(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FIFTH YEAR SPECIAL/SUPPLIMENTARY EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 421

COURSE TITLE: POWER SYSTEMS III

DATE: OCTOBER 6th, 2022   **TIME:** 03.00 – 05.00 PM

INSTRUCTIONS TO CANDIDATES

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

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over.

a) Briefly explain the following two fundamental economic principles which closely influence the electrical design of a transmission line. Use graphical illustration to aid the explanation.

   (i) Economic choice of conductor size

   (ii) Economic choice of transmission voltage   [10 Marks]

b) The conductor is one of the crucial component of a transmission line as most of the financial outlay is invested on it. Hence, correct selection of conductor material and size is of significant importance. Give any five (5) characteristics that a conductor material used for transmission and distribution of electric power must posses.   [10 Marks]

c) **(i)** A tariff must have the following desirable characteristics .   [5 Marks]

   (ii) A consumer has a maximum demand of 200 kW at 40% load factor. If the tariff is Kshs. 100 per kW of maximum demand plus 10 cents per kWh, find the overall cost per kWh.   [5 Marks]

Question Two   **20 Marks**

a) Discuss the factors influencing power system transient stability.   [4 Marks]

b) Consider a generator is connected to an infinite bus through a transformer with leakage reactance of j0.2pu and two parallel transmission lines as shown in Fig. Q2(b) below. The generator's transient reactance $X'_d = $ j0.2 pu and each transmission line has a reactance of j0.4 pu and negligible resistance. The generator is delivering a load current of $1.0\angle -36.9°$ pu to the infinite bus whose voltage is $1.0\angle 0°$, when a 3-phase fault occurs midway along one of the transmission lines.
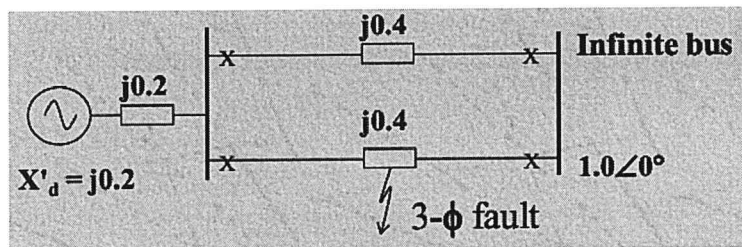

Figure 1: Q2(b)

   i) Assuming that the mechanical power input is 1.0 pu at the time of the fault, determine the critical clearing angle.

   ii) If the generator has a rating of 50 MVA and H = 2.7 MJ/MVA at rated speed and supplying 50 MW to the infinite bus when the $3 - \phi$ fault occurs:

   • Plot the swing curve for a sustained fault upto 0.5 secs.

   • Plot the swing curve if the fault is cleared in 0.10 secs by simultaneous opening of the breakers at both ends of the faulted line.   [16 Marks]

Question Three   **20 Marks**

a) The supporting structures for overhead line conductors are different pole and tower types called line supports. What are the typically characteristics should the line supports have?   [4 Marks]

b) Discuss any three types of line supports.

c) A transmission line has a span of 200 m between level supports. The conductor has a cross-sectional area of 2 cm^2. The tension in the conductor is 2000 kg. If the conductor material specific gravity is 9.9 gm/cm^3 and wind pressure is 1.5 kg/m length, calculate the vertical sag.   [10 Marks]

a) As an energy manager in a leading manufacturing firm, one of your responsibility is to initiate and maintain efficient energy management programs. Briefly describe five energy efficient options/technologies you may initiate to ensure optimal energy utilization within the establishment.   [10 marks]

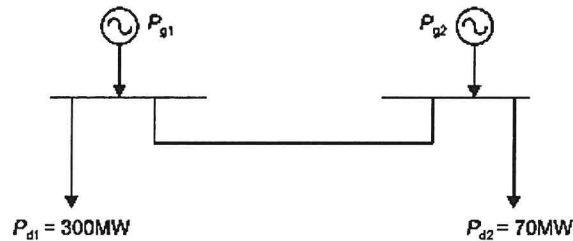b) The diagram below is an illustration of a two bus power system.

Figure 2: Q4(b)

The incremental cost for each generator in the generating station is given as below

$$IC_1 = 0.35\, P_{g1} + 41 \quad \text{Ksh/MWhr}$$
$$IC_2 = 0.35\, P_{g2} + 41 \quad \text{Ksh/MWhr}$$

The power above power system suffers power loss which is given by the equation

$$P_l = 0.001(P_{g2} + 70)^2 \quad \text{MW}$$

Given that the total power demanded is 370MW, in three iterations, determine the optimal scheduling and power loss for the transmission link.   [10 Marks]

a) Explain the typical application of strain insulators.   [4 Marks]

b) Briefly explain any three means of enhancing string efficiency.   [6 Marks]

c) In a 33 kV overhead distribution line, there are three elements in the string of insulators. If the capacitance between each insulator pin and ground is 11% of selfcapacitance of each insulator, calculate:

(i) voltage distribution over 3 insulators and

(ii) string efficiency.   [10 Marks]