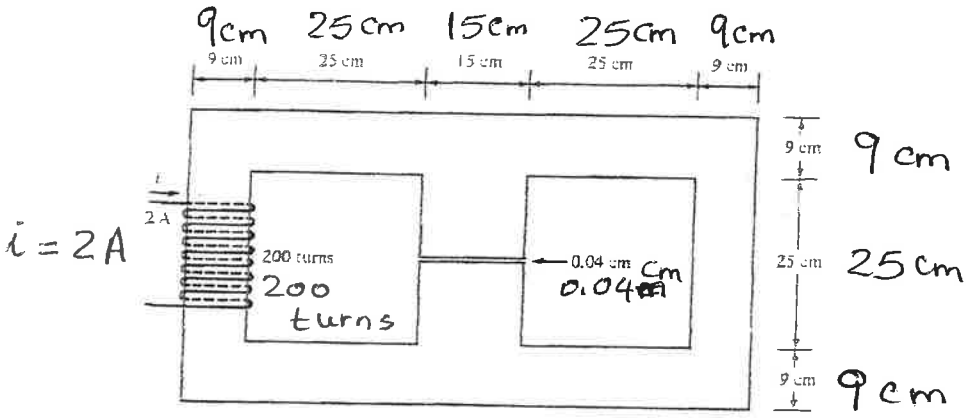
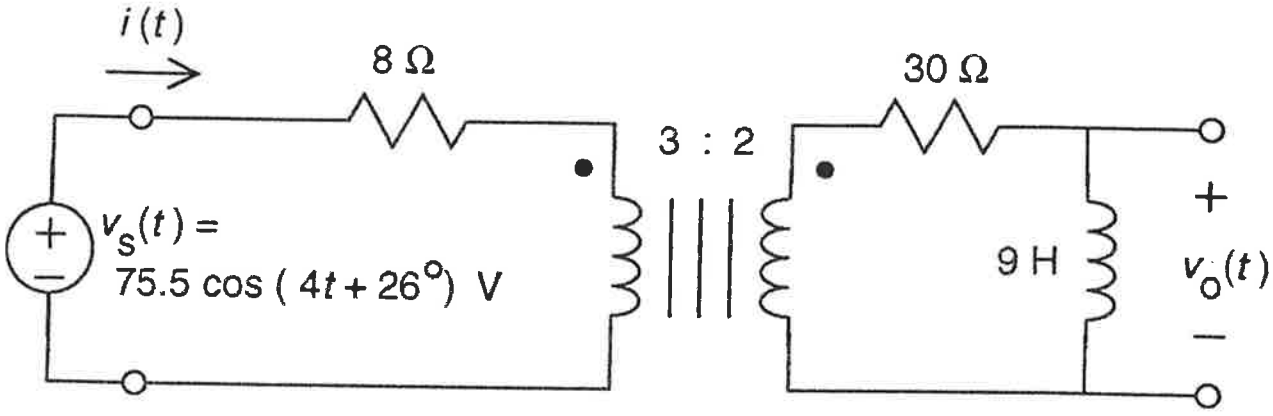
Preliminary Exam
Fall 2016
Power Systems

Name _____ October 28, 2016

1. A core with three legs is shown below. Its depth is 0.04 m, and there are 200 turns on the left most leg. The relative permeability of the core is 1500 with core lengths as shown. For the transformer circuit derive the following:
   a) Equivalent circuit diagram with calculated values of Magnetomotive forces and reluctances. Neglect fringing at air gap
   b) Flux Φg in the left leg and the flux in the right leg
   c) Flux density in the left leg



2. Consider the circuit shown below. The input to the circuit is the voltage of the voltage source, $v_s(t)$. The output is the voltage across the 9 H inductor, $v_o(t)$. Determine the output voltage, $v_o(t)$.



