LINEAR INEQUATIONS

Inequations :- A statement which involves variable and sign of inequality viz. $>, <, \geq$ or $\leq$ is an inequation.

Solution of inequation: A solution of an inequation is the value of the variable, which makes it true statement.

Linear inequation: A inequation is said to be linear if each term of the algebric expression of the inequation contain variable of the first degree and does not involving the products of the variable.

Exercise 6.1

Q1 Solve : $24x < 100$, when

(i) x is a natural numbers

(ii) x is an integer.

Sol: We have $24x < 100$ —(1)

$\Rightarrow x < \frac{100}{24} = \frac{25}{6}$

(i) Solution set is $\{1,2,3,4\}$

(ii) Solution set is

$\{\dots -1,0,1,2,3,4\}$

Q2: Solve : $-12x > 30$

Solution: $-12x > 30$

$\Rightarrow x < \frac{30}{-12}$

$\Rightarrow x < -\frac{5}{2}$

(i) x is a natural number

$x = \{\phi\}$

(ii) x is an integer

$x = \{\dots, -4, -3\}$.

Q3. Solve: $5x - 3 < 7$

Sol: $5x - 3 < 7$

$5x < 7 + 3$

$5x < 10$

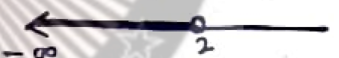
$x < \frac{10}{5} \Rightarrow x < 2$.

(i) x is an integer

$x = \{\dots, -2, -1, 0, 1\}$

(ii) x is a real numbers

Solution set $x = (-\infty, 2)$



Q4. Solve $3x + 8 > 2$

Sol: $3x + 8 > 2$

$3x > 2 - 8$

$3x > -6$

$x > -\frac{6}{3} \Rightarrow x > -2$

(i) Solution set is $\{-1, 0, 1, 2, 3 \dots\}$

(ii) x is a real numbers

Solution set is $(-2, \infty)$

Solve the inequalities in for real x.

(5) $4x+3<6x+7$

Sol $4x-6x<7-3$

$-2x<4$

$x>\frac{4}{-2} \Rightarrow x>-2$

Solution set is $(-2,\infty)$

(6) $3x-7>5x-1$

Sol: $3x-5x>-1+7$

$-2x>6$

$x<\frac{6}{-2} \Rightarrow x<-3$

Solution set is $\cancel{x}$ $(-\infty,-3)$

(7) $3(x-1)\leq 2(x-3)$

Sol: $3x-3\leq 2x-6$

$\Rightarrow 3x-2x\leq -6+3$

$\Rightarrow x\leq -3$

Solution set is $(-\infty,-3]$

(8) $3(2-x)\geq 2(1-x)$

Sol: $6-3x\geq 2-2x$

$-3x+2x\geq 2-6$

$-x\geq -4 \Rightarrow x\leq 4.$

Solution set is $(-\infty,4]$

Q9. $x+\frac{x}{2}+\frac{x}{3}<11$

Sol: $x+\frac{x}{2}+\frac{x}{3}<11$

$\Rightarrow \frac{6x+3x+2x}{6}<11$

$\Rightarrow \frac{11x}{6}<11 \Rightarrow x<6$

Solution is $(-\infty,6)$

Q10: $\frac{x}{3}>\frac{x}{2}+1$

Sol: $\frac{x}{3}-\frac{x}{2}>1 \Rightarrow \frac{1}{6}(2x-3x)>1$

$\Rightarrow -\frac{x}{6}>1 \Rightarrow x<-6$

Solution set is $(-\infty,-6)$

Q11. $\frac{3(x-2)}{5}\leq\frac{5(2-x)}{3}$

Sol: $9(x-2)\leq 25(2-x)$

$\Rightarrow 9x-18\leq 50-25x$

$\Rightarrow 9x+25x\leq 50+18$

$\Rightarrow 34x\leq 68 \Rightarrow x\leq 2.$

Hence solution is $(-\infty,2]$.

Q12. $\frac{1}{2}\left(\frac{3x}{5}+4\right)\geq\frac{1}{3}(x-6)$

Sol: $\frac{1}{2}\left(\frac{3x+20}{5}\right)\geq\frac{1}{3}(x-6)$

$\Rightarrow 3(3x+20)\geq 10(x-6)$

$\Rightarrow 9x+60\geq 10x-60$

$\Rightarrow 9x-10x\geq -60-60$

$\Rightarrow -x\geq -120 \Rightarrow x\leq 120.$

Q13: $2(2x+3)-10<6(x-2)$

Sol. $4x+6-10<6x-12$

$\Rightarrow 4x-4<6x-12$

$\Rightarrow 4x-6x<-12+4$

$\Rightarrow -2x<-8 \Rightarrow x>4.$

Hence solution set is $(4,\infty)$

Q14. $37-(3x+5) \geq 9x-8(x-3)$

Sol: $37-3x-5 \geq 9x-8x+24$

$32-3x \geq x+24$

$-3x-x \geq 24-32$

$-4x \geq -8$

$\Rightarrow x \leq \frac{-8}{-4} \Rightarrow x \leq 2$

Solution set is $(-\infty, 2]$

Q15: $\frac{x}{4} < \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$

Sol: Multiply b/s by 60
[Lcm of 4,3,5]

$15x < 20(5x-2) - 12(7x-3)$

$15x < 100x - 40 - 84x + 36$

$15x < 16x - 4$

$15x - 16x < -4$

$-x < -4 \Rightarrow x > 4$

Solution set is $(4, \infty)$

16. $\frac{2x-1}{3} \geq \frac{3x-2}{4} - \frac{(2-x)}{5}$

Sol: Multiply b/s by Lcm of 3,4,5 i.e. 60

$20(2x-1) \geq 15(3x-2) - 12(2-x)$

$40x - 20 \geq 45x - 30 - 24 + 12x$

$40x - 20 \geq 57x - 54$

$40x - 57x \geq -54 + 20$

$-17x \geq -34$

$x \leq \frac{-34}{-17} \Rightarrow x \leq 2.$

$\therefore$ The solution set is $(-\infty, 2]$

Solve the inequalities and show the graph of the solution in each case.

