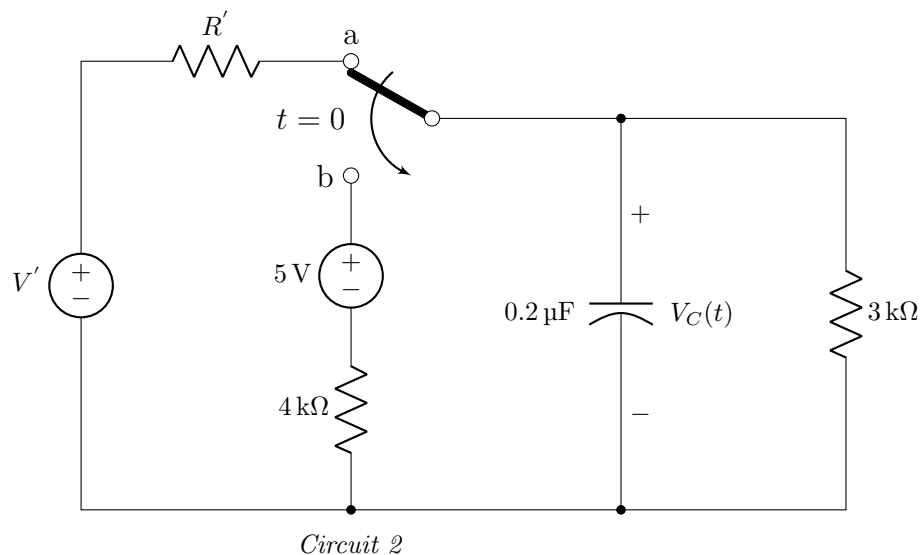
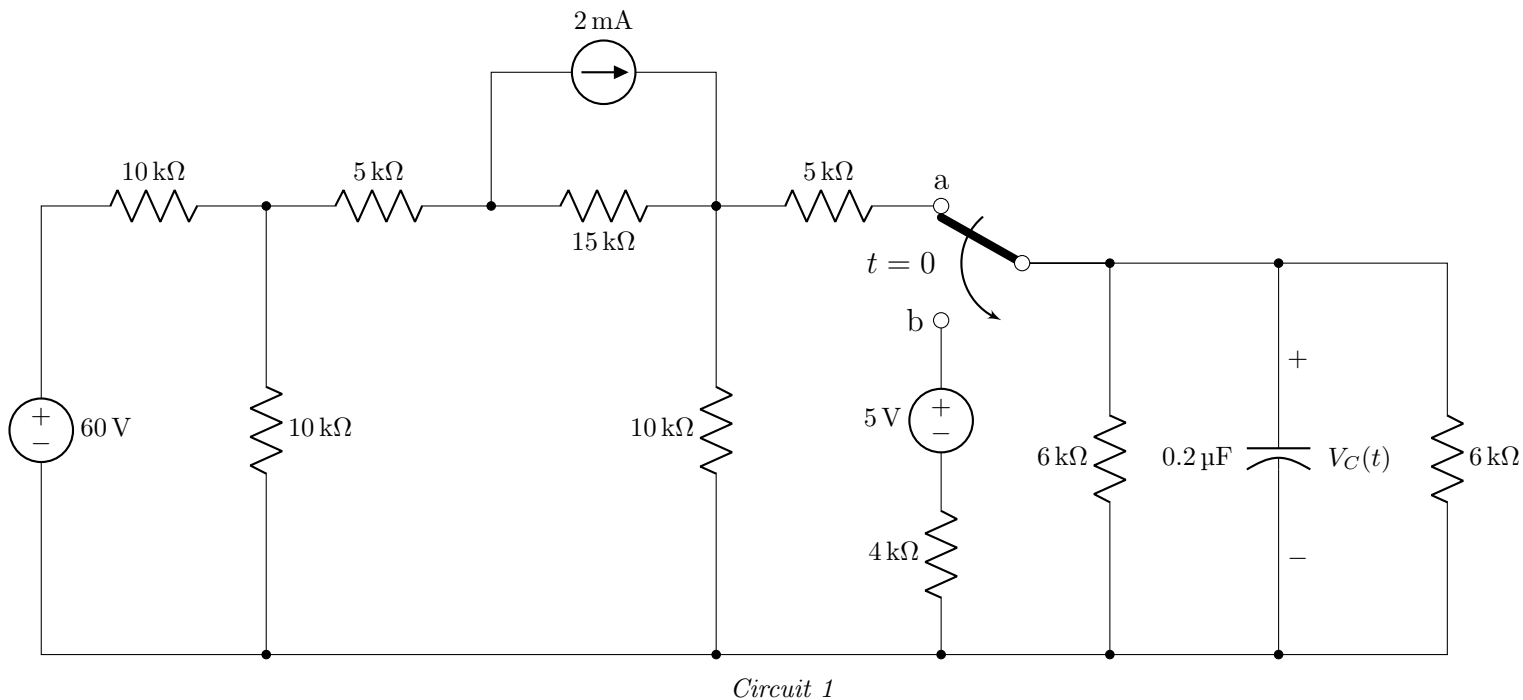


