FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

ELECTRICAL ENGINEERING PRINCIPLES

EGS 1206 / EMI 1203 / EMR 1203

Final Examination Paper

July 2022

This examination paper consists of 8 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Mr. K. Garapo

INSTRUCTIONS

1. Answer any 5 questions
2. Each question carries 20 **marks** each.
3. Use of calculators is permissible

Additional Requirements

NONE

MARK ALLOCATION

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

Question 1

(a) State Ohm's law and give any one use of a resistor in a circuit. [3]

(b) Given a copper wire of cross-sectional diameter 1 mm and length 1m, calculate its conductance (in siemens), given the resistivity of 1.8×10^{-8} Ωm. [5]

(c) Given the circuit shown in Figure 1, what is the total resistance across the points A and B? [6]

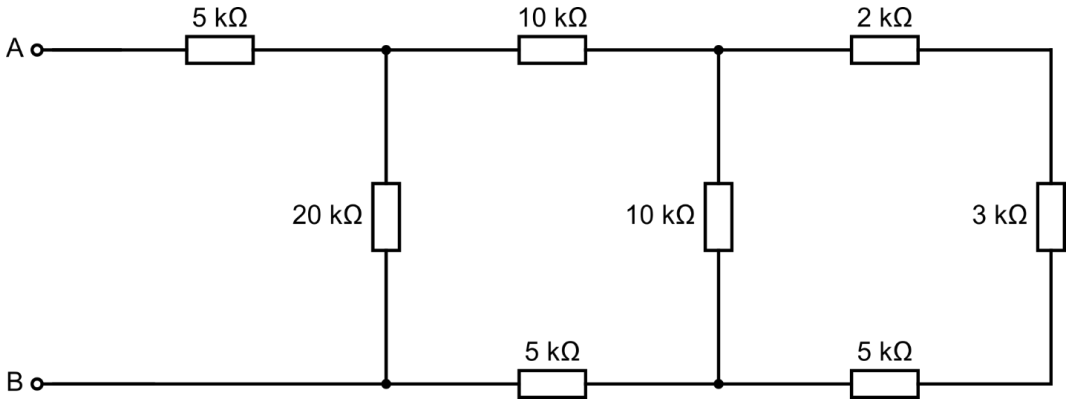

Figure 1

(d) Given the wye and delta circuits shown in Figure 2, calculate the resistances R_a, R_b and R_c, given that $R_1 = 10\Omega$, $R_2 = 15\Omega$ and $R_1 = 5\Omega$. [6]

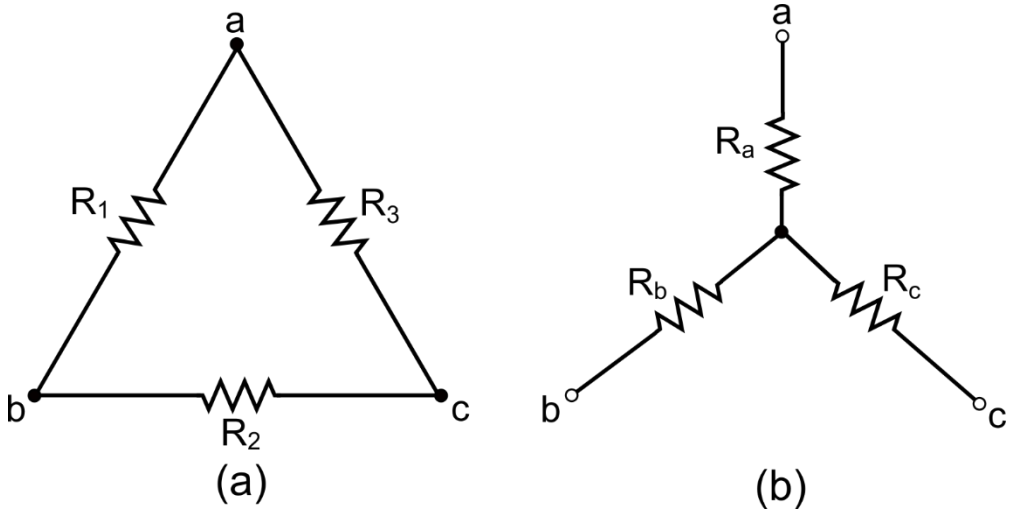

Figure 2

Question 2

(a) Refer to the circuit in shown in Figure 3.

