1. Details of Module and its structure

Module Detail	
Subject Name	Mathematics
Course Name	Mathematics 01 (Class XI, Semester - 1)
Module Name/Title	Linear inequality - Part 4
Module Id	kemh_10604
Pre-requisites	Basic knowledge of plotting equation on graph and solving simultaneous equations.
Objectives	After going through this lesson, the learners will be able to understand the following: ● Difference between an equation and an inequality. ● Solve system of linear inequalities in two variables. ● Plot a graph of systems of linear inequalities. ● Describe the shaded region when inequalities are plotted graphically.
Keywords	Linear inequality, Graphical solution, Shaded region

2. Development Team

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1. Solution of System of Linear Inequalities in Two Variables

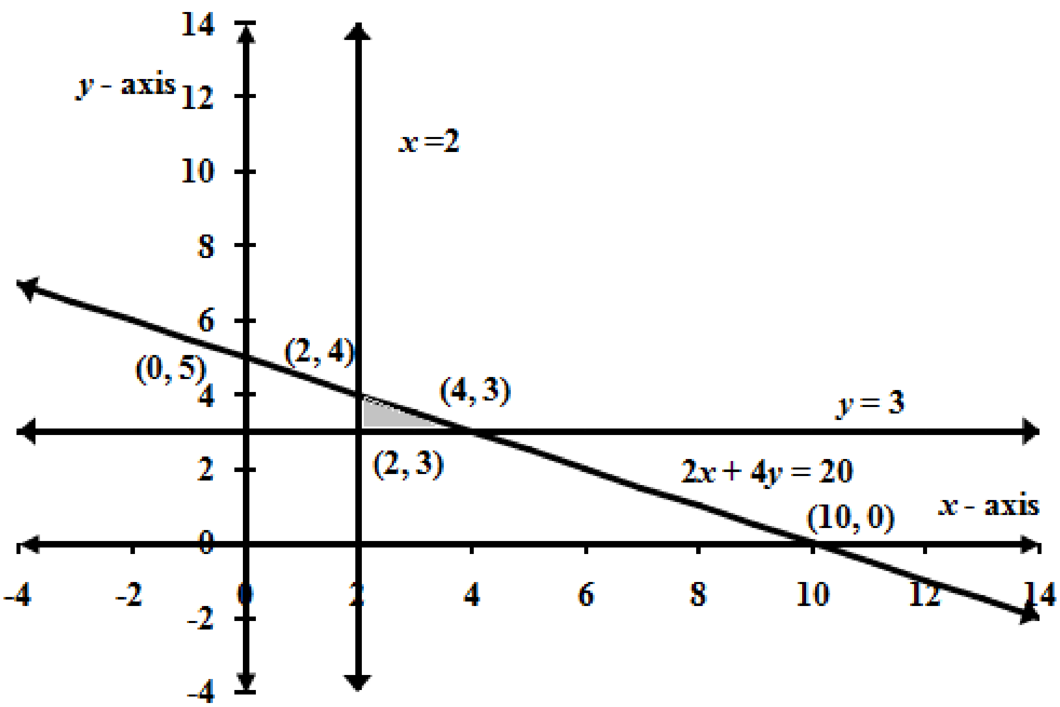
When more than one inequality is given then solution region of the system of linear inequalities is the common shaded region to all the inequalities.

Example 1: Solve the following system of inequalities: $2x + 4y \leq 20,\ x \geq 2,\ y \geq 3$.

Solution: First step is to draw the graph of the lines $2x + 4y = 20$, $x = 2$, $y = 3$

To draw the line $2x + 4y = 20$, consider the points (10, 0) and (0, 5) which are on x – axis and y – axis respectively.

Inequality $2x + 4y \leq 20$ gives the region containing (0, 0). Inequality $x \geq 2$ gives the region above the line $x = 2$ and $y \geq 3$ gives the region which is on the right side of the line $y = 3$. Thus, solution region is the shaded part which is the intersection of all three regions given by three inequalities as shown here.

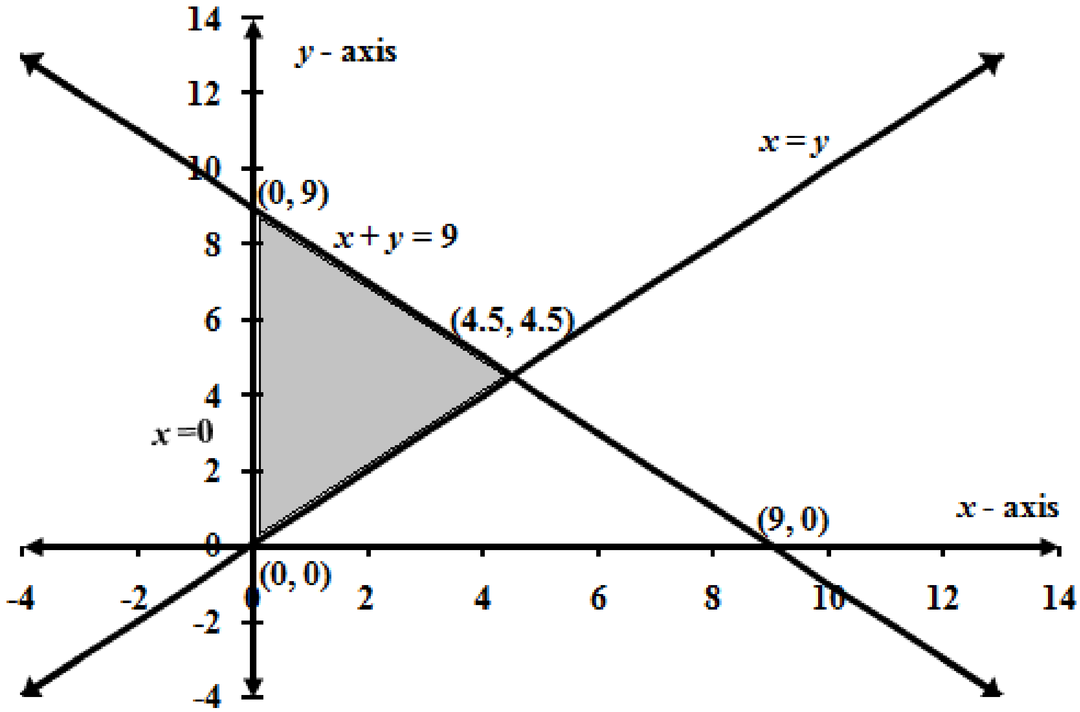


Example 2: Solve the following system of inequalities graphically: $x + y \leq 9,\ y > x,\ x \geq 0$.

Solution: First step is to draw the graph of the lines $x + y = 9$, $y = x$

To draw the line $x + y = 9$, consider the points (9, 0) and (0, 9) which are on x – axis and y – axis respectively.

Inequality $x + y \leq 9$ gives the region containing (0, 0). Inequality $y > x$ gives the region which contains positive direction of y – axis and $x \geq 0$ gives the positive values of x. Thus, solution region is the shaded part which is the intersection of all three regions given by three inequalities as shown here.



Example 3: Solve the following system of inequalities graphically: $2x + y \geq 4$, $x + y \leq 3$, $2x - 3y \leq 6$

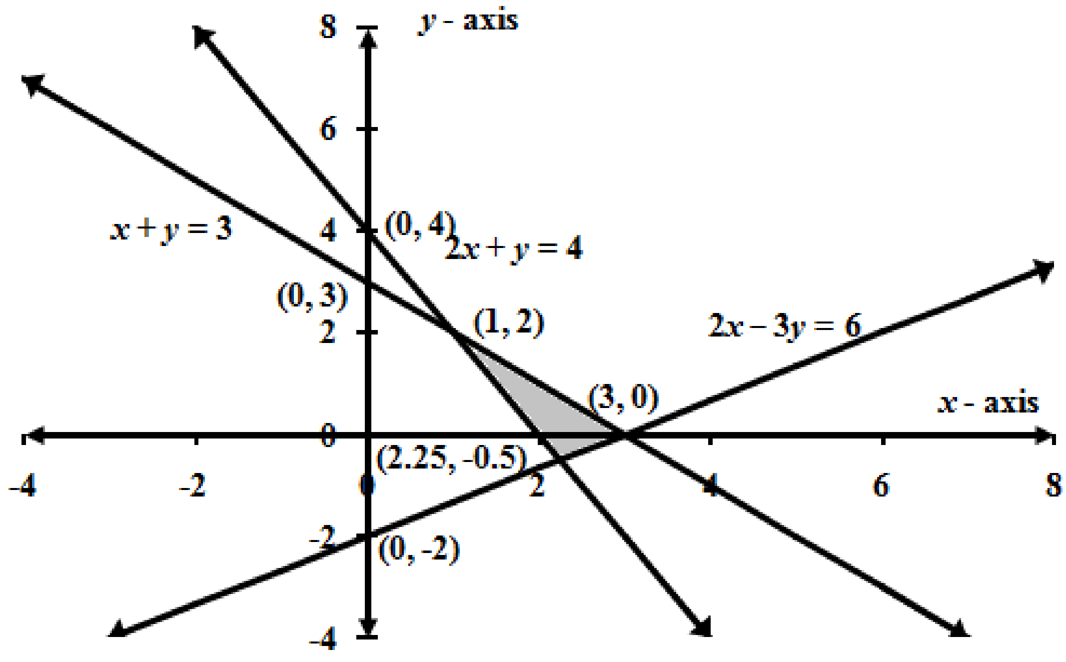
Solution: First step is to draw the graph of the lines $2x + y = 4$, $x + y = 3$, $2x - 3y = 6$

a. To draw the line $2x + y = 4$, consider the points (2, 0) and (0, 4) which are on x – axis and y – axis respectively.

b. To draw the line $x + y = 3$, consider the points (3, 0) and (0, 3) which are on x – axis and y – axis respectively.

c. To draw the line $2x - 3y = 6$, consider the points (3, 0) and (0, -2) which are on x – axis and y – axis respectively.

Inequality $2x + y \geq 4$ gives the region not containing (0, 0). Inequality $x + y \leq 3$ gives the region which contains origin (0, 0) and $2x - 3y \leq 6$ gives the region containing (0, 0). Thus, solution region is the shaded part which is the intersection of all three regions given by three inequalities as shown here.



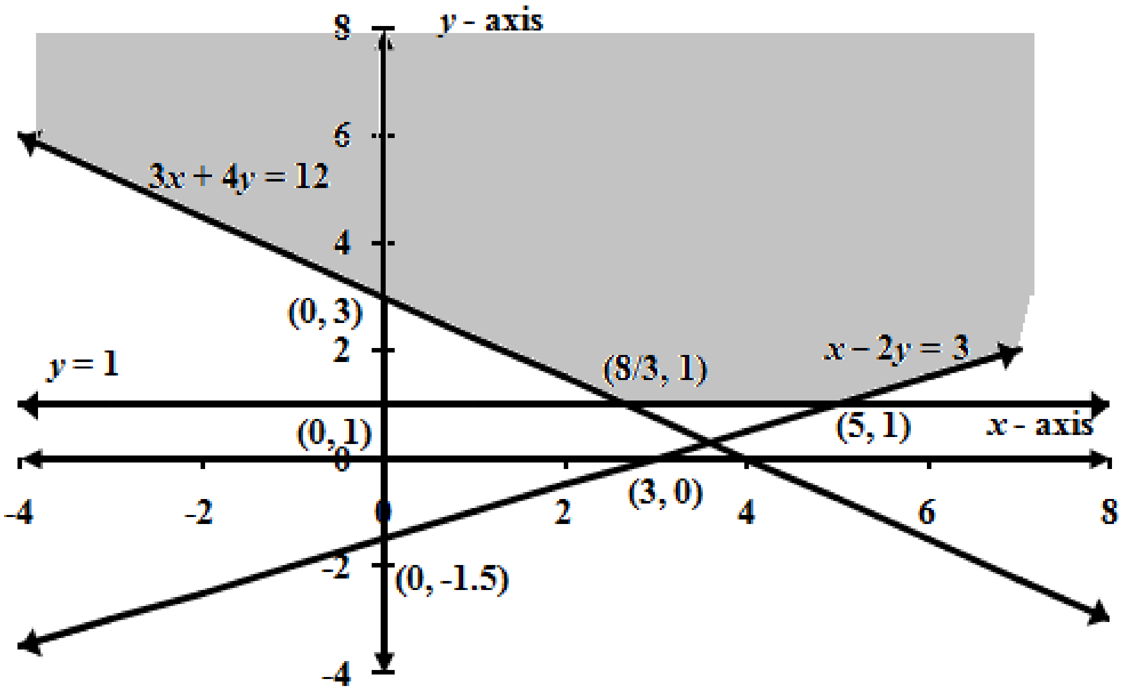
Example 4: Solve the following system of inequalities graphically: $x - 2y \leq 3$, $3x + 4y \geq 12$, $x \geq 0$, $y \geq 1$.

Solution: First step is to draw the graph of the lines $x - 2y = 3$, $3x + 4y = 12$, $y = 1$

a. To draw the line $x - 2y = 3$, consider the points (3, 0) and (0, –3/2) which are on x – axis and y – axis respectively.

b. To draw the line $3x + 4y = 12$, consider the points (4, 0) and (0, 3) which are on x – axis and y – axis respectively.

Inequality $x - 2y \leq 3$ gives the region containing (0, 0). Inequality $3x + 4y \geq 12$ gives the region which does not contain origin (0, 0) and $y \geq 1$ gives the region to the right of the line $y = 1$. $x \geq 0$ gives positive values of x. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



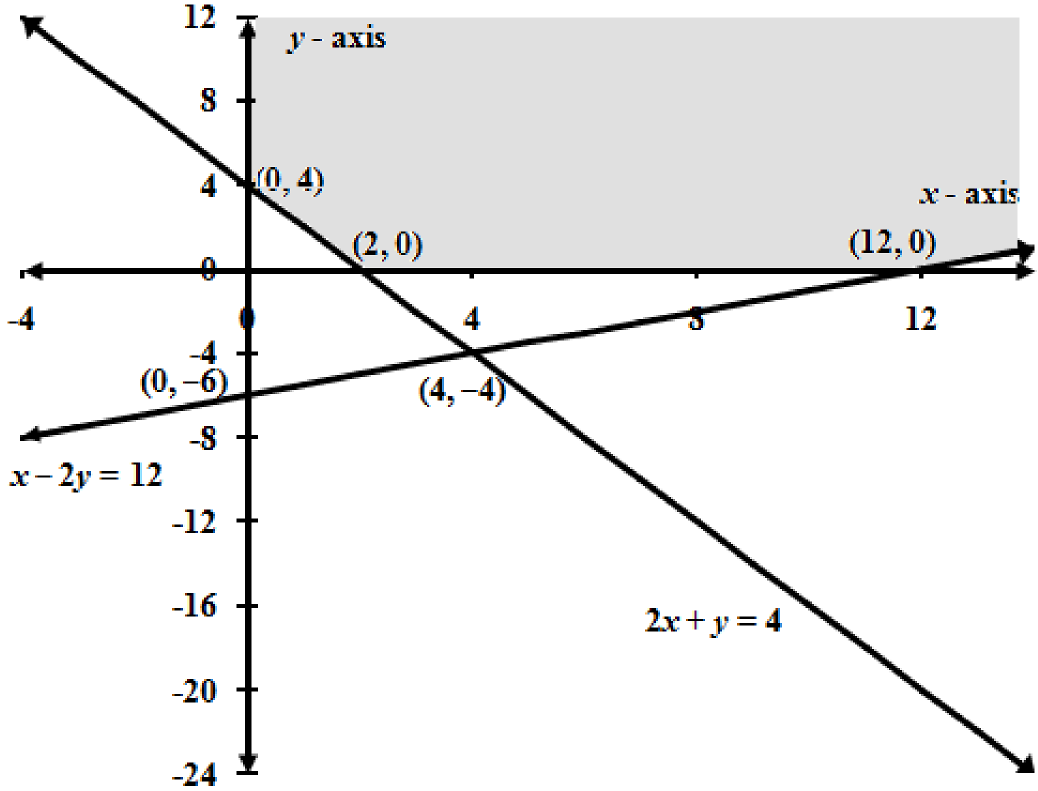
Example 5: Solve the following system of inequalities graphically: $x - 2y \leq 12$, $2x + y \geq 4$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $x - 2y = 12$, $2x + y = 4$

a. To draw the line $x - 2y = 12$, consider the points (12, 0) and (0, –6) which are on x – axis and y – axis respectively.

b. To draw the line $2x + y = 4$, consider the points (2, 0) and (0, 4) which are on x – axis and y – axis respectively.

Inequality $x - 2y \leq 12$ gives the region containing (0, 0). Inequality $2x + y \geq 4$ gives the region which does not contain origin (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



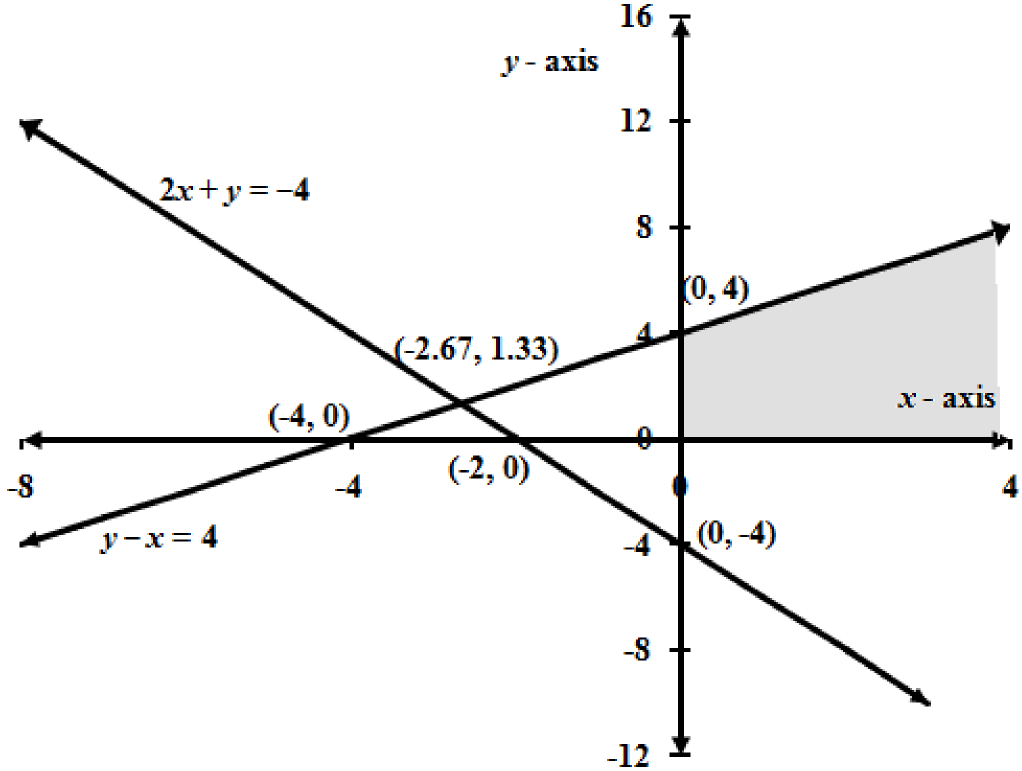
Example 6: Solve the following system of inequalities graphically: $y - x \leq 4$, $2x + y \leq -4$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $y - x = 4$, $2x + y = -4$

a. To draw the line $y - x = 4$, consider the points (–4, 0) and (0, 6) which are on x – axis and y – axis respectively.

b. To draw the line $2x + y = -4$, consider the points (–2, 0) and (0, –4) which are on x – axis and y – axis respectively.

Inequality $y - x \leq 4$ gives the region containing (0, 0). Inequality $2x + y \leq -4$ gives the region containing (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



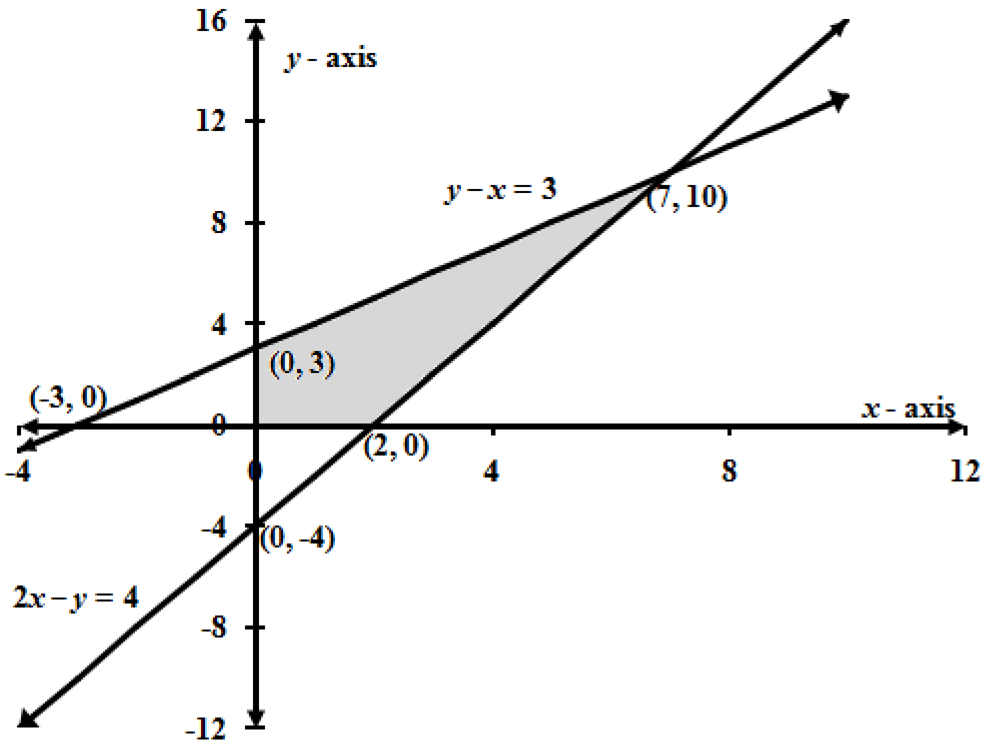
Example 7: Solve the following system of inequalities graphically: $y - x \leq 3$, $2x - y \leq 4$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $y - x = 3$, $2x - y = 4$

a. To draw the line $y - x = 3$, consider the points (–3, 0) and (0, 3) which are on x – axis and y – axis respectively.

b. To draw the line $2x - y = 4$, consider the points (2, 0) and (0, –4) which are on x – axis and y – axis respectively.

Inequality $y - x \leq 3$ gives the region containing (0, 0). Inequality $2x - y \leq 4$ gives the region containing (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



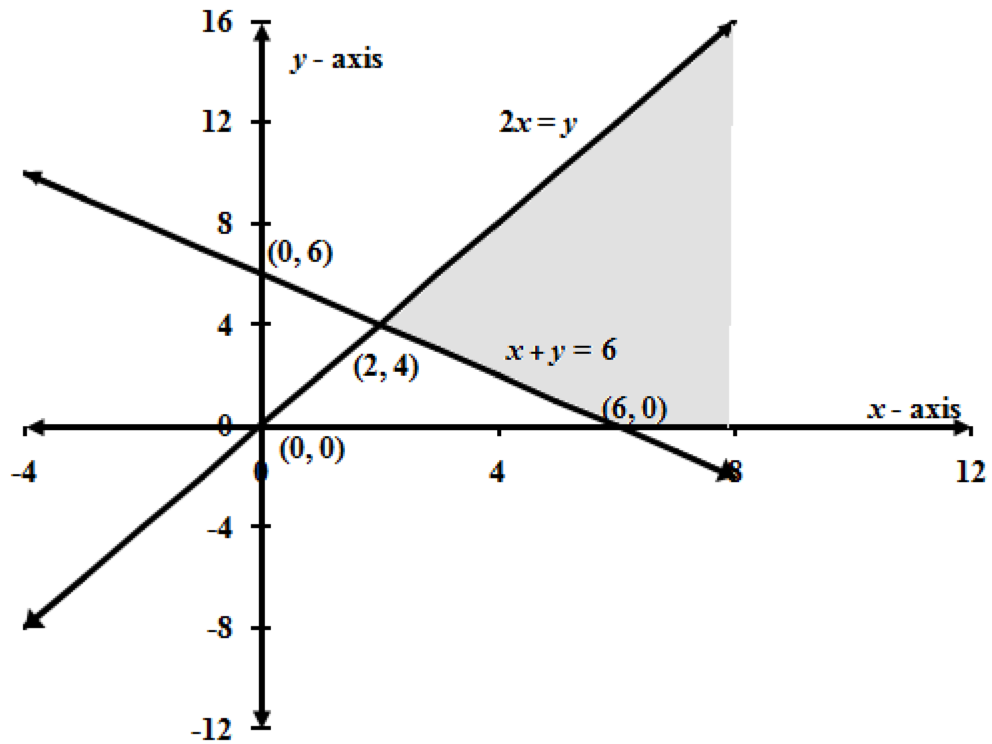
Example 8: Solve the following system of inequalities graphically: $x + y \geq 6$, $2x - y \geq 0$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $x + y = 6$, $2x - y = 0$

a. To draw the line $x + y = 6$, consider the points (6, 0) and (0, 6) which are on x – axis and y – axis respectively.

b. To draw the line $2x - y = 0$, consider the points (1, 2), (–1, –2) and (2, 4) since line passes through origin.

Inequality $x + y \geq 6$ gives the region not containing (0, 0). Inequality $2x \geq y$ gives the region which is on the right side of the line. $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



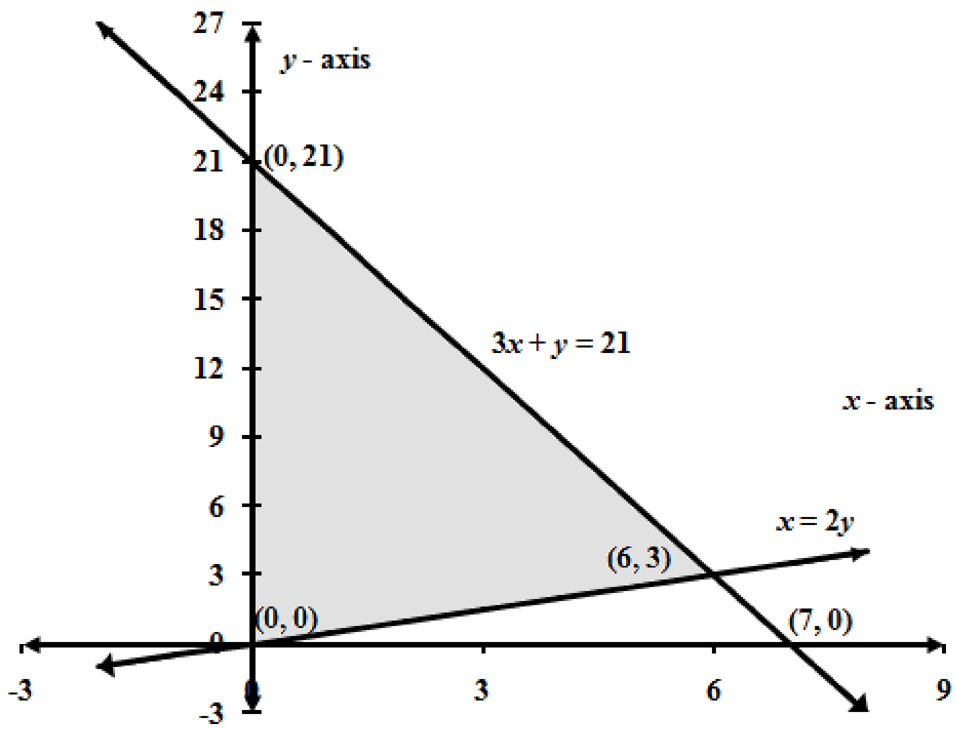
Example 9: Solve the following system of inequalities graphically: $3x + y \leq 21$, $x - 2y \leq 0$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $3x + y = 21$, $x - 2y = 0$

a. To draw the line $3x + y = 21$, consider the points (7, 0) and (0, 21) which are on x – axis and y – axis respectively.

b. To draw the line $x - 2y = 0$, consider the points (2, 1), (–2, –1) and (4, 2) since line passes through origin.

Inequality $3x + y \leq 21$ gives the region containing (0, 0). Inequality $x - 2y \leq 0$ gives the region which is on the left side of the line. $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



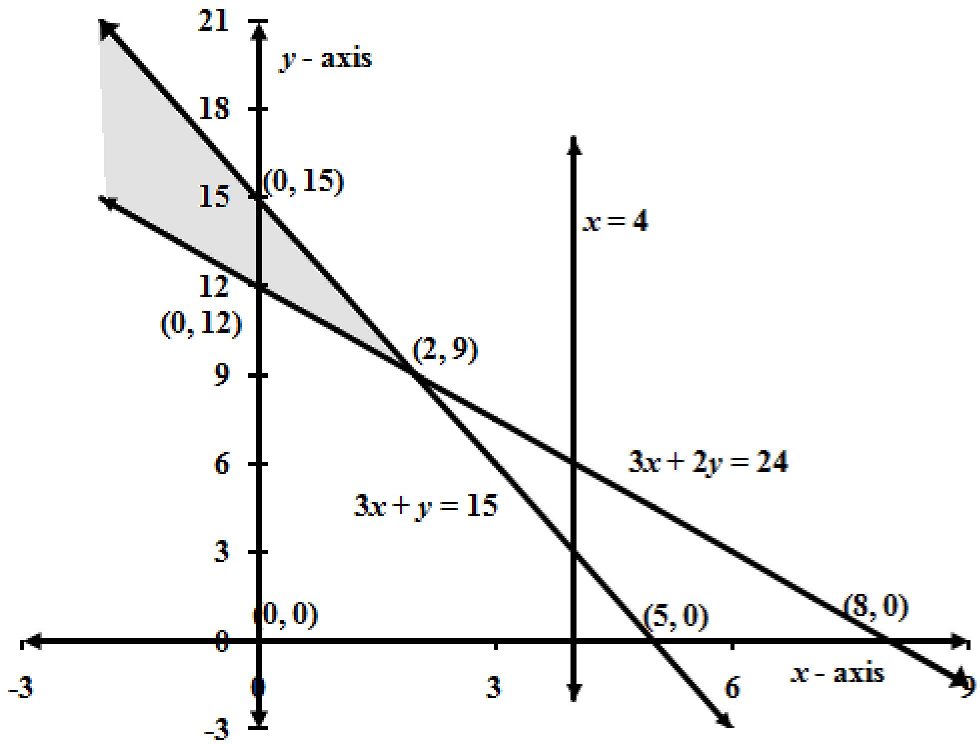
Example 10: Solve the following system of inequalities graphically: $3x + 2y \geq 24$, $3x + y \leq 15$, $x \leq 4$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $3x + 2y = 24$, $3x + y = 15$

a. To draw the line $3x + 2y = 24$, consider the points (8, 0) and (0, 12) which are on x – axis and y – axis respectively.

b. To draw the line $3x + y = 15$, consider the points (5, 0) and (0, 15) which are on x – axis and y – axis respectively.

