```
% MECH 6318 - HW 2
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% 2021-09-07

clear
close all
```

Problem 11.3

```
f = @(x) 8*x(1,:,:) + 10*x(2,:,:) + 4
```

```
f = function_handle with value:
    @(x)8*x(1,:,:)+10*x(2,:,:)+4
```

```
A = [-1,-1;
     1, 1]
```

```
A = 2×2
    -1    -1
     1     1
```

```
b = [4;
     6]
```

```
b = 2×1
     4
     6
```

```
LB = [0;
      0]
```

```
LB = 2×1
     0
     0
```

```
UB = []
```

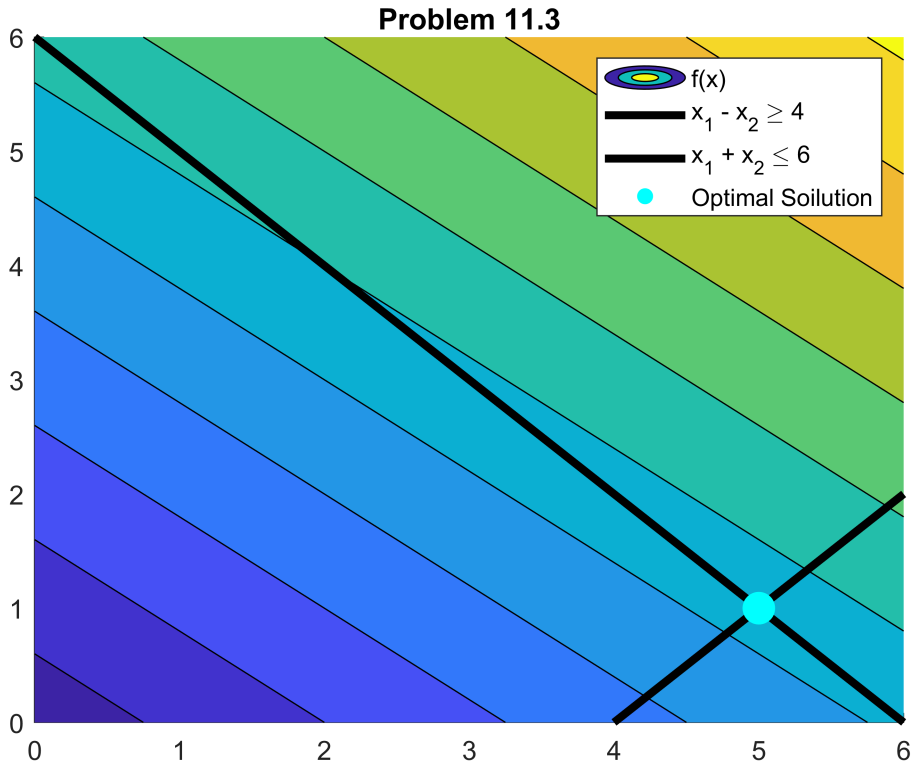
```
UB =

     []
```

```
% Plot F(x)
lb = 0;
ub = 6;
[X1,X2] = meshgrid(lb:0.1:ub, lb:0.1:ub);%3.5:0.1:6,0:0.1:2);
F = 8*X1 + 10*X2 + 4
```

```
F = 61×61
    4.0000    4.8000    5.6000    6.4000    7.2000    8.0000    8.8000    9.6000 ···
    5.0000    5.8000    6.6000    7.4000    8.2000    9.0000    9.8000   10.6000
    6.0000    6.8000    7.6000    8.4000    9.2000   10.0000   10.8000   11.6000
    7.0000    7.8000    8.6000    9.4000   10.2000   11.0000   11.8000   12.6000
    8.0000    8.8000    9.6000   10.4000   11.2000   12.0000   12.8000   13.6000
    9.0000    9.8000   10.6000   11.4000   12.2000   13.0000   13.8000   14.6000
```

```
   10.0000   10.8000   11.6000   12.4000   13.2000   14.0000   14.8000   15.6000
   11.0000   11.8000   12.6000   13.4000   14.2000   15.0000   15.8000   16.6000
   12.0000   12.8000   13.6000   14.4000   15.2000   16.0000   16.8000   17.6000
   13.0000   13.8000   14.6000   15.4000   16.2000   17.0000   17.8000   18.6000
      ⋮
      ⋮
```

```
figure()
hold on
contourf(X1, X2, F, 'DisplayName', 'f(x)')
fimplicit(@(x1,x2) x1 - x2 - 4, [lb,ub], ...
    'k', 'LineWidth', 3, ...
    'DisplayName', 'x_1 - x_2 \geq 4')
fimplicit(@(x1,x2) x1 + x2 - 6, [lb,ub], ...
    'k', 'LineWidth', 3, ...
    'DisplayName', 'x_1 + x_2 \leq 6')
scatter(5,1, 150, 'filled', 'c',...
    'DisplayName', 'Optimal Soilution')
legend
title('Problem 11.3')
```



Problem 11.4

```
F = [1;
     5;
     3]
```

```
F = 3×1
```

```
     1
     5
     3
```

```
A = [-1, 5, -3;
       5, 1, 2;
      -2, 1, 2;
       3, 8, 3]
```

```
A = 4×3
    -1     5    -3
     5     1     2
    -2     1     2
     3     8     3
```

```
b = [-1;
       5;
       4;
       3]
```

```
b = 4×1
    -1
     5
     4
     3
```

```
LB = [0; 0; -inf]
```

```
LB = 3×1
     0
     0
  -Inf
```

```
UB = []
```

```
UB =

     []
```

```

```

Problem 11.5

```
A = [1, 2, 2, 0;
     1, 1, 1 -1;
     0, 3, 1, 2]
```

```
A = 3×4
     1     2     2     0
     1     1     1    -1
     0     3     1     2
```

```
b = [4;
     1;
     6]
```

```
b = 3×1
```

```
     4
     1
     6
```

```
% Part a
n = size(A,1)
```

```
n = 3
```

```
m = rank(A)
```

```
m = 3
```

```
max_basic_sol = nchoosek(n,m)
```

```
max_basic_sol = 1
```

```
% Part b
rref_11_5 = rref([A,b])
```

```
rref_11_5 = 3×5
    1.0000         0         0   -2.0000   -2.0000
         0    1.0000         0    0.5000    1.5000
         0         0    1.0000    0.5000    1.5000
```

Problem 11.7

```
c = [1;
     -2]
```

```
c = 2×1
     1
    -2
```

```
A = [-4, 6;
       1, 1]
```

```
A = 2×2
    -4     6
     1     1
```

```
b = [9;
     4]
```

```
b = 2×1
     9
     4
```

```
syms f
T = [[A,eye(2),b];[c',zeros(1,2),f]]
```

T =

$$\begin{pmatrix} -4 & 6 & 1 & 0 & 9 \\ 1 & 1 & 0 & 1 & 4 \\ 1 & -2 & 0 & 0 & f \end{pmatrix}$$

```
R1 = T(1,:)
```

R1 = $\begin{pmatrix} -4 & 6 & 1 & 0 & 9 \end{pmatrix}$

```
R2 = T(2,:)
```

R2 = $\begin{pmatrix} 1 & 1 & 0 & 1 & 4 \end{pmatrix}$

```
R3 = T(3,:)
```

R3 = $\begin{pmatrix} 1 & -2 & 0 & 0 & f \end{pmatrix}$

```
R1 = R1/6
```

R1 =

$$\begin{pmatrix} -\frac{2}{3} & 1 & \frac{1}{6} & 0 & \frac{3}{2} \end{pmatrix}$$

```
T = [R1;R2;R3]
```

T =

$$\begin{pmatrix} -\frac{2}{3} & 1 & \frac{1}{6} & 0 & \frac{3}{2} \\ 1 & 1 & 0 & 1 & 4 \\ 1 & -2 & 0 & 0 & f \end{pmatrix}$$

```
R2 = (3/5)*(R2 - R1)
```

R2 =

$$\begin{pmatrix} 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \end{pmatrix}$$

```
T = [R1;R2;R3]
```

T =

$$\begin{pmatrix} -\frac{2}{3} & 1 & \frac{1}{6} & 0 & \frac{3}{2} \\ 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \\ 1 & -2 & 0 & 0 & f \end{pmatrix}$$

```
R1 = R1 + (2/3)*R2
```

R1 =

$$\begin{pmatrix} 0 & 1 & \frac{1}{10} & \frac{2}{5} & \frac{5}{2} \end{pmatrix}$$

```
T = [R1;R2;R3]
```

T =

$$\begin{pmatrix} 0 & 1 & \frac{1}{10} & \frac{2}{5} & \frac{5}{2} \\ 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \\ 1 & -2 & 0 & 0 & f \end{pmatrix}$$

```
R3 = R3 + 2*R1
```

R3 =

$$\begin{pmatrix} 1 & 0 & \frac{1}{5} & \frac{4}{5} & f+5 \end{pmatrix}$$

```
T = [R1;R2;R3]
```

T =

$$\begin{pmatrix} 0 & 1 & \frac{1}{10} & \frac{2}{5} & \frac{5}{2} \\ 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \\ 1 & 0 & \frac{1}{5} & \frac{4}{5} & f+5 \end{pmatrix}$$

```
R3 = R3 - R2
```

R3 =

$$\begin{pmatrix} 0 & 0 & \frac{3}{10} & \frac{1}{5} & f+\frac{7}{2} \end{pmatrix}$$

```
T = [R1;R2;R3]
```

T =

$$\begin{pmatrix} 0 & 1 & \frac{1}{10} & \frac{2}{5} & \frac{5}{2} \\ 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \\ 0 & 0 & \frac{3}{10} & \frac{1}{5} & f+\frac{7}{2} \end{pmatrix}$$

```
final_simplex_tbl = [T(2,:);T(1,:);T(3,:)]
```

final_simplex_tbl =

$$\begin{pmatrix} 1 & 0 & -\frac{1}{10} & \frac{3}{5} & \frac{3}{2} \\ 0 & 1 & \frac{1}{10} & \frac{2}{5} & \frac{5}{2} \\ 0 & 0 & \frac{3}{10} & \frac{1}{5} & f+\frac{7}{2} \end{pmatrix}$$

```
final_simplex_soln = final_simplex_tbl(1:2,5)
```

final_simplex_soln =

$$\begin{pmatrix} \frac{3}{2} \\ \frac{5}{2} \end{pmatrix}$$

```
final_simplex_value = c'*final_simplex_soln
```

final_simplex_value =

$$-\frac{7}{2}$$

Problem 11.8

```
c = [1;
     2;
    -7]
```

```
c = 3×1
     1
     2
    -7
```

```
A = [2, 1, 1;
    -1, 2,-1;
     1, 5, 5]
```

```
A = 3×3
     2     1     1
    -1     2    -1
     1     5     5
```

```
b = [15;
       7;
      25]
```

```
b = 3×1
    15
     7
```

25

```
syms f
T = [[A,eye(3),b];[c',zeros(1,3),f]]
```

T =

$$\begin{pmatrix} 2 & 1 & 1 & 1 & 0 & 0 & 15 \\ -1 & 2 & -1 & 0 & 1 & 0 & 7 \\ 1 & 5 & 5 & 0 & 0 & 1 & 25 \\ 1 & 2 & -7 & 0 & 0 & 0 & f \end{pmatrix}$$

```
R1 = T(1,:)
```

R1 = $\begin{pmatrix} 2 & 1 & 1 & 1 & 0 & 0 & 15 \end{pmatrix}$

```
R2 = T(2,:)
```

R2 = $\begin{pmatrix} -1 & 2 & -1 & 0 & 1 & 0 & 7 \end{pmatrix}$

```
R3 = T(3,:)
```

R3 = $\begin{pmatrix} 1 & 5 & 5 & 0 & 0 & 1 & 25 \end{pmatrix}$

```
R4 = T(4,:)
```

R4 = $\begin{pmatrix} 1 & 2 & -7 & 0 & 0 & 0 & f \end{pmatrix}$

```
T = [R1; R2; R3; R4]
```

T =

$$\begin{pmatrix} 2 & 1 & 1 & 1 & 0 & 0 & 15 \\ -1 & 2 & -1 & 0 & 1 & 0 & 7 \\ 1 & 5 & 5 & 0 & 0 & 1 & 25 \\ 1 & 2 & -7 & 0 & 0 & 0 & f \end{pmatrix}$$

```
R3 = R3/5
```

R3 =

$$\begin{pmatrix} \frac{1}{5} & 1 & 1 & 0 & 0 & \frac{1}{5} & 5 \end{pmatrix}$$

```
T = [R1; R2; R3; R4]
```

T =

$$\begin{pmatrix} 2 & 1 & 1 & 1 & 0 & 0 & 15 \\ -1 & 2 & -1 & 0 & 1 & 0 & 7 \\ \frac{1}{5} & 1 & 1 & 0 & 0 & \frac{1}{5} & 5 \\ 1 & 2 & -7 & 0 & 0 & 0 & f \end{pmatrix}$$

```
R1 = R1 - R3
```

R1 =

$$\begin{pmatrix} \frac{9}{5} & 0 & 0 & 1 & 0 & -\frac{1}{5} & 10 \end{pmatrix}$$

```
R2 = R2 + R3
```

R2 =

$$\begin{pmatrix} -\frac{4}{5} & 3 & 0 & 0 & 1 & \frac{1}{5} & 12 \end{pmatrix}$$

```
R4 = R4 + 7*R3
```

R4 =

$$\begin{pmatrix} \frac{12}{5} & 9 & 0 & 0 & 0 & \frac{7}{5} & f+35 \end{pmatrix}$$

```
T = [R1; R2; R3; R4]
```

T =

$$\begin{pmatrix} \frac{9}{5} & 0 & 0 & 1 & 0 & -\frac{1}{5} & 10 \\ -\frac{4}{5} & 3 & 0 & 0 & 1 & \frac{1}{5} & 12 \\ \frac{1}{5} & 1 & 1 & 0 & 0 & \frac{1}{5} & 5 \\ \frac{12}{5} & 9 & 0 & 0 & 0 & \frac{7}{5} & f+35 \end{pmatrix}$$

```
R1 = (5/9) * R1
```

R1 =

$$\begin{pmatrix} 1 & 0 & 0 & \frac{5}{9} & 0 & -\frac{1}{9} & \frac{50}{9} \end{pmatrix}$$

```
T = [R1;R2;R3;R4]
```

T =

$$\begin{pmatrix} 1 & 0 & 0 & \frac{5}{9} & 0 & -\frac{1}{9} & \frac{50}{9} \\ -\frac{4}{5} & 3 & 0 & 0 & 1 & \frac{1}{5} & 12 \\ \frac{1}{5} & 1 & 1 & 0 & 0 & \frac{1}{5} & 5 \\ \frac{12}{5} & 9 & 0 & 0 & 0 & \frac{7}{5} & f+35 \end{pmatrix}$$

```
R2 = (1/3)*( R2 + (4/5)*R1)
```

R2 =

$$\begin{pmatrix} 0 & 1 & 0 & \frac{4}{27} & \frac{1}{3} & \frac{1}{27} & \frac{148}{27} \end{pmatrix}$$

```
T = [R1;R2;R3;R4]
```

T =

$$\begin{pmatrix} 1 & 0 & 0 & \frac{5}{9} & 0 & -\frac{1}{9} & \frac{50}{9} \\ 0 & 1 & 0 & \frac{4}{27} & \frac{1}{3} & \frac{1}{27} & \frac{148}{27} \\ \frac{1}{5} & 1 & 1 & 0 & 0 & \frac{1}{5} & 5 \\ \frac{12}{5} & 9 & 0 & 0 & 0 & \frac{7}{5} & f+35 \end{pmatrix}$$

```
R3 = R3 - R1/5 -R2
```

R3 =

$$\begin{pmatrix} 0 & 0 & 1 & -\frac{7}{27} & -\frac{1}{3} & \frac{5}{27} & -\frac{43}{27} \end{pmatrix}$$

```
R4 = R4 - (12/5) * R1 - 9*R2
```

R4 =

$$\begin{pmatrix} 0 & 0 & 0 & -\frac{8}{3} & -3 & \frac{4}{3} & f-\frac{83}{3} \end{pmatrix}$$

```
T = [R1;R2;R3;R4]
```

T =

$$\begin{pmatrix} 1 & 0 & 0 & \frac{5}{9} & 0 & -\frac{1}{9} & \frac{50}{9} \\ 0 & 1 & 0 & \frac{4}{27} & \frac{1}{3} & \frac{1}{27} & \frac{148}{27} \\ 0 & 0 & 1 & -\frac{7}{27} & -\frac{1}{3} & \frac{5}{27} & -\frac{43}{27} \\ 0 & 0 & 0 & -\frac{8}{3} & -3 & \frac{4}{3} & f-\frac{83}{3} \end{pmatrix}$$

```
final_simplex_tbl = T
```

final_simplex_tbl =

$$\begin{pmatrix} 1 & 0 & 0 & \frac{5}{9} & 0 & -\frac{1}{9} & \frac{50}{9} \\ 0 & 1 & 0 & \frac{4}{27} & \frac{1}{3} & \frac{1}{27} & \frac{148}{27} \\ 0 & 0 & 1 & -\frac{7}{27} & -\frac{1}{3} & \frac{5}{27} & -\frac{43}{27} \\ 0 & 0 & 0 & -\frac{8}{3} & -3 & \frac{4}{3} & f-\frac{83}{3} \end{pmatrix}$$

```
final_simplex_soln = T(1:3,7)
```

final_simplex_soln =

$$\begin{pmatrix} \frac{50}{9} \\ \frac{148}{27} \\ -\frac{43}{27} \end{pmatrix}$$

```
final_simplex_value = c'*final_simplex_soln
```

final_simplex_value =

$$\frac{83}{3}$$