CBSE Class 10 Mathematics

Important Questions

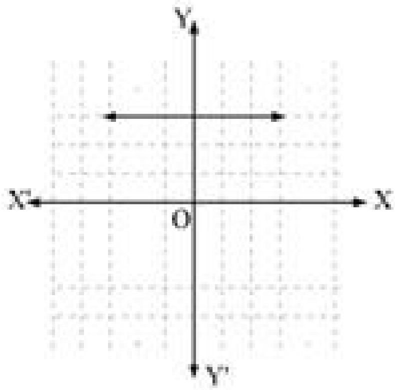
Chapter 2

Polynomails

1 Marks Questions

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)



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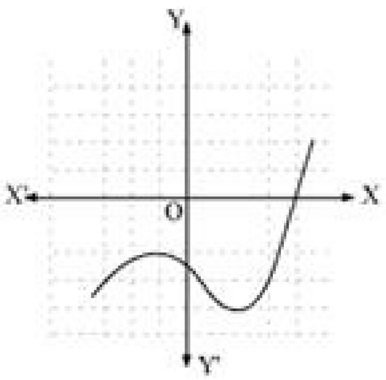

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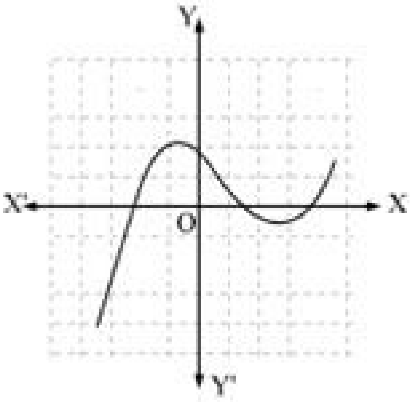

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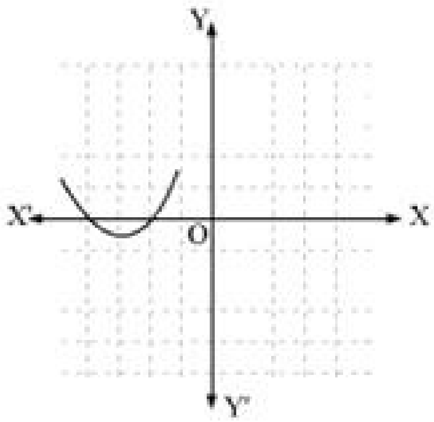
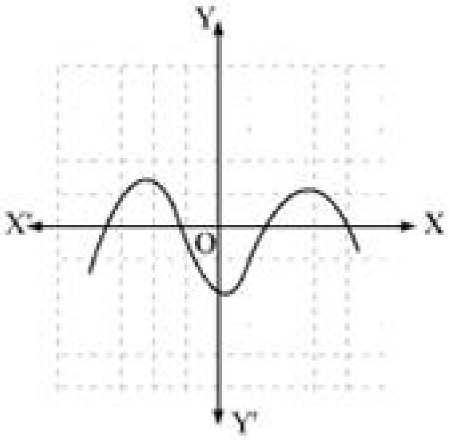
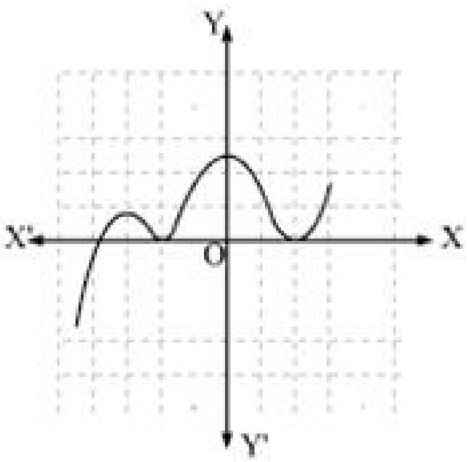
(iv) 

(v) 

(vi) 

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

(ii) Graph meets x-axis 1 time. It means this polynomial has 1 zero.

(iii) Graph meets x-axis 3 times. Therefore, it has 3 zeroes.

(iv) Graph meets x-axis 2 times. Therefore, it has 2 zeroes.

