CBSE Class–10 Mathematics

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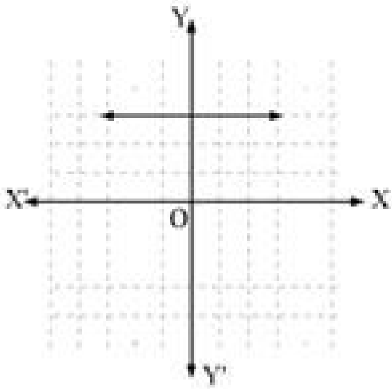
Chapter - 2

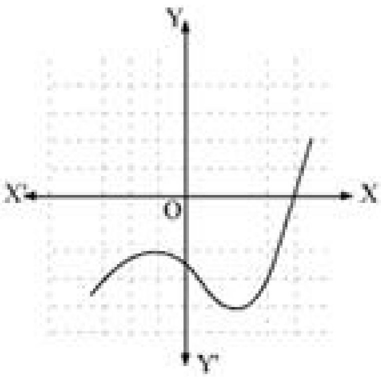
Polynomials - Exercise 2.1

1. The graphs of y=p(x) are given to us, for some polynomials p(x). Find the number of zeroes of p(x), in each case.

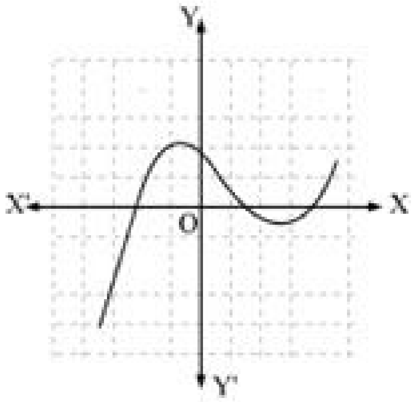
(i)



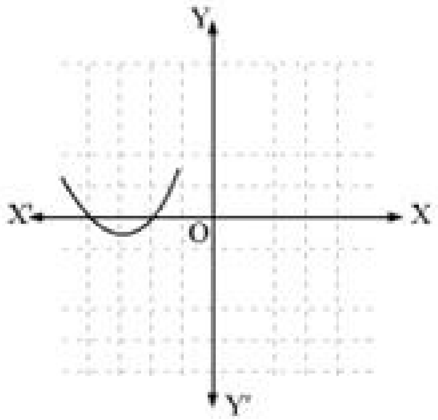
(ii)



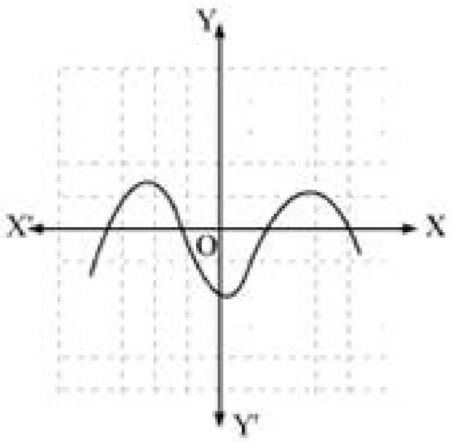
(iii)



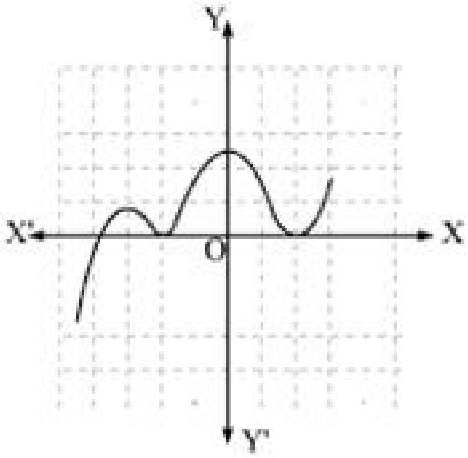
(iv)



(v)



(vi)



Ans. (i) The given graph does not intersects x-axis at all. Hence, it does not have any zero.

(ii) Given graph intersects x-axis 1 time. It means this polynomial has 1 zero.

(iii) Given graph intersects x-axis 3 times. Therefore, it has 3 zeroes.

