



# **UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY END OF SEMESTER ONE EXAMINATIONS**

## **ACADEMIC YEAR 2024/2025**

**DEPARTMENT: ICT**

**SEMESTER: ONE**

**PROGRAMME(S): DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING (DEEE)**

**YEAR OF STUDY: TWO**

**COURSE: AC MACHINES AND SYSTEMS I**

**COURSE CODE : ELT2102**

**DATE: FRIDAY 11TH, DECEMBER 2024**

**TIME: 2:00 PM – 5:00 PM**

**DURATION: 3 HOURS**

### **INSTRUCTIONS:**

- (i) This paper contains two Sections: A (40 marks) & B (60 marks).**
- (ii) Attempt ALL questions in Section A, and ONLY THREE questions in Section B.**
- (iii) All questions in Section B carry equal marks.**
- (iv) Credit will be given for use of relevant examples and illustrations.**
- (v) Begin each number in Section B on a new page of the answer sheet.**
- (vi) DO NOT write on this question paper.**

## SECTION A [40 MARKS]

Attempt **ALL** the Questions in this Section.

1. State Faraday's Law of electromagnetic induction. **(2 marks)**
2. What is a vector group as applied in electrical engineering? **(2 marks)**
3. In relation to induction motors, what is meant by the term slip? **(2 marks)**
4. A 3-phase, 4 pole induction motor is connected to 400 V, 50 Hz supply.  
Determine:
  - i) Synchronous speed. **(2 marks)**
  - ii) Actual speed of the motor when running at 4% slip **(2 marks)**
  - iii) Frequency of emf induced in rotor. **(2 marks)**
5. What is a tap-changer and on which transformer side is it preferred to be connected? **(3 marks)**
6. Explain why a transformer has iron core? **(2 marks)**
7. Describe how the end rings help in the operation of a 3-phase squirrel cage induction motor. **(4 marks)**
8. State any **two** disadvantages of utilising the rotor resistance starting method to start three-phase induction motors. **(4 marks)**
9. In a given transformer at a specific applied voltage, which losses remain constant irrespective of load changes? **(2 marks)**
10. State any **two** advantages and any **two** disadvantages of an autotransformer over a 2-winding transformer of the same rating. **(4 marks)**
11. What do you understand by parallel operation of transformers? What is its necessity? **(5 marks)**
12. Even at no-load, a transformer draws current from the mains. Why? **(2 marks)**
13. What do you understand by the term "crawling" as applied in 3-phase induction motors? **(2 marks)**

## SECTION B [60 MARKS]

Attempt **ONLY THREE** Questions in this Section.

### Question 1

- a) With reference to transformers, define what is meant by magnetic leakage. **(2 marks)**
- b) In practice, explain how magnetic leakage is minimized in the construction of large transformers. **(4 marks)**
- c) Explain why the rating of a transformer is specified in kVA. **(3 marks)**
- d) List any 3 reasons why unbalanced voltages can occur in a power system. **(3 marks)**
- e) With the aid of a simple diagram, show the connection for a delta/wye connected three phase transformer. Explain where it is applied. **(4 marks)**
- f) Describe any **four** advantages of operating three phase transformers in parallel in a given substation. **(4 marks)**

### Question 2

- a) Describe how the direction of rotation of a three-phase induction motor can be reversed. **(2 marks)**
- b) Explain why an induction motor cannot operate using a DC supply. **(4 marks)**
- c) A 3-phase induction motor is a self-starting machine; explain why starting methods are required for these machines. **(3 marks)**
- d) State any 3-induction motor starting methods used in industries. **(3 marks)**
- e) The rotor of an induction motor cannot run at synchronous speed; explain why this is the case. **(4 marks)**
- f) A 3-phase induction motor operates on the same principle as a 3-phase transformer. Explain why the efficiency of the induction motor is less than that of the transformer. **(4 marks)**

### Question 3

- a) Define the term “efficiency” of a transformer and state the condition for obtaining maximum efficiency. **(3 marks)**
- b) Explain the working of an on-load tap-changer with the help of neat schematic diagram. **(7 marks)**
- c) A 5 kVA single phase transformer has full-load copper loss of 100 watt and 60 watt as iron loss. The daily variation of load on the transformer is as follows:
- |                 |                                   |
|-----------------|-----------------------------------|
| a. 7 AM to 1 PM | 3 kW at power factor 0.6 lagging. |
| b. 1 PM to 6 PM | 2 kW at power factor 0.8 lagging. |
| c. 6 PM to 1 AM | 5 kW at power factor 0.9 lagging. |
| d. 1 AM to 7 AM | No-load                           |
- d) Determine the all-day efficiency. **(10 marks)**

### Question 4

- a) Describe any **four** induction motor speed control methods. **(4 marks)**
- b) Given the following information found on the name-plate of a 3-phase transformer, describe what each of the following are saying about the individual transformer:
- |           |                  |
|-----------|------------------|
| i) Dd0    | <b>(2 marks)</b> |
| ii) Yd1   | <b>(2 marks)</b> |
| iii) Dy11 | <b>(2 marks)</b> |
- c) The power supplied to a three-phase induction motor is 32 kW and the stator losses are 1.2 kW. If the slip is 5%, determine:
- |   |                  |
|---|------------------|
| i) the rotor copper loss                                      | <b>(4 marks)</b> |
| ii) the total mechanical power developed by the rotor,        | <b>(3 marks)</b> |
| iii) the efficiency of the motor, neglecting rotor iron loss. | <b>(3 marks)</b> |

### Question 5

- a) Define the term induction motor and explain its principle of operation. **(5 marks)**
- b) Differentiate between squirrel cage and phase wound rotor construction with the help of sketches. **(5 marks)**
- c) State and explain the various losses that occur in an induction motor? Clearly showing which ones are constant and those that are variable? **(6 marks)**
- d) A 3-phase induction motor has a 4-pole star-connected stator winding. The motor runs at a line voltage of 200 V, 50 Hz supply. The rotor resistance and standstill reactance per phase are 0.1 and 0.9 ohm respectively; and the ratio of rotor to stator turns is 0.67. Calculate the total torque at 4% slip. **(4 marks)**

### Question 6

Your employed by Shaker industries limited as their Electrical technician. During system improvement meeting, the bosses agreed to buy a new squirrel cage induction motor rated 15Kw to run their new feeder line. As their electrical technician, your required to design a starter to be used to run this new squirrel cage induction motor.

Questions;

- a) List the components you require to wire the starter for this motor. **(3 marks)**
- b) Draw the power circuit diagram for this starter. **(7 marks)**
- c) With the use of clear illustrations and drawing, show and explain the control circuit for the above-mentioned motor. **(10 marks)**