# MACHAKOS UNIVERSITY

**University Examinations for 2016/2017**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**FOURTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING**

**EEE 404 POWER SYSTEMS II**

**DATE: 14/6/2017** **TIME: 8:30 – 10:30 AM**

---

**INSTRUCTIONS:**

**This paper consists of FIVE questions. Answer question ONE and any other TWO**

**QUESTION ONE (COMPULSORY) (30 MARKS)**

a) Using the parameters given below, show that the volume of conductor material required is inversely proportional to the square of transmission voltage and power factor. Let:

| | | | |
|---|---|---|---|
| P | = | power transmitted in Watts | |
| V | = | Line voltage in volts | |
| Cos ø | = | power factor of the load | |
| L | = | length of the line in metres | |
| R | = | resistance per conductor in ohms | |
| $\rho$ | = | resistivity of conductor material | |
| a | = | area of cross section of conductor | (9 marks) |

b) A single phase transmission line has two parallel conductors, each of 1.2 cm diameter, and 2.5 metres apart. Calculate the loop impedance per km length of the line if the material of the conductor is

i. Copper

ii. Steel with relative permeability of 200 (7 marks)

c) A single line diagram of a 3-phase system is shown in figure 1(c). The percentage reactance of each alternator is based on its own capacity. Find the short-circuit current that will flow into a complete 3-phase short circuit fault at F. (9 marks)

d) A wye connected unloaded synchronous generator with neutral solidly grounded has a single-phase-to-ground short circuit at its terminals. Determine the fault current in p.u. Let

$$X_d = 150\% \ , \ X'_d = 35\% \ , \ X''_d = 25\% \ , \ X_0 = 10\%$$

(5 marks)

**QUESTION TWO (20 MARKS)**

a) A 60 km long transmission line is to supply a load of 6 MVA at 0.8 p.f. lagging at 33kV, with transmission efficiency of 88 percent. Determine the volume of Aluminum conductor required in the following cases:

i. Single phase two wire system (9 marks)

ii. Three phase three wire system (7 marks)

Take resistivity of aluminum conductor as $2.84\ x\ 10^{-8}\Omega m$

b) Describe using a well labelled diagram a typical power system between generation and consumer (4 marks)

**QUESTION THREE (20 MARKS)**

a) Draw the nominal-T equivalent circuit of medium transmission line. (4 marks)

b) Show that the A.B, C, D parameters of the nominal-T equivalent circuit of medium transmission line are given by

$$A = D = \left[1 + \frac{YZ}{2}\right], \ B = Z\left[1 + \frac{YZ}{4}\right] \ and \ C = Y$$

(10 marks)

c) Draw the phasor diagram of the nominal-T equivalent circuit of medium transmission line. (6 marks)

**QUESTION FOUR (20 MAKRS)**

Consider the system shown in **figure 4(a)** and whose parameters are indicated below.

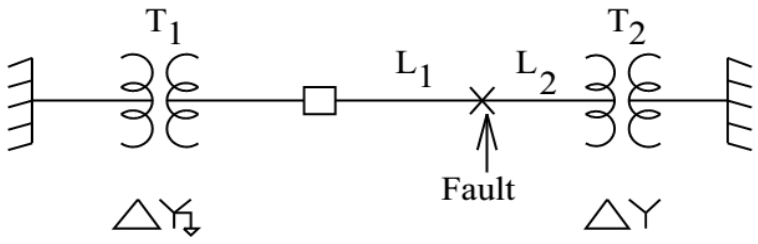


Figure 4(a)

| | |
|---|---|
| System Base Voltage | 138 kV |
| System Base Power | 100 MVA |
| Transformer T1 Leakage Reactance | j0.1 per-unit |
| Transformer T2 Leakage Reactance | j0.1 per-unit |
| Line L1 Positive and Negative Sequence Reactance | j0.05 per-unit |
| Line L1 Zero Sequence Impedance | j0.1 per-unit |
| Line L2 Positive and Negative Sequence Reactance | j0.02 per-unit |
| Line L2 Zero Sequence Impedance | j0.1 per-unit |

Determine the maximum current through the breaker B due to a fault at the location shown under the following fault conditions

a) Symmetrical fault (4 marks)
b) Single line to ground fault (6 marks)
c) Double line to ground fault (5 marks)
d) Line to line fault (5 marks)

**QUESTION FIVE (20 MARKS)**

A 3-phase medium overhead transmission line delivers a load of 80 MW at 0.8 p.f. lagging and 220 kV between the lines. Its total series impedance per phase and total shunt admittance per phase are $200 < 80^0$ ohms and $0.0013 < 90^0$ mho per phase respectively. Using nominal-T method determine the following:

a) A, B, C, D constants (6 marks)
b) Sending end voltage (5 marks)
c) Sending end current (4 marks)
d) Sending end power factor (3 marks)
e) Transmission efficiency (2 marks)