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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	ELECTRICAL PRINCIPLES I
COURSE CODE	:	BNR 10203
PROGRAMME	:	1 BND/ 1 BNF
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TWENTY ONE (21)** PAGES

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Q1 (a) Define and calculate the following questions:

(i) What is the prefix micro stands for?

(1 mark)

(ii) Calculate the current flows when a charge of 2 C flowing past a given point each second.

(1 mark)

(iii) Find the voltage across a 1.1kW toaster that produces a current of 10 A?

(2 marks)

(iv) A current of 3.2 A flows through a conductor. Calculate how much charge passes through any cross-section of the conductor in 20 s.

(2 marks)

(b) Calculate the amounts coulombs for the following amounts of electrons?

(i) 6.482×10^{17}

(1 mark)

(ii) 1.24×10^{18}

(1 mark)

(iii) 2.46×10^{19}

(1 mark)

(iv) 1.628×10^{20}

(1 mark)

(c) A constant current of 3 A for 4 hours is required to charge an automotive battery. If the terminal voltage is $10 + t/2$ V, where t is in hours,

(i) Find the amount of charge is transported as a result of the charging?

(2 marks)

(ii) Calculate the amount of energy is expended?

(2 marks)

(iii) how much does the charging cost? Assume electricity costs 9 cents/kWh.

(2 marks)

(d) A battery may be rated in ampere-hours (Ah). A lead-acid battery is rated at 160 Ah.

(i) What is the maximum current it can supply for 40 h?

(2 marks)

(ii) How many days will it last if it is discharged at 1 mA?

(2 marks)

Q2 (a) Determine i_1 and i_2 in the circuit of Figure Q2(a).

(3 marks)

(b) The lightbulb in Figure Q2(b) is rated 120 V, 0.75 A. Calculate to make the lightbulb operate at the rated conditions.

(5 marks)

(c) Find R_{eq} and I in the circuit of Figure Q2(c).

(12 marks)

Q3 (a) In the circuit of Figure Q3(a), solve for I_1, I_2 and I_3.

(10 marks)

(b) By inspection, obtain the mesh-current equations for the circuit in Figure Q3(b).

(10 marks)

Q4 (a) Determine v_x in the circuit of Figure 4(a) using source transformation.

(5 marks)

(b) For the circuit in Figure Q4(b), find the Thevenin and Norton equivalent circuits at terminals *a-b*.

(7 marks)

.(b) Determine the maximum power that can be delivered to the variable resistor R. In the circuit of Figure Q4(c).

(8 marks)

Q5 (a) Find the equivalent capacitance between terminals a and b in the circuit of Figure Q5(a). All capacitances are in μF.

(4 marks)

(b) Determine L_{eq} that may be used to represent the inductive network of Figure Q5(b) at the terminals.

(8 marks)

(c) (i) An op amp integrator has R=100 kΩ and C=0.01 μF. If the input voltage is v_i=10sin50t mV, obtain the output voltage.

(4 marks)

(ii) A 10 V dc voltage is applied to an integrator with R=50 kΩ, C=100 μF at t=0. How long will it take for the op amp to saturate if the saturation voltages are +12 V and -12 V? Assume that the initial capacitor voltage was zero.

(4 marks)

Q6 (a) The switch in Figure Q6(a) has been in position A for a long time. Assume the switch moves instantaneously from A to B at t = 0. Find v for t > 0.

(3 marks)

(b) For the circuit in Figure Q6(b), find i_o for t > 0.

(5 marks)

(c) Express the signals in Figure Q6(c) in terms of sigularity functions.

(6 marks)

(d) Determine the inductor current i(t) for both t < 0 and t > 0 for each of the circuits in Figure Q6(d).

(6 marks)

- END OF QUESTION -

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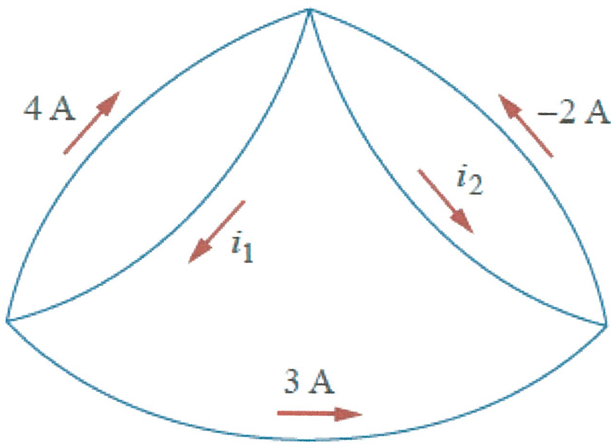

FIGURE Q2(a)

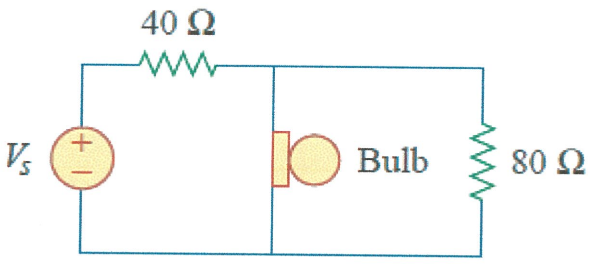

FIGURE Q2(b)

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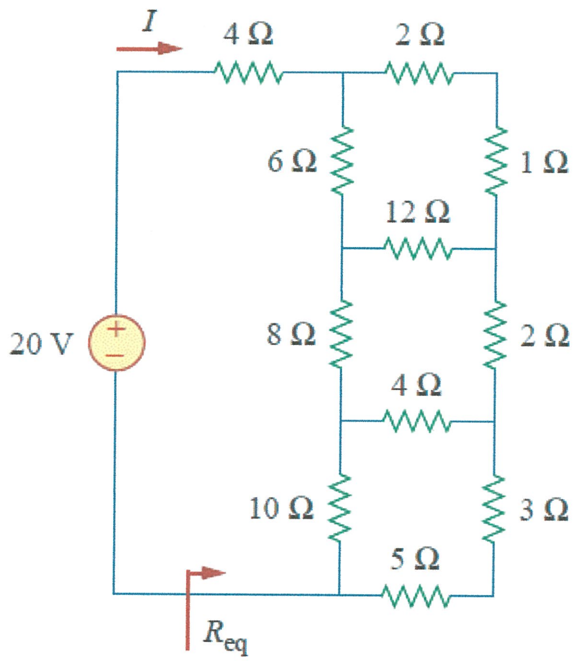

FIGURE Q2(c)

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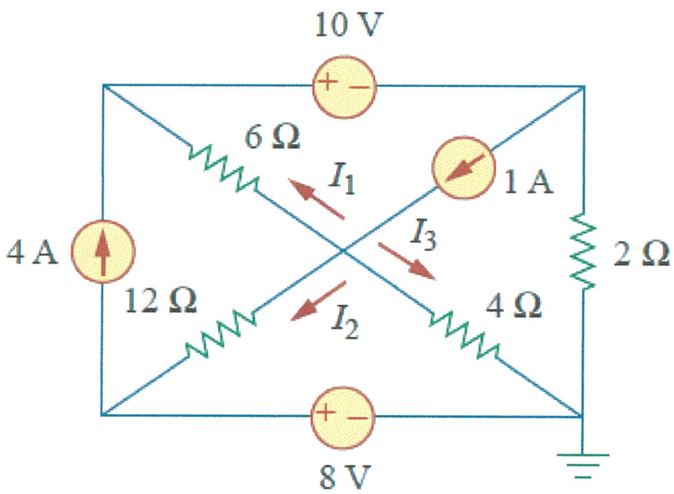

FIGURE Q3(a)

