ID:	Name:

Set **A**

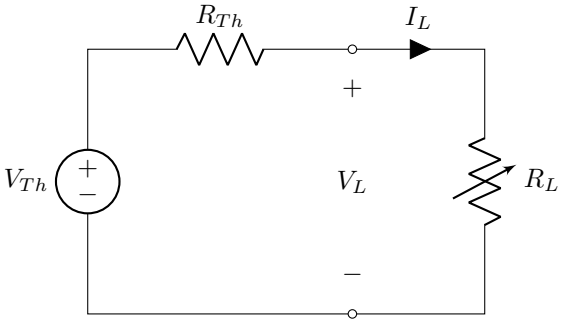
Brac University
Semester: Spring 2025
Course Code: CSE250
Circuits and Electronics

Assessment: *Final Exam*
Duration: 1 hour 45 minutes
Date: May 23, 2025
Full Marks: 65

- ✓ No washroom breaks. Phones must be turned off. Using/carrying any notes during the exam is not allowed.
- ✓ At the end of the exam, both the **answer script** and the **question paper** must be returned to the invigilator.
- ✓ All **4 questions** are compulsory. Marks allotted for each question are mentioned beside each question.
- ✓ Proper units must be included for all calculated values. Marks will be deducted for missing or incorrect units.
- ✓ Symbols have their usual meanings.

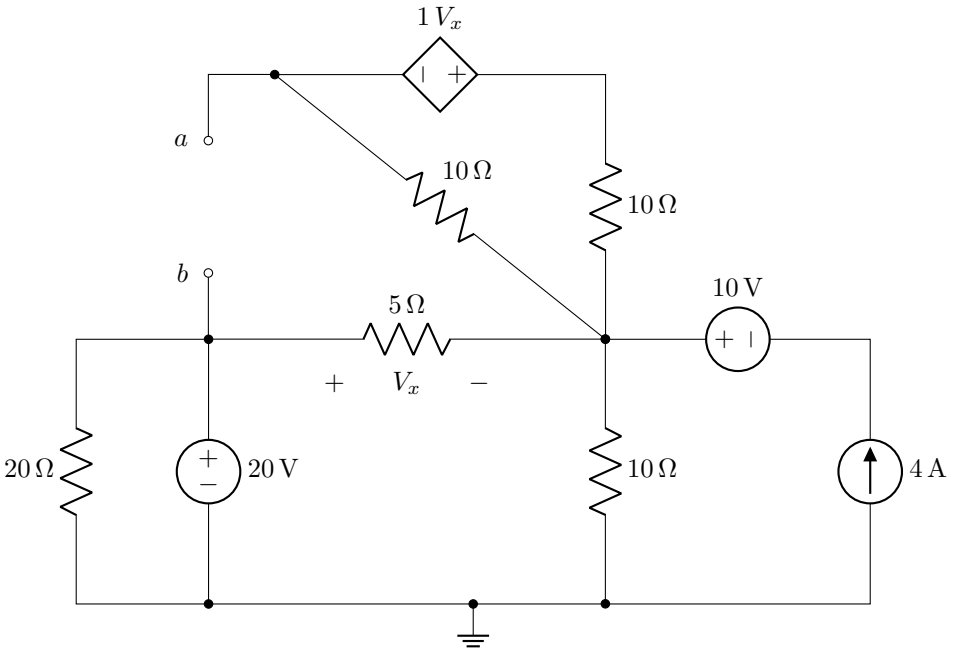
■ Question 1 of 4 *[CO2] [20 marks]*

(a) ***[5 marks]*** For the Thevenin equivalent circuit shown below, the load voltage V_L is measured for different values of the load resistance R_L. Using the data provided in the table, determine the Thevenin equivalent resistance R_{Th} and the Thevenin equivalent voltage V_{Th} of the circuit.



