

EEEN203 Circuit Analysis

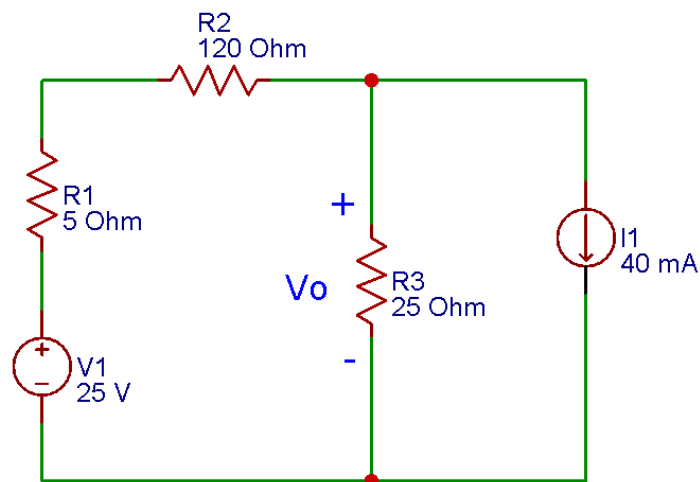
Assignment 1 – Circuit Analysis

Due date: Tuesday, 26th March 2024 (worth: 15%; online submission to VUW website)

A. DC Analysis

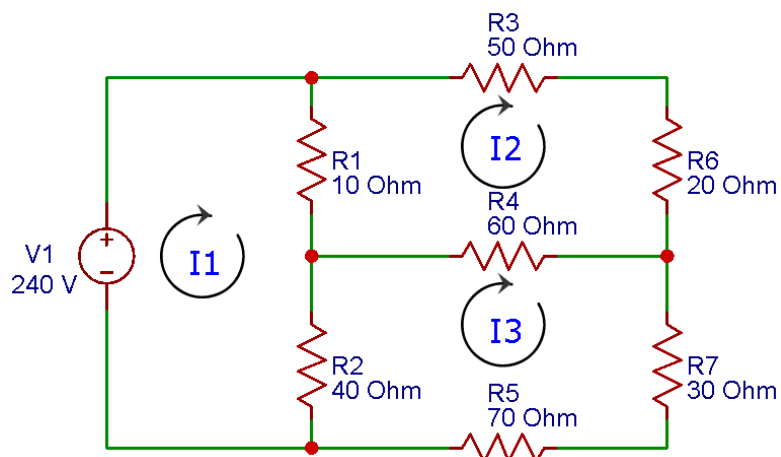
[42 marks]

1. Use the node-voltage method to find unknown parameters in the circuit in the figure given below.



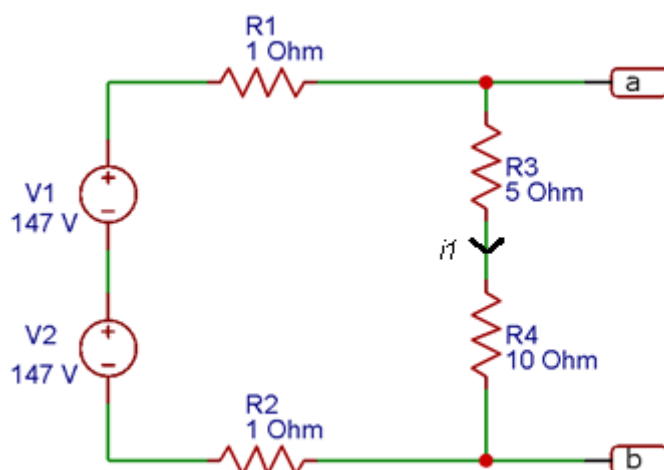
- a. Find the potential difference across the 25 Ω resistor, v_o . [3 marks]
- b. Verify that the total power developed in the circuit equals the total power dissipated. [7 marks]

