



ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER
ENGINEERING

SEMESTER II EXAMINATION, 2017/2018 ACADEMIC SESSION

COURSE TITLE: POWER SYSTEM ENGINEERING

COURSE CODE: EEE 528

EXAMINATION DATE: 31st JULY, 2018

COURSE LECTURER: ENGR. OSHIN OLA AUSTIN

TIME ALLOWED: 3 HOURS

A rectangular box containing a handwritten signature in black ink.

HOD's SIGNATURE

INSTRUCTIONS:

1. ANSWER ANY **5** QUESTIONS
2. ANY INCIDENT OF MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM SHALL BE SEVERELY PUNISHED.
3. YOU ARE **NOT** ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.
4. ELECTRONIC DEVICES CAPABLE OF STORING AND RETRIEVING INFORMATION ARE PROHIBITED.
5. DO **NOT** TURN OVER YOUR EXAMINATION QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO

QUESTION 1

- What do you understand by the term symmetrical components of unbalanced phasor? {4 marks}
- Using suitable phasor diagrams, explain the positive, negative and zero phase sequence components of a 3-phase system. {8 marks}
- A generator supply an unbalanced load measures the following phase to ground voltage

$$V_a = 20 \angle 0^\circ$$

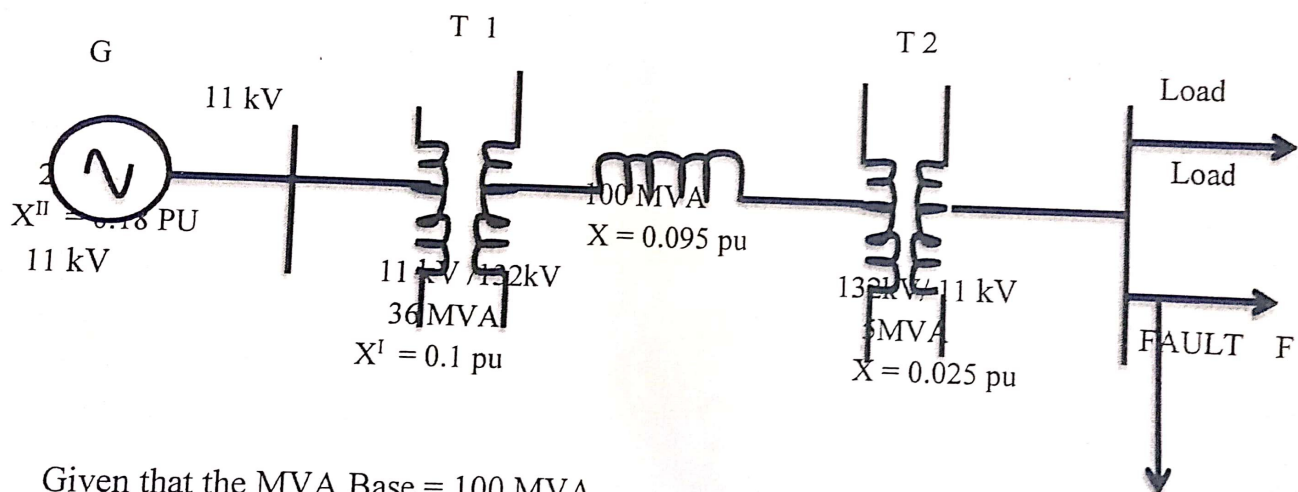
$$V_b = 14 \angle -132^\circ$$

$$V_c = 12.6 \angle +110^\circ$$

Find the symmetrical positive sequence components of the set of phasor voltages. {8 marks}

QUESTION 2

- What is an Electrical fault? {2 marks}
 - State two types of fault and state to examples under each type. {6 marks}
- A symmetrical 3 phase short circuit fault occurs on the 33 kV bus bar of the power system network shown below

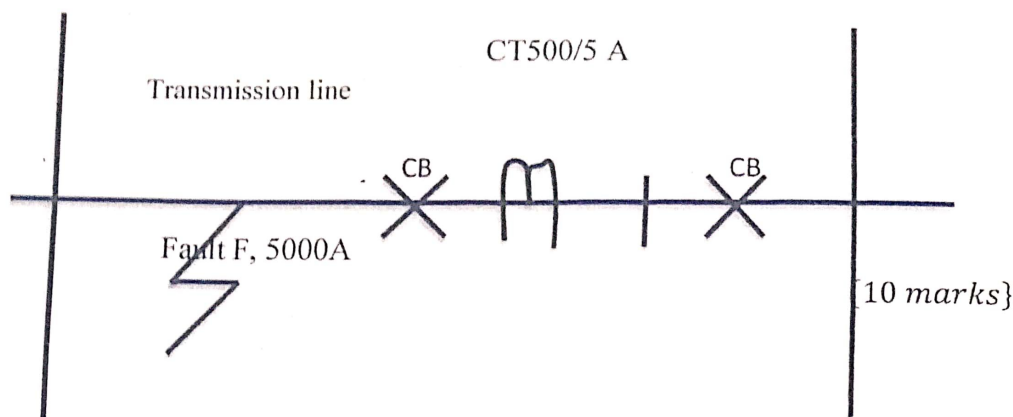


Given that the MVA Base = 100 MVA,

- Calculate the fault current {6 marks}
- Determine the fault MVA {6 marks}

QUESTION 3

- What is a protective relay? State the main function of a protective relay {5 marks}
- State 5 types of protective relay {5 marks}
- An inverse definite minimum time relay is used in the protection of the transmission line shown below. The relay has a setting of 125%, time multiplier setting of 0.5 and it is connected through a current transformer of 500/5 A. A fault current occurs along the line and the fault current is 5,000 A.. Determine the time of operation of the definite minimum time relay with rating 5A. Operating time for plug setting multiplier PSM of 8 is 3.2 seconds.

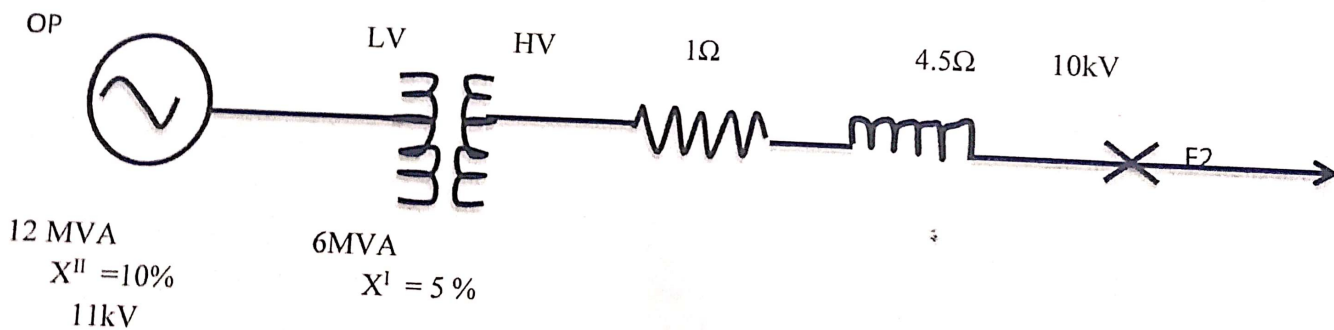


QUESTION 4

- What is meant by the term unit type protection? {4 marks}
- Using a suitable diagram, explain the construction of a single bus bar arrangement. {8 marks}
- A 30MVA, 11 kV generator has a reactance of 0.4 p.u. Determine the per unit reactance referred to base kVA of 50MVA and base kV of 33kV. {8 marks}

QUESTION 5

- What is meant by fault level in power system analysis? {4 marks}
- A 3 phase transmission line is operating at 10 kV. it has a resistance of 1.0Ω and reactance of 4.5Ω . it is connected to a generating station through 6MVA step up transformer with reactance of 5% as shown below.

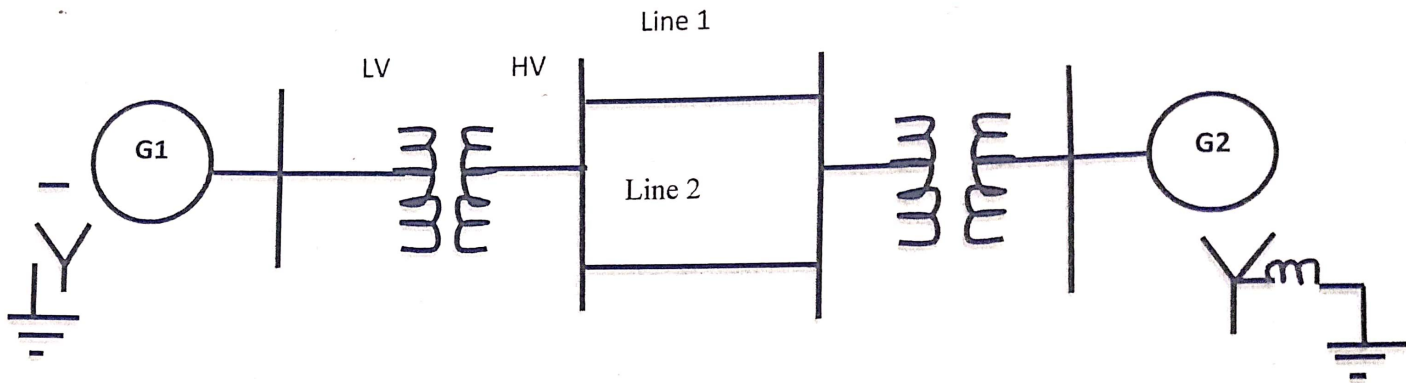


- The bus bars are supplied by 12MVA alternator with percentage reactance of 10%. Calculate the short circuit KVA fed to symmetrical fault between phases when it occurs: Let the base MVA be 12 MVA
- At the load end of the transmission line {8 marks}
 - At the high voltage side of the transmission line {8 marks}

QUESTION 6

{4 marks}

- a. What are sequence network?
 b. Draw the positive sequence network for the power system shown below.



- Generator 1: 50 MVA, $X'' = j0.25$, 11kV
 Generator 2: 30 MVA, $X' = j0.2$, 11kV
 Transmission line 1: 50 MVA, 220kVj0.12 pu
 Transmission line 2: 50 MVA, 220kVj0.14 pu
 Transformer 1: 50 MVA, $X = j0.1$ pu, 11/ 220 kV
 Transformer 2: 30 MVA, $X = j0.05$ pu, 11/ 220 kV

Take base MVA for the complete system as 50 MVA, base kV for generator side as 11 kV and base kV for transmission line as 220 kV. {16 marks}

QUESTION 7

- a. The expression of the phasor of an unbalanced three phase system in terms of their symmetrical components are given below

$$A = A_1 + A_2 + A_0$$

$$B = B_1 + B_2 + B_0$$

$$C = C_1 + C_2 + C_0$$

Using phasor operator a

Prove that i. $A_0 = \frac{A + B + C}{3}$ {6 marks}

ii. $A_1 = \frac{A + aB + a^2C}{3}$ {6 marks}

- b. Determine the positive sequence components of the three phase current

$$I_a = 10 \angle 0^\circ$$

$$I_b = 10 \angle 230^\circ$$

$$I_c = 10 \angle 130^\circ$$

Given that $A_2 = \frac{A + a^2B + aC}{3}$, $A_0 = \frac{A + B + C}{3}$, $A_1 = \frac{A + aB + a^2C}{3}$ {8 marks}