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(v) Graph meets x-axis 4 times. It means it has 4 zeroes.

(vi) Graph meets x-axis 3 times. It means it has 3 zeroes

2. Which of the following is polynomial?

(a) $x^2 - 6\sqrt{x} + 2$

(b) $\sqrt{x} + \frac{1}{\sqrt{x}}$

(c) $\frac{5}{x^2 - 3x + 1}$

(d) none of these

Ans. (d) none of these

3. Polynomial $2x^4 + 3x^3 - 5x^2 - 5x^2 + 9x + 1$ **is a**

(a) linear polynomial

(b) quadratic polynomial

(c) cubic polynomial

(d) bi-quadratic polynomial

Ans. (d) bi-quadratic polynomial

4. If α **and** β **are zeros of** $x^2 + 5x + 8$**, then the value of** $(\alpha + \beta)$ **is**

(a) 5

(b) -5

(c) 8

(d) -8

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Ans. (b) -5

5. The sum and product of the zeros of a quadratic polynomial are 2 and -15 respectively. The quadratic polynomial is

(a) $x^2 - 2x + 15$

(b) $x^2 - 2x - 15$

(c) $x^2 + 2x - 15$

(d) $x^2 + 2x + 15$

Ans. (b) $x^2 - 2x - 15$

6. If p (x) = $2x^2 - 3x + 5, 3x + 5$, then P(-1) is equal to

(a) 7

(b) 8

(c) 9

(d) 10

Ans. (d) 10

7. Zeros of p (x) = $x^2 - 2x - 3$ are

(a) 3 and 1

(b) 3 and -1

(c) -3 and -1

(d) 1 and -3

Ans. (b) 3 and -1

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8. If α and β are the zeros of $2x^2 + 5x - 10$, then the value of $\alpha\beta$ is

(a) $-\frac{5}{2}$

(b) 5

(c) -5

(d) $\frac{2}{5}$

Ans. (c)-5

9. A quadratic polynomial, the sum and product of whose zeros are 0 and $\sqrt{5}$ respectively is

(a) $x^2 + \sqrt{5}$

(b) $x^2 - \sqrt{5}$

(c) $x^2 - 5$

(d) None of these

Ans. a) $x^2 + \sqrt{5}$

10. Which of the following is polynomial?

(a) $x^2 - 6\sqrt{x} + 2$

(b) $\sqrt{x} + \frac{1}{\sqrt{x}}$

(c) $\frac{5}{x^2 - 3x + 1}$

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(d) none of these

Ans. (d) none of these

11. Polynomial $2x^4+3x^3-5x^2-5x^2+9x+1$ **is a**

(a) linear polynomial

(b) quadratic polynomial

(c) cubic polynomial

(d) bi-quadratic polynomial

Ans. (d) bi-quadratic polynomial

12. If α **and** β **are zeros of** x^2+5x+8**, then the value of** $(\alpha+\beta)$ **is**

(a) 5

(b) -5

(c) 8

(d) -8

Ans. (b) -5

13. The sum and product of the zeros of a quadratic polynomial are 2 and -15 respectively. The quadratic polynomial is

(a) $x^2-2x+15$

(b) $x^2-2x-15$

(c) $x^2+2x-15$

(d) $x^2+2x+15$

Ans. (b) $x^2-2x-15$

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CBSE Class 10 Mathematics

Important Questions

Chapter 2

Polynomails

2 Marks Questions

1. Find the quadratic polynomial where sum and product of the zeros are a and $\frac{1}{a}$.

Ans. Polynomial $x^2 - 9x + \frac{1}{9}$ i.e. $\frac{1}{9}\left[9x^2 - 9^2x + 1\right]$

2. If α and β are the zeros of the quadratic polynomial $f(x) = x^2 - x - 4$, find the value of $\frac{1}{\alpha} + \frac{1}{\beta} - \alpha\beta$.

Ans. $f(x) = x^2 - x - 4$ i.e.