- ✓ No washroom breaks. Phones must be turned off. Using/carrying any notes during the exam is not allowed.
- ✓ At the end of the exam, both the **answer script** and the **question paper** must be returned to invigilator.
- ✓ All **3 questions** are compulsory. Marks allotted for each question are mentioned beside each question.
- ✓ Symbols have their usual meanings.

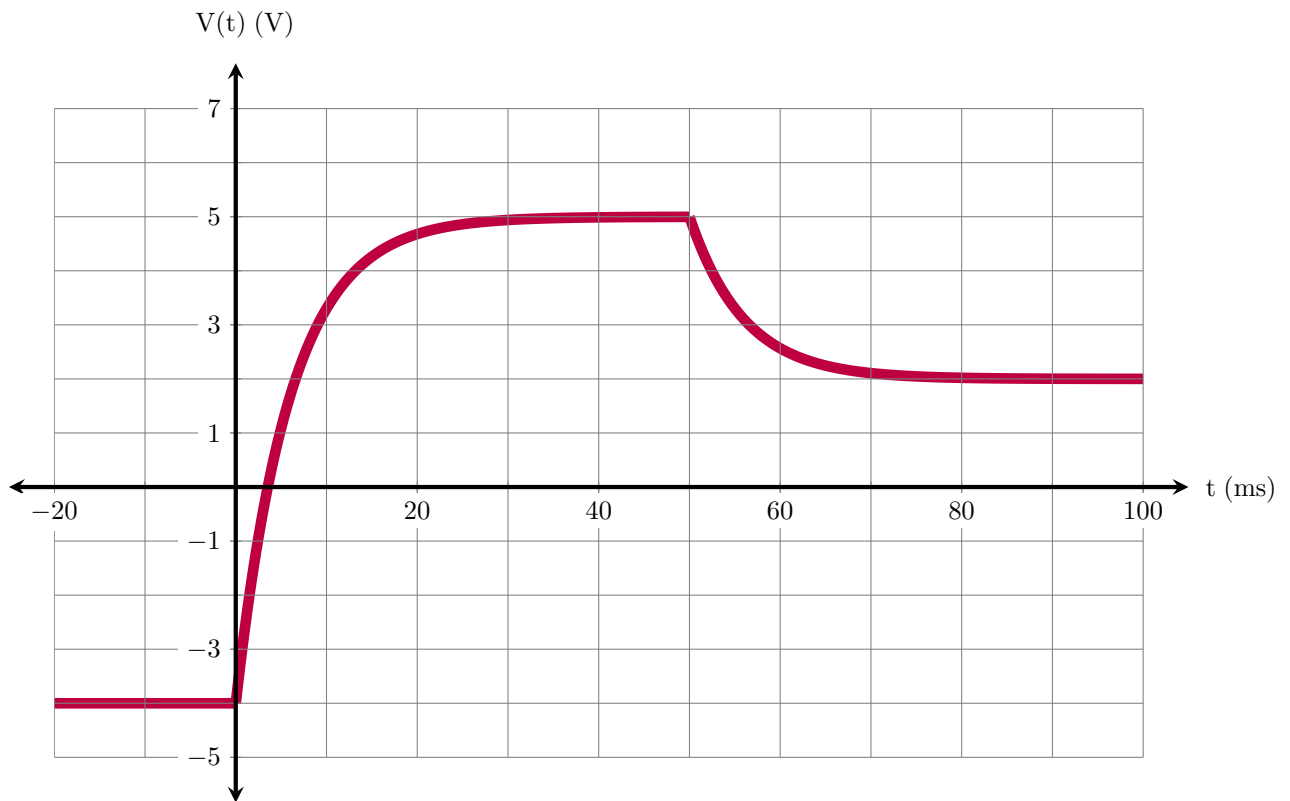
### ■ Question 1 of 3 [CO2, CO3] [20 marks]

Consider the the following circuits which are equivalent to each other.



