

VERY SHORT ANSWER TYPE QUESTIONS

1. If α and β are the roots of $ax^2 - bx + c = 0$ ($a \neq 0$), then calculate $\alpha + \beta$.

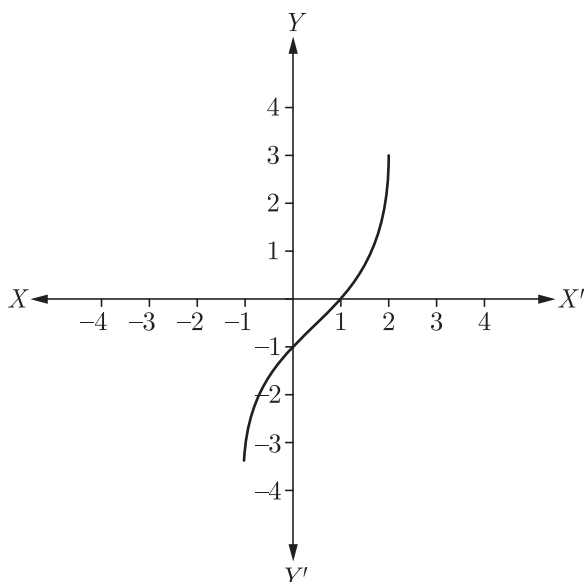
Ans : [Board Term-1, 2014]

We know that

$$\text{Sum of the roots} = -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

$$\text{Thus } \alpha + \beta = -\left(\frac{-b}{a}\right) = \frac{b}{a}$$

2. In given figure, the graph of a polynomial $p(x)$ is shown. Calculate the number of zeroes of $p(x)$.



Ans :

The graph intersects x-axis at one point $x = 1$. Thus the number of zeroes of $p(x)$ is 1.

3. Calculate the zeroes of the polynomial $p(x) = 4x^2 - 12x + 9$.

Ans :

$$\begin{aligned} \text{We have } p(x) &= 4x^2 - 12x + 9 \\ &= 4x^2 - 6x - 6x + 9 \\ &= 2x(2x - 3) - 3(2x - 3) \\ &= (2x - 3)(2x - 3) \end{aligned}$$

Substituting $p(x) = 0$, and solving we get $x = \frac{3}{2}, \frac{3}{2}$

$$x = \frac{3}{2}, \frac{3}{2}$$

Hence, zeroes of the polynomial are $\frac{3}{2}, \frac{3}{2}$. 1

4. If sum of the zeroes of the quadratic polynomial

$3x^2 - kx + 6$ is 3, then find the value of k .

Ans :

$$\text{We have } p(x) = 3x^2 - kx - 6$$

$$\text{Sum of the zeroes} = 3 = -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

$$\text{Thus } 3 = -\frac{(-k)}{3} \Rightarrow k = 9$$

5. If -1 is a zero of the polynomial $f(x) = x^2 - 7x - 8$, then calculate the other zero.

Ans :

$$\text{We have } f(x) = x^2 - 7x - 8$$

Let other zero be k , then we have

$$\text{Sum of zeroes, } -1 + k = -\left(\frac{-7}{1}\right) = 7$$

$$\text{or } k = 8$$

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SHORT ANSWER TYPE QUESTIONS - I

1. If zeroes of the polynomial $x^2 + 4x + 2a$ are a and $\frac{2}{a}$, then find the value of a .

Ans : [Board Term-1, 2016 Set-O4YP6G7]

Product of (zeroes) roots,

$$\frac{c}{a} = \frac{2a}{1} = \alpha \times \frac{2}{\alpha} = 2$$

$$\text{or, } 2a = 2$$

$$\text{Thus } a = 1$$

2. Find all the zeroes of $f(x) = x^2 - 2x$.

Ans : [Board Term-1, 2013, LK-59]

$$\begin{aligned} \text{We have } f(x) &= x^2 - 2x \\ &= x(x - 2) \end{aligned}$$

Substituting $f(x) = 0$, and solving we get $x = 0, 2$

Chap 2 : Polynomials

Hence, zeroes are 0 and 2.

