Supplemental 1: Finish your code from question 19 of the worksheet on implementing LU decomposition with partial pivoting. Then use this code together with the course page `lsolve` and your own `usolve` to solve $A\mathbf{x} = \mathbf{b}$ where

$$A = \begin{pmatrix} 9 & 3 & 2 & 0 & 7 \\ 7 & 6 & 9 & 6 & 4 \\ 2 & 7 & 7 & 8 & 2 \\ 0 & 9 & 7 & 2 & 2 \\ 7 & 3 & 6 & 4 & 3 \end{pmatrix}$$

and $b = [35, 58, 53, 37, 39]^T$. For the record, the true solution is $x = [0, 1, 2, 3, 4]^T$.

Solution:
The following is a modified LUPivot Function that takes an augmented matrix in the form of the matrix A and the vector b and returns the pivoted LU factorization as well as the pivoted vector b' where $Pb = b'$. The Usolve and LSolve function remain unchanged from last week.

Code:

```
function [L,A, b] = LUPivot(A, b)
%This function takes an NxN matrix A and vector b and returns an LU
%factorization and permuted b.

n = size(A,2);
L = zeros(n);


for k = 1:n %Initializes the diagonal of L
    L(k,k) = 1;
end

P = zeros(1,n);
for i = 1:n-1 % Iterates through columns of A

    %U pivot
     [M, I] = max(A(i,:));
     tmp = A(i,:);
     A(i,:) = A(I,:);
     A(I,:) = tmp;

     % Vector pivot
     tmp = b(i,:);
```

```
        b(i,:) = b(I,:);
        b(I,:) = tmp;


        %L Pivot
        tmp = L(i, 1:i-1);
        L(i, 1:i-1) = L(I, 1:i-1);
        L(I, 1:i-1) = tmp;


    for j = i+1:n % Iterates through Rows of A

        x = A(j,i)/A(i,i); %Calculates factor for Gauss Elim

        L(j,i) = x; %Stores factor in L

        for k = 1:n % Iterates through current row and performs
                    %Gaussian Elim step
            A(j,k) = A(j,k) - (A(i,k)*x);
        end

    end

end
```

Finally we can write a function that solves a matrix equation using *LU* factorization with partial pivoting,

Code:

```
function x = PivotSolve(A, b)
%This funciton solves a linear system where A
%is NxN

[L,U,z] = LUPivot(A, b);

y = lsolve(L,z);

x = usolve(U,y);
```

Console

```
>> A = [9 3 2 0 7; 7 6 9 6 4; 2 7 7 8 2; 0 9 7 2 2; 7 3 6 4 3]

A =

     9     3     2     0     7
     7     6     9     6     4
     2     7     7     8     2
     0     9     7     2     2
     7     3     6     4     3

>> b = [35, 58, 53, 37, 39]

b =

    35    58    53    37    39

>> PivotSolve(A,b')

ans =

    0.0000    1.0000    2.0000    3.0000    4.0000
```

Exercise 7.8: Compute the $2-norm$, the $1-norm$ and the $\infty-norm$ of,

$$v = \begin{pmatrix} 4 \\ 5 \\ -6 \end{pmatrix}$$

Solution:
By definition we can compute all vector norms easily,

$$[v]_2 = \sqrt{4^2 + 5^2 + (-6)^2} = \sqrt{77}$$

$$[v]_1 = |4| + |5| + |-6| = 15$$

$$[v]_\infty = max\{|v|\} = 6$$