(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATION ENGINEERING

COURSE CODE: ECE 421

COURSE TITLE: POWER SYSTEMS IV

DATE : 12TH APRIL 2023 **TIME: 12:00 NOON - 2:00 PM**

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

Question One **[30 Marks]**

a)

i) Name any five methods of effectively improving the power system transient stability.

ii) A 50Hz, 4 pole. 500MVA, 22kV, turbo-generator is delivering rated power at 0.8 power factor. Sudenly a fault occurs reducing its power output by 40%. Neglecting losses, determine the accelerating torque atthe time of fault. [10 Marks]

b) A generation station of 10MW supplied two regions (A and B) which have the following demands.

Region A			Region B		
From	To	Demand (kW)	From	To	Demand (kW)
Midnight	9 am	600	Midnight	8 am	800
9 am	12 noon	2500	8 am	1 pm	5000
12 noon	5 pm	800	1 pm	2 pm	800
5 pm	6 pm	5000	2 pm	5 pm	5000
6 pm	7 pm	No-load	5 pm	Midnight	800
7 pm	Midnight	4000	-	-	-

(i) Draw the load curve and load duration curve for regions A and B and for the total loads

(ii) The average load and the load factor of the total system

(ii) Find the reserve capacity of the plant, Plant use factor and the Diversity Factor. [10 Marks]

c)

i) Explain any three commonly used types of tariff.

ii) The monthly readings of a consumer's meter are as follows : Maximum demand = 50 kW Energy consumed = 36,000 kWh Reactive energy = 23,400 kVAR If the tariff is Kshs 80 per kW of maximum demand plus 8 cents per unit plus 0·5 cents per unit for each 1% of power factor below 86%, calculate the monthly bill of the consumer. [10 Marks]

Question Two **[20 Marks]**

a)

i) Define Steady State Stability Limit. Briefly explain any two methods of improving Steady State Stability Limit. [6 Marks]

ii) Derive to show that the maximum steady state power transfer,P_{max} for a lossless line in given by $P_{max} = \frac{EV}{X}$. [7 Marks]

b) A transmission line has a series reactance of 0.2 pu. Reactive power is applied at the mid point of the line and is controlled such that the midpoint voltage of the transmissioin line is always maintained at 0.98pu. If the voltage at both sides of the line are maintained at 1.0pu, find the steady state power power transfer limit of the line? [7 Marks]

Question Three **[20 Marks]**

a) Explain the significance of neutral grounding in transmission lines. [4 Marks]

b

i) Mention the factors that affect sag in the transmission line.

ii) A transmission line has a span of 200 metres between level supports. The conductor has a cross-sectional area of 1.29 cm^2, weighs 1170 kg/km and has a breaking stress of 4218 kg/cm^2. Find the sag for a safety factor of 5, allowing a wind pressure of 122 kg per square metre of projected surface. Calculate the vertical sag. [16 Marks]

Question Four **[20 Marks]**

a) Define the following terms:

i) Economic dispatch

ii) Incremental cost

iii) Spinning reserve

iv) Minimum up time [8 Marks]

b) An area of an interconnected power system has two fossil-fuel units operating on economic dispatch. The variable operating costs of these units are given by where P_1 and P_2 are in megawatts. Determine the power output of each unit, the incremental operating cost, and the total operating cost C_T that minimizes C_T as the total load demand P_T varies from 500 to 1500 MW.

$$C_1 = 10P_1 + 8 \times 10^{-3}P_1^2$$

$$C_2 = 10P_2 + 9 \times 10^{-3}P_2^2$$

Generating unit inequality constraints and transmission losses are neglected. [12 Marks]

Question Five **[20 Marks]**

a) What are the stability problems in power system? [6 Marks]

b) The synchronous generator shown in the figure is supplying active power to an infinite bus via two short, lossless transmission lines, and is initially in steady state. The mechanical power input to the generator and the voltage magnitude E are constant. If one line is tripped at time t_1 by opening the circuit breakers at the two ends (although there is no fault), and it is observed that the generator undergoes a stable transient. Give a sketch of the waveforms of the rotor angle δ depicting the transients correctly. Explain your sketch diagram. [7 Marks]

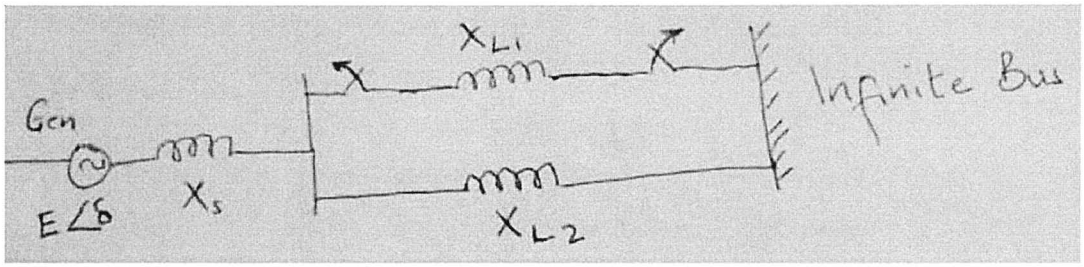

Figure 1: Q5

c) In the single machine infinite bus system shown in fig. Q5 above, the generator is delivering the real power of 0.8 pu at 0.8 power factor lagging to the infinite bus. If $X_s = 0.4$ pu and $X_{L1} = X_{L2} = 0.5$ pu, find the power angle of the generator in degrees. [7 Marks]