KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

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

EEE 300: ELECTRICAL MACHINES I

DATE: MONDAY 16TH APRIL 2012 **TIME: 2.00 P.M. – 4.00 P.M.**

INSTRUCTIONS:
Answer question ONE and any other TWO questions from this examination paper

QUESTION ONE

a) A conductor carries a current of 20A and is at right angles to a magnetic field having a flux density of 0.9T. If the length of the conductor in the field is 30 cm, calculate the force acting on the conductor. Determine also the value of the force if the conductor is inclined at an angle of 30^{o} to the direction of the field. **(5 marks)**

b) With the aid of schematic circuits, explain action of a commutator. **(5 marks)**

c) Considering all the DC machine losses, deduce the expression of the efficiency of a dc generator. **(5 marks)**

d) A 250 V series motor draws a current of 40 A. The armature resistance is 0.15Ω and the field resistance is 0.05Ω. Determine the maximum efficiency of the motor **(5 marks)**

e) A three-phase induction motor is supplied from a 50 Hz supply and runs at 1200rev/ when the slip is 4%. Determine the synchronous speed. **(5 marks)**

e) A 4500 V/225 V, 50Hz single phase transformer is to have an approximate e.m.f per turn of 15 V and operate with a maximum flux of 1.4T. Calculate the number of primary and secondary turns and also the cross-sectional area of the core. **(5 marks)**

QUESTION TWO

a) With the aid of a phasor diagram, explain the operation of an electro-mechanical system shown in figure Q2.

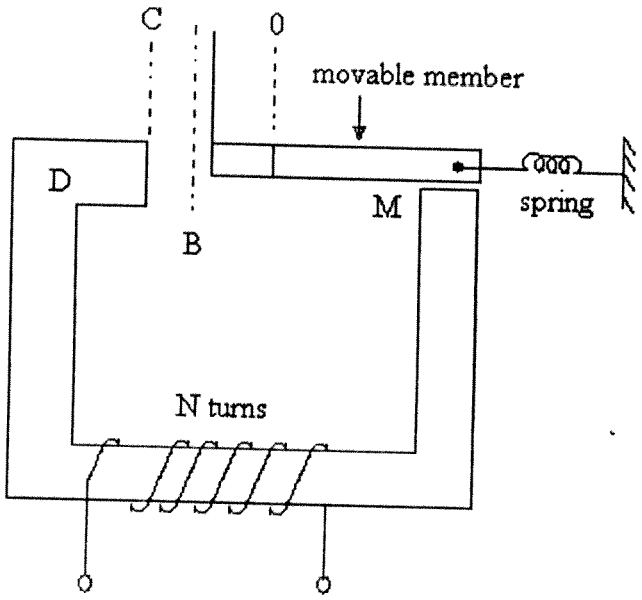

Figure Q2

b) An electromagnetic relay has an exciting coil of 800 turns. The coil has a cross-sectional area of 5cm x 5cm. Neglect reluctance of the magnetic circuit and fringing. (Sketch the schematic diagram of this relay).
Find the:

i) coil inductance if the air-gap length is 0.5 cm.
ii) field energy stored for a coil current of 1.25 amperes.
iii) If coil current remains constant at 1.25A, find the mechanical energy output based on field-energy changes when the armature moves to a position for which x = 0.25cm. (Assume slow movement of the armature)

QUESTION THREE

a) With the aid of a diagram explain how a dc machine is constructed. **(4 marks)**

b) Sketch the schematic diagram of an electro-mechanical system of a dc motor and deduce the expression for the torque developed by the dc motor and show that it can be expressed as

$$T = \left(\frac{p\Phi z}{\pi c}\right) I_a$$

(7 marks)

c) A series motor runs at 800rev/min. when taking 120A from a 240 V supply. The resistance of the armature circuit is 0.15Ω and that of the series winding is 0.05Ω. Calculate the speed when the current has fallen to 50A, assuming the useful flux per pole for 120A to be 0.0158Wb. **(8 marks)**

QUESTION FOUR

a) The stator of a 3-phase, 4-pole induction motor is connected to 50Hz supply. The rotor runs at 1420rev/min at full load. Determine the synchronous speed and slip at full-load. **(4 marks)**

b) The power supplied to a 3-phase induction motor is 82kW and the stator losses are 2kW. If the slip is 7.5%, determine the:

i) rotor copper losses
ii) output power of the motor if friction and windage losses are 900W
iii) total mechanical power developed by the motor
iv) efficiency of the motor neglecting rotor iron losses.

(8 marks)

c) A 415 V, three-phase, 50Hz, 4-pole, star connected induction motor runs at 24revsec^{-1} on full-load. The rotor resistance and reactance per phase are 3.5 Ω and 4.2 Ω, respectively, and the effective rotor-stator turns ratio is 0.85:1. At full-load, determine the:

i) rotor copper loss
ii) starting current
iii) full-load torque

(8 marks)

QUESTION FIVE

a) With the aid of schematic diagram and the resulting voltage waveform, explain how the three-phase voltage is generated. **(4 marks)**

b) Assuming a three-phase balanced load deduce the expression for the line and phase voltage and also line and phase currents for a STAR and DELTA connected loads. **(6 marks)**

c) A three-phase transformer supplies a delta connected loads as indicated: between red and yellow phases a purely resistive load of 100 Ω; between red and blue phases, a purely capacitive load of 30μF. Between yellow and blue phases an inductive load of 20 Ω and inductance of 0.191H.

i) phase currents
ii)line current of the red phase (I_R) if the supply voltage is 415,50Hz.