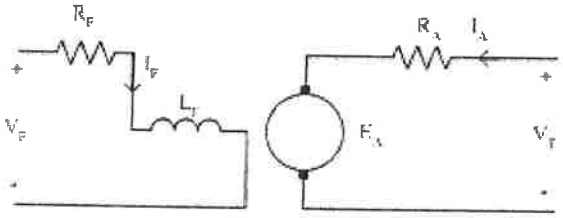
3. A separately excited DC motor shown below is rotated at 1000rpm. The variation of armature terminal voltage as a function of field current is measured under no-load conditions and tabulated below:

I_F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
V_T	0	30	60	85	102	115	124	130	134

The field winding supply V_F = 24 V and the field resistance R_F is adjustable. The armature winding resistance R_A=0.2 Ω and the armature terminal voltage V_T= 130 V.

a. What is the field current if the motor is operated with no-load at 1000 rpm
b. The motor drives a load at 1200 rpm. Calculate the armature voltage at 1200 rpm if the field resistance R_F = 60 Ω
c. Calculate the torque for the above condition

Note: Related voltage to speed is $E_A/E_{A0} = n_m/ n_0$ and P = is product of torque and angular speed, $\omega = n * 2\pi/60$

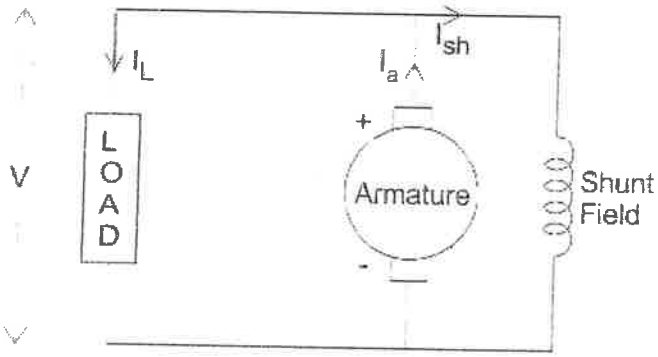


4. A shunt DC generator has a shunt field resistance of 60 ohms. When the generator delivers 60 KW to a resistive load at terminal voltage of V = 120 volts, while the generated E_g is 135 volts. Determine

a) The armature circuit resistance R_A

b) Determine the generated voltage Eg when the output is changed to 20 KW and the terminal voltage is V = 135 V.

Note: Armature consists of generated voltage Eg in series with armature resistance Ra



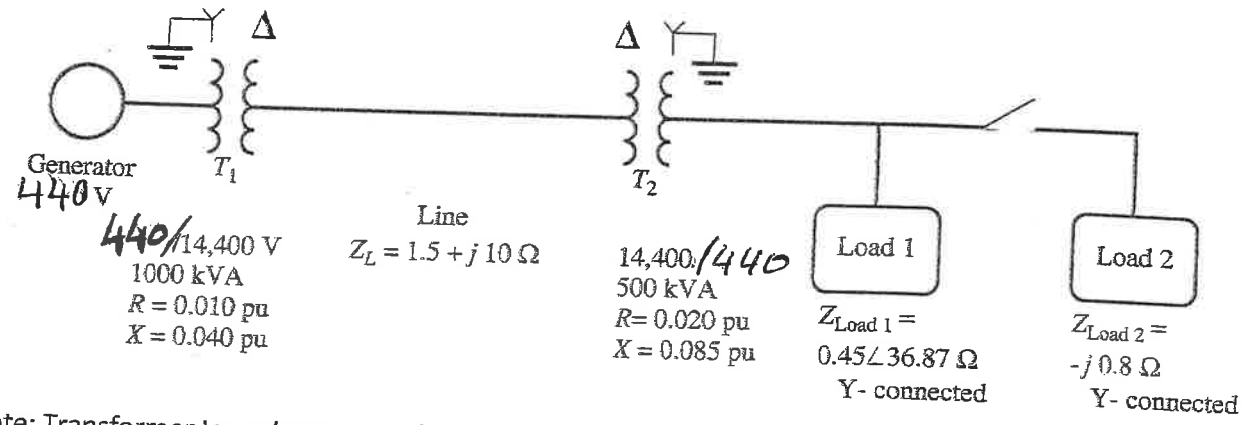
Shunt Wound Generator

5. The figure below shows a power system consisting of a three-phase 440-V 60-Hz generator supplying two loads through a transmission line with a pair of transformers at either end.

(a) Sketch the per-phase equivalent circuit of this power system using a starting base at the generator end of S_{base1} = 1000 KVA and V_{base1} = 440 volts

(b) With the switch opened, find the real power P, reactive power Q, and apparent power S supplied by the generator. What is the power factor of the generator?

(c) With the switch closed, find the real power P, reactive power Q, and apparent power S supplied by the generator. What is the power factor of the generator?



Note: Transformer Impedances are already in per unit but with T_2 in per unit based on 500 KVA base2