



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

## UNIVERSITY EXAMINATIONS FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 4508: SWITCH GEAR AND PROTECTION

## END-OF-SEMESTER EXAMINATION

**SERIES:** JULY 2025

**TIME:** 2 HOURS

**DATE:** July 2025

### Instructions to Candidates

It would be best if you had the following for this examination

*-Answer Booklet, examination pass, and student ID*

This paper consists of FIVE questions. Attempt **Questions ONE plus any TWO Questions.**

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

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### **Question ONE 30 -MARKS (COMPULSORY)**

- a) Compare the fuses and circuit breakers under the following;
  - i. Operation
  - ii. Operating time
  - iii. Breaking capacity (6 marks)
- b) Explain the following terms as applied to circuit breakers :
  - i. Arc voltage
  - ii. Restriking voltage
  - iii. Recovery voltage (6 marks)
- c) Explain any THREE methods of arc extinction in a circuit breaker. (6 marks)
- d) A circuit breaker is rated 2500 A, 1500 MVA, 33 kV, 3 sec, 3-phase oil circuit breaker. Determine
  - i. The rated normal current
  - ii. Breaking current
  - iii. Making current
  - iv. Short time rating current (12 marks)

## Question TWO

- a) State the importance of bus bar protection (2 marks)
- b) Discuss the following protection schemes for bus bar protection
  - i. Differential protection
  - ii. Fault bus protection (8 marks)
- c) State any two requirements for the protection of parallel feeders (2 marks)
- d) Describe the following protection schemes for feeders
  - i. Differential pilot wire method
  - ii. Translay protection scheme (8 marks)

## Question THREE

- a) State any TWO faults that alternators are protected against in power systems (2 marks)
- b) Using well-labeled diagrams, describe the Merz-Price circulating current scheme (6 marks)
- c) Merz-Price circulating current system protects a 10 MVA, 6.6 kV, 3-phase, star-connected alternator. Suppose the ratio of the current transformers is 1000/5. In that case, the minimum operating current for the relay is 0.75 A, and the neutral point earthing resistance is 6  $\Omega$ . Calculate:
  - i. The percentage of each of the stator windings that is unprotected against earth faults when the machine is operating at normal voltage.
  - ii. The minimum resistance to protect 90% of the stator winding set to operate when there is an out-of-balance current of 1.5 A (12 marks)

## Question FOUR

- a) State the difference between an earth relay and an overcurrent relay (2 marks)
- b) Discuss the following faults in transformers
  - i. Open circuit fault
  - ii. Winding overheating
  - iii. Winding short circuit (6 marks)
- c) Explain three factors to consider when choosing the protection scheme for transformer (6 marks)
- d) A 3-phase transformer having line-voltage ratio of 0.4 kV/11kV is connected in star-delta and protective transformers on the 400 V side have a current ratio of 500/5. What must be the ratio of the protective transformers on the 11 kV side (6 marks)

### Question FIVE

- a) Explain the harmful effects of lightning discharge on the following parts of the power system
- i. Insulators
  - ii. Generators
  - iii. Transformer (6 marks)
- b) Describe how the following operation causes internal overvoltage in the power system.
- i. Arcing ground
  - ii. Resonance
  - iii. Current chopping (9 marks)
- c) Using a diagram, discuss the construction & working principle of an expulsion-type arrester(5 marks)