MURANG'A UNIVERSITY COLLEGE

(A Constituent College of Jomo Kenyatta University of Agriculture and Technology)

DEPARTMENT: ELECTRICAL AND ELECTRONIC ENGINEERING

LEVEL: Diploma in Electrical and Electronic Engineering

CLASS: KNEC/EEP/15DJ MOD III

TERM/SEMESTER: I

YEAR OF STUDY 3

ACADEMIC YEAR: 2014/2015

UNIT TITLE: MACHINES AND UTILIZATION

UNIT CODE: EE1307

DATE:17TH APRIL 2015 **TIME:** 2 HOURS

EXAMINATION: **MAIN**(JAN-APR 2015)

Instructions to candidates

i) This paper contains seven (7) questions

ii) Answer any **five(5)** of the questions

iii) Mobile phones are not allowed in the examination room

iv) You should have the following for this examination;

- Drawing instruments
- Scientific calculator

1. a) Describe the main parts in the construction of an induction motor [**12mks]**
   b) Explain why the conductors in a squirrel cage rotor are skewed. **[4mks]**
   c) Explain why the rotor of an induction motor cannot run at synchronous speed [**4mks]**

2. a) Explain how torque is produced in an induction motor [**8mks]**

   b) Show that the frequency of rotor current is f'=sf [4**mks]**
   c) A 4-pole, 3-phase induction motor operates from a supply whose frequency is 50Hz. Calculate

   i) the speed at which the magnetic field of the stator is rotating
   ii) the speed of the rotor when the slip is 0.03
   iii) the frequency of the rotor currents when the slip is 0.04
   iv) the frequency of the rotor currents at standstill [**8mks]**

3. a) Derive the following torque relationships for an induction motor [**8mks**

i) starting torque and full load torque

ii) full load torque and maximum torque

b) A 746-kW, 3-phase, 50Hz, 16-pole induction motor has a rotor impedance of (0.02+ j0.15) Ω at stand still. Full load torque is obtained at 360rpm. Calculate:

i) the synchronous speed

ii) full load speed

iii) full load slip

iv) the ratio of maximum to full - load torque

v) the speed of maximum torque

vi) the rotor resistance to be added to get maximum starting torque [**12mks]**

4. a) Explain why a synchronous motor is not self-starting [**8mks]**

b) Explain how a synchronous motor is started [**4mks]**

c) A 1MVA, 11KV, 3-phase, star connected synchronous motor has an armature resistance and reactance per phase of 3.5Ω and 40Ω respectively. Determine the induced emf and angular retardation of the rotor when fully loaded at 0.8 lagging [**8mks]**

5. a) State TWO advantages and TWO applications of synchronous motor [**4mks]**

b) Explain the term hunting as applied in synchronous motor [**6mks]**

c) A 400V, 50Hz, 6-pole, 3-phase, Y-connected synchronous motor has a synchronous reactance of 4Ω/phase and a resistance of 0.5Ω/phase. On full load, the excitation is adjusted so that the machine takes an armature current of 60A at 0.866 p.f. leading. Excitation, friction, windage and iron losses total 2kW. Keeping the excitation unchanged, determine the maximum power output. [**10mks**

6. a) Describe briefly the effect of varying excitation of a synchronous motor when input power to the motor is maintained constant upon the:

i) armature current

ii) power factor [**8mks**

b) A 400V, 50Hz, 3-phase, 37.3kW, star -connected synchronous motor has a full load efficiency of 88%. The synchronous impedance of the motor is (0.2+j1.6)Ω per phase. If the excitation of the motor is adjusted to give a leading p.f. of 0.9, calculate for full load;

i) the induced emf

ii) the total mechanical power developed [**12mks**

7. a) i) State the voltage equation of a dc motor [**2mks**

iii) derive the condition for maximum power in a dc motor [**6mks**

b) i) With the aid of a graph show the toque/armature current characteristic of a dc series motor [**4mks]**

c) A 250V shunt motor runs at 1000rpm at no-load and takes 8A. The total armature and shunt field resistances are respectively 0.2Ω and 250Ω. Calculate the speed when loaded and taking 50A. Assume the flux to be constant. [**6mks]**