



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: 5th 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) State the Faraday's laws law of electromagnetic induction. (2mks)
- b) A long shunt compound D.C generator delivers a load current of 50A at 500V and has armature, series, and shunt field resistances of 0.05Ω , 0.03Ω and 250Ω respectively. Draw its circuit diagram hence determine the armature current and the generated electromotive force. Allow a 1V per brush voltage drop. (9mks)
- c) Show that torque developed by D.C motor is given by;

$$T_a = 0.159 \frac{P\Phi Z I_a}{A}, \text{ where;}$$

P = number of poles

Φ = magnetic flux

Z = total number of armature conductors

I_a = armature current

A = number of parallel paths (9mks)

Question TWO

- a) Single phase A.C motors are not self-starting. Explain. (3mks)
- b) With an aid of a diagram, describe the operation of a shaded pole single phase A.C motor. (7mks)
- c) (i) A 200w, 230V 50HZ capacitor start motor has the following winding constants.
Main winding: $R = 4.5\Omega$, $X_l = 3.7\Omega$
Starting winding: $R = 9.5\Omega$, $X_l = 3.5\Omega$
Determine the value of the starting capacitance that will result in the maximum starting Torque. (6mks)
- (ii) State any four applications of single phase A.C series motor. (4mks)

Question THREE

- a) A 75KW, 3ϕ star connected, 50HZ, 440V cylindrical rotor synchronous motor operates at a rated condition with 0.8 p.f leading. The motor efficiency excluding field and stator losses is 95% and $X_s = 2.5\Omega$. Determine:
- Mechanical power developed
 - Armature current
 - Back emf
 - Power angle
 - Pull out torque of the motor (10mks)

- b) With an aid of phasor diagram, Show that the maximum power developed by a synchronous motor is given by;

$$P_{max} = \frac{E_b V}{Z_s} - \frac{E_b^2}{Z_s} \cos\theta \quad (10\text{mks})$$

Question FOUR

- a) With an aid of a circuit diagram describe open circuit test as administered in single phase transformers. (8mks)
- b) A 3 ϕ , 50HZ transformer has a delta connected primary and star connected secondary windings. The line voltages being 22,000V and 400V respectively, the secondary winding has a star connected load at 0.8 pf lagging. The line current on the primary side is 5A. Determine:
- The phase current in primary winding
 - The phase current in the secondary winding
 - The transformer output power in kilo watts. (12mks)

Question FIVE

- a) With an aid of a control and power circuit, direct on line starting method of three phase squirrel cage induction motor, describe its operation. (10mks)
- b) Show that the maximum torque of a three phase induction motor under running condition is obtained when ;

$$S = \frac{R_2}{X_2},$$

Where;

S = slip

R_2 = rotor resistance/phase

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