(iv) Given graph intersects x-axis 2 times. Therefore, it has 2 zeroes.

(v) Given graph intersects x-axis 4 times. It means it has 4 zeroes.

(vi) Given graph intersects x-axis 3 times. It means it has 3 zeroes.

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Chapter - 2

Polynomials - Exercise 2.2

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1. Find the zeroes of the following quadratic polynomials and verify the relationship between the zeros and the coefficients.

(i) $x^2 - 2x - 8$

(ii) $4s^2 - 4s + 1$

(iii) $6x^2 - 3 - 7x$

(iv) $4u^2 + 8u$

(v) $t^2 - 15$

(vi) $3x^2 - x - 4$

Ans. (i) $x^2 - 2x - 8$

Comparing given polynomial with general form of quadratic polynomial $ax^2 + bx + c$,

We get a = 1, b = -2 and c = -8

We have, $x^2 - 2x - 8$

$= x^2 - 4x + 2x - 8$

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

Equating this equal to 0 will find values of 2 zeroes of this polynomial.

$(x-4)(x+2) = 0$

$\Rightarrow x = 4, -2$ are two zeroes.

Sum of zeroes = 4 + (– 2) = 2 =

=> $\frac{-(-2)}{1}$ = $\frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of zeroes = 4 × (−2) = −8

= $\frac{-8}{1} = \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

(ii) $4s^2 - 4s + 1$

Here, a = 4, b = -4 and c = 1

We have, $4s^2 - 4s + 1$

= $4s^2 - 2s - 2s + 1$

=$2s(2s-1)-1(2s-1)$
= $(2s-1)(2s-1)$

Equating this equal to 0 will find values of 2 zeroes of this polynomial.

⇒ $(2s-1)(2s-1) = 0$

⇒ $s = \frac{1}{2}, \frac{1}{2}$

Therefore, two zeroes of this polynomial are $\frac{1}{2}, \frac{1}{2}$

Sum of zeroes = $\frac{1}{2} + \frac{1}{2}$ = 1 = $\frac{-(-1)}{1} \times \frac{4}{4} = \frac{-(-4)}{4}$

= $\frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of Zeroes = $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

$= \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

(iii) $6x^2 - 3 - 7x \quad \Rightarrow \quad 6x^2 - 7x - 3$

Here, a = 6, b = -7 and c = -3

We have, $6x^2 - 7x - 3$

$= 6x^2 - 9x + 2x - 3$

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

Equating this equal to 0 will find values of 2 zeroes of this polynomial.

$\Rightarrow (2x-3)(3x+1) = 0$

$\Rightarrow x = \frac{3}{2}, \frac{-1}{3}$

Therefore, two zeroes of this polynomial are $\frac{3}{2}, \frac{-1}{3}$

Sum of zeroes = $\frac{3}{2} + \frac{-1}{3} = \frac{9-2}{6} = \frac{7}{6} = \frac{-(-7)}{6} = \frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of Zeroes = $\frac{3}{2} \times \frac{-1}{3} = \frac{-1}{2} = \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

(iv) $4u^2 + 8u$

Here, a = 4, b = 8 and c = 0

$4u^2 + 8u = 4u(u+2)$

Equating this equal to 0 will find values of 2 zeroes of this polynomial.

$\Rightarrow 4u(u+2) = 0$

$\Rightarrow u = 0, -2$

Therefore, two zeroes of this polynomial are 0, −2

Sum of zeroes = 0−2 = −2

$= \frac{-2}{1} \times \frac{4}{4} = \frac{-8}{4} = \frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of Zeroes $= 0 \times -2$ = 0

$= \frac{0}{4} = \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

(v) $t^2 - 15$

Here, a = 1, b = 0 and c = -15

We have, $t^2 - 15 \Rightarrow t^2 = 15 \Rightarrow t = \pm\sqrt{15}$

Therefore, two zeroes of this polynomial are $\sqrt{15}, -\sqrt{15}$

Sum of zeroes = $\sqrt{15} + \left(-\sqrt{15}\right) = 0 = \frac{0}{1} = \frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of Zeroes = $\sqrt{15} \times \left(-\sqrt{15}\right) = -15$

$= \frac{-15}{1} = \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

(vi) $3x^2 - x - 4$

Here, a = 3, b = -1 and c = -4

We have, $3x^2 - x - 4 = 3x^2 - 4x + 3x - 4$

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

Equating this equal to 0 will find values of 2 zeroes of this polynomial.

