KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 313: ELECTRICAL MACHINES II

DATE: FRIDAY 20TH APRIL 2012 **TIME: 8.00 A.M. – 10.00 A.M.**

INSTRUCTIONS

This paper contains TWO sections A and B.

- **Section A** to be attempted by **First Semester** and
- **Section B** to be attempted by **Second Semester Group**

SECTION A: FIRST SEMESTER GROUP

- Answer Question 1 and any other TWO questions from this section.

QUESTION ONE – COMPULSORY

a) With the aid of the general arrangement of a single phase transformer, show that the full-load primary ampere-turns is approximately equal to full-load secondary ampere-turn. (6 marks)

b) Sketch the voltage waveforms of a three phase transformer and with the aid of a voltage phasor diagram, show the relationship of the phase voltage and time voltage.(6 marks)

c) With the aid f circuit diagram of open-circuit test and short-circuit test on a transformer, explain their significance in transformer. (6 marks)

d) State any tow advantage and two disadvantage of ac motors used for various industrial drives. (6 marks)

e) Sketch the waveforms of tow alternative flux of a two phase 3-wire system of supply to a phase induction motor and show that the result and flux (ϕr) at any instant in time is expressed as

$\phi r = \phi m$

Where ϕr = resultant flux

ϕm = mximum flux of each phase (6marks)

QUESTION 2

A three phase 415-V induction motor gave the following test results
No load: 415V, 120W, 9A
Short circuit: 150V, 4kw, 38A
Draw the circle diagram

If the normal rating is 14.9 KW, find form the circle diagram

(i) The full-load
(ii) Value of current
(iii) Power factor
(iv) Slip

(20 marks)

QUESTION THREE

A 500-kva, 3-PHASE, 50 Hz transformer has a voltage ration (line voltages) of 33/11KV and is delta connected. The resistance per phase is: high voltage 35 Ω, low voltage 0.876 Ω and the iron loss is 3050 watts.

Calculate the value of efficiency at full load and half full load respectively at

a) unity power factor
b) 0.8 power factor

(20 marks)

QUESTION 4

A single-phase transformer is rated at 100-KVA, 2300/230-V, 50Hz. The maximum flux density n the core is 1.2wb/m^2 and the net cross-sectional area of the core is 0.04 m^2. Determine:

a) The number of primary and secondary turns needed.
b) If the mean length of the magnetic circuit is 2.5 m and the relative permeability is 1200; determine the magnetizing current. (Neglect the current drawn for the core loss)
c) On short circuit with full-load current flowing, the power input is 1200w and an open-circuit with rated voltage, the power input was 400w determine the efficiency of the transformer at 75% of full-load with 0.8 power factor lag.
d) If the same transformer is connected to a supply is similar voltage but double the frequency, what is the effect on its efficiency.

(20 marks)

QUESTION FIVE.

(a) A 3-phase slip-ring induction motor with star-connected rotor has an induced e.m.f of 120 volts between slip-rings at standstill with normal voltage applied to the stator. The rotor winding has a resistance per phase of 0.3 Ω. Calculate
(i) Rotor current per phase when running short-circuited with 4% slip and
(ii) The slip rotor current per phase when the rotor is developing maximum torque.

(b) The power supplied to a three induction motor is 64 KW and the stator losses are 2.4 KW. If the slip is 6%, determine:
(i) Rotor copper loss
(ii) Total mechanical power developed by the rotor.
(iii) Output power of the motor if friction and windage losses are 1.5 KW
(iv) Efficiency of the motor neglecting rotor iron loss. (20 marks)

SECTION B: SECOND SEMESTER GROUP

- Answer question **ONE (1)** and any other **TWO (2)** questions

Question 1 — 30 marks

a) (i) State three major advantages of induction machines. (3 marks)

(ii) Explain with the aid of sketch diagrames the formation of a rotation magnetic field in a three phase induction motor. (6 marks)

(iii) Explain four losses that occcur in an induction machine. (4 marks)

b) (i) What do you understand by transformer vector groups? (2 marks)

(ii) State four conditions that must be met for transformers to operate in parallel. (4 marks)

(iii) One possible connection for a 3-phase transformer bank is Y-Y. State two problems associated with this connection . How are these problems solved? (4 marks)

c) Give the two types of instrument transformers. Using a circuit connection diagram, explain there operation. (4 marks)

d) Make a brief description of an autotransformer? State one major disadvantage of an autotransformer. (3 marks)

Question 2 — 20 marks

a) How can one accuratelly determine the efficiency of a transformer. (3marks)

b) A 2KVA, 50Hz power transformer has the following equivalent circuit parameters referred to the primary:

$R_e = 0.682\Omega$ $X_e = 0.193\Omega$ $R_c = 1080\Omega$

$X_m = 657\Omega$ $N_2/N_1 = 0.472$

If the primary is connected to 230V 50Hz supply and a load of $6.0+j2.5\Omega$ is connected to the secondary, determine:

(i) Sketch the equivalent diagram and indicate the given parametors. (3 marks)

(ii) the secondary current magnitude. (3 marks)

(iii) the magnitude of the secondary terminal voltage. (2 marks)

(iv) the primary current magnitude. (3 marks)

(v) the voltage regulation. (3 marks)

(vi) the efficiency of the transformer. (3 marks)

Question 3

20 marks

a) (i) Hilight the main disadvantage of a single phase induction motor. (2 marks)

(ii) Draw an equivalent circuit of an elementary single phase induction motor. Sketch its torque-speed characteristic. What observation can you make from your sketch. (6 marks)

b) With the aid of sketch diagrames explain the various modes of starting a single phase induction motor. (12 marks)

Question 4

20 marks

a) What is per unit system. State three advantages of using p.u system. (4 marks)

b) Consider a simple power system given by the circuit in Fig. Q4 (b) below.

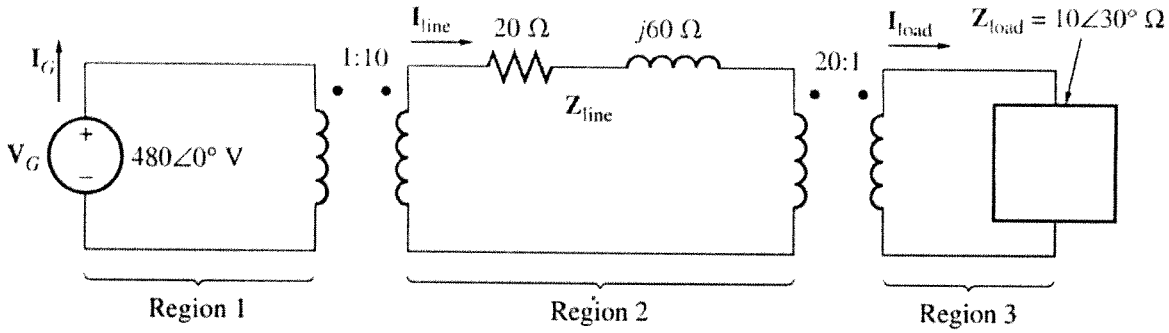

Fig. Q4 (b)

The generator is rated at 480V and 10 kVA.

(i) Find the base voltage, current, impedance, and apparent power at every points in the power system; (4 marks)

(ii) Convert the system to its per-unit equivalent circuit; (3 marks)

(iii) Find the power supplied to the load in this system; (3 marks)

(iv) Find the power lost in the transmission line. (3 marks)

c) Draw the winding connection of a Scott 3-phase to 2-phase transformer. Briefly describe its operation. (3 marks)

Question 5

20 marks

a) Sketch and briefly explain the slip-torque characteristics of an induction machine. (6 marks)

b) Skecth an equivalent circuit of an induction motor. (2 marks)

c) A 4-pole 3KW star connected induction motor operates from 50Hz-415V line to line supply. The equivalent circuit parameters per phase are as follows:

$R_s = 2.27\Omega$ $R_r = 2.28\Omega$ $r_c = 3.95\Omega$

$X_m = 74.8\Omega$ $X_s = 2.83\Omega$ $X_r = 2.83\Omega$

If the full-load slip is 5%, determine:

(i) the no-load current. (3 marks)

(ii) the full-load stator current. (2 marks)

(iii) the full-load rotor current. (2 marks)

(iv) the full-load speed in rev/min. (3 marks)

(v) the full-load developed torque. (2 marks)