S. KARAKI
G. DEEB
K. JOUJOU

AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE

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QUIZ 1

ELECTRIC MACHINES AND POWER SYSTEMS FUNDAMENTALS
(EECE 370)

CLOSED BOOK (2 HOURS) **NOVEMBER 6, 2008**

NAME: ________________________ **ID#:** ________________________

1. Answer each of the following questions in a maximum of 5 lines (50 words). No drawings, no mathematical or other symbols, and no abbreviations are allowed. Answers not complying will get a reduced grade.

a) What are eddy current losses and how can they be reduced?

b) What are the components of the excitation current of a transformer and how are they modeled in the transformer equivalent circuit with brief explanation?

2. The single line diagram of a 50 Hz 3-phase balanced system is shown in Fig.1. The generator (G) delivers power to a load (L) through a transmission line (T). The load is Δ-connected with a phase impedance $Z_\Phi = 6\angle 36°$. The transmission line impedance is $0.04 + j0.2\ \Omega$ and the generator voltage is 380V.

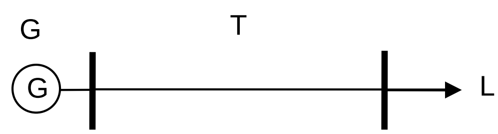

Figure 1: Single line diagram of 3-phase balanced system

a) Draw the per-phase equivalent circuit and label it with known voltages and impedances.

b) Calculate the current in the transmission line and the phase voltage across the load. Deduce the magnitude of the voltage drop across the line in volts and in percent of generator voltage.

c) What are the active and reactive powers supplied to the load and the active and reactive power delivered by the generator? Deduce the active losses in the transmission line and the power factor of the generator.

d) How would you reduce the losses in the transmission line for the same loading? Design a system that will reduce the line losses and quickly estimate the new losses. How would you improve (increase) the power factor of the load? Quickly estimate the size of equipment needed.

3. A single phase 20kVA 2400/240V transformer is subjected to an open circuit and a short circuit test carried out on the high voltage winding. The test data measured on the low voltage is given in Table 1.

Table 1: Test Data for Transformer

Open Circuit	Short Circuit
V_{OC}= 240 V	V_{SC}= 5.75 V
I_{OC} = 1.07 A	I_{SC} = 83.4 A
P_{OC}= 127 W	P_{SC}= 284 W

a) Draw the experimental set up used to carry out the tests and label the equipment used.

b) Calculate the series resistance (RS) and reactance (XS) referred to the low voltage side. Also calculate the excitation admittance (Y_E) referred to the low voltage side and deduce the core resistance (R_C) and magnetizing reactance (X_M).

c) Draw the equivalent circuit of the transformer referred to the low voltage side and label it with symbols and values. Show the ideal transformer in the equivalent circuit.

d) Compute the efficiency of the transformer and its voltage regulation at rated load current and terminal voltage and 0.85 power factor.

4. The cross section of the magnetic circuit of a machine is shown in Fig. 2. The essential dimensions are given on the figure and the axial length or thickness of the machine is 20 cm, and each of the poles has a coil of 50 turns. The approximate magnetization (B-H) curve of the magnetic material is shown in Fig. 3. Neglect fringing effects.

a) Complete the geometrical information, to allow you the calculation of the magnetic properties in the following sections, by calculating the length and area of the air gaps, the poles, the two parts of the yoke, and the rotor.

b) Draw the equivalent magnetic circuit and calculate the various reluctances involved assuming the steel of the machine is unsaturated.

c) Calculate the flux density in the air gaps, the poles, the rotor and yoke parts of the machine for a field current I= 2A. What do you conclude in terms of machine saturation?

d) What is the maximum field current that will allow machine operation without saturation?

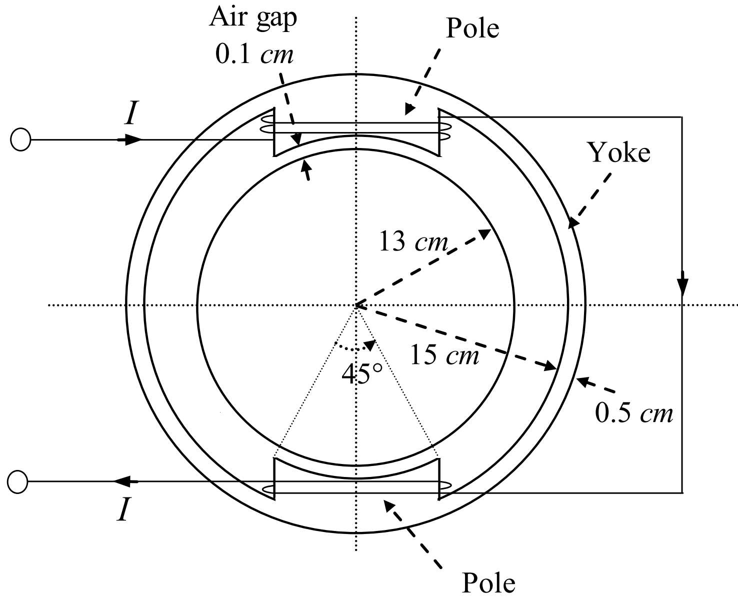

Figure 2: Simple Machine Core

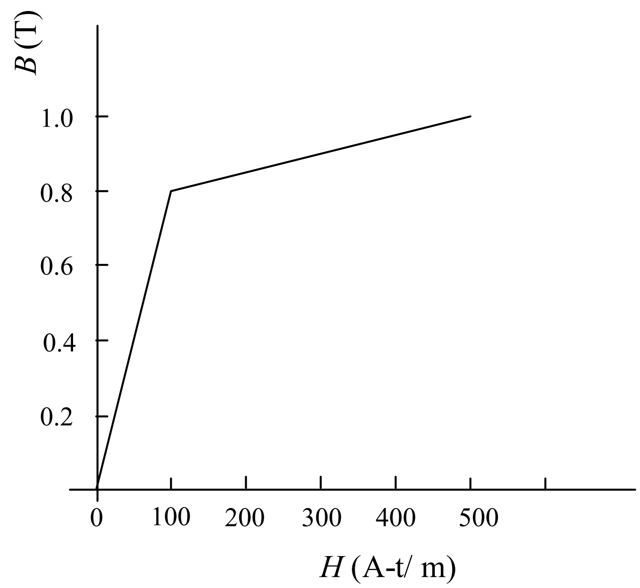

Figure 3: Magnetization Curve for Machine Core.