⇒ $(3x-4)(x+1) = 0$

$\Rightarrow x = \frac{4}{3}, -1$

Therefore, two zeroes of this polynomial are $\frac{4}{3}, -1$

Sum of zeroes = $\frac{4}{3} + (-1) = \frac{4-3}{3} = \frac{1}{3} = \frac{-(-1)}{3} = \frac{-b}{a} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of Zeroes = $\frac{4}{3} \times (-1) = \frac{-4}{3} = \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

---

2. Find a quadratic polynomial each with the given numbers as the sum and product of its zeroes respectively.

(i) $\frac{1}{4}$ **, −1**

(ii) $\sqrt{2}$ **, 13**

(iii) 0, $\sqrt{5}$

(iv) 1, 1

(v) $\frac{-1}{4}, \frac{1}{4}$

(vi) 4, 1

Ans. (i) $\frac{1}{4}$, −1

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β are two zeroes of above quadratic polynomial.

$\alpha+\beta = \frac{1}{4} = \frac{-b}{a}$

$\alpha \times \beta$ = -1 $= \frac{-1}{1} \times \frac{4}{4} = \frac{-4}{4}$ = $\frac{c}{a}$

On comparing, we get

$\therefore\ a = 4, b = -1, c = -4$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions = $4x^2 - x - 4$

(ii) $\sqrt{2}, \frac{1}{3}$

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β be two zeros of above quadratic polynomial.

$\alpha+\beta$ = $\sqrt{2} \times \frac{3}{3} = \frac{3\sqrt{2}}{3}$ = $\frac{-b}{a}$

$\alpha \times \beta$ = $\frac{1}{3}$ which is equal to $\frac{c}{a}$

On comparing, we get

$\therefore\ a = 3, b = -3\sqrt{2}, c = 1$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions = $3x^2 - 3\sqrt{2}x + 1$.

(iii) 0, $\sqrt{5}$

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β be two zeros of above quadratic polynomial.

$\alpha+\beta$ = 0 $= \frac{0}{1}$ = $\frac{-b}{a}$

$\alpha \times \beta = \sqrt{5} = \dfrac{\sqrt{5}}{1} = \dfrac{c}{a}$

On comparing, we get

$\therefore\ a = 1, b = 0, c = \sqrt{5}$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions $= x^2 + \sqrt{5}$

(iv) 1, 1

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β be two zeros of above quadratic polynomial.

$\alpha + \beta = 1 = \dfrac{-(-1)}{1} = \dfrac{-b}{a}$

$\alpha \times \beta = 1 = \dfrac{1}{1} = \dfrac{c}{a}$

On comparing, we get

$\therefore\ a = 1, b = -1, c = 1$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions = $x^2 - x + 1$

(v) $\dfrac{-1}{4}, \dfrac{1}{4}$

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β be two zeros of above quadratic polynomial.

$\alpha+\beta = \frac{-1}{4} = \frac{-b}{a}$

$\alpha \times \beta = \frac{1}{4} = \frac{c}{a}$

On comparing, we get

$\therefore\ a = 4, b = 1, c = 1$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions = $4x^2 + x + 1$

(vi) 4, 1

Let quadratic polynomial be $ax^2 + bx + c$

Let α and β be two zeros of above quadratic polynomial.

$\alpha+\beta = 4\ \frac{-(-4)}{1} = \frac{-b}{a}$

$\alpha \times \beta = 1 = \frac{1}{1} = \frac{c}{a}$

On comparing, we get

$\therefore\ a = 1, b = -4, c = 1$

Putting the values of a, b and c in quadratic polynomial $ax^2 + bx + c$, we get

Quadratic polynomial which satisfies above conditions $= x^2 - 4x + 1$

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Chapter - 2

Polynomials - Exercise 2.3

---

1. Divide the polynomial p(x) by the polynomial g(x) and find the quotient and remainder in each of the following.

(i) $\mathbf{p}(\mathbf{x}) = x^3 - 3x^2 + 5x - 3,\ \mathbf{g}(\mathbf{x}) = x^2 - 2$

(ii) $\mathbf{p}(\mathbf{x}) = x^4 - 3x^2 + 4x + 5,\ \mathbf{g}(\mathbf{x}) = x^2 - x + 1$

(iii) $\mathbf{p}(\mathbf{x}) = x^4 - 5x + 6,\ \mathbf{g}(\mathbf{x}) = 2 - x^2$

Ans. (i)

$$
\begin{array}{r l}
 & \qquad\qquad x - 3 \\ \hline
x^2 - 2) & x^3 - 3x^2 + 5x - 3 \\
 & \pm x^3 \qquad\quad \mp 2x \\ \cline{2-2}
 & \quad -3x^2 + 7x - 3 \\
 & \quad \mp 3x^2 \qquad \pm 6 \\ \cline{2-2}
 & \qquad\qquad 7x - 9
\end{array}
$$

Therefore, quotient = x – 3 and Remainder = 7x – 9

(ii)

$$
\begin{array}{r}
x^2 + x - 3 \\
\hline
x^2 - x + 1 \,\big)\; x^4 - 3x^2 + 4x + 5 \\
\pm x^4 \pm x^2 \qquad \mp x^3 \\
\hline
-4x^2 + 4x + 5 + x^3 \\
\mp x^2 \pm x \qquad \pm x^3 \\
\hline
-3x^2 + 3x + 5 \\
\mp 3x^2 \pm 3x \mp 3 \\
\hline
8
\end{array}
$$

Therefore, quotient = $x^2 + x - 3$ and, Remainder = 8

(iii)

$$
\begin{array}{r}
-x^2 - 2 \\
\hline
-x^2 + 2 \,\big)\; x^4 - 5x + 6 \\
\pm x^4 \qquad \mp 2x^2 \\
\hline
-5x + 6 + 2x^2 \\
\mp 4 \pm 2x^2 \\
\hline
-5x + 10
\end{array}
$$

Therefore, quotient = $-x^2 - 2$ and, Remainder = $-5x + 10$

---

2. Check whether the first polynomial is a factor of the second polynomial by dividing the second polynomial by the first polynomial.

(i) $t^2 - 3, 2t^4 + 3t^3 - 2t^2 - 9t - 12$

(ii) $x^2 + 3x + 1, 3x^4 + 5x^3 - 7x^2 + 2x + 2$

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

Ans. (i)

$$
\begin{array}{r}
2t^2+3t+4 \\
t^2-3\overline{\big)\,\cancel{2t^4}+3t^3-2t^2-9t-12} \\
\underline{\pm\cancel{2t^4}\qquad\mp 6t^2\qquad\qquad} \\
+\cancel{3t^3}+4t^2-\cancel{9t}-12 \\
\underline{\pm\cancel{3t^3}\qquad\mp\cancel{9t}\qquad} \\
+\cancel{4t^2}\qquad-\cancel{12} \\
\underline{\pm\cancel{4t^2}\qquad\mp\cancel{12}} \\
0\qquad\quad
\end{array}
$$

∵ Remainder = 0

Hence first polynomial is a factor of second polynomial.

(ii)

$$
\begin{array}{r}
3x^2-4x+2 \\
x^2+3x+1\overline{\big)\,3x^4+5x^3-7x^2+2x+2} \\
\underline{\pm 3x^4\pm 9x^3\pm 3x^2\qquad\quad} \\
-4x^3-10x^2+2x+2 \\
\underline{\mp 4x^3\mp 12x^2\mp 4x\quad} \\
+2x^2+6x+2 \\
\underline{\pm 2x^2\pm 6x\pm 2} \\
0\qquad
\end{array}
$$

∵ Remainder = 0

Hence first polynomial is a factor of second polynomial.

(iii)

$$
\begin{array}{r|l}
 & x^2 - 1 \\
x^3 - 3x + 1 & x^5 - 4x^3 + x^2 + 3x + 1 \\
 & \underline{\pm x^5 \mp 3x^3 \pm x^2} \\
 & -x^3 + 3x + 1 \\
 & \underline{\mp x^3 \pm 3x \mp 1} \\
 & 2
\end{array}
$$

∵ Remainder ≠0

Hence first polynomial is not factor of second polynomial.

