



---

**TECHNICAL UNIVERSITY OF MOMBASA**

---

FACULTY OF ENGINEERING AND TECHNOLOGY  
DEPARTMENT OF MEDICAL ENGINEERING  
**UNIVERSITY EXAMINATION FOR:**  
BACHELOR OF SCIENCE IN MEDICAL ENGINEERING  
SECOND YEAR FIRST SEMESTER  
EEE 4233: ELECTRICAL MACHINES  
END OF SEMESTER EXAMINATION  
**SERIES: DEC 2016**  
**TIME: 2 HOURS**  
**DATE: 5<sup>th</sup> DEC 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. Attempt any three questions, all questions carry equal marks.

**Do not write on the question paper.**

---

### Question ONE

- a) Explain the function of the following parts of a D.C machine
- (i) Field system
  - (ii) Commutator (4mks)
- b) A 20KW, 250V D.C shunt generator has armature and field resistances of  $0.1\Omega$  and  $125\Omega$  respectively. Determine the total armature power developed when running as:
- (i) A generator delivering 20KW output
  - (ii) A motor taking 20KW input (10mks)
- c) Show that the D.C motor speed is given by;

$$N = \frac{V - I_a R_a}{K\phi}$$

Where,

N = motor speed

V = supply voltage

$I_a$  = armature current

$R_a$  = armature resistance (6mks)

### Question TWO

- a) Single phase A.C motors are not self-starting. Explain. (3mks)
- b) With an aid of a circuit diagram, describe the operation of a capacitor start capacitor run single phase A.C motor (7mks)
- c) At starting, the windings of 230V, 50HZ split phase induction motor have the following:

Main winding:  $R = 4\Omega$ ,  $X_l = 7.5\Omega$

Starting winding  $R = 7.5\Omega$ ,  $X_l = 4\Omega$

Determine:

- (i) Current in the main winding ( $I_m$ )
- (ii) Current in the starting winding ( $I_s$ )
- (iii) Phase angle between  $I_m$  and  $I_s$
- (iv) Line current
- (v) Power factor (10mks)

### Question THREE

- a) State the three conditions that must be met before a machine can be synchronized with the power supply. (3mks)

- b) With an aid of a diagram describe the operation of lamps in sequence synchronization method. (7mks)
- c) With an aid of a diagram, describe the operation of a pony motor start method of a three phase synchronous motor. (10mks)

#### Question FOUR

- a) Show that the single phase transformer EMF equation is given by:

$$E = 4.44f\phi_m N \quad (8mks)$$

- b) The input current to a three phase step down transformer connected to 11kv supply system is 14A. Determine the secondary line voltage and current for:
- (i) Star-star connection
- (ii) Delta-star connection if the phase turns ratio is 44. (12mks)

#### Question FIVE

- a) A 250v shunt motor on no load runs at 1000rpm and takes 5A. the total armature and shunt field resistance are  $0.2\Omega$  and  $250\Omega$  respectively. Determine the speed when the motor is loaded and takes a current of 50A if the armature reaction weakens the main field by 3%. (10mks)
- b) Show that the maximum starting torque of a three phase induction motor is obtained when ;

$$X_2 = R_2$$

where;

$R_2$  = rotor resistance/phase

$X_2$  = stand still rotor reactance/phase (10mks)