

ECE 320 & ECE 329

ENERGY SYSTEMS I
BACKGROUND STUDY IN ENERGY SYSTEMS

SESSION no. 26

DC MACHINES

SEPARATELY EXCITED SHUNT MOTOR

$$V_A = 240\text{V} \quad I_{\text{FL}} = 100\text{A Full Load}$$

$$N_F = 1500$$

$$N_{SE} = 15$$

$$R_A = 0.14\Omega$$

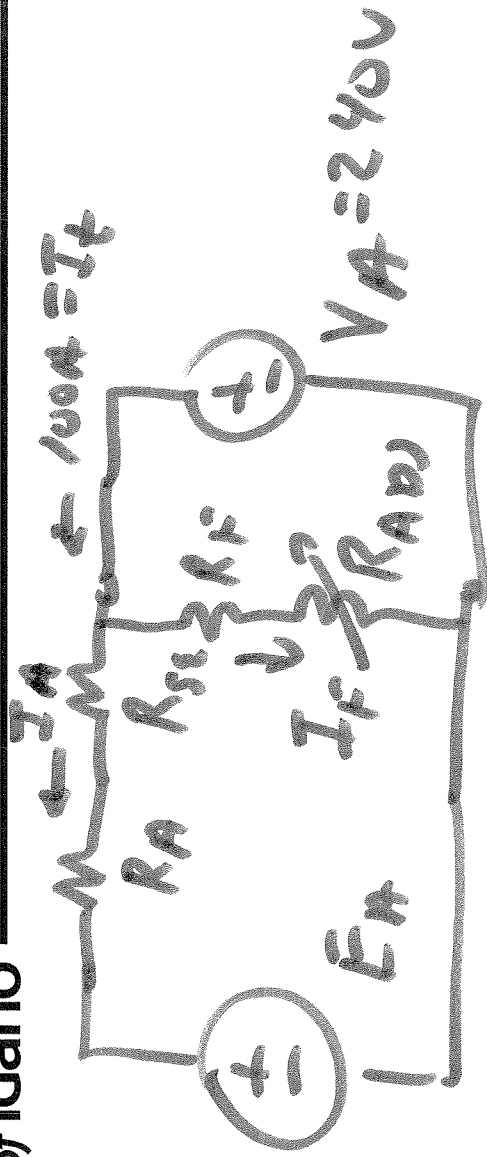
$$R_S = 0.05\Omega$$

$$R_F = 200\Omega$$

$$R_{ADJ} = 120\Omega$$

$$n_m = 3000 \text{ RPM} = 314.2 \frac{\text{rad}}{\text{sec}}$$

$$0.2 \leq R_{ADJ} \leq 300\Omega$$



a) FIND NO LOAD SPEED

$$R_{AD} = 120\Omega$$

EXCITATION CURVE FIG. P. 6

$$I_F = \frac{240V}{(200\Omega) + (120\Omega)} = 0.75A$$

$$I_A = 100A - 0.75A = 99.25A$$

$$E_{A0} = 245 \text{ V}$$

$$\omega_0 = 3000 \text{ RPM} = 314.2 \frac{\text{rad}}{\text{sec}}$$

NO LOAD \rightarrow NO TORQUE

NO I_A

$$\tau = K \phi I_A$$

$$I_A = 0$$

$$E_A = V_f = V_A = 240 \text{ V}$$

$$\frac{E_{AO}}{E_{ANE}} = \frac{K \phi_d I_o}{K \phi_d \omega_{nd}}$$