If α and β are the zeroes

$\therefore\ \alpha + \beta = \frac{1}{1} = 1$

$\alpha.\beta = \frac{-4}{1} = -4$

So,

$\frac{1}{\alpha} + \frac{1}{\beta} - \alpha\beta = \frac{\alpha+\beta}{\alpha\beta} - \alpha\beta$

$= \frac{1}{-4} - (-4)$

$= -\frac{1}{4} + 4$

$= \frac{15}{4}$

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3. If the square of the difference of the zeros of the quadratic polynomial f(x) = x^2+ px +45 is equal to 144, find the value of *p*.

Ans. $\alpha+\beta=-p$

$\alpha\beta=45$

$(\alpha-\beta)^2=144$

$\Rightarrow \alpha^2+\beta^2-2\alpha\beta$

$\Rightarrow (\alpha+\beta)^2-4\alpha\beta=144$

$\Rightarrow \ (-p)^2-4\times 45=144$

$\Rightarrow \ p^2=144+180$

$\Rightarrow \ p=\pm 18$

4. Divide $\left(6x^3-26x-21+x^2\right)$ **by** $(-7+3x)$.

Ans.

$$
\begin{array}{r|l}
 & 2x^2+5x+3 \\
\hline
3x-7 & 6x^3+x^2-26x-21 \\
 & \underline{_-6x^3\,_+^-14x^2} \\
 & \quad 15x^2-26x-21 \\
 & \quad \underline{_-15x^2\,_+^-35x} \\
 & \qquad 9x-21 \\
 & \qquad \underline{_-9x\,_+^-21} \\
 & \qquad\quad 0
\end{array}
$$

$\therefore \quad quotient=2x^2+5x+3$

5. Find the value of 'k' such that the quadratic polynomial x^2 - (k + 6) x + 2 (2k +1) has sum of the zeros is half of their product.

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Ans. Sum of the zeros = $\frac{1}{2}$ product of the zeros

$$\Rightarrow (k+6)=\frac{1}{2}[2(2k+1)]$$
$$\Rightarrow k+6=2k+1$$
$$\Rightarrow k=5$$

6. If α and β are the zeros of the quadratic polynomial f(x) = $x^2 - p(x+1) - c$, show that $(\alpha+1)(\beta+1) = 1 - c$.

Ans.

$$f(x)=x^2-p(x+1)-c$$
$$=x^2-px-(p+c)$$
$$\therefore\ \alpha+\beta=p \text{ and } \alpha\beta=-(p+c)$$
$$\text{Now } (\alpha+1)(\beta+1)=\alpha\beta+(\alpha+\beta)+1$$
$$=-p-c+p+1$$
$$=1-c$$

7. If the sum of the zeros of the quadratic polynomial f (t) = $kt^2 + 2t + 3k$ is equal to their product, find the value of 'k'.

Ans.

$$f(t)=kt^2+2t+3k$$
Sum of the zeros = Product of the zeros
$$\Rightarrow \frac{-2}{k}=\frac{3k}{k}$$
$$\Rightarrow k=-\frac{2}{3}$$

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8. Divide (x^4 - 5x + 6) by (2 – x^2).

Ans.

$$\begin{array}{r} -x^2-2 \\ 2-x^2 \overline{\big)\, x^4 - 5x + 6} \\ \underline{x^4 \mp 2x^2 \quad\quad} \\ 2x^2 - 5x + 6 \\ \underline{2x^2 \quad\quad \mp 4} \\ -5x + 10 \end{array}$$

Quotient = $-x^2-2$

Remainder = -5x + 10

9. Find the zeros of the polynomial p(x) = 4 $\sqrt{3}$ x^2 + 5x – 2 $\sqrt{3}$ and verify the relationship between the zeros and its coefficients.