2. For the circuit given in the figure below, answer the following questions.

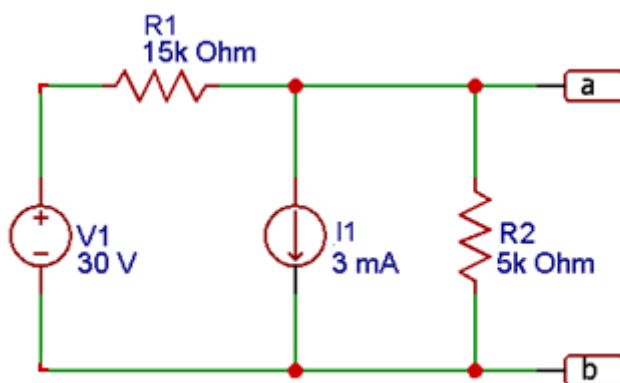


- a. Use mesh analysis to find expressions for mesh currents I_1 , I_2 , and I_3 . [3 marks]
- b. Determine values for mesh currents I_1 , I_2 , and I_3 by using substitution or matrix method. Determine the currents that flow in the voltage source V_1 and resistor R_4 . [9 marks]

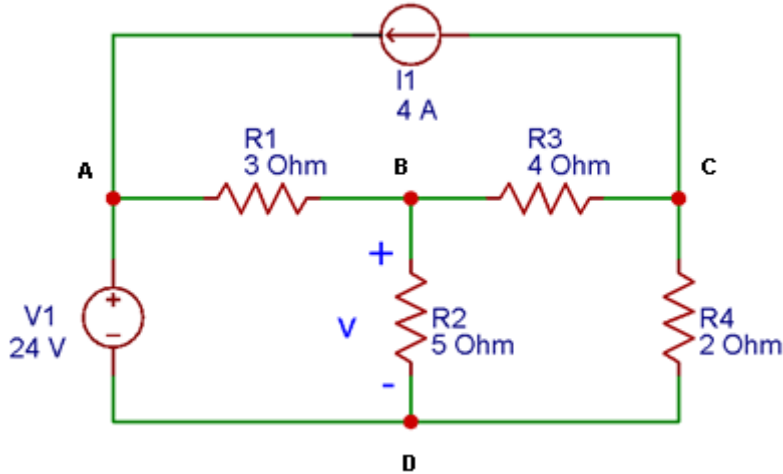
3. For the circuit given in the figure below, attempt the following tasks.



- a. Find the Thevenin equivalent circuit between points a and b in the circuit above. [5 marks]
- b. Find the Norton equivalent circuit with respect to the terminals a and b in the circuit given below [5 marks]



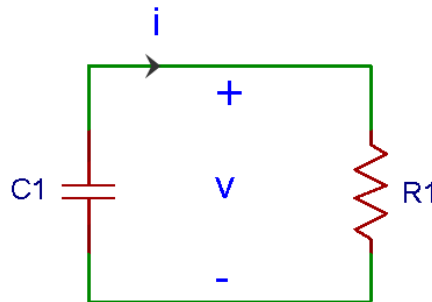
4. Use superposition to find the voltage across the 5Ω resistor in the circuit below. [10 marks]



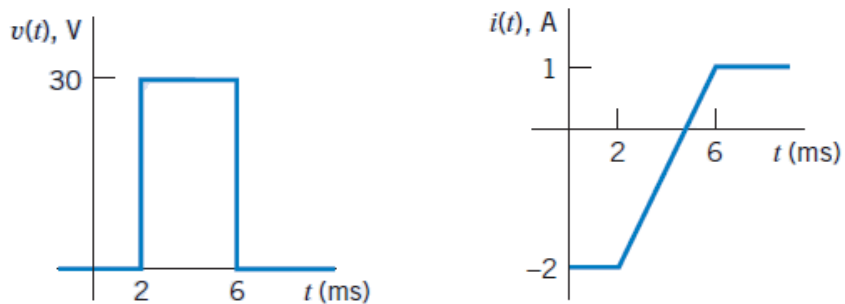
B. AC Analysis

[44 marks]

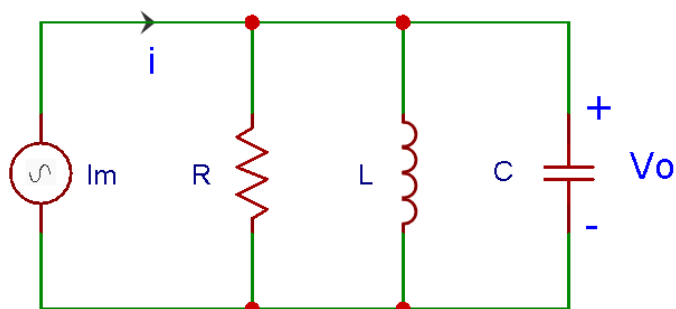
5. Capacitor has charging and discharging characteristics that depend on the applied current and capacitance value of the capacitor.
 - a. A current of $10 \mu\text{A}$ is applied to a $22 \mu\text{F}$ capacitor, which initially has no-voltage difference between its plates. Calculate the voltage between the plates after 3 seconds. [7 marks]
 - b. After a brief time, the capacitor has a voltage between its plates of 15 V and the current source is turned off. The capacitor is connected to a $1 \text{ k}\Omega$ resistor and allowed to discharge to ground, as shown in the circuit diagram below.



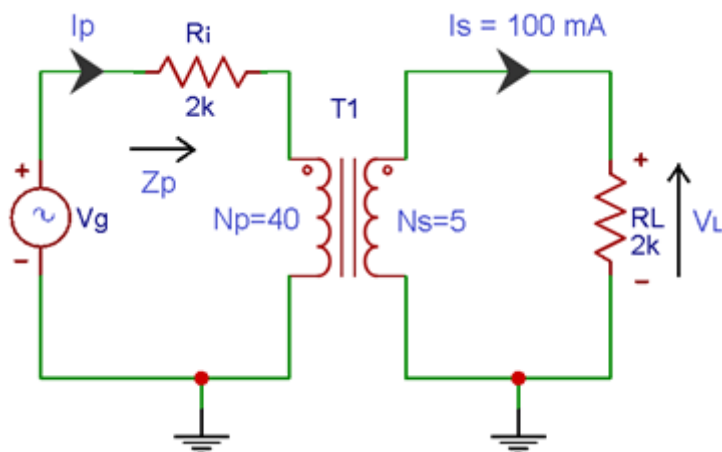
- i. Write a differential equation for the charge on the capacitor once it starts to discharge. [4 marks]
 - ii. Sketch the charge on the capacitor plates with respect to time as the capacitor discharges. Take care to include all relevant information on your plot, include axes labels, coordinates, and units. [3 marks]
6. The plots given below are the current and voltage of an inductor connected with a voltage source. Determine the value of the inductance of the inductor. [5 marks]



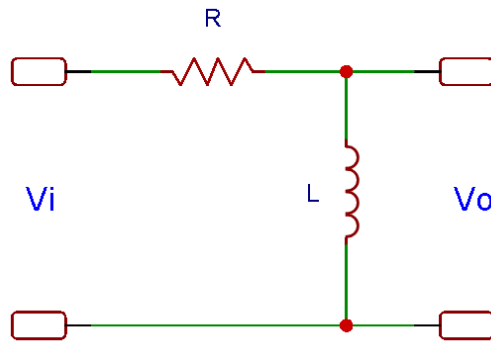
7. Consider the circuit shown below, where $L = 100$ mH, $C = 50$ nF, and $R = 470 \Omega$.



- Calculate the impedance of the inductor, Z_L , resistor, Z_R , and capacitor, Z_C , at a frequency of 5 kHz. [3 marks]
 - Draw the Thévenin equivalent for this circuit, assuming $I_{in} = 10 \sin(10,000\pi t)$ mA. Give values for the Thévenin voltage, V_{Th} , and the Thevenin impedance, Z_{Th} . [6 marks]
 - Based on your answer to part (b), what is the phase difference between the open-circuit voltage, v_o , and the short-circuit current, I_{SC} , in this circuit? [2 marks]
8. Considering the transformer circuit shown below, determine the following parameters of the transformer:
- The voltage across the voltage source at the primary. [5 marks]
 - The input resistance of the transformer. [3 marks]



9. Consider the LR circuit shown below, where $L = 470 \text{ mH}$ and $R = 10 \text{ k}\Omega$.

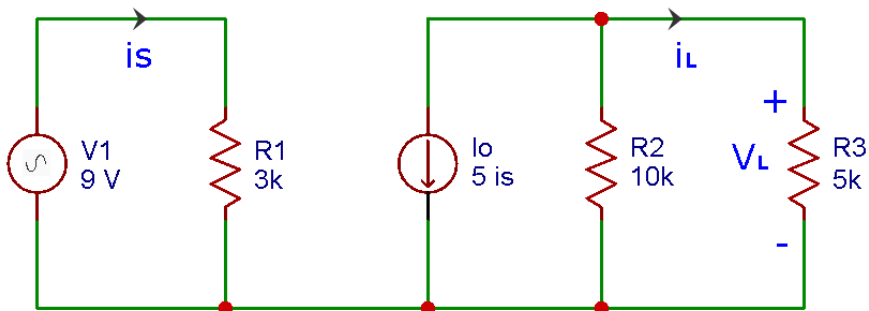


- Derive an equation for the transfer function of this circuit, $H(j\omega)$, i.e. V_o/V_i . [2 marks]
- Calculate the cut-off frequency for this circuit. [2 marks]
- Evaluate the gain and phase of the transfer function you derived in part (a) at half of the cut-off frequency you calculated in part (b). [4 marks]

C. Amplifiers and Op Amps

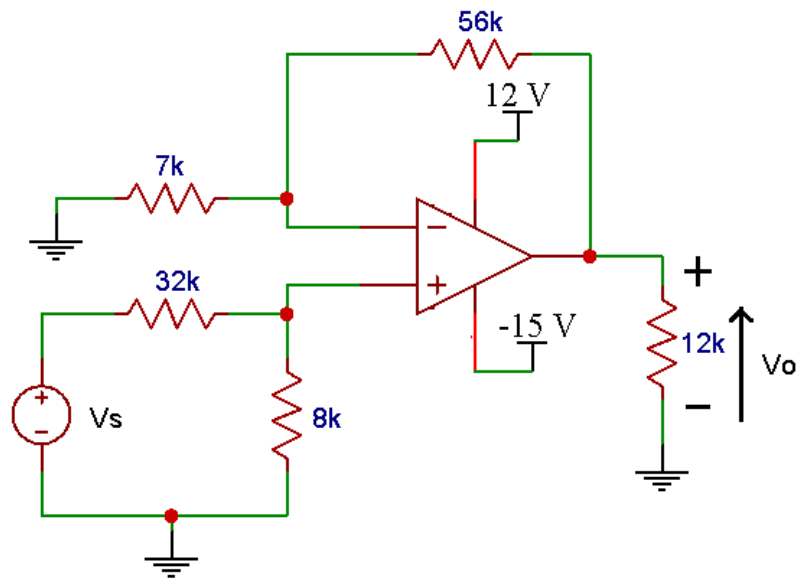
[14 marks]

10. Consider the amplifier model circuit below.



- What type of amplifier does this circuit represent and briefly describe? [2 marks]
- Calculate the current, i_L , through and voltage, v_L , across the load resistor, R_3 . [4 marks]

11. Consider the operational amplifier on the circuit given below. Assume the op amp is ideal.



- Find v_o in terms of v_s . [5 marks]
- Find the range of values for v_s such that v_o does not saturate and the op amp remains in its linear region of operation. [3 marks]

Marking Schedule

Student Name : _____

Student ID : _____

No	Description	Mark	Your Mark	Remark
A	DC Analysis			
1a	Potential difference across the 25 Ω resistor.	3		
1b	Verification of the total power developed and dissipated.	7		
2a	Expressions for I_1 , I_2 , and I_3 .	3		
2b	Values for I_1 , I_2 , and I_3 by using substitution or matrix method. Values of the currents that flow in the voltage source V_1 and resistor R_4 .	9		
3a	Thevenin equivalent circuit.	5		
3b	Norton equivalent circuit.	5		
4	Voltage across the 5 Ω resistor using superposition.	10		
B	AC Analysis			
5a	Voltage between the plates after 3 seconds.	4		
5bi	Differential equation for the charge on the capacitor	3		
5bii	Sketch the charge on the capacitor plates.	5		
6	Inductance of the inductor.	5		
7a	Impedance of the inductor, Z_L , resistor, Z_R , and capacitor, Z_C , at a frequency of 5 kHz.	3		
7b	Thévenin equivalent and values for V_{Th} and Z_{Th} .	6		
7c	Phase difference between the open-circuit voltage, v_o , and the	2		

	short-circuit current, I_{sc} ,			
8a	Voltage across the voltage source at the primary.	5		
8b	Input resistance of the transformer.	3		
9a	Equation for the transfer function of the circuit	2		
9b	Cut-off frequency for the circuit.	2		
9c	Gain and phase of the transfer function of the circuit.	4		
C	Amplifiers and Op Amps			
10a	Type of amplifier and its brief description.	2		
10b	Current through and voltage across the load resistor.	4		
11a	Output voltage v_o in terms of v_s .	5		
11b	Range of values for v_s so v_o does not saturate and the op amp is in linear region of operation.	3		
	Total	100		

Comment: