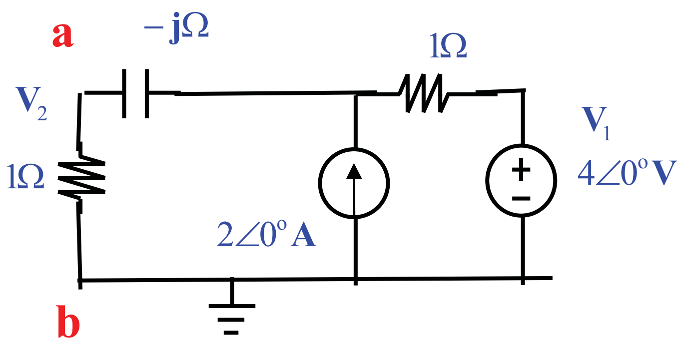
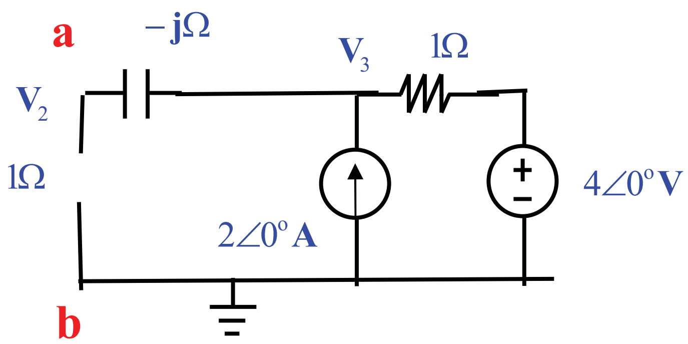
3 Show that the **open circuit voltage** at terminal ab is $6\angle 0^o$ V. Find the Thevenin impedance and hence use Thevenin's Theorem to find V2. Draw also V_1 and V_2 in a **phasor diagram**. (25)





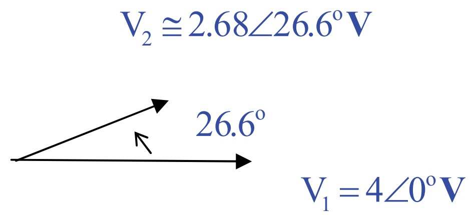
$$\therefore V_{OC} = V_3 = 4\angle 0^o + 2\angle 0^o * 1\Omega = 6\angle 0^o \text{ V} \qquad \textbf{(4.5)}$$

Thevenin impedance, Z = 1- j Ω **(5.5)**

$$\therefore V_2 = \frac{1}{1+1-j\Omega} * 6\angle 0^o \text{ V} \qquad \textbf{(5)}$$

$$= \frac{6\angle 0^o}{\sqrt{5}\angle -26.6^o}$$

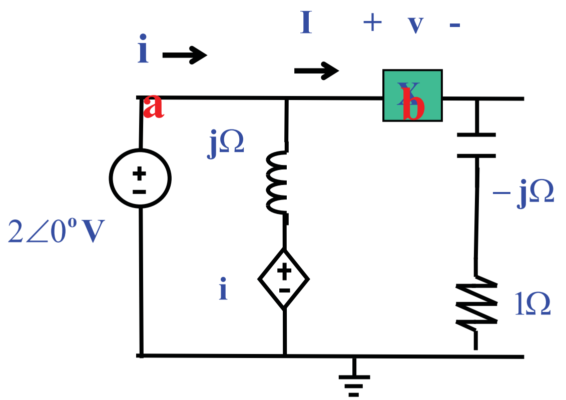
$$\cong 2.68\angle 26.6^o \text{ V} \qquad \textbf{(5)}$$



