Assignment 1
Of
Modelling & Simulation Lab (CS1052)

Masters of Technology in Computer Science And Engineering

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Problem statement 1

A firm manufactures two products A and B on which the profits earned per unit are ₹ 3 and ₹ 4 respectively. Each product is processed on two machines M1 and M2. Product A requires one minute of processing time on M_1 and two minutes on M_2, while B requires one minute on M_1 and one minute on M_2. Machine M_1 is available for not more than 1 hr 30 min while machine M_2 is available for 10 hr during any working day. Find the number of units of products A and B to be manufactured to get maximum profit.

Problem formulation :-

Let x and y be no. of production of product A and B respectively

the profit of product A is ₹ 3

and the profit of product B is ₹ 4

the total profit over the product is

$$z = 3x + 4y$$

objective of the function is to maximize the profit

i.e Maximise $(z) = 3x + 4y$

if M_1 machine is used,

$$x + y \leq 450 \quad \text{——} \ (1)$$

if M_2 machine is used,

$$2x + y \leq 600 \quad \text{——} \ (2)$$

<u>Solutions</u> :-

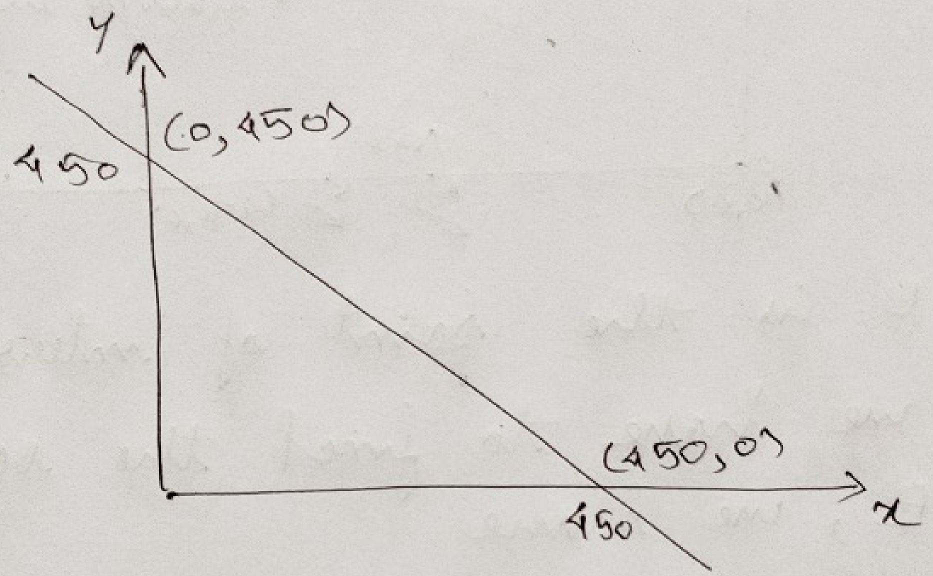
Co-ordinates for line $x + y = 450$

when $x = 450$, $y = 0$

