



**FACULTY OF EXPLORATION AND EARTH SCIENCES**  
**DEPARTMENT OF SURVEYING AND GEOMATICS**

**ELECTRICAL PRINCIPLES**

**ESG 1206 / EMG 1203 / EMN 1203**

**Final Examination Paper**

**September 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 from 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**

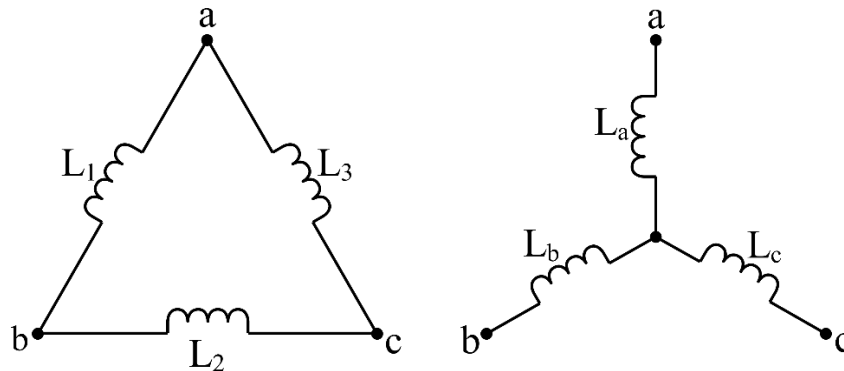
<b>Questions</b>	<b>Marks</b>
<b>Question 1</b>	<b>10</b>
<b>Question 2</b>	<b>10</b>
<b>Question 3</b>	<b>10</b>
<b>Question 4</b>	<b>10</b>
<b>Question 5</b>	<b>20</b>
<b>Question 6</b>	<b>20</b>
<b>Question 7</b>	<b>20</b>
<b>Question 8</b>	<b>20</b>
<b>Total Attainable</b>	<b>100</b>

**SECTION A (40 Marks): Answer all questions**

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**Question 1**

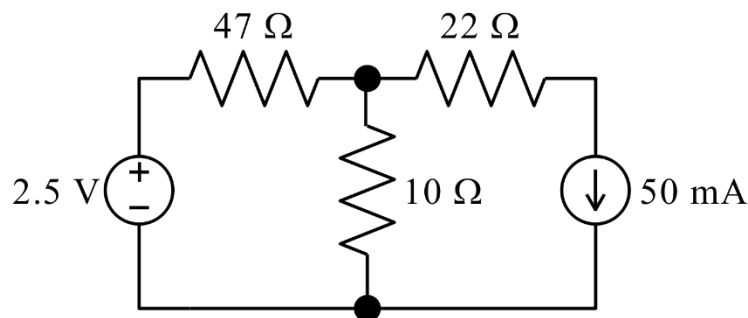
Given that the delta and star circuits shown in Figure A1 are equivalent, determine the values of  $L_a$ ,  $L_b$  and  $L_c$ , given that  $L_1 = 200$  mH,  $L_2 = 500$  mH and  $L_3 = 300$  mH. [10]



**Figure A1**

**Question 2**

Given the circuit shown in Figure B3, apply the superposition theorem to determine the current flowing through the  $10 \Omega$  resistor. [10]



**Figure A2**

### Question 3

a) State the truth tables for each of the following two-input logic gates:

i) NAND, [3]

ii) NOR. [3]

b) Draw the logic circuit described by the following logic equation:  $O = AB + \overline{B}C$  using basic two-input logic gates. [4]

### Question 4

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

i) star, [5]

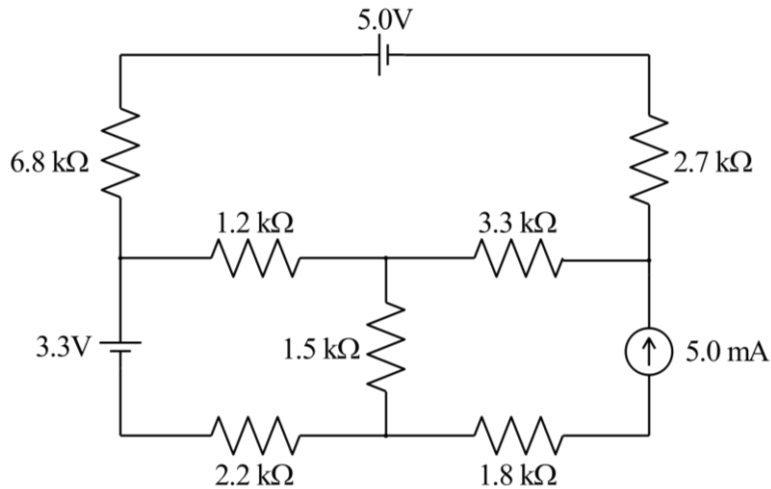
ii) delta. [5]

