



TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

**UNIVERSITY EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN
ELECTRICAL & ELECTRONIC ENGINEERING**

EEE 4508: POWER SYSTEM PROTECTION AND SWITCH GEAR

TIME: 2 HOURS

SERIES AUGUST, 2024

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for this examination;
 - Answer Booklet
 - A Non- Programmable Scientific Calculator
 2. This paper consists of **FIVE** Questions.
 3. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions
 4. This paper consists of **FIVE** printed pages.
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QUESTION ONE [30 MARKS]

- (a) Explain THREE set of events that takes place in a protection system and state the device used for EACH operation. **(6 marks)**
- (b) With aid of diagrams/Sketches explain the following radial feeder coordination schemes
 - (i) Feeders from a common point
 - (ii) Feeder points in tandem (series)**(4 marks)**
- (c) With the aid of diagrams describe the following types of Relays;
 - (i) Over current protection

- (ii) Differential Protection
- (iii) Distance Protection

(9 marks)

- (d) The current rating of an over current relay is 5A. PSM = 2, TSM=0.3, CT Ratio is 400/5, Fault current is 4000A. Determine the operating time of the relay. At TSM = 1. The operating time of various PSM are shown in Table 1. **(4 marks)**

Table 1.

PSM	2	4	5	8	10	20
OPERATING TIME IN SECONDS	10	5	4	3	2.8	2.4

- (e) A 50Hz, 11kv, three-phase alternator with earthed neutral has a reactance of 5Ω per phase, and is connected to bus bar through a circuit breaker. The capacitance to earth between the alternator and the circuit breaker is $0.02\mu\text{F}$ per phase. Assuming the resistances of the generator to be negligible. Determine the following;

- (i) Maximum voltage across the contacts of the circuit breaker
- (ii) Frequency of oscillations.
- (iii) The average rate of rise of Re-striking voltage up to the first peak

(7 marks)

QUESTION TWO [20 MARKS]

- (a) Explain FOUR ways used for arc extinction while using High resistance methods

(4

marks)

- (b) With the aid of a circuit, current and voltage waveform and a Laplace equivalent circuit derive Re-striking voltage. **(10 marks)**

- (c) A generator connected through 5cycle CB to a transformer is rated 8000Kva with the reactance's of $X''_d = 10\%$, $X'_d = 16\%$ and $X_d = 100\%$. It is operating at no load and rated voltage when 3phases short circuit occurs between breaker and transformer Determine:

- (i) Sustained short circuit current in breaker
- (ii) The initial symmetrical rms current in breaker
- (iii) Minimum possible dc components of short circuit in breaker.
- (iv) The momentary current rating of breaker
- (v) Current to be interrupted by breaker
- (vi) The interrupting kva

(6

marks)

QUESTION THREE [20 MARKS]

- (a) With the aid of a diagram describe Merz – Price differential protection of delta-delta power transformer showing clearly the flow of current in each branch.

(8 marks)

- (b) With the aid of a diagram describe the characteristics of the following relays.

- (i) Impedance relay
- (ii) Reactance relay
- (iii) Admittance relay on R-X diagram

(8

marks)

- (i) A three phase transformer having a line voltage ratio of 400V/33,000V is connected in star-delta. The CTs on the 400V side have a current ratio of 1000/5. Determine the ratio of CTs on the 33,000V side.

(4 marks)

QUESTION FOUR [20 MARKS]

- (a) With the aid of sketches(s)/block diagram describe two categories of faults in a synchronous generator, stating in EACH case how the fault can be mitigated.

(11

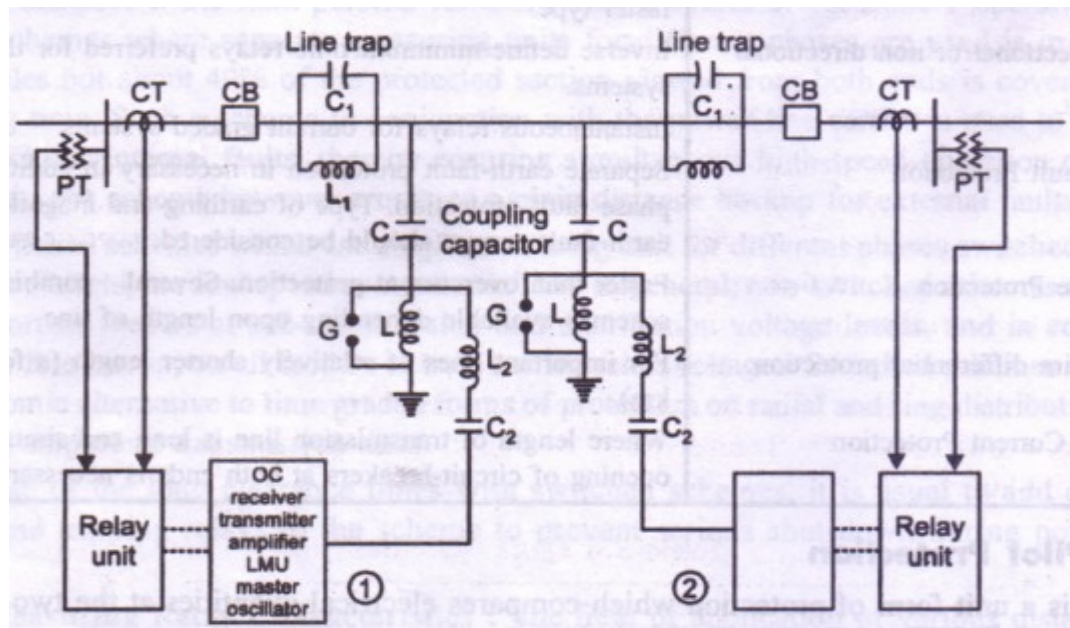
marks)

- (b) A 3- phase 20MVA, 11KV star connected alternator has a synchronous reactance of $2.5\Omega/\text{phase}$ and resistance of $0.75\Omega/\text{phase}$. It is being protected by a Merz-price balanced

current system. Determine what portion of the winding remains unprotected and if the neutral of the alternator is earthed through a resistor 5Ω . Assume that the relay operates, when the out of balance current exceeds 25% of the load current. **(9 marks)**

QUESTION FIVE [20 MARKS]

- a) With aid of a diagram describe the Buchholoz relay and state its merits and drawbacks **(7 marks)**
- b) Figure Q5(b) shows a Translay or Wire Pilot protection of feeders. Describe the principle of operation of the system siting TWO advantages and disadvantages. **(7 marks)**



- (c) Figure Q5(C) Shows a 10MVA,6.6KV, 3-phase star connected alternator having a reactance of 20% is connected through a 5MVA,6.6KV/33KV Transformer of 10% reactance to a transmission line having a resistance and conductance per kilometer of 0.2 and 1 respectively. Fifty kilometers along the line, a short circuit occurs between the three conductors. Determine the current fed to the fault by the alternator. **(6 mark)**

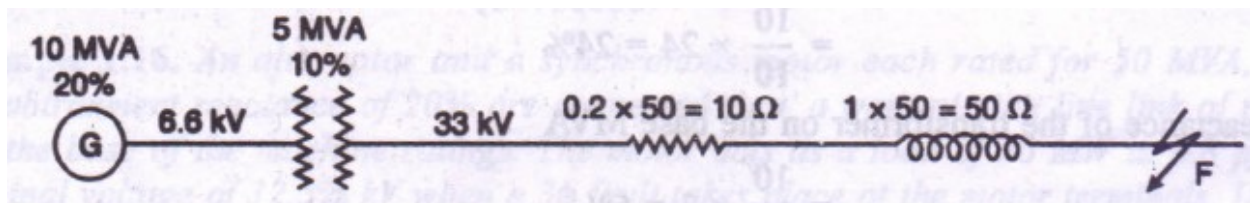


Figure Q5(C)