(i) Determine the mesh currents I_1, I_2 and I_3. [8]

(ii) What is the current flowing through R_4 ? [2]

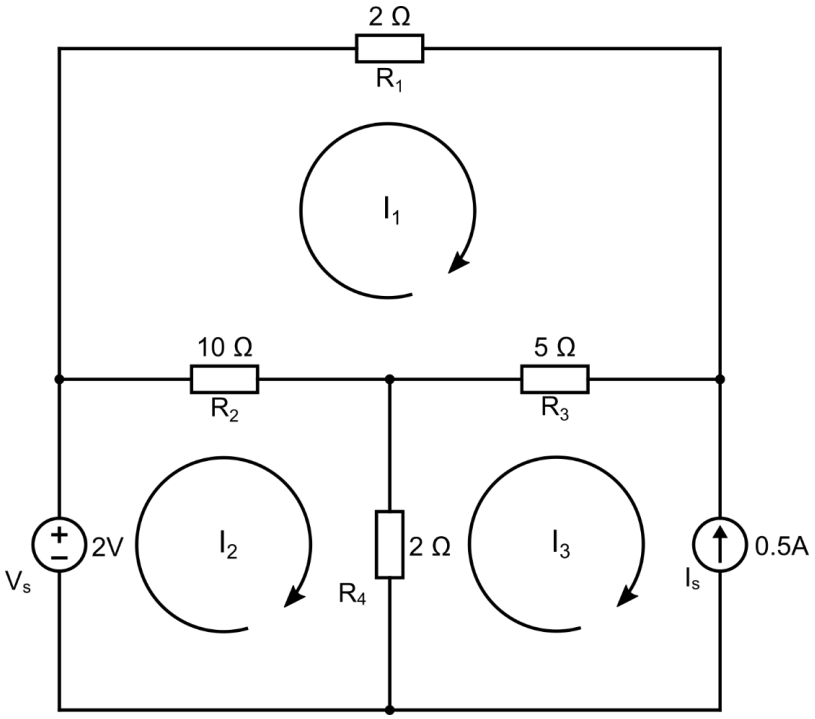

Figure 3

(b) Refer to the circuit shown in Figure 4.

(i) State Kirchhoff's current law (KCL). [2]

(ii) Using Kirchhoff's current law (together with any other applicable circuit laws or theorems), compute branch currents I_1, I_2 and I_4, given that $I_3 = 0.27A$. [8]

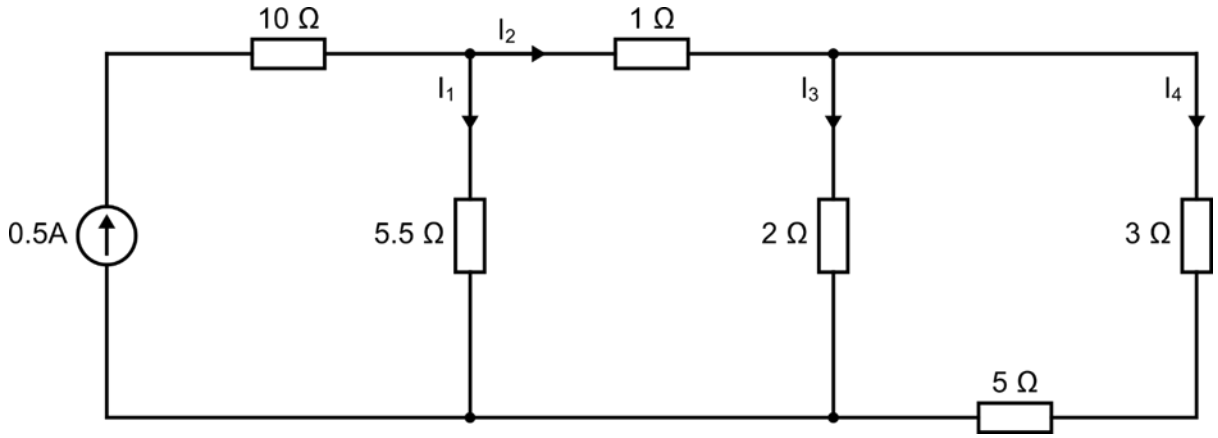

Figure 4

Question 3

Refer to the circuit in Figure 5.

(a) State Thevenin's theorem. [2]

(b) For the circuit shown in Figure 5, determine the Thevenin equivalent voltage and resistance. [10]

(c) Draw the Norton equivalent circuit. [8]

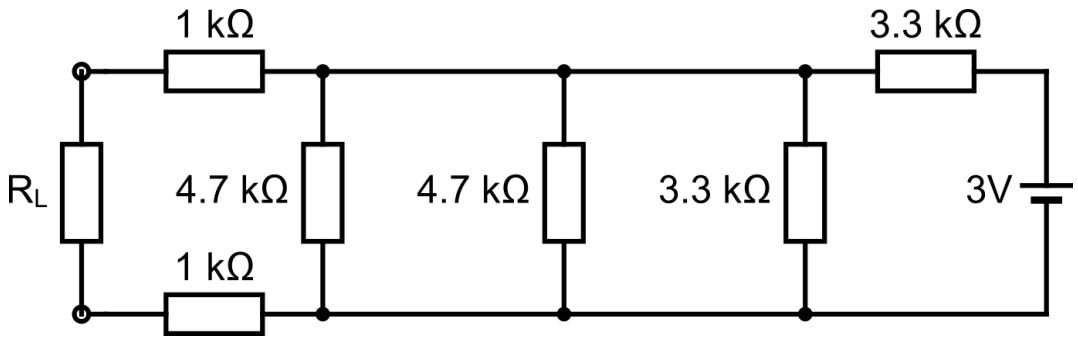

Figure 5

Question 4

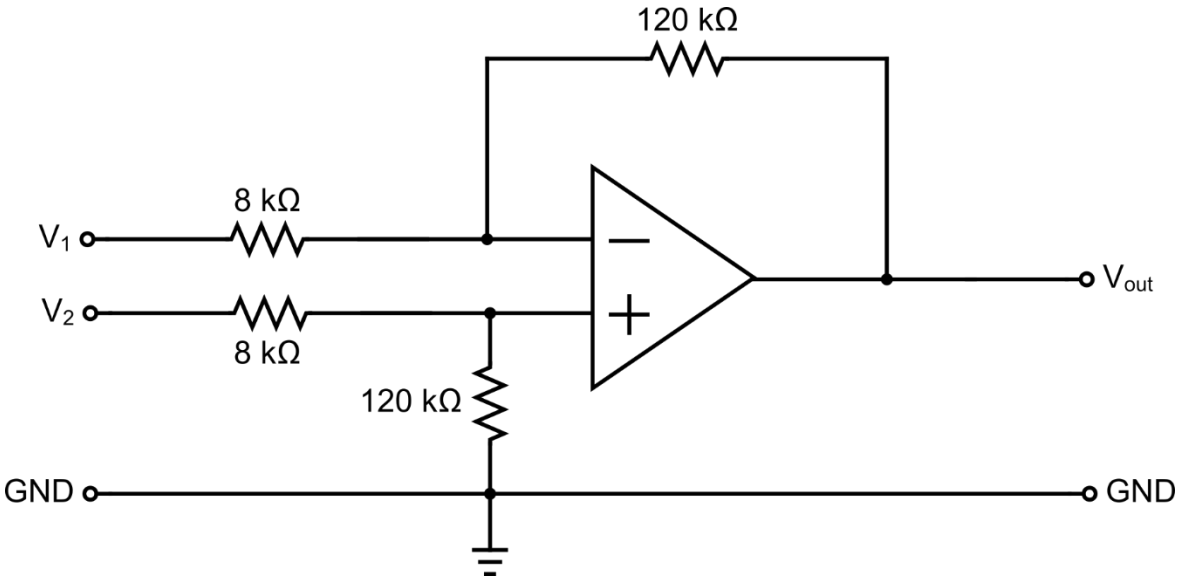

Figure 6

(a) Referring to the differential amplifier in Figure 6, determine the output voltage V_{out} when:

