

University of Saskatchewan  
EE 341 Electric Machines I  
Mid-Term Examination (Total Duration: 2 hrs)  
Term 2 (2005-'06)

Dated: 2005-02-09

Time: 2:30pm – 4:30 pm

Instructor: Dr. Rama Gokaraju

Total Marks: 30

**Instructions:**

- 1) This examination paper consists of four problems and two pages in total.
- 2) This is a closed-book examination. One-page formula sheet is allowed. The formula sheet should not include solved problems.
- 3) Your solutions should be methodical (write the steps of numerical computations clearly).

**Problem 1 - Single-phase Transformer**

These data were obtained from tests carried out on a 10 kVA, 2300:230 V, 60 Hz distribution transformer:

Open-circuit test, with the low-voltage winding excited:

Open-circuit test
$V_{OC} = 230 \text{ V}$
$I_{OC} = 0.45 \text{ A}$
$P_{OC} = 70 \text{ W}$

Short-circuit test, with the high-voltage winding excited:

Short-circuit test
$V_{SC} = 120 \text{ V}$
$I_{SC} = 4.5 \text{ A}$
$P_{SC} = 240 \text{ W}$

- a. Determine the equivalent circuit of the transformer referred to its high-voltage side, in actual ohmic values for impedances as well as in pu.
- b. Express the exciting current of the transformer in pu on the basis of the full-load current.
- c. Compute the efficiency of the transformer when it is delivering full load at 230 V & 0.85 pf lagging. Also, determine the voltage regulation of the transformer and the power factor at the high-voltage terminals.

**10 Marks****Problem 2 – Autotransformer**

A 5000 VA, 480/120 V conventional transformer is to be used to supply power from a 600 V source to a 480 V load. Consider the transformer to be ideal, and assume that all insulation can handle 600 V.

- a) Sketch the transformer connection that will do the required job.
- b) Find the input-output kVA rating of the auto-transformer assuming that the winding rating of the auto-transformer is equal to 5000 VA.
- c) Find the maximum primary and secondary currents under these conditions.

**5 Marks**

**Problem 3 – Three-phase Transformer**

A 200 MVA, 345 kV/34.5 kV, Y-Y substation transformer has an 8% leakage reactance (series reactance). Transformer winding resistances and exciting current are neglected. The HV-side of the transformer is connected to an ideal 345 kV source with negligible source impedance. Using the transformer ratings as base values, determine the per-unit magnitudes of transformer voltage drop and voltage at the low-voltage terminals when rated transformer current at 0.8 pf lagging enters the high-voltage terminals.

**5 Marks****Problem 4 – Three-phase Transformer**

A three-phase load is supplied from a 2.4 kV : 460 V, 150 kVA transformer whose equivalent series impedance is  $0.038 + j 0.135 pu$  on its own base. The load voltage is observed to be 438 V line-line, and it is drawing 85 kW at 0.8 pf lagging. Calculate the voltage at the high-voltage side of the transformer. Perform the calculations on a 460 V, 100 kVA base.

**10 Marks****XXXXX**