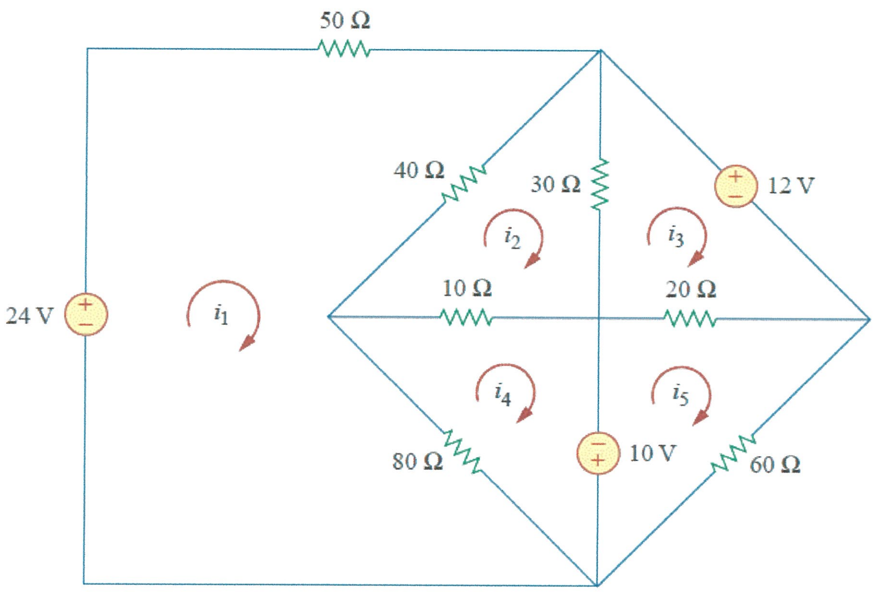

FIGURE Q3(b)

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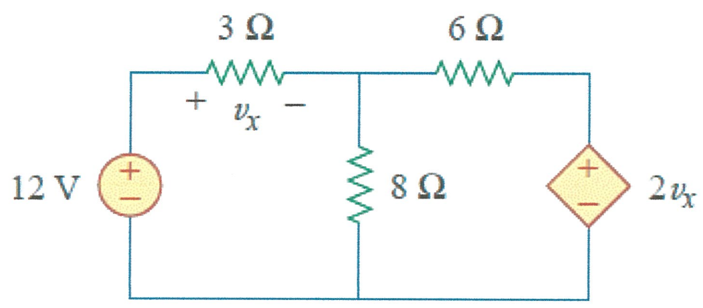

FIGURE Q4(a)

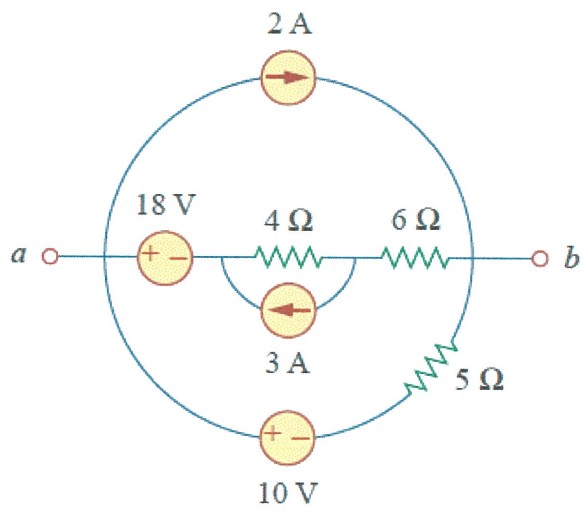

FIGURE Q4(b)

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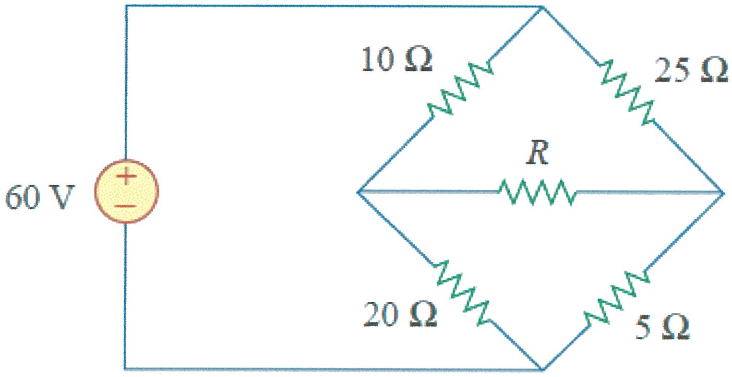