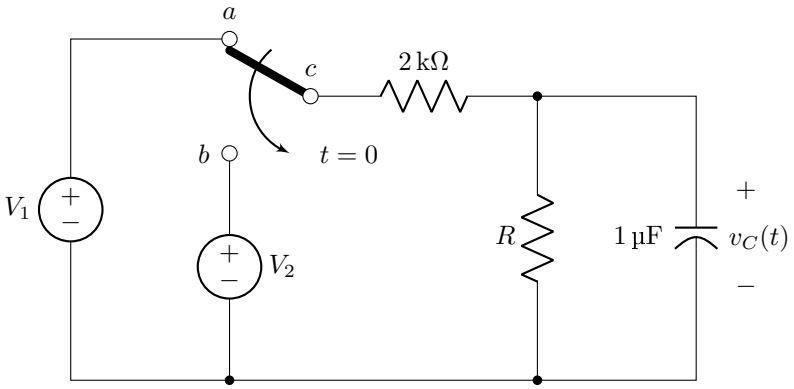
R_L	V_L
1 kΩ	12 V
2 kΩ	20 V
4 kΩ	30 V
6 kΩ	36 V
16 kΩ	48 V
56 kΩ	56 V

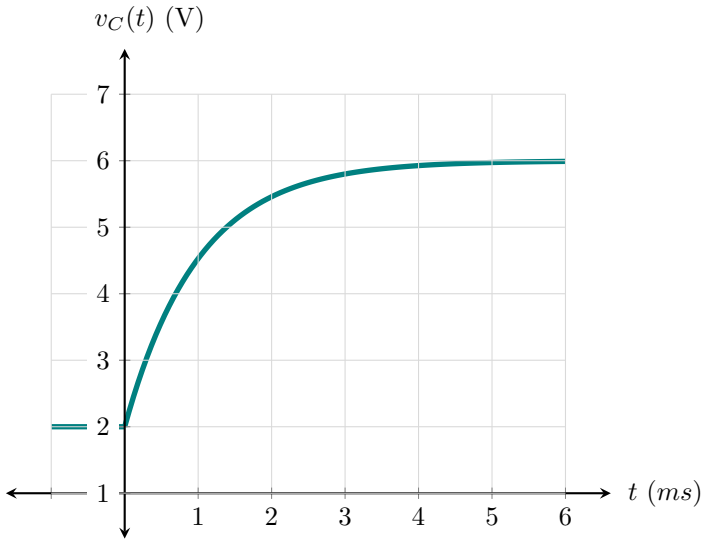
(b) ***[15 marks]*** **Apply Thevenin's/Norton's theorem** to the circuit below to determine the **Maximum Power** that can be delivered to a load connected between terminals a and b.



■ Question 2 of 4 *[CO3] [25 marks]*

(a) The switch in the following circuit moves from position a to position b at time $t = 0$, while the terminal c remains fixed. As a result, the capacitor voltage $v_C(t)$ increases exponentially, as shown in the plot below with respect to time t.



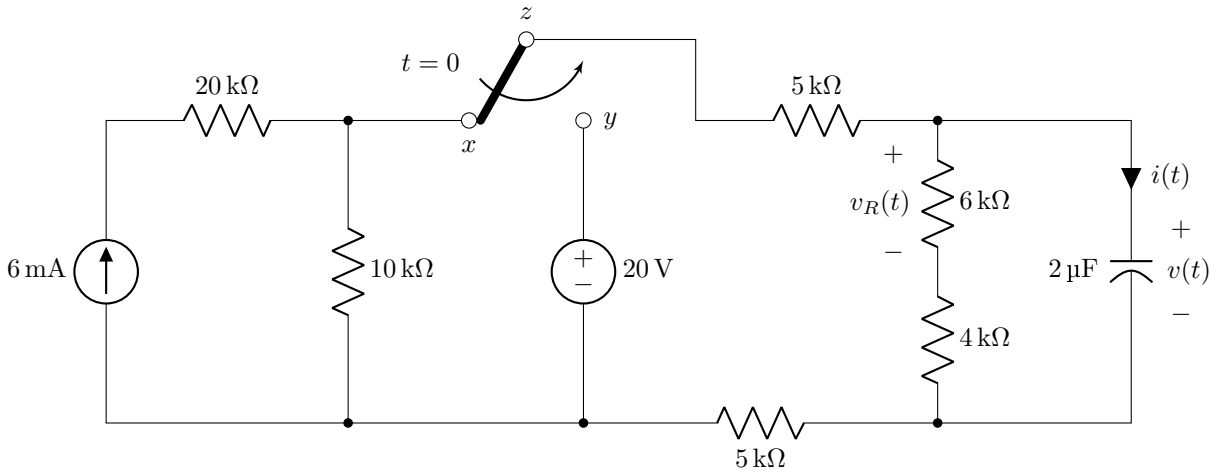


(i) ***[1 mark]*** What is the time constant of the RC circuit?

(ii) ***[2 marks]*** Write an expression for the capacitor voltage $v_C(t)$ for $t > 0$ as a function of time.

(iii) ***[3 marks]*** Based on the time constant determined in (i), determine the value of the resistance R in the circuit.

(b) The switch in the following circuit moves from position x to position y at time $t = 0$, while the terminal z remains fixed.



Analyze the **Transient Behavior** of the RC circuit shown above to answer the following queries-

(i) ***[7 marks]*** Determine the initial and final steady-state voltages of the capacitor, before and long after the switch is moved.

(ii) ***[4 marks]*** Determine the time constant of the circuit.

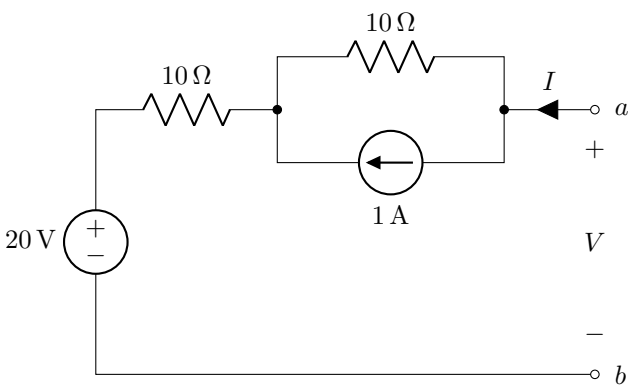
(iii) ***[2 marks]*** Using the values obtained in parts (i) and (ii), write the expression for the capacitor voltage $v(t)$ for $t > 0$ as a function of time.

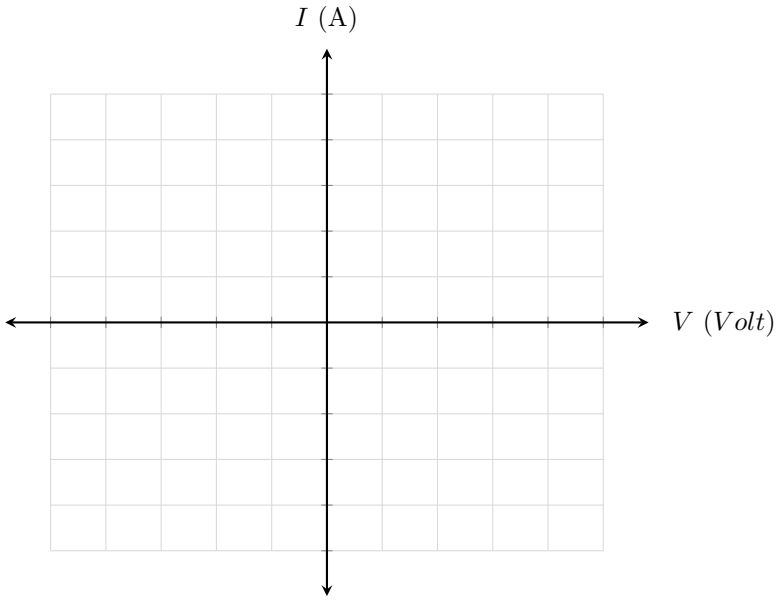
(iv) ***[3 marks]*** Determine the current $i(t)$ through the capacitor for $t > 0$ as a function of time.

(v) ***[3 marks]*** Using the $v(t)$ from part (iii), determine the voltage $v_R(t)$ across the 6 kΩ resistor for $t > 0$ as a function of time.

■ Question 3 of 4 *[CO3] [10 marks]*

For the circuit shown below, derive the I–V characteristic equation with respect to terminals a and b, and plot it on the blank grid provided. Note that V and I are the only variables allowed in the equation; all other quantities must be constants. You must label the axes with appropriate values.

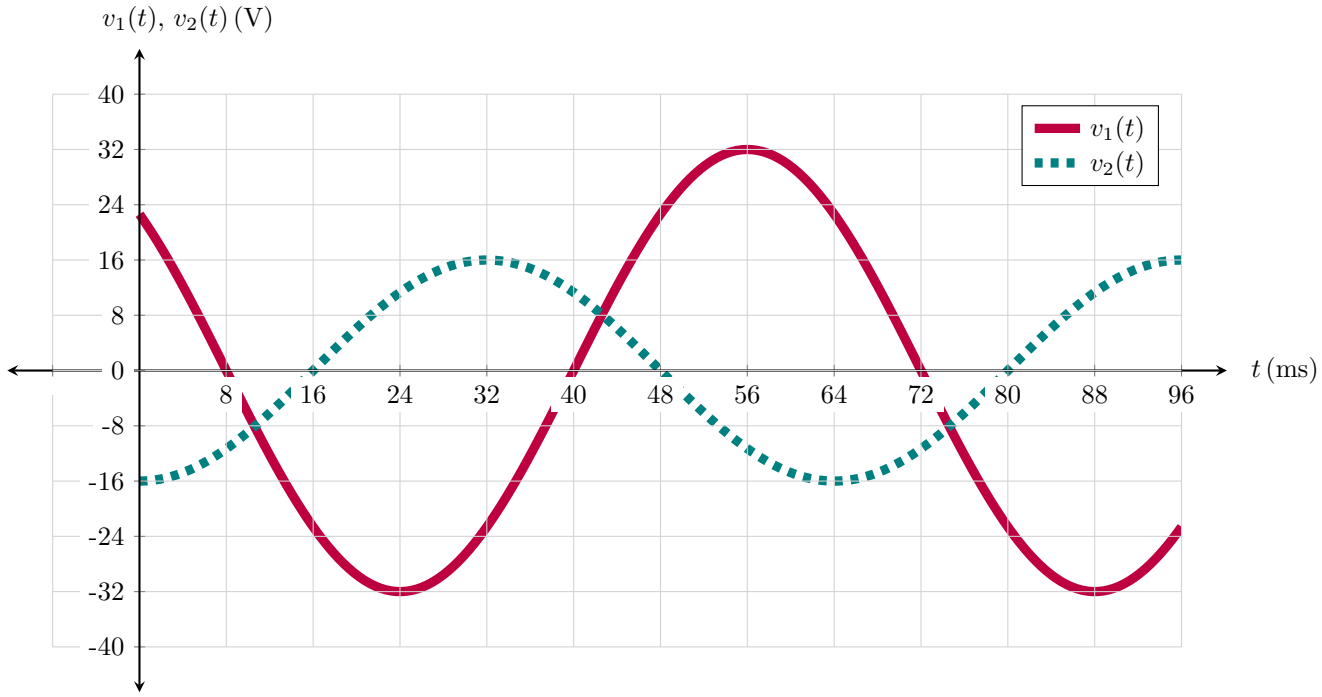




■ Question 4 of 4 *[CO3] [10 marks]*

(a) ***[4 marks]*** By how much time in ms is the sinusoidal voltage $-16\sin(150\pi t+45°)$ V shifted to the left or right compared to the voltage $5\cos(150\pi t)$ V?

(b) Two voltage waveforms $v_1(t)$ and $v_2(t)$ from an ac circuit are plotted below as a function of time t.



(i) ***[3 marks]*** Determine the phase difference ($0° \leq \Delta\varphi \leq 180°$) between the two and identify which one is leading.

(ii) ***[3 marks]*** Write analytical expressions for both $v_1(t)$ and $v_2(t)$ as a function of t with the initial phases (φ) in degrees, where $-180° \leq \varphi \leq 180°$.