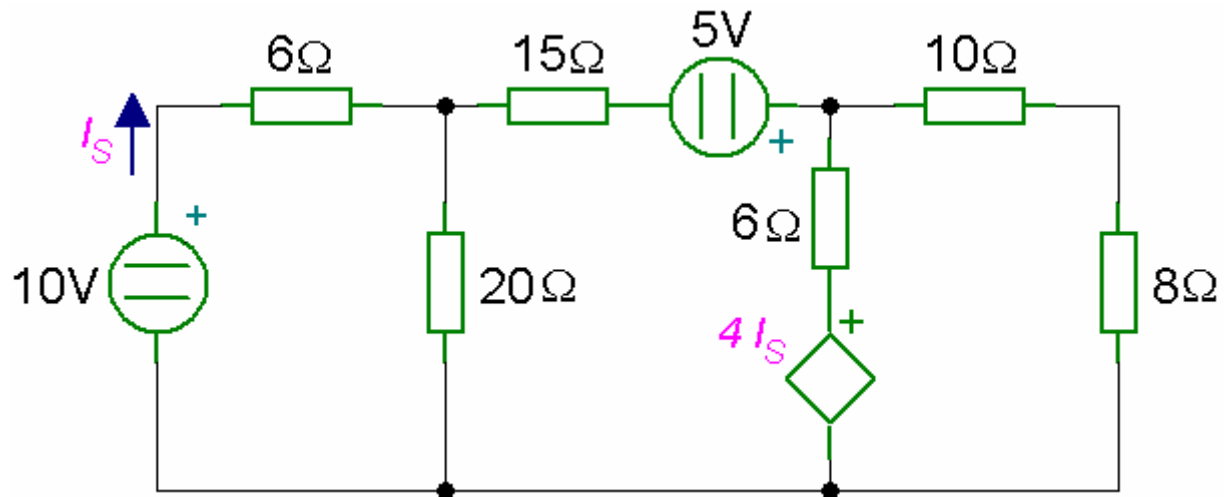


Loop Analysis (Dependent Source)

Example

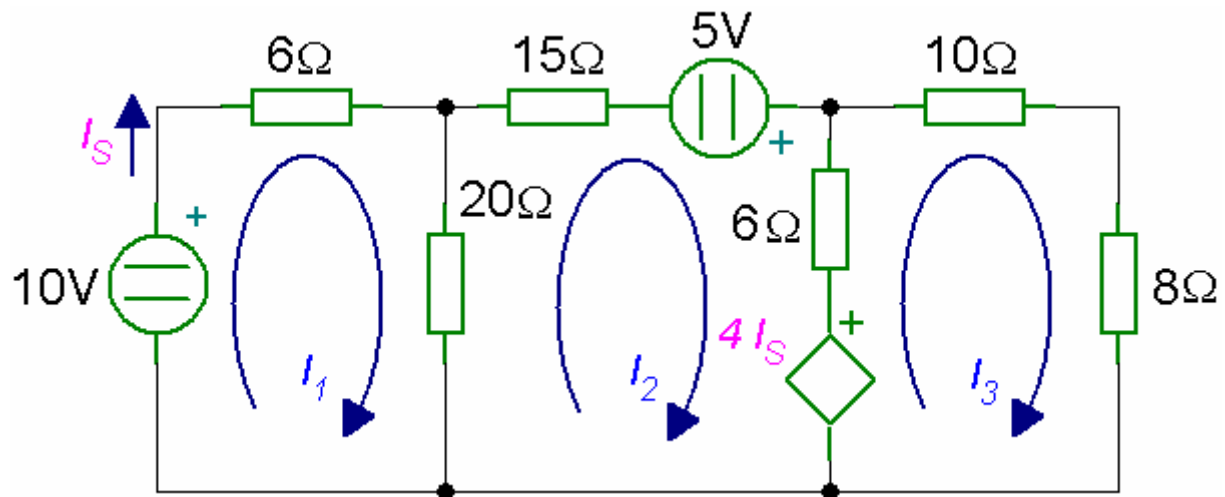
For the circuit shown below find the power dissipated by the 8-ohm resistor and the current supplied by the 10-volt source.



Circuit with Dependent and Independent Sources

Solution

Using loop analysis and denoting the loop currents as I_1 , I_2 , I_3 , we obtain the following figure.



Circuit with Loop Currents

By inspection, the current supplied by the source is $I_S = I_1$.

The loop equations are:

$$\text{Loop 1:} \quad -10 + 6 I_1 + 20 (I_1 - I_2) = 0$$

$$26 I_1 - 20 I_2 = 10$$

$$\text{Loop 2:} \quad 15 I_2 - 5 + 6 (I_2 - I_3) + 4 I_S + 20 (I_2 - I_1) = 0$$

Using equation $I_S = I_1$, the above expression simplifies to

$$-16 I_1 + 41 I_2 - 6 I_3 = 5$$

$$\text{Loop 3:} \quad 10 I_3 + 8 I_3 - 4 I_S + 6 (I_3 - I_2) = 0$$

Using equation $I_S = I_1$, the above expression simplifies to

$$-4 I_1 - 6 I_2 + 24 I_3 = 0$$

In matrix form, we have

$$\begin{bmatrix} 26 & -20 & 0 \\ -16 & 41 & -6 \\ -4 & -6 & 24 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 5 \\ 0 \end{bmatrix}$$

The power dissipated by the 8-ohm resistor is

$$P = R I_3^2 = 8 I_3^2$$

The MATLAB program for obtaining the power dissipated by the 8-ohm resistor and the current supplied by the source is

MATLAB Script

```
% this program determines the power dissipated by
% 8-ohm resistor and current supplied by the 10-volt source
%
% the program computes the loop currents, when
% the impedance matrix Z and voltage vector U are given
%
% Z is the impedance matrix
% U is the voltage vector
% initialize the matrix Z and vector U of equation ZI=U
Z = [26  -20   0;
     -16   41  -6;
       -4   -6  24];
U = [10; 5; 0];
% solution for loop currents
I = inv(Z)*U;
% the power dissipation in 8-ohm resistor is P
P = 8*I(3)^2;
% print out the results
disp(['Power dissipated in 8-ohm resistor is ',num2str(P), '
W.'])
disp(['Current in 10-volt source is ',num2str(I(1)), ' A.'])
```

The results obtained from MATLAB are

```
Power dissipated in 8-ohm resistor is 0.42047 W.
Current in 10-volt source is 0.72052 A.
```