FIGURE Q4(c)

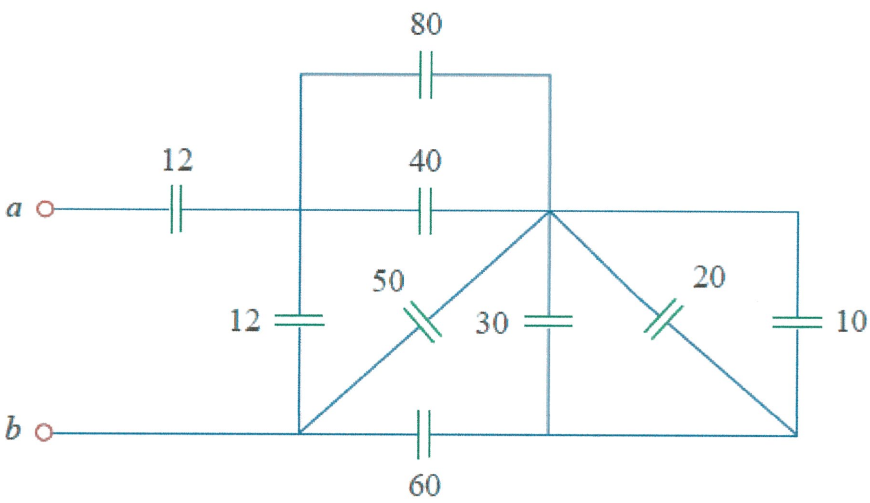

FIGURE Q5(a)

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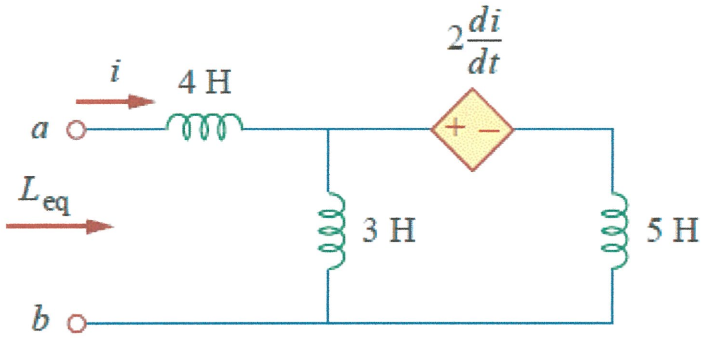

FIGURE Q5(b)

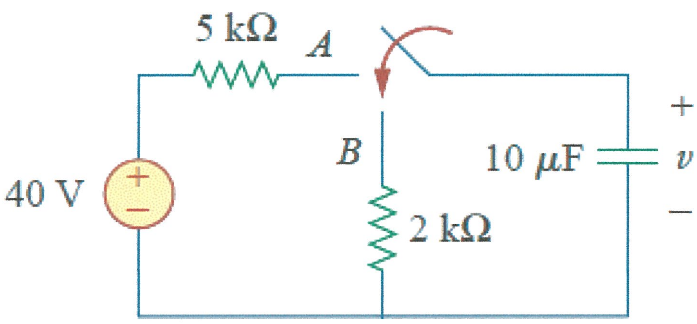

FIGURE Q6(a)

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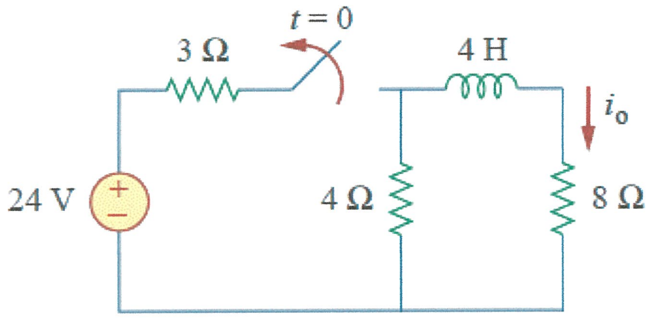

FIGURE Q6(b)