**SECTION B (60 Marks): Answer any three questions**

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**Question 5**

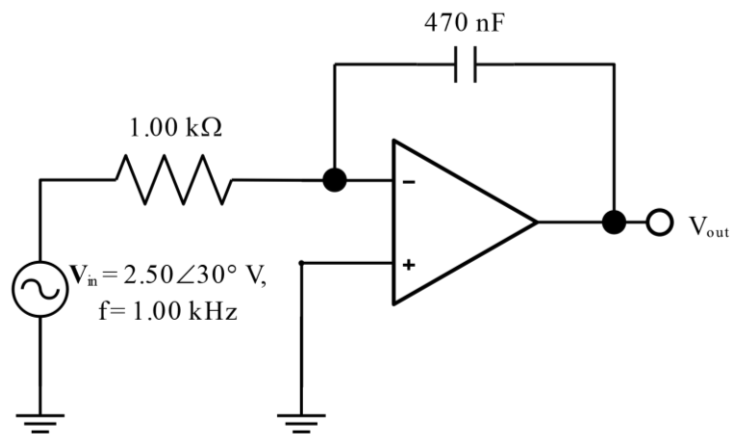
Use mesh analysis to determine the current flowing through each of the seven resistors in the planar circuit shown in Figure B1. [20]



**Figure B1**

**Question 6**

Given the circuit of an ideal OPAMP, as shown in Figure B2, determine the output  $V_{out}$ , [20]

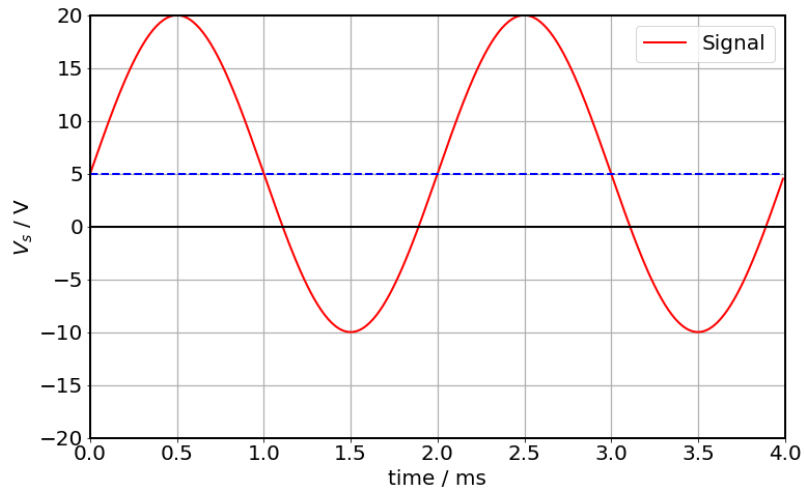


**Figure B2**

### Question 7

Given the oscillogram shown in Figure A2, answer the questions that follow.

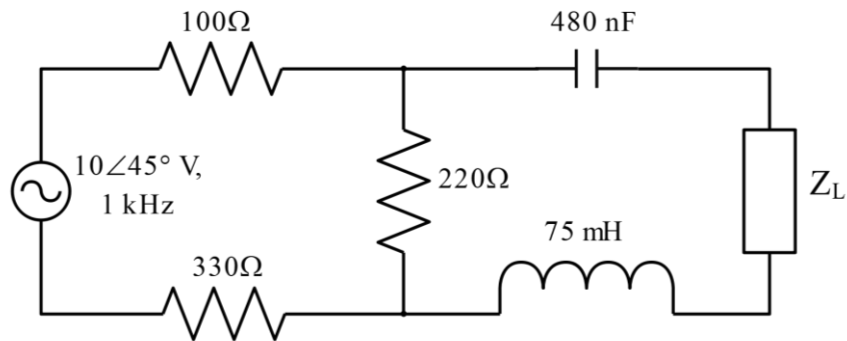
- a) Determine the i) *peak voltage*, ii) *period* and iii) *frequency* of the AC component of the signal. [9]
- b) Determine the value the DC component of the signal. [5]
- c) The voltage phasor of the AC component of the signal. [6]



**Figure B3**

### Question 8

- a) Determine Norton's equivalent circuit for the planar circuit shown in Figure B4, given that  $Z_L$  is the load of interest. [15]
- b) Deduce the value of  $Z_L$  for maximum power to be transferred to the load. [5]



**Figure B4**