UNIVERSITY EXAMINATIONS 2024/2025

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING
AND
THIRD YEAR, FIRST TRIMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

EET 3313: POWER SYSTEMS ENGINEERING I

DATE: JANUARY 2025   **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

(a) Discuss two benefits and two disadvantages of power system interconnection.   [4 Marks]

(b) The cost of a 3-phase transmission line is KSh (25000a + 2500) per km where 'a' is the area of X-section of each conductor in cm^2. The line is supplying a load of 5 MW at 33kV and 0.8 p.f. lagging assumed to be constant throughout the year. Energy costs 4 cents per kWh and interest and depreciation total 10% per annum. Determine the most economical size of the conductor. Given that specific resistance of conductor material is 10^{-6} Ωcm.   [7 Marks]

(c) A 132 kV transmission line has the following data: Wt. of conductor = 680 kg/km; Length of span = 260 m; ultimate strength = 3100 kg; Safety factor = 2. Calculate the height above ground at which the conductor should be supported. Ground clearance required is 10m.

[4 Marks]

(d) The phase voltages across a certain load are given as:

$$V_a = (176 - j132) \text{ V}$$
$$V_b = (-128 - j96) \text{ V}$$
$$V_c = (-160 + j100) \text{ V}$$

Compute positive, negative and zero sequence component of voltage. [6 Marks]

(e) An overhead transmission line at a river crossing is supported from two towers of heights 40m and 80m above water level with a span of 250 m. Weight of the conductor is 1.16 kg/m and the working tension is 1800 kg. Determine the clearance between the conductor and the water level midway between the towers. [9 Marks]

QUESTION TWO (15 MARKS)

(a) Discuss any three factors affecting the sag in an overhead line. [3 Marks]

(b) An 132kV overhead transmission line has a span of 300 m. Ultimate strength is 600kg and factor of safety is 2.0. If the sag is 2 m, determine the weight of the conductor and the length of the line. [4 Marks]

(c) A synchronous generator and motor rated 25MVA, 11kV each have sub-transient reactance of 15% each. Line reactance is 12% on the machine rating base. The motor is drawing 32MW at 0.85 leading power factor. When the terminal voltage is 10.5 kV 3 phase fault occurs at motor terminals. Calculate the sub-transient current in the generator, motor and at fault point. [8 Marks]

QUESTION THREE (15 MARKS)

(a) Briefly discuss the phenomenon of corona and how it can be minimized in high voltage overhead power lines. [4 Marks]

(b) Discuss three demerits of providing too small or too large sag on a line. [3 Marks]

(c) An overhead transmission line at a river crossing is supported from two towers at height of 30 m and 70 m above the water level. The horizontal distance between the towers is 250 m. If the required clearance between the conductors and the water midway between the towers is 45m

and if both the towers are on the same side of the point of maximum sag, draw parabolic configuration diagram and calculate the tension in the conductor. The weight of the conductor is 0.8 kg/m. [8 Marks]

QUESTION FOUR (15 MARKS)

(a) Briefly describe the three unsymmetrical faults that occur in electrical power systems.
[3 Marks]

(b) Explain the p.u. system of analyzing power system problems and also outline three advantages of this method over the absolute method of analysis. [4 Marks]

(c) From the single line diagram of a simple system show in Fig. Q4(c) below, redraw this system where the per unit impedances of the components are represented on a common 500VA base and common system base voltage of 250V. [8 Marks]
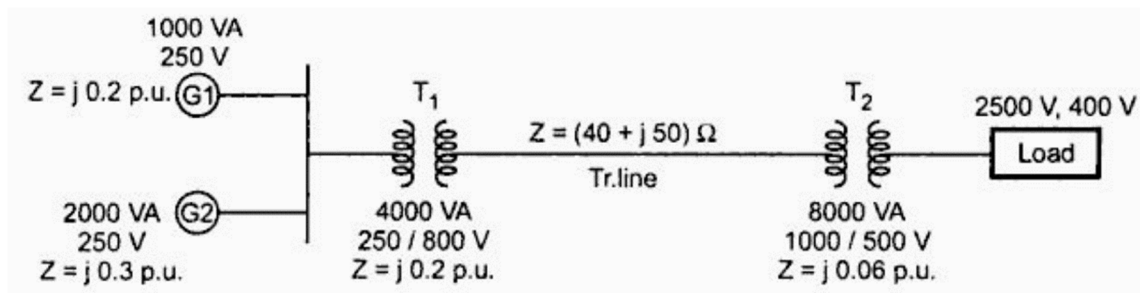

Fig. Q4(c)

QUESTION FIVE (15 MARKS)

(a) Briefly explain the terms "one-line-diagram" as applied in power systems engineering.
[2 Marks]

(b) A 3 phase 20MVA 10kV alternator has an internal reactance of 5% and negligible resistance. Find the internal reactance to be connected in series with each phase so that steady current in each phase does not exceed 8 times full load current. [6 Marks]

(c) The horizontal distance between the two 40 and 80 m unequal towers is found to be 400 m as shown in Fig. Q5(c). The weight of the conductor and working tension are given as 1.25 kg/m and 920 kg, respectively. Calculate:

i)   the clearance between the lowest point of the conductor and the ground level.

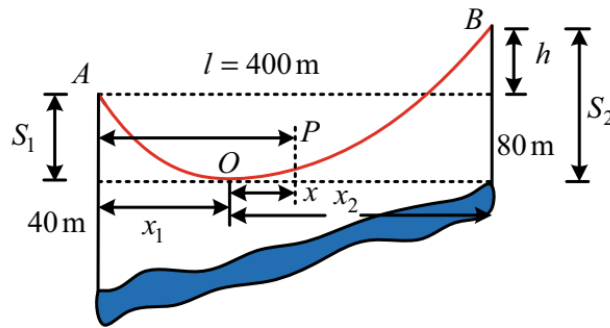ii) the sag and clearance from the ground at the midpoint.

[7 Marks]

Fig. Q5(c)