Ans. $p(x) = 4\sqrt{3}x^2 + 5x - 2\sqrt{3}$

$= 4\sqrt{3}x^2 + 8x - 3x - 2\sqrt{3}$

$= 4x\left(\sqrt{3}x+2\right) - \sqrt{3}\left(\sqrt{3}x+2\right)$

$= \left(4x-\sqrt{3}\right)\left(\sqrt{3}x+2\right)$

$\therefore$ zeros are $4x-\sqrt{3}=0$ and $\sqrt{3}x+2=0$

$\Rightarrow\ x = \dfrac{\sqrt{3}}{4}$ and $x = -\dfrac{2}{\sqrt{3}}$

$$\text{Sum of zeros} = \frac{-\text{Coefficient of } x}{\text{Coefficient of } x^2}$$

$$= \left[\frac{\sqrt{3}}{4} + \frac{(-2)}{\sqrt{3}}\right] = \frac{-5}{4\sqrt{3}}$$

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$$\text{Product of zeros} = \frac{\text{Constant term}}{\text{Cofficient of } x^2}$$

$$= \frac{-2\sqrt{3}}{4\sqrt{3}} = \frac{-1}{2}$$

10. Find the value of 'k' so that the zeros of the quadratic polynomial $3x^2 - kx + 14$ are in the ratio 7:6.

Ans. Let the zeros are 7p and 6p.

$3x^2 - k + 14$

$$\therefore \; 7p + 6p = \frac{-(-k)}{3} = \frac{k}{3}$$

$$\text{and } 7p \times 6p = \frac{14}{3}$$

$$\Rightarrow \; 42p^2 = \frac{14}{3}$$

$p = 3$

$\Rightarrow \; 39p = k$

$\therefore \; k = 39 \times 3$

$\therefore \; k = 117$

11. If one zero of the quadratic polynomial $f(x) = 4x^2 - 8kx - 9$ is negative of the other, find the value of 'k'.

Ans. $4x^2 - 8kx - 9$, if one zero is α then other is $-\alpha$

$\therefore$ Sum of the zero $= 0$

$$\frac{8k}{4} = 0$$

$\Rightarrow k = 0$

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12. Check whether the polynomial ($t^2 – 3$) is a factor of the polynomial $2t^4 + 3t^3 – 2t^2 – 9t – 12$ by Division method.

Ans.

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

Yes, $(t^2 - 3)$ is the factor of given polynomial.

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Important Questions

Chapter 2

Polynomails

3 Marks Questions

1. Apply division algorithm to find the quotient q (x) and remainder r (x) an dividing f (x) by g (x), where $f(x)=x^3-6x^2+11x-6,\ g(x)=x^2+x+1$

Ans. $f(x)=g(x)\times q(x)+r(x)$

$$
\begin{array}{r l}
 & x-7 \\
x^2+x+1 & \overline{)\,x^3-6x^2+11x-6} \\
 & \underline{\underset{-}{x^3}\ \underset{-}{+x^2}\ \underset{-}{+x}} \\
 & -7x^2+10x-6 \\
 & \underline{\mp 7x^2 \mp 7x \mp 7} \\
 & -17x+1
\end{array}
$$

$\therefore\ (x^3-6x^2+11x-6)=x^2+2x+1(x-7)+(17x+1)$

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

Ans. Two zeros are $2\pm\sqrt{3}$

$\therefore$ *Sum* of zeros $=4$

and product of the zeros $=1$

$\therefore\ (x^2-4x+1)$ is the factor of $x^4-6x^3-26x^2+138x-35$

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$$x^2-2x-35$$
$$x^2-4x+1\overline{)x^4-6x^3-26x^2+138x-35}$$
$$\underline{\mp x^4 \mp 4x^3 \pm x^2}$$
$$-2x^3-27x^2+138x-35$$
$$\underline{\mp 2x^3 \pm 8x^2 \mp 2x}$$
$$-35x^2+140x-35$$
$$\underline{\mp 35x^2 \pm 140x \mp 35}$$
$$0$$

Now,

$x^2-2x-35$

$=x^2-7x+5x-35$

$=x(x-7)+5(x-7)$

$=(x-5)(x-7)$

$\therefore$ Zeros are

$x=7$ and $x=-5$

$\therefore$ Other two zeros are 7 *and* -5

3. What must be subtracted from the polynomial $f(x)=x^4+2x^3-13x^2-12x+21$ so that the resulting polynomial is exactly divisible by $g(x)=x^2-4x+3$?