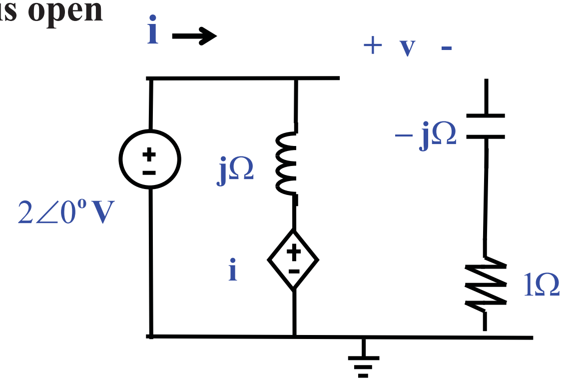
(5)

4

(a) If X is open, find v. (b) If X = 0 Ω, find I. (c) Find the Thevenin equivalent at termianls ab. (d) If $I = 2\angle 0^{o}$ A, find X. (24)

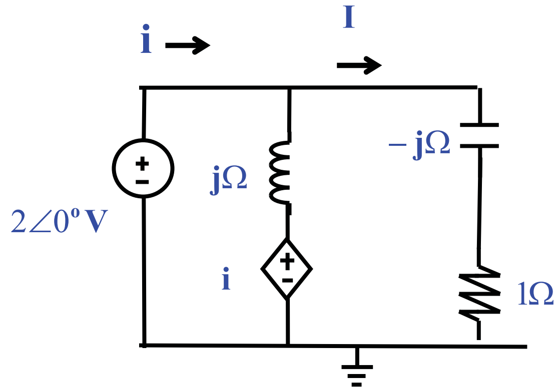


(a) **If X is open**



$$\therefore v = 2\angle 0^{o}\,V$$ **(6)**

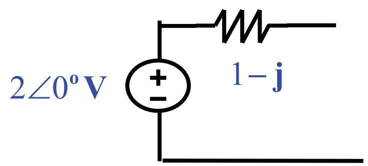
(b) **If X = 0 Ω**



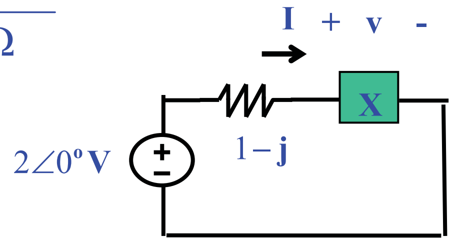
$$\therefore I = \frac{2V}{1\Omega - j\Omega}$$ **(6)**

(c) $$\therefore Zth = \frac{Voc}{Isc} = \frac{v}{I} = \frac{2\angle 0^{o}}{2\angle 0^{o}/(1-j)} = 1\Omega - j\Omega$$

Thevenin equivalent at terminals ab **(6)**



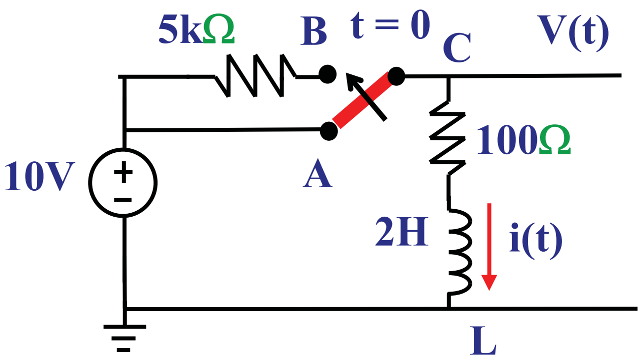
(d) **If** $I = 2\angle 0^{o}\,A = \dfrac{2\angle 0^{o}\,V}{1\Omega}$



$$\therefore X = j\Omega$$ **(6)**

1 The circuit is at steady state for $t < 0$. At $t = 0$, the switch is **switched from A to B** (i.e. BC is shorted). (a) Find i(t) for $t \geq 0$. (b) Find the maximum energy stored in L. (c) Plot V(t) for $t < 0$ and $t \geq 0$. Label clearly the voltage and time. (33)

Given that $i(t) = i(\infty) + [i(0) - i(\infty)] * e^{-t/\tau}$ **and** $\tau = L/R$



