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Jordan University of Science & Technology
Electrical Engineering Department

First Examination
Spring Semester 2003 / 2004

EE 332 *Electrical Machines I* 29.3.2004

Problem 1

The following test results are obtained for a 24 kVA , 2400 / 240 V , 50 Hz transformer:

No-Load Test 240 V , 5 A , 200 W
Short-Circuit Test 100 V , 10 A , 350 W

a) Determine the approximate equivalent circuit parameters referred to the high voltage side. Draw the circuit and insert the parameters values. **(8 marks)**

b) Calculate the output voltage when the transformer is connected to a 2.4 kV supply and supplies a load with rated current at a power factor of 0.8 lagging. **(6 marks)**

c) What is the efficiency of the transformer and the voltage regulation at this load? **(3 marks)**

d) Calculate the load current that will give maximum efficiency. What will be the maximum efficiency? **(2 marks)**

e) The above transformer is to be used as a 2640 / 240 V autotransformer. Draw , *clearly* , the connection of the autotransformer. Calculate the supply current, the load current and the kVA rating of the autotransformer. **(3 marks)**

Problem 2

Three single phase , 110 kVA , 2200 / 440 V transformers are connected to form a three phase , 2200 / 440 V transformer bank. The equivalent impedance of each transformer referred to its low-voltage side is (0.048 + j 0.15) Ω . The transformer is connected to a 3-phase source through 3-phase feeders, the impedance of each feeder being (0.5 + j1.5) Ω . The transformer bank delivers full load at 440 V and 0.8 power factor lagging.

a) Draw a schematic diagram showing the transformer connection. **(2 marks)**

b) Determine the single-phase equivalent circuit. **(3 marks)**

c) Determine the sending end line voltage of the 3-phase source. **(3 marks)**

Jordan University of Science & Technology
Electrical Engineering Department

First Examination

EE 332 *Electrical Machines I* 27.7.2004

Q.1. A 6.6 kVA , 660/220 V , 50 Hz transformer gave the following test results :

Open Circuit test 660 V , 0.3 A , 40 W
Short Circuit test 15 V , 30 A , 90 W

a) Determine the equivalent circuit parameters referred to the high voltage side. Draw the equivalent circuit and insert the parameters.
b) Determine the efficiency and voltage regulation when the transformer is supplying full-load at rated voltage and 0.8 power factor lagging.
c) Repeat (b) for half full-load and 0.8 power factor leading.

(45%)

Q.2. A 12 kVA , 480/240 V , 50 Hz transformer has an efficiency of 95% when it delivers 9.6 kW at 0.8 power factor. The transformer is connected as an autotrar.sformer to supply load to a 480 V circuit from a 720 V supply.

a) Show a *clear diagram* of the autotransformer connection.
b) Determine the maximum kVA the autotransformer can supply to the 480 V load.
c) Determine the efficiency of the autotransformer for full-load at 0.8 power factor.

(25%)

Q.3. Three single phase , 15 kVA , 480 / 120 V transformers are connected to form a three phase , 480 / 208 V transformer bank. The equivalent impedance of each transformer referred to the high-voltage side is (1.5 + j3) Ω. The transformer supplies a three-phase, 208 V , 32 kW , 0.8 power factor leading load.

a) Draw a schematic diagram showing the transformer connection.
b) Determine the transformer winding currents.
c) Determine the primary voltage and voltage regulation.

(30%)

Jordan University of Science & Technology
Electrical Engineering Department

First Examination

EE 332 *Electrical Machines I* *10.11.2003*

Name: Univ. # : Section:

Note : Write the Best answer in the Answer Box at the Bottom of the page.

A) A 150 kVA , 2400/240 V transformer has the following parameters : $R_1 = 0.2\ \Omega$, $R_2 = 0.002\ \Omega$, $X_1 = 0.45\ \Omega$, $X_2 = 0.0045\ \Omega$, $R_{cH} = 10\ k\Omega$, $X_{mH} = 1.55\ k\Omega$. The secondary is delivering rated load current at rated voltage and 0.8 power factor lagging.

1. The voltage regulation is :
a) 2.1% b) 3.1% c) 2.2% d) 4.1%

2. The efficiency at full load is :
a) 97% b) 97.5% c) 98% d) 98.2%

3. The primary input voltage at full load is :
a) 2400 V b) 2453 V c) 2380 V d) 2498 V

4. The maximum efficiency will occur at a percentage of full load equal to :
a) 62% b) 70% c) 74% d) 85%

5. The load power factor angle that will give zero voltage regulation is :
a) 24° lag b) 24° lead c) 37° lead d) 37° lag

6. The no-load current as a percentage of full-load current is :
a) 2.1% b) 3.5% c) 2.6% d) 4.1%

7. The transformer is reconnected as a step-up 2400/2640 V autotransformer. The maximum kVA rating of the autotransformer is :
a) 150 b) 1418 c) 1716 d) 1650

B) Three of the transformers in (A) above are connected to form a 3-phase 2400/415 V transformer bank. The 3-phase transformer supplies a 3-phase 300 kVA , 415 V , 0.85 power factor lagging load.

