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CLASS: CO16

OT LAB ASSIGNMENT 2-3

Q1 Solve the problem using graphical method. Write MATLAB code and find the optimal solution.

$$\text{Maximize} \quad Z = 6x_1 + 11x_2$$

$$\begin{aligned} \text{s.t.} \quad 2x_1 + x_2 &\leq 104, \\ x_1 + 2x_2 &\leq 76, \\ x_1, x_2 &\geq 0 \end{aligned}$$

Code:

```
%% QUESTION 1: Graphical method to solve
% Max Z= 6x1+11x2
% 2x1+x2<=104
% x1+2x2<=76
% x2>=0
% x1>=0
clc
clear all
format short
%INPUT PARAMETERS
c=[6,11]; %cost objective function
A=[2,1;1,2;0,1;1,0];
B=[104;76;0;0];
n=size(A,1);
x1=0:0.01:max(B);

for i=1:n-2 %we take n-2 since we are also taking x1=0 and x2=0 as they have no significance in our graph
    y(i,:)=(B(i)-A(i,1)*x1)/A(i,2);
end

%DRAWING THE LINES
for i=1:n-2
    y(i,:)=max(0,y(i,:));
    plot(x1,y(i,:),'linewidth',4)
    hold on
end
hold on
%FINDING THE POINT OF INTERSECTION
pt=[0;0];
for i=1:size(A,1)
    A1=A(i,:);
    B1=B(i,:);
    for j=i+1:size(A,1)
        A2=A(j,:);
        B2=B(j,:);
        A3=[A1;A2];
        B3=[B1;B2];
        %X3=inv(A3)*B3
        X3=A3\B3;
        if(X3>=0)%since the number of chairs can never be negative
            pt= [pt X3];
        end
    end
```

```
end
X=pt';
X=unique(X,'rows')%solution
hold on
% KEEP ONLY FEASIBLE POINTS
x1=X(:,1);
x2=X(:,2);

for i=1:n-2
    ind=find(A(i,:)*X'>B(i));
    X(ind,:)=[];
end

% EVALUATE THE OBJECTIVE FUNCTION VALUE
obj_val=c*X';
[value, ind]=max(obj_val);
value;
X(ind,:);
Optimal=[X(ind,:) value]
Optimal_Coordinates = X(ind,:)
Optimal_Value= value
% Shaded feasible region
x=X(:,1);
y=X(:,2);
scatter(X(:,1),X(:,2),'*')
hold on
k=convhull(x,y);%the shaded region where a and y is satisfied
fill(x(k),y(k),'m')

% setting the axes
xlim([0 max(x)+1])
ylim([0 max(y)+1])

xlabel('x-axis')
ylabel('y-axis')
title('Feasible region of the linear programming problem')
legend('2x_1+x_2\leq104','x_1+2x_2\leq76','x_1,x_2\geq0')
```

Output:

```
X =

     0     0
     0    38
     0   104
    44    16
    52     0
    76     0


Optimal =

    44    16   440


Optimal_Coordinates =

    44    16


Optimal_Value =

   440
```

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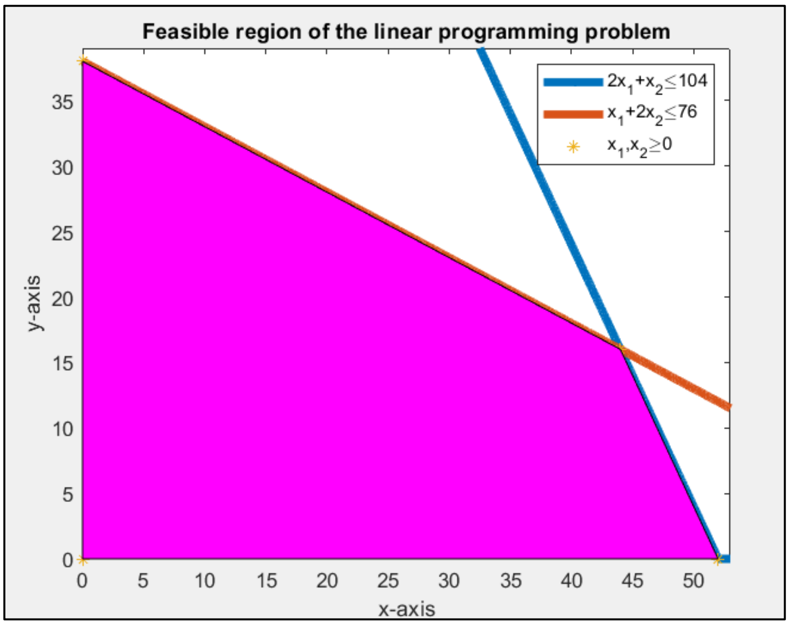
Graph:



