4. Kirchhoff's voltage law says that the sum of the voltage drops around any closed path in the network in a given direction is zero. When this principle is applied to the circuit shown in Figure 3.5, we obtain the following linear system of equations:

$$\begin{aligned}
(R_1 + R_3 + R_4)I_1 + R_3 I_2 + R_4 I_3 &= E_1 \\
R_3 I_1 + (R_2 + R_3 + R_5)I_2 - R_5 I_3 &= E_2 \\
R_4 I_1 - R_5 I_2 + (R_4 + R_5 + R_6)I_3 &= 0.
\end{aligned} \tag{1}$$

Use Program 3.3 to solve for the current I_1, I_2, and I_3 if

(a) $R_1 = 1$, $R_2 = 1$, $R_3 = 2$, $R_4 = 1$, $R_5 = 2$, $R_6 = 4$, and $E_1 = 23$, $E_2 = 29$

(b) $R_1 = 1$, $R_2 = 0.75$, $R_3 = 1$, $R_4 = 2$, $R_5 = 1$, $R_6 = 4$, and $E_1 = 12$, $E_2 = 21.5$

(c) $R_1 = 1$, $R_2 = 2$, $R_3 = 4$, $R_4 = 3$, $R_5 = 1$, $R_6 = 5$, and $E_1 = 41$, $E_2 = 38$

(The problems are from Triangular Factorization.)

Figure 3.5:

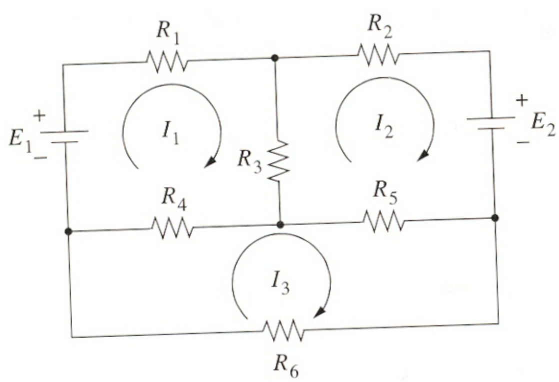

Figure 3.5 The electrical network for Exercise 4.

Program 3.3:

Program 3.3 ($PA = LU$: Factorization with Pivoting). To construct the solution to the linear system $AX = B$, where A is a nonsingular matrix.

```
function X = lufact(A,B)
%Input   - A is an N x N matrix
%        - B is an N x 1 matrix
%Output - X is an N x 1 matrix containing the solution to AX = B.
%Initialize X, Y, the temporary storage matrix C, and the row
% permutation information matrix R
   [N,N]=size(A);
   X=zeros(N,1);
   Y=zeros(N,1);
   C=zeros(1,N);
   R=1:N;
for p=1:N-1
%Find the pivot row for column p
   [max1,j]=max(abs(A(p:N,p)));
%Interchange row p and j
   C=A(p,:);
   A(p,:)=A(j+p-1,:);
   A(j+p-1,:)=C;
   d=R(p);
   R(p)=R(j+p-1);
   R(j+p-1)=d;
if A(p,p)==0
   'A is singular.  No unique solution'
   break
end
%Calculate multiplier and place in subdiagonal portion of A
   for k=p+1:N
      mult=A(k,p)/A(p,p);
      A(k,p) = mult;
      A(k,p+1:N)=A(k,p+1:N)-mult*A(p,p+1:N);
   end
end
%Solve for Y
Y(1) = B(R(1));
for k=2:N
   Y(k)= B(R(k))-A(k,1:k-1)*Y(1:k-1);
end
%Solve for X
X(N)=Y(N)/A(N,N);

for k=N-1:-1:1
   X(k)=(Y(k)-A(k,k+1:N)*X(k+1:N))/A(k,k);
end
```