TECHNICAL UNIVERSITY OF MOMBASA

FACUULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTRMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EEE2230: INTRODUCTION TO ELECTRICAL MACHINES

END OF SEMESTER EXAMINATION

SERIES: APRIL 2017

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) Explain the following terms for electrical machines

i. Output Torque
ii. Power
iii. Electromotive Force
iv. Tangential Speed

(4 Marks)

b)

i. State any TWO hazards associated with Electrical machines
ii. Compare and contrast any FOUR features of electrical machines with those of mechanical machines

(6 Marks)

c)

i. Describe with the aid of a cross sectional sketch the construction of a Electromagnet DC Motor
ii. Explain the structural difference between the Electromagnet DC Motor above and a Permanent Magnet AC Generator

(10 Marks)

d)

Show from first principle and with the aid of sketches that the e.m.f. produced by an AC generator is given by:

$$E_G = K_G sin\theta$$

Hence determine the angular speed required to rotate a 50 turn coil generator having length per turn of 200cm with 90% of coil effective length to produce 270V peak. Take the armature radius of 5cm and air gap Flux Density of 30T.

(10 Marks)

Question TWO

a)

i. Explain with the aid of a sketch the term armature Reaction in DC machines

ii. State the problem caused by armature reaction in the machine above

(5 Marks)

b) A DC Motor has the following Parameters:

- No. of Poles = 12
- Winding Type = Lap Wound
- No. of Armature Conductors =960
- Field turns = 200
- Field Current =0.5A
- Pole Reluctance = 2kΩ

Given that the machine is rotating at 500 revolutions per minute with armature current of 20A,

i. Show that torque produced is given by $T_m=K_mI_a$
ii. Calculate the Torque produced
iii. Find Mechanical power output

(7 Marks)

c) Read the DC machine shunt circuit **Fig Q2(c)** below and answer the questions following it:

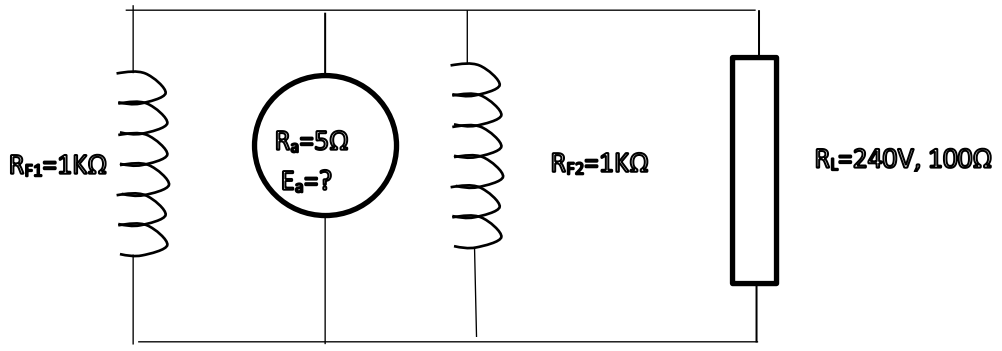

Fig Q2(c)

Calculate:

i. Field Current
ii. Total output current of the generator
iii. The electrical power generated

(8 Marks)

Question THREE

a) State the purpose of the following parts of a transformer:
   i. Core
   ii. Primary winding
   iii. Winding insulation

(3 Marks)

b)
   i. With the aid of a sketch and transformer equations explain the principle of operation a transformer
   ii. State the features of the high voltage winding in the transformer above compared to primary.

(11 Marks)

c) A single phase transformer is required to supply a 12kW, 240V load from a 12V battery supply via an inverter. If the secondary number of turns are 200, determine:
   i. The turns ratio required and the number of primary turns
   ii. The current and power output of the battery
   iii. The load current

(6 Marks)

Question FOUR

a) Define the following terms for induction machines:
   i. Slip
   ii. Synchronous speed
   iii. Standstill torque

(3 Marks)

b)
   i. State any THREE advantages of induction machines over DC machines
   ii. Using a classification diagram show types of losses in an induction machine

(7 Marks)

c) Fig. Q4(c) below is a per phase equivalent circuit of an induction machine.

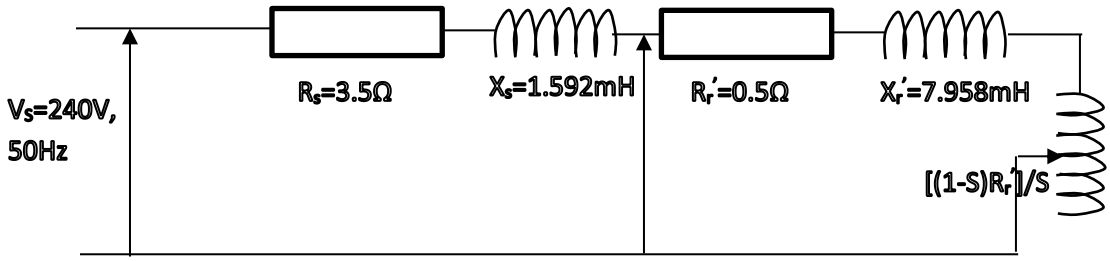

Fig. Q4(c)

Show that when a variable voltage constant frequency **(VV/Hz controller)** drive is applied the Torque output is given by:

$$T_m = k_m V_s^2$$

Hence determine the torque output for a 1- phase induction machine having the equivalent circuit above at full and at half voltages respectively. Take slip of 5%.

(10 Marks)

Question FIVE

a)

i. Describe how revolving field phenomena aids starting of 3-Phase induction machines
ii. With the aid of labelled sketch explain how a3-phase Direct-on-line- starter works
iii. State ONE advantage of DOL starter over Star-Delta Starter System

(10 Marks)

b) Explain any

i. THREE unique applications of stepper motors
ii. TWO disadvantages of electronically driven machines

(5 Marks)

c) 240V, 50Hz, 20Hp input, 24 pole, 1-Phase, synchronous generator has total losses of 920W while operating at power factor of 0.8. Calculate:

i. Efficiency of the machine
ii. Power and current output
iii. The input torque

(5 Marks)