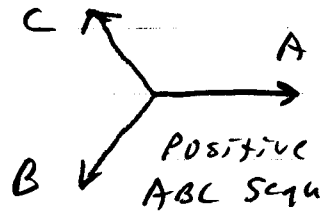
ECE 333

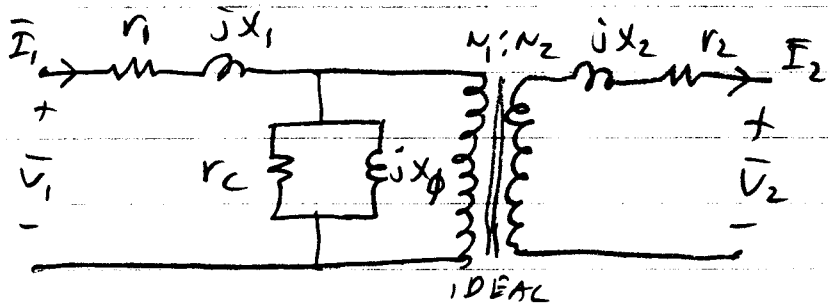
FINAL EXAM SPRING 1993

Closed book, closed notes, formulas given below. work all problems in exam books.



$$\bar{Z}_{equiv_Y} = \bar{Z}_\Delta / 3 \qquad \bar{S} = \bar{V}\bar{I}^* \qquad T = \frac{P}{\omega}$$

TRANSFORMER



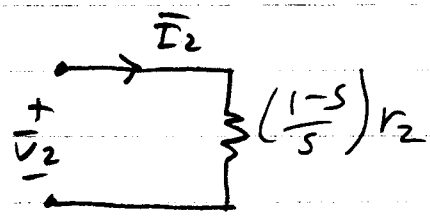
$$\bar{Z}_{1e} = \bar{Z}_1 + \left(\frac{N_1}{N_2}\right)^2 \bar{Z}_2$$

$$\%V.R. = \frac{|\bar{V}_{2NL}| - |\bar{V}_{2FL}|}{|\bar{V}_{2FL}|} \times 100 \qquad (|\bar{V}_1| = \text{fixed})$$

$$\%Z = \frac{|\bar{Z}_{1e}|}{Z_{1rated}} \times 100$$

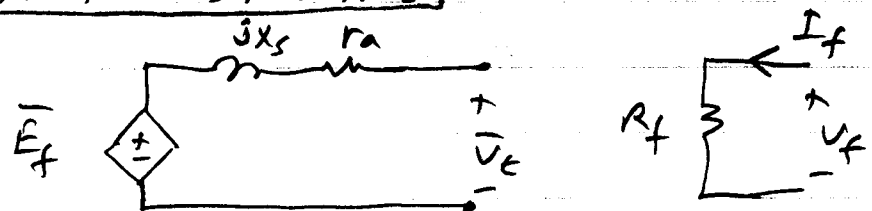
INDUCTION MACHINE

SAME AS TRANSFORMER WITH



$$s = \frac{\omega_s - \omega}{\omega_s}$$

SYNCHRONOUS MACHINE

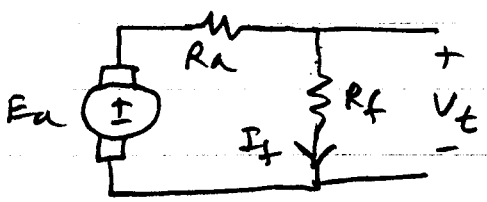


$$|\bar{E}_f| = K_f \omega I_f$$

$$P_{IN_{3\phi}} = \frac{3|\bar{E}_f||\bar{V}_t|}{x_s} \sin(-\delta)$$

$$Q_{IN_{3\phi}} = \frac{3|\bar{V}_t|^2}{x_s} - \frac{3|\bar{E}_f||\bar{V}_t|}{x_s} \cos(-\delta)$$

DC-SHUNT



$$E_a = \lambda_R \omega + K_f \omega I_f$$

PROBLEM #1
15 POINTS

Given: A 100 KVA, 2400V/120V transformer with 7% impedance

Find: the magnitude of the low voltage side current if the low voltage side is shorted when rated voltage is applied to the high side.

PROBLEM #2
15 POINTS

A balanced 4 pole, 3ϕ, 60Hz, 208 V, l-l induction motor has $r_1 = x_1 = x_2 = 0$, $r_c = \infty$, $x_\phi = 20\,\Omega$, $r_2' = 1\,\Omega$ $\left(r_2' = \left(\frac{N_1}{N_2}\right)^2 r_2\right)$

(a) How much current will flow in each line when the machine is at no load?

(b) How much current will flow in each line when the machine is at blocked rotor?

(c) How much current will flow in each line when the machine is running at 1620 rpm?

(d) What is the frequency of the rotor currents for part (c)?

PROBLEM #3
20 POINTS

You have a 240V dc source to be used for the source of a shunt dc motor and the field of a 2pole, 3ϕ, 60Hz synchronous generator. The dc motor has $R_a = 1\Omega$, $\lambda_R = 0$, $K_f = 1.0\ \Omega$ sec/m.R. The synchronous machine has $K_f = 1.0\ \Omega$ sec/m.R., $X_s = 20\Omega$, $r_a = 0\Omega$. If the d.c. motor is driving the synchronous generator (with load resistor of 10Ω per phase), find the values of the d.c. machine and synchronous machine field resistances to provide the load with 120 V. l-n at 60Hz.

PROBLEM #4
15 POINTS

A 240V dc shunt motor has a no-load speed of 1300RPM. At this speed, its internal voltage may be approximated by:

$$E_a\Big|_{1300\text{RPM}} = 15 + 200 I_f$$

The armature resistance is 1Ω and your starting box is broken.

(a) What value of resistance should be added in series with your 240V supply to limit the terminal current to 10A during startup?

(b) What speed will the motor reach with your resistor in the circuit? (It is unloaded)

PROBLEM #5
20 POINTS

The dynamic model for a synchronous generator is

$$\frac{d\delta}{dt} = \omega_t \qquad \delta(0) = \pi/6$$

$$\frac{d\omega_t}{dt} = A - B \sin\delta \qquad \omega_t(0) = 0$$

A is 1000 and B is initially 2000

If B is reduced to zero at time zero and then made equal to 1600 after .04 seconds, will the machine recover from the disturbance and return to $\omega_t = 0$? (EXPLAIN)

PROBLEM #6
15 POINTS

Suppose the dynamic model for a machine is as follows:

$$120 = 0.5\, i_a + 0.1 \frac{di_a}{dt} + 1.2\omega \qquad i_a(0) = 0$$

$$0.1 \frac{d\omega}{dt} = -0.1\omega^2 + 1.2\, i_a \qquad \omega(0) = 0$$

Find i_a and ω after .002 seconds using euler's method with a step size of .001 sec.