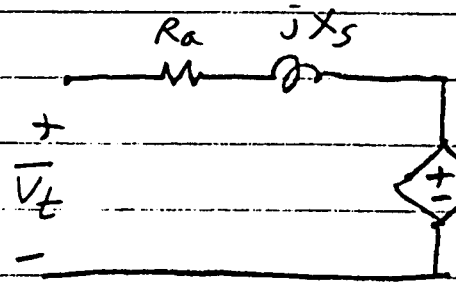
ECE 333

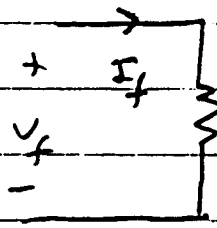
Exam II — SPRING 1994

50 minutes, closed book, closed notes, open mind

Given Information:

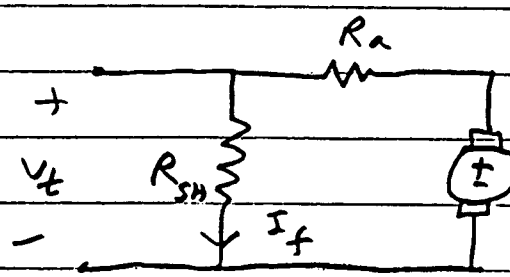


$\bar{E}_f \approx K_f \omega I_f \angle \delta$ $\quad (\delta_t = \delta - \measuredangle V_t)$



$$P_{in}^{3\phi} = \frac{3|\bar{V}_t||\bar{E}_f|}{X_s}\sin(-\delta_t)$$

$$Q_{in}^{3\phi} = \frac{3|\bar{V}_t|^2}{X_s} - \frac{3|\bar{V}_t||\bar{E}_f|}{X_s}\cos(-\delta_t)$$



$E_a \approx \lambda_R \omega + K_f^{SH} \omega I_f$

$$T = \frac{P}{\omega}$$

Problem #1
25 points

Given the following test data for a 3φ synchronous machine:

open circuit: $I_f = 5A$ $V_{ll} = 480 V (l-l)$

short circuit: $I_f = 1A$ $I_l = 40A$

(a) What value of I_f do you need to produce rated voltage at rated current if the machine is a generator serving a load with 0.8 power factor lagging?

(b) If you use this value of I_f, will the actual V_t be lower or higher? Explain

Problem #2
25 points

An unloaded synchronous machine (3φ) is connected to an infinite bus at 120 V (l-n). It has a synchronous reactance of 5Ω. When I_f is equal to 2A, the line current is zero.

(a) What will the line current be if I_f is changed to 3A?

(b) What is the maximum load this machine can supply when $I_f = 3A$?

Problem #3 (25 points)

An unloaded self-excited dc generator with $R_A = 0.5\ \Omega$ is tested at 1200 RPM. The test results are: $I_f = 0\ A$ $V_t = 10\ V$; $I_f = 1\ A$ $V_t = 120\ V$

(a) What value of total field resistance is needed to keep the terminal voltage at 120V if the speed drops to 1180 RPM when a $30\ \Omega$ load resistor is applied to the terminals?

(b) If this value of resistance is used, will the actual voltage be higher or lower than 120V? Explain

Problem #4 (25 points)

A 120V shunt dc motor with $R_A = 0.5\ \Omega$ runs at 1400 RPM at no load with a total field resistance of $120\ \Omega$.

(a) What field resistance is needed to change the no-load speed to 1600 RPM?

(b) What will the terminal current and speed be if it is loaded with 10 NM shaft torque? (ORIGINAL R_f

(Neglect residual voltage, saturation and armature reaction)