ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIRST SEMESTER EXAMINATION, 2020/2021 ACADEMIC SESSION

COURSE TITLE: ELECTRIC CIRCUIT THEORY

COURSE CODE: EEE 317

EXAMINATION DATE: --RD MARCH, 2021

COURSE LECTURER: DR R. O. Alli-Oke

HOD's SIGNATURE

TIME ALLOWED: 3 HRS

INSTRUCTIONS:

1. ANSWER **QUESTION 1** AND ANY OTHER FOUR QUESTIONS **(TOTAL OF 5 QUESTIONS)**
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU ARE **NOT** ALLOWED TO BORROW CALCULATORS AND ANY OTHER WRITING MATERIALS DURING THE EXAMINATION.

QUESTION #1

a) Consider the source-driven RC circuit shown in Figure 1a below. **[10 marks]**

i) Find v_C for all times t.

ii) Analytically determine the time constant. *Hint: this is the time at which* $v_C(t) = 0.632v_C(0)$

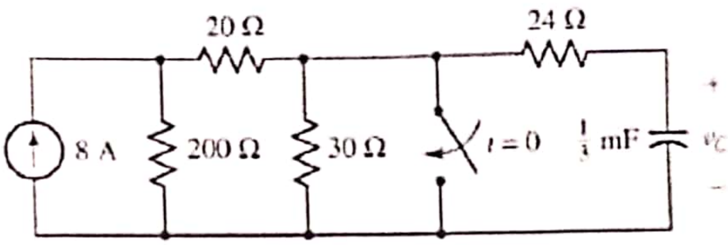


Figure 1a: Source-Driven RC Circuit

b) The second-order filter in Figure 1b is used after the rectification stage of a power supply design. **[10 marks]**

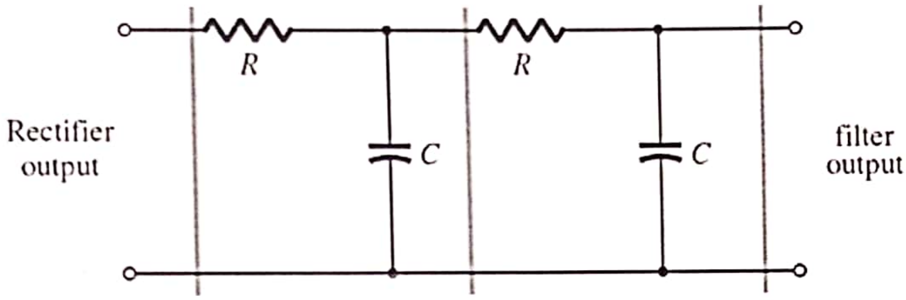


Figure 1b: Second-Order Low-Pass Filter

i) With the aid of diagrams explain why a filter needed after rectification

ii) Let V_i and V_o represents phasors corresponding to input and output voltages respectively. Show that the transfer function $H(j\omega) = \frac{V_o}{V_i} = \frac{1}{(1-\omega^2R^2C^2) + 3j\omega RC}$. *Hint: Use the phasor-domain circuit*

iii) Analytically obtain the DC gain and AC gain from the expression obtained in (ii) above.

iv) Determine the –3 dB cut-off frequency f_c of this filter. *Hint set RC as τ, and solve for ω such that* $|H(j\omega)| = \frac{1}{\sqrt{2}}$

v) Choose R ≥ 5 $k\Omega$ and C such that it has a DC gain of 0 dB and a bandwidth of 1 kHz.

QUESTION #2

a) Consider the op-amp circuit shown in the Figure 2a below. Using only KCL, determine v_{out}. **[4 marks]**

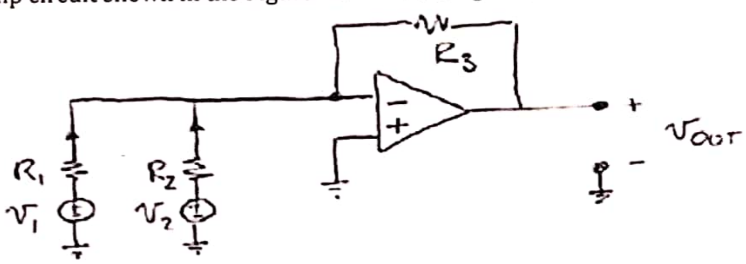


Figure 2a: Op-Amp Circuit

b) Assume $v_o(0) = 5$ and use Laplace-domain analysis to determine $v_o(t)$. *Hint:* $\mathcal{L}\{e^{-t}\,u(t)\} = \frac{1}{s+1}$ *and* $\mathcal{L}\{\partial t\} = 1$.