and when we put ~~y=0~~, $x=0$

$$\cancel{x}=450 \longrightarrow (0, 450)$$

the graph is,



from equation 2, similarly

when $x=0$, we get

$$2 \cdot 0 + y = 600$$

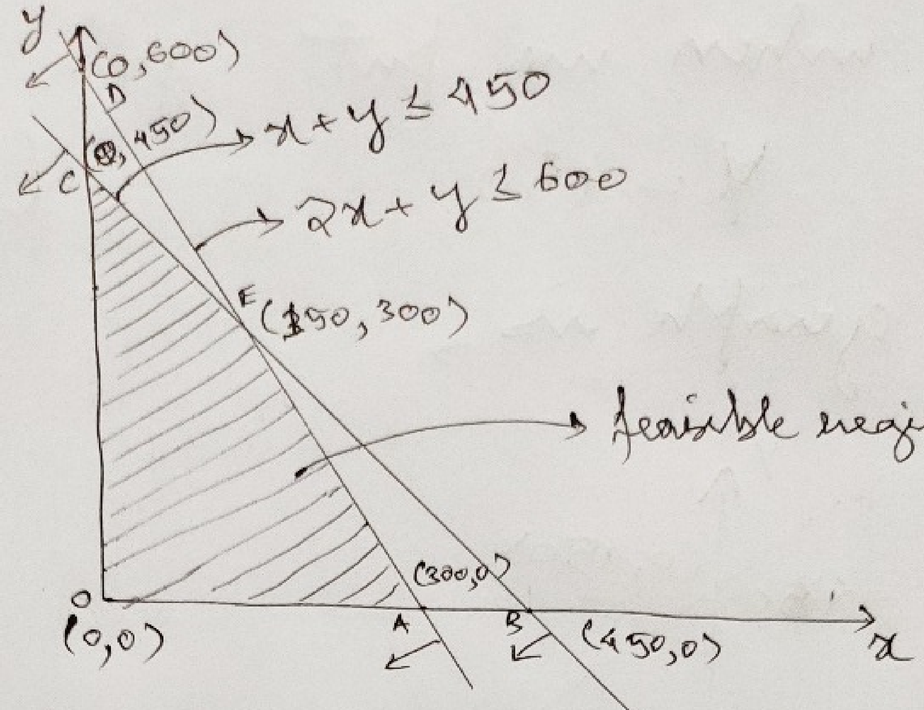
$$y = 600 \longrightarrow (0, 600)$$

when $y=0$, we get

$$2 \cdot x + 0 = 600$$

$$x = 300 \longrightarrow (300, 0)$$

After making the graph, we get the feasible region which is the shaded region.



Here, E is the point of intersection

Now, we have to find the coordinate for E, we have

$$x + y = 450$$
$$2x + y = 600$$
$$- \quad - \quad -$$
$$\overline{-x = -150}$$
$$\boxed{\therefore x = 150}$$

$$\Rightarrow 150 + y = 450$$
$$\therefore y = 300 \rightarrow (150, 300)$$

Now, the value of objective function at the corner points are :-

$Z(O) = 3\times 0 + 4\times 0 = 0$

$Z(A) = 3\times 300 + 4\times 0 = 900$

$\cancel{Z(B) = 3\times 450 + 4\times 0 =}$

$Z(C) = 3\times 0 + 4\times 450 = 1800 \leftarrow$ maximum

$Z(E) = 3\times 150 + 4\times 300 = 1650$

Therefore Z is maximum at

corner points C(0, 450)

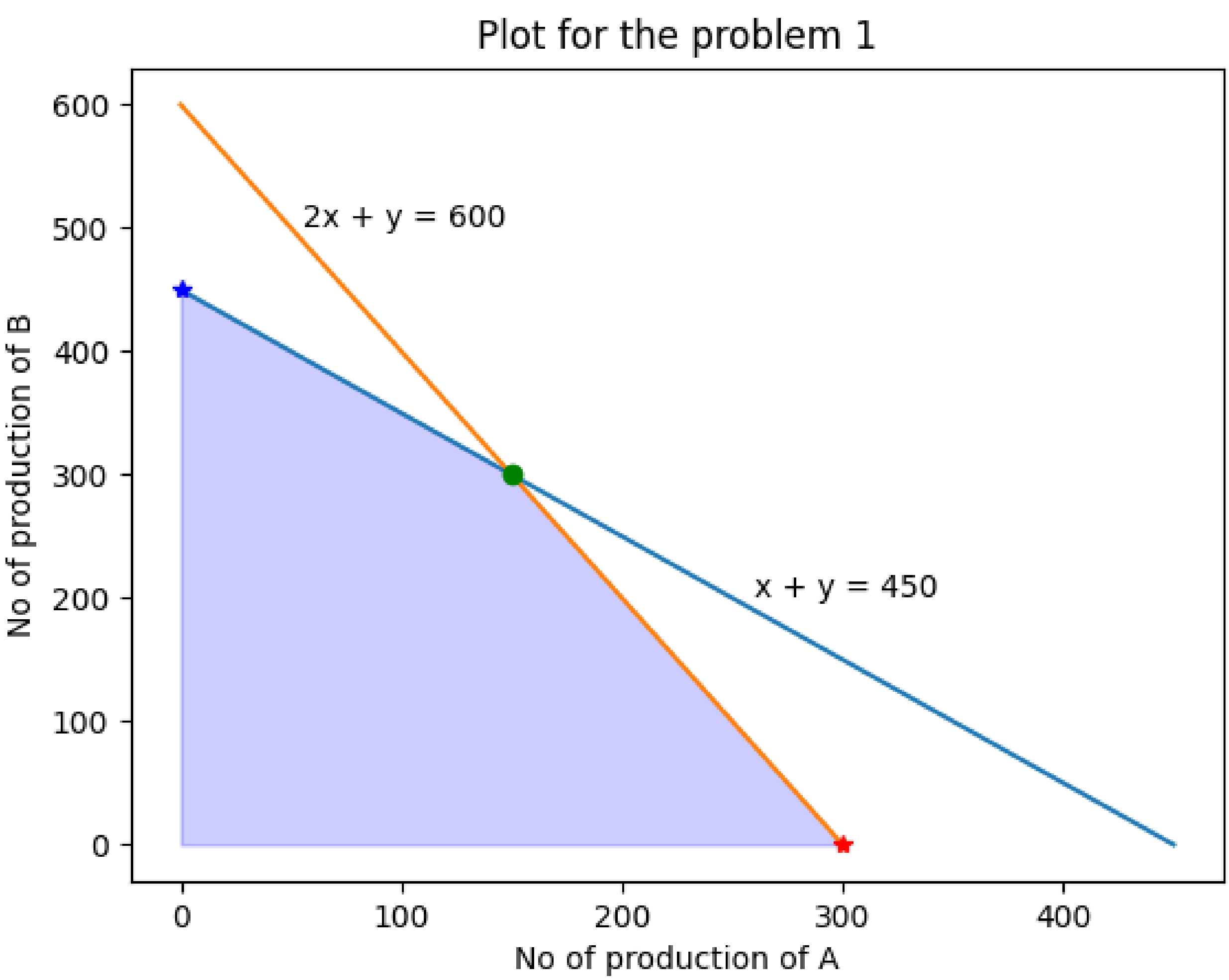
Hence the firm will earn a maximum profit of ₹1800 if it manufactures 450 units of product B and 0 units of product A i.e doesn't manufactures product A at all.

