



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: 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 **Question ONE** and any other Two.

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 of 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) A three-phase transformer having a voltage ratio of 415V/11kV is connected in star delta, and a protective transformer on the 415 V side has a current ratio of 600/6 A. Determine the current of the protective transformer on the 11 kV side (6 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 (6 marks)
- c) State any THREE requirement for line protection (3 marks)
- d) Using diagrams explain the following methods of transmission line protection
 - i. Using definite time relays.
 - ii. Distance Protection
 - iii. Ring main system (9 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 A 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 A, determine the ratio of CTs on the high-voltage side (8 marks)

Question FIVE

- a) State any TWO effects of overvoltage on a power system (2 marks)

- b) Describe how the following operation causes internal overvoltage in powers system
- i. Switching of unloaded lines
 - ii. Switching of loaded lines
 - iii. Insulation failure (9 marks)
- c) Explain how the following methods can be used to protect the power system from external over voltages.
- i. Overhead ground wires
 - ii. Rod gap diverter
 - iii. Multigap arresters (9 marks)