motor and Generators

Type of Dc Motors

1- separately Excited
2- Shunt
3- Series
4- Compounded
5- Permanent magnatic

Equivalent Circuit of Dc



$\phi = K_f I_F$

$E_A = K\phi\omega$

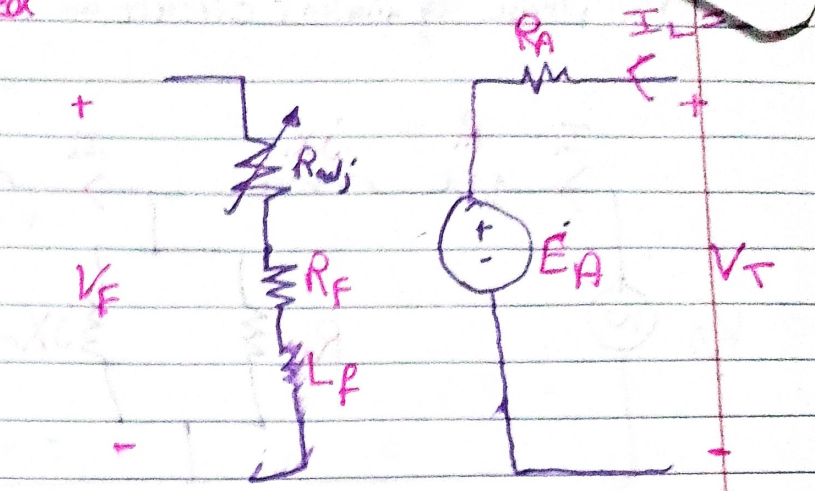
$\tau = K\phi I_A$

1 separately Excited

$$V_T = E_A + R_A I_A$$

$$I_F = \frac{V_F}{R_F + R_{adj}}$$

$$I_L = I_A$$

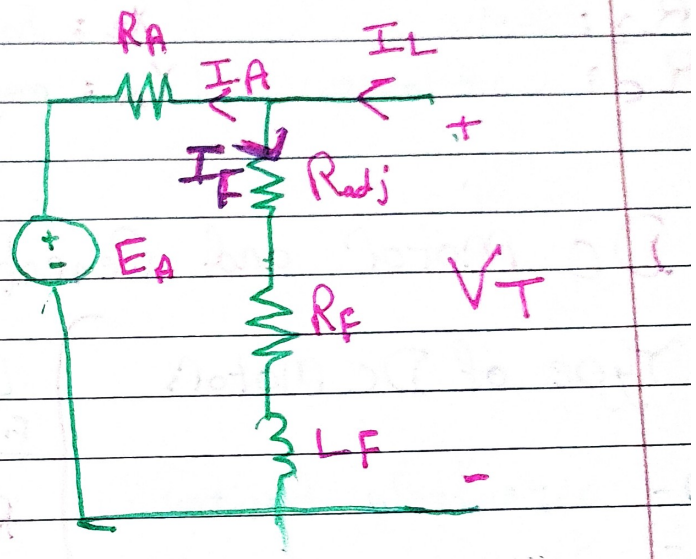


2 Shunt

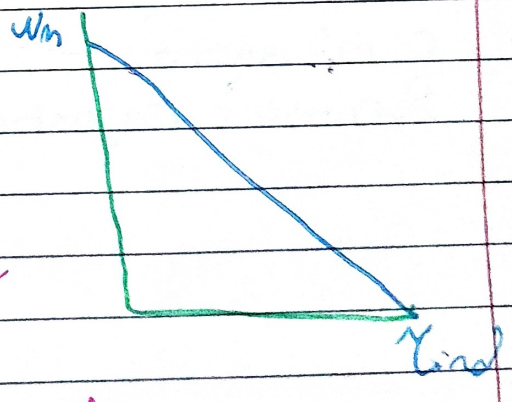
$$V_T = R_A I_A + E_A$$

$$I_F = \frac{V_T}{R_F + R_{adj}}$$

$$I_L = I_A + I_F$$



$$\omega = \frac{V_T}{K\Phi} - \frac{\tau_{ind} R_A}{(K\Phi)^2}$$



speed control

1- Change R_F
2- Change terminal voltage
3- add R in series with armature winding

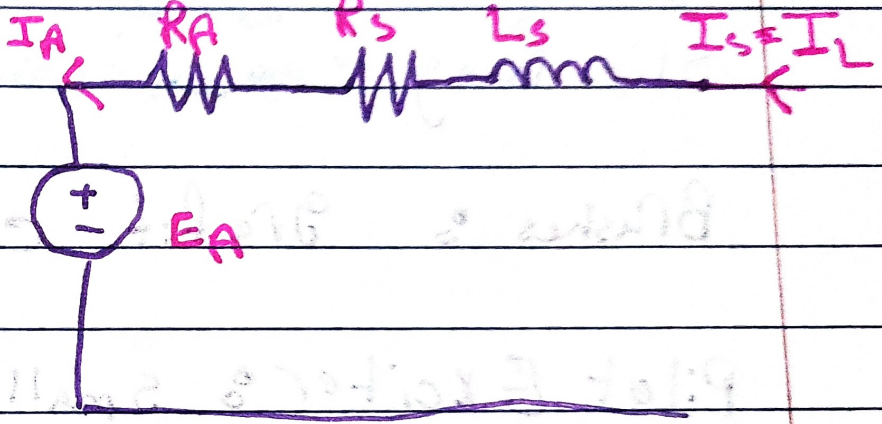
[3] series

$$V_T = E_A + I_L [R_A + R_S]$$

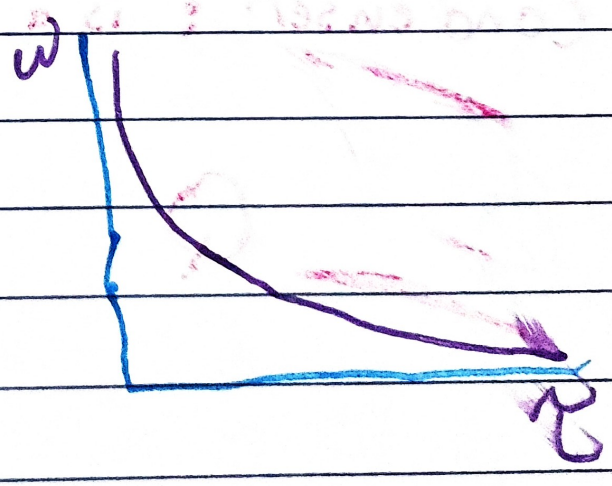
$$\Phi = C I_A$$

$$\gamma_{in} = K C I_A^2$$

$$\Rightarrow \omega = \frac{V_T}{\sqrt{K C}\sqrt{\gamma_{ind}}} - \frac{R_A + R_S}{K C}$$



$$I_A = I_S = I_L$$



Control speed

1- Change terminal Voltage

2- add Resistor

3- Field Divert resistor