TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:
HIGHER DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEP 3204: ELECTRICAL MACHINES I

END OF SEMESTER EXAMINATION
SERIES: MAY 2016
TIME: 2 HOURS
DATE:

Instructions to Candidates
You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of FIVE questions. Attempt any **THREE Questions**
Do not write on the question paper.

QUESTION ONE

a. With the aid of a diagram, explain the operation of Split phase induction motor. (5 marks)

b. Derive the expression for the starting torque of a three phase induction motor and explain the effect of change of supply voltage V on the starting torque. (5 mark)

c. Explain three factors that affect the speed of a dc motor. (6 marks)

d. A 350V shunt motor runs at its normal speed of 600 r.p.m when the armature current is 100A. The resistance of armature is 0.2Ω. Calculate the speed when a resistance is inserted in the field reducing the shunt field to 90% of normal value and armature current is 200A. (4 marks)

QUESTION TWO

a. A 3- phase induction motor is wound for 6 poles and is supplied from 60Hz system. Calculate :
   (i) The synchronous speed.
   (ii) The speed of the motor when slip is 3%.
   (iii) Rotor current frequency when motor runs at 800 r.p.m. (6 marks)

b. A 4-pole inductor motor has a star-connected rotor. The rotor has a resistance of 0.1Ω per phase and standstill reactance of 2Ω/phase. The induced emf between the slip rings is 100V. if the full-load speed is 1460rpm, calculate:
   i. The slip.
   ii. The emf induced in the rotor in each phase.
   iii. The rotor reactance per phase.
   iv. The rotor current.
   v. Rotor power factor. (assume slip rings are short-circuited) (10 marks)

c. Explain how Torque-Slip Characteristics vary when adding resistance to rotor circuit? (2 marks)

d. What is the condition for maximum torque in induction motor? (1 mark)

e. State three applications of a single phase induction motor (3 marks)

QUESTION THREE

(i) Explain why a single phase induction motor is not self starting and how the motor can be made self starting. (4 marks)

(ii) At starting, the winding of a 230V, 50Hz, split-phase induction motor have the following parameters:

Main winding: $R = 4\Omega$; $X_L = 7.5\Omega$

Starting winding: $R = 7.5\ \Omega$; $X_L = 4\Omega$.

Find:
   a. Current I_m in the main winding.
   b. Current I_s in the starting winding.
   c. Phase angle between I_s and I_m.
   d. Line current.
   e. Power factor of the motor. (8 marks)

(iii) Explain the disadvantages of Star-Delta Starting of Induction motor. (2 marks)

(iv) Explain why power factor of a single phase induction motor is low. (2 marks)

(v) Give two methods employed in making single phase induction motors self-starting. (2 marks)

QUESTION FOUR

(i) Describe the torque- slip characteristics of a three phase induction motor. (5 marks)

(ii) Describe how speed control of a three phase induction motor by changing the applied voltage can be achieved and state any TWO limitations of this method. (5 marks)

(iii) A dc motor takes an armature current of 220A at 960V. The armature circuit resistance is 0.4Ω. The machine has 6 poles and the armature is lap connected with 1728 conductors. The flux per pole is 0.1wb. calculate:
   (a) The speed.
   (b) The gross torque developed by the armature. (4 marks)

(iv) A 250V, 60 kW, 1200 rpm dc shunt motor has on full load an efficiency of 80%. The armature circuit resistance is 0.25Ω and there is total voltage drop of 1v at the brushes. The field current is 1.7A. determine:
   (a) Full load current.
   (b) Full load shaft torque in N-m.

(v) Total resistance in motor starter to limit the starting current to 1.5 times the full load. (6 marks)

QUESTION FIVE

f. Explain the principle on which electric motor works. (4 marks)

g. Explain how the speed of a dc motor can be regulated using the rheostatic control method. (4 marks)

h. A 3-phase synchronous motor has 12 poles and operates from 440V, 50Hz supply. Calculate its speed. If it takes a line current of 100A at 0.8 power factor leading, what torque the motor will be developing? Neglect losses. (4 marks)

i. A 3-phase slip ring motor gives a reading of 55V across slip rings on open circuit when at stand still with normal stator voltage applied. The rotor is star-connected and has impedance of (0.7 + j5) Ω per phase. Find the rotor current and pf when the machine is:
   a. At standstill with slip rings joined to a star-connected starter with a phase impedance of (4 + j3) Ω.
   b. When running normally with a 5% slip. (8 marks)