



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS FOR:

BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

TEE 4420: SWITCHGEAR AND PROTECTION

END-OF-SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: April 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 **QUESTION ONE AND ANY TWO**.

Do not write on the question paper.

Question ONE 30 -MARKS (COMPULSORY)

- a) State any TWO desirable characteristics of a good fusing element (2 marks)
- b) Concerning fuses, explain the meaning of the following terms
 - i. Fusing factor
 - ii. Fusing current (4 marks)
- c) Using diagrams, explain the construction and working of the following types of fuses.
 - i. High-rupturing capacity (H.R.C.) cartridge fuse
 - ii. H.R.C. fuse with tripping device (8 marks)
- d) Compare circuit breakers and fuses under the following subheadings
 - i. Function
 - ii. Operating time (4 marks)
- e) 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 TWO reasons why faults in the power system should be eliminated as fast as possible (2 marks)
- b) Describe the construction and operation of the following types of relays
 - i. Induction Type Directional Power Relay
 - ii. Differential current relays (8 marks)
- c) A relay is connected to a 500/6 current transformer and set at 130%. If the primary fault current is 3000 A, determine the plug-setting multiplier (PSM) (4 marks)
- d) Using diagrams, describe the following types of protection in a power system.
 - i. Primary protection
 - ii. Back-up protection (6 marks)

Question THREE

- a) Explain TWO reasons why overcurrent protection for alternators is considered unnecessary (4 marks)
- b) With the aid of well-labeled diagrams, describe the modified differential protection for Alternators (6 marks)
- c) The neutral point of a 25 MVA, 11 kV alternator is grounded through a resistance of $5\ \Omega$, the relay is set to operate when there is an out-of-balance current of 2A. The CTs used have a ratio of 1000/5. Calculate (neglect reactance of alternator) :
 - i. The percentage of the stator winding protected against an earth fault
 - ii. The minimum value of earthing resistance to protect 95% of the winding (10 marks)

Question FOUR

- a) State TWO reasons why transformers should be protected against overvoltage (2 marks)
- b) State FOUR system requirements for choosing a particular protection system for transformers (4 marks)
- c) Using a diagram, explain the combined leakage and overload protection. (6 marks)

- d) A 3-phase transformer having a 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 (8 marks)

Question FIVE

- a) Explain any THREE harmful effects of lightning on power system equipment (6 marks)
- b) Explain in detail the following ways lightning may strike the power system.
- i. Direct stroke
 - ii. Indirect stroke (8 marks)
- c) Describe how the following operation causes internal overvoltage in the power system.
- i. Switching of the unloaded line
 - ii. Switching of loaded lines (6 marks)