Basic Electricity and Electrical Circuits
Classtest-01

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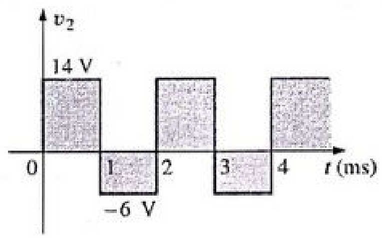
1. What is alternating current? What are the advantages of alternating current?
Solution:
The electricity produced by generators like Dynamo constantly alternates(switches direction) and is therefore known ad alternating current(AC).
Advantages of alternating current(AC):

- Easy to be transformed (step up or step down using a transformer).
- Easier to convert from AC to DC than from DC to AC.
- Easier to generate.
- It can be transmitted at high voltage and low current over long distances with less energy lost.
- High frequency used in AC makes it suitable for motors.

2. Determine the average value of the waveforms in the figure given below:



Solution:

Average value, $G=\frac{14\,V.1\,ms+(-6\,V).1\,ms}{2\,ms}=\frac{14\,V-6\,V}{2}=\frac{8\,V}{2}=4\,V[ans]$

3. Show that for a capacitor, i_C leads V_C by 90° or V_C lags i_C by 90°.
Solution:

For a capacitor, $V_C=V_m \sin\omega t$ and $i_C=C\frac{dV_C}{dt}$

Applying differentiation, $\frac{dV_C}{dt}=\omega V_m cos\omega t$

Now, $i_C=C\frac{dV_C}{dt}=C(\omega V_m cos\omega t)=\omega CV_m cos\omega t=\omega CV_m \sin(\omega t+90°)$

again, $i_C=i_m \sin\omega t$

therefore, $i_m=\omega CV_m$

From the equation above, we can see that the phase angle between V_C and i_C ,
$\varphi=(90°-0°)=90°$

So, we can say that, For a capacitor, i_C leads V_C by 90°, or V_C lags i_C by 90°.

Figure:

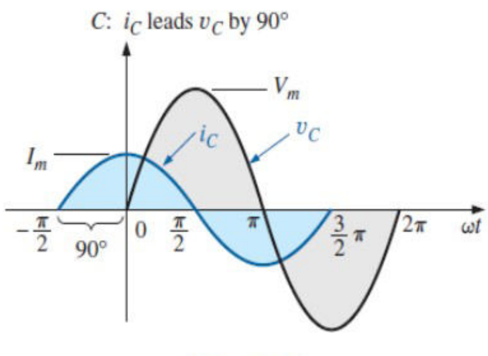


FIG. 14.12
The current of a purely capacitive element leads the voltage across the element by 90°.

4. The current through a 0.1H coil is given. Find the sinusoidal expression of the voltage across the coil. Sketch the v and I curves.

$i = 7\sin(377t - 70°)$

Solution:

Given data,

Inductance, $L = 0.1\,H$

$i = 7\sin(377t - 70°)$ comparing it with, $i_C = i_m \sin(\omega t + \theta)$

$i_m = 7\,A$

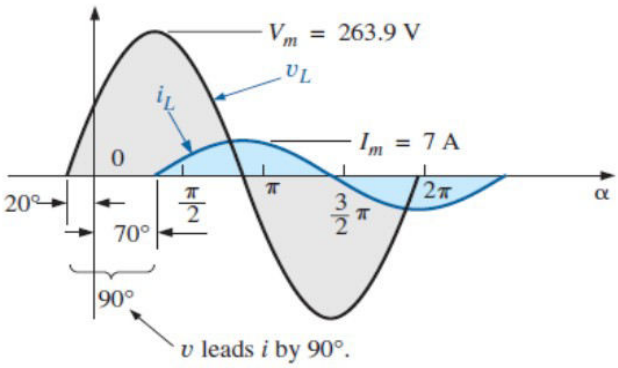
$\omega = 377\,rads^{-1}$

For a inductor circuit, $V_m = i_m X_L = i_m \omega L = 7\,A \times 377\,rads^{-1} \times 0.1\,H = 263.9\,V$

and V_L leads i_L by 90° in inductor circuits. So,

$V_L = V_m \sin(\omega t + 90°) = 263.9\sin(377t - 70° + 90°) = 263.9\sin(377t + 20°)$

Figure:



5. Find the average power dissipation in a network whose input current and voltage are the following:

$i = 5\sin(\omega t + 40°)$

$v = 10\sin(\omega t + 40°)$

Solution:

Given data,

$i = 5\sin(\omega t + 40°)$

$v = 10\sin(\omega t + 40°)$

$i_m = 5\,A$

$V_m = 10\,V$

Since V and I are in phase, the circuit appears to be purely resistive at the input terminals. Therefore,

$$P = \frac{I_m V_m}{2} = \frac{10\,V\,5\,A}{2} = 25\,W$$

Classtest-02

1. What are the steps of Norton's theorem.

Solution:

Step-01: Determine the two terminal points on the circuit for which we are calculating Norton's equivalent circuit.

