TECHNICAL UNIVERSITY OF MOMBASA

Engineering

Electrical Department

UNIVERSITY EXAMINATION FOR:

EEE2214: ELECTRICAL MACHINES I

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2 HOURS

DATE: MAY 2016

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)

1 (a) (i) State the difference between motors and generators and describe TWO laws which govern the principle of operation of all rotating electrical machines **(5mks)**

(ii) With aid of a sketch describe the field system of a DC machine **(5mks)**

(iii) Derive the E.M.F equation of a generator and state assumptions made **(3mks)**

(b) A six pole 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 **(6mks)**

(c) 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 **(5mks)**

(d) In a 120V compound generator the resistance of the armature, shunt, and series winding are 0.06Ω, 25Ω and 0.04Ω respectively. The load current is 100A at 120V. Find the armature current and induced EMF when the machine is connected as (i) long shunt and as (ii) short shunt. How will ampere turns of series field be changed in (i) if a diverter of 0.1Ω is connected in parallel with the series winding? Neglect brush contact drop and ignore armature reaction. **(6mks)**

Question TWO

(a)(i) State TWO reasons why DC motors are preferred to AC motors in Industrial application **(2mks)**

(ii) Describe the principle of operation of a DC motor and explain the importance of back EMF **(5mks)**

(iii) Show that mechanical power developed by a motor is maximum when $E_b = \frac{V}{2}$, where E_b is the back EMF **(5mks)**

(b) (i) Describe the difference of armature torque (T_a) and shaft torque (T_{Sh}) of a DC motor**(2mks)**

(ii) Derive the gross torque equation of a DC motor and show that it can also be given by $Ta = 9.55 \times \frac{EbIa}{N} N/M$ **(4mks)**

(iii) A 100h.p, 500V shunt motor has 4 poles and a 2 circuit wave winding with 492 conductors. The flux is 50mwb per pole and full load efficiency 92%. The armature and commutating field winding have a total resistance of 0.1Ω. The shunt field resistance is 250Ω. Calculate for full load (i) the speed (ii) the useful torque **(4mks)**

Question THREE

(a) (i) State the THREE major characteristics of a DC motor and describe the N/I_a characteristics of a compound motor **(3mks)**

((ii) With aid of sketches describe any TWO methods which can be used to control the speed of a DC series motor **(3)**

(iii) A d.c series motor connected to a 440V supply runs at 600rpm when taking a current of 60A. Calculate the value of resistance, which when inserted in series with the motor will reduce the speed to 400rpm, the gross torque then being half of the previous value. The resistance of the motor is 0.2ohms. Take flux to be proportional to field current **(4mks)**

(b)(i) State TWO strategies which can be used to control the speed of a shunt motor **(2mks)**

(ii) Describe the ward-Leonard speed control method for DC shunt motor **(4mks)**

(iiiA 240V dc shunt driven motor runs at 800rpm and takes armature current of 2A. Find the resistance required in series with the shunt winding so that the motor may run at 950rpm when taking

armature current of 28A. Assume flux is proportional to field current. The shunt field resistance is 160Ω and armature resistance is 0.4Ω. (**4mks)**

Question FOUR

(a)(i) Define a transformer and with aid of an equivalent phasor diagram explain the operation of an ideal transformer **(2mks)**

(ii) Describe winding resistance and leakage reactance as used in practical transformer and draw equivalent circuit diagram of a practical transformer **(3mks)**

(b) 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 **(5mks)**

(c) (i) 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

(ii) Describe TWO conditions the primary current of practical transformer on load must meet for successful operation. **(5mks)**

(iii) A single phase transformer with a ratio of $440/110$ takes no load current of 5A at 0.2 power factor lagging. If the secondary supplies a current of 120A at a power factor of 0.8 lagging and power, draw the phasor representation of this transformer and calculate the current taken by the primary **(5mks)**

Question FIVE

(a)(i)Explain the need for testing a DC motor **(2mks)**

(ii) Show that in brake test, the efficiency of a D.C machine is given by $n = \frac{2\pi N(W-S)\times r\times 9.8}{60\times V_1}$ **(3mks)**

(b) In a brake test on a small shunt motor, the speed was 1500rpm, the load on one side of the brake band was 28.9N and the other side is 1.67N. The diameter of brake pulley was 15.2cm. If the input current was 2A at 250V, determine, Torque, brake horse power and efficiency **(5mks)**

(c)(i) Describe simplex DC motor wave winding and define its various pitches **(2mks)**

(ii) Define the terms coil span and commutator pitch as used in DC winding systems **(3mks)**

(d) Design a 4 pole simplex lap winding suitable for an armature containing 20 slots; assume a single turn's coil with 2 conductors per slot. **(5mks**