---

3. Obtain all other zeroes of $\left(3x^4 + 6x^3 - 2x^2 - 10x - 5\right)$, if two of its zeroes are $\sqrt{\frac{5}{3}}$ and $-\sqrt{\frac{5}{3}}$.

Ans. Two zeroes of $\left(3x^4 + 6x^3 - 2x^2 - 10x - 5\right)$ are $\sqrt{\frac{5}{3}}$ and $-\sqrt{\frac{5}{3}}$ which means that $\left(x - \sqrt{\frac{5}{3}}\right)\left(x + \sqrt{\frac{5}{3}}\right) = x^2 - \frac{5}{3}$ = $3x^2 - 5$ is a factor of $\left(3x^4 + 6x^3 - 2x^2 - 10x - 5\right)$.

Applying Division Algorithm to find more factors we get:

$$
\begin{array}{r|l}
 & \quad 3x^2+6x+3 \\
\hline
x^2-\frac{5}{3} & 3x^4+6x^3-2x^2-10x-5 \\
 & \pm 3x^4 \quad \mp 5x^2 \\
\hline
 & \quad +6x^3+3x^2-10x-5 \\
 & \quad \pm 6x^3 \quad \mp 10x \\
\hline
 & \qquad +3x^2 \quad -5 \\
 & \qquad \pm 3x^2 \quad \mp 5 \\
\hline
 & \qquad\quad 0
\end{array}
$$

We have $p(x) = g(x) \times q(x)$.

$\Rightarrow \left(3x^4+6x^3-2x^2-10x-5\right)$

$= \left(3x^2-5\right)\left(x^2+2x+1\right)$

$= \left(3x^2-5\right)(x+1)(x+1)$

Therefore, other two zeroes of $\left(3x^4+6x^3-2x^2-10x-5\right)$ are −1 and −1.

---

4. On dividing $\left(x^3-3x^2+x+2\right)$ by a polynomial g(x), the quotient and remainder were (x-2) and (-2x+4) respectively. Find g(x).

Ans. Let $p(x) = x^3-3x^2+x+2$, q(x) = (x – 2) and r(x) = (–2x+4)

According to Polynomial Division Algorithm, we have

p(x) = g(x).q(x) + r(x)

$\Rightarrow x^3-3x^2+x+2 = g(x).(x-2)-2x+4$

$\Rightarrow x^3-3x^2+x+2+2x-4 = g(x).(x-2)$

$\Rightarrow x^3-3x^2+3x-2 = g(x).(x-2)$

$\Rightarrow g(x) = \dfrac{x^3 - 3x^2 + 3x - 2}{x - 2}$

So, Dividing $\left(x^3 - 3x^2 + 3x - 2\right)$ by $(x-2)$, we get

$$
\begin{array}{r|l}
 & x^2 - x + 1 \\
\hline
x-2) & x^3 - 3x^2 + 3x - 2 \\
 & \underline{\pm x^3 \mp 2x^2} \\
 & \quad -x^2 + 3x - 2 \\
 & \quad \underline{\mp x^2 \pm 2x} \\
 & \qquad\quad x - 2 \\
 & \qquad\quad \underline{\pm x \mp 2} \\
 & \qquad\quad 0
\end{array}
$$

Therefore, we have $g(x) = \dfrac{x^3 - 3x^2 + 3x - 2}{x - 2} = x^2 - x + 1$

---

5. Give examples of polynomials p(x), g(x), q(x) and r(x), which satisfy the division algorithm and

(i) deg p(x) = deg q(x)

(ii) deg q(x) = deg r(x)

(iii) deg r(x) = 0

Ans. (i) Let $p(x) = 3x^2 + 3x + 6$, g(x) = 3

$$
\begin{array}{r}
x^2+x+2 \\
\hline
3)\ 3x^2+3x+6 \\
\pm 3x^2 \qquad\qquad \\
\hline
+3x+6 \\
\pm 3x \quad\ \\
\hline
+6 \\
\pm 6 \\
\hline
0
\end{array}
$$