Step-02: Remove the rest of the circuit.

Step-03: Turn off all the sources on the network (open circuit the current sources and short circuit the voltage sources). Then find the equivalent resistance $R_{eq} = R_N$

Step-04: Return all the sources on the circuit.

Step-05: Short the circuit on the two terminals and calculate the value of I_N.

Figure:

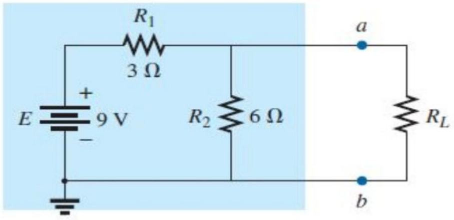


FIG. 9.61
Example 9.11.

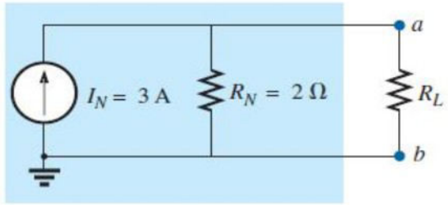
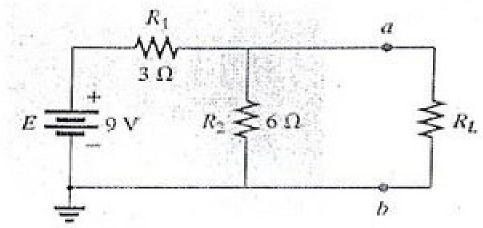


FIG. 9.65
Substituting the Norton equivalent circuit for the network external to the resistor R_L in Fig. 9.61.

2. Find out the value of current through R_L using Norton's theorem. Consider $R_L = 4\,\Omega$



Solution:

(I) Finding** R_N **at a,b terminal: Turning off all the sources (Voltage source to short circuit and current sources to open circuit) and Removing R_L

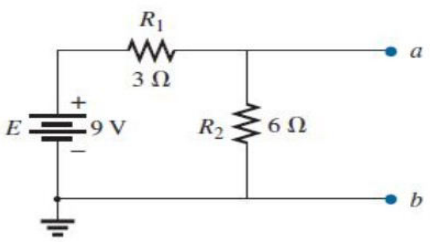


FIG. 9.62
Identifying the terminals of particular interest for the network in Fig. 9.61.

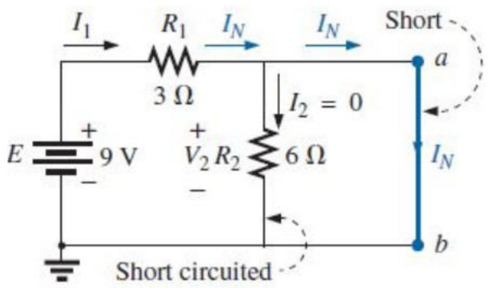


FIG. 9.64
Determining I_N for the network in Fig. 9.62.

R_1, R_2 resistance are in parallel. So,

$$R_N = R_1 \parallel R_2 = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{3 \times 6}{3+6} = 2\,\Omega$$

(II) Finding** I_N **at a,b terminal:

1. Short circuit the path at two terminals

***2. Returning back all the sources and removing** R_L*

After shorting, the current will not pass through R_2 resistance. Thus from the circuit fig 9.64 we get, $I_N = \frac{E_N}{R_1} = \frac{9}{3} = 3\,A$

Norton's equivalent circuit :

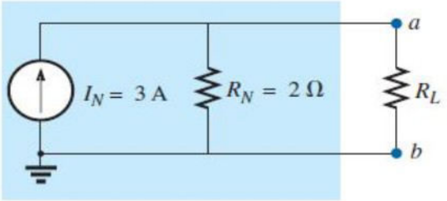


FIG. 9.65
Substituting the Norton equivalent circuit for the network external to the resistor R_L in Fig. 9.61.