(17) $3x - 2 < 2x + 1$

Sol: $3x - 2x < 1+2$

$x < 3$

The solution set is $(-\infty, 3)$

18) $5x - 3 \geq 3x - 5$

Sol: $5x - 3x \geq -5+3$

$2x \geq -2$

$x \geq -1$

Hence the solution set is $[-1, \infty)$.

19) $3(1-x) < 2(x+4)$.

Sol: $3 - 3x < 2x + 8$

$-3x - 2x < 8 - 3$

$-5x < 5 \Rightarrow x > \frac{5}{-5}$

$x > -1$.

Solution set is $(-1, \infty)$.

Q20. $\frac{x}{2} < \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$

Multiply b/s by 30
[Lcm of 2,3,5 = 30]

$\Rightarrow 15x < 10(5x-2) - 6(7x-3)$

$\Rightarrow 15x < 50x - 20 - 42x + 18$

$\Rightarrow 15x < 8x - 2$

$\Rightarrow 15x - 8x < -2$

$\Rightarrow 7x < -2 \Rightarrow x < -\frac{2}{7}$

Solution set is $\left(-\infty, -\frac{2}{7}\right)$

Q21. Ravi obtained 70 and 75 marks in first two unit test. Find the number of minimum marks he should get in the third test to have an average of at ~~test~~ least 60 marks.

Sol: Let x be the marks obtained by Ravi

Then $\frac{70+75+x}{3} \geq 60$

$\Rightarrow 145 + x \geq 180$

$\Rightarrow x \geq 180 - 145$

$\Rightarrow x \geq 35$

Hence Ravi must obtain a minimum of 35 marks to get an average of 60.

Q22 To received Grade A in a course, one must obtain an average of 90 marks or more in five examination. If sunita's marks in first four examination are 87, 92, 94, and 95. Find the minimum marks that Sunita must obtain in fifth exam to get grade A in the course.

Sol: Let sunita obtain 'x' in fifth examination.

Then $\frac{87+92+94+95+x}{5} \geq 90$

$\Rightarrow 368 + x \geq 450$

$\Rightarrow x \geq 450 - 368$

$x \geq 82.$

Q23 Find all pairs of consecutive odd positive integers, both of which are smaller than 10, such that their sum is more than 11.

Sol: let two consecutive odd integer are $x, x+2$.

Acco. to question.

$x < 10$

and $x + x + 2 > 11$

$2x + 2 > 11$

$\Rightarrow 2x > 11 - 2 \Rightarrow 2x > 9$

$\Rightarrow x > \frac{9}{2}$

If one number is 5 other is $2 + 5 = 7$

If one number is 7 other number is $7 + 2 = 9$

$\therefore$ Possible pairs are $(5,7)$ $(7,9)$.

Q24 Find all pairs of consecutive even positive number both of which are larger than 5. such that their sum is less than 23.

Sol: let x be the smaller of the two positive even number.

Then other number $= x+2$

A.T.Q

$x > 5$ —(1)

$x + (x+2) < 23$

$\Rightarrow 2x + 2 < 23$

$\Rightarrow 2x < 23-2 \Rightarrow 2x < 21$

$\Rightarrow x < \frac{21}{2}$.

Thus x may be 6, 8, 10

The Possible pair are (6,8) (8,10) (10,12).

Q25 The longest side of a triangle is 3 times the shortest side. and the third side is 2cm shorter than the longest side. If the perimeter is at least 61 cm. find the minimum length of shortest side.

Sol: let shortest side $= x$

longest side $= 3x$

third side $= 3x - 2$

Now $x + 3x + 3x - 2 \geq 61$

$\Rightarrow 7x \geq 61+2$

$\Rightarrow 7x \geq 63 \Rightarrow x \geq \frac{63}{7}$

$\Rightarrow x \geq 9$.

Hence the minimum length of shortest side = 9 cm.

Q26 A man wants to cut three length from a single piece of board of length 91cm. The second length is to be 3 cm longer than the shortest. and third length is thrice as long as the shortest. What are the possible length for the shortest board if the third piece is to be at least 5 cm longer than the second.

Sol: let shortest length $= x$

second length $= 1x + 3$

third length $= 2x$

A.T.Q

$2x \geq (x+3) + 5$

$2x - x \geq 8 \Rightarrow x \geq 8$. —(1)

Also $x + (x+3) + 2x \leq 91$

$4x \leq 91 - 3$

$4x \leq 88 \Rightarrow x \leq \frac{88}{4}$

$x \leq 22$ —(2)

From (1) and (2)

$8 \le x \le 22$.

Hence the shortest board is at least 8 cm long but not more than 22 cm.