(i) $V_1 = 4$ mV and $V_2 = 0$ mV, [2]

(ii) $V_1 = 0$ mV and $V_2 = -6$ mV, [2]

(iii) $V_1 = 40$ mV and $V_2 = 30$ mV, [2]

(iv) $V_1 = 24$ mV and $V_2 = 42$ mV, [2]

(v) $V_1 = -10$ mV and $V_2 = -10$ mV. [2]

(b) Referring to the differentiating amplifier in Figure 7, determine the output function V_{out}, given the input function $V_{in} = 5Cos(\pi t)$, where t is time in seconds. [5]

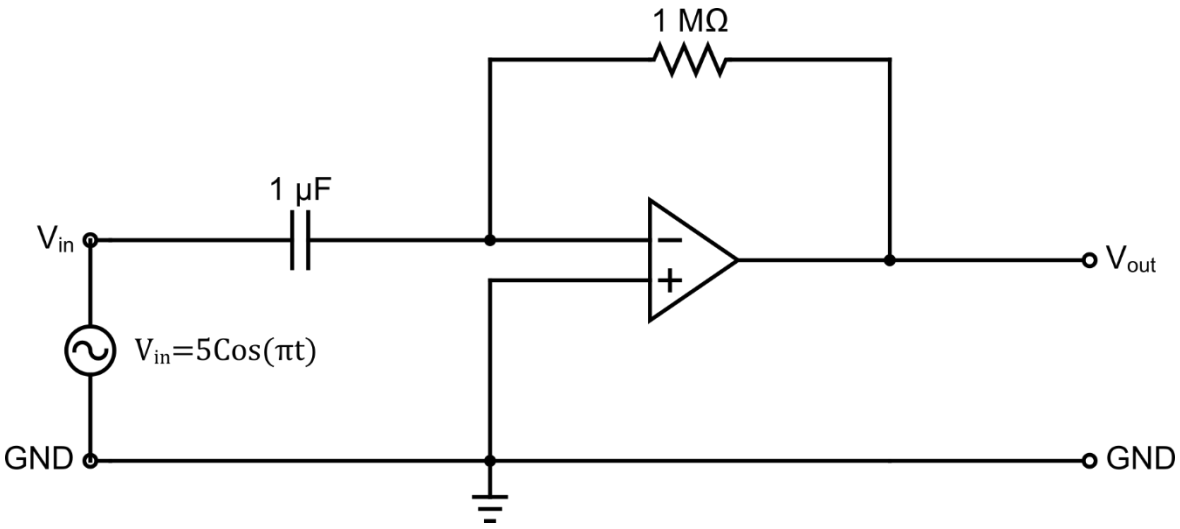

Figure 7

(c) Sketch the output signal V_{out} determined in part (b) as a function of time.

[5]