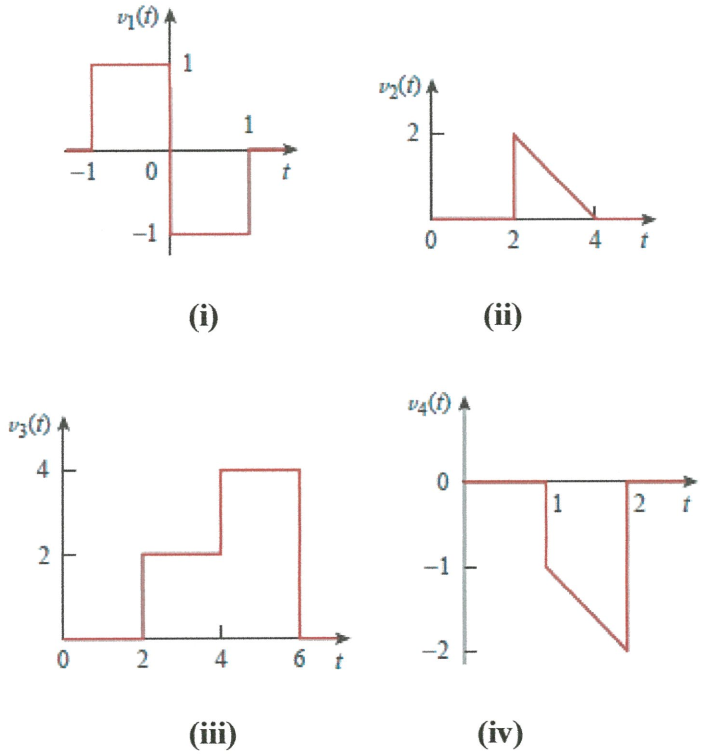

FIGURE Q6(c)

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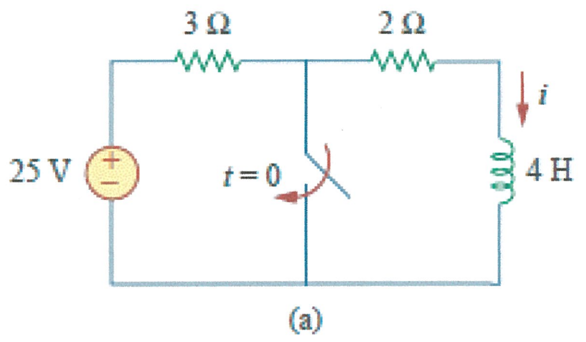
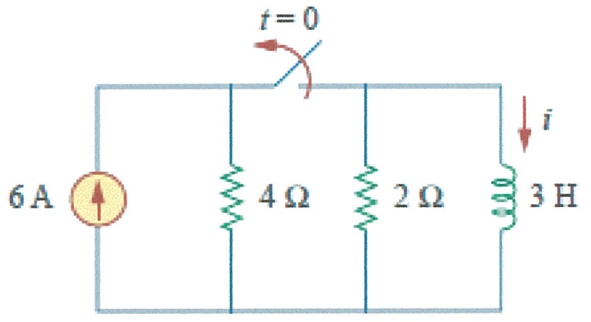


(i)



(ii)

FIGURE Q6(d)

