TECHNICAL UNIVERSITY OF MOMBASA

Engineering

Electrical Deparment

UNIVERSITY EXAMINATION FOR

EEE2330 Introduction to electrical machines paper 2

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: SEPTEMBER 2018

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) (i) Describe the principle of operation of a DC machine

(ii) Derive an expression for E.M.F generated by a generator

(iii)A 6pole dc generator runs at 1200rpm on no load and has a generated e.m.f of 250V. Its armature diameter is 350mm and the radial air gap between the field poles and the armature is 3mm. The axial length of the field poles is 260mm and the field poles effective coverage is 80%. If the armature has 96 coils having 3 turns per coil and is wound duplex lap calculate flux per pole, effective pole length arc, average air gap flux density **(10mks)**

(b) (i)Explain how self excitation takes place in a self excited DC generator and with aid of sketches differentiate between long shunt and shunt DC generator

(ii) A separately excited DC generator when running at 1200rpm supplies 200A at 240V, to a circuit of constant resistance. What will be the load current, when the speed is dropped to 1000rpm if the field is unaltered? Armature resistance=0.04ohms, RL=0.625 and total voltage drop=2V **(8mks)**

c) (i) Show that the torque equation of a DC motor is given by $T_a = 0.159 z \theta I_a \frac{(P)}{(A)} NM$

(ii) An armature of a 6pole machine 75cm in diameter has 664 conductors each having an effective length of 30cm and carrying a current of 100A. If 70% of total conductors lie simultaneously in the field of average flux density of o.85wb, calculate the armature torque and the horsepower output at 250rpm

(iii) (State the reason why they are preferred to AC motors in industrial application (12mks**)**

Question 2

(a)(i) Explain why DC motors are preferred to AC motors in industrial application **(2mks)**

(iii) Derive the power equation of a DC motor and express conditions for maximum power **(4mks)**

(iii) The counter emf of a shunt motor is 227V, the field resistance is 160ohms and the field current is 1.5A. The line current is 39.5A. Find the armature resistance. Also find the armature current when the motor is stationary **(12mks)**

(b)(i) Describe the importance of back emf during the operation of a DC motor

(ii) A 500V shunt motor runs at its normal speed of 250rpm, when armature current is 200A. The resistance of the armature is 0.2ohms. Calculate the speed when a resistance is inserted in the field winding reducing the shunt field to 80% of the normal value. The armature current is 100A.**(8mks)**

Question 3

(a)(i) Derive an expression for the starting torque of a three phase induction motor and explain the effect of change in supply voltage V on the starting torque

(ii) Show that starting torque will be maximum when $R_2 = X_2$ for a three phase induction motor and explain how starting torque of a wound rotor motor can be improved

(iii)Explain how an Induction motor is capable of maintaining constant speed even when a load is added on its shaft **(10marks)**

b (i) State TWO strategies which can be used to control the speed of a shunt motor

(ii) Describe the ward-Leonard speed control method for DC shunt motor

(c) A 10KW, 250 shunt generator having an armature resistance of 0.1ohms and field resistance of 250ohms delivers full load at rated voltage and 800rpm. The machine is now run as a motor while taking 10KW at 250V. What is the speed of the motor? Neglect brush contact drop (**10mks)**

Question 4

(a)(i) Describe the phaser diagram diagrams of a practical transformer on load and on no load

(ii) Describe winding resistance and leakage fluxes as used in practical transformers

(b) A single phase transformer on no load takes 4.5A at a power factor of 0.25 lagging, when connected to a 230V, 50Hz supply. The number of turns of the primary winding is 250. Calculate magnetizing current, core loss and maximum flux in the core. **(10mks)**

(b) (i) Derive the E.M.F equation of a transformer

(ii) Describe TWO conditions the primary current of practical transformer on load must meet for successful operation

(iii) The voltage on the secondary of a single phase transformer is 200V, when supplying a load of 8KW at a power factor of 0.8 lagging. The secondary resistance is 0.04ohms and the secondary leakage reactance is 0.8ohms. Calculate the induced E.M.F in the secondary **(10mks)**

Question 5

(a) (i) Define Slip and explain how it affects the operation of a three phase induction motor

(ii) Derive an expression for the starting torque of a three phase induction motor and explain the effect of change in supply voltage V on the starting torque

(iii) A 4 pole, 3 phases, 50Hz induction motor has a star connected rotor. The rotor has a resistance of 0.1 ohms per phase and standstill reactance of 2ohms per phase. The induced e.m.f between the slip rings is 100V. If the full load speed is 460rpm, calculate the slip, the induced e.m.f in the rotor of each phase, the rotor current and the motor power factor, assume the slip rings are short circuited **(14)**

(b)(i)Explain why a single phase induction motor is not self starting and how the motor can be made self starting

(ii)Describe the construction and principle of operation of capacitor start, capacitor run single phase induction motor **(6mks)**