(a)

$$\therefore i(t=0) = i(t<0) = 0.1A \quad (4)$$

$$\therefore i(\infty) = \frac{10V}{5100\Omega} \cong 2mA \quad (4)$$

$$\therefore \tau = \frac{L}{R} = \frac{2H}{5100\Omega} \cong 0.4ms \quad (4)$$

$$\therefore i(t) = i(\infty) + [i(0) - i(\infty)] * e^{-\frac{t}{\tau}}$$

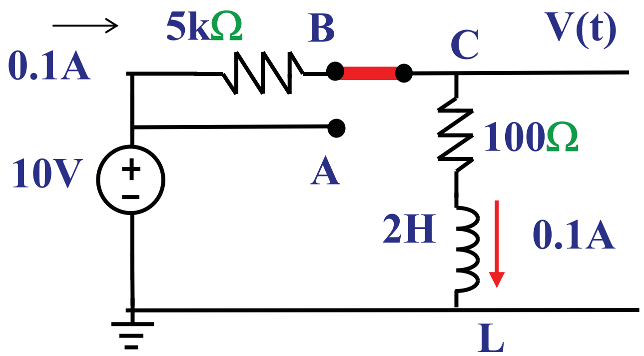
$$\cong 2mA + [100mA - 2mA] * e^{-t/0.4ms} \quad (3)$$

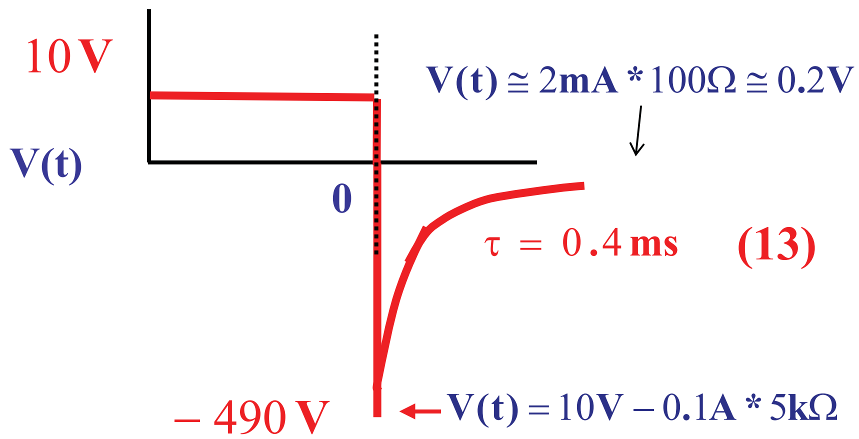
(b)

$$\therefore E_L = \frac{1}{2}Li^2 = \frac{1}{2}(2H)(0.1A)^2 = 10\,mJ$$

(5)

(c)





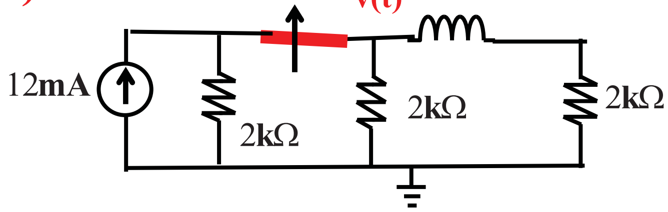
(13)

2

(a) Explain briefly why the current in an inductor is continuous with switching.

(b) Circuit is at steady state for $t < 0$. At $t = 0$, the switch is opened. Find $v(<0)$, $v(0)$, $v(10\tau)$ and sketch $v(t)$. (26)

(b)



(a) $$E_L = \frac{L i_L(t)^2}{2}$$ **(8)**

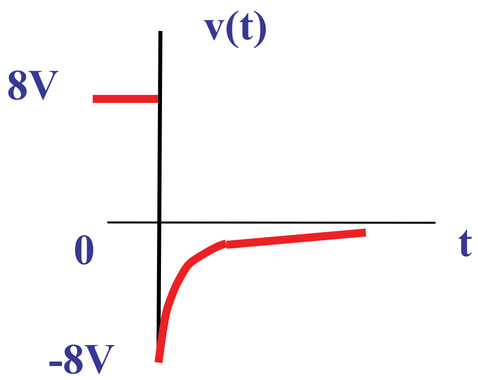
E_L (hence i_L) must be continuous with time

$$i(0) = i(<0) = 12mA * \frac{2k\Omega}{2k\Omega // 2k\Omega + 2k\Omega} * \frac{1}{2} = 4mA$$ **(4)**

$$v(<0) = 4mA * 2k\Omega = 8V$$ **(3)**

$$v(0) = -i(0) * 2k\Omega$$
$$= -4mA * 2k\Omega = -8V$$ **(4)**

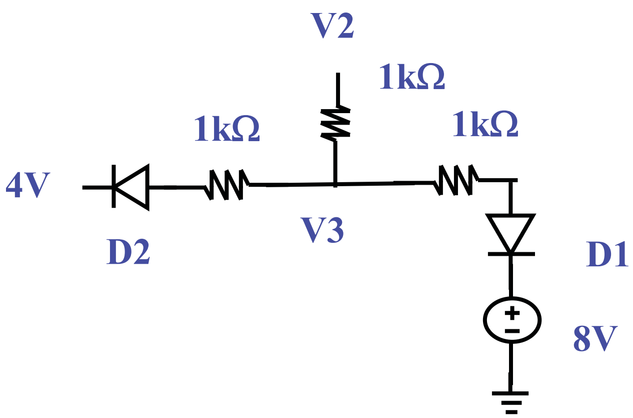
$$v(10\tau) \cong 0V$$ **(3)**

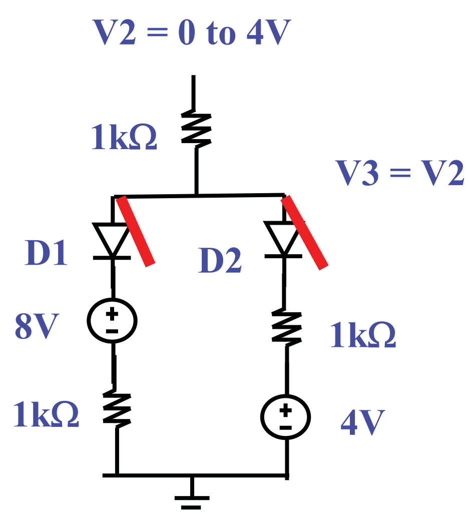


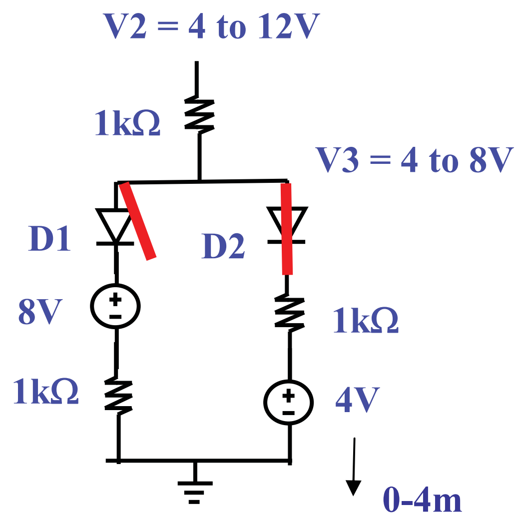
(4)

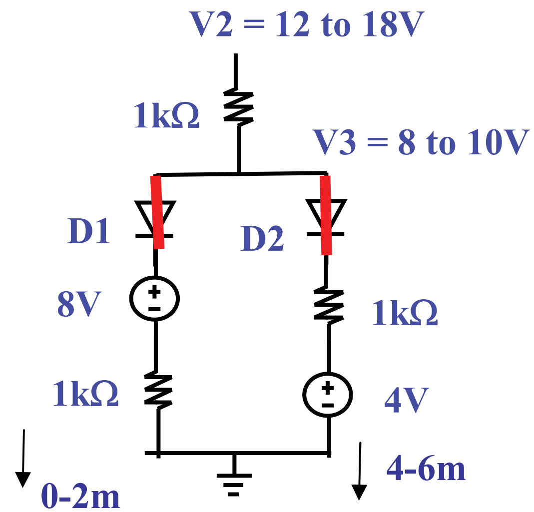
3 In the ideal diode circuit, plot V3 versus V2 for $18V \geq V2 \geq 0V$. (24)