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FORMULAS

The voltage division principle for two resistors in series is

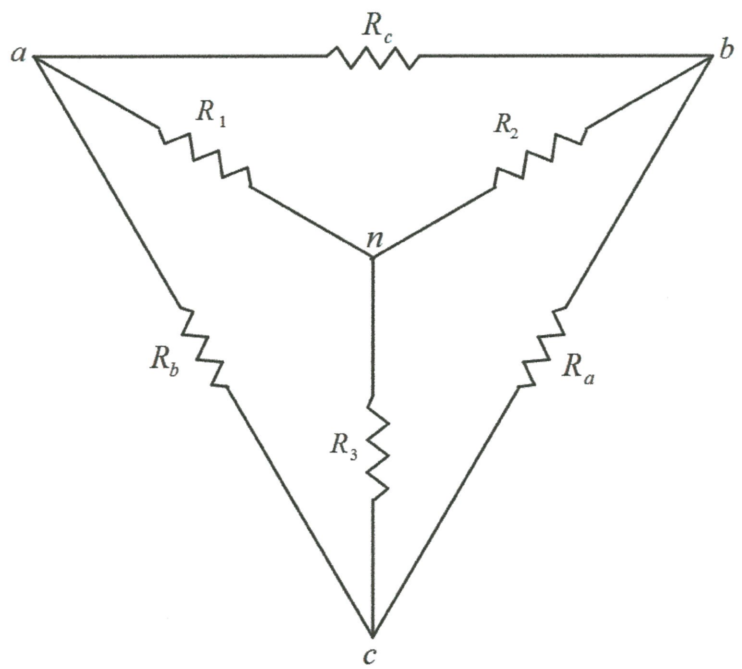
$$v_1 = \frac{R_1}{R_1 + R_2} v$$

$$v_2 = \frac{R_2}{R_1 + R_2} v$$

The current division principle for two resistors in parallel is

$$i_1 = \frac{R_2}{R_1 + R_2} i$$

$$i_2 = \frac{R_1}{R_1 + R_2} i$$



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Delta to Wye-Conversion

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

Wye to Delta Conversion

$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

The number of branches b, the number of nodes n, and the number of independent loops l in a network are related as

$$b = l + n - 1$$

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The power delivered to the load is:

$$P = i^2 R_L = \left(\frac{V_{Th}}{R_{Th} + R_L} \right)^2 R_L$$

For maximum power dissipated in R_L, P_{max}, for a given R_{TH}, and V_{TH},

$$R_L = R_{TH} \quad \Rightarrow \quad P_{\max} = \frac{V_{Th}^{\ 2}}{4R_L}$$

CAPACITORS

The current-voltage relationship of capacitor according to above convention is

$$i = C \frac{dv}{dt}$$

$$v = \frac{1}{C} \int_{t_0}^{t} i \, dt + v(t_0)$$

The energy, *w*, stored in the capacitor is

$$w = \frac{1}{2} C v^2$$

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INDUCTORS

The current-voltage relationship of an inductor:

$$i = \frac{1}{L}\int_{t_0}^{t} v(t)\, dt + i(t_0)$$

The energy, *w*, stored by an inductor:

$$w = \frac{1}{2} L\, i^2$$

Current and voltage relationship for R, L, C

Circuit element	Units	Voltage	Current	Power
 Resistance	ohms (Ω)	$v = Ri$ (Ohm's law)	$i = \frac{v}{R}$	$p = vi = i^2 R$
 Inductance	henries (H)	$v = L\frac{di}{dt}$	$i = \frac{1}{L}\int v\, dt + k_1$	$p = vi = Li\frac{di}{dt}$
 Capacitance	farads (F)	$v = \frac{1}{C}\int i\, dt + k_2$	$i = C\frac{dv}{dt}$	$p = vi = Cv\frac{dv}{dt}$

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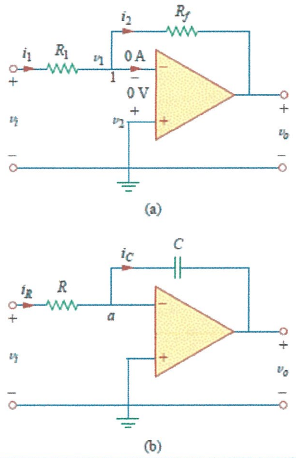
Important characteristics of the basic elements.

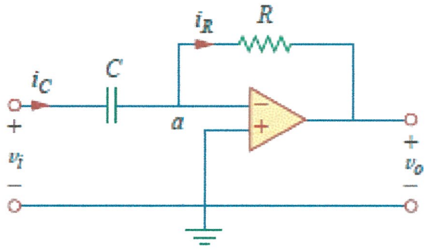
Relation	**Resistor (R)**	**Capacitor (C)**	**Inductor (L)**
v-i:	$v = iR$	$v = \frac{1}{C}\int_{t_o}^{t} i dt + v(t_o)$	$v = L\frac{di}{dt}$
i-v:	$i = \frac{v}{R}$	$i = C\frac{dv}{dt}$	$i = \frac{1}{L}\int_{t_o}^{t} v dt + i(t_o)$
p or w	$p = i^2 R = \frac{v^2}{R}$	$w = \frac{1}{2}Cv^2$	$w = \frac{1}{2}Li^2$
Series	$R_{eq} = R_1 + R_2$	$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$	$L_{eq} = L_1 + L_2$
Parallel	$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$	$C_{eq} = C_1 + C_2$	$L_{eq} = \frac{L_1 L_2}{L_1 + L_2}$
At dc:	**Same**	**Open circuit**	**Short circuit**
Circuit variable that cannot change abruptly:	**Not applicable**	v	i