3. Find the zeroes of the quadratic polynomial $\sqrt{3}x^2 - 8x + 4\sqrt{3}$.

Ans : [Board Term-1, 2013, LK-59]

$$\begin{aligned} p(x) &= \sqrt{3}x^2 - 8x + 4\sqrt{3} = 0 \\ &= \sqrt{3}x^2 - 6x - 2x + 4\sqrt{3} = 0 \\ &= \sqrt{3}x(x - 2\sqrt{3}) - 2(x - 2\sqrt{3}) = 0 \\ &= (\sqrt{3}x - 2)(x - 2\sqrt{3}) = 0 \end{aligned}$$

Substituting $p(x) = 0$, and solving we get $x = \frac{2}{\sqrt{3}}, 2\sqrt{3}$

Hence, zeroes are $\frac{2}{\sqrt{3}}$ and $2\sqrt{3}$.

4. Find a quadratic polynomial, the sum and product of whose zeroes are 6 and 9 respectively. Hence find the zeroes.

Ans : [Board Term-1, 2016 Set- LGRKEGO]

Sum of zeroes, $\alpha + \beta = 6$

Product of zeroes $\alpha\beta = 9$

Now $p(x) = x^2 - (\alpha + \beta)x + \alpha\beta$

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

Thus quadratic polynomial is $x^2 - 6x + 9$.

Now $p(x) = x^2 - 6x + 9$

$$= (x - 3)(x - 3)$$

Substituting $p(x) = 0$, we get $x = 3, 3$

Hence zeroes are 3, 3

5. Find the quadratic polynomial whose sum and product of the zeroes are $\frac{21}{8}$ and $\frac{5}{16}$ respectively.

Ans : [Board Term-1, 2012, Set-35]

Sum of zeroes, $\alpha + \beta = \frac{21}{8}$

Product of zeroes $\alpha\beta = \frac{5}{16}$

Now $p(x) = x^2 - (\alpha + \beta)x + \alpha\beta$

$$= x^2 - \frac{21}{8}x + \frac{5}{16}$$

or $p(x) = \frac{1}{16}(16x^2 - 42x + 5)$

6. Form a quadratic polynomial $p(x)$ with 3 and $-\frac{2}{5}$ as sum and product of its zeroes, respectively.

Ans : [Board Term-1, 2012, Set-64]

Sum of zeroes, $\alpha + \beta = 3$

Product of zeroes $\alpha\beta = -\frac{2}{5}$

Now $p(x) = x^2 - (\alpha + \beta)x + \alpha\beta$

$$= x^2 - 3x - \frac{2}{5}$$

$$= \frac{1}{5}(5x^2 - 15x - 2)$$

The required quadratic polynomial is $\frac{1}{5}(5x^2 - 15x - 2)$

7. What should be added to the polynomial $x^3 - 3x^2 + 6x - 15$ so that it is completely divisible by $x - 3$.

Ans : [Board Term-1, 2016 Set-ORDAWEZ]

We divide $x^3 - 3x^2 + 6x - 15$ by $x - 3$ as follows.

$$\begin{array}{r} x^2 + 6 \\ x-3 \overline{) x^3 - 3x^2 + 6x - 15} \\ \underline{x^3 - 3x^2} \\ 6x - 15 \\ \underline{6x - 18} \\ 3 \end{array}$$

Here remainder is 3, hence -3 must be added so that there is no remainder.

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8. If m and n are the zeroes of the polynomial $3x^2 + 11x - 4$, find the value of $\frac{m}{n} + \frac{n}{m}$.

Ans : [Board Term-1, 2012, Set-40]

We have $\frac{m}{n} + \frac{n}{m} = \frac{m^2 + n^2}{mn} = \frac{(m+n)^2 - 2mn}{mn}$ (1)

Sum of zeroes $m + n = -\frac{11}{3}$

Product of zeroes $mn = \frac{-4}{3}$

Substituting in (1) we have

$$\begin{aligned} \frac{m}{n} + \frac{n}{m} &= \frac{(m+n)^2 - 2mn}{mn} \\ &= \frac{\left(-\frac{11}{3}\right)^2 - \frac{-4}{3} \times 2}{\frac{-4}{3}} \\ &= \frac{121 + 4 \times 3 \times 2}{-4 \times 3} \end{aligned}$$

or $\frac{m}{n} + \frac{n}{m} = \frac{-145}{12}$

9. If p and q are the zeroes of polynomial $f(x) = 2x^2 - 7x + 3$, find the value of $p^2 + q^2$.

Ans : [Board Term-1, 2012, Set-21]