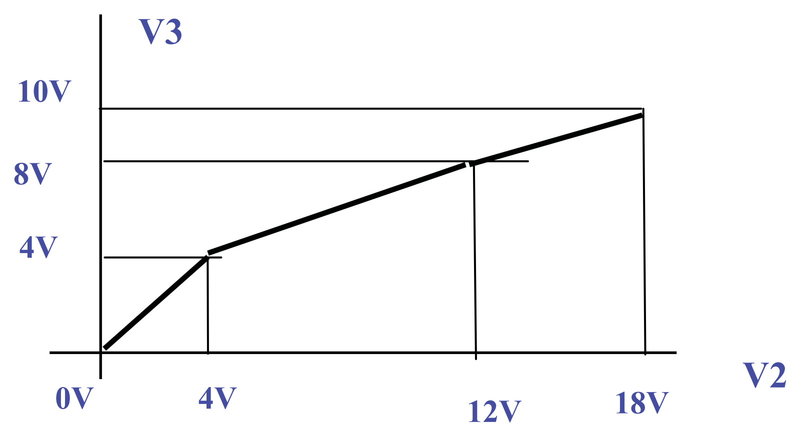
(b)







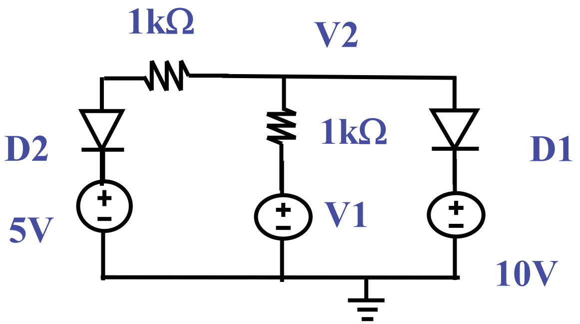




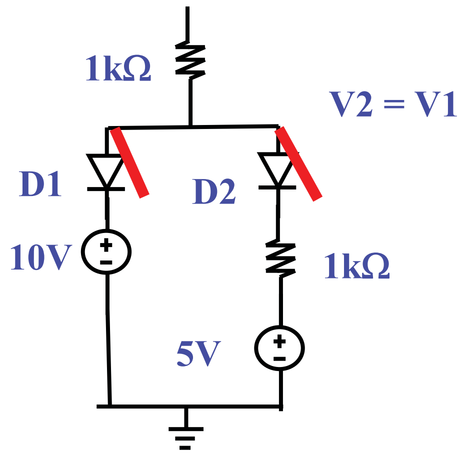
(8) (8) (8)

11 In the ideal diode circuit, plot V2 versus V1 for $20V \geq V1 \geq 0V$. (22)

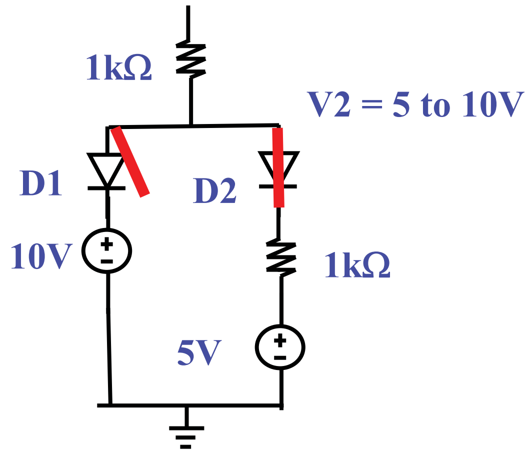
(c)



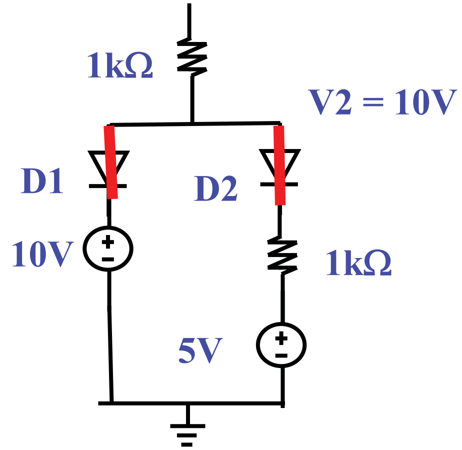
V1 = 0 to 5V

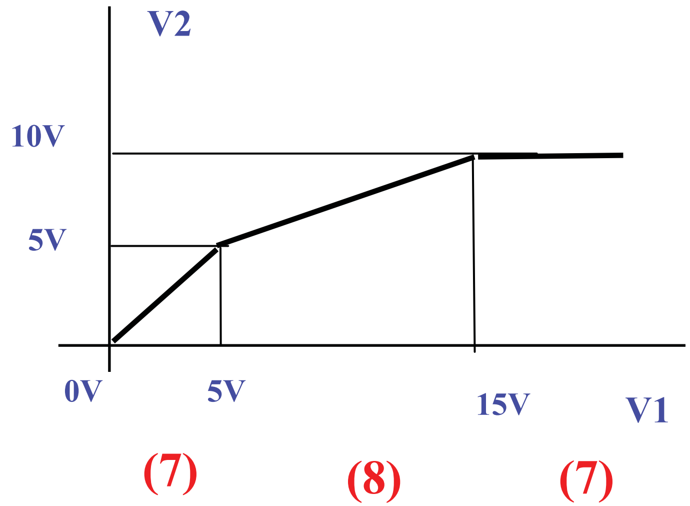


V1 = 5 to 15V



V1 > 15V

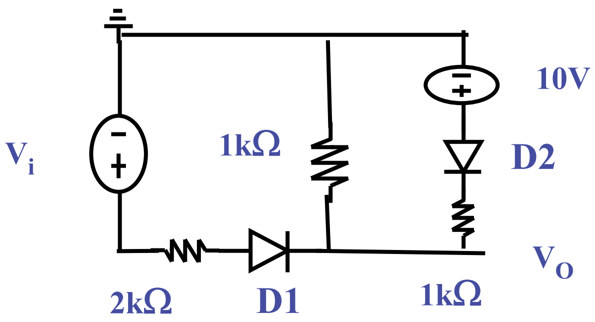


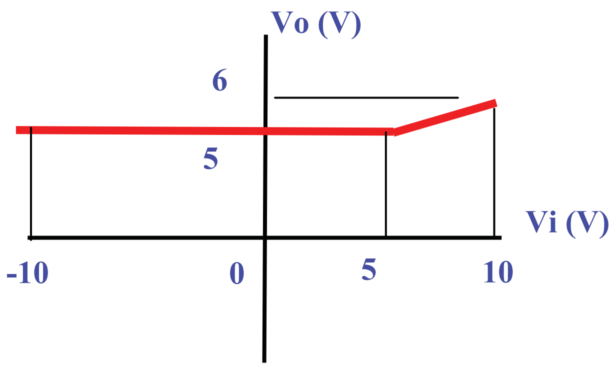


(20)

6

(b) In the ideal diode circuit, plot Vo versus Vi for
-10V ≤Vi ≤ 10V.
Show clearly all voltages in your sketch. (20)





(6)

Vi < 5V, D1 OFF and D2 ON

$\therefore Vo = 5V$

Vi > 5V, D1 and D2 ON,

$$\therefore \frac{Vi - Vo}{2k} + \frac{10 - Vo}{1k} = \frac{Vo}{1k}$$

$$\therefore Vi - Vo + 20 - 2Vo = 2Vo$$

$$\therefore Vo = \frac{Vi + 20}{5}$$