



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: NOVEMBER 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) State any FOUR:
- types of LOW voltage switchgear devices.
 - consequences of electric faults.

(8 Marks)

- b) Given dimensions and parameters of a fuse length shown in **Figure Q1** below:

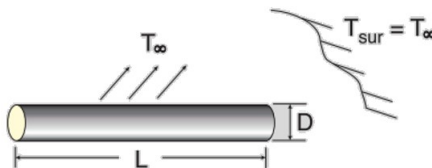


Fig. Q1

$$D=0.1\text{ mm}, T_{\text{melt}}=900^{\circ}\text{C}, L=10\text{ mm}, R=0.2\text{ ohms}$$

$$T_{\infty}=30^{\circ}\text{C}, k=20\frac{\text{Wm}}{\text{K}}, \alpha=5\times 10^{-5}\text{ m m}^2/\text{s} \equiv k/\rho C_p, h=h_{\text{conv}}+h_{\text{rad}}=10\text{ W/m}^2\text{K}$$

Determine the time it takes a fuse to melt if a current of 3A suddenly flows through the fuse subject to the following conditions.

(12 Marks)

Question TWO

a)

- i. State any FOUR factors which affect quality of a protection system.
- ii. Explain FOUR ways of classifying Relays.

(8 Marks)

- b) A standard C400 type CT rated 0.5VA, 5A Delta connected relay, connected to a 398MVA, 161kV transformer has a resistance of 0.2Ω . The round trip resistance is 2Ω while the resistance of burden is 0.2Ω . Assume maximum secondary current of 90A and wye connected CTs. Sketch the equivalent circuit and calculate:
- i. The total loop resistance
 - ii. Voltage and corresponding DC offset value
 - iii. Tap setting for the winding.

(12 Marks)

Question THREE

- a) Distinguish using statements between the following in Protection Relays:

- i. Directional and Non-directional
- ii. Distance and Pilot
- iii. Impedance and Reactance
- iv. Differential and Summing

(8 Marks)

- b) The layout of 138kV Transmission line is as shown in Fig Q3 below. A load of 50MVA, 0.8pf lag is supplied through R_{12} . 80%(Zone 1), 120%(Zone 2) and 120% (Zone 3) settings are applied. Relays are impedance with directionality.

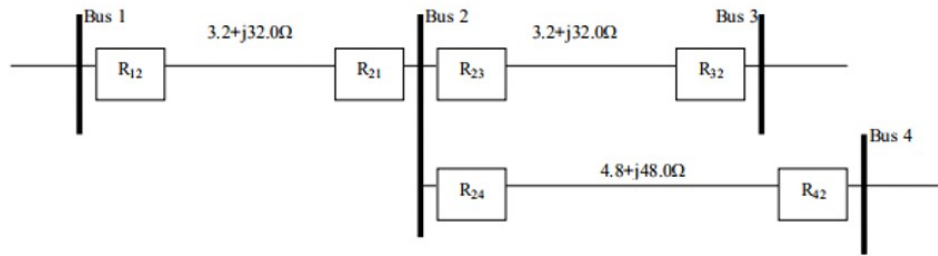


Fig Q3

- Select the CT ratio (1:5) so that maximum load current provides 5A.
- Select the VT ratio(V:1) so that the rated line to neutral voltages provide 67V on the relay side.
- Determine an expression seen on the relay side as function of Z_{line} and CT and VT ratios.
- Identify zone 1, 2 and 3 settings for R_{12}
- Draw zone 1,2,3 circles on R-X diagram

(12 Marks)

Question FOUR

- Sketch a circuit showing relay protection of a Star-Delta Transformer.
 - Write expressions for finding relay current and voltages for circuit in (b) above.
- (8 Marks)**

 - A star connected 3 phases, 12 MVA, 11kV generator has a phase reactance of 10%. It is protected by Merz-Price circulating current scheme which is set to operate for fault current not less than 200A. The earthing resistance must ensure that only 15% of alternator winding remains unprotected.
 - Sketch the circuit of the system
 - calculate the value of earthing resistance

(12 Marks)

Question FIVE

- Sketch a diagram of an Air Blast Circuit Breaker (ACB).
 - State any FOUR advantages of ACBs over Oil Circuit Breakers(OCBs).
- (8 Marks)**

 - A simplified Relay (R1) is shown the system **Fig. Q5** below. A characteristic chart for the Relay is appended.

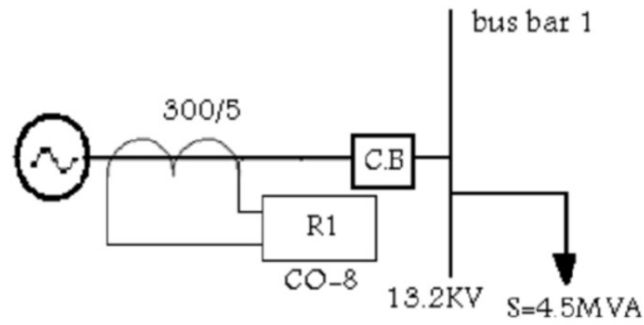


Fig. Q5

The maximum three phase fault current is 2400A, and the TDS=2.0

- Determine the Current Tap Setting(CTD)
- Find the operation time.

(12 Marks)