An op amp integrator



$$v_o = -\frac{1}{RC}\int_0^t v_i(t)\, dt$$

An op amp differentiator



$$v_o = -RC\frac{dv_i}{dt}$$

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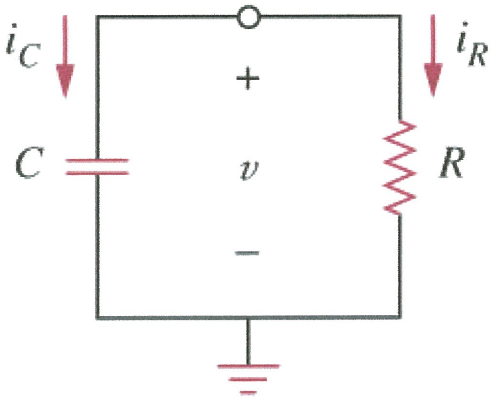
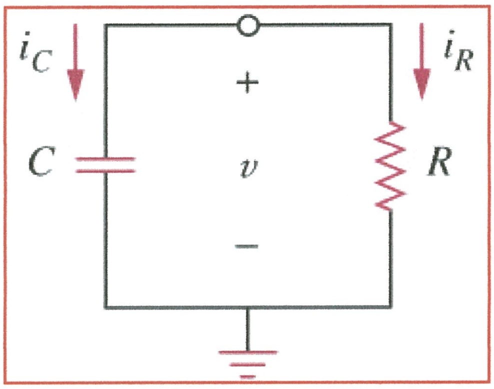
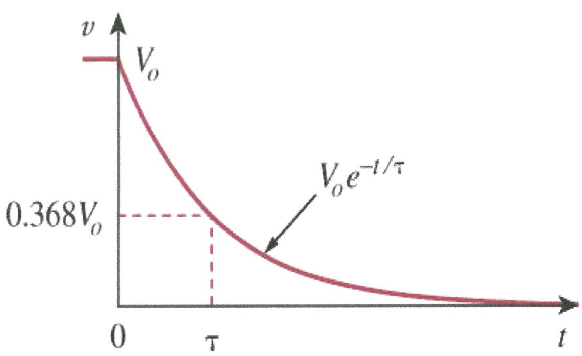


KCL=> $i_R + i_C = 0 \rightarrow \frac{v}{R} + C\frac{dv}{dt} = 0$

A RC source-free circuit

$v(t) = V_0\, e^{-t/\tau} \rightarrow \tau = R\,C$





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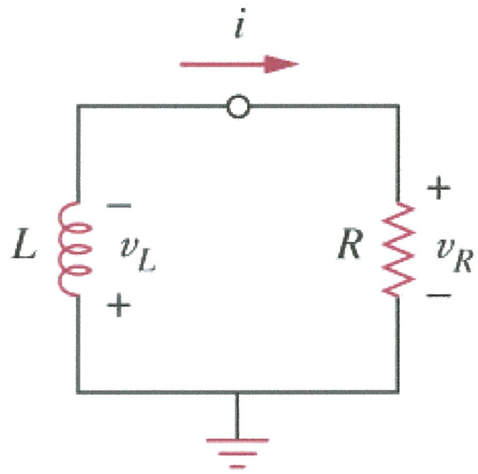
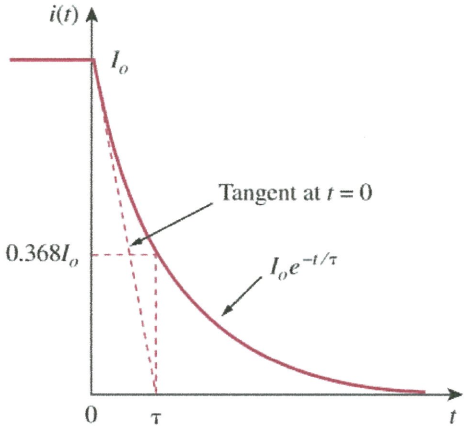
A first-order RL circuit consists of a inductor L (or its equivalent) and a resistor (or its equivalent