- (a) [8 marks] **Derive** Circuit 2 from Circuit 1. What are the values of  $V'$  and  $R'$ ?
- (b) [7 marks] Now, **analyze** the transient behavior of the circuit assuming that the switch moves from position a to position b at  $t = 0$ . Determine  $V_C(t)$  for  $t > 0$ .

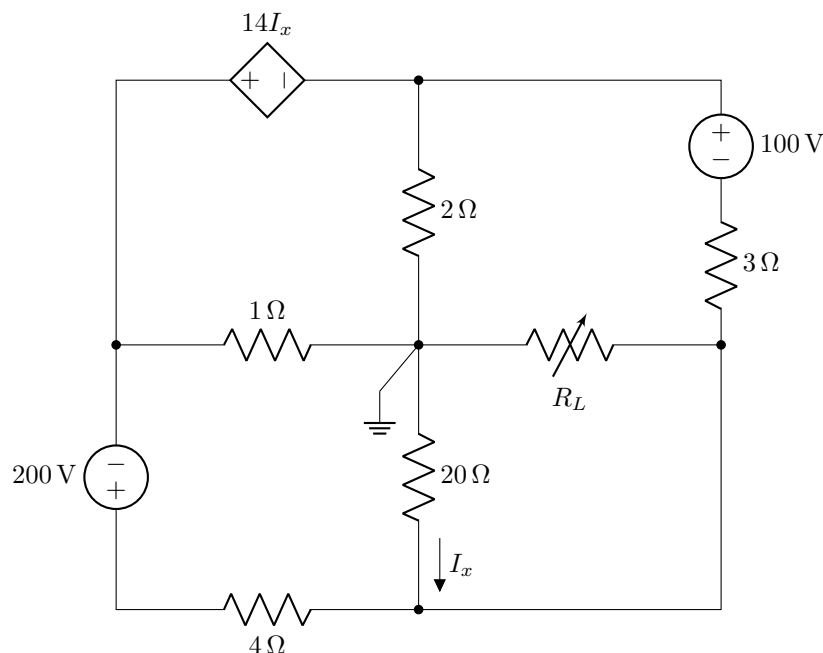
- (c) The following  $V(t)$  vs.  $t$  plot shows the response of a capacitor in a series RC circuit to sudden changes in the DC voltage applied through resistors.



- (i) [3 marks] Write the mathematical expression of  $V(t)$  for  $t > 0$ . Use appropriate values from the plot. [Hint: consider the plot in segments.]
- (ii) [2 marks] Predict and draw a circuit with appropriate switching mechanism that can generate the voltage response as shown only for up to 30 ms. The value of the capacitance is  $100\ \mu\text{F}$ . Mention the values of the resistances and sources used.