Ans.

$$x^2+6x+8$$
$$x^2-4x+3\overline{)x^4+2x^3-13x^2-12x+21}$$
$$\underline{-x^4 \mp 4x^3 \pm 3x^2}$$
$$6x^3-16x^2-12x+21$$
$$\underline{-6x^3 \mp 14x^2 \pm 18x}$$
$$8x^2-30x+21$$
$$\underline{-8x^2 \mp 32x \pm 24}$$
$$2x-3$$

We must be subtract (2x – 3) to become a factor.

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4. What must be added to $6x^5+5x^4+11x^3-3x^2+x+5$ so that it may be exactly divisible by $3x^2-2x+4$?

Ans.

$$x^2+6x+8$$

$$3x^2-2x+4\overline{\big)\,6x^5+5x^4+11x^3-3x^2+x+5}$$

$$\underline{\underset{-}{}6x^5\underset{+}{-}4x^4\underset{-}{+}8x^3}$$

$$9x^4+3x^3-3x^2+x+5$$

$$\underline{\underset{-}{}9x^4\underset{+}{-}6x^3\underset{-}{+}12x^2}$$

$$9x^3-15x^2+x+5$$

$$\underline{\underset{-}{}9x^3\underset{+}{-}6x^2\underset{-}{+}12x}$$

$$-9x^2-11x+5$$

$$\underline{\underset{+}{-}9x^2\underset{-}{+}6x\underset{+}{-}12}$$

$$-17x+17$$

So we must be added $\left(3x^2-2x+4\right)-\left(-17x+17\right)$

$=3x^2-2x+4+17x-17$

$=3x^2+15x-13$

5. Find all the zeros of the polynomial f (x) = $2x^4-3x^3-3x^2+6x-2$, if being given that two of its zeros are $\sqrt{2}$ and - $\sqrt{2}$.

Ans. $\sqrt{2}$ *and* $-\sqrt{2}$ are the zeros.

$\therefore\left(x-\sqrt{2}\right)\left(x+\sqrt{2}\right)$ is the factor of the given polynomial.

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$$
\begin{array}{r}
2x^2 - 3x + 1 \\
x^2 - 2 \overline{\big)\, 2x^4 - 3x^3 - 3x^2 + 6x - 2} \\
\underset{-}{2x^4} \qquad \underset{+}{\mp} 4x^2 \qquad\qquad \\
\hline
-3x^3 + x^2 + 6x - 2 \\
\underset{+}{\mp} 3x^3 \quad \underset{-}{\pm} 6x \qquad \\
\hline
x^2 \qquad -2 \\
\underset{-}{x^2} \qquad \underset{+}{\mp} 2 \\
\hline
0 \qquad
\end{array}
$$

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

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

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

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

$\therefore$ other two zero's are

$x = 1$ and $x = \dfrac{1}{2}$

6. On dividing $x^3 - 3x^2 + x + 2$ by a polynomial g (x) the quotient and the remainder were (x – 2) and -2x + 4 respectively, find g (x).

Ans. $p(x) = q(x) \times g(x) + r(x)$

$g(x) = \dfrac{p(x) - r(x)}{q(x)}$

$= \dfrac{x^3 - 3x^2 + x + 2 + 2x - 4}{x - 2}$

$$
\begin{array}{r}
x^2 - x + 1 \\
x - 2 \overline{\big)\, x^3 - 3x^2 + 3x - 2} \\
\underset{-}{x^3} \underset{+}{\mp} 2x^2 \qquad\qquad \\
\hline
-x^2 + 3x - 2 \\
\underset{+}{\mp} x^2 \underset{-}{\pm} 2x \qquad \\
\hline
x - 2 \\
\underset{-}{x} \underset{+}{\mp} 2 \\
\hline
0 \quad
\end{array}
$$

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

7. Find all zeros of f(x) = 2x^3 - 7x^2 + 3x + 6 if its two zeros are - $\sqrt{\frac{3}{2}}$ **and** $\sqrt{\frac{3}{2}}$ **.**