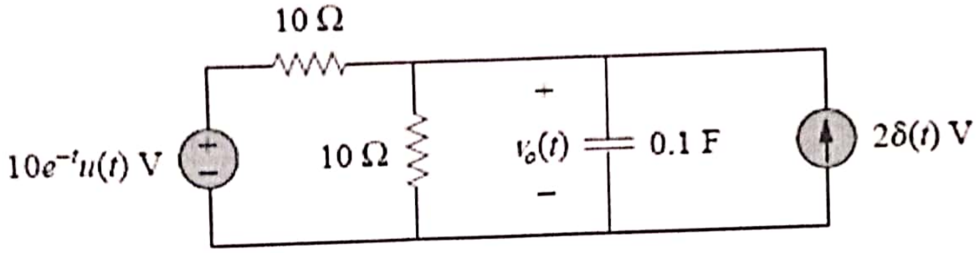


Figure 2b: Source-Driven RC Circuit

QUESTION #3

a) Using phasor-domain analysis, determine the steady-state current $i(t)$ shown in Figure 3b. **[4 marks]**

b) Use time-domain analysis to obtain the inductor current $i_L(t)$ for all times for the circuit in Figure 3a.

[6 marks]

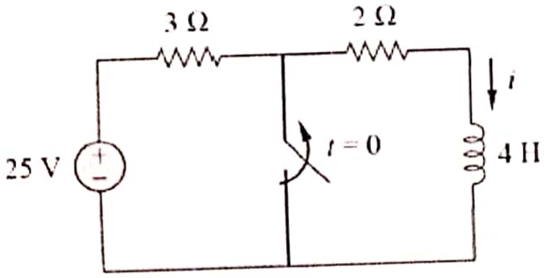


Figure 3a: R-L Network

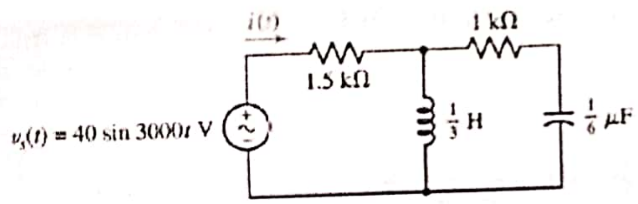
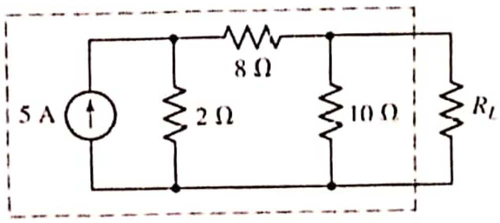


Figure 3b: A Sinusoidal-Excited Circuit

QUESTION #4

a) Using repeated source transformation, determine the Norton equivalent of network A. **[4 marks]**



Network A

Figure 5: Source Transformation

b) Consider the schematic diagram of 2-bit op-amp-based R-2R ladder logic shown in Figure 4b. Use ONLY Thevenin's theorem to determine V_o. Do not use superposition theorem. **[6 marks]**

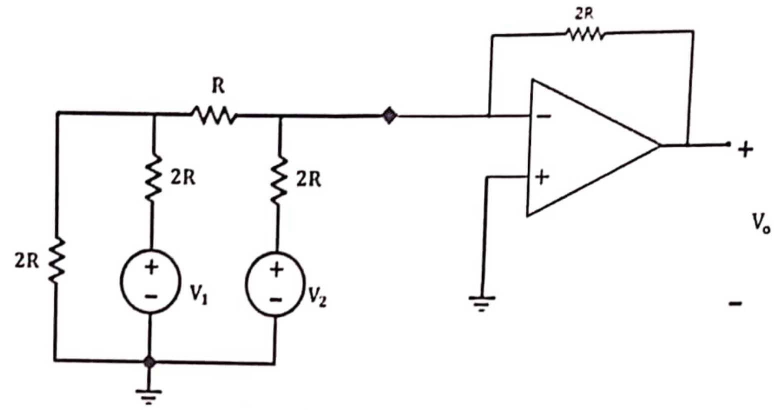


Figure 4b: Op-Amp Based R-2R ladder DAC Circuit

QUESTION #5

a) Determine the current through the 10Ω resistor in Figure 1 using nodal analysis. **[4 marks]**

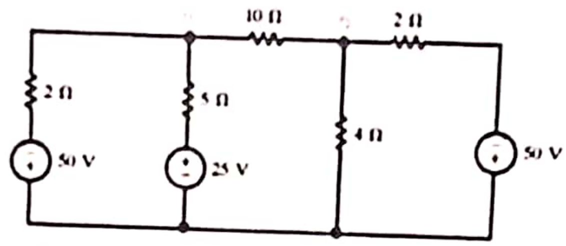


Figure 1: Resistive Circuit with Voltage Sources

b) Let $V(s)$ be the Laplace-transform of $v(t)$ shown in Figure 5. Derive the expression for $V(s)$. **[6 marks]**

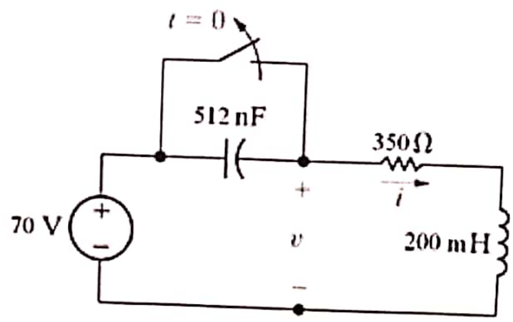


Figure 5: Source-Driven RLC Circuit

QUESTION #6

a) Compute the voltage v_o at the output port in Figure 3b, and the power absorbed by the voltage–dependent source.

[5 marks]

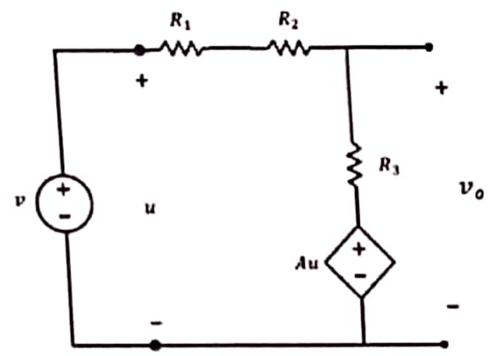


Figure 3b: Voltage-Dependent Source Circuit

b) Consider the single node-pair circuit below in in Figure 6b. We want to determine the current in the 3kΩ resistor using Thevenin's theorem. **[5 marks]**

i. Find the Thevenin's network of network A.

ii. Find the Thevenin's network of network B.

iii. Draw the diagram of the reduced circuit diagram of Figure 6b by replacing network A & B with their respective Thevenin's network.

iv. Use KVL to compute the current through the 3kΩ resistor.

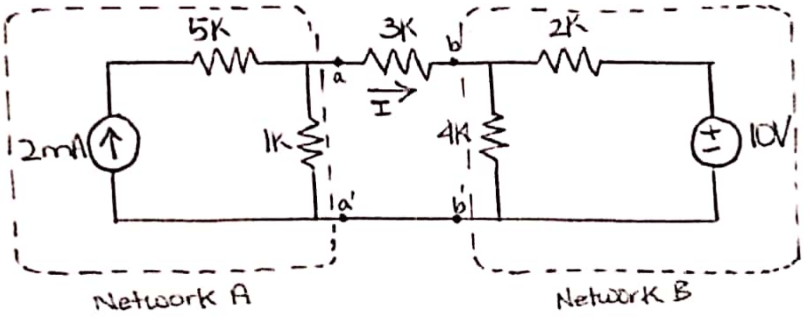


Figure 6b: Resistive Network

QUESTION #7

a) Consider the network shown in Figure 7a. When $V = 10\ V$ and $I = 0\ A$, it is observed that $i = -1\ A$ and $v = 5\ V$. Additionally, when $I = 2\ A$ and $V = 0$, it is observed that $v = 20\ V$. With this information, determine R_1, R_2 and R_3.

[4 marks]

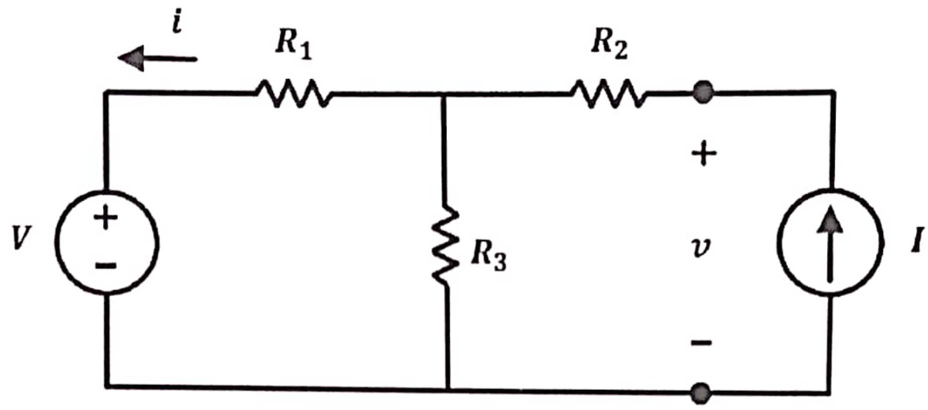


Figure 7a: Resistive Network

b) Use phasor-domain analysis on the circuit shown in the figure (b) to determine the sinusoidal steady-state phasor currents $\mathbf{I}_1$, and $\mathbf{I}_2$

[6 marks]

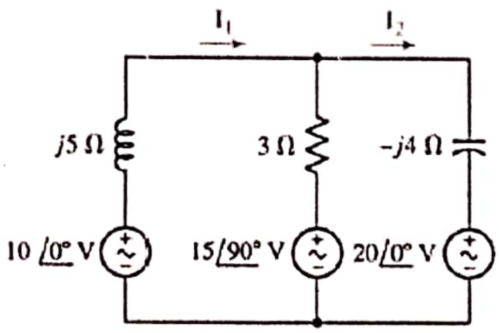


Figure 8: Phasor-Domain Analysis