$$\frac{E_{AO}}{E_{ANE}} = \frac{\omega_o}{\omega_{nd}}$$

SAME IF \rightarrow SAME ϕ_d

$$\frac{E_{AO}}{E_{ANE}} = \frac{\omega_o}{\omega_{nd}}$$

$$\omega_{nd} = \frac{E_{ANE} \omega_o}{E_{AO}}$$

$$\omega_{nr} = \frac{(240V)(3000\text{ RPM})}{(245V)}$$

$$\omega_{nr} = 2938 \text{ RPM}$$

$$F_{AD} = K \phi_d \omega_o$$

b) Full Load Sizing

$$I_A = 100A - 0.75A = 99.25A$$

$$E_A = V_A - (R_A + R_f) I_A$$

$$E_A = 240V - (0.14 + 0.05) \Omega (99.25A)$$

$$E_A = 240 - 18.86 = \underline{\underline{221.14V}}$$

$$\frac{E_{A0} = K \phi \omega_0}{E_{AFL} = K \phi_f \omega_{FL}}$$

$$\frac{E_{A0}}{E_{AFL}} = \frac{\omega_0}{\omega_{FL}}$$

$$\omega_{FC} = \frac{E_{AF} \cdot \omega_0}{E_{A0}}$$

$$\omega_{FC} = \frac{(221.14V)(3000 \text{ RPM})}{245V}$$

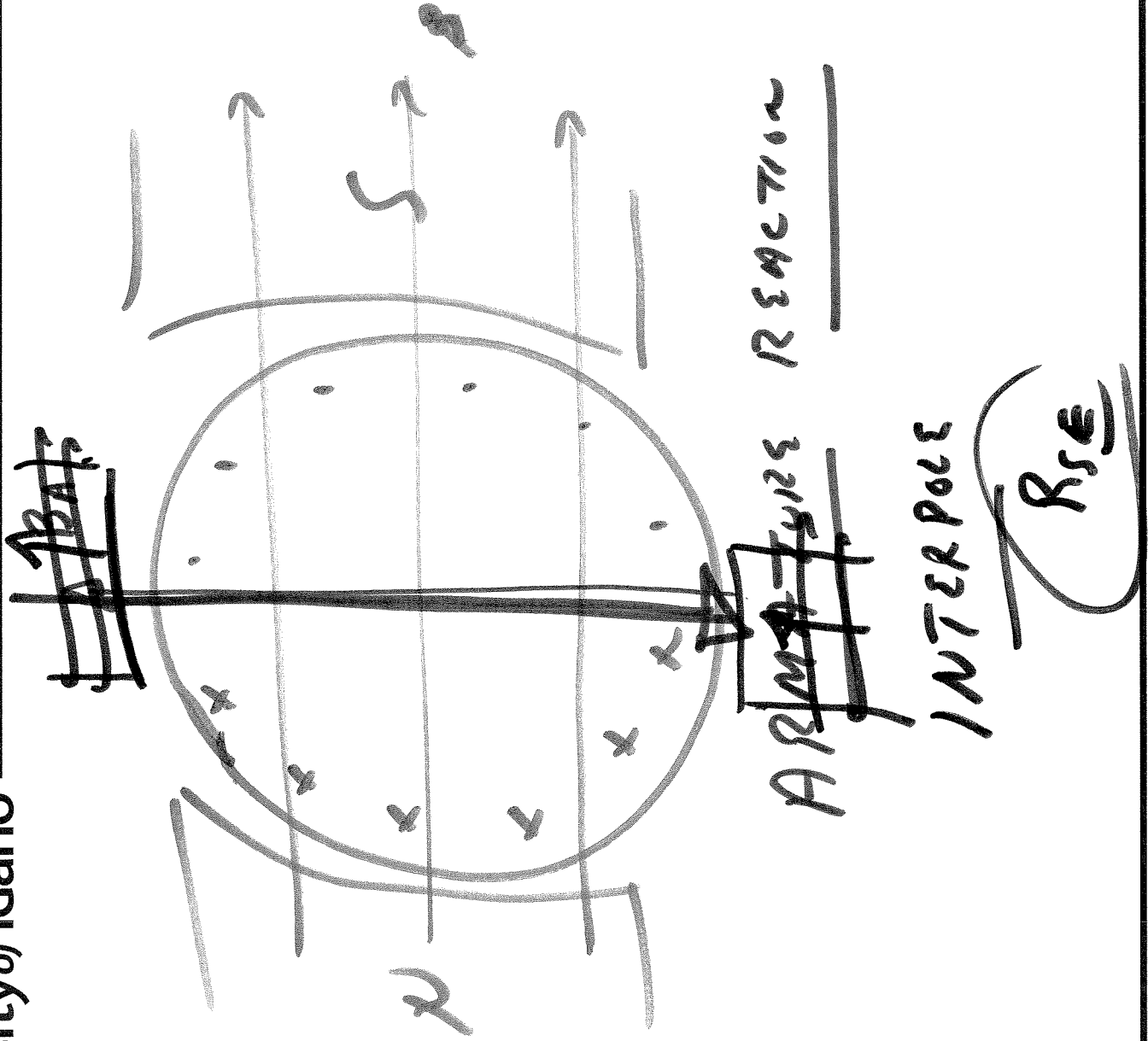
$$\omega_{FC} = \underline{\underline{2703 \text{ RPM}}}$$

$$\tau_{FC} = \frac{E_{AF} I_A}{\omega_{FC}} = \frac{(221.14V)(99.25A)}{283.6 \frac{\text{rad}}{\text{s}}}$$

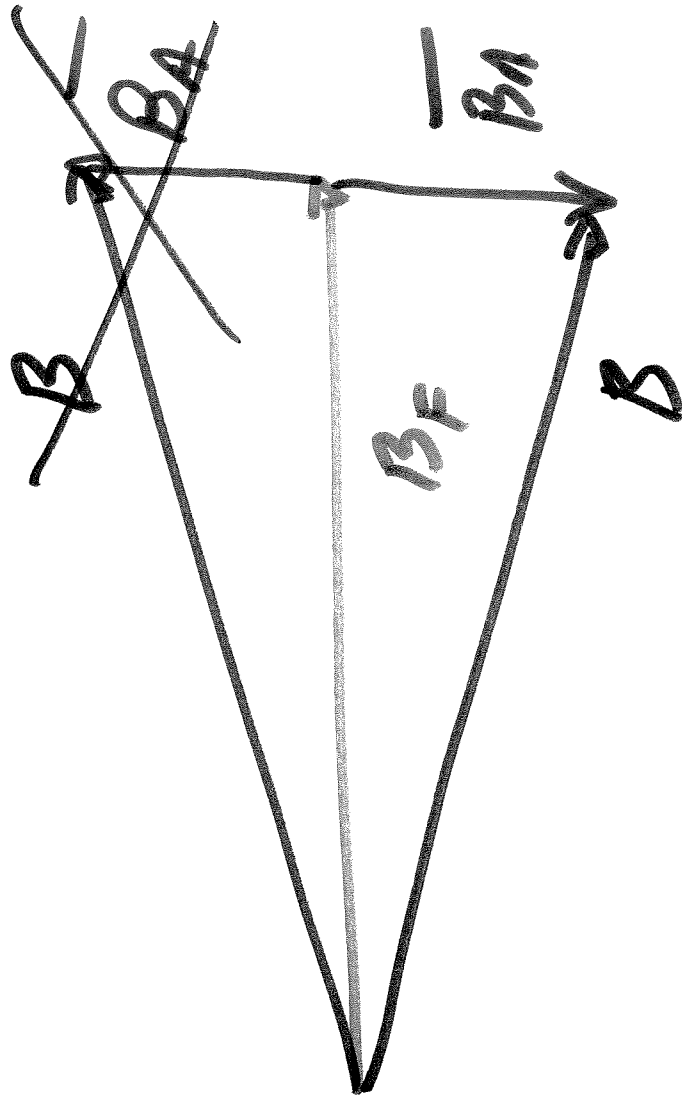
$$\tau_{FC} = \underline{\underline{77.4 \text{ N}\cdot\text{m}}}$$

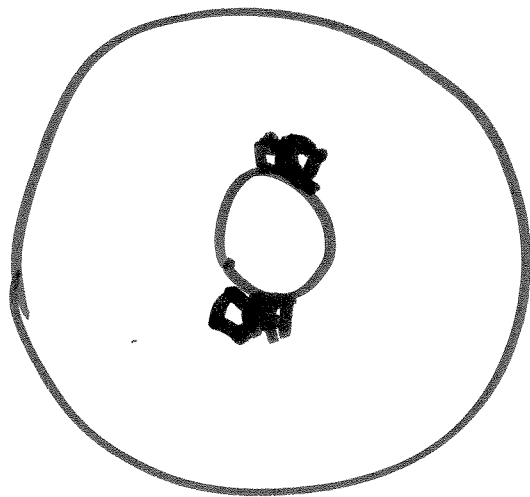
$$K\psi_0 = \left(\frac{EA}{u}\right)$$

$$\gamma = K\psi_0 I_A$$



Fig





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