



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

## *Faculty of Engineering and Technology*

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

### **DIPLOMA IN TECHNOLOGY**

Electrical Power Engineering

**EEC 2205**

### **MACHINES UTILIZATION I**

SEMESTER EXAMINATION

**SERIES:** FEBRUARY 2011 SERIES

**TIME:** 2 HOURS

#### **Instructions to Candidates:**

1. You are required to have the following for this examination;
  - Answer booklet
  - A non-programmable calculator
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions.

**(COMPULSORY)**

**Question ONE**

- a) i) Explain any THREE significance of back emf in d.c motors. (3 marks)
- ii) A 440V shunt motor has an armature resistance of  $0.8\Omega$  and a field resistance of  $200\Omega$ . Determine the back emf when the motor is giving an output of 7.46 kw at 85% efficiency. (4 marks)
- iii) State any THREE applications of d.c. shunt motors. (3 marks)
- b) i) State any TWO application of the following single phase machine.  
I) Hysteresis motors  
II) Universal motor (4 marks)
- ii) With the aid of a circuit diagram, explain the operation of a capacitor start – capacitor run single phase induction motor. (6 marks)
- c) i) State any TWO types of rotors used in induction motor. (2 marks)
- ii) A 3-phase induction motor is wound for a pole and is supplied from 50Hz system. Calculate:  
I) The syndronous speed  
II) The rotor speed when the slip is 4%  
III) Rotor frequency when the rotor is at 600vpm. (3 marks)
- iii) Using a well labelled diagram explain the autotransformer method of starting induction motors. (5 marks)

**(ANSWER ANY OTHER TWO QUESTIONS)**

**Question TWO**

- a) i) State any THREE tests carried in d.c. machines. (3 marks)
- ii) Show that the armature torque developed in a series d.c motor is given by:  
 $T_a \propto T_a^2$  (7 marks)
- b) i) State any TWO applications of the following d.c. motor  
I) Compound motors  
II) Series Motors (4 marks)
- ii) A 25kw 250v d.c. slunt generator has an armature field resistance of  $0.06\Omega$  and  $100\Omega$  respectively. Determine the total armature power developed when working as:  
I) Generator delivering 25kw  
II) Motor taking 25kw (6 marks)

### **Question THREE**

- a) i) Define the term slip as used in induction. (2 marks)
- ii) Give TWO significance of having skewed slots on squirrel-cage rotor. (2 marks)
- iii) The input to a 3 phase 4-pole – 50Hz induction motor is 150kw, stator losses are 5kw mechanical losses are 3kw and full load slip 0.05. Find
- I) Frequency of the rotor emf at standstill
- II) Frequency of the rotor emf at full load
- III) Rotor copper loss
- IV) Efficiency of the motor (6 marks)
- b) A 415V three-phase 50Hz four pole star connected induction motor operates at 1425rev/min on full load. The rotor resistance and reactance per phase are  $0.4\Omega$  and  $4\Omega$  respectively and the effective rotor-stator terms ratio is 0.8:1. Calculate:
- i) The full load torque
- ii) The power output if the mechanical losses amount to 480W.
- iii) The maximum torque
- iv) The speed at which maximum torque occurs
- v) The torque at start. (10marks)

### **Question FOUR**

- a) i) State any TWO types of repulsion-type single phase motors. (6 marks)
- ii) With the aid of circuit diagrams differentiate between a resistor-start and an inductor-start single phase motors. (6 marks)
- b) i) With the aid of a well labelled diagram, explain the Hopkinson's test for d.c. motors. (4 marks)
- ii) A 250V d.c. shunt machine has an armature resistance including inter-pole of  $0.5\Omega$  and shunt field resistance of  $125\Omega$  both values at working temperatures. When it is running light as a motor, the current taken from the supply is 5A. Calculate the efficiency of the machine.
- I) When taking a current of 52A from the supply as a motor
- II) When delivering a current of 35A as a generator. (8 marks)

### **Question FIVE**

a) Draw a well labelled exact equivalent circuit diagram of a 3 phase induction motor.(2marks)

b) For a 3-phase induction motor; show that the maximum torque is reached when

$$S = \frac{R_2}{X_2} \quad (8 \text{ marks})$$

c) A 440V, 3  $\phi$ , 50Hz 8 pole star connected induction motor has the following equivalent circuit parameters per phase.  $R_1 = R_2 = 0.1\Omega$ ,  $X_1 = X_2 = 0.7\Omega$   $R_m = 100\Omega$   $X_m = 25\Omega$ . Calculate the rotor current referred to the stator current. The input power factor, the torque and the efficiency of the motor at 40% slip and the starting torque. (10marks)