## ■ Question 2 of 3 [CO2] [15 marks]

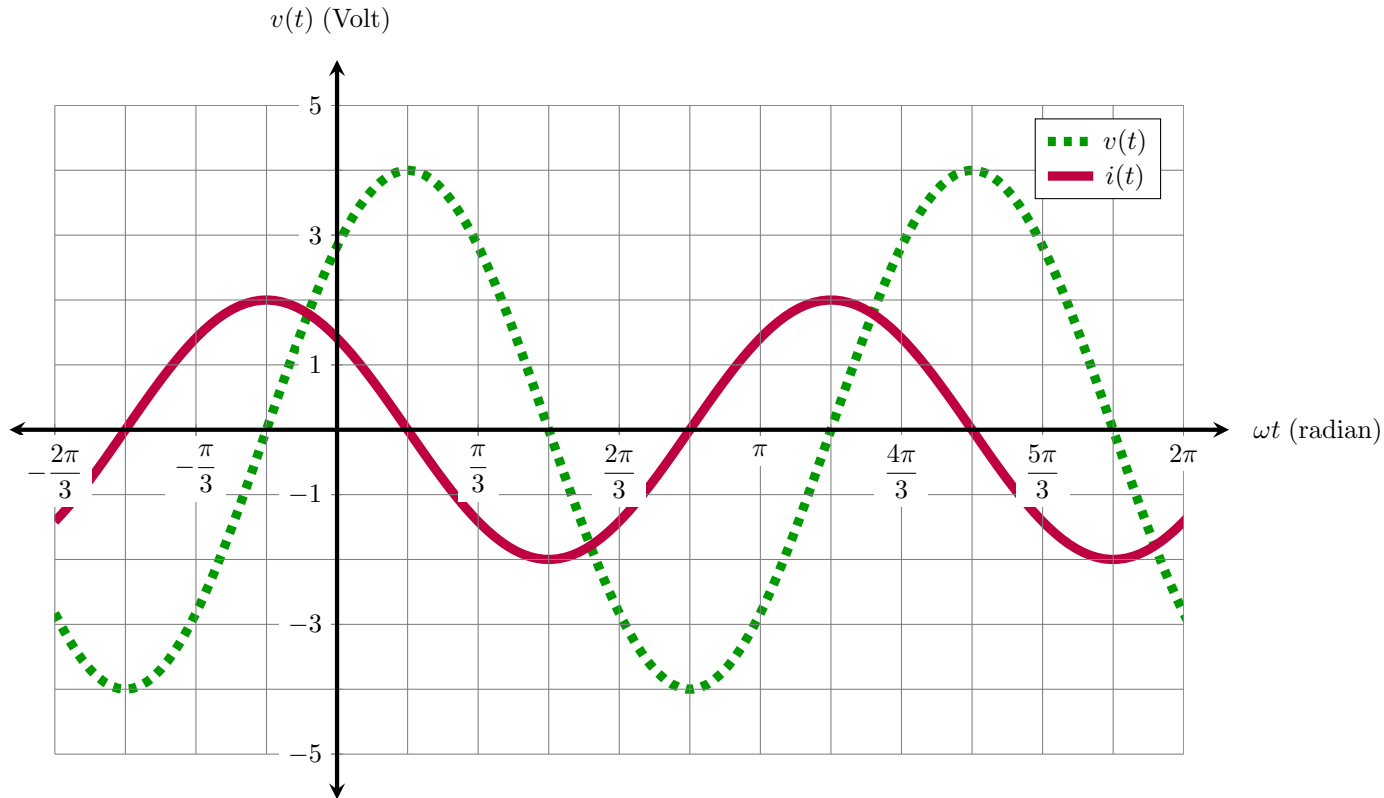
Consider the following circuit with a load  $R_L$  connected between terminals a and b.



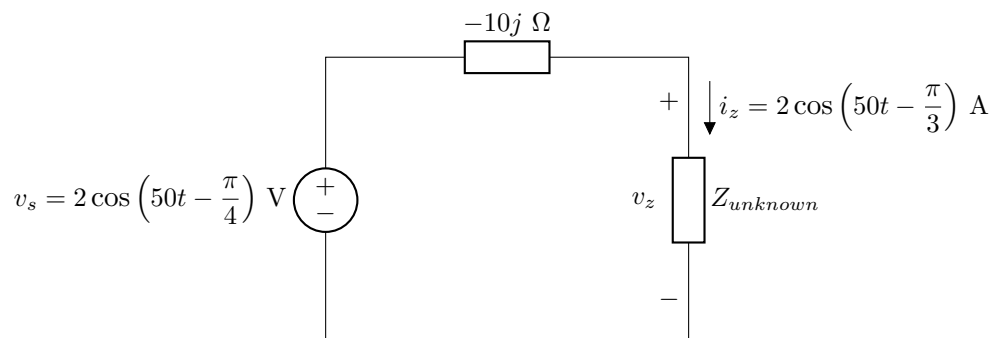
- (a) [8 marks] Determine the value of  $R_L$  that will draw the maximum power from the circuit.
- (b) [7 marks] Determine the value of the maximum power.

### ■ Question 3 of 3 [CO3] [20 marks]

- (a) Voltage  $v(t)$  and current  $i(t)$  of a two terminal circuit element connected in an ac circuit are plotted as a function of angle ( $\omega t$ ) below.
- [1½ marks] **Determine** the phase difference between  $v(t)$  and  $i(t)$  and specify which one is leading.
  - [½ mark] Is the element capacitive or inductive?
  - [2 marks] Determine the minimum difference in time between the waveforms.



- (b) When a current of  $i_s = 2 \cos(100t - 60^\circ)$  A passes through an unknown circuit element with an impedance of  $Z_{unknown}$ , it causes a voltage drop of  $v_z = 4 \cos(100t + 30^\circ)$  V across it as shown below.



- [1 mark] Does the voltage ( $v_z$ ) lead or lag the current ( $i_s$ )?
- [1 mark] Determine the value of the impedance  $Z_{unknown}$ .
- [2 marks] Based on your answer in (ii), guess the circuit element and **determine** the value of it with appropriate units.

(c) [12 marks] For the circuit shown below, **determine**  $i_o(t)$ , the current through the inductor.

