23MAT204 – Mathematics for Intelligent Systems - 3
Practise Sheet-10
(Feasible Region)

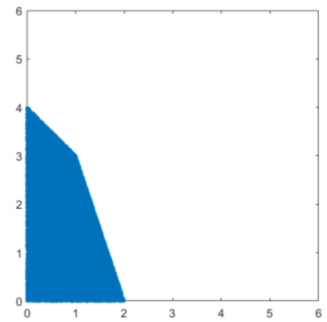
Plotting the feasible region of a constrained optimization problem:

Example 1:

If constraints of the Optimization problem are: $x + y \leq 4, 3x + y \leq 6, x \geq 0, y \geq 0$, plot the feasible region

```
N=200000; % number (x,y) points in domain
x = rand(N,1)*6; % generates values in (0,6)
y = rand(N,1)*6; % generates values in (0,6)
f1 = x+y-4;  % An array of N fn values in domain
ind1 = (f1<0); % An N array of logical 0s and 1s
f2 = 3*x+y-6; % An array of N fn values in domain
ind2 = (f2<0); % An N_array of logical 0s and 1s
ind3=and(ind1,ind2); % An N_array of logical 0s and 1s
a = [x(ind3),y(ind3)];% points which are in feasible
region
figure
plot(a(:,1),a(:,2),'.','MarkerSize',10);
axis equal
xlim([0 6])
ylim([0 6])
```

Output:



```
%third and forth constarints, x and y are positive are already considered since by using 'rand'
command, we randomly generate points only between 0 and 1.
```

Note:
If we have to generate x in the interval (a,b), the formula to be used is:

$$x = a + (b - a)rand(N, 1)$$

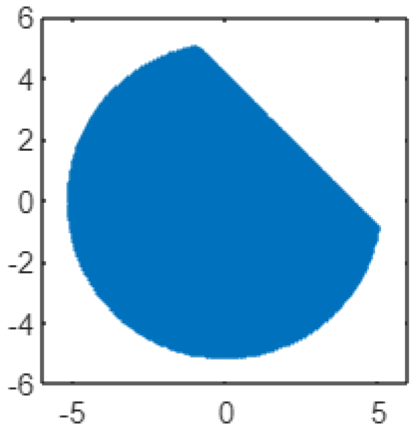
In previous example x and y were generated from (0,6), hence a=0, b=6 in above formula was used.

Example 2:

Plot the region: $x + y \leq 4,\ x^2 + y^2 \leq 25$

```
N=200000; % number (x,y) points in domain
x = -6+12*rand(N,1); % generates values in (-6,6)
y = -6+12*rand(N,1); % generates values in (-6,6)
f1 = x+y-4;  % An array of N fn values in domain
ind1 = (f1<0); % An N array of logical 0s and 1s
f2 = x.^2+y.^2-25; % An array of N fn values in domain
ind2 = (f2<0); % An N_array of logical 0s and 1s
ind3=and(ind1,ind2); % An N_array of logical 0s and 1s
a = [x(ind3),y(ind3)];% points which are in feasible region
figure
plot(a(:,1),a(:,2),'.','MarkerSize',10);
axis equal
xlim([-6 6])
ylim([-6 6])
```

Output:



Practice questions:

1. Plot the following regions using MATLAB.

(a) $3x + y \leq 1$
$2x - 3y \leq 3$
$x \geq 0, y \geq 0$

(b) $\frac{x^2}{1} + \frac{y^2}{4} \leq 1$
$x + y \leq 1$

(c) $x + y \leq 4$
$2x + x^2 + y^2 \leq 15$
$x \geq 0, y \geq 0$

(d) $x^2 + y^2 = 1$
$x + y \geq 1$

(e) $x^2 + y^2 \leq 1$
$x + y \geq 1$

(f) $(x-1)^2 + (y-1)^2 \leq 1$
$x \leq 1$
$y \leq 1$

2. Draw the feasible region for the given problems. Also mention the points where the optimum will exist

(a) Maximize $-6x + 9y$
$\textit{subject to } \ x - y \leq 2$
$3x + y \leq 1$
$2x - 3y \leq 3$

(b) Minimize x+y
$\textit{subject to } \ x + y \leq 4$
$2x + x^2 + y^2 \leq 15$

(c) Minimize x+y
$\textit{subject to } \ x^2 - y \leq 0$
$y^2 - x \leq 0$