EE 372, Spring 2003
Exam 1
6 March, 2003

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.

Problem 1 (25) ______

Problem 2 (20) ______

Problem 3 (25) ______

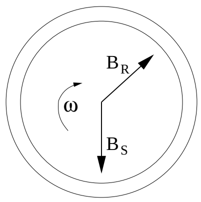
Problem 4 (30) ______

Total (100) ______

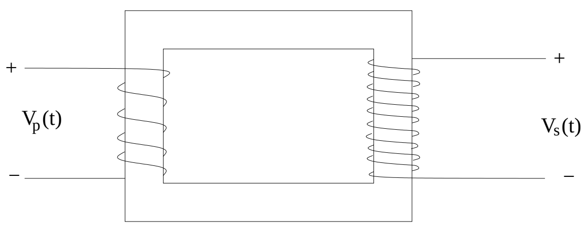
Name________________________________

1. The following short answer questions are to be answered briefly, but require some support for your answer.

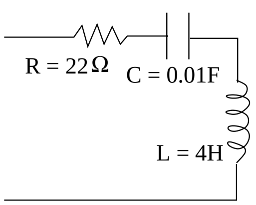
   (a) (5 pts.) A 460V AC machine has rotor and stator magnetic fields as shown below, and both are rotating at synchronous speed in the direction indicated by the arrow. Is this machine functioning as a motor or as a generator? How do you know?



   (b) (5 pts.) This ideal transformer has primary voltage $v_p(t) = 150\cos(120\pi t)$. What is $v_s(t)$?

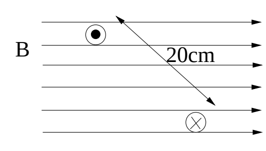


   (c) (5 pts.) What is the power factor of this load when connected to a 60 Hz source?

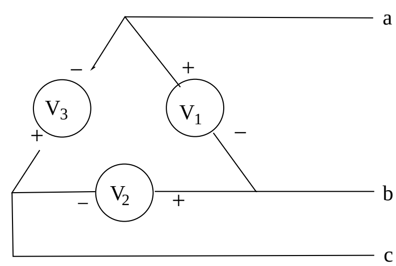


(d) (5 pts.) The 1 hp, three-phase induction motor with which we tinkered in the lab was powered by 230 V line-to-line voltage, and drew about 4.4 amps of line current at full load. It has a nominal efficiency of 75%. If all these figures are accurate, what must be the phase angle of the motor, viewed as a simple impedance, when operated at full load?

(e) (5 pts.) If the magnetic field intensity **B** is 0.1 Tesla and the wires indicated below are connected in a rotor loop with axis length 30 cm, what is the magnitude and direction of the torque on this loop with the current shown being 1 amp?



2. The Δ-connected three phase generator below has phase voltages $v_1(t) = 14.1\cos(\omega t)$, $v_2(t) = 14.1\cos(\omega t - 120^o)$ and $v_3(t) = 14.1 cos(\omega t - 240^o)$. The last phase of the generator is removed, as indicated by the broken line, leaving an open its place.



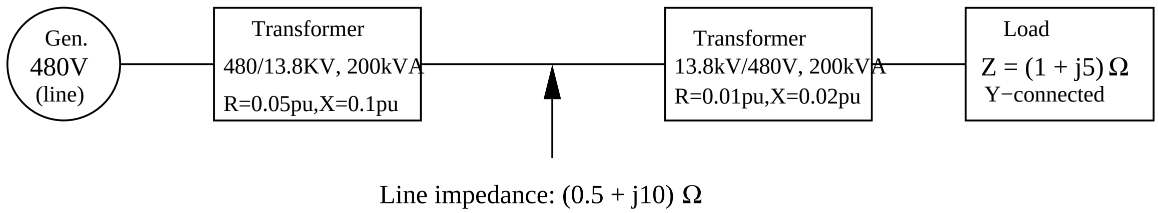
(a) (10 pts.) Compute and sketch the phasor diagram for the the line-to-line voltages V_{ab}, V_{bc} and V_{ca} in this "open delta" state.

(b) (10 pts.) If this generator is attached to a balanced, purely resistive, Δ-connected three-phase load and was operating at full capacity before the third phase was removed, how must the load impedances (kept balanced) be scaled up or down to make sure the remaining phases are not overloaded in terms of power output?

3. (25 pts.) A three-phase, 440-V (line-to-line), four-pole, 60 Hz, Δ-connected induction motor has the following per-phase equivalent circuit parameters:
$R_1 = 0.2\Omega$, $X_1 = 0.4\Omega$, $R_2 = 0.1\Omega$, $X_2 = 0.4\Omega$, $X_M = 20\Omega$. Mechanical losses are 1000W; you may ignore core and miscellaneous losses in this problem. For a slip of 5%, compute (a) line current I_L, (b) P_{conv}, (c) torque delivered to the load, τ_{load}, (d) the motor's efficiency and (e) motor's speed in rpm. You may use both this and the next page for this problem.

3. (continued): $R_1 = 0.2\Omega$, $X_1 = 0.4\Omega$, $R_2 = 0.1\Omega$, $X_2 = 0.4\Omega$, $X_M = 20\Omega$. Mechanical losses are 1000W; you may ignore other losses in this problem. For a slip of 5%, compute (a) line current I_L, (b) P_{conv}, (c) torque delivered to the load, τ_{load}, (d) the motor's efficiency and (e) motor's speed in rpm.

4. Below is a one-line diagram for a 3-phase power system. The transformer impedance parameters are those of the simplified equivalent circuit, with no shunt (excitation) impedance.



(a) (15 pts.) Find the apparent, real and reactive power supplied by the generator, and the real power consumed by the transmission line.

(b) (15 pts.) Find the values for, and sketch, a phasor diagram of the step-up transformer under the given conditions. (Recall that this diagram relates the input and output voltages of the transformer.) You may refer to either side, or use per-unit values for your diagram.