Ans. $f(x) = 2x^4 - 2x^3 - 7x^2 + 3x + 6$

Two zeros are $\pm\sqrt{\frac{3}{2}}$

$\therefore \left(x + \sqrt{\frac{3}{2}}\right)\left(x - \sqrt{\frac{3}{2}}\right) = \frac{1}{2}\left(2x^2 - 3\right)$

$\therefore \left(2x^2 - 3\right)$ is the factor of $f(x)$.

$$\begin{array}{r|l} & x^2 - x - 2 \\ 2x^2 - 3 & 2x^4 - 2x^3 - 7x^2 + 3x + 6 \\ & \underline{\;2x^4 \qquad\quad \mp 3x^2} \\ & \quad -2x^3 - 4x^2 + 3x + 6 \\ & \quad \underline{\mp 2x^3 \qquad\quad \pm 3x} \\ & \qquad\quad -4x^2 + 6 \\ & \qquad\quad \underline{\mp 4x^2 \pm 6} \\ & \qquad\qquad 0 \end{array}$$

$$\begin{aligned} g(x) &= x^2 - x - 2 \\ &= x^2 - 2x + x - 2 \\ &= x(x-2) + 1(x-2) \\ &= (x+1)(x-2) \end{aligned}$$

$\therefore$ other two zeros are

$x + 1 = 0$ or $x = -1$

and $x - 2 = 0$ or $x = 2$

$\therefore$ other two zeros are -1 and 2

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8. Obtain all zeros of the polynomial f (x) = $2x^4 + x^3 - 14x^2 - 19x - 6$, if two of its zeros are -2 and -1.

Ans. $f(x) = 2x^4 + x^3 - 14x^2 - 19x - 6$, two zeros are -2 *and* -1

$\therefore$ $(x+2)$ and $(x+1)$ are the factors of $f(x)$.

$\therefore$ $(x+2)(x+1) = x^2 + 3x + 2$

$$
\begin{array}{r|l}
 & 2x^2 - 5x - 3 \\
x^2 + 3x + 2 & 2x^4 + x^3 - 14x^2 - 19x - 6 \\
 & \underline{2x^4 + 6x^3 + 4x^2} \quad (-\ -\ -) \\
 & -5x^3 - 18x^2 - 19x - 6 \\
 & \underline{-5x^3 - 15x^2 - 10x} \quad (+\ +\ +) \\
 & -3x^2 - 9x - 6 \\
 & \underline{-3x^2 - 9x - 6} \quad (+\ +\ +) \\
 & 0
\end{array}
$$

Now $2x^2 - 5x - 3$

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

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

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

$\therefore$ *zeros* are

$x - 3 = 0$

$\Rightarrow x = 3$

and $2x + 1 = 0$

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

other two zeros are 3 and $-\frac{1}{2}$

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9. Obtain all other zeros of $3x^4 + 6x^3 - 2x^2 - 10x - 5$. If two of its zeros are $\sqrt{\frac{5}{3}}$ and $-\sqrt{\frac{5}{3}}$

Ans. $3x^4 + 6x^3 - 2x^2 - 10x - 5$

zeros are $\pm\sqrt{\frac{5}{3}}$

$\left(x+\sqrt{\frac{5}{3}}\right)\left(x-\sqrt{\frac{5}{3}}\right)$ is the factor given polynomial i.e. $\left(x^2-\frac{5}{3}\right)\frac{1}{3}\left(3x^2-5\right)$

$$
\begin{array}{r|l}
 & x^2+2x+1 \\
3x^2-5 & 3x^4+6x^3-2x^2-10x-5 \\
 & \underline{-3x^4 \mp 5x^2} \\
 & 6x^3+3x^2-10x-5 \\
 & \underline{-6x^3 \mp 10x} \\
 & 3x^2-5 \\
 & \underline{-3x^2 \mp 5} \\
 & 0
\end{array}
$$

$Now\ x^2+x+1$

$\Rightarrow (x+1)^2$

$\therefore$ other zeros are

$(x+1)=0$ and $x+1=0$

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

$\therefore$ other two zeros -1 and -1

10. 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.

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$$
\begin{array}{r}
x^2-4x+(8-k) \\
x^2-2x+k\overline{)\,x^4-6x^3+16x^2-25x+10} \\
\underline{x^4-2x^3+kx^2} \\
-4x^3+(16-k)x^2-25x+10 \\
\underline{-4x^3+8x^2 \qquad -4kx} \\
(8-k)x^2+(4k-25)x+10 \\
\underline{(8-k)x^2-(16-2k)x+(8k-k^2)} \\
(2k-9)x+(k^2-8k+10)
\end{array}
$$

but remainder is $(x+a)$

$\therefore$ equating the cofficient of x and constant term.

so $2k-8k+10=a$

$\Rightarrow \; 25-40+10=a$

$\Rightarrow \; -5=a$

$\therefore \; k=5$ and $a=-5$

11. Find the value of '*k*' for which the polynomial $x^4+10x^3+25x^2+15x+k$ is exactly divisible by (x + 7).

Ans. $p(x)=x^4+10x^3+25x^2+15x+k$

$\therefore \; (x+7)$ is the factor.

$\therefore \; p(-7)=0$

or $(-7)^4+10(-7)^3+25(-7)^2+15(-7)+k=0$

$2401-3430+1225-105+k=0$

$k=91$

12. If α and β are the zeros of the polynomial f (x) = x^2 + px + q, find polynomial

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whose zeros are (α + β)^2 and (α - β)^2.

Ans. $f(x)=x^2+px+q$, if α and β are zeros

$\therefore\ \alpha+\beta=-p \text{ and } \alpha\beta=q$

If zeros are $(\alpha+\beta)^2$ and $(\alpha-\beta)^2$

$(\alpha-\beta)^2=(\alpha+\beta)^2-4\alpha\beta$

$=(-p)^2-4q$

$(\alpha-\beta)^2=-p^2-4q$

Now sum of zeros

$(\alpha+\beta)^2+(\alpha-\beta)^2=(-p)^2+(p^2-4q)$

$=2p^2-4q$

Product of zeros

$(\alpha+\beta)^2(\alpha-\beta)^2=(-p)^2+(p^2-4q)$

$=4p^4-4p^2q$

$\therefore$ required polynomial is

$x^2-(\text{sum of zeros})x+\text{ product of zeros}$

$=x^2-(2p^2-4q)x+4p^4-4p^2q$

$=x^2-2p^2x-4qx+p^4-4p^2q$

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CBSE Class 10 Mathematics

Important Questions

Chapter 2

Polynomails

4 Marks Questions

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

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

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

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

Ans. (i)

$$x - 3$$

$$x^2 - 2)\ x^3 - 3x^2 + 5x - 3$$

$$\pm x^3 \quad \pm 2x$$

$$-3x^2 + 7x - 3$$

$$\mp 3x^2 \quad \pm 6$$

$$7x - 9$$

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

(ii)

$$x \ + x - 3$$

$$x^2 - x + 1)\ x^4 - 3x^2 + 4x + 5$$

$$\pm x^4 \pm x^2 \quad \mp x^3$$

$$-4x^2 + 4x + 5 + x^3$$

$$\mp x^2 \pm x \quad \pm x^3$$

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

$$\mp 3x^2 \pm 3x \mp 3$$

$$8$$

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

(iii)

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

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)

$$
\begin{array}{r}
2t^2+3t+4 \\
\hline
x^2-3)\ 2t^4+3x^3-2t^2-9t-12 \\
\pm 2t^4 \qquad \mp 6t^2 \\
\hline
+3t^3+4t^2-9t-12 \\
\pm 3t^3 \qquad \mp 9t \\
\hline
+4t^2+0-12 \\
\pm 4t^2 \qquad \mp 12 \\
\hline
0
\end{array}
$$

$\because$ Remainder = 0

Hence first polynomial is a factor of second polynomial.

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(ii)

$$
\begin{array}{r}
3x^2-4x+2 \\
x^2+3x+1\overline{)\;3x^4+5x^3-7x^2+2x+2} \\
\pm3x^4\pm9x^3\pm3x^2 \qquad\qquad \\
\hline
-4x^3-10x^2+2x+2 \\
\mp4x^3\mp12x^2\mp4x \qquad \\
\hline
+2x^2+6x+2 \\
\pm2x^2\pm6x\pm2 \\
\hline
0
\end{array}
$$

∵ Remainder = 0

Hence first polynomial is a factor of second polynomial.

