FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

ELECTRICAL PRINCIPLES

EMI 1203 / EMR 1203 / EGS 1206

Final Examination Paper

June 2023

This examination paper consists of 5 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: Mr. K. Garapo

INSTRUCTIONS

1. Answer all questions in Section A and any three questions in Section B.
2. Begin each solution for a new question on a new page and show all working.
3. Section A consists of a **four** question carrying **10 marks** each.
4. Section B consists of **four** questions carrying **20 marks** each.
5. Use of calculators is permissible.

Additional Requirements

None

MARK ALLOCATION

Questions	Marks
Question 1	**10**
Question 2	**10**
Question 3	**10**
Question 4	**10**
Question 5	**20**
Question 6	**20**
Question 7	**20**
Question 8	**20**
Total Attainable	**100**

SECTION A (40 Marks): Answer all questions

Question 1

The delta and star circuits shown in Figure A1 are equivalent. Determine the values of C_a, C_b and C_c, given that $C_1 = 20$ µF, $C_2 = 50$ µF and $C_3 = 30$ µF. [10]

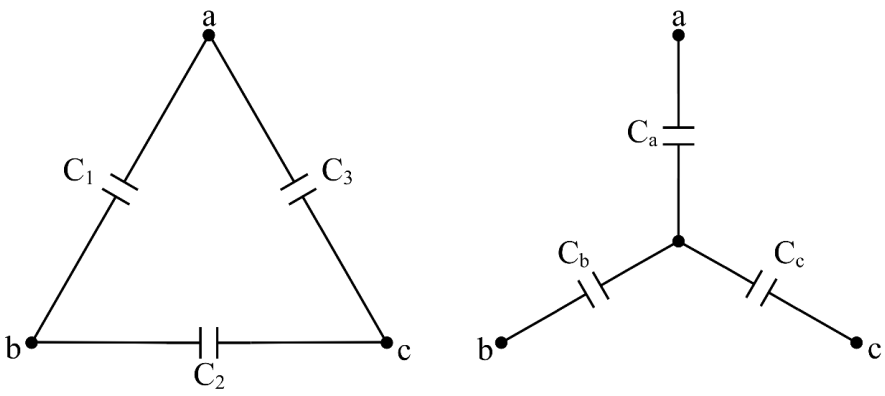

Figure A1

Question 2

Refer to the oscillogram shown in Figure A2 and answer the following:

a) Determine the following values: i) peak voltage, ii) period, iii) frequency and iv) rms voltage, of the AC component of the signal, [8]

b) Determine the value of the DC component of the signal. [2]

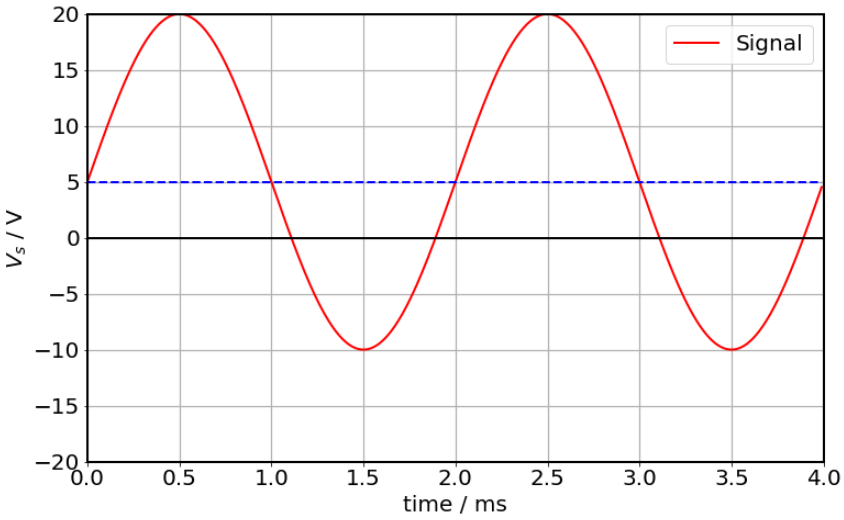

Figure A2

Question 3

Given a balanced three-phase voltage system, show (with the aid of phasors) that the sum of the three phase voltages is zero. [10]

Question 4

Given that the circuit shown in Figure A3 was in a steady state when the switch was toggled at a time $t = 0$, answer the following:

a) Determine the time constant τ of the resulting RC circuit, [3]

b) Determine the power dissipation of the resistor at a time $t = 1.5\tau$. [7]

