PP2

TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY EXAMINATION FOR:

DEGREE

TEE 4316: POWER SYSTEM II.

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

DATE:

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 [Compulsory 30 Marks]

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 495MΩ per km. If the core diameter is 2.5 cm and the resistivity of the cable insulation is $4.5*10^{14}\Omega$/cm, find the insulation thickness. [3 MARKS]

h. Describe two methods used for corona reduction [3 MARKS]

Question TWO [20 Marks]

a. Using well labelled diagrams and equations derive the sag equation [6 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 $396N/M^2$. Find the vertical sag if [5 MARKS]

Ice density = $9400kg/m^3$

Copper density = $91470kg/m^3$

Tensile strength = $17100N/m^3$

c. A synchronous generator, capable of developing 500MW power per phase, operates at a power angle of 8^{o}. By how much can the input shaft power be increased suddenly without loss of stability? Assume that Pmax will remain constant [5 MARKS]

d. Deduce the expression of the swing equation [4 MARKS]

Question THREE [20 Marks]

a. Describe four types of insulators [2 MARKS]

b. Using a well labled diagrams derive the expression of the capacitance of a cable of length L, with a relative permittivity $\mathscr{E}_r$, and $\mathscr{E}_0=8.854*10^{-12}$ [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 reactance. [4 MARKS]

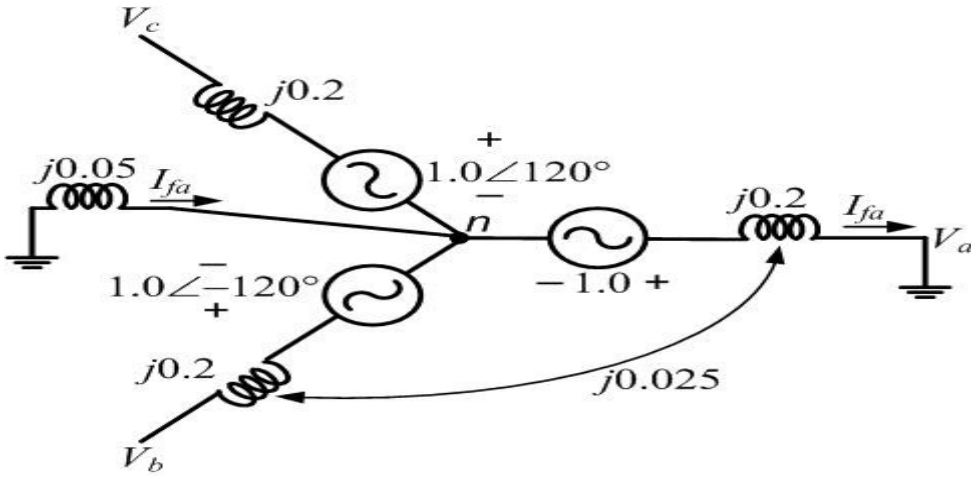

Figure Question 3e

Question FOUR [20 Marks]

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 $40^0 C$ 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%, *Xn* = 5%

Transformer *T*1: 50 MVA, 20 kVΔ/110 kVY, *X* = 10%

Transformer *T*2: 50 MVA, 20 kVΔ/110 kVY, *X* = 10%

Transmission line: *X*1 = *X*2 = 24.2 Ω, *X*0 = 60.5 Ω

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

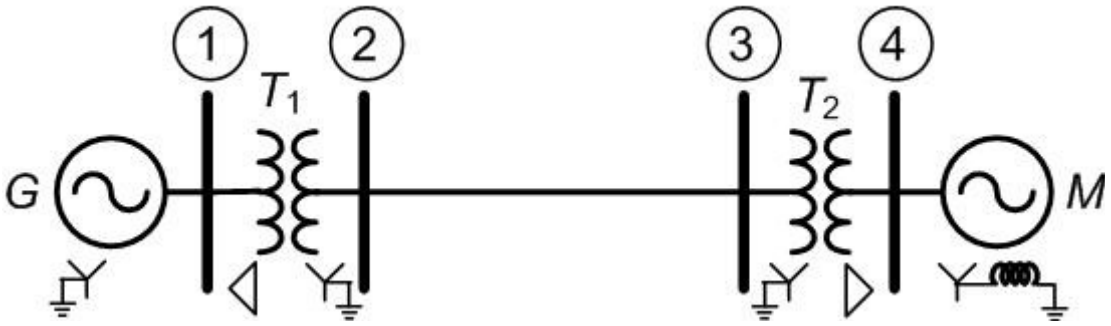

Figure Question 4b

Question FIVE [20 Marks]

a. Describe the following types of transmission lines [3 MARKS]

   i. Short transmission lines

   ii. Medium transmission lines

   iii. Long transmission lines

b. State and explain two methods of reducing the corona loss [7 MARKS]

c. A 60 Hz, 4 pole turbo-generator rated 100MVA, 13.8 KV has inertia constant of 10 MJ/MVA. [10 MARKS]

i. Find stored energy in the rotor at synchronous speed.

ii. If the input to the generator is suddenly raised to 60 MW for an electrical load of 50 MW, find rotor acceleration.

iii. If the rotor acceleration calculated in part (b) is maintained for 12 cycles, find the change in torque angle and rotor speed in rpm at the end of this period.

iv. Another generator 150 MVA, having inertia constant 4 MJ/MVA is put in parallel with above generator. Find the inertia constant for the equivalent generator on a base 50 MVA.