Exercise 6.2

Solve the following inequalities graphically in two dimensional plane:

1:- $x+y \le 5$

Sol: The given inequality is

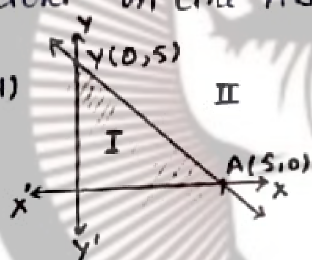
$x+y < 5 \quad -(1)$

The corresponding equation is

$x+y = 5 \quad -(2)$

This passes through the pt $A(5,0)$ and $B(0,5)$

$x+y=5$ represent on line AB



Put $x=0, y=0$ in (1) we get

$0+0<5$

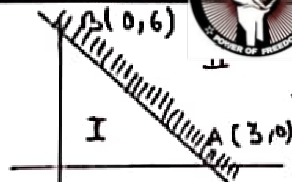
$0<5$ which is true.

Hence half plane I is the solution region of given inequality.

Q2:- $2x+y \ge 6 \quad -(1)$

Sol: The corresponding equation is

$2x+y=6 \quad -(2)$ The passes through the pt $A(3,0)$ and $B(0,6)$ and represent on the line AB



Put $x=0, y=0$

in (1) $0+0 \ge 6$

$0 \ge 6$ which is not true. Origin does not lies in solution region

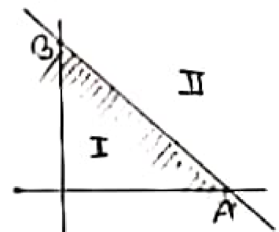
Hence half plane II is the solution region.

Q3:- $3x+4y \le 12 \quad -(1)$

The corresponding equation is

$3x+4y=12 \quad -(2)$

This passes through the pt $A(4,0)$ and $B(0,3)$ and represent on the line AB



Put $x=0, y=0$ in (1)

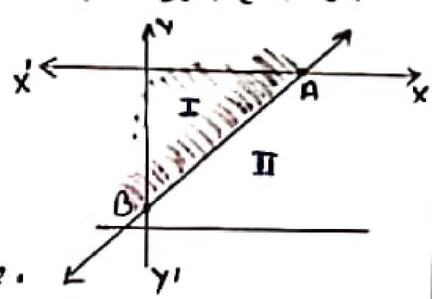
$0+0 \le 12$, which is true.

$\therefore$ origin lies in the required plane. Hence half plane I is the solution region of the given inequality

Ques4:- $y+8 \ge 2x \quad -(1)$

Sol: The corresponding equation is $y+8=2x \quad -(2)$

This passes through the pt $A(4,0)$ and $B(0,-8)$ and represent on the line AB.



Putting $x=0$, $y=0$ in (1)

$0+8 \ge 0$

$8 \ge 0$

which is true.

∴ origin lies in the required solution region.
Hence half plane I is the solution region of the given inequality.

Q5. $x - y \le 2$

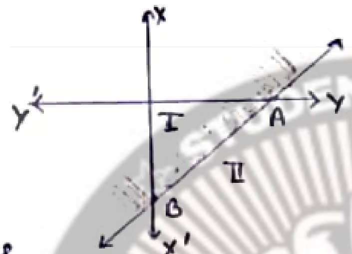
Sol: The given inequality is

$x - y \le 2$ — (1)

The corresponding equation is

$x - y = 2$ — (2)

This passes through pt $A(2,0)$ and $B(0,-2)$ and represent on line AB.



Putting $x=0$
$y=0$ in (1)

$0-0 \le 2$

$\Rightarrow 0 < 2$ which is true.

∴ Origin lies in the solution region. Hence half plane I is the solution region of the given inequality.

Q6:- $2x - 3y > 6$

Sol:- The given inequality is

$2x - 3y > 6$ — (1)

The corresponding equation is

$2x - 3y = 6$ — (2)

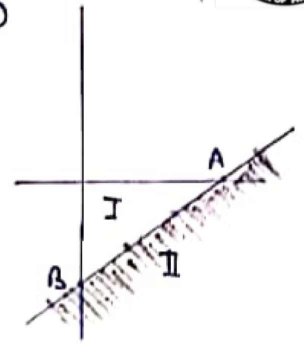
This passes through the pt $A(3,0)$ and $B(0,-2)$ and represent on the line AB

Put $x=0$, $y=0$ in (1)

$0 - 0 > 6$

$0 > 6$ which is not true.

Origin does not lies in the solution region.



Hence half plane II is the solution region of given inequality.

Q7 :- $-3x + 2y \geq -6$

Sol: The given inequality is

$-3x + 2y \geq -6$ — (1)

The corresponding equation is

$-3x + 2y = -6$

$3x - 2y = 6$ — (2)

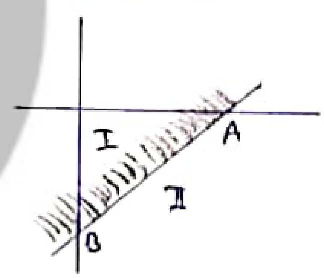
This passes through the pt. $A(2,0)$ and $B(0,-3)$ and represent on the line AB

Put $x=0$, $y=0$ in (1)

$-0 + 0 \geq -6$

$0 \geq -6$

which is true



Hence half plane I lies in the solution region of given inequality..

Q8:- $3y - 5x < 30$

Sol:- The given inequality is

$3y - 5x < 30$ — (1)

The corresponding equation is

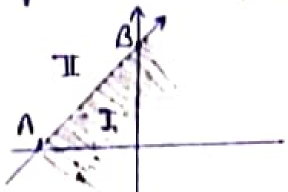
$3y - 5x = 30$ — (2)

This passes through A(−6, 0) and B(0, 10). and represent on line AB.

Putting $x=0, y=0$ in (1) we get

$0-0<30$

$\Rightarrow 0<30$ which is true.



