UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

END OF SEMESTER TWO EXAMINATION

ACADEMIC YEAR 2025/2026

DEPARTMENT:	**ICT & ENGINEERING**
YEAR OF STUDY:	**TWO**
PROGRAMME:	**DEEE**
COURSE:	**Power Systems Protection & Coordination**
COURSE CODE:	**ELT2202**
DATE:	**24th June 2026**
TIME:	**2:00 – 5:00PM**
DURATION:	**3 Hours**
VENUE:	**TENT A**

INSTRUCTIONS:

(a) This paper consists of two questions
(b) Attempt all Questions in Section A and ANY THRE in Section B
(c) Credit will be given for use of relevant examples and illustrations
(d) Begin each number on a new page of the answer sheet

SECTION A (COMPULSORY)

PART I: MULTIPLE CHOICE QUESTIONS (20 MARKS)

Answer ALL questions in this part. Each question carries 2 marks. Select the MOST appropriate answer.

Question 1

A 33 kV distribution feeder supplying an industrial area experiences a fault during a thunderstorm. The protection system detects the abnormal condition and isolates the faulty section before damage occurs to transformers and cables.

Which component is primarily responsible for detecting the fault condition and initiating the tripping process?

A. Isolator

B. Circuit Breaker

C. Protective Relay

D. Surge Arrester

Question 2

A current transformer with a ratio of 400/5 A is installed on a feeder carrying a primary current of 320 A.

What secondary current will be supplied to the protective relay?

A. 2 A

B. 4 A

C. 5 A

D. 8 A

Question 3

A transmission line conductor accidentally comes into contact with a tree branch during a storm, causing one phase conductor to touch earth.

Which type of fault has most likely occurred?

A. Three-phase fault

B. Line-to-line fault

C. Single line-to-ground fault

D. Open-circuit fault

Question 4

In a radial distribution network, relays are installed at different locations along the feeder. A fault occurs near the end of the feeder.

Which protection principle ensures that only the relay closest to the fault operates first while upstream relays remain inactive unless required?

A. Sensitivity

B. Selectivity

C. Reliability

D. Stability

Question 5

An inverse-time overcurrent relay is protecting a feeder supplying several industrial motors. During a severe short-circuit fault, the relay trips much faster than it would for a smaller overcurrent.

This behavior is characteristic of:

A. Instantaneous overcurrent protection

B. Distance protection

C. Inverse-time protection

D. Differential protection

Question 6

A power transformer installed in a substation requires protection against internal winding faults and inter-turn short circuits.

Which protection scheme is most suitable for this application?

A. Distance Protection

B. Differential Protection

C. Under-voltage Protection

D. Directional Overcurrent Protection

Question 7

A distance relay measures the voltage and current at its location to determine the apparent impedance between the relay and fault point.

Which expression is used by the relay to determine the impedance?

A. $Z = I/V$

B. $Z = V \times I$

C. $Z = V/I$

D. $Z = P/I$

Question 8

A feeder relay fails to operate during a fault due to a malfunction in its trip circuit. Another relay located upstream subsequently clears the fault after a short delay.

The second relay is performing the function of:

A. Main protection

B. Differential protection

C. Backup protection

D. Pilot protection

Question 9

Before maintenance is carried out on a section of high-voltage equipment, the equipment must be visibly disconnected from all power sources to ensure worker safety.

Which device is specifically designed for this purpose?

A. Circuit Breaker

B. Isolator

C. Relay

D. Current Transformer

Question 10

When coordinating two overcurrent relays on the same feeder, engineers include a grading margin between their operating times.

The grading margin mainly accounts for:

A. Transformer losses

B. Load fluctuations

C. Relay tolerances, breaker operating time, and safety margin

D. Conductor resistance

PART II: SHORT ANSWER QUESTIONS (20 MARKS)

Answer ALL questions in this part. Each question carries 5 marks.

Question 11 (5 Marks)

A utility engineer notices that some disturbances on a transmission line disappear automatically after a few cycles, while others require circuit breakers to isolate the affected section.

Differentiate between a transient disturbance and a permanent fault in a power system.

In your answer, discuss:

a) Causes of each condition.

b) Their effects on system operation.

c) Typical protective actions taken by the protection system.

Question 12 (5 Marks)

Protective relays play a critical role in maintaining the reliability and security of electrical power systems.

Explain any four functions of protective relays in a modern power network.

For each function, provide a practical example of where it may be applied in a transmission or distribution system

Question 13 (5 Marks)

A newly commissioned 132/33 kV substation is equipped with Current Transformers (CTs) and Voltage Transformers (VTs) connected to various protective relays.

Explain the role of:

a) Current Transformers (CTs)

b) Voltage Transformers (VTs)

Your answer should highlight how these devices contribute to accurate measurement, protection, and operator safety.

Question 14 (5 Marks)

A radial feeder supplying several communities is protected by relays installed at the substation, midway along the feeder, and near the load end.

Explain the concept of protection discrimination (selectivity**)** and discuss how proper coordination between these relays improves:

a) Continuity of supply

b) Equipment protection

c) Overall system reliability

SECTION B: ATTEMPT ANY THREE (20 MARKS EACH)

QUESTION ONE :

SCADA systems play a vital role in modern power system operation by providing real-time monitoring, control, automation, and decision-making capabilities. They enhance system reliability, security, and efficiency across generation, transmission, and distribution networks.

Using your knowledge of SCADA systems and power system control, answer the following questions:

a) Explain any four objectives of power system control and describe how SCADA contributes to achieving each objective. (8 marks)
b) Describe the role of SCADA in power system control under the following functions:
    i. Data acquisition.
    ii. Real-time monitoring.
    iii. Control actions.
    iv. System coordination. (4 marks)
c) Modern SCADA systems consist of both hardware and software components. Explain the functions of the following components:
    i. Remote Terminal Unit (RTU). (0.5 mark)
    ii. Programmable Logic Controller (PLC). (0.5 mark)
    iii. Human-Machine Interface (HMI). (0.5 mark)
    iv. SCADA Master Station. (0.5 mark)
d) State two benefits and two challenges associated with the implementation of SCADA systems in modern power networks. (2 marks)
e) Outline four emerging trends or technologies shaping the future of SCADA in smart grids.(4 marks)

QUESTION TWO:

Power system protection is essential for ensuring the safe, reliability, and continuous operation of electrical power networks. It helps detect faults and isolate faulty sections to protect equipment and maintain system stability.

Using your knowledge of power system protection, answer the following questions:

a) Define power system protection and explain its importance in electrical power systems. (3 marks)
b) State any three objectives of power system protection. (3 marks)
c) Draw a well-labelled diagram of a typical power system, showing the major stages from generation to consumers. (4 marks)
d) Name and briefly describe the functions of four primary protective equipment components used in power systems. (4 marks)
e) Explain the following requirements of a good power system protection scheme:
    i. Reliability. (2 marks)
    ii. Selectivity. (2 marks)
    iii. Sensitivity. (1 mark)
    iv. Speed. (1 mark)

QUESTION THREE:

Electrical faults are among the major disturbances that affect the performance, reliability, and safety of power systems. Understanding their causes, classification, and effects is essential for effective power system protection.

Using your knowledge of power system faults, answer the following questions:

a) Define an electrical fault and explain the main causes of faults in power systems. (4 marks)
b) Differentiate between open-circuit faults and short-circuit faults, highlighting two effects of each type. (6 marks)
c) Classify the types of open-circuit faults and short-circuit faults commonly encountered in transmission systems. (4 marks)
d) Describe four effects of electrical faults on power system operation and equipment. (4 marks)
e) Explain three possible internal or external causes of short-circuit faults in a power system. (2 marks)

QUESTION FOUR:

A utility company is evaluating different circuit breaker technologies for use in a new 132 kV substation.

Required:

a) Describe in detail the operating sequence of a circuit breaker from the moment a relay issues a trip command until fault current interruption is completed. (6 marks)

b) Compare Air Circuit Breakers (ACBs), SF_6 Circuit Breakers and Vacuum Circuit Breakers under the following headings:

i. Arc extinguishing medium

ii. Voltage rating

iii. Maintenance requirements

iv. Environmental considerations (6 marks)

c) Explain the process of arc formation and arc extinction during current interruption. (4 marks)

d) Discuss two maintenance activities that should be carried out periodically to ensure dependable operation of circuit breakers. (4 marks)

QUESTION FIVE:

A utility company is constructing a new 33/11 kV distribution substation to supply power to a rapidly growing industrial area. During the design review, concerns are raised regarding personnel safety, equipment protection, fault current dissipation, and compliance with earthing standards.

Required:

a) Explain the purpose of earthing in power systems and discuss its importance in ensuring personnel safety, equipment protection, and system reliability. (6 marks)

b) Differentiate between the following earthing arrangements, giving one application of each:

i. Solid earthing

ii. Resistance earthing

iii. Reactance earthing (6 marks)

c) During a line-to-ground fault, describe the path followed by fault current in a properly earthed system and explain how protective relays use this information to detect and isolate the fault. (4 marks)

d) A soil resistivity survey at the proposed substation site reveals high soil resistivity values.

Discuss two challenges that high soil resistivity presents to the earthing system and propose two engineering solutions that can be implemented to achieve acceptable earth resistance values. (4 marks)

END OF SECTION