PP2

TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY EXAMINATION FOR:

DEGREE

EEE 4507: ELECTRICAL MACHINE V.

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: NOVEMBER 2025

TIME: 2 HOURS

DATE: November 2025

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 Question 1, Compulsory and any other Two Questions.

Do not write on the question paper.

Question ONE

a. Using a well labeled diagram , explain the operation of a single phase transformer on load **[4 MARKS]**

b. Explain the operation of a single phase induction motor under the following **[4 MARKS]**

   i. Rotor at standstill

   ii. Rotor running

c. Using appropriate phasor diagrams derive the EMF equation of a transformer **[4 MARKS]**

d. Name and describe four types of tests performed on single phase AC motors **[4 MARKS]**

e. A single phase transformer has 1000 turns on the primary and 200 turns on the secondary. The no load current is 3A at a power factor of 0.2 lagging when the secondary current is 280A at a power of 0.8 lagging. Calculate the primary current and the primary power factor. Assume the voltage drop in the windings to be negligible **[4 MARKS]**

f. A 2.5kW single phase rotary converter operates at full load from 230V AC supply. Assuming unity power factor and 100% efficiency, calculate **[6 MARKS]**

   i. AC voltage and current

   ii. AC input current at slip rings

g. The following test data are obtained from a 1=4 hp, 1φ, 120 V, 60 Hz, 1730 rpm induction motor.

[4 MARKS]

Stator winding (main) resistance = 2.9 ohms

Blocked rotor (standstill) test: The rotor is prevented from rotating,

V =43 V, I=5A, P=140W

No-load test: Motor is running freely,

V =120 V, I=3:5A, P=125W

i. Obtain the double revolving field equivalent circuit for the motor.

ii. Determine the rotational loss.

QUESTION TWO

a) The primary of an ideal transformer draws 1A at a power factor of 0.4lag when connected across a 230V supply and the secondary is on open circuit. The number of turns in the primary is twice that of the secondary. A load taking 50A at a lagging power factor of 0.8 is now connected across the secondary. Calculate the primary current and primary power factor

[8 MARKS]

b) A 220V, single phase induction motor gave the following tests:
No load=220V, I=6.15A, W=348W
Locked rotor-126V, I=15A, W=577W
Stator winding resistance=1.5Ω
Determine the parameters of the equivalent circuit of the machine **[6 MARKS]**

c) Using well labeled diagrams explain the principle of operation of a hysteresis motor

[6 MARKS]

QUESTION THREE

a. Name four types of AC machines **[4 MARKS]**

b. Describe using diagrams and appropriate circuitry operating and working principle of a tachogenerator.

[4 MARKS]

c. Using appropriate circuit diagrams deduce the expression of the efficiency of a single phase AC motor

[3 MARKS]

d. A single phase, 230V, 4 pole, 50HZ, 0.5kW induction motor gave the following tests.

Locked rotor test=60V, 1.5A, 0.6 lag

No load test=230V, 0.535A, 0.174 lag

Determine the approximate equivalent circuit parameters for the machine. Assume that the stator and the rotor loss are equal **[3 MARKS]**

e. A four-pole, single-phase, 120 V, 60 Hz induction motor gave the following standstill impedances when tested at rated frequency: **[6 MARKS]**

Main winding: Zm =1:5+j4:0 ohms

Auxiliary winding: Za =3+j6:0 ohms

i. Determine the value of external resistance to be inserted in series with the auxiliary winding to obtain maximum starting torque as a resistor split-phase motor.

ii. Determine the value of the capacitor to be inserted in series with the auxiliary winding to obtain maximum starting torque as a capacitor-start motor.

iii. Determine the value of the capacitor to be inserted in series with the auxiliary winding to obtain maximum starting torque per ampere of the starting current as a capacitor-start motor.

iv. Compare the starting torques and starting currents in parts (a), (b), and (c) expressed as per unit of the starting torque without any external element in the auxiliary circuit, when operated at 120 V, 60 Hz.

Question FOUR

a) Using appropriate phasor and equivalent circuits derive the current and voltage equations of a transformer at no load **[6MARKS]**

b) Using well labeled diagrams explain the construction and principle of operation of a rotary converter. **[8 MARKS]**

c) Explain the principle of operation of the following single phase motors **[6 MARKS]**

i. Split phase induction motor

ii. Capacitor start motors

iii. Capacitor run motors

Question FIVE

a. Develop the phasor diagram for an ideal transformer supplying a leading load. Label all the phasors and angles properly **[4 MARKS]**

b. A single phase series motor has a resistance of 30Ω and a total inductance of 0.5H. when connected to a 250V dc supply and loaded to take 0.8A, it runs at 2000rpm. Estimate the speed and power factor when connected to 250V, 50hz supply and loaded to take the same current.

[6 MARKS]

c. A 1100/110V single phase transformer takes an input of 850kVA at a no load and rated voltage of 1100V. The core loss is 400w. Find **[6 MARKS]**

   i. Core loss component of no load current
   ii. Magnetizing component of no load current
   iii. No load power factor

d. A three-phase, 460 V, 60 Hz, six-pole wound-rotor induction motor drives a constant load of 100 N _m at a speed of 1140 rpm when the rotor terminals are short-circuited. It is required to reduce the speed of the motor to 1000 rpm by inserting resistances in the rotor circuit. Determine the value of the resistance if the rotor winding resistance per phase is 0.2 ohms. Neglect rotational losses. The stator-to-rotor turns ratio is unity.

[4 MARKS]