(iii)

$$
\begin{array}{r}
x^2-1 \\
x^3-3x+1\overline{)\;x^5-4x^3+x^2+3x+1} \\
\pm x^5\mp3x^3\mp x^2 \qquad\qquad \\
\hline
-x^3+3x+1 \\
\mp x^3+3x\mp1 \\
\hline
2
\end{array}
$$

∵ Remainder ≠0

Hence first polynomial is not factor of second polynomial.

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

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

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$\left(x-\sqrt{\frac{5}{3}}\right)\left(x+\sqrt{\frac{5}{3}}\right)=x^2-\frac{5}{3}$ is a factor of $(3x^4+6x^3-2x^2-10x-5)$.

Applying Division Algorithm to find more factors we get:

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

We have p(x) = g(x) × q(x).

$\Rightarrow (3x^4+6x^3-2x^2-10x-5) = (x^2-\frac{5}{3})(3x^2+6x+3)$

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

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

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

4. On dividing (x^3-3x^2+x+2) 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

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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 (x^3-3x^2+3x-2) by $(x-2)$, we get

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

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 $p(x)=3x^2+3x+6$, $g(x)=3$

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

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

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

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

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

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

6. Find the zeroes of the following quadratic polynomials and verify the relationship

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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 $ax^2 + bx + c$,

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

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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.

$\Rightarrow (2s-1)(2s-1)=0$

$\Rightarrow s=\frac{1}{2},\frac{1}{2}$

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

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

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

$=6x^2-7x-3 = 6x^2-9x+2x-3$

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

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

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

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

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×−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

$\Rightarrow t^2=15$

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$\Rightarrow t = \pm\sqrt{15}$

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.

$\Rightarrow (3x-4)(x+1)=0$

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

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

Sum of zeroes= $\frac{4}{3}+\left(-1\right)=\frac{4-3}{3}=\frac{1}{3}=\frac{-(-1)}{3}$

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

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

7. Find a quadratic polynomial each with the given numbers as the sum and product of

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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.

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

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

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

$\therefore$ 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.

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

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

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

$\therefore$ 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.

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

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

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

$\therefore$ 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.

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

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

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

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

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

Let quadratic polynomial be ax^2+bx+c

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

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

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

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

$\therefore$ 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.

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

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

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

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

8. Verify that the numbers given alongside of the cubic polynomials below are their

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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 $d = 2$.

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

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

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

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

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

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

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

$= -16 + 16 = 0$

$\therefore \frac{1}{2}, 1$ 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 $\alpha\beta + \beta\gamma + \gamma\alpha$

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

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

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 $d=-2$.

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

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

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

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

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

9. 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.

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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 $x^3-2x^2-7x+14$.

10. 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+3x+1.

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

$\Rightarrow 3a=3$

$\Rightarrow a=1$

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

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

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

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

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

$\Rightarrow 3-b^2=1$

$\Rightarrow b=\pm 2$

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Hence $a = 1$ and $b = \pm 2$.

11. 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.

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

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

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

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

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

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

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

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

12. 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 $x^2 - 2x + k$.

$$\begin{array}{r l}
 & x^2 - 4x + (8-k) \\
\hline
x^2 - 2x + k) & x^4 - 6x^3 + 16x^2 - 25x + 10 \\
 & \pm x^4 \mp 2x^3 \pm kx^2 \\
\hline
 & -4x^3 + (16-k)x^2 - 25x + 10 \\
 & \mp 4x^3 \pm 8x^2 \mp 4kx \\
\hline
 & (8-k)\ x^2 + (5k-25)x + 10 \\
 & \mp (8-k)x^2 \mp 2(8-k)x \pm (8-k)k \\
\hline
 & (2k-9)x - (8-k)k + 10
\end{array}$$

$\therefore$ 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 $-(8-k)k + 10 = a$

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

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