So, we can see in this example that deg p(x) = deg q(x) = 2

(ii) Let $p(x) = x^3+5$ and $g(x) = x^2-1$

$$
\begin{array}{r}
x \\
\hline
x^2-1)\ x^3+5 \\
\pm x^3 \quad \mp x \\
\hline
x+5
\end{array}
$$

We can see in this example that deg q(x) = deg r(x) = 1

(iii) Let $p(x) = x^2+5x-3$, g(x) = x+3

$$
\begin{array}{r}
x+2 \\
\hline
x+3)\ x^2+5x-3 \\
\pm x^2 \pm 3x \quad \\
\hline
+2x-3 \\
\pm 2x \pm 6 \\
\hline
-9
\end{array}
$$

We can see in this example that deg r(x) = 0

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Chapter - 2

Polynomials - Exercise 2.4

---

1. Verify that the numbers given alongside of the cubic polynomials below are their zeroes. Also verify the relationship between the zeroes and the coefficients in each case:

(i) $2x^3 + x^2 - 5x + 2; \frac{1}{2}, 1, -2$

(ii) $x^3 - 4x^2 + 5x - 2; 2, 1, 1$

Ans. (i) Comparing the given polynomial with $ax^3 + bx^2 + cx + d$, we get

$a = 2, b = 1, c = -5$ and $d = 2.$

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

$= \frac{1}{4} + \frac{1}{4} - \frac{5}{2} + 2 = \frac{1+1-10+8}{4} = \frac{0}{4} = 0$

$p(1) = 2(1)^3 + (1)^2 - 5(1) + 2$

$= 2 + 1 - 5 + 2 = 0$

$p(-2) = 2(-2)^3 + (-2)^2 - 5(-2) + 2$

$= 2(-8) + 4 + 10 + 2 = -16 + 16 = 0$

$\therefore \frac{1}{2}, 1$ and -2 are the zeroes of $2x^3 + x^2 - 5x + 2.$

Now, $\alpha + \beta + \gamma$

$= \frac{1}{2}+1+(-2) = \frac{1+2-4}{2} = \frac{-1}{2} = \frac{-b}{a}$

And $\alpha\beta+\beta\gamma+\gamma\alpha$

$= \left(\frac{1}{2}\right)(1)+(1)(-2)+(-2)\left(\frac{1}{2}\right)$

$= \frac{1}{2}-2-1 = \frac{-5}{2} = \frac{c}{a}$

And $\alpha\beta\gamma = \frac{1}{2}\times 1\times(-2) = -1 = \frac{-2}{2} = \frac{-d}{a}$

(ii) Comparing the given polynomial with ax^3+bx^2+cx+d, we get

$a=1, b=-4, c=5$ and $d=-2$.

$p(2) = (2)^3 - 4(2)^2 + 5(2) - 2$

$= 8-16+10-2 = 0$

$p(1) = (1)^3 - 4(1)^2 + 5(1) - 2$

$= 1-4+5-2 = 0$

$\therefore$ $2, 1$ and 1 are the zeroes of x^3-4x^2+5x-2.

Now, $\alpha+\beta+\gamma$

$= 2+1+1 = 4 = \frac{-(-4)}{1} = \frac{-b}{a}$

And $\alpha\beta+\beta\gamma+\gamma\alpha = (2)(1)+(1)(1)+(1)(2)$

$= 2+1+2 = \frac{5}{1} = \frac{c}{a}$

And $\alpha\beta\gamma$ = $2\times1\times1=2=\frac{-(-2)}{1}=\frac{-d}{a}$

---

2. Find a cubic polynomial with the sum of the product of its zeroes taken two at a time and the product of its zeroes are $2, -7, -14$ respectively.

Ans. Let the cubic polynomial be ax^3+bx^2+cx+d and its zeroes be α, β and γ.

Then $\alpha+\beta+\gamma$ = 2 = $\frac{-(-2)}{1}=\frac{-b}{a}$ and $\alpha\beta+\beta\gamma+\gamma\alpha$ = $-7=\frac{-7}{1}=\frac{c}{a}$

And $\alpha\beta\gamma$ = $-14=\frac{-14}{1}=\frac{d}{a}$

Here, $a=1, b=-2, c=-7$ and $d=14$

Hence, cubic polynomial will be $x^3-2x^2-7x+14$.

---

3. If the zeroes of the polynomial x^3-3x^2+x+1 are $a-b, a, a+b$, find a and b.

Ans. Since $(a-b), a, (a+b)$ are the zeroes of the polynomial x^3-3x^2+x+1.

$\therefore\ \alpha+\beta+\gamma$ = $a-b+b+a+b=\frac{-(-3)}{1}=3$

$\Rightarrow 3a=3$

$\Rightarrow\ a=1$

And $\alpha\beta+\beta\gamma+\gamma\alpha$

= $(a-b)a+a(a+b)+(a+b)(a-b)=\frac{1}{1}=1$

$\Rightarrow\ a^2-ab+a^2+ab+a^2-b^2=1$

$\Rightarrow\ 3a^2-b^2=1$

$\Rightarrow 3(1)^2 - b^2 = 1 \; [\because a = 1]$

$\Rightarrow 3 - b^2 = 1 \qquad \Rightarrow \qquad b^2 = 2$

$\Rightarrow b = \pm\sqrt{2}$

Hence $a = 1$ and $b = \pm\sqrt{2}$.

---

4. If the two zeroes of the polynomial $x^4 - 6x^3 - 26x^2 + 138x - 35$ are $2 \pm \sqrt{3}$, find other zeroes.

Ans. Since $2 \pm \sqrt{3}$ are two zeroes of the polynomial $p(x) = x^4 - 6x^3 - 26x^2 + 138x - 35$.

Let $x = 2 \pm \sqrt{3} \Rightarrow x - 2 = \pm\sqrt{3}$

Squaring both sides, $x^2 - 4x + 4 = 3$

$\Rightarrow x^2 - 4x + 1 = 0$

Now we divide $p(x)$ by $x^2 - 4x + 1$ to obtain other zeroes.

$$
\begin{array}{r}
x^2 - 2x - 35 \\
\hline
x^2 - 4x + 1 \,)\; x^4 - 6x^3 - 26x^2 + 138x - 35 \\
\pm x^4 \mp 4x^3 \pm x^2 \qquad\qquad\quad \\
\hline
-2x^3 - 27x^2 + 138x \qquad \\
\mp 2x^3 \pm 8x^2 \mp 2x \qquad \\
\hline
-35x^2 + 140x - 35 \\
\mp 35x^2 \pm 140x \mp 35 \\
\hline
0
\end{array}
$$

$\therefore p(x) = x^4 - 6x^3 - 26x^2 + 138x - 35$

$= (x^2 - 4x + 1)(x^2 - 2x - 35)$

$= \left(x^2-4x+1\right)\left(x^2-7x+5x-35\right)$

$= \left(x^2-4x+1\right)\left[x(x-7)+5(x-7)\right]$

$= \left(x^2-4x+1\right)(x+5)(x-7)$

$\Rightarrow (x+5)$ and $(x-7)$ are the other factors of $p(x)$.

$\therefore -5$ and 7 are other zeroes of the given polynomial.

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5. If the polynomial $x^4-6x^3+16x^2-25x+10$ is divided by another polynomial x^2-2x+k, the remainder comes out to be $x+a$, find k and a.

Ans. Let us divide $x^4-6x^3+16x^2-25x+10$ by x^2-2x+k.

$$
\begin{array}{r|l}
 & x^2-4x+(8-k) \\
\hline
x^2-2x+k & x^4-6x^3+16x^2-25x+10 \\
 & \pm x^4 \mp 2x^3 \pm kx^2 \\
\hline
 & -4x^3+(16-k)x^2-25x+10 \\
 & \mp 4x^3 \pm 8x^2 \mp 4kx \\
\hline
 & (8-k)\,x^2+(4k-25)x+10 \\
 & \pm(8-k)x^2 \mp 2(8-k)x \pm (8-k)k \\
\hline
 & (2k-9)x-(8-k)k+10
\end{array}
$$

$\therefore$ Remainder = $(2k-9)x-(8-k)k+10$

On comparing this remainder with given remainder, i.e. $x+a$,

$2k-9=1 \Rightarrow 2k=10$

$\Rightarrow k=5$

And $-(8-k)k+10=a$

$\Rightarrow a=-(8-5)5+10=-5$