MAT343 LAB2

Question 1

```
E1 = eye(4);
E1([2,3],:) = E1([3,2],:)

E2 = eye(4);
E2(3,3) = -3

E3 = eye(4);
E3(3,4) = 5

A = floor(10*rand(4,3))
E1*A
E2*A
E3*A

% E1*A swaps row 3 with row 2. This is true because the elementary
% matrix has row 3 swapped with row 2.

% E2*A muliplies row 3 with scalar of -3. This is true because the
% elementary row 3 gets replaced by -3. And the scalar of the
% multiplied by A would also multiply E2 by the same scalar to row 3.

% E3*A multilies takes row 3 and adds 5 times row 4 into row 3. Using
% muliplication you notice that since 5 is the last element in the row
% you will use that value to multiply the last column in matrix A.
```

```
E1 =

     1     0     0     0
     0     0     1     0
     0     1     0     0
     0     0     0     1


E2 =

     1     0     0     0
     0     1     0     0
     0     0    -3     0
     0     0     0     1


E3 =

     1     0     0     0
     0     1     0     0
     0     0     1     5
     0     0     0     1
```

```
A =

     6     8     2
     0     1     8
     6     3     5
     6     1     3


ans =

     6     8     2
     6     3     5
     0     1     8
     6     1     3


ans =

     6     8     2
     0     1     8
   -18    -9   -15
     6     1     3


ans =

     6     8     2
     0     1     8
    36     8    20
     6     1     3
```

Question 2

```
    A = [2,3,2;-4,9,-9;-8,-24,-1]
% a)
    E1 = eye(3);
    E2 = eye(3);
    E3 = eye(3);

    E1(2,1) = 2
    E2(3,1) = 4

    E2*E1*A
    format rat
    E3(3,2) = 4/5
    U = E3*E2*E1*A
% b)
    L = inv(E1)*inv(E2)*inv(E3)
```

```
format short
A-L*U  % answer is close enough to zero to say its accurate
```

```
A =

     2     3     2
    -4     9    -9
    -8   -24    -1


E1 =

     1     0     0
     2     1     0
     0     0     1


E2 =

     1     0     0
     0     1     0
     4     0     1


ans =

     2     3     2
     0    15    -5
     0   -12     7


E3 =

       1             0             0
       0             1             0
       0           4/5             1


U =

       2             3             2
       0            15            -5
       *             *             3


L =

       1             0             0
      -2             1             0
      -4          -4/5             1
```

```
ans =

   1.0e-14 *

         0         0         0
         0         0         0
         0    0.3553    0.0888
```

Question 3

```
    p = [2,3,1,5,4];
    E = eye(length(p));
    E = E(p,:)

    A = floor(10*rand(5))
% a)
    E*A
    A*E
    % E*A, the permute matrix represents the row number. So since the first
    % index of the permute matrix is 2 and you are multiplying matrix A,
    % the first row of the result would be row 2. The permute matrix also
    % matches the elementary matrix with the corresponding indexes.

    % A*E, does the same as E*A, but now you look at the columns of E
    % instead of the rows and use that as the result.
% b)
    inv(E)
    E'
    % inv(E) and E' are the same matricies.
```

```
E =

     0     1     0     0     0
     0     0     1     0     0
     1     0     0     0     0
     0     0     0     0     1
     0     0     0     1     0


A =

     2     0     7     2     5
     5     9     5     9     3
     5     2     7     8     4
     3     8     8     7     6
     5     1     4     5     0


ans =

     5     9     5     9     3
```

```
     5     2     7     8     4
     2     0     7     2     5
     5     1     4     5     0
     3     8     8     7     6


ans =

     7     2     0     5     2
     5     5     9     3     9
     7     5     2     4     8
     8     3     8     6     7
     4     5     1     0     5


ans =

     0     0     1     0     0
     1     0     0     0     0
     0     1     0     0     0
     0     0     0     0     1
     0     0     0     1     0


ans =

     0     0     1     0     0
     1     0     0     0     0
     0     1     0     0     0
     0     0     0     0     1
     0     0     0     1     0
```

Question 4

```
    A = [-4,-9,-3,6;-1,3,5,4;-7,-1,-3,-5;-5,4,9,-7]
    b = [62,-47,70,-19]'
    x = [-5,-5,-5,-3]'
% a)
    [L,U,P] = lu(A)
    P*A-L*U
% b)
    x_lu = U\(L\(P*b))
% c)
    norm (x_lu - x)
```

```
A =

    -4    -9    -3     6
    -1     3     5     4
    -7    -1    -3    -5
    -5     4     9    -7
```

```
b =

    62
   -47
    70
   -19


x =

    -5
    -5
    -5
    -3


L =

    1.0000         0         0         0
    0.5714    1.0000         0         0
    0.7143   -0.5593    1.0000         0
    0.1429   -0.3729    0.4748    1.0000


U =

   -7.0000   -1.0000   -3.0000   -5.0000
         0   -8.4286   -1.2857    8.8571
         0         0   10.4237    1.5254
         0         0         0    7.2927


P =

     0     0     1     0
     1     0     0     0
     0     0     0     1
     0     1     0     0


ans =

   1.0e-15 *

         0         0         0         0
         0         0         0   -0.8882
   -0.8882   -0.8882         0    0.8882
         0         0         0         0


x_lu =
```

```
   -5.0000
   -5.0000
   -5.0000
   -3.0000


ans =

   4.4409e-16
```

Question 5

```
    A = rand(600);
    x = ones(600,1);
    b = A*x;
% a)
    tic; R = rref([A,b]); x_rref = R(:,end); toc
% b)
    tic; [L,U,P] = lu(A); x_lu = U\(L\(P*b)); toc % faster
% c)
    norm(x_rref - x) % more accurate but slower
    norm(x_lu - x)
```

```
Elapsed time is 1.826751 seconds.
Elapsed time is 0.015337 seconds.

ans =

   4.4931e-11


ans =

   4.5195e-11
```