Question 5

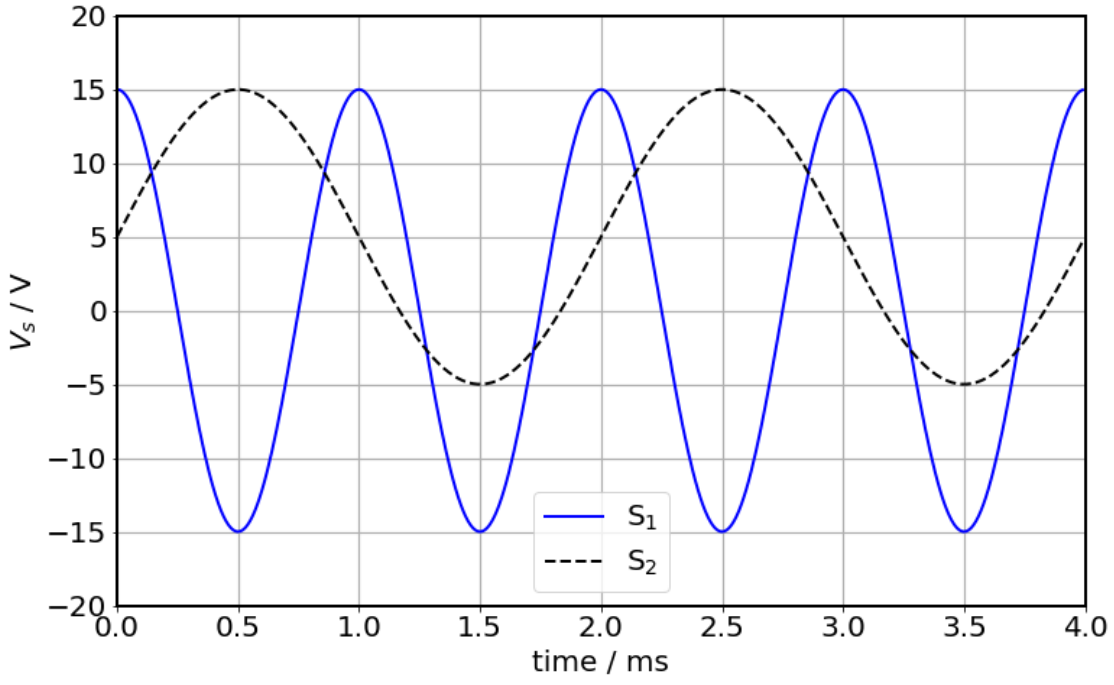

Figure 8

Figure 8 shows the graphs of two alternating voltage signals S_1 and S_2. For each signal, determine the following:

(a) the d.c. voltage $V_{d.c.}$, [2]

(b) the peak voltage $V_{p.}$, [2]

(c) the peak to peak voltage V_{pp}, [2]

(d) the r.m.s. voltage V_{rms}, [2]

(e) the period T, [2]

(f) the frequency f, [2]

(g) the function $V = A\ Cos(2\pi ft\ +\ \varphi) + V_{d.c.}$, where φ is the phase angle, that describes each of the signals. [8]

Question 6

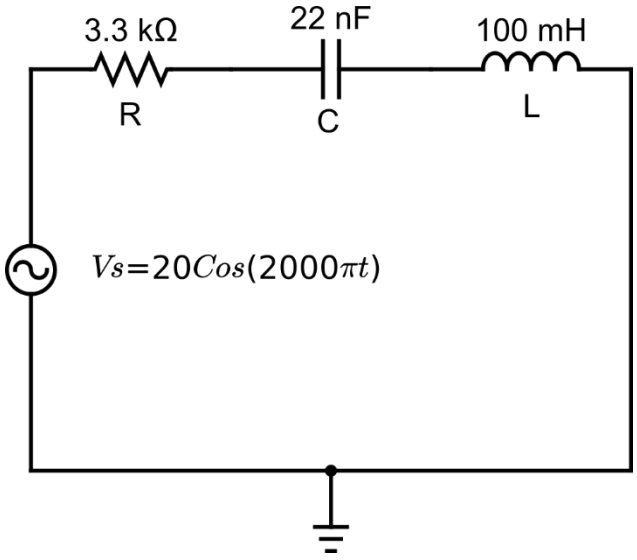

Figure 9

Refer to the circuit in Figure 9.

(a) What is the capacitive reactance? [3]

(b) What is the inductive reactance? [2]

(c) What is the total reactance? [3]

(d) What is the total impedance of the circuit? [3]

(e) What is the phase angle between the source voltage and the current? [3]

(f) What is the voltage across L, C and R? [6]

Question 7

(a) Three inductive loads each of resistance 75Ω and inductance $318.4\ \mathrm{mH}$ are connected in delta to a $415\ \mathrm{V}, 50\ \mathrm{Hz}$, 3-phase supply. Determine

(i) the phase voltage, [3]

(ii) the phase current, [6]

(iii) the line current. [3]

(b) Determine the total power dissipated by three 20Ω resistors when connected to a 440 V, 3-phase supply

(i) in star, [4]

(ii) in delta. [4]