Python Code:

```
from shapely.geometry import LineString
from matplotlib import pyplot as plt

# main function
if __name__ == '__main__':

        # The end point coordinates of the line for the equation 1
        x1 = [450, 0]
        y1 = [0, 450]

        # Plots the line for the equation 1
        plt.plot(x1, y1)

        # The end point coordinates of the line for the equation 2
        x2 = [300, 0]
        y2 = [0, 600]

        # Plots the line for the equation 2
        plt.plot(x2, y2)

        # Labels the axis and the plot
        plt.xlabel('No of production of A')
        plt.ylabel('No of production of B')
        plt.title('Plot for the problem 1')

        # Create the lines using the coordinates
        line1 = LineString([(450, 0), (0, 450)])
        line2 = LineString([(300, 0), (0, 600)])

        # Calculates the intersection and assigns it to the variable
        intersection = line1.intersection(line2)

        # Places a green colored circular disc on the coordinate specified
        plt.plot(*intersection.xy, 'go')

        # Places a blue colored star on the coordinate specified
        plt.plot(0, 450, 'b*')

        # Places a red colored star on the coordinate specified
        plt.plot(300, 0, 'r*')

        # Calculates the feasible regions dimensions
        p1, q1 = intersection.xy
        x = []
        y = []
        x.append(0)
        x.append(round(p1[0]))
        x.append(300)
        y.append(450)
        y.append(round(q1[0]))
        y.append(0)
```

```
# Shades the feasible region
plt.fill_between(x, y, color='blue', alpha=0.2)
plt.text(260, 200, "x + y = 450")
plt.text(55, 500, "2x + y = 600")

# Opens the dialog showing the plot
plt.show()
print("Point of Intersection 1: ")
print(p1[0])
print(q1[0])
z = []
for i in range(len(x)):
        eqn = 3 * x[i] + 4 * y[i]
        z.append(eqn)
        print("Z = ", z)
max_val = max(z)
xy_index = z.index(max_val)
print("The Value of Z ", max_val,
        " at point (", x[xy_index],
        ",", y[xy_index], ")")
```

Output:



Problem statement ?

Egg contains 6 units of vitamin A per gram and 7 units of vitamin B per gram and costs 12 paisa per gram. Milk contains 8 units of vitamins A per gram and 12 units of vitamin B per gram and costs 20 paisa per gram. The daily minimum A & B is 100 unit & 120 units. Formulate the LPP and find the optimal solution by graphical method.

Problem formulation

Amount of vitamin $A \geq 100$ unit

amount of vitamin $B \geq 120$ unit

Lets take. x gm of Egg

and y gm of milk.

