



TECHNICAL UNIVERSITY OF MOMBASA

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: 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 plus any other TWO Questions.**

Do not write on the question paper.

Question ONE 30 -MARKS (COMPULSORY)

- a) Derive the expression for the fuse law (5 marks)
- b) A fuse wire with a circular cross-section has a radius of 0.8 mm. The wire blows off at a current of 8A. Calculate the radius of the wire that will blow off at a current of 1A. (5 marks)
- c) Concerning protective relays, explain the following terms;
 - i. Pick-up current
 - ii. Plug setting multiplier
 - iii. Current setting (6 marks)
- d) With the aid of a well-labeled diagram, describe the operation of the induction-type directional power relay (8 marks)
- e) An overcurrent relay having a current setting of 125% is connected to a supply circuit through a current transformer of 400/5. If a primary fault current of 2400 A is experienced in the line being protected. Determine;
 - i. Pick-up current
 - ii. Plug setting multiplier (6 marks)

Question TWO

- a) Explain the arc phenomenon in circuit breakers (2 marks)
- b) Explain the meaning of the following terms as used in circuit breakers
 - i. Arc voltage
 - ii. Restriking voltage
 - iii. Recovery voltage (6 marks)
- c) 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-term rating current. (12 marks)

Question THREE

- a) State Any TWO faults that alternators are protected against in power systems (2 marks)
- b) With the aid of well-labeled diagrams, describe the balanced earth fault system of protection for alternators (6 marks)
- c) Merz-Price's circulating current system protects a 3-phase, 20 MVA, 11kV star-connected alternator. The star point is earthed through a resistance of 5 ohms. If the CTs have a ratio of 1000/5 and the relay is set to operate when there is an out-of-balance current of 1.5 A, calculate :
 - i. The percentage of each phase of the stator winding that is unprotected
 - ii. The minimum value of earthing resistance to protect 90% of the winding (12 marks)

Question FOUR

- a) Briefly describe the construction of Buchholz relays and explain how they are used to protect the transformers . (6 marks)
- b) Using a diagram, explain how transformers are protected against Earth-Fault (6 marks)
- c) A Merz-Price circulating current system protects a 3-phase, 33/6.6 kV, star/delta-connected transformer. If the CTs on the low-voltage side have a ratio of 300/5, determine the ratio of CTs on the high-voltage side (8 marks)

Question FIVE

- a) Using diagrams, explain the following methods of transmission line protection
- i. Distance Protection
 - ii. Ring main system
 - iii. Time-graded overcurrent protection (12 marks)
- b) Explain how the following methods can protect the power system from external overvoltages.
- i. Overhead ground wires
 - ii. Rod gap diverters (8 marks)