$\therefore$ origin lies in the solution region. Hence half plane I is the solution region of the given inequality.

Q. $y<-2$

Sol: The given inequality is

$y<-2$ —(1)

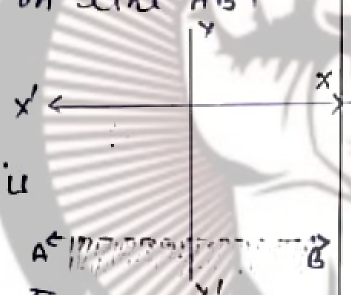
The corresponding equation is

$y=-2$ —(2)

This represent on line AB.

Putting $x=0, y=0$ in (1)

$0<-2$ which is not true.



Hence half plane II is the solution region of given inequality.

Q10:- $x>-3$

Sol: The given inequality is

$x>-3$ —(1)

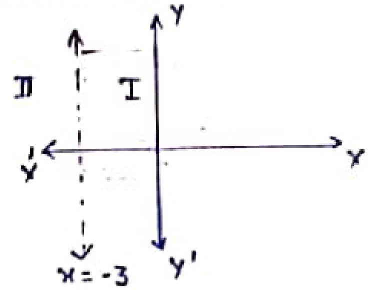
The corresponding equation is

$x=-3$ —(2)

This represent on line AB.

Putting $x=0, y=0$ in (1)

$0>-3$ which is true.

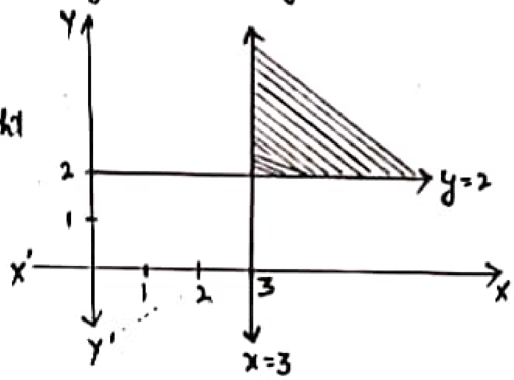


Hence half plane I is the solution region of the given inequality.

Ex: 6.3

Solve the following system of inequalities graphically:

Q1 $x \geq 3$, $y \geq 2$



Sol: $x \geq 3$ represent the region on the right side of $x = 3$ including $x = 3$

∴ $y \geq 2$ represent the region above $y = 2$ including $y = 2$

Hence the feasible region is as shown shaded in the figure. Any point in this region is the solution of $x \geq 3, y \geq 2$.

Q2 $3x + 2y \leq 12$, $x \geq 1$, $y \geq 2$

Sol: Let us draw the graph of $3x + 2y = 12$ —(1) , $x \geq 1$, $y \geq 2$

The straight line $3x + 2y \leq 12$ passes through A(4,0) and B(0,6)

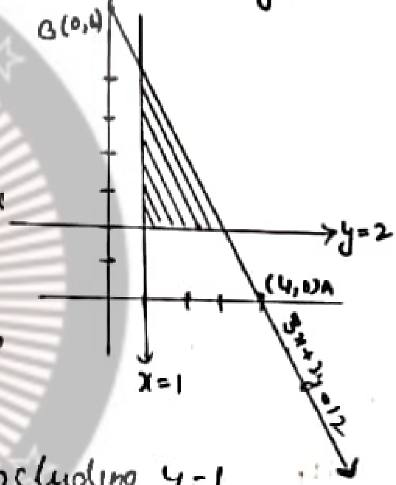
Put $x = 0$, $y = 0$ in (1) $0 + 0 \leq 12 \Rightarrow 0 \leq 12$ is true

∴ Shaded portion is toward the origin

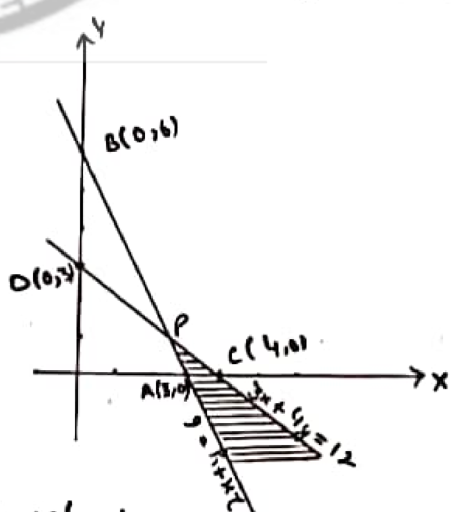
$x \geq 1$ represent the region on the right side of $x = 1$ including $x = 1$,

$y \geq$ represent the region above $y = 2$ including $y = 1$

Hence the feasible region is as shown as shaded is the solution set of given inequations.



Q3: $2x + y \geq 6$, $3x + 4y \leq 12$.



Sol: The corresponding equation are

$2x + y = 6$ —(i)

$3x + 4y = 12$ —(ii)

(i) passes through A(3,0) and B(0,6)

(ii) passes through C(4,0) and D(0,3)

Putting $x = 0, y = 0$ in $2x + y \geq 06 \Rightarrow 0 + 0 \geq 6$ which is not true.

$\therefore$ Origin does not lies in this region

$\therefore$ The region lying above AB and all point on AB represent (1)

Again, Put $x=0,\ y=0$ in (2)

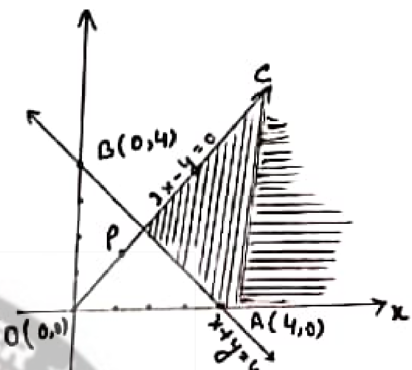
$0+0 \le 12 \Rightarrow 0 \le 12$ which is true. Origin lies in this region

$\therefore$ The region lies below CD (above origin) and all point on CD.

Hence the common region (shaded portion) is the solution set of given equation.

Q4:- $x+y > 4$ — (1)

$2x-y > 0$ — (2)



The corresponding equation are

$x+y = 4$ — (3) $\quad 2x-y=0$ — (4)

(3) passes through A(4,0) and B(0,4)

Putting $x=0,\ y=0$ in (1) $0+0>4 \Rightarrow 0>4$ which is not true.

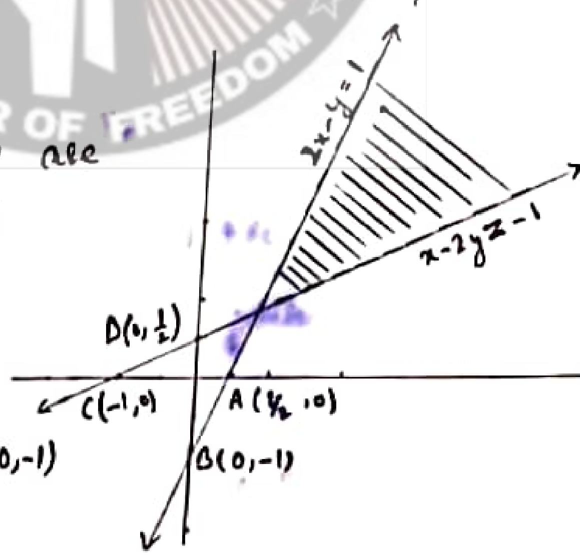
$\therefore$ Origin does not lies in this region

The line (4) passes through O(0,0) and P(1,2). This represent on line OC., Put $x=1,\ y=0$ in (2) $2>0$ which is true

$\therefore$ (1,0) lies in this region.

The solution set is the common shaded portion.

Q5:- $2x-y>1,\ x-2y<-1$



Sol:- The given inequalities are

$2x-y>1$ — (1) $\quad x-2y<-1$ — (2)

The corresponding equation are

$2x-y=1$ — (3)

$x-2y=-1$ — (4)

line passes through $A(\frac{1}{2},0)$ B(0,-1)

Put $x=0,\ y=0$ in (1) $0-0>1$

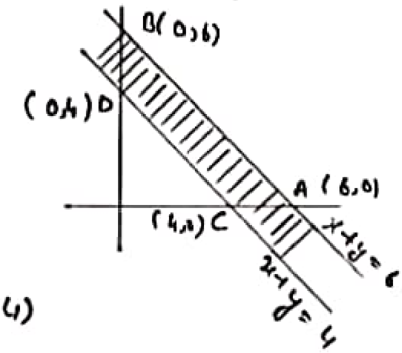
$0>1$ which is not true.

Origin does not lies in this region.

Again (3) line passes through $C(-1,0)$ and $D(0,\frac{1}{2})$.
Put $x=0, y=0$ in (2) $0-0<-1 \Rightarrow 0<-1$ which is not true
$\therefore$ Origin does not lies in this region
The solution set is the common shaded region in the figure.

Q6:- $x+y \leq 6, \quad x+y \geq 4$

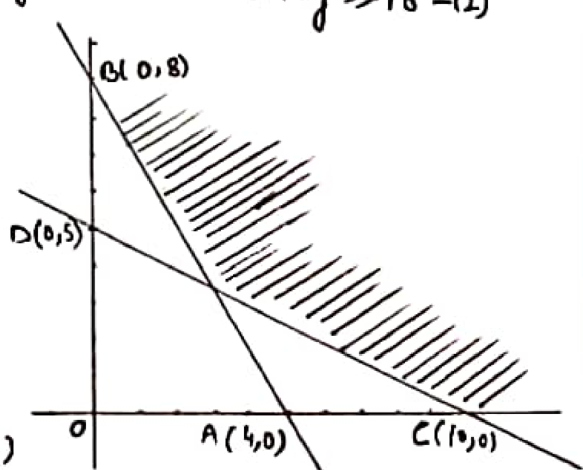
Sol: The given inequalities are $x+y \leq 6$ — (1) $x+y \geq 4$ — (2)
The corresponding equation are $x+y=6$ — (3) $x+y=4$ — (4)



(3) passes through $A(6,0)$ and $B(0,6)$
Putting $x=0, y=0$ in (1), $0+0 \leq 6 \Rightarrow 0 \leq 6$
which is true.
$\therefore$ Origin lies in this region
(4) line passes through pt. $C(4,0)$ and $D(0,4)$
Putting $x=0, y=0$ in (2) $0+0 \geq 4 \Rightarrow 0 \geq 4$ which is not true
$\therefore$ origin does not lies in this region.
$\therefore$ The solution set is the common region is shown as shaded in the figure.

Q7:- $2x+y \geq 8, \quad x+2y \geq 10$

Sol:- The given inequalities are $2x+y \geq 8$ — (1) $x+2y \geq 10$ — (2)
The corresponding equation are
$2x+y=8$ — (3) and $x+2y=10$ — (4)

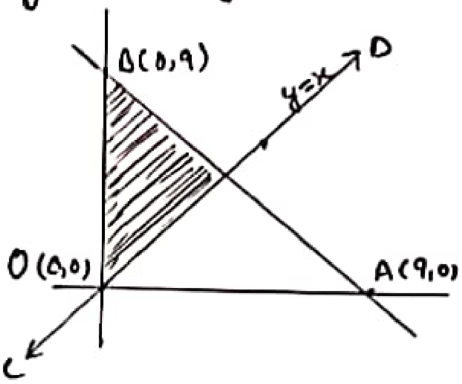


(3) passes through $A(4,0)$ and $B(0,8)$
Putting $x=0, y=0$ in (1), $0+0 \geq 8$
$\Rightarrow 0 \geq 8$. which is not true.
$\therefore$ Origin does not lies in this region
Again (4) passes through pt $C(10,0)$, $D(0,5)$
Putting $x=0, y=0$ in (2) $0+0 \geq 10 \Rightarrow 0 \geq 10$ which is not true
$\therefore$ origin does not lies in this region
$\therefore$ The common region is shown as shaded in the figure.

Q8: $x+y \le 9$, $y > x$, $x \ge 0$

Sol: The given inequalities are $x+y \le 9 - (1)$ $y > x - (2)$ $x \ge 0 - (3)$

The corresponding equation of (1) is $x+y=9$. It passes through $A(9,0)$ and $B(0,9)$.



Putting $x=0, y=0$ in (1) $0+0 \le 9$

$0 \le 9$ which is true.

$\therefore$ origin lies in the region

Now corresponding eq. of (2) $y=x$. This passes through pt $O(0,0), C(4,4)$

Putting $x=0, y=1$ in (2) $y > x$ i.e $y-x > 0$

$1-0 > 0 \Rightarrow 1 > 0$ which is true

$\therefore$ (0,1) lies in this region

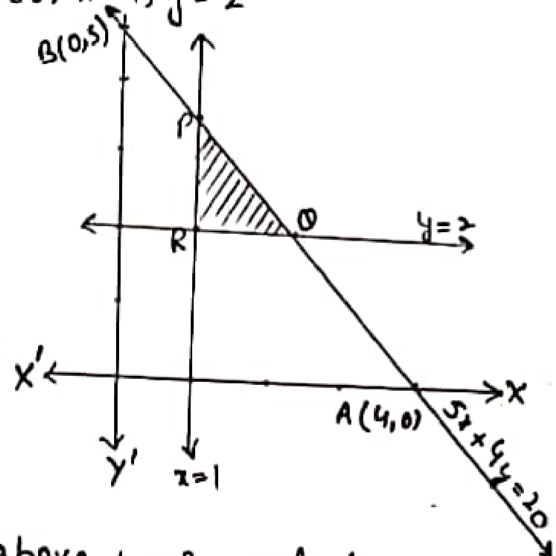
lastly $x > 0$ represents the region right of y-axis.

The common region is shown as shaded in the figure.

Q9:- $5x+4y \le 20$, $x \ge 1$, $y \ge 2$

Sol:- Let us draw the graph of $5x+4y \le 60$, $x=1$, $y=2$

The line $5x+4y=20$ passing through pt $A(4,0)$ and $B(0,5)$



Put. $x=0, y=0$ in $5x+4y \le 20$

$0+0 \le 20 \Rightarrow 0 \le 20$ which is true

$\therefore$ Shaded portion is toward the origin

$x \ge 1$ represent the region on the right side of $x=1$ including $x=1$

$y \ge 2$ represent the region above $y=2$ including $y=2$.

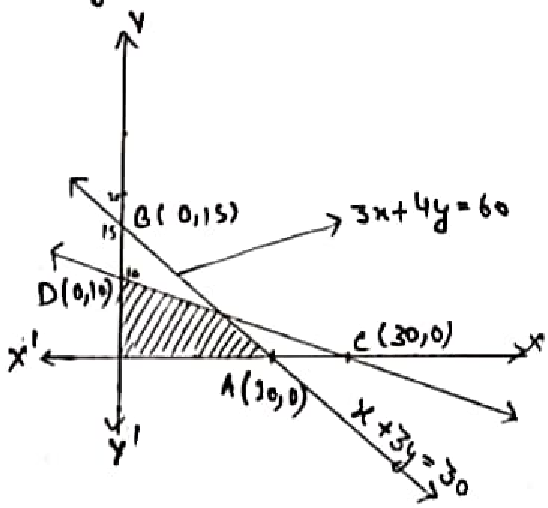
$\therefore$ The shaded area bounded by ΔPQR is the required solution.

Q10:- $3x+4y \le 60$, $x+3y \le 30$, $x \ge 0$, $y \ge 0$.

Solution:- The given inequalities are $3x+4y \le 60$ —(1) $x+3y \le 30$ —(2) $x \ge 0$, $y \ge 0$.

The corresponding equation are $3x+4y = 60$ —(3) and $x+3y = 30$ —(4) and $x=0$, $y=0$

Line (3) passes through A (20,0) B(0,15)



Putting $x=0$, $y=0$ in (1)

$0+0 \le 60 \Rightarrow 0 \le 60$ which is true

$\therefore$ Origin lies in the region of $3x+4y \le 60$

Line (4) passes through pt. C(30,0) and D(0,10). Putting $x=0$, $y=0$ in (2)

$0+0 \le 30 \Rightarrow 0 \le 30$ which is true. Origin lies in the region.