$$v_L + v_R = 0$$

$$L\frac{di}{dt} + iR = 0$$

Inductors law Ohms law

A RL source-free circuit

$$i(t) = I_0\, e^{-t/\tau}$$

where $\tau = \dfrac{L}{R}$

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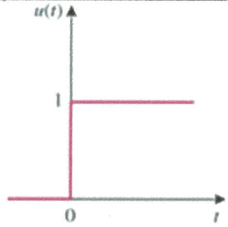
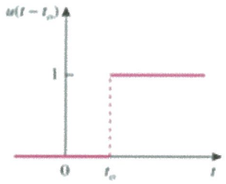
The unit step function $u(t)$ is 0 for negative values of t and 1 for positive values of t.

$$u(t)=\begin{cases}0, & t<0\\ 1, & t>0\end{cases}$$

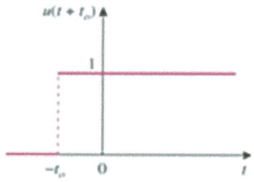


$$u(t-t_o)=\begin{cases}0, & t<t_o\\ 1, & t>t_o\end{cases}$$



(a)

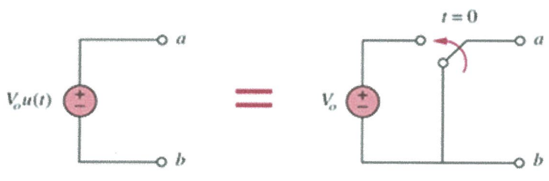
$$u(t+t_o)=\begin{cases}0, & t<-t_o\\ 1, & t>-t_o\end{cases}$$



(b)

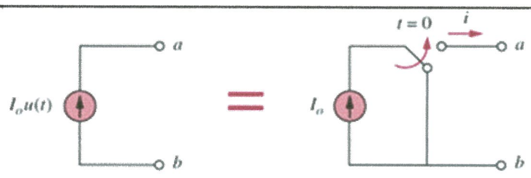
Represent an abrupt change for:

1. voltage source.



(a) (b)

2. for current source:



(a) (b)

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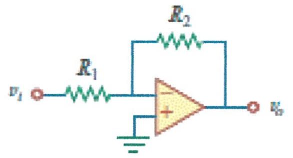
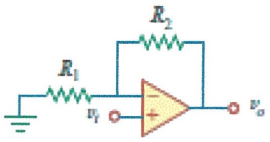
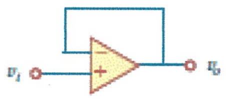
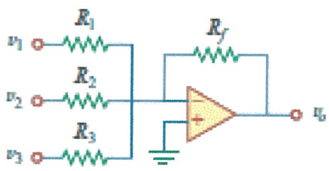
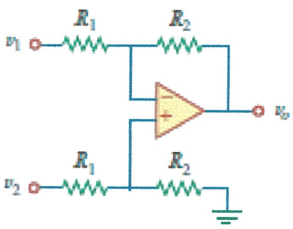
Summary of basic op amp circuits.

Op amp circuit	Name/output-input relationship
	Inverting amplifier $v_o = -\frac{R_2}{R_1} v_i$
	Noninverting amplifier $v_o = \left(1 + \frac{R_2}{R_1}\right) v_i$
	Voltage follower $v_o = v_i$
	Summer $v_o = -\left(\frac{R_f}{R_1} v_1 + \frac{R_f}{R_2} v_2 + \frac{R_f}{R_3} v_3\right)$
	Difference amplifier $v_o = \frac{R_2}{R_1}(v_2 - v_1)$