



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

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 Date Select Month Pick 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
- Output Torque
 - Power
 - Electromotive Force
 - Tangential Speed

(4 Marks)

- b)
- State any TWO hazards associated with Electrical machines
 - Compare and contrast any FOUR features of electrical machines with those of mechanical machines

(6 Marks)

- c)
- Describe with the aid of a cross sectional sketch the construction of a Electromagnet DC Motor
 - 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 = $2\text{k}\Omega$

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

- i. Show that torque produced is given by $T_m = K_m I_a$
- 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:

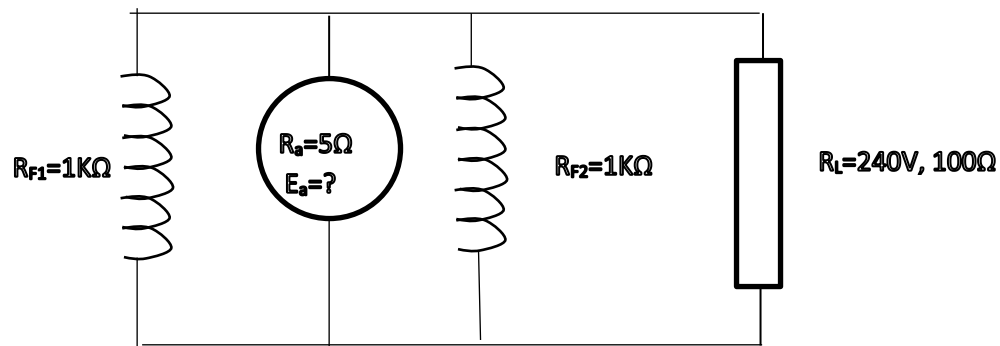


Fig Q2(c)

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:
- Core
 - Primary winding
 - Winding insulation
- (3 Marks)**
- b)
- With the aid of a sketch and transformer equations explain the principle of operation a transformer
 - 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:
- The turns ratio required and the number of primary turns
 - The current and power output of the battery
 - The load current
- (6 Marks)**

Question FOUR

- a) Define the following terms for induction machines:
- Slip
 - Synchronous speed
 - Standstill torque
- (3 Marks)**
- b)
- State any THREE advantages of induction machines over DC machines
 - 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.

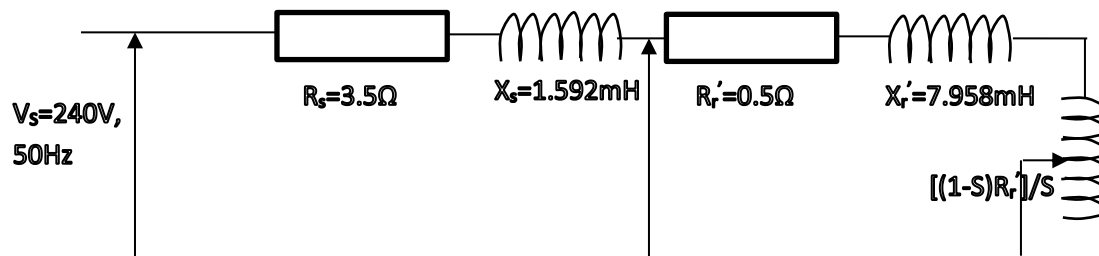


Fig. Q4(c)

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 a 3-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)