Q2 Solve the problem using graphical method. Write MATLAB code and find the optimal solution.

$$\text{Maximize} \quad Z = 5x_1 + 8x_2$$

$$\begin{aligned} \text{s.t.} \quad x_1 + 2x_2 &\leq 200, \\ x_1 + x_2 &\leq 150, \\ x_2 &\leq 60, \\ x_1, x_2 &\geq 0 \end{aligned}$$

Code:

```
%% QUESTION 2: Graphical method to solve
% Max Z= 5x1+8x2
% 2x1+x2<=200
% x1+2x2<=150
% x2<=60
% x1,x2>=0
clc
clear all
format short
%INPUT PARAMETERS
c=[5,8]; %cost objective function
A=[1,2;1,1;0,1;1,0;0,1];
B=[200;150;60;0;0];
n=size(A,1);
x1=0:0.01:max(B);

for i=1:n-2 %we take n-2 since we are also taking x1=0 and x2=0 as they have no
significance in our graph
```

```
    y(i,:)=(B(i)-A(i,1)*x1)/A(i,2);
end

%DRAWING THE LINES
for i=1:n-2
    y(i,:)=max(0,y(i,:));
    plot(x1,y(i,:),'linewidth',4)
    hold on
end
hold on
%FINDING THE POINT OF INTERSECTION
pt=[0;0];
for i=1:size(A,1)
    A1=A(i,:);
    B1=B(i,:);
    for j=i+1:size(A,1)
        A2=A(j,:);
        B2=B(j,:);
        A3=[A1;A2];
        B3=[B1;B2];
        %X3=inv(A3)*B3
        X3=A3\B3;
        if(X3>=0)%since the number of chairs can never be negative
            pt= [pt X3];
        end
    end
end

X=pt';
X=unique(X,'rows')%solution
hold on

% KEEP ONLY FEASIBLE POINTS
x1=X(:,1);
x2=X(:,2);

for i=1:n-2
    ind=find(A(i,:)*X'>B(i));
    X(ind,:)=[];
end

% EVALUATE THE OBJECTIVE FUNCTION VALUE
obj_val=c*X';
[value, ind]=max(obj_val);
value;
X(ind,:);
Optimal=[X(ind,:) value]
Optimal_Coordinates=X(ind, :)
Optimal_Value= value

% Shaded feasible region
x=X(:,1);
y=X(:,2);
scatter(X(:,1),X(:,2),'*')
hold on
k=convhull(x,y);%the shaded region where a and y is satisfied
fill(x(k),y(k),'m')

% setting the axes
```

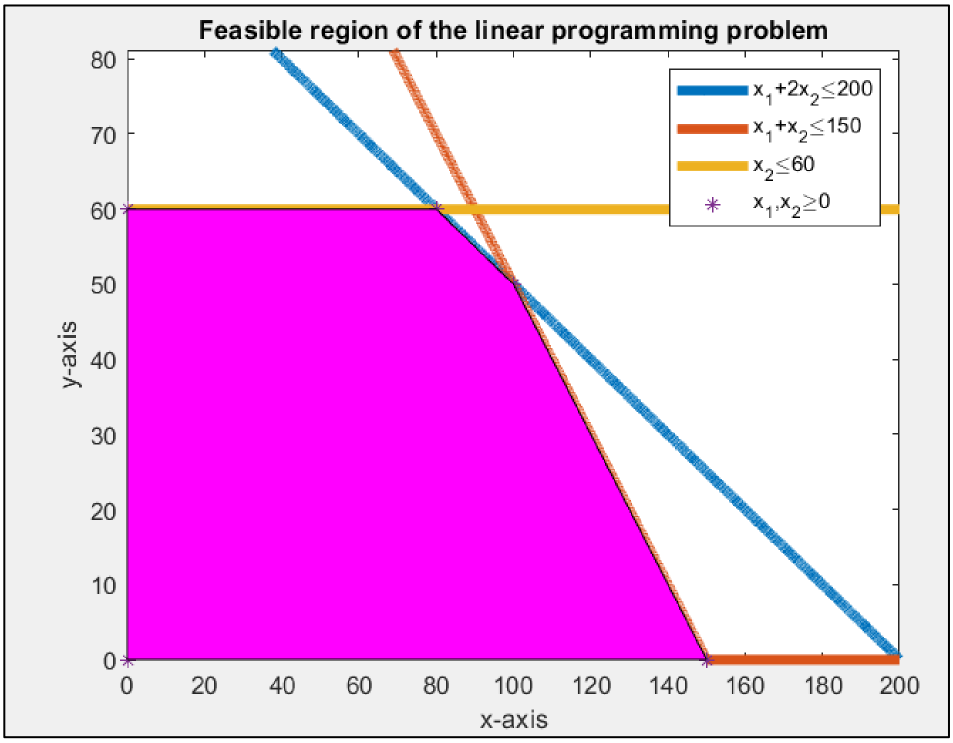
NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

```
xlim([0 max(x)+1])
ylim([0 max(y)+1])

xlabel('x-axis')
ylabel('y-axis')
title('Feasible region of the linear programming problem')
legend('x_1+2x_2\leq200','x_1+x_2\leq150','x_2\leq60', 'x_1,x_2\geq0')
```

Output:

```
X =

     0     0
     0    60
     0   100
     0   150
    80    60
    90    60
   100    50
   150     0
   200     0
   Inf     0


Optimal =

   100    50   900


Optimal_Coordinates =

   100    50


Optimal_Value =

   900
```

Graph:



NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

Q3 Solve the problem using graphical method. Write MATLAB code and find the optimal solution.

$$\text{Maximize} \quad Z = 5x_2 - x_1$$

$$\begin{aligned} \text{s.t.} \quad x_1 + x_2 &\leq 2, \\ 2x_1 + 5x_2 &\leq 8, \\ x_1, x_2 &\geq 0 \end{aligned}$$

Code:

```
%% QUESTION 3: Graphical method to solve
% Max Z= 5x1-x2
% x1+x2<=2
% 2x1+5x2<=8
% x2>=0
% x1>=0
clc
clear all
format short
%INPUT PARAMETERS
c=[5,-1]; %cost objective function
A=[1,1;2,5;1,0;0,1];
B=[2;8;0;0];
n=size(A,1);
x1=0:0.01:max(B);

for i=1:n-2 %we take n-2 since we are also taking x1=0 and x2=0 as they have no significance in our graph
    y(i,:)=(B(i)-A(i,1)*x1)/A(i,2);
end

%DRAWING THE LINES
for i=1:n-2
    y(i,:)=max(0,y(i,:));
    plot(x1,y(i,:),'linewidth',4)
    hold on
end
hold on
%FINDING THE POINT OF INTERSECTION
pt=[0;0];
for i=1:size(A,1)
    A1=A(i,:);
    B1=B(i,:);
    for j=i+1:size(A,1)
        A2=A(j,:);
        B2=B(j,:);
        A3=[A1;A2];
        B3=[B1;B2];
        %X3=inv(A3)*B3
        X3=A3\B3;
        if(X3>=0)%since the number of chairs can never be negative
            pt= [pt X3];
        end
    end
end
```

NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

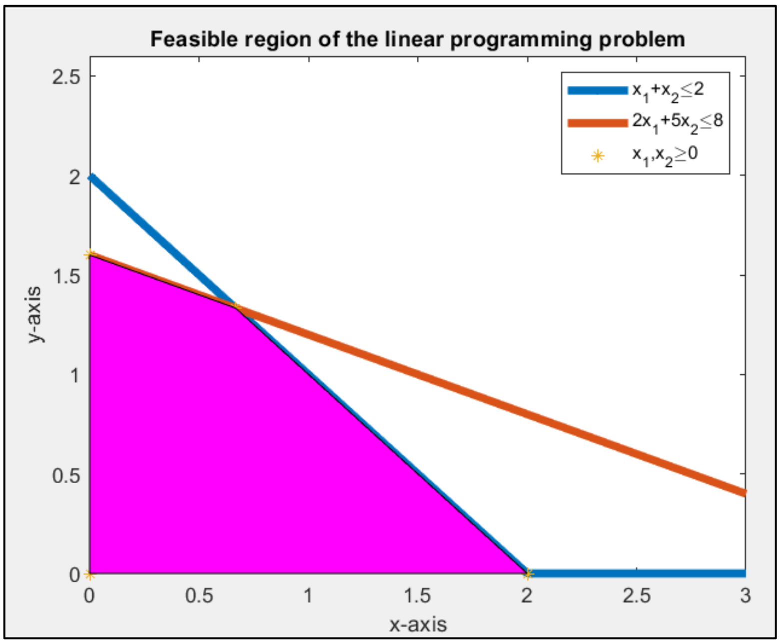
```
X=pt';
X=unique(X,'rows')%solution
hold on

% KEEP ONLY FEASIBLE POINTS
x1=X(:,1);
x2=X(:,2);

for i=1:n-2
    ind=find(A(i,:)*X'>B(i));
    X(ind,:)=[];
end

% EVALUATE THE OBJECTIVE FUNCTION VALUE
obj_val=c*X';
[value, ind]=max(obj_val);
value;
X(ind,:);
Optimal=[X(ind,:) value]
Optimal_Coordinates=X(ind,:)
Optimal_Value= value
% Shaded feasible region
x=X(:,1);
y=X(:,2);
scatter(X(:,1),X(:,2),'*')
hold on
k=convhull(x,y);%the shaded region where a and y is satisfied
fill(x(k),y(k),'m')

% setting the axes
xlim([0 max(x)+1])
ylim([0 max(y)+1])

xlabel('x-axis')
ylabel('y-axis')
title('Feasible region of the linear programming problem')
legend('x_1+x_2\leq2','2x_1+5x_2\leq8', 'x_1,x_2\geq0')
```

Output:

```
X =

         0         0
         0    1.6000
         0    2.0000
    0.6667    1.3333
    2.0000         0
    4.0000         0


Optimal =

     2     0    10


Optimal_Coordinates =

     2     0


Optimal_Value =

    10
```

NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

Graph:



Q4 Solve the problem using graphical method. Write MATLAB code and find the optimal solution.

$$\text{Minimize} \quad Z = 40x_1 + 24x_2$$

$$\begin{aligned} \text{s.t.} \quad 20x_1 + 50x_2 &\geq 480, \\ 80x_1 + 50x_2 &\geq 720, \\ x_1, x_2 &\geq 0 \end{aligned}$$

Code:

```
%% QUESTION 4: Graphical method to solve
% Min Z= 40x1+24x2
% 20x1+50x2>=480
% 80x1+50x2>=720
% x2>=0
% x1>=0
clc
clear all
format short
%INPUT PARAMETERS
c=[40,24]; %cost objective function
A=[20,50;80,50;0,1;1,0];
B=[480;720;0;0];
n=size(A,1);
x1=0:0.01:max(B);

for i=1:n-2 %we take n-2 since we are also taking x1=0 and x2=0 as they have no
significance in our graph
    y(i,:)=(B(i)-A(i,1)*x1)/A(i,2);
```

NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

```
end

%DRAWING THE LINES
for i=1:n-2
    y(i,:)=max(0,y(i,:));
    plot(x1,y(i,:),'linewidth',4)
    hold on
end
hold on
%FINDING THE POINT OF INTERSECTION
pt=[0;0];
for i=1:size(A,1)
    A1=A(i,:);
    B1=B(i,:);
    for j=i+1:size(A,1)
        A2=A(j,:);
        B2=B(j,:);
        A3=[A1;A2];
        B3=[B1;B2];
        %X3=inv(A3)*B3
        X3=A3\B3;
        if(X3>=0)%since the number of chairs can never be negative
            pt= [pt X3];
        end
    end
end

X=pt';
X=unique(X,'rows')%solution
hold on

% KEEP ONLY FEASIBLE POINTS
x1=X(:,1);
x2=X(:,2);

for i=1:n-2
    ind=find(A(i,:)*X'<B(i));
    X(ind,:)=[];
end

% EVALUATE THE OBJECTIVE FUNCTION VALUE
obj_val=c*X';
[value, ind]=min(obj_val);
value;
X(ind,:);
Optimal=[X(ind,:) value]
Optimal_Coordinates=X(ind,:)
Optimal_Value=value

% Shaded feasible region
x=X(:,1);
y=X(:,2);
scatter(X(:,1),X(:,2),'*')
hold on
k=convhull(x,y);%the shaded region where a and y is satisfied
fill(x(k),y(k),'m')

% setting the axes
xlim([0 max(x)+1])
```

NAME: Shreeya Chatterji
ROLL NO: 102103447
CLASS: CO16

```
ylim([0 max(y)+1])

xlabel('x-axis')
ylabel('y-axis')
title('Feasible region of the linear programming problem')
legend('20x_1+50x_2\geq480','80x_1+50x_2\geq720', 'x_1,x_2\geq0')
```

Output:

```
X =

         0         0
         0    9.6000
         0   14.4000
    4.0000    8.0000
    9.0000         0
   24.0000         0


Optimal =

         0   14.4000  345.6000


Optimal_Coordinates =

         0   14.4000


Optimal_Value =

  345.6000
```

Graph: