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# ASEN 5014 Midterm 2 Main Script

## Table of Contents

Housekeeping .....	1
Problem 1 scratchpad .....	1
Problem 2a .....	3
Problem 2b .....	5
Problem 2c .....	7

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## Housekeeping

```
clc; clear; close all;
```

## Problem 1 scratchpad

```
y=Mx+b

fprintf("--- Problem 1 Scratchpad ---\n")
M = [
    1 0 1 2 3;
    0 1 1 0 0;
    2 0 2 4 6;
    1 0 0 2 3
];
b = [-2; 3; 5; 9];
y = [3; 4; 1; 5];

yNew = y-b

LN_M = null(M')
CS_M = orth(M)

a_delta = LN_M\yNew;

yStar = yNew - LN_M*a_delta

xStar = M\yStar

yCheck = y - b
yStar = M*xStar

w = yCheck - yStar

--- Problem 1 Scratchpad ---

yNew =
```

5  
1  
-4  
-4

*LN\_M* =

-0.8944  
0.0000  
0.4472  
0.0000

*CS\_M* =

-0.4120	0.0733	0.1578
-0.0239	0.8813	-0.4720
-0.8239	0.1467	0.3156
-0.3884	-0.4432	-0.8079

*yStar* =

-0.6000  
1.0000  
-1.2000  
-4.0000

*Warning: Rank deficient, rank = 3, tol = 8.158440e-15.*

*xStar* =

0  
-2.4000  
3.4000  
0  
-1.3333

*yCheck* =

5  
1  
-4  
-4

*yStar* =

-0.6000  
1.0000  
-1.2000  
-4.0000

```
w =
    5.6000
     0
   -2.8000
   -0.0000
```

## Problem 2a

```
fprintf("--- Problem 2a ---\n")
M = [
    1 -3 5 1 6;
    0 -1 1 0 3;
    3 -4 10 3 3;
    1 -1 3 1 0
];
y = [1; 1; 2; -2];
z = [-1; -2; 7; 3];

% Column space
G = M'*M
det(G)
CSMat = rref(M)
CS_M = M(:,1:2)

% Left null space
LNMat = rref([M', zeros(5,1)])
LN_M = [
    -3 -1;
     5  2;
     1  0;
     0  1
]

% Right null space
RNMat = rref([M, zeros(4,1)])
RN_M = [
    -2 -1 3;
     1  0 3;
     1  0 0;
     0  1 0;
     0  0 1
]

% Row space
G = M*M'
det(G)
RSMat = rref(M')
RS_M = [
    1  0;
```

```

        -3 -1;
        5  1;
        1  0;
        6  3
    ];

--- Problem 2a ---

G =

    11    -16     38     11     15
   -16     27    -59    -16    -33
    38    -59   135     38     63
    11    -16     38     11     15
    15    -33     63     15     54

ans =

    0

CSMat =

     1     0     2     1    -3
     0     1    -1     0    -3
     0     0     0     0     0
     0     0     0     0     0

CS_M =

     1    -3
     0    -1
     3    -4
     1    -1

LNMat =

     1     0     3     1     0
     0     1    -5    -2     0
     0     0     0     0     0
     0     0     0     0     0
     0     0     0     0     0

LN_M =

    -3    -1
     5     2
     1     0
     0     1

```

---

*RNMat* =

1	0	2	1	-3	0
0	1	-1	0	-3	0
0	0	0	0	0	0
0	0	0	0	0	0

*RN\_M* =

-2	-1	3
1	0	3
1	0	0
0	1	0
0	0	1

*G* =

72	26	86	20
26	11	23	4
86	23	143	40
20	4	40	12

*ans* =

-1.2811e-26

*RSMat* =

1	0	3	1
0	1	-5	-2
0	0	0	0
0	0	0	0
0	0	0	0

## Problem 2b

```
fprintf("--- Problem 2b ---\n")
B = CS_M;
a_CS = (B'*B)^-1*B'*y
c = B*a_CS

B = LN_M;
a_LN = (B'*B)^-1*B'*y
delta = B*a_LN

% Check answer
yCheck = c + delta
```

```

orth = dot(z,delta)

    % Pull out component in CS(M)
yStar = y - delta

    % Solve for xStar
xStarMat = rref([M,c])
xStar = [-0.6098; -0.7317; 0; 0; 0];

w = y - M*xStar
minError = norm(w)

--- Problem 2b ---

a_CS =

    -0.6098
    -0.7317

c =

    1.5854
    0.7317
    1.0976
    0.1220

a_LN =

    0.9024
    -2.1220

delta =

    -0.5854
    0.2683
    0.9024
    -2.1220

yCheck =

    1.0000
    1.0000
    2.0000
    -2.0000

orth =

    8.8818e-16

```

```
yStar =
```

```
1.5854
0.7317
1.0976
0.1220
```

```
xStarMat =
```

```
1.0000    0    2.0000    1.0000   -3.0000   -0.6098
    0    1.0000   -1.0000    0   -3.0000   -0.7317
    0    0    0    0    0    0
    0    0    0    0    0    0
```

```
w =
```

```
-0.5853
0.2683
0.9026
-2.1219
```

```
minError =
```

```
2.3941
```

## Problem 2c

```
fprintf("--- Problem 2c ---\n")
```

```
xMat = rref([M,z])
```

```
B = CS_M;
```

```
a = (B'*B)^-1)*B'*z;
```

```
c_c = B*a
```

```
x = [5; 2; 0; 0; 0]
```

```
B = RS_M;
```

```
a_RS = (B'*B)^-1)*B'*x;
```

```
r = B*a_RS % New xStar
```

```
B = RN_M;
```

```
a_RN = (B'*B)^-1)*B'*x;
```

```
n = B*a_RN
```

```
minLength = norm(r)
```

```
zCheck = M*r
```

--- Problem 2c ---

$xMat =$

1	0	2	1	-3	5
0	1	-1	0	-3	2
0	0	0	0	0	0
0	0	0	0	0	0

$c_c =$

-1.0000  
-2.0000  
7.0000  
3.0000

$x =$

5  
2  
0  
0  
0

$r =$

0.3534  
-0.0431  
0.7500  
0.3534  
-0.9310

$n =$

4.6466  
2.0431  
-0.7500  
-0.3534  
0.9310

$minLength =$

1.2965

$zCheck =$

-1.0000  
-2.0000



7.0000

3.0000

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