(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

MAIN EXAMINATIONS

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

COURSE CODE: ECE 213

COURSE TITLE: POWER SYSTEMS I

DATE: 7TH DECEMBER 2022 **TIME:** 8.00 AM - 10.00 AM

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 4 Printed Pages. Please Turn Over.

Question 1 **30 marks**

a) (i) Give any four advantages of a three phase over a single phase system. (4 marks)

(ii) Explain clearly the concept of reactive power in single phase and three phase circuits, and hence show that the total instantaneous 3-phase power is constant and is equal to three times the real power per phase i.e., $P_{3\theta}=3P_{1\theta}$ where $P_{1\theta}$ is the power per phase.

(7 marks)

b) Consider a simple power system given by the circuit in Fig. Q1 (b) below.

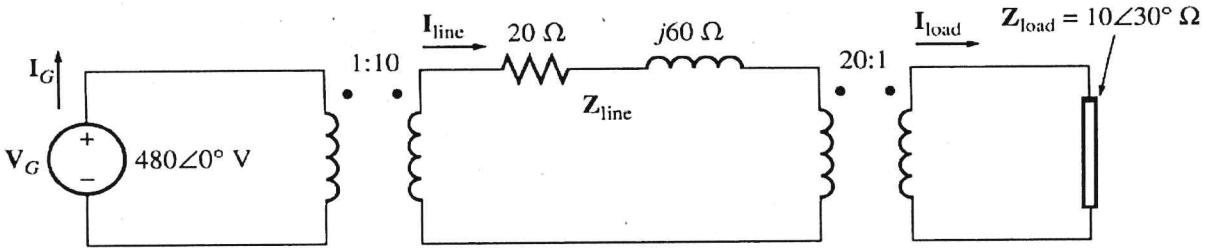


Fig. Q1 (b) If the generator is rated at 480V and 10 kVA:

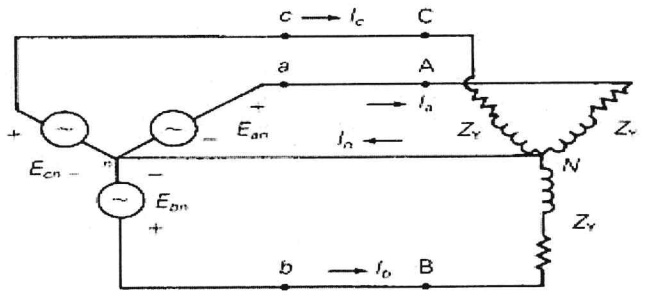
(i) Find the base voltage, current, impedance, and apparent power at relevant points in the power system;

(ii) Convert the system to its per-unit equivalent circuit;

(iii) Find the power supplied to the load in this system;

(iv) Find the power lost in the transmission line. (12 marks)

c) The figure below shows a balanced three-phase circuit.



By taking E_{an} as $10<0^o$, show that the equivalent line-line voltage is given by $\sqrt{\ }$ of line-phase voltage and is offset by $+30^0$ (7 marks)

Question 2 — 20 marks

a) A distribution system is represented as the single-phase circuit shown in Fig. Q2(b).

(i) Find the apparent power S, active power P, reactive power Q and the power factor Pf of the load.

(ii) If a 0.95 lagging power factor is desired, what capacitance (in F) should be connected across the line to correct the power factor to the desired value.

(iii) Draw the power triangles before and after power factor correction. (12 marks)

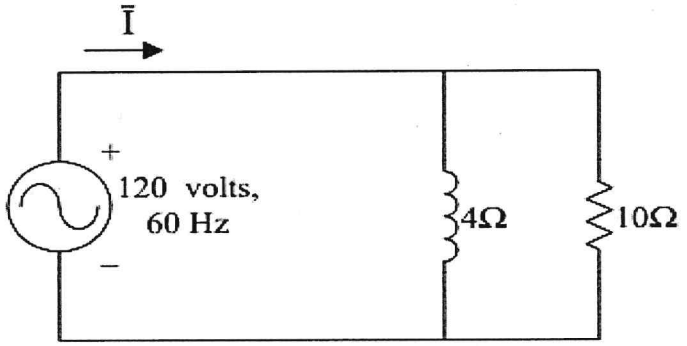


Fig. Q2(a)

b) James Millers company, a steel milling company based in Nairobi has been paying a lot of electricity bills over the last two years. Troika Energy services which is an energy audit company has been called upon to analyze the power situation at James Millers company. You are part of the Troika energy services audit team, upon carrying out full energy audit on the James Millers company; amongst many other factors, you realized it has been operating at a power factor of 0.57. Explain any three possible ways how you would help the company reduce the electricity bills. You may use diagrams where applicable. (8 marks)

Question 3 — 20 marks

a) What is ABCD parameters? With the aid of a circuit diagram, derive the equation of a short transmission line. (6 marks)

b) A 50 km long three phase, 60 Hz transmission line delivers 36 MW at 60 kV (phase), 0.8 power factor lagging. The line constants per conductor are; R = 2.5 Ω, L = 0.1 H, C = 0.25 μF). Shunt leakage may be neglected. Determine the voltage, current, power factor, active and reactive powers at the sending-end. Also, determine the efficiency and voltage regulation of the line. Use:

(i) nominal-T method (7 marks)

(ii) nominal-π method. (7 marks)

Question 4 **20 marks**

a) Explain the p.u. system of analysing power system problems. Discuss the advantages of this method over the absolute method of analysis. (6 marks)

b) Consider a system with the single line diagram shown in Fig. Q4(b). The three phase transformer name plate ratings are listed. The transformer reactances are given in percent; 10% = 0.1 p.u. The transmission line impedance Z_L is 10 + j100 ohms and load impedance Z_{load} is 440 ohms. The generator has a terminal voltage (magnitude) of 13.2 kV (line-line). Find the power delivered to the load, the power supplied by the generator and the efficiency. (14 marks)

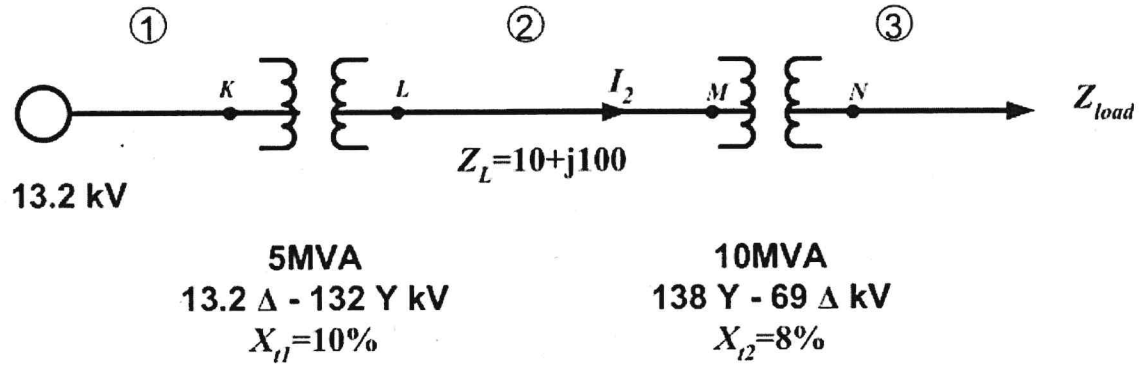


Fig. Q4(b)