Now $x \ge 0$ is the region on and right of y-axis.

and $y \ge 0$ is the region on and above of x-axis

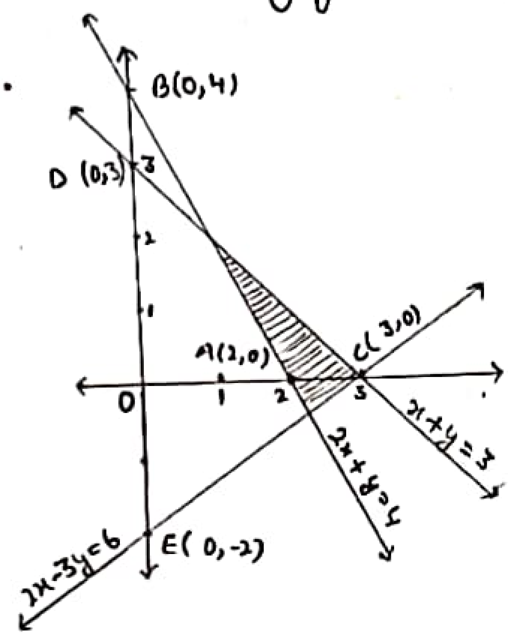
The common region is shown as shaded in the figure

Q11:- $2x+y \ge 4$, $x+y \le 3$, $2x-3y \le 6$.

Sol:- The given inequalities are

$2x+y \ge 4$ —(1). $x+y \le 3$ —(2)

$2x-3y \le 6$ —(3)



The corresponding equation are

$2x+y=4$ —(4) $x+y=3$ —(5)

$2x-3y=6$ —(6)

Eq line (4) passes through A(2,0) and B(0,4)

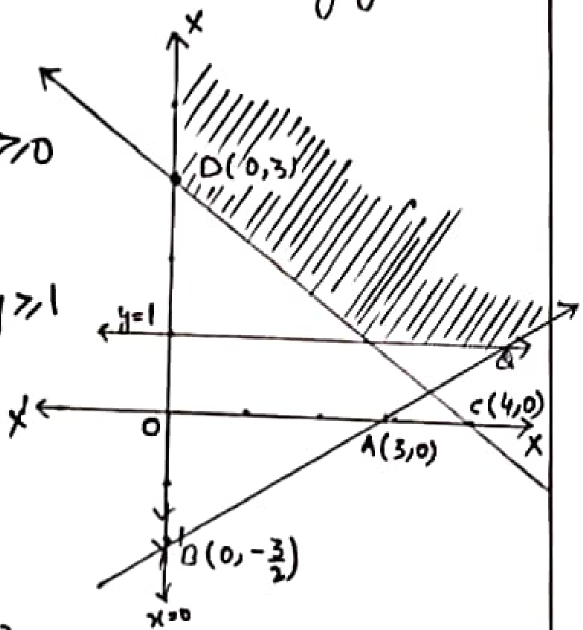
Putting $x=0$, $y=0$ in (1) $0+0 \ge 4 \Rightarrow 0 \ge 4$ which is not true.

$\therefore$ Origin does not lie in this region line ⑤ passes through $C(3,0)$ and $D(0,3)$. Putting $x=0, y=0$ in $x+y \le 3$. $0+0 \le 3 \Rightarrow 0 \le 3$ which is true.

$\therefore$ Origin lies in the region.

Line ⑥ passes through pt. $C(3,0)$ and $E(0,-2)$. Putting $x=0, y=0$ in ③ $0-0 \le 6 \Rightarrow 0 \le 6$ which is true.

$\therefore$ The common region is shown as shaded in the figure is the solution set.



Q12:- $x-2y \le 3,\ 3x+4y \ge 12,\ x \ge 0,\ y \ge 0$

Sol:- The given inequalities are

$x-2y \le 3$ — (1) $3x+4y \ge 12$ —(2) $x \ge 0, y \ge 1$

The corresponding equation are

$x-2y=3,\ 3x+4y=12,\ x=0,\ y=1$

line $x-2y=3$ passes through $A(3,0)$ and $B(0,-\frac{3}{2})$. Putting $x=0, y=0$ in $x-2y \le 3$

$0-0 \le 3 \Rightarrow 0 \le 3$. which is true.

$\therefore$ Origin lies in this region.

$3x+4y=12$ passes through the point $C(4,0)$ and $D(0,3)$

Putting $x=0, y=0$ in ② $0+0 \ge 12 \Rightarrow 0 \ge 12$ which is not true

$\therefore$ Origin does not lies in the region

Now $x \ge 0$ represent y-axis and right of y-axis and $y \ge 1$ represent the line $y=1$ and the region above it

$\therefore$ The common region is the shaded region as shown in figure.

Line $x+4y=80$ passes through C(80,0) and D(0,20) and represent on the line CD.
Putting $x=0, y=0$ in ② $0+0 \le 80 \rightarrow 0 \le 80$ which is true
$\therefore$ Origin lies in this region.
Now $x \le 15$ represent the line $x=15$ and left of it.
and $y \geq 0$ represent x-axis and above it.
Hence, the common region is shown as shaded in the figure.

