



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
ELECTRICAL AND ELECTRONICS ENGINEERING
UNIVERSITY EXAMINATION FOR:
DEGREE

TEE 4316: ELECTRICAL POWER SYSTEM II
END OF SEMESTER EXAMINATION

SERIES: MAY 2025

TIME: 2 HOURS

DATE: May 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Attempt Question 1, (Compulsory) and any other Two Questions.

Do not write on the question paper.

Question ONE

- a. List four properties of conductor material used for transmission and distribution of electric power

[2 MARKS]

- b. Describe the ABCD parameters as applied in transmission lines [4 MARKS]

- c. Highlight FOUR properties of a line support [2 MARKS]

- d. Using well labelled diagrams and equations describe the following sequences

[6 MARKS]

- i. Positive sequence
- ii. Negative sequence
- iii. Zero sequence

- e. An overhead transmission line at a river crossing is supported from two towers. The height of one towers is 52.5 m above water level. calculate the height of the other towers in order to make the

vertical distance between the conductor and water level 82.5 m in a point has a horizontal distance of 60m far from the other towers that its height more than 52.5 m. The tension in the wires is 22250 N and the weight of one meter of the conductor is 14.24 N. The distance between the towers is 300 m.

[5 MARKS]

f. Derive the equal area criterion

[5 MARKS]

g. The insulation resistance of a single core cable is $495\text{M}\Omega$ per km. If the core diameter is 2.5 cm and the resistivity of the cable insulation is $4.5 \times 10^{14} \Omega/\text{cm}$, find the insulation thickness.

[3 MARKS]

h. Describe two methods used for corona reduction

[3 MARKS]

Question TWO

a. Using well labelled diagrams and equations derive the sag equation

[7 MARKS]

b. An overhead transmission line has a radius of conductor of 0.50m and supported from two towers.

The distance between the two towers is 150 m and at the same level. The conductor is covered by ice of the thickness 0.99 cm and the wind pressure is $396\text{N}/\text{M}^2$. Find the vertical sag if

[7 MARKS]

$$\text{Ice density} = 9400\text{kg}/\text{m}^3$$

$$\text{Copper density} = 91470\text{kg}/\text{m}^3$$

$$\text{Tensile strength} = 17100\text{N}/\text{m}^3$$

c. A synchronous generator, capable of developing 500MW power per phase, operates at a power angle of 8° . By how much can the input shaft power be increased suddenly without loss of stability? Assume that

P_{max} will remain constant

[6 MARKS]

Question THREE

a. Describe four types of insulators

[2 MARKS]

b. Using a well labeled diagrams derive the expression of the capacitance of a cable of length L, with a relative permittivity ϵ_r , and $\epsilon_0 = 8.854 \times 10^{-12}$

[4 MARKS]

- c. A single core cable has a conductor diameter of 1cm and internal sheath diameter of 1.8cm. If impregnated with paper of relative permittivity of 4 is used, calculate the capacitance for 1km length of cable. [4 MARKS]
- d. Describe using diagrams three types of faults in power systems [6 MARKS]
- e. A three-phase Y-connected synchronous generator is running unloaded with rated voltage when a 1LG fault occurs at its terminals. The generator is rated 20 kV, 220MVA, with sub synchronous reactance of 0.2 per unit. Assume that the sub-transient mutual reactance between the windings is 0.025 per unit. The neutral of the generator is grounded through a 0.05 per unit reactance. The equivalent circuit of the generator is shown in Figure Question 3e. Find out the negative and zero sequence reactances. [4 MARKS]

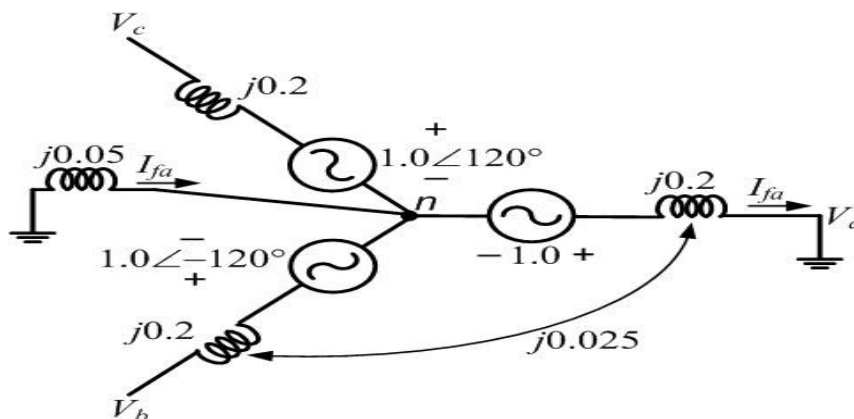


Figure Question 3e

Question FOUR

- a. Highlight three four factors affecting corona [2 MARKS]
- b. A three phase 220kV,50Hz transmission line consists of 1.5cm radius conductors spaced 2cm apart in equilateral triangular formation. If the temperature is 40°C and atmospheric temperature is 76cm, calculate the corona loss per km of line. Take $m_0=0.85$ [4 MARKS]
- c. Mention FIVE assumptions made during power system stability studies [5 MARKS]
- d. Consider the network shown in Figure Question 4b. The system parameters are given below:

Generator G: 50 MVA, 20 kV, $X'' = X_1 = X_2 = 20\%$, $X_0 = 7.5\%$

Motor M : 40 MVA, 20 kV, $X'' = X_1 = X_2 = 20\%$, $X_0 = 10\%$, $X_n = 5\%$

Transformer T_1 : 50 MVA, 20 kV Δ /110 kVY, $X = 10\%$

Transformer T_2 : 50 MVA, 20 kV Δ /110 kVY, $X = 10\%$

Transmission line: $X_1 = X_2 = 24.2 \Omega$, $X_0 = 60.5 \Omega$

Find the fault current when a fault occurs at bus 2 for the following types of faults

[9 MARKS]

- i. Line –line fault
- ii. Single line-ground fault
- iii. Double line-ground fault

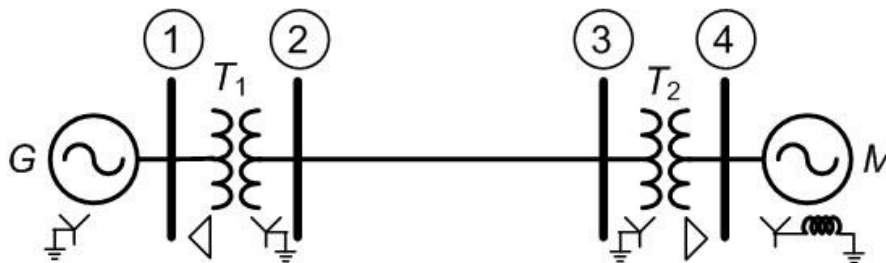


Figure Question 4b

Question FIVE

a. Describe the following types of transmission lines

[4 MARKS]

- i. Short transmission lines
- ii. Medium transmission lines
- iii. Long transmission lines

b. State and explain two methods of reducing the corona loss

[6 MARKS]

c. Discuss the effects of wind and ice load on a cable and the respective sag resultant

[4 MARKS]

d. Briefly discuss the following terms giving their respective expressions

[6 MARKS]

- i. Critical disruptive voltage
- ii. Visual critical voltage
- iii. Power loss due to corona