EE 372, Spring 2005
Exam 1
1 March, 2005

Show all your work and your answers clearly on the test pages. In any plots and sketches, label and include units (if possible) on anything that might be of interest. For full credit, simplify your answers as much as possible. You may use calculators for numerical evaluations but no programming capabilities. This exam is closed-book.

Problem 1 (20) ______

Problem 2 (20) ______

Problem 3 (30) ______

Problem 4 (25) ______

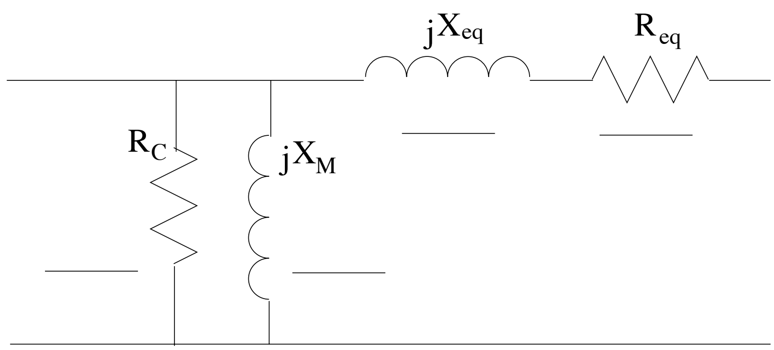
Problem 5 (10) ______

Total (100) ______

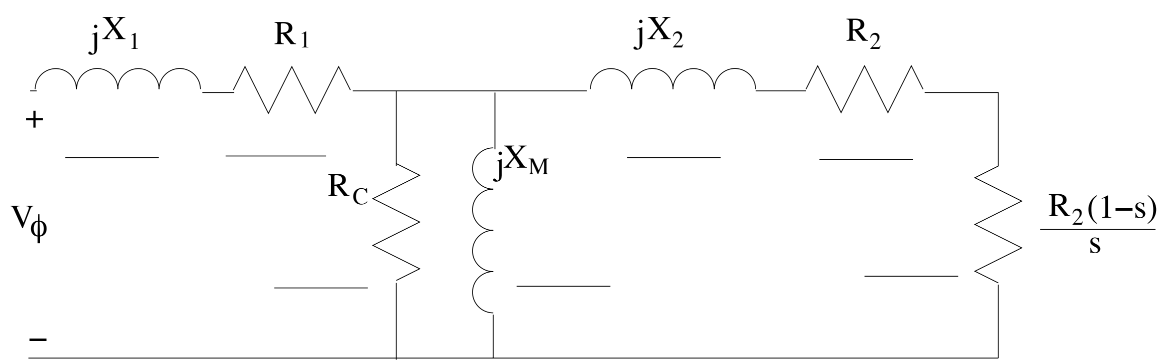
Name________________________________

1. (20 pts.) Shown below are equivalent circuits for a transformer and an induction motor. These equivalent circuits include components to model non-ideal features of the respective machines. Next to each of the components is a blank line. On the line nearest each component, place the letter(s) from the following list which best describe the physical phenomenon(or phenomena) modeled.
A. Eddy current losses in core; B. stator copper resistive loss; C. rotor copper loss; D. hysteresis losses; E. armature reactance; F. rotor inductive impedance; G. copper losses in primary coil; H. copper losses in secondary coil; I. flux leakage in primary coils; J. flux leakage in secondary coils; K. inductive impedance to core magnetization current; L. electric power converted to mechanical; M. Friction losses in bearings; N. stator self-inductance.

Transformer Eq. Circuit



Induction Motor Equivalent Circuit



2. (20 pts.) Suppose a permanent-magnet DC motor, such as the one we ran in class, has armature resistance of 0.5Ω, and has a no-load speed of 1500 rpm when connected to a source of 120 V. Under these conditions, the total losses due to friction and windage are 150 W. (Note that I_A is *not* to be assumed zero.) If we disconnect the source and drive the motor as a generator at 1000 rpm, what voltage will we see at the terminals (a) with no load, (b) a 120V, 200W light bulb connected to the terminals?

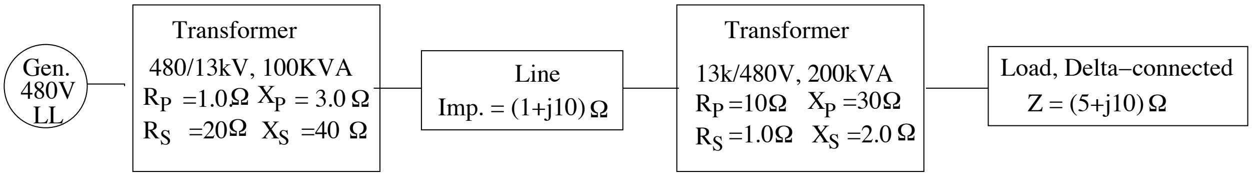
3. The following concern a two-pole, single-phase AC generator.

(a) (10 pts.) The generator is connected to a purely capacitive load. Assuming the generator is ideal (no internal impedances) and the rotor has a constant magnetic field rotating through the stator coil, sketch the stator coil and the relationship between the rotor and stator fields at a sufficient number of points during the rotation to verify the direction of induced torque at all parts of the cycle.

(b) (10 pts.) Suppose now the generator has 100 turns of wire in the stator, the rotor has total flux of 0.03 Webers and rotates at 3000 rpm. It has internal resistance of 0.5Ω and synchronous reactance of $j2.0\Omega$ and the load is disconnected. What is the induced voltage in the stator (time-domain expression)?

(c) (10 pts.) If the capacitive load connected to the generator is 0.0001 farads and the generator's parameters are as in (b), find the generator's voltage regulation under these conditions.

4. The one-line diagram for a three-phase system below includes all "real" values of impedances, using our standard notation. You may assume that the transformers are both Y-Y connected for this exercise.



(a) (10 pts.) Convert the entire system into per-unit values under S_{base} of 200kVA, with a single, equivalent impedance pair (R and X) for each transformer in per-unit.

(b) (15 pts.) Find the line current and apparent, real and reactive power consumed by the load.

5. (10 pts.) Given the fields and rotation illustrated below, is this machine functioning as a generator or motor?