Now, current through $R_L, I_{R_L} = \frac{R_N}{R_N + R_L} \times I_N = \frac{2}{2+4} \times 3 = 1\,A$

3. State KVL.
Solution:
KVL(Kirchoff's Voltage Law) states that, the algebraic sum of the total potential rises and drops around a closed path or closed loop is zero. Mathematically, $\sum E = 0$

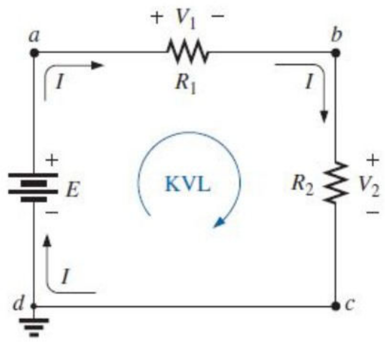
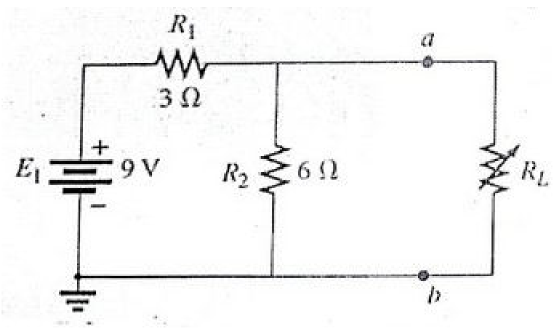


FIG. 5.26
Applying Kirchhoff's voltage law to a series dc circuit.

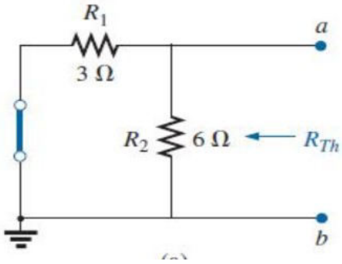
In the figure, From KVL,

$\sum E = 0$
$\rightarrow V_1 + V_2 - E = 0$
$\rightarrow E = V_1 + V_2$

4. Find the Thevenin equivalent circuit for the network in the shaded area of the following network. Then find the current through R_L for values of 10Ω and 100Ω.



Solution:
(I) Finding R_{Th} ***at a,b terminal:*** Turning off all the sources (Voltage source to short circuit and current sources to open circuit) and Removing R_L



R_1, R_2 resistance are in parallel. So,

$$R_{Th} = R_1 \parallel R_2 = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{3 \times 6}{3+6} = 2\,\Omega$$

<u>(II) Finding V_{Th} or E_{Th} at a,b terminal:</u>

1. Short circuit the path at two terminals

2. Returning back all the sources and removing R_L

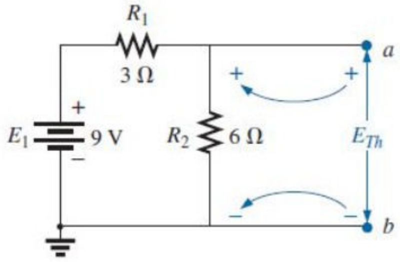


FIG. 9.29
Determining E_{Th} for the network in Fig. 9.27.

$$E_{Th} = \frac{R_2 E_1}{R_2 + R_1} = \frac{6\,\Omega \times 9\,V}{6\,\Omega + 3\,\Omega} = 6\,V$$

Thevenin's Equivalent Circuits:

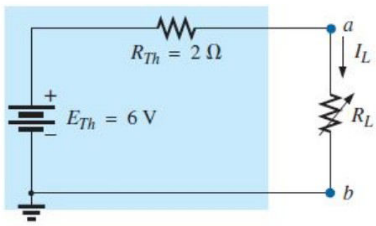


FIG. 9.31
Substituting the Thévenin equivalent circuit for the network external to R_L in Fig. 9.26.

For $R_L = 10\,\Omega$

$$I_{Th} = \frac{E_{Th}}{R_{eq}} = \frac{6}{10+2} = \frac{1}{2}\,\Omega$$

For $R_L = 100\,\Omega$

$$I_{Th} = \frac{E_{Th}}{R_{eq}} = \frac{6}{100+2} = \frac{1}{17}\,\Omega$$

<u>BKP poraiche:</u>

Electrostatics: *Electric dipole, Electric field due to dipole, dipole on external electric field, Gauss's Law and its application.*
Capacitors: *Parallel plate capacitors with dielectrics, dielectric and Gauss's Law*
Electromagnetic Induction: *Faraday's experiment, Faraday's law, Lenz's law*
Network analysis: *Kirchoff's law, Superposition theorem, Thevenin's theorem, Norton Theorem, Maximum power transfer theorem, Mesh and node circuit analysis.*
DC and AC circuits: *DC circuits with LR, RC, LCR in series, AC circuits LR, RC, LC, LCR in series.*