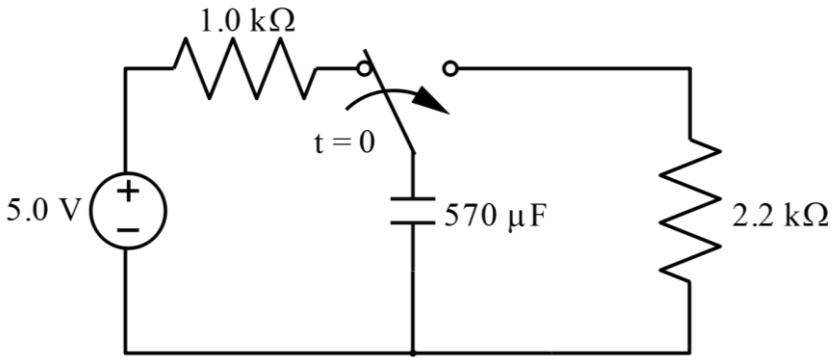

Figure A3

SECTION B (60 Marks): Answer any three questions

Question 5

a) Thévenise the circuit shown in Figure B1 given that Z_L is the load of interest. [15]

b) Deduce the combination of capacitance or inductance and/or resistance required to constitute the load for maximum power to be transferred from the Thévenin's equivalent voltage source, determined in a), to the load. [5]

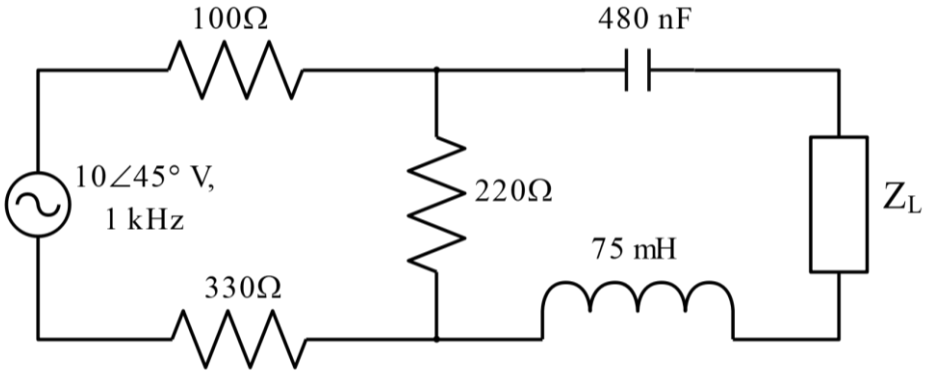

Figure B1

Question 6

a) Given the circuit shown in Figure B2, apply the superposition theorem to determine the current flowing through the 10 Ω resistor. [10]

b) Apply mesh analysis to verify the current flowing through the 10 Ω, which you calculated in part a). [10]

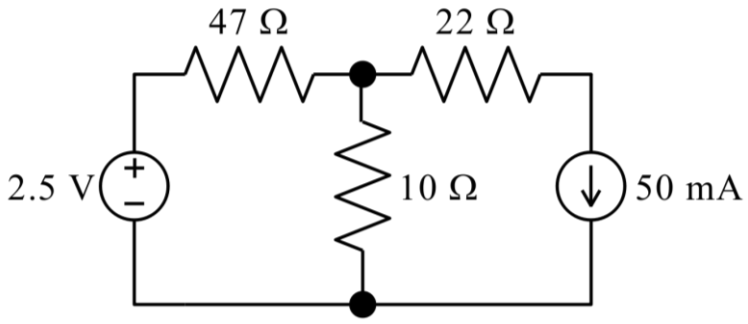

Figure B2

Question 7

a) Given the following binary numbers: A = 10011011_2 and B = 11011011_2, determine the following (without using a calculator and stating all steps necessary):

i) 1's complement of A, [2]

ii) 2's complement of B, [2]

iii) A + B, [2]

iv) A – B, giving your answer in hexadecimal (HEX). [4]

b) Using universal logic gates of the same type draw the logic circuit represented by the following equation: $O = A\bar{B} + \bar{A}C$. [5]

c) Draw the diagram of a simple NPN BJT transistor inverter. [5]

Question 8

a) Three inductive loads each of resistance $150\ \Omega$ and inductance 318.4 mH are connected in delta to a 415 V, 50 Hz, 3-phase supply. Determine the following:

i) phase voltage, [3]

ii) phase current, [6]

iii) line current. [3]

b) Determine the total power dissipated by three $68\ \Omega$ resistors when connected to a 440 V, 3-phase supply

i) in star, [4]

ii) in delta. [4]