vitamin A content $= 6x + 8y \geq 100$ — ①

vitamin B content $= 7x + 12y \geq 120$ — ②

cost of food $(C) = 12x + 20y$

$x \geq 0$, $y \geq 0$

Solution :-

from eqn ① →

when $x=0$, $y = 100/8 = 25/2$ $(0, 25/2)$

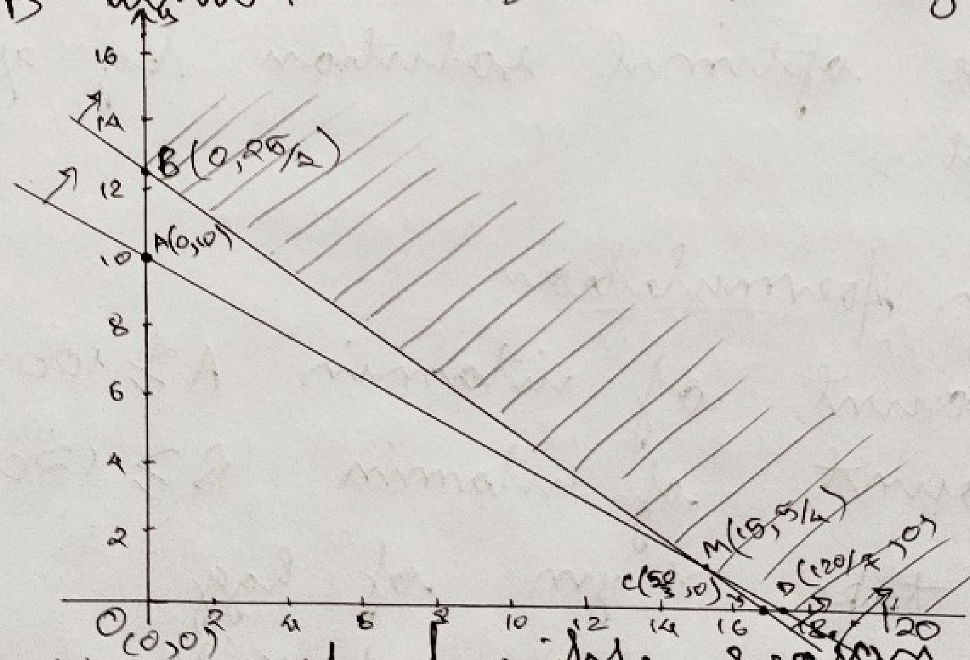
for $y=0$, $x = 100/6 = 50/3$ $(50/3, 0)$

from eqn ② →

when $x=0$, $y = 120/12 = 10$ $(0, 10)$

when $y=0$, $x = 120/7$ $(120/7, 0)$

Feasible unbound region is BMD which is shaded in graph.



vertices of feasible region

$B(0, 25/2)$, $D(120/7, 0)$

M is point of intersection of the lines

$$6x + 8y \geq 100 \quad \times 3 \qquad 18x + 24y = 300$$

$$7x + 12y \geq 120 \quad \times 2 \qquad \underline{-14x \mp 24y = -240}$$

$$4x = 60$$

hence $x = 15 \Rightarrow 6 \times 15 + 8y = 100$

$$y = \frac{10}{8} = \frac{5}{4}$$

$M\left(15, \frac{5}{4}\right)$

Objective function $z = 12x + 20y$

cost at $B\left(0, \frac{25}{2}\right) = 12 \times 0 + \frac{25}{2} \times 20$

$= 250$ paise

cost at $D\left(\frac{120}{7}, 0\right) = \frac{120}{7} \times 12 + 20(0)$

$= 205.7$ paise

Cost at $M\left(15, \frac{5}{4}\right) = 12(15) + \frac{20 \times 5}{4}$

$= 205$ paise

Minimum cost for the diet = 205 paise in which 15 are eggs and 1.25 of milk.

Python Code:

```
from shapely.geometry import LineString
from matplotlib import pyplot as plt

# main function
if __name__ == '__main__':

        # The end point coordinates of the line for the equation 1
        x1 = [0,16.66]
        y1 = [12.5,0]

        # Plots the line for the equation 1
        plt.plot(x1, y1)

        # The end point coordinates of the line for the equation 2
        x2 = [17.14,0]
        y2 = [0,10]

        # Plots the line for the equation 2
        plt.plot(x2, y2)

        # Labels the axis and the plot
        plt.xlabel('Amount of Eggs in gms')
        plt.ylabel('Amount of Milk in gms')
        plt.title('Plot for the problem 2')

        # Create the lines using the coordinates
        line1 = LineString([(16.66,0),(0,12.5)])
        line2 = LineString([(17.14,0),(0,10)])

        # Calculates the intersection and assigns it to the variable
        # Places a green colored circular disc on the coordinate specified
        plt.plot(*intersection.xy, 'go')

        # Places a blue colored star on the coordinate specified
        plt.plot(0,12.5,'b*')
        plt.plot(17.14,0,'r*')

        # Calculates the feasible regions dimensions
        p1, q1 = intersection.xy
        x = []
        y = []
        x.append(0)
        x.append(round(p1[0],2))
        x.append(17.14)
        y.append(12.5)
        y.append(round(q1[0],2))
        y.append(0)

        # Shades the feasible region
        plt.fill_between(x,y,max(y),color='blue',alpha=0.2)
        plt.text(7,8,"6x + 8y = 100")
```

```
plt.text(3,5,"7x + 12y = 120")

# Opens the dialog showing the plot
plt.show()
print("Point of Intersection 1: ")
print(round(p1[0],2))
print(round(q1[0],2))
z=[]
for i in range(len(x)):
        eqn = 12*x[i] + 20*y[i]
        z.append(round(eqn,2))
        print("Z = ",z)
min_val = min(z)
xy_index = z.index(min_val)
print("The Value of Z ",min_val,
        " at point (",x[xy_index],
        ",",y[xy_index],")")
```

Output: