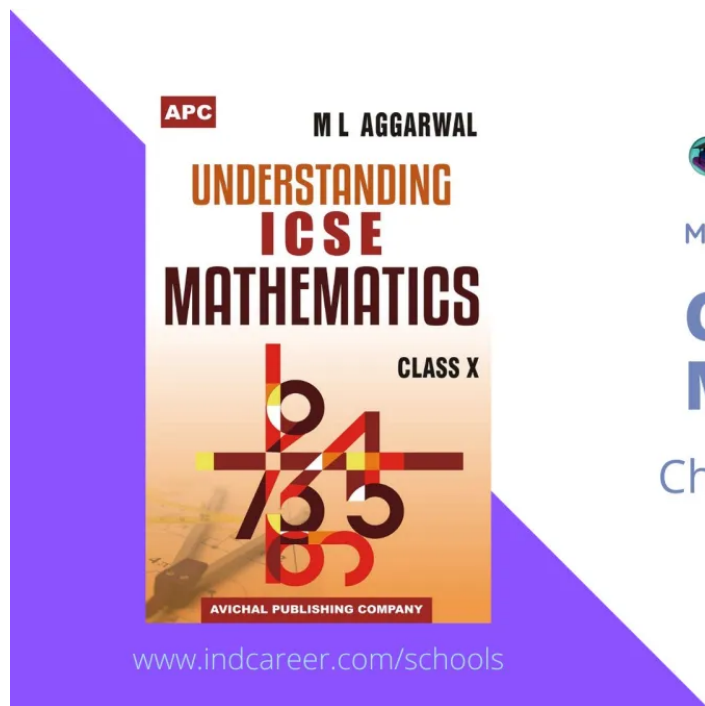


ML Aggarwal Solutions for Class 10 Maths Chapter 6- Factorization



ML Agrawal Solutions

CLASS 10 MATHS

Chapter 6: Factorization

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Chapter 6- Factorization

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ML Aggarwal 10th Maths Chapter 6, Class 10 Maths Chapter 6 solutions

Exercise 6.1

1. Find the remainder (without division) on dividing $f(x)$ by $(x - 2)$ where

(i) $f(x) = 5x^2 - 7x + 4$

Solutions:-

Let us assume $x - 2 = 0$

Then, $x = 2$

Given, $f(x) = 5x^2 - 7x + 4$

Now, substitute the value of x in $f(x)$,

$$f(2) = (5 \times 2^2) - (7 \times 2) + 4$$

$$= (5 \times 4) - 14 + 4$$

$$= 20 - 14 + 4$$

$$= 24 - 14$$

$$= 10$$

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Therefore, the remainder is 10.

(ii) $f(x) = 2x^3 - 7x^2 + 3$

Solution:-

Let us assume $x - 2 = 0$

Then, $x = 2$

Given, $f(x) = 2x^3 - 7x^2 + 3$

Now, substitute the value of x in $f(x)$,

$$f(2) = (2 \times 2^3) - (7 \times 2^2) + 3$$

$$= (2 \times 8) - (7 \times 4) + 3$$

$$= 16 - 28 + 3$$

$$= 19 - 28$$

$$= -9$$

Therefore, the remainder is -9.

2. Using the remainder theorem, find the remainder on dividing $f(x)$ by $(x + 3)$ where

(i) $f(x) = 2x^2 - 5x + 1$

Solution:-

Let us assume $x + 3 = 0$

Then, $x = -3$

Given, $f(x) = 2x^2 - 5x + 1$

Now, substitute the value of x in $f(x)$,

$$f(-3) = (2 \times -3^2) - (5 \times (-3)) + 1$$

$$= (2 \times 9) - (-15) + 1$$

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$$= 18 + 15 + 1$$

$$= 34$$

Therefore, the remainder is 34.

$$(ii) f(x) = 3x^3 + 7x^2 - 5x + 1$$

Solution:-

Let us assume $x + 3 = 0$

Then, $x = -3$

$$\text{Given, } f(x) = 3x^3 + 7x^2 - 5x + 1$$

Now, substitute the value of x in $f(x)$,

$$f(-3) = (3 \times -3^3) + (7 \times -3^2) - (5 \times -3) + 1$$

$$= (3 \times -27) + (7 \times 9) - (-15) + 1$$

$$= -81 + 63 + 15 + 1$$

$$= -81 + 79$$

$$= -2$$

Therefore, the remainder is -2.

3. Find the remainder (without division) on dividing $f(x)$ by $(2x + 1)$ where,

$$(i) f(x) = 4x^2 + 5x + 3$$

Solution:-

Let us assume $2x + 1 = 0$

Then, $2x = -1$

$$x = -\frac{1}{2}$$

$$\text{Given, } f(x) = 4x^2 + 5x + 3$$

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Now, substitute the value of x in $f(x)$,

$$f(-\frac{1}{2}) = 4(-\frac{1}{2})^2 + 5(-\frac{1}{2}) + 3$$

$$= (4 \times \frac{1}{4}) + (-\frac{5}{2}) + 3$$

$$= 1 - \frac{5}{2} + 3$$

$$= 4 - \frac{5}{2}$$

$$= \frac{(8 - 5)}{2}$$

$$= \frac{3}{2} = 1\frac{1}{2}$$

Therefore, the remainder is $1\frac{1}{2}$.

$$(ii) f(x) = 3x^3 - 7x^2 + 4x + 11$$

Solution:-

Let us assume $2x + 1 = 0$

Then, $2x = -1$

$$x = -\frac{1}{2}$$

$$\text{Given, } f(x) = 3x^3 - 7x^2 + 4x + 11$$

Now, substitute the value of x in $f(x)$,

$$f(-\frac{1}{2}) = (3 \times (-\frac{1}{2})^3) - (7 \times (-\frac{1}{2})^2) + (4 \times -\frac{1}{2}) + 11$$

$$= 3 \times (-\frac{1}{8}) - (7 \times \frac{1}{4}) + (-2) + 11$$

$$= -\frac{3}{8} - \frac{7}{4} - 2 + 11$$

$$= -\frac{3}{8} - \frac{7}{4} + 9$$

$$= \frac{(-3 - 14 + 72)}{8}$$

$$= \frac{55}{8}$$

=

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$$6\frac{7}{8}$$

4. Using remainder theorem, find the value of k if on dividing $2x^3 + 3x^2 - kx + 5$ by $x - 2$ leaves a remainder 7.

Solution:-

Let us assume, $x - 2 = 0$

Then, $x = 2$

Given, $2x^3 + 3x^2 - kx + 5$

Now, substitute the value of x in f(x),

$$f(2) = (2 \times 2^3) + (3 \times 2^2) - (k \times 2) + 5$$

$$= (2 \times 8) + (3 \times 4) - 2k + 5$$

$$= 16 + 12 - 2k + 5$$

$$= 33 - 2k$$

Form the question it is given that, remainder is 7.

$$\text{So, } 7 = 33 - 2k$$

$$2k = 33 - 7$$

$$2k = 26$$

$$K = 26/2$$

$$K = 13$$

Therefore, the value of k is 13.

5. Using remainder theorem, find the value of 'a' if the division of $x^3 + 5x^2 - ax + 6$ by $(x - 1)$ leaves the remainder 2a.

Solution:-

Let us assume $x - 1 = 0$

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Then, $x = 1$

Given, $f(x) = x^3 + 5x^2 - ax + 6$

Now, substitute the value of x in $f(x)$,

$$f(1) = 1^3 + (5 \times 1^2) - (a \times 1) + 6$$

$$= 1 + 5 - a + 6$$

$$= 12 - a$$

From the question it is given that, remainder is $2a$

$$\text{So, } 2a = 12 - a$$

$$2a + a = 12$$

$$3a = 12$$

$$a = 12/3$$

$$a = 4$$

Therefore, the value of a is 4.

6. (i) What number must be divided be subtracted from $2x^2 - 5x$ so that the resulting polynomial leaves the remainder 2, when divided by $2x + 1$?

Solution:-

let us assume 'p' be subtracted from $2x^2 - 5x$

So, dividing $2x^2 - 5x$ by $2x + 1$,

$$\begin{array}{r} 2x + 1 \overline{) 2x^2 - 5x - p} \\ \underline{2x^2 + x} \\ -6x - p \\ \underline{-6x - 3} \\ + \\ \hline -p + 3 \end{array}$$

Hence, remainder is $3 - p$

From the question it is given that, remainder is 2.

$$3 - p = 2$$

$$p = 3 - 2$$

$$p = 1$$

Therefore, 1 is to be subtracted.

(ii) What number must be added to $2x^3 - 7x^2 + 2x$ so that the resulting polynomial leaves the remainder -2 when divided by $2x - 3$?

Solution:-

let us assume 'p' be subtracted from $2x^3 - 7x^2 + 2x$,

So, dividing it by $2x - 3$,

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$$\begin{array}{r}
 2x - 3 \overline{) 2x^3 - 7x^2 + 2x + p} \quad (x^2 - 2x - 2) \\
 \underline{2x^3 - 3x^2} \\
 -4x^2 + 2x \\
 \underline{-4x^2 + 6x} \\
 + - \\
 \underline{-4x + p} \\
 -4x + 6 \\
 \underline{+ } \\
 P - 6
 \end{array}$$

Hence, remainder is $p - 6$

From the question it is given that, remainder is -2 .

$$P - 6 = -2$$

$$P = -2 + 6$$

$$P = 4$$

Therefore, 4 is to be added.

7. (i) When divided by $x - 3$ the polynomials $x^3 - px^2 + x + 6$ and $2x^3 - x^2 - (p + 3)x - 6$ leave the same remainder. Find the value of 'p'.

Solution:-

From the question it is given that, by dividing $x^3 - px^2 + x + 6$ and $2x^3 - x^2 - (p + 3)x - 6$ by $x - 3 = 0$, then $x = 3$.

$$\text{Let us assume } p(x) = x^3 - px^2 + x + 6$$

Now, substitute the value of x in $p(x)$,

$$p(3) = 3^3 - (p \times 3^2) + 3 + 6$$

$$= 27 - 9p + 9$$

$$= 36 - 9p$$

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Then, $q(x) = 2x^3 - x^2 - (p + 3)x - 6$

Now, substitute the value of x in $q(x)$,

$$q(3) = (2 \times 3^3) - (3)^2 - (p + 3) \times 3 - 6$$

$$= (2 \times 27) - 9 - 3p - 9 - 6$$

$$= 54 - 24 - 3p$$

$$= 30 - 3p$$

Given, the remainder in each case is same,

$$\text{So, } 36 - 9p = 30 - 3p$$

$$36 - 30 = 9p - 3p$$

$$6 = 6p$$

$$p = 6/6$$

$$p = 1$$

Therefore, value of p is 1.

(ii) Find 'a' if the two polynomials $ax^3 + 3x^2 - 9$ and $2x^3 + 4x + a$, leaves the same remainder when divided by $x + 3$.

Solution:-

Let us assume $p(x) = ax^3 + 3x^2 - 9$ and $q(x) = 2x^3 + 4x + a$

From the question it is given that, both $p(x)$ and $q(x)$ leaves the same remainder when divided by $x + 3$.

Let us assume that, $x + 3 = 0$

Then, $x = -3$

Now, substitute the value of x in $p(x)$ and in $q(x)$,

$$\text{So, } p(-3) = q(-3)$$

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$$a(-3)^3 + 3(-3)^2 - 9 = 2(-3)^3 + 4(-3) + a$$

$$-27a + 27 - 9 = -54 - 12 + a$$

$$-27a + 18 = -66 + a$$

$$-27a - a = -66 - 18$$

$$-28a = -84$$

$$a = 84/28$$

Therefore, $a = 3$

(iii) The polynomials $ax^3 + 3x^2 - 3$ and $2x^3 - 5x + a$ when divided by $x - 4$ leave the remainder r_1 and r_2 respectively. If $2r_1 = r_2$, then find the value of a .

Solution:

Let us assume $p(x) = ax^3 + 3x^2 - 3$ and $q(x) = 2x^3 - 5x + a$

From the question it is given that, both $p(x)$ and $q(x)$ leaves the remainder r_1 and r_2 respectively when divided by $x - 4$.

Also, given relation $2r_1 = r_2$

Let us assume that, $x - 4 = 0$

Then, $x = 4$

Now, substitute the value of x in $p(x)$ and in $q(x)$,

By factor theorem, $r_1 = p(x)$ and $r_2 = q(x)$

So, $2 \times p(4) = q(4)$

$$2[a(4)^3 + 3(4)^2 - 3] = 2(4)^3 - 5(4) + a$$

$$2[64a + 48 - 3] = 128 - 20 + a$$

$$128a + 96 - 6 = 128 - 20 + a$$

$$128a + 90 = 108 + a$$

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$$128a - a = 108 - 90$$

$$127a = 18$$

$$a = 18/127$$

Therefore, the value of $a = 18/127$.

8. Using remainder theorem, find the remainders obtained when $x^3 + (kx + 8)x + k$ is divided by $x + 1$ and $x - 2$. Hence, find k if the sum of two remainders is 1.

Solution:

Let us assume $p(x) = x^3 + (kx + 8)x + k$

From the question it is given that, the sum of the remainders when $p(x)$ is divided by $(x + 1)$ and $(x - 2)$ is 1.

Let us assume that, $x + 1 = 0$

Then, $x = -1$

Also, when $x - 2 = 0$

Then, $x = 2$

Now, by remainder theorem we have

$$p(-1) + p(2) = 1$$

$$(-1)^3 + [k(-1) + 8](-1) + k + (2)^3 + [k(2) + 8](2) + k = 1$$

$$-1 + k - 8 + k + 8 + 4k + 16 + k = 1$$

$$7k + 15 = 1$$

$$7k = 1 - 15$$

$$k = -14/7$$

$$k = -2$$

Therefore, $k = -2$.

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9. By factor theorem, show that $(x + 3)$ and $(2x - 1)$ are factors of $2x^2 + 5x - 3$.

Solution:-

Let us assume, $x + 3 = 0$

Then, $x = -3$

Given, $f(x) = 2x^2 + 5x - 3$

Now, substitute the value of x in $f(x)$,

$$f(-3) = (2 \times (-3)^2) + (5 \times -3) - 3$$

$$= (2 \times 9) + (-15) - 3$$

$$= 18 - 15 - 3$$

$$= 18 - 18$$

$$= 0$$

Now, $2x - 1 = 0$

Then, $2x = 1$

$$x = \frac{1}{2}$$

Given, $f(x) = 2x^2 + 5x - 3$

Now, substitute the value of x in $f(x)$,

$$f\left(\frac{1}{2}\right) = (2 \times (\frac{1}{2})^2) + (5 \times \frac{1}{2}) - 3$$

$$= (2 \times (\frac{1}{4})) + \frac{5}{2} - 3$$

$$= \frac{1}{2} + \frac{5}{2} - 3$$

$$= (1 + 5)/2 - 3$$

$$= 6/2 - 3$$

$$= 3 - 3$$

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$$= 0$$

Hence, it is proved that, $(x + 3)$ and $(2x - 1)$ are factors of $2x^2 + 5x - 3$.

10. Without actual division, prove that $x^4 + 2x^3 - 2x^2 + 2x + 3$ is exactly divisible by $x^2 + 2x - 3$.

Solution:-

Consider $x^2 + 2x - 3$

By factor method, $x^2 + 3x - x - 3$

$$= x(x + 3) - 1(x + 3)$$

$$= (x - 1)(x + 3)$$

$$\text{So, } f(x) = x^4 + 2x^3 - 2x^2 + 2x + 3$$

Now take, $x + 3 = 0$

$$x = -3$$

$$\text{Then, } f(-3) = (-3)^4 + 2 \times (-3)^3 - (2 \times (-3)^2) + (2 \times -3) + 3$$

$$= 81 - 54 - 18 - 6 - 3$$

$$= 0$$

Therefore, $(x + 3)$ is a factor of $f(x)$

And also, take $x - 1 = 0$

$$x = 1$$

$$\text{Then, } f(1) = 1^4 + 2(1)^3 - 2(1)^2 + 2(1) - 3$$

$$= 0$$

Therefore, $(x - 1)$ is a factor of $f(x)$

By comparing both results, $p(x)$ is exactly divisible by $x^2 + 2x - 3$.

11. Show that $(x - 2)$ is a factor of $3x^2 - x - 10$. Hence factories $3x^2 - x - 10$.

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Solution:-

Let us assume $x - 2 = 0$

Then, $x = 2$

Given, $f(x) = 3x^2 - x - 10$

Now, substitute the value of x in $f(x)$,

$$f(2) = (3 \times 2^2) - 2 - 10$$

$$= (3 \times 4) - 2 - 10$$

$$= 12 - 2 - 10$$

$$= 12 - 12$$

$$= 0$$

Therefore, $(x - 2)$ is a factor of $f(x)$

Then, dividing $(3x^2 - x - 10)$ by $(x - 2)$, we get

$$\begin{array}{r} x-2 \overline{) 3x^2 - x - 10} \quad (3x + 5 \\ \underline{3x^2 + x} \\ -5x - 10 \\ \underline{5x + 10} \\ 0 \end{array}$$

Therefore, $3x^2 - x - 10 = (x - 2)(3x + 5)$

12. Using the factor theorem, show that $(x - 2)$ is a factor of $x^3 + x^2 - 4x - 4$. Hence factorize the polynomial completely.

Solution:-

Let us assume, $x - 2 = 0$

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Then, $x = 2$

Given, $f(x) = x^3 + x^2 - 4x - 4$

Now, substitute the value of x in $f(x)$,

$$f(2) = (2)^3 + (2)^2 - 4(2) - 4$$

$$= 8 - 4 - 8 - 4$$

$$= 0$$

Therefore, by factor theorem $(x - 2)$ is a factor of $x^3 + x^2 - 4x - 4$

Then, dividing $f(x)$ by $(x - 2)$, we get

$$\begin{array}{r} \overline{) \begin{array}{r} x^3 + x^2 - 4x - 4 \end{array}} \\ \underline{x^3 - 2x^2} \\ 3x^2 - 4x - 4 \\ \underline{- 3x^2 + 6x} \\ 2x - 4 \\ \underline{- 2x + 4} \\ 0 \end{array}$$

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Therefore, $x^3 + x^2 - 4x - 4 = (x - 2)(x^2 + 3x + 2)$

$$= (x - 2)(x^2 + 2x + x + 2)$$

$$= (x - 2)(x(x + 2) + 1(x + 2))$$

$$= (x - 2)(x + 2)(x + 1)$$

13. Show that $2x + 7$ is a factor of $2x^3 + 5x^2 - 11x - 14$. Hence factorize the given expression completely, using the factor theorem.

Solution:-

Let us assume $2x + 7 = 0$

Then, $2x = -7$

$$x = -7/2$$

Given, $f(x) = 2x^3 + 5x^2 - 11x - 14$

Now, substitute the value of x in $f(x)$,

$$f(-7/2) = 2(-7/2)^3 + 5(-7/2)^2 + 11(-7/2) - 14$$

$$= 2(-343/8) + 5(49/4) + (-77/2) - 14$$

$$= -343/4 + 245/4 - 77/2 - 14$$

$$= (-343 + 245 + 154 - 56)/4$$

$$= -399 + 399/4$$

$$= 0$$

Therefore, $(2x + 7)$ is a factor of $2x^3 + 5x^2 - 11x - 14$

Then, dividing $f(x)$ by $(2x + 1)$, we get

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$$\begin{array}{r}
 \overline{x^2 - x - 2} \\
 2x+7 \overline{) 2x^3 + 5x^2 - 11x - 14} \\
 \underline{2x^3 + 7x^2} \\
 - 2x^2 - 11x - 14 \\
 \underline{ - 2x^2 - 7x} \\
 - 4x - 14 \\
 \underline{ - 4x - 14} \\
 0
 \end{array}$$

Therefore, $2x^3 + 5x^2 - 11x - 14 = (2x + 7)(x^2 - x - 2)$

$$= (2x + 7)(x^2 - 2x + x - 2)$$

$$= (2x + 7)(x(x - 2) + 1(x - 2))$$

$$= (x + 1)(x - 2)(2x + 7)$$

14. Use factor theorem to factorize the following polynomials completely.

(i) $x^3 + 2x^2 - 5x - 6$

Solution:-

Let us assume $x = -1$,

Given, $f(x) = x^3 + 2x^2 - 5x - 6$

Now, substitute the value of x in $f(x)$,

$$f(-1) = (-1)^3 + 2(-1)^2 - 5(-1) - 6$$

$$= -1 + 2(1) + 5 - 6$$

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$$= -1 + 2 + 5 - 6$$

$$= -7 + 7$$

$$= 0$$

Then, dividing $f(x)$ by $(x + 1)$, we get

$$\begin{array}{r}
 x^2 + x - 6 \\
 x + 1 \overline{) x^3 + 2x^2 - 5x - 6} \\
 \underline{x^3 + x^2} \\
 x^2 - 5x - 6 \\
 \underline{x^2 + x} \\
 -6x - 6 \\
 \underline{-6x - 6} \\
 0
 \end{array}$$

$$\text{Therefore, } x^3 + 2x^2 - 5x - 6 = (x + 1)(x^2 + 3x - 2x - 6)$$

$$= (x + 1)(x(x + 3) - 2(x + 3))$$

$$= (x + 1)(x - 2)(x + 3)$$

$$(ii) x^3 - 13x - 12$$

Solution:-

Let us assume $x = -1$,

$$\text{Given, } f(x) = x^3 - 13x - 12$$

Now, substitute the value of x in $f(x)$,

$$f(-1) = (-1)^3 - 13(-1) - 12$$

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$$= -1 + 13 - 12$$

$$= -13 + 13$$

$$= 0$$

Then, dividing $f(x)$ by $(x + 1)$, we get

$$\begin{array}{r}
 \begin{array}{cccc}
 x^2 & -x & -12 \\
 x+1 & \overline{) x^3 + 0x^2 - 13x - 12} \\
 \underline{x^3} & & & \\
 & +x^2 & & \\
 & \underline{-x^2} & & \\
 & & -13x & -12 \\
 & & \underline{-12x} & \\
 & & & -12 \\
 & & & \underline{-12} \\
 & & & 0
 \end{array}
 \end{array}$$

$$\text{Therefore, } x^3 - 13x - 12 = (x + 1)(x^2 - x - 12)$$

$$= (x + 1)(x^2 - 4x + 3x - 12)$$

$$= (x + 1)(x(x - 4)) + 3(x - 4)$$

$$= (x + 1)(x + 3)(x - 4)$$

15. Use the remainder theorem to factorize the following expression.

(i) $2x^3 + x^2 - 13x + 6$

Solution:-

Let us assume $x = 2$,

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Then, $f(x) = 2x^3 + x^2 - 13x + 6$

Now, substitute the value of x in $f(x)$,

$$f(2) = (2 \times 2^3) + 2^2 - 13 \times 2 + 6$$

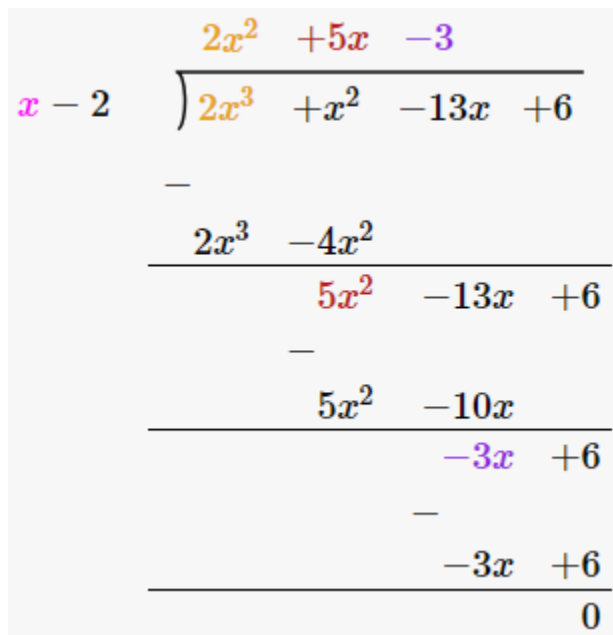
$$= (2 \times 8) + 4 - 26 + 6$$

$$= 16 + 4 - 26 + 6$$

$$= 26 - 26$$

$$= 0$$

Then, dividing $f(x)$ by $(x - 2)$, we get


$$\begin{array}{r} 2x^2 + 5x - 3 \\ x - 2 \overline{) 2x^3 + x^2 - 13x + 6} \\ \underline{2x^3 - 4x^2} \\ 5x^2 - 13x + 6 \\ \underline{5x^2 - 10x} \\ -3x + 6 \\ \underline{-3x + 6} \\ 0 \end{array}$$

Therefore, $2x^3 + x^2 - 13x + 6 = (x - 2)(2x^2 + 5x - 3)$

$$= (x - 2)(2x^2 + 6x - x - 3)$$

$$= (x - 2)(2x(x + 3) - 1(x + 3))$$

$$= (x - 2)(x + 3)(2x - 1)$$

(ii) $3x^2 + 2x^2 - 19x + 6$

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Solution:-

$$\text{Given, } f(x) = 3x^3 + 2x^2 - 19x + 6$$

Let us assume $x = 1$

$$\text{Then, } f(1) = 3(1)^3 + 2(1)^2 - (19 \times 1) + 6$$

$$= 3 + 2 - 19 + 6$$

$$= 11 - 19$$

$$= -8$$

$$\text{So, } -8 \neq 0$$

Let us assume $x = -1$

$$\text{Then, } f(-1) = 3(-1)^3 + 2(-1)^2 - (19 \times (-1)) + 6$$

$$= -3 + 2 + 19 + 6$$

$$= -3 + 27$$

$$= 24$$

$$\text{So, } 24 \neq 0$$

Now, assume $x = 2$

$$\text{Then, } f(2) = 3(2)^3 + 2(2)^2 - (19 \times (2)) + 6$$

$$= 24 + 8 - 38 + 6$$

$$= 38 - 38$$

$$= 0$$

$$\text{So, } 0 = 0$$

Therefore, $(x - 2)$ is a factor of $f(x)$.

$$f(x) = 3x^3 + 2x^2 - 19x + 6$$

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$$= 3x^3 - 6x^2 + 8x^2 - 16x - 3x + 6$$

$$= 3x^2 (x - 2) + 8x (x - 2) - 3(x - 2)$$

$$= (x - 2) (3x^2 + 8x - 3)$$

$$= (x - 2) (3x^2 + 9x - x - 3)$$

$$= (x - 2) (3x(x + 3) - 1(x + 3))$$

$$= (x - 2) (x + 3) (3x - 1)$$

$$\text{(iii) } 2x^3 + 3x^2 - 9x - 10$$

Solution:-

$$\text{Given, } f(x) = 2x^3 + 3x^2 - 9x - 10$$

Let us assume, $x = -1$

$$= 2(-1)^3 + 3(-1)^2 - 9(-1) - 10$$

$$= -2 + 3 + 9 - 10$$

$$= 12 - 12$$

$$= 0$$

Therefore, $(x + 1)$ is the factor of $2x^3 + 3x^2 - 9x - 10$

Then, dividing $f(x)$ by $(x + 1)$, we get

$$\begin{array}{r}
 2x^2 + x - 10 \\
 x + 1 \overline{) 2x^3 + 3x^2 - 9x - 10} \\
 \underline{2x^3 + 2x^2} \\
 x^2 - 9x - 10 \\
 \underline{x^2 + x} \\
 -10x - 10 \\
 \underline{-10x - 10} \\
 0
 \end{array}$$

Therefore, $2x^3 + 3x^2 - 9x - 10 = 2x^2 + 5x - 4x - 10$

$$= x(2x + 5) - 2(2x + 5) - (2x + 5)(x - 2)$$

Hence the factors are $(x + 1)(x - 2)(2x + 5)$

(iv) $x^3 + 10x^2 - 37x + 26$

Solution:-

Given, $f(x) = x^3 + 10x^2 - 37x + 26$

Let us assume, $x = 1$

Then, $f(1) = 1^3 + 10(1)^2 - 37(1) + 26$

$$= 1 + 10 - 37 + 26$$

$$= 37 - 37$$

$$= 0$$

Therefore, $x - 1$ is a factor of $x^3 + 10x^2 - 37x + 26$

Then, dividing $f(x)$ by $(x - 1)$, we get

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$$\begin{array}{r}
 x^2 + 11x - 26 \\
 x - 1 \overline{) x^3 + 10x^2 - 37x + 26} \\
 \underline{x^3 - x^2} \\
 11x^2 - 37x + 26 \\
 \underline{11x^2 - 11x} \\
 -26x + 26 \\
 \underline{-26x + 26} \\
 0
 \end{array}$$

Therefore, $x^3 + 10x^2 - 37x + 26 = (x - 1)(x^2 + 11x - 26)$

$$= (x - 1)(x^2 + 13x - 2x - 26)$$

$$= (x - 1)(x(x + 13) - 2(x + 13))$$

$$= (x - 1)((x - 2)(x + 13))$$

16. If $(2x + 1)$ is a factor of $6x^3 + 5x^2 + ax - 2$ find the value of a .

Solution:-

Let us assume $2x + 1 = 0$

Then, $2x = -1$

$$x = -\frac{1}{2}$$

$$\text{Given, } f(x) = 6x^3 + 5x^2 + ax - 2$$

Now, substitute the value of x in $f(x)$,

$$f\left(-\frac{1}{2}\right) = 6\left(-\frac{1}{2}\right)^3 + 5\left(-\frac{1}{2}\right)^2 + a\left(-\frac{1}{2}\right) - 2$$

$$= 6\left(-\frac{1}{8}\right) + 5\left(\frac{1}{4}\right) - \frac{1}{2}a - 2$$

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$$= -3/4 + 5/4 - a/2 - 2$$

$$= (-3 + 4 - 2a - 8)/4$$

$$= (-6 - 2a)/4$$

From the question, $(2x + 1)$ is a factor of $6x^3 + 5x^2 + ax - 2$

Then, remainder is 0.

$$\text{So, } (-6 - 2a)/4 = 0$$

$$-6 - 2a = 4 \times 0$$

$$-6 - 2a = 0$$

$$-2a = 6$$

$$a = -6/2$$

$$a = -3$$

Therefore, the value of a is -3 .

17. If $(3x - 2)$ is a factor of $3x^3 - kx^2 + 21x - 10$, find the value of k .

Solution:-

Let us assume $3x - 2 = 0$

Then, $3x = 2$

$$X = 2/3$$

Given, $f(x) = 3x^3 - kx^2 + 21x - 10$

Now, substitute the value of x in $f(x)$,

$$f(2/3) = 3(2/3)^3 - k(2/3)^2 + 21(2/3) - 10$$

$$= 3(8/27) - k(4/9) + 14 - 10$$

$$= 8/9 - 4k/9 + 14 - 10$$

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$$= 8/9 - 4k/9 + 4$$

$$= (8 - 4k + 36)/9$$

$$= (44 - 4k)/9$$

From the question, $(3x - 2)$ is a factor of $3x^3 - kx^2 + 21x - 10$

Then, remainder is 0

$$\text{So, } (44 - 4k)/9 = 0$$

$$44 - 4k = 0 \times 9$$

$$44 = 4k$$

$$K = 44/4$$

$$K = 11$$

18. If $(x - 2)$ is a factor of $2x^3 - x^2 + px - 2$, then (i) find the value of p . (ii) with this value of p , factorize the above expression completely.

Solution:-

Let us assume $x - 2 = 0$

Then, $x = 2$

$$\text{Given, } f(x) = 2x^3 - x^2 + px - 2$$

Now, substitute the value of x in $f(x)$,

$$f(2) = (2 \times 2^3) - 2^2 + (p \times 2) - 2$$

$$= (2 \times 8) - 4 + 2p - 2$$

$$= 16 - 4 + 2p - 2$$

$$= 16 - 6 + 2p$$

$$= 10 + 2p$$

From the question, $(x - 2)$ is a factor of $2x^3 - x^2 + px - 2$

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Then, remainder is 0.

$$10 + 2p = 0$$

$$2p = -10$$

$$P = -10/2$$

$$P = -5$$

So, $(x - 2)$ is a factor of $2x^3 - x^2 + 5x - 2$

$$\begin{array}{r}
 \textcolor{red}{2x^2} \text{ } \textcolor{red}{+3x} \text{ } \textcolor{blue}{+11} \\
 x - 2 \overline{) 2x^3 - x^2 + 5x - 2} \\
 \underline{2x^3 } \\
 \textcolor{red}{3x^2} \\
 \underline{ - 6x } \\
 \textcolor{blue}{11x} \\
 \underline{ - 22} \\
 \textcolor{violet}{20}
 \end{array}$$

$$\text{Therefore, } 2x^3 - x^2 + 5x - 2 = (x - 2)(2x^2 + 3x + 1)$$

$$= (x - 2)(2x^2 + 2x + x + 1)$$

$$= (x - 2)(2x(x + 1) + 1(x + 1))$$

$$= (x + 1)(x - 2)(2x + 1)$$

19. What number should be subtracted from $2x^3 - 5x^2 + 5x$ so that the resulting polynomial has $2x - 3$ as a factor?

Solution:-

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Let us assume the number to be subtracted from $2x^3 - 5x^2 + 5x$ be p .

$$\text{Then, } f(x) = 2x^3 - 5x^2 + 5x - p$$

$$\text{Given, } 2x - 3 = 0$$

$$x = 3/2$$

$$f(3/2) = 0$$

$$\text{So, } f(3/2) = 2(3/2)^3 - 5(3/2)^2 + 5(3/2) - p = 0$$

$$2(27/8) - 5(9/4) + 15/2 - p = 0$$

$$27/4 - 45/4 + 15/2 - p = 0 \text{ [multiply by 4 for all numerator]}$$

$$27 - 45 + 30 - 4p = 0$$

$$57 - 45 - 4p = 0$$

$$12 - 4p = 0$$

$$P = 12/4$$

$$P = 3$$

Therefore, 3 is the number should be subtracted from $2x^3 - 5x^2 + 5x$.

20. (i) Find the value of the constants a and b , if $(x - 2)$ and $(x + 3)$ are both factors of the expression $x^3 + ax^2 + bx - 12$.

Solution:-

$$\text{Let us assume } x - 2 = 0$$

$$\text{Then, } x = 2$$

$$\text{Given, } f(x) = x^3 + ax^2 + bx - 12$$

Now, substitute the value of x in $f(x)$,

$$f(2) = 2^3 + a(2)^2 + b(2) - 12$$

$$= 8 + 4a + 2b - 12$$

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$$= 4a + 2b - 4$$

From the question, $(x - 2)$ is a factor of $x^3 + ax^2 + bx - 12$.

$$\text{So, } 4a + 2b - 4 = 0$$

$$4a + 2b = 4$$

By dividing both the side by 2 we get,

$$2a + b = 2 \dots \text{[equation (i)]}$$

Now, assume $x + 3 = 0$

$$\text{Then, } x = -3$$

$$\text{Given, } f(x) = x^3 + ax^2 + bx - 12$$

Now, substitute the value of x in $f(x)$,

$$f(-3) = (-3)^3 + a(-3)^2 + b(-3) - 12$$

$$= -27 + 9a - 3b - 12$$

$$= 9a - 3b - 39$$

From the question, $(x - 3)$ is a factor of $x^3 + ax^2 + bx - 12$.

$$\text{So, } 9a - 3b - 39 = 0$$

$$9a - 3b = 39$$

By dividing both the side by 3 we get,

$$3a - b = 13 \dots \text{[equation (ii)]}$$

Now, adding both equation (i) and equation (ii) we get,

$$(2a + b) + (3a - b) = 2 + 13$$

$$2a + 3a + b - b = 15$$

$$5a = 15$$

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$$a = 15/5$$

$$a = 3$$

Consider the equation (i) to find out 'b'.

$$2a + b = 2$$

$$2(3) + b = 2$$

$$6 + b = 2$$

$$b = 2 - 6$$

$$b = -4$$

(ii) If $(x + 2)$ and $(x + 3)$ are factors of $x^3 + ax + b$, Find the values of a and b .

Solution:-

Let us assume $x + 2 = 0$

Then, $x = -2$

Given, $f(x) = x^3 + ax + b$

Now, substitute the value of x in $f(x)$,

$$f(-2) = (-2)^3 + a(-2) + b$$

$$= -8 - 2a + b$$

From the question, $(x + 2)$ is a factor of $x^3 + ax + b$.

Therefore, remainder is 0.

$$f(x) = 0$$

$$-8 - 2a + b = 0$$

$$2a - b = -8 \dots \text{[equation (i)]}$$

Let us assume $x + 3 = 0$

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Then, $x = -3$

Given, $f(x) = x^3 + ax + b$

Now, substitute the value of x in $f(x)$,

$$f(-2) = (-3)^3 + a(-3) + b$$

$$= -27 - 3a + b$$

From the question, $(x + 3)$ is a factor of $x^3 + ax + b$.

Therefore, remainder is 0.

$$f(x) = 0$$

$$-27 - 3a + b = 0$$

$$3a - b = -27 \dots \text{[equation (i)]}$$

Now, subtracting both equation (i) and equation (ii) we get,

$$(2a - b) - (3a - b) = -8 - (-27)$$

$$2a - 3a - b + b = -8 + 27$$

$$-a = 19$$

$$a = -19$$

Consider the equation (i) to find out 'b'.

$$2a - b = -8$$

$$2(-19) - b = -8$$

$$-38 - b = -8$$

$$b = -38 + 8$$

$$b = -30$$

21. If $(x + 2)$ and $(x - 3)$ are factors of $x^3 + ax + b$, find the values of a and b . With these values of a and b , factorize the given expression.

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Solution:-

Let us assume $x + 2 = 0$

Then, $x = -2$

Given, $f(x) = x^3 + ax + b$

Now, substitute the value of x in $f(x)$,

$$f(-2) = (-2)^3 + a(-2) + b$$

$$= -8 - 2a + b$$

From the question, $(x + 2)$ is a factor of $x^3 + ax + b$.

Therefore, remainder is 0.

$$f(x) = 0$$

$$-8 - 2a + b = 0$$

$$2a - b = -8 \dots \text{[equation (i)]}$$

Now, assume $x - 3 = 0$

Then, $x = 3$

Given, $f(x) = x^3 + ax + b$

Now, substitute the value of x in $f(x)$,

$$f(3) = (3)^3 + a(3) + b$$

$$= 27 + 3a + b$$

From the question, $(x - 3)$ is a factor of $x^3 + ax + b$.

Therefore, remainder is 0.

$$f(x) = 0$$

$$27 + 3a + b = 0$$

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$$3a + b = -27 \dots \text{[equation (ii)]}$$

Now, adding both equation (i) and equation (ii) we get,

$$(2a - b) + (3a + b) = -8 - 27$$

$$2a - b + 3a + b = -35$$

$$5a = -35$$

$$a = -35/5$$

$$a = -7$$

Consider the equation (i) to find out 'b'.

$$2a - b = -8$$

$$2(-7) - b = -8$$

$$-14 - b = -8$$

$$b = -14 + 8$$

$$b = -6$$

Therefore, value of $a = -7$ and $b = -6$.

$$\text{Then, } f(x) = x^3 - 7x - 6$$

$$(x + 2)(x - 3)$$

$$= x(x - 3) + 2(x - 3)$$

$$= x^2 - 3x + 2x - 6$$

$$= x^2 - x - 6$$

Dividing $f(x)$ by $x^2 - x - 6$ we get,

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$$\begin{array}{r}
 x^2 - x - 6 \quad \overline{) \begin{array}{l} x^3 + 0x^2 - 7x - 6 \\ - (x^3 - x^2 - 6x) \\ \hline x^2 - x - 6 \\ - (x^2 - x - 6) \\ \hline 0 \end{array}} \\
 \hline
 \end{array}$$

Therefore, $x^3 - 7x - 6 = (x + 1)(x + 2)(x - 3)$

22. $(x - 2)$ is a factor of the expression $x^3 + ax^2 + bx + 6$. When this expression is divided by $(x - 3)$, it leaves the remainder 3. Find the values of a and b .

Solution:-

From the question it is given that, $(x - 2)$ is a factor of the expression $x^3 + ax^2 + bx + 6$

Then, $f(x) = x^3 + ax^2 + bx + 6 \dots$ [equation (i)]

Let assume $x - 2 = 0$

Then, $x = 2$

Now, substitute the value of x in $f(x)$,

$$f(2) = 2^3 + a(2)^2 + 2b + 6$$

$$= 8 + 4a + 2b + 6$$

$$= 14 + 4a + 2b$$

By dividing the numbers by 2 we get,

$$= 7 + 2a + b$$

From the question, $(x - 2)$ is a factor of the expression $x^3 + ax^2 + bx + 6$.

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So, remainder is 0.

$$f(x) = 0$$

$$7 + 2a + b = 0$$

$$2a + b = -7 \dots \text{[equation (ii)]}$$

Now, expression is divided by $(x - 3)$, it leaves the remainder 3.

$$\begin{array}{r}
 \begin{array}{r}
 x^2 \quad +x(a+3) \quad +3a+b+9 \\
 x-3 \overline{) x^3 + ax^2 + bx + 6} \\
 \underline{x^3 \qquad -3x^2} \\
 x^2(a+3) +6 \\
 \underline{ x^2(a+3) +x(-3a-9)} \\
 x(3a+b+9) +6 \\
 \underline{ x(3a+b+9) + -9a-3b-27} \\
 9a+3b+33
 \end{array}
 \end{array}$$

$$\text{So, remainder} = 33 + 9a + 3b = 3$$

$$9a + 3b = 3 - 33$$

$$9a + 3b = -30$$

By dividing the numbers by 3 we get,

$$= 3a + b = -10 \dots \text{[equation (iii)]}$$

Now, subtracting equation (iii) from equation (ii) we get,

$$(3a + b) - (2a + b) = -10 - (-7)$$

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$$3a - 2a + b - b = -10 + 7$$

$$a = -3$$

Consider the equation (ii) to find out 'b'.

$$2a + b = -7$$

$$2(-3) + b = -7$$

$$-6 + b = -7$$

$$b = -7 + 6$$

$$b = -1$$

23. If $(x - 2)$ is a factor of the expression $2x^3 + ax^2 + bx - 14$ and when the expression is divided by $(x - 3)$, it leaves a remainder 52, find the values of a and b.

Solution:-

From the question it is given that, $(x - 2)$ is a factor of the expression $2x^3 + ax^2 + bx - 14$

Then, $f(x) = 2x^3 + ax^2 + bx - 14$... [equation (i)]

Let assume $x - 2 = 0$

Then, $x = 2$

Now, substitute the value of x in $f(x)$,

$$f(2) = 2(2)^3 + a(2)^2 + 2b - 14$$

$$= 16 + 4a + 2b - 14$$

$$= 2 + 4a + 2b$$

By dividing the numbers by 2 we get,

$$= 1 + 2a + b$$

From the question, $(x - 2)$ is a factor of the expression $2x^3 + ax^2 + bx - 14$.

So, remainder is 0.

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$$f(x) = 0$$

$$1 + 2a + b = 0$$

$$2a + b = -1 \dots [\text{equation (ii)}]$$

Now, expression is divided by $(x - 3)$, it leaves the remainder 52.

$$\begin{array}{r}
 \begin{array}{ccccccc}
 & 2x^2 & +x(a+6) & +3a+b+18 & & & \\
 x-3 & \overline{) 2x^3} & +ax^2 & +bx & -14 & & \\
 \underline{2x^3} & & -6x^2 & & & & \\
 & & x^2(a+6) & & +bx & & -14 \\
 \underline{& & x^2(a+6)} & & +x(-3a-18) & & \\
 & & & & x(3a+b+18) & & -14 \\
 & & & & \underline{x(3a+b+18)} & & + -9a-3b-54 \\
 & & & & & & 9a+3b+40
 \end{array}
 \end{array}$$

$$\text{So, remainder} = 9a + 3b + 40 = 52$$

$$9a + 3b = 52 - 40$$

$$9a + 3b = 12$$

By dividing the numbers by 3 we get,

$$= 3a + b = 4 \dots [\text{equation (iii)}]$$

Now, subtracting equation (iii) from equation (ii) we get,

$$(3a + b) - (2a + b) = 4 - (-1)$$

$$3a - 2a + b - b = 4 + 1$$

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$$a = 5$$

$$a = 5$$

Consider the equation (ii) to find out 'b'.

$$2a + b = -1$$

$$2(5) + b = -1$$

$$10 + b = -1$$

$$b = -1 - 10$$

$$b = -11$$

24. If $ax^3 + 3x^2 + bx - 3$ has a factor $(2x + 3)$ and leaves remainder -3 when divided by $(x + 2)$, find the values of a and b . With these values of a and b , factorize the given expression.

Solution:-

Let us assume, $2x + 3 = 0$

Then, $2x = -3$

$$x = -3/2$$

Given, $f(x) = ax^3 + 3x^2 + bx - 3$

Now, substitute the value of x in $f(x)$,

$$f(-3/2) = a(-3/2)^3 + 3(-3/2)^2 + b(-3/2) - 3$$

$$= a(-27/8) + 3(9/4) - 3b/2 - 3$$

$$= -27a/8 + 27/4 - 3b/2 - 3$$

From the question it is given that, $ax^3 + 3x^2 + bx - 3$ has a factor $(2x + 3)$.

So, remainder is 0.

$$-27a/8 + 27/4 - 3b/2 - 3 = 0$$

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$$-27a + 54 - 12b - 24 = 0$$

$$-27a - 12b = -30$$

By dividing the numbers by -3 we get,

$$9a + 4b = 10 \text{ [equation (i)]}$$

Now, let us assume $x + 2 = 0$

Then, $x = -2$

$$\text{Given, } f(x) = ax^3 + 3x^2 + bx - 3$$

Now, substitute the value of x in $f(x)$,

$$f(2) = a(-2)^3 + 3(-2)^2 + b(-2) - 3$$

$$= -8a + 12 - 2b - 3$$

$$= -8a - 2b + 9$$

Leaves the remainder -3

$$\text{So, } -8a - 2b + 9 = -3$$

$$-8a - 2b = -3 - 9$$

$$-8a - 2b = -12$$

By dividing both sides by -2 we get,

$$4a + b = 6 \text{ [equation (ii)]}$$

By multiplying equation (ii) by 4 ,

$$16a + 4b = 24$$

Now, subtracting equation (ii) from equation (i) we get,

$$(16a + 4b) - (9a + 4b) = 24 - 10$$

$$16a - 9a + 4b - 4b = 14$$

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$$7a = 14$$

$$a = 14/7$$

$$a = 2$$

Consider the equation (i) to find out 'b'.

$$9a + 4b = 10$$

$$9(2) + 4b = 10$$

$$18 + 4b = 10$$

$$4b = 10 - 18$$

$$4b = -8$$

$$b = -8/4$$

$$b = -2$$

$$\text{Therefore, } f(x) = ax^3 + 3x^2 + bx - 3$$

$$= 2x^3 + 3x^2 - 2x - 3$$

Given, $2x + 3$ is a factor of $f(x)$

So, divide $f(x)$ by $2x + 3$

$$\begin{array}{r}
 x^2 - 1 \\
 2x + 3 \overline{) 2x^3 + 3x^2 - 2x - 3} \\
 \underline{2x^3 + 3x^2} \\
 0 - 2x - 3 \\
 \underline{-2x - 3} \\
 0
 \end{array}$$

Therefore, $2x^3 + 3x^2 - 2x - 3 = (2x + 3)(x^2 - 1)$

$$= (2x + 3)(x + 1)(x - 1)$$

25. Given $f(x) = ax^2 + bx + 2$ and $g(x) = bx^2 + ax + 1$. If $x - 2$ is a factor of $f(x)$ but leaves the remainder -15 when it divides $g(x)$, find the values of a and b . With these values of a and b , factorize the expression. $f(x) + g(x) + 4x^2 + 7x$.

Solution:-

From the question it is given that, $f(x) = ax^2 + bx + 2$ and $g(x) = bx^2 + ax + 1$ and $x - 2$ is a factor of $f(x)$,

$$\text{So, } x = 2$$

Now, substitute the value of x in $f(x)$,

$$f(2) = 0$$

$$a(2)^2 + b(2) + 2 = 0$$

$$4a + 2b + 2 = 0$$

By dividing both sides by 2 we get,

$$2a + b + 1 = 0 \dots \text{[equation (i)]}$$

Given, $g(x)$ divide by $(x - 2)$, leaves remainder -15

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$$g(x) = bx^2 + ax + 1$$

$$\text{So, } g(2) = -15$$

$$b(2)^2 + 2a + 1 = -15$$

$$4b + 2a + 1 + 15 = 0$$

$$4b + 2a + 16 = 0$$

By dividing both sides by 2 we get,

$$2b + a + 8 = 0 \dots [\text{equation (ii)}]$$

Now, subtracting equation (ii) from equation (i) multiplied by 2,

$$(4a + 2b + 2) - (a + 2b + 8) = 0 - 0$$

$$4a - a + 2b - 2b + 2 - 8 = 0$$

$$3a - 6 = 0$$

$$3a = 6$$

$$a = 6/3$$

$$a = 2$$

Consider the equation (i) to find out 'b'.

$$2a + b + 1 = 0$$

$$2(2) + b = -1$$

$$4 + b = -1$$

$$b = -1 - 4$$

$$b = -5$$

$$\text{Now, } f(x) = ax^2 + bx + 2 = 2x^2 - 5x + 2$$

$$g(x) = bx^2 + ax + 1 = -5x^2 + 2x + 1$$

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$$\begin{aligned} &\text{then, } f(x) + g(x) + 4x^2 + 7x \\ &= 2x^2 - 5x + 2 - 5x^2 + 2x + 1 + 4x^2 + 7x \\ &= x^2 + 4x + 3 \\ &= x^2 + 3x + x + 3 \\ &= x(x + 3) + 1(x + 3) \\ &= (x + 1)(x + 3) \end{aligned}$$

Chapter Test

1. Find the remainder when $2x^3 - 3x^2 + 4x + 7$ is divided by

(i) $x - 2$

(ii) $x + 3$

(iii) $2x + 1$

Solution:-

From the question it is given that, $f(x) = 2x^3 - 3x^2 + 4x + 7$

(i) Consider $x - 2$

let us assume $x - 2 = 0$

Then, $x = 2$

Now, substitute the value of x in $f(x)$,

$$f(2) = 2(2)^3 - 3(2)^2 + 4(2) + 7$$

$$= 16 - 12 + 8 + 7$$

$$= 31 - 12$$

$$= 19$$

Therefore, the remainder is 19

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(ii) consider $x + 3$

let us assume $x + 3 = 0$

Then, $x = -3$

Now, substitute the value of x in $f(x)$,

$$f(2) = 2(-3)^3 - 3(-3)^2 + 4(-3) + 7$$

$$= 2(-27) - 3(9) - 12 + 7$$

$$= -54 - 27 - 12 + 7$$

$$= -93 + 7$$

$$= -86$$

Therefore, remainder is -86.

(iii) consider $2x + 1$

Let us assume, $2x + 1 = 0$

Then, $2x = -1$

$$x = -\frac{1}{2}$$

Now, substitute the value of x in $f(x)$,

$$f(-\frac{1}{2}) = 2(-\frac{1}{2})^3 - 3(-\frac{1}{2})^2 + 4(-\frac{1}{2}) + 7$$

$$= 2(-\frac{1}{8}) - 3(\frac{1}{4}) + 4(-\frac{1}{2}) + 7$$

$$= -\frac{1}{4} - \frac{3}{4} - 2 + 7$$

$$= -1 - 2 + 7$$

$$= 4$$

Therefore, remainder is 4.

2. When $2x^3 - 9x^2 + 10x - p$ is divided by $(x + 1)$, the remainder is -24 . Find the value of p .

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Solution:-

Let us assume $x + 1 = 0$

Then, $x = -1$

Given, $f(x) = 2x^3 - 9x^2 + 10x - p$

Now, substitute the value of x in $f(x)$,

$$f(-1) = 2(-1)^3 - 9(-1)^2 + 10(-1) - p$$

$$= -2 - 9 - 10 + p$$

$$= -21 + p$$

From the question it is given that, the remainder is -24 ,

$$\text{So, } -21 + p = -24$$

$$p = -24 + 21$$

$$p = -3$$

$$\text{So, } f(x) = 2x^3 - 9x^2 + 10x - (-3)$$

$$= 2x^3 - 9x^2 + 10x + 3$$

Therefore, the value of p is 3 .

3. If $(2x - 3)$ is a factor of $6x^2 + x + a$, find the value of a . With this value of a , factorise the given expression.

Solution:-

Let us assume $2x - 3 = 0$

Then, $2x = 3$

$$x = 3/2$$

Given, $f(x) = 6x^2 + x + a$

Now, substitute the value of x in $f(x)$,

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$$f(3/2) = 6(3/2)^2 + (3/2) + a$$

$$= 6(9/4) + (3/2) + a$$

$$= 3(9/2) + (3/2) + a$$

$$= 27/2 + 3/2 + a$$

$$= 30/2 + a$$

$$= 15 + a$$

From the question, $(2x - 3)$ is a factor of $6x^2 + x + a$.

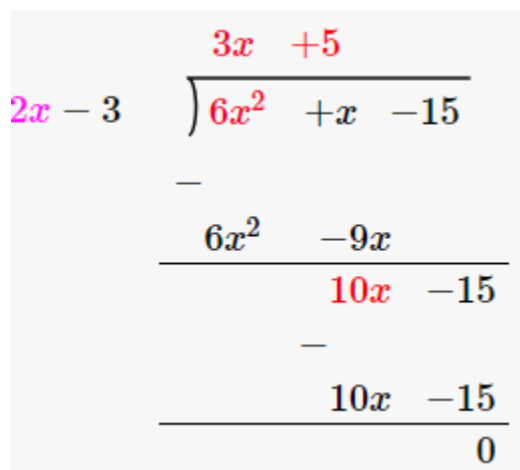
So, remainder is 0.

$$\text{Then, } 15 + a = 0$$

$$a = -15$$

$$\text{Therefore, } f(x) = 6x^2 + x - 15$$

Dividing $f(x)$ by $2x - 3$ we get,


$$\begin{array}{r} 3x + 5 \\ 2x - 3 \overline{) 6x^2 + x - 15} \\ \underline{6x^2 - 9x} \\ 10x - 15 \\ \underline{10x - 15} \\ 0 \end{array}$$

$$\text{Therefore, } 6x^2 + x - 15 = (2x - 3)(3x + 5)$$

4. When $3x^2 - 5x + p$ is divided by $(x - 2)$, the remainder is 3. Find the value of p . Also factorize the polynomial $3x^2 - 5x + p - 3$.

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Solution:-

Let us assume $x - 2 = 0$

Then, $x = 2$

Given, $f(x) = 3x^2 - 5x + p$

Now, substitute the value of x in $f(x)$,

$$\text{So, } f(2) = 3(2)^2 - 5(2) + p$$

$$= 3(4) - 10 + p$$

$$= 12 - 10 + p$$

$$= 2 + p$$

From the question it is given that, remainder is 3.

$$\text{So, } 2 + p = 3$$

$$p = 3 - 2$$

$$p = 1$$

Therefore, $f(x) = 3x^2 - 5x + 1$

Consider the polynomial, $3x^2 - 5x + p - 3$

Now, substitute the value of p in polynomial,

$$= 3x^2 - 5x + 1 - 3$$

$$= 3x^2 - 5x - 2$$

Now, by factorizing the polynomial $3x^2 - 5x - 2$,

Dividing $3x^2 - 5x - 2$ by $x - 2$ we get,

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$$\begin{array}{r} 3x + 1 \\ x - 2 \overline{) 3x^2 - 5x - 2} \\ \underline{3x^2 - 6x} \\ x - 2 \\ \underline{x - 2} \\ 0 \end{array}$$

Therefore, $3x^2 - 5x - 2 = (x - 2)(3x + 1)$

5. Prove that $(5x + 4)$ is a factor of $5x^3 + 4x^2 - 5x - 4$. Hence factorize the given polynomial completely.

Solution:-

Let us assume $(5x + 4) = 0$

Then, $5x = -4$

$$x = -4/5$$

Given, $f(x) = 5x^3 + 4x^2 - 5x - 4$

Now, substitute the value of x in $f(x)$,

$$\text{So, } f(-4/5) = 5(-4/5)^3 + 4(-4/5)^2 - 5(-4/5) - 4$$

$$= 5(-64/125) + 4(16/25) + 4 - 4$$

$$= -64/25 + 64/25$$

$$= (-64 + 64)/25$$

$$= 0/25$$

$$= 0$$

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Hence, $(5x + 4)$ is a factor of $5x^3 + 4x^2 - 5x - 4$.

So, dividing $5x^3 + 4x^2 - 5x - 4$ by $5x + 4$ we get,

$$\begin{array}{r}
 x^2 - 1 \\
 5x + 4 \overline{) 5x^3 + 4x^2 - 5x - 4} \\
 \underline{5x^3 + 4x^2} \\
 0 - 5x - 4 \\
 \underline{-5x - 4} \\
 0
 \end{array}$$

Therefore, $5x^3 + 4x^2 - 5x - 4 = (5x + 4)(x^2 - 1)$

$$= (5x + 4)(x^2 - 1^2)$$

$$= (5x + 4)(x + 1)(x - 1)$$

6. Use factor theorem to factorize the following polynomials completely:

(i) $4x^3 + 4x^2 - 9x - 9$

Solution:-

Let us assume $x = -1$,

Given, $f(x) = 4x^3 + 4x^2 - 9x - 9$

Now, substitute the value of x in $f(x)$,

$$f(-1) = 4(-1)^3 + 4(-1)^2 - 9(-1) - 9$$

$$= -4 + 4 + 9 - 9$$

$$= 0$$

Therefore, $x + 1$ is the factor of $4x^3 + 4x^2 - 9x - 9$.

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Now, dividing $4x^3 + 4x^2 - 9x - 9$ by $x + 1$ we get,

$$\begin{array}{r}
 4x^2 - 9 \\
 x + 1 \overline{) 4x^3 + 4x^2 - 9x - 9} \\
 \underline{4x^3 + 4x^2} \\
 0 - 9x - 9 \\
 \underline{-9x - 9} \\
 0
 \end{array}$$

Therefore, $4x^3 + 4x^2 - 9x - 9 = (x + 1)(4x^2 - 9)$

$$= (x + 1)((2x)^2 - (3)^2)$$

$$= (x + 1)(2x + 3)(2x - 3)$$

(ii) $x^3 - 19x - 30$

Solution:-

Let us assume $x = -2$,

$$\text{Given, } f(x) = x^3 - 19x - 30$$

Now, substitute the value of x in $f(x)$,

$$f(-1) = (-2)^3 - 19(-2) - 30$$

$$= -8 + 38 - 30$$

$$= -38 + 38$$

$$= 0$$

Therefore, $x + 2$ is the factor of $x^3 - 19x - 30$.

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Now, dividing $x^3 - 19x - 30$ by $x + 2$ we get,

$$\begin{array}{r}
 x^2 - 2x - 15 \\
 x + 2 \overline{) x^3 + 0x^2 - 19x - 30} \\
 \underline{x^3 + 2x^2} \\
 -2x^2 - 19x - 30 \\
 \underline{-2x^2 - 4x} \\
 -15x - 30 \\
 \underline{-15x - 30} \\
 0
 \end{array}$$

Therefore, $x^3 - 19x - 30 = (x + 2)(x^2 - 2x - 15)$

$$= (x + 2)(x^2 - 5x + 3x - 15)$$

$$= (x + 2)(x - 5)(x + 3)$$

7. If $x^3 - 2x^2 + px + q$ has a factor $(x + 2)$ and leaves a remainder 9, when divided by $(x + 1)$, find the values of p and q . With these values of p and q , factorize the given polynomial completely.

Solution:-

From the question it is given that, $(x + 2)$ is a factor of the expression $x^3 - 2x^2 + px + q$

$$\text{Then, } f(x) = x^3 - 2x^2 + px + q$$

Let assume $x + 2 = 0$

$$\text{Then, } x = -2$$

Now, substitute the value of x in $f(x)$,

$$f(-2) = (-2)^3 - 2(-2)^2 + p(-2) + q$$

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$$= -8 - 8 - 2p + q$$

$$= -16 - 2p + q$$

$$2p - q = -16 \dots \text{[equation (i)]}$$

Now, consider $(x + 1)$

$$\text{Then, } f(x) = x^3 - 2x^2 + px + q$$

Let assume $x + 1 = 0$

$$\text{Then, } x = -1$$

Now, substitute the value of x in $f(x)$,

$$f(-1) = (-1)^3 - 2(-1)^2 + p(-1) + q$$

$$= -1 - 2 - p + q$$

$$= -3 - p + q$$

Given, remainder is 9

$$\text{So, } -3 - p + q = 9$$

$$-p + q = 9 + 3$$

$$-p + q = 12 \dots \text{[equation (ii)]}$$

Now, adding equation (i) and equation (ii) we get,

$$(2p - q) + (-p + q) = -16 + 12$$

$$2p - q - p + q = -4$$

$$p = -4$$

Consider the equation (ii) to find out 'b'.

$$-p + q = 12$$

$$-(-4) + q = 12$$

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$$4 + q = 12$$

$$q = 12 - 4$$

$$q = 8$$

Therefore, by substituting the value of p and q $f(x) = x^3 - 2x^2 - 4x + 8$

Dividing $f(x)$ by $(x + 2)$ we get,

$$\begin{array}{r} x^2 - 4x + 4 \\ x + 2 \overline{) x^3 - 2x^2 - 4x + 8} \\ \underline{x^3 + 2x^2} \\ -4x^2 - 4x + 8 \\ \underline{-4x^2 - 8x} \\ 4x + 8 \\ \underline{4x + 8} \\ 0 \end{array}$$

$$x^3 - 2x^2 - 4x + 8 = (x + 2)(x^2 - 4x + 4)$$

$$= (x + 2)(x^2 - 2 \times x(-2) + 2^2)$$

$$= (x + 2)(x - 2)^2$$

8. If $(x + 3)$ and $(x - 4)$ are factors of $x^3 + ax^2 - bx + 24$, find the values of a and b: With these values of a and b, factorize the given expression.

Solution:-

Let us assume $x + 3 = 0$

Then, $x = -3$

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Given, $f(x) = x^3 + ax^2 - bx + 24$

Now, substitute the value of x in $f(x)$,

$$f(-3) = (-3)^3 + a(-3)^2 - b(-3) + 24$$

$$= -27 + 9a + 3b + 24$$

$$= 9a + 3b - 3$$

Dividing all terms by 3 we get,

$$= 3a + b - 1$$

From the question, $(x + 3)$ is a factor of $x^3 + ax^2 - bx + 24$.

Therefore, remainder is 0.

$$f(x) = 0$$

$$3a + b - 1 = 0$$

$$3a + b = 1 \dots \text{[equation (i)]}$$

Now, assume $x - 4 = 0$

Then, $x = 4$

Given, $f(x) = x^3 + ax^2 - bx + 24$

Now, substitute the value of x in $f(x)$,

$$f(4) = 4^3 + a(4)^2 - b(4) + 24$$

$$= 64 + 16a - 4b + 24$$

$$= 88 + 16a - 4b$$

Dividing all terms by 4 we get,

$$= 22 + 4a - b$$

From the question, $(x - 4)$ is a factor of $x^3 + ax^2 - bx + 24$.

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Therefore, remainder is 0.

$$f(x) = 0$$

$$22 + 4a - b = 0$$

$$4a - b = -22 \dots \text{[equation (ii)]}$$

Now, adding both equation (i) and equation (ii) we get,

$$(3a + b) + (4a - b) = 1 - 22$$

$$3a + b + 4a - b = -21$$

$$7a = -21$$

$$a = -21/7$$

$$a = -3$$

Consider the equation (i) to find out 'b'.

$$3a + b = 1$$

$$3(-3) + b = 1$$

$$-9 + b = 1$$

$$b = 1 + 9$$

$$b = 10$$

Therefore, value of $a = -3$ and $b = 10$.

Then, by substituting the value of a and b $f(x) = x^3 - 3x^2 - 10x + 24$

$$(x + 3)(x - 4)$$

$$= x(x - 4) + 3(x - 4)$$

$$= x^2 - 4x + 3x - 12$$

$$= x^2 - x - 12$$

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Dividing $f(x)$ by $x^2 - x - 12$ we get,

$$\begin{array}{r} x^2 - x - 12 \overline{) x^3 - 3x^2 - 10x + 24} \\ \underline{x^3 - x^2 - 12x} \\ -2x^2 + 2x + 24 \\ \underline{-2x^2 + 2x + 24} \\ 0 \end{array}$$

Therefore, $x^3 - 3x^2 - 10x + 24 = (x^2 - x - 12)(x - 2)$

$$= (x + 3)(x - 4)(x - 2)$$

9. If $(2x + 1)$ is a factor of both the expressions $2x^2 - 5x + p$ and $2x^2 + 5x + q$, find the value of p and q . Hence find the other factors of both the polynomials.

Solution:-

Let us assume $2x + 1 = 0$

Then, $2x = -1$

$$x = -\frac{1}{2}$$

Given, $p(x) = 2x^2 - 5x + p$

Now, substitute the value of x in $p(x)$,

$$p(-\frac{1}{2}) = 2(-\frac{1}{2})^2 - 5(-\frac{1}{2}) + p$$

$$= 2(\frac{1}{4}) + \frac{5}{2} + p$$

$$= \frac{1}{2} + \frac{5}{2} + p$$

$$= \frac{6}{2} + p$$

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$$= 3 + p$$

From the question it is given that, $(2x + 1)$ is a factor of both the expressions $2x^2 - 5x + p$

So, remainder is 0.

$$\text{Then, } 3 + p = 0$$

$$p = -3$$

Now consider $q(x) = 2x^2 + 5x + q$

Substitute the value of x in $q(x)$

$$q(-\frac{1}{2}) = 2(-\frac{1}{2})^2 + 5(-\frac{1}{2}) + q$$

$$= 2(\frac{1}{4}) - \frac{5}{2} + q$$

$$= \frac{1}{2} - \frac{5}{2} + q$$

$$= (1 - 5)/2 + q$$

$$= -4/2 + q$$

$$= q - 2$$

From the question it is given that, $(2x + 1)$ is a factor of both the expressions $2x^2 + 5x + q$

So, remainder is 0.

$$q - 2 = 0$$

$$q = 2$$

Therefore, $p = -3$ and $q = 2$

$$P(x) = 2x^2 - 5x - 3$$

$$q(x) = 2x^2 + 5x + 2$$

Then, divide $p(x)$ by $2x + 1$

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$$\begin{array}{r}
 \textcolor{brown}{x} - 3 \\
 2x + 1 \overline{) 2x^2 - 5x - 3} \\
 \underline{2x^2 \quad + x} \\
 -6x - 3 \\
 \underline{-6x - 3} \\
 0
 \end{array}$$

Therefore, $2x^2 - 5x - 3 = (2x + 1)(x - 3)$

Now, divide $q(x)$ by $2x + 1$

$$\begin{array}{r}
 \textcolor{brown}{x} + 2 \\
 2x + 1 \overline{) 2x^2 + 5x + 2} \\
 \underline{2x^2 \quad + x} \\
 4x + 2 \\
 \underline{4x + 2} \\
 0
 \end{array}$$

Therefore, $2x^2 + 5x + 2 = (2x + 1)(x + 2)$

10. If a polynomial $f(x) = x^4 - 2x^3 + 3x^2 - ax + b$ leaves remainder 5 and 19 when divided by $(x - 1)$ and $(x + 1)$ respectively, Find the values of a and b . Hence determined the remainder when $f(x)$ is divided by $(x - 2)$.

Solution:-

From the question it is given that,

$$f(x) = x^4 - 2x^3 + 3x^2 - ax + b$$

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Factor $(x - 1)$ leaves remainder 5,

Factor $(x + 1)$ leaves remainder 19,

Where $x = 1$ and $x = -1$

$$f(-1) = (-1)^4 - 2(-1)^3 + 3(-1)^2 - a(-1) + b = 19$$

$$1 - 2(-1) + 3(1) - a(-1) + b = 19$$

$$1 + 2 + 3 + a + b = 19$$

$$6 + a + b = 19$$

$$a + b = 19 - 6$$

$$a + b = 13 \dots \text{[equation (i)]}$$

$$f(1) = (1)^4 - 2(1)^3 + 3(1)^2 - a(1) + b = 5$$

$$1 - 2(1) + 3(1) - a(1) + b = 5$$

$$1 - 2 + 3 - a + b = 5$$

$$2 - a + b = 5$$

$$-a + b = 5 - 2$$

$$-a + b = 3 \dots \text{[equation (ii)]}$$

Now, subtracting equation (ii) from equation (i) we get,

$$(a + b) - (-a + b) = 13 - 3$$

$$a + b + a - b = 10$$

$$2a = 10$$

$$a = 10/2$$

$$a = 5$$

To find out the value of b , substitute the value of a in equation (i) we get,

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$$a + b = 13$$

$$5 + b = 13$$

$$b = 13 - 5$$

$$b = 8$$

Therefore, value of $a = 5$ and $b = 8$

11. When a polynomial $f(x)$ is divided by $(x - 1)$, the remainder is 5 and when it is, divided by $(x - 2)$, the remainder is 7. Find the remainder when it is divided by $(x - 1)(x - 2)$.

Solution:-

From the question it is given that,

Polynomial $f(x)$ is divided by $(x - 1)$,

Remainder = 5

Let us assume $x - 1 = 0$

$$x = 1$$

$$f(1) = 5$$

and the divided by $(x - 2)$, remainder = 7

let us assume $x - 2 = 0$

$$x = 2$$

$$\text{Therefore, } f(2) = 7$$

$$\text{So, } f(x) = (x - 1)(x - 2)q(x) + ax + b$$

Where, $q(x)$ is the quotient and $ax + b$ is remainder,

Now put $x = 1$, we get,

$$f(1) = (1 - 1)(1 - 2)q(1) + (a \times 1) + b$$

$$a + b = 5 \dots [\text{equation (i)}]$$

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$$x = 2,$$

$$f(2) = (2 - 1)(2 - 2)q(2) + (a \times 2) + b$$

$$2a + b = 7 \dots [\text{equation (ii)}]$$

Now subtracting equation (i) from equation (ii) we get,

$$(2a + b) - (a + b) = 7 - 5$$

$$2a + b - a - b = 2$$

$$a = 2$$

To find out the value of b, substitute the value of a in equation (i) we get,

$$a + b = 5$$

$$2 + b = 5$$

$$b = 5 - 2$$

$$b = 3$$

Therefore, the remainder = $ax + b = 2x + 3$



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