Q15 :- $x+2y \le 10$, $x+y \geq 1$, $x-y \le 0$, $x \geq 0$, $y \geq 0$

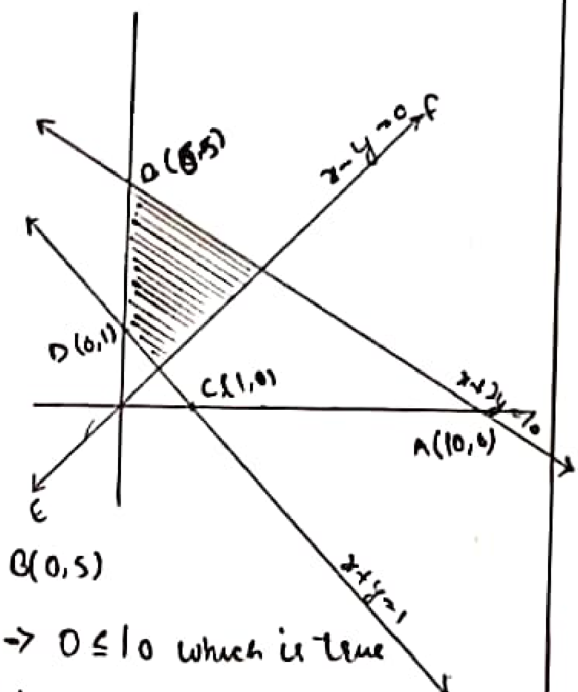
Sol: The given inequalities are

$x+2y \le 10$ — ①

$x+y \geq 1$ — ②

$x-y \le 0$ — ③

and $x \geq 0$, $y \geq 0$ — ④



The corresponding equation are

$x+2y=10$

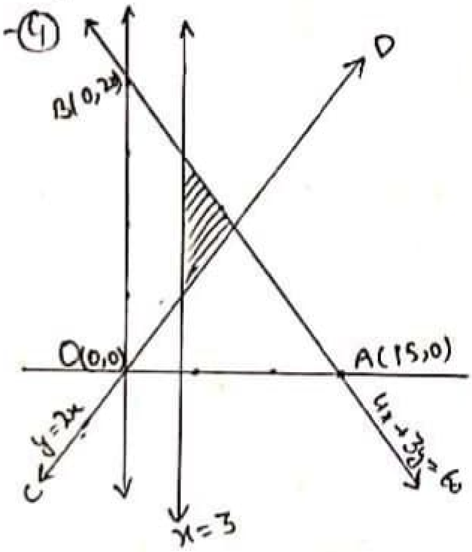
$x+y=1$, $x-y=0$

and $x=0$, $y=0$

Line $x+2y=10$ passes through A(10,0) B(0,5)
Putting $x=0, y=0$ in ① $0+0 \le 10 \rightarrow 0 \le 10$ which is true
$\therefore$ Origin lies in this region.
Line $x+y=1$ passes through C(1,0) and (0,1)
Put $x=0$, $y=0$ in ② $0+0 \geq 1 \Rightarrow 0 \geq 1$ which is not true
$\therefore$ Origin does not lies in this region.
Line $x-y=0$ passes through (0,0) and (1,1)
Putting $x=0$, $y=1$, $0-1 \le 0 \Rightarrow -1 \le 0$ which is true
$\therefore$ (0,1) lies in the region
And $x \geq 0$, $y \geq 0$ represent Ist quadrant
The common region is shown as shaded in the figure.

Q13:- $4x + 3y \le 60$, $y \ge 2x$, $x \ge 3$, and $x, y \ge 0$.

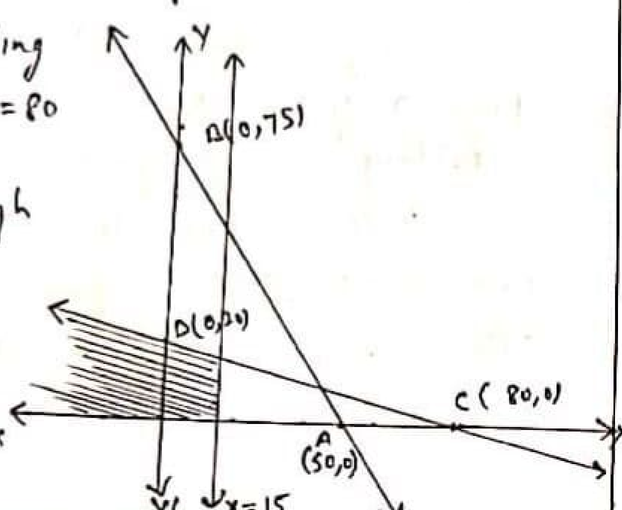
Sol: The given inequalities are $4x+3y \le 60$ —(1)
$y \ge 2x$ —(2), $x \ge 3$ —(3) and $x, y \ge 0$ —(4)



Line $4x+3y=60$ passes through point A(15,0) and B(0,20).
Putting $x=0$, $y=0$ in $4x+3y \le 60$
$0+0 \le 60 \Rightarrow 0 \le 60$ which is true.
∴ Origin lies in this region
Now $y=2x$ passes through O(0,0) and (5,10). Therefore $y=2x$ represent the line CD.
Putting $x=0, y=5$ in $y \ge 2x$, $5 \ge 0$ which is true.
∴ (0,5) lies in this region
$x \ge 3$ represent the line $x=3$ and right of it.
$x \ge 0$ is the region on the right side of y-axis
$y \ge 0$ is the region ~~on the~~ above x-axis
Hence the common region is shown as shaded in the figure.

Ques 14:- $3x + 2y \le 150$, $x + 4y \le 80$, $x \le 15$, $y \ge 0$

Solution :- The given inequalities are $3x+2y \le 150$ —(1) $x+4y \le 80$ —(2)
$x \le 15$ —(3) $y \ge 0$. The corresponding equation are $3x+2y=150$, $x+4y=80$
$x=15$, $y=0$



The line $3x+2y=150$ passes through A(50,0) and B(0,75) and represent on the line AB.
Putting $x=0$, $y=0$ in $3x+2y \le 150$
$0+0 \le 150 \Rightarrow 0 \le 150$ which is true
∴ Origin lies in this region.