



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

TEE 4420: SWITCHGEAR AND PROTECTION

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2024

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass, and student ID

This paper consists of **five** Questions; Each question carries 20 marks. Attempt any **THREE** Questions.

Do not write on the question paper.

Question ONE

- a) With aid of sketches explain how the following devices work in high voltage switchgear systems:

- i. Lightning arrester
- ii. Silicon Carbide Lightening Arrester(SCLA)

(8 Marks)

- b) A short circuit test was carried on a 3 pole, 132kV circuit breaker. The following observations were made:

Power factor of fault	= 0.4
recovery voltage	=0.9 times full line value
the breaking value	=symmetrical
frequency of oscillations of restriking voltage	=16kHz

Assume the neutral is grounded and fault is not grounded.

- i. Sketch the current breaking characteristics curve and write corresponding equation.
- ii. Calculate the time required to reach maximum restriking voltage.
- iii. Determine Rate of Rise of Restriking Voltage (RRRV).

(12 Marks)

Question TWO

a)

- i. Sketch a block diagram of the general layout of a protection system.
- ii. Explain any FOUR requirements of a good protection system.

(8 Marks)

- b) A 132KV transmission Line has the following data: Resistive Burden (3ϕ) = 1500VA, frequency deviation $\Delta f = 3\text{Hz}$, phase angle error $\beta = 40$ minutes. Consider three choices of V_2 as 33kV, 11kV, and 6.6kV. The standardized VT secondary voltage is 110volts (L-L).

- i. Design a CCVT protection system.
- ii. Sketch the designed circuit

(12 Marks)

Question THREE

a)

- i. Sketch a diagram of Translay Scheme applied to two ends of a feeder.
- ii. State any FOUR advantages of a Translay Scheme

(8 Marks)

- b) Given a 138kV in **Fig Q3**. Assume that the maximum load at the relay site is 120 MVA, and select CT ratio accordingly. The available distance has a zone 1 and zone 2 settings from 0.2Ω to 10Ω , and zone 3 settings from 0.5Ω to 40Ω in the increments of 0.1Ω respectively. The angle of maximum torque can be adjusted to 75° or 90° .

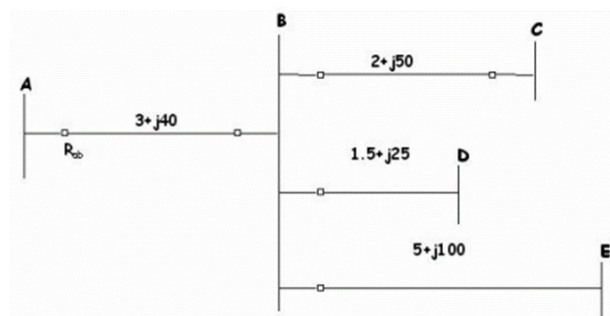


Fig. Q3

- c) Calculate the impedance transformation ratio T_r
- d) Determine the tree zone settings for the relay R_{AB}

(12 Marks)

Question FOUR

- a)
 - i. Sketch a circuit showing a unrestricted earth fault protection for generators.
 - ii. Explain any FOUR kinds of faults occurring in transformers and generators.

(8 Marks)

- b) A rough sketch of system is shown in Fig. Q4 below:

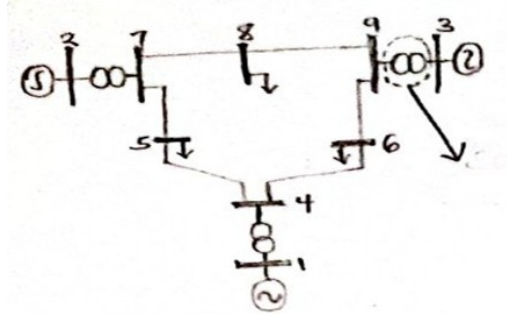


Fig Q4

The transformer element between Bus 9 and Bus 3 is rated 50 mVA 220 kV/11kV.
A net zero differential current scheme is applied.

- i. Sketch the differential current scheme system.
- ii. Calculate the CT currents and percentage error.
- iii. Show that the selected CT's are ideal at normal working conditions.

(12 Marks)

Question FIVE

- a)
 - i. Sketch the general arrangement of Numerical Relay.
 - ii. State any FOUR reasons why regular maintenance of relays is required.

(8 Marks)

- a) Study the system Fig Q5 below:

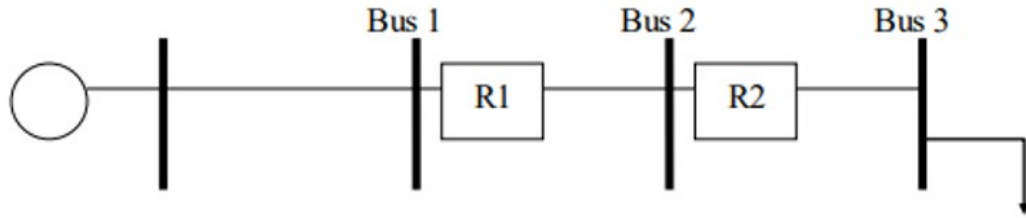


Fig Q5

Given that: Line-line fault at bus, 3:300 A; Three phase fault at bus, 2:500 A; possible CT ratios are, 50:5, 100:5 and Possible taps are, 4,5,6,7,8. Also that that coordination time is specified to be at least 0.35 seconds. Use the relay characteristic curve appended to provide the CT ratios, the pickups, and the time dial settings for R1 and R2 .

(12 Marks)

