Contents

```matlab
% HW 2 Problem 1(c) & (d)

clear
clc
close all

load('testproblem.mat');
```

Problem 1(c): Lower & upper triang. matrices from the previous problem

```matlab
La = [1.0000         0         0         0         0         0         0         0;
      0.4641    1.0000         0         0         0         0         0         0;
     -0.1350   -0.4295    1.0000         0         0         0         0         0;
      0.2876   -0.2767    0.0696    1.0000         0         0         0         0;
     -0.2974   -0.4159    0.3247    1.4176    1.0000         0         0         0;
     -0.3940   -1.0627   -0.3439    2.1578    8.1997    1.0000         0         0;
      0.9163    0.9053    0.9062   -0.7006    4.3450    0.8867    1.0000         0;
      0.1742   -0.0886   -0.1767    0.6487   -1.1912   -0.1647   -2.0441    1.0000];

Ua = [  -1.0149   -2.1321    2.1778   -0.2730   -0.7841   -0.4677   -0.2841   -0.2883;
              0    2.1349    0.1277    1.7030   -1.4414    0.0922    0.0452    0.4839;
              0         0   -2.1480    0.2136    1.1336    1.4554   -1.4883   -1.6670;
              0         0         0    0.8624   -0.8568   -0.8022    0.3901    1.3688;
              0         0         0         0    0.1172    1.3485   -0.9577    1.1407;
              0         0         0         0         0   -8.6038    6.3411  -11.5207;
              0         0         0         0         0         0    0.7162    7.2391;
              0         0         0         0         0         0         0   13.5981];
```

Display the results

```matlab
xLU = backsub(cat(2,Ua,fwdsub(cat(2,La,b))));
disp('Solution for x using LU factorization (Rounded)')
disp(xLU)

xmat = A\b;
disp('Solution for x using MATLAB bulit-in function')
disp(xmat)
```

```
Solution for x using LU factorization (Rounded)
    1.0058
    1.9982
    3.0030
    4.0048
    5.0039
    6.0012
    7.0007
    7.9996

Solution for x using MATLAB bulit-in function
```

```
    1.0000
    2.0000
    3.0000
    4.0000
    5.0000
    6.0000
    7.0000
    8.0000
```

Remarks

```
disp('Because there are some rounding errors, let''s re-calculated the solution using the original L & U matrices.')
```

Because there are some rounding errors, let's re-calculated the solution using the original L & U matrices.

Let's do it again

```
[L,U] = DLLUF(A,b);
xLUb = backsub(cat(2,U,fwdsub(cat(2,L,b))));
xLUb2 = backsub(cat(2,U,fwdsub(cat(2,L,b2))));
xLUb3 = backsub(cat(2,U,fwdsub(cat(2,L,b3))));

xmat2 = A\b2;
xmat3 = A\b3;

disp('Solution for x using LU factorization (b)')
disp(xLUb)
disp('Solution for x using MATLAB bulit-in function (b)')
disp(xmat)
disp('Error (b): ')
disp(xLUb - xmat)

disp('Solution for x using LU factorization (b2)')
disp(xLUb2)
disp('Solution for x using MATLAB bulit-in function (b2)')
disp(xmat2)
disp('Error (b2): ')
disp(xLUb2 - xmat2)

disp('Solution for x using LU factorization (b3)')
disp(xLUb3)
disp('Solution for x using MATLAB bulit-in function (b3)')
disp(xmat3)
disp('Error (b3): ')
disp(xLUb3 - xmat3)
```

```
Doolittle LU factorization:
L =
  Columns 1 through 7

    1.0000         0         0         0         0         0         0
    0.4641    1.0000         0         0         0         0         0
   -0.1350   -0.4295    1.0000         0         0         0         0
    0.2876   -0.2767    0.0696    1.0000         0         0         0
   -0.2974   -0.4159    0.3247    1.4176    1.0000         0         0
   -0.3940   -1.0627   -0.3439    2.1578    8.1997    1.0000         0
    0.9163    0.9053    0.9062   -0.7006    4.3450    0.8867    1.0000
    0.1742   -0.0886   -0.1767    0.6487   -1.1912   -0.1647   -2.0441
```

Column 8

           0
           0
           0
           0
           0
           0
           0
      1.0000

U =
  Columns 1 through 7

    -1.0149   -2.1321   2.1778   -0.2730   -0.7841   -0.4677   -0.2841
          0   2.1349   0.1277   1.7030   -1.4414   0.0922   0.0452
          0   0   -2.1480   0.2136   1.1336   1.4554   -1.4883
          0   0   0   0.8624   -0.8568   -0.8022   0.3901
          0   0   0   0   0.1172   1.3485   -0.9577
          0   0   0   0   0   -8.6038   6.3411
          0   0   0   0   0   0   0.7162
          0   0   0   0   0   0   0

  Column 8

    -0.2883
     0.4839
    -1.6670
     1.3688
     1.1407
   -11.5207
     7.2391
    13.5981

Solution for x using LU factorization (b)
      1.0000
      2.0000
      3.0000
      4.0000
      5.0000
      6.0000
      7.0000
      8.0000

Solution for x using MATLAB bulit-in function (b)
      1.0000
      2.0000
      3.0000
      4.0000
      5.0000
      6.0000
      7.0000
      8.0000

Error (b):
     1.0e-14 *

    -0.5884
     0.3775
    -0.0444
    -0.5329
    -0.1776
     0.0888
    -0.5329
     0.1776

```
Solution for x using LU factorization (b2)
    2.0000
    4.0000
    6.0000
    8.0000
   10.0000
   12.0000
   14.0000
   16.0000

Solution for x using MATLAB bulit-in function (b2)
    2.0000
    4.0000
    6.0000
    8.0000
   10.0000
   12.0000
   14.0000
   16.0000

Error (b2):
   1.0e-13 *

   -0.1177
    0.0755
   -0.0089
   -0.1066
   -0.0355
    0.0178
   -0.1066
    0.0355

Solution for x using LU factorization (b3)
   10.0000
   20.0000
   30.0000
   40.0000
   50.0000
   60.0000
   70.0000
   80.0000

Solution for x using MATLAB bulit-in function (b3)
   10.0000
   20.0000
   30.0000
   40.0000
   50.0000
   60.0000
   70.0000
   80.0000

Error (b3):
   1.0e-12 *

    0.0497
    0.0782
    0.0462
   -0.0426
    0.0426
   -0.1350
   -0.1847
    0.0142
```

Problem 1(d): Find the inverse A

```
n = length(A(1,:));
I = eye(n);
Ainv = zeros(n);

for k = 1 : n
    Ainv(:,k) = backsub(cat(2,U,fwdsub(cat(2,L,I(:,k)))));
end % for

disp('Inverse A using L & U: ')
disp(Ainv)
invAmat = inv(A);
disp('Inverse A using MATLAB built-in function: ')
disp(invAmat)
disp('Error (Inverse A): ')
disp(inv(A) - Ainv)
```

```
Inverse A using L & U:
  Columns 1 through 7

   -0.4480    0.3835    0.0281   -0.0881   -0.5795    1.0474   -0.5356
   -0.0540   -0.1948   -0.2456   -0.6264    0.1978   -0.2692    0.2222
    0.2062   -0.1064   -0.3766   -1.1154   -0.0220    0.5605    0.2837
   -0.3250    0.4251    0.0724   -0.1670   -0.3128    0.8816    0.4305
   -0.0697   -0.5582   -0.4000   -1.3059    0.0704    0.6537    0.8908
    0.3565    0.3345    0.1079   -0.1491    0.2014    0.0363   -0.2920
   -0.1222    0.1436    0.0008    0.7677   -0.2421   -0.0132   -0.1231
    0.1043   -0.2818   -0.2839   -0.2878    0.4281   -0.1212    0.1503

  Column 8

    0.2581
    0.2324
    0.3873
    0.2608
    0.6467
   -0.6463
   -0.7433
    0.0735

Inverse A using MATLAB built-in function:
  Columns 1 through 7

   -0.4480    0.3835    0.0281   -0.0881   -0.5795    1.0474   -0.5356
   -0.0540   -0.1948   -0.2456   -0.6264    0.1978   -0.2692    0.2222
    0.2062   -0.1064   -0.3766   -1.1154   -0.0220    0.5605    0.2837
   -0.3250    0.4251    0.0724   -0.1670   -0.3128    0.8816    0.4305
   -0.0697   -0.5582   -0.4000   -1.3059    0.0704    0.6537    0.8908
    0.3565    0.3345    0.1079   -0.1491    0.2014    0.0363   -0.2920
   -0.1222    0.1436    0.0008    0.7677   -0.2421   -0.0132   -0.1231
    0.1043   -0.2818   -0.2839   -0.2878    0.4281   -0.1212    0.1503

  Column 8

    0.2581
    0.2324
    0.3873
    0.2608
    0.6467
   -0.6463
   -0.7433
    0.0735
```

```
Error (Inverse A):
   1.0e-15 *

  Columns 1 through 7

    0.4441   -0.2776   -0.2255    0.3331   -0.3331    0.4441    0.4441
   -0.2290    0.1665    0.0833   -0.1110   -0.2776    0.0555   -0.1110
    0.3886    0.0971   -0.2220    0.2220   -0.3157    0.2220    0.2220
    0.7772    0.3331   -0.3469    0.5551   -0.0555         0    0.1110
    0.6245    0.4441   -0.4441    0.4441   -0.4163    0.3331    0.2220
    0.0555    0.0555    0.1249    0.2776    0.3331   -0.0625    0.0555
    0.2498    0.1943    0.0505    0.3331    0.5551   -0.1527   -0.0555
   -0.0694         0   -0.0555   -0.1110   -0.0555    0.0416    0.0278

  Column 8

    0.7216
   -0.0833
    0.6661
    0.5551
    0.5551
         0
   -0.4441
         0
```