Inequality $3x + 2y \geq 24$ gives the region not containing (0, 0). Inequality $3x + y \leq 15$ gives the region containing (0, 0). $x \leq 4$ gives values left of the line $x = 4$. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



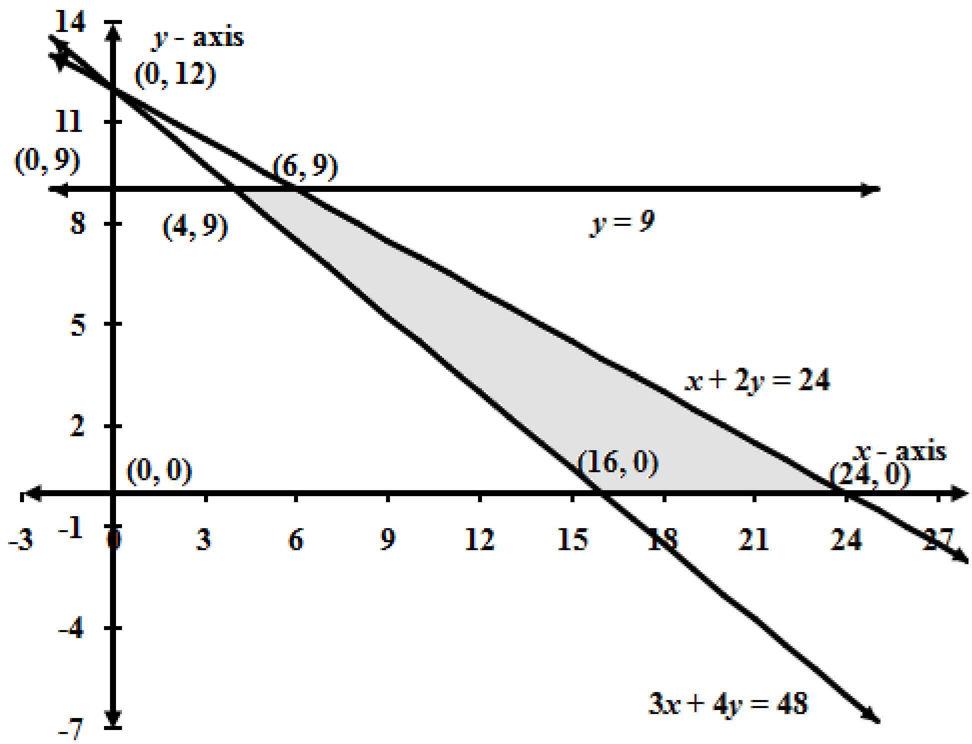
Example 11: Solve the following system of inequalities graphically: $3x + 4y \geq 48$, $x + 2y \leq 24$, $y \leq 9$, $x \geq 0$.

Solution: First step is to draw the graph of the lines $3x + 4y = 48$, $x + 2y = 24$

a. To draw the line $3x + 4y = 48$, consider the points (16, 0) and (0, 12) which are on x – axis and y – axis respectively.

b. To draw the line $x + 2y = 24$, consider the points (24, 0) and (0, 12) which are on x – axis and y – axis respectively.

Inequality $3x + 4y \geq 48$ gives the region not containing (0, 0). Inequality $x + 2y \leq 24$ gives the region containing (0, 0). $x \geq 0$ gives positive values of x. $y \leq 9$ gives values which are below the line $y = 9$. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.



Example 12: Solve the following system of inequalities graphically: $x + 2y \geq 16$, $x + y \geq 12$, $2x + y \geq 14$, $x \geq 0$, $y \geq 0$.

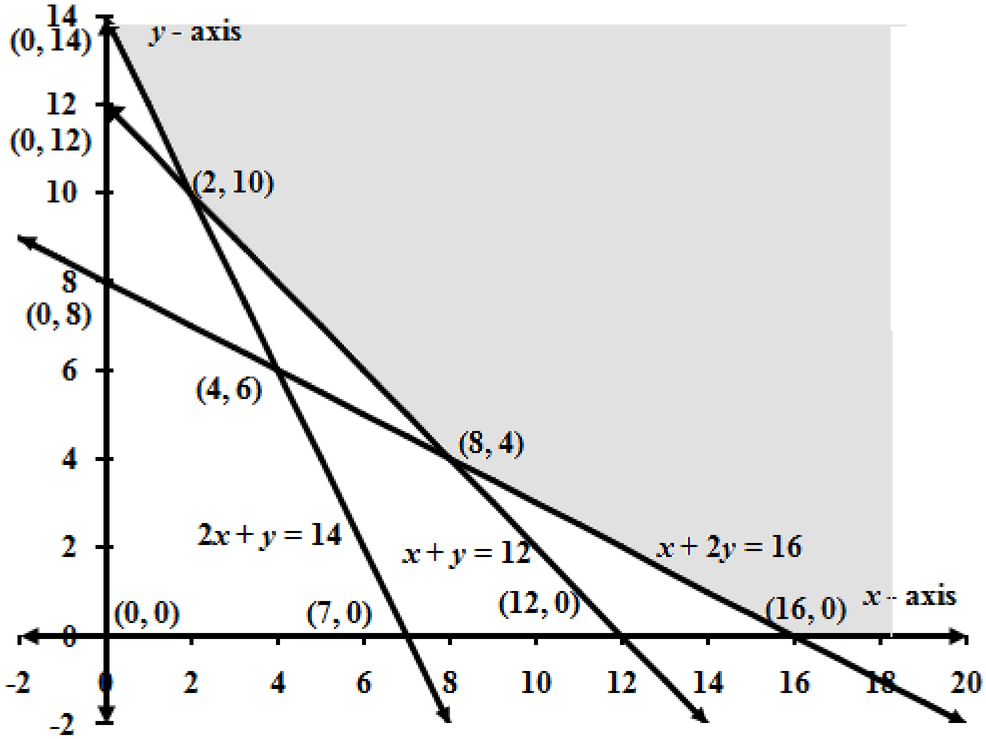
Solution: First step is to draw the graph of the lines $x + 2y = 16$, $x + y = 12$, $2x + y = 14$

a. To draw the line $x + 2y = 16$, consider the points (16, 0) and (0, 8) which are on x – axis and y – axis respectively.

b. To draw the line $x + y = 12$, consider the points (12, 0) and (0, 12) which are on x – axis and y – axis respectively.

c. To draw the line $2x + y = 14$, consider the points (7, 0) and (0, 14) which are on x – axis and y – axis respectively.

Inequality $x + 2y \geq 16$ gives the region not containing (0, 0). Inequality $x + y \geq 12$ gives the region not containing (0, 0). Inequality $2x + y \geq 14$ gives the region not containing (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all four regions given by five inequalities as shown here.



Example 13: Solve the following system of inequalities graphically: $2x + y \leq 22$, $x + y \leq 13$, $2x + 5y \leq 50$, $x \geq 0$, $y \geq 0$.

Solution: First step is to draw the graph of the lines $2x + y = 22$, $x + y = 13$, $2x + 5y = 50$

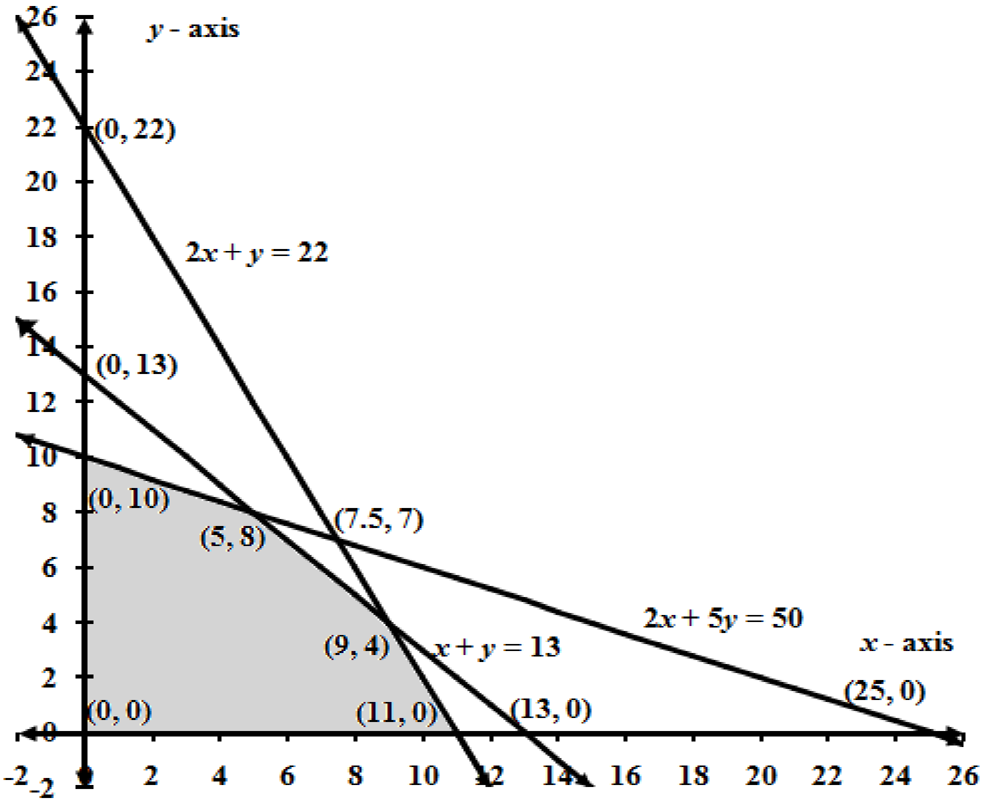
a. To draw the line $2x + y = 22$, consider the points (11, 0) and (0, 22) which are on x – axis and y – axis respectively.

b. To draw the line $x + y = 13$, consider the points (13, 0) and (0, 13) which are on x – axis and y – axis respectively.

c. To draw the line $2x + 5y = 50$, consider the points (25, 0) and (0, 10) which are on x – axis and y – axis respectively.

Inequality $2x + y \leq 22$ gives the region containing (0, 0). Inequality $x + y \leq 13$ gives the region containing (0, 0). Inequality $2x + 5y \leq 50$ gives the region containing (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of y. Thus, solution region is the shaded part which is the intersection of all five regions given by five inequalities as shown here.

Example 14: Solve the following system of inequalities graphically: $2x + 5y \leq 20$, $x - y \leq -5$, $x \geq 0$, $y \geq 0$.



Solution: First step is to draw the graph of the lines $2x + 5y = 20$, $x - y = -5$

a. To draw the line $2x + 5y = 20$, consider the points (10, 0) and (0, 4) which are on x – axis and y – axis respectively.

b. To draw the line $x - y = -5$, consider the points (–5, 0) and (0, 5) which are on x – axis and y – axis respectively.

Inequality $2x + 5y \leq 20$ gives the region containing (0, 0). Inequality $x - y \leq -5$ gives the region not containing (0, 0). $x \geq 0$ gives positive values of x. $y \geq 0$ gives positive values of *y*. Thus, solution region is the shaded part which is the intersection of all four regions given by four inequalities as shown here.