8. The secondary line current is :
a) 417 A b) 355 A c) 491 A d) 722 A

9. The primary phase current is :
a) 72 A b) 36 A c) 49 A d) 42 A

C) A four-pole, separately excited dc generator has lap winding of 300 turns. The flux per pole is 0.025 Wb. The machine rotates at 1000 rpm. The armature resistance is 0.1 Ω and the rated current through the turn is 25 A.

10. The terminal voltage at full load is :
a) 250 V b) 247.5 V c) 125 V d) 240 V

11. The output power of the machine at full load is :
a) 24 kW b) 25 kW c) 12.5 kW d) 6.25 kW

12. The electromagnetic torque developed is :
a) 229 Nm b) 239 Nm c) 60 Nm d) 119 Nm

Answers

1	2	3	4	5	6	7	8	9	10	11	12

Electrical Engineering Department
First Exam EE 332
Electric Machines

Dr. Ahmad Harb — July 25, 2002

Q1:

a) A single phase transformer (220 KVA, 11 / 2.2 KV) is to be used as an autotransformer. Draw the connection that will result in maximum KVA rating and calculate this KVA rating.

b) What is the armature reaction effect? And how can you reduce that effect?

Q2: A single phase transformer (10 KVA, 2200/220 V, 60 Hz) has the following equivalent circuit parameters (in ohms):

$Z_{eq,\,II} = 10.4 + j\,31.3$
$R_{cII} = 48400$
$X_{mII} = 8980$

Standard no-load and short-circuit tests are performed on this transformer. Determine the no-load as well as the short-circuit tests values (V, I, and P)

Q3: A dc machine (6 KW, 120 V, 1200 rpm) has the following magnetization characteristics at 1200 rpm.

I_f	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2	(A)
E_a	5.0	20	40	60	79	93	102	114	120	125	(V)

The machine parameters are $R_a = 0.2$ ohm, $R_{fw} = 100$ ohm. The machine is driven at 1200 rpm and is separately excited. The field current is adjusted at $I_f = 0.8$ A. A load resistance $R_L = 2$ ohm is connected to the armature terminals.

- **No armature reaction:**
  (a) Determine the quantity $K_a\phi$ for the machine.
  (b) Determine E_a and I_a.
  (c) Determine the torque T and load power P_L.
- Repeat the above three parts with the present of armature reaction 0.2 A

With my best wishes for all of you

Dr. Ahmad Harb

Jordan University of Science & Technology
Electrical Engineering Department

First Examination

EE 332 *Electrical Machines I* 13.11.2002

Q.1. A 220 kVA , 11 kV / 2.2 kV , single phase transformer has the following parameters:

$R_{HV} = 1.3\ \Omega$ $X_{HV} = 4.5\ \Omega$
$R_{LV} = 0.05\ \Omega$ $X_{LV} = 0.16\ \Omega$
$R_{C(LV)} = 2.4\ k\Omega$ $X_{m(LV)} = 0.8\ k\Omega$

a) Draw the approximate equivalent circuit referred to the HV side and show the parameter values.
b) Determine the no-load current in amperes and as a percentage of rated current.
c) If the low-voltage winding terminals are shorted, determine:
   i) The supply voltage required to pass rated current through the shorted winding.
   ii) The losses in the transformer.
d) The HV winding of the transformer is connected to the 11 kV supply and a load , $Z_L = 15\ \angle -90^\circ\ \Omega$ is connected to the low-voltage winding. Determine:
   i) Load voltage.
   ii) Voltage regulation.

(50%)

Q.2. A six-pole, 1500 rpm, dc generator has 48 armature slots with 6 conductors per slot. The flux per pole is 20 mWb and each armature conductor has a maximum current carrying capacity of 40 A.
a) Calculate the terminal voltage, armature current and power rating for a lap winding.
b) Repeat part (a) for a wave winding.

(25%)

Q.3. Three , single phase , 15 kVA , 480 / 120 V transformers are connected to form a three phase , 480 / 208 V transformer bank. The equivalent impedance of each transformer referred to the high-voltage side is (1 + j2) Ω. The transformer supplies a three-phase, 208 V , 32 kW , 0.8 power factor leading load.
a) Draw a schematic diagram showing the transformer connection.
b) Determine the transformer winding currents and the primary input current.
c) Determine the primary voltage and voltage regulation.

(25%)