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

Sum of zeroes $p + q = -\frac{b}{a} = -\left(\frac{-7}{2}\right) = \frac{7}{2}$

Product of zeroes $pq = \frac{c}{a} = \frac{3}{2}$

Since, $(p + q)^2 = p^2 + q^2 + 2pq$

so, $p^2 + q^2 = (p + q)^2 - 2pq$
 $= \left(\frac{7}{2}\right)^2 - 3 = \frac{49}{4} - \frac{3}{1} = \frac{37}{4}$

Hence $p^2 + q^2 = \frac{37}{4}$.

10. Find the condition that zeroes of polynomial $p(x) = ax^2 + bx + c$ are reciprocal of each other.

Ans : [Board Term-1, 2012, Set-50]

We have $p(x) = ax^2 + bx + c$

Let α and $\frac{1}{\alpha}$ be the zeroes of $p(x)$. then

of p and q .

Ans : [Board Term-1, 2012, Set-39]

We have $f(x) = 2x^2 - 5x - 3$

Let the zeroes of polynomial be α and β , then

Sum of zeroes $\alpha + \beta = \frac{5}{2}$

Product of zeroes $\alpha\beta = -\frac{3}{2}$

According to the question, zeroes of $x^2 + px + q$ are 2α and 2β .

Sum of zeros, $2\alpha + 2\beta = \frac{-p}{1}$

$$2(\alpha + \beta) = -p$$

Substituting $\alpha + \beta = \frac{5}{2}$ we have

$$2 \times \frac{5}{2} = -p$$

or $p = -5$

Product of zeroes, $2\alpha 2\beta = \frac{q}{1}$

$$4\alpha\beta = q$$

Substituting $\alpha\beta = -\frac{3}{2}$ we have

$$4 \times \frac{-3}{2} = q$$

$$-6 = q$$

Thus $p = -5$ and $q = -6$.

19. If α and β are zeroes of $x^2 - (k-6)x + 2(2k-1)$, find the value of k if $\alpha + \beta = \frac{1}{2}\alpha\beta$.

Ans : [KVS Practice Test 2017]

We have $p(x) = x^2 - (k-6)x + 2(2k-1)$
 Since α, β are the zeroes of polynomial $p(x)$, we get

$$\alpha + \beta = -[-(k-6)] = k-6$$

$$\alpha\beta = 2(2k-1)$$

Now $\alpha + \beta = \frac{1}{2}\alpha\beta$

Thus $k+6 = \frac{2(2k-1)}{2}$

or, $k-6 = 2k-1$

$$k = -5$$

Hence the value of k is -5 .

SHORT ANSWER TYPE QUESTIONS - II

1. Verify whether 2, 3 and $\frac{1}{2}$ are the zeroes of the polynomial $p(x) = 2x^3 - 11x^2 + 17x - 6$.

Ans : [Board Term-1, 2013, LK-59]

If 2, 3 and $\frac{1}{2}$ are the zeroes of the polynomial $p(x)$, then these must satisfy $p(x) = 0$

(1) 2, $p(x) = 2x^3 - 11x^2 + 17x - 6$

$$p(2) = 2(2)^3 - 11(2)^2 + 17(2) - 6$$

$$= 16 - 44 + 34 - 6$$

$$= 50 - 50$$

or $p(2) = 0$

(2) 3, $p(3) = 2(3)^3 - 11(3)^2 + 17(3) - 6$

$$= 54 - 99 + 51 - 6$$

$$= 105 - 105$$

or $p(3) = 0$

(3) $\frac{1}{2}$ $p\left(\frac{1}{2}\right) = 2\left(\frac{1}{2}\right)^3 - 11\left(\frac{1}{2}\right)^2 + 17\left(\frac{1}{2}\right) - 6$

$$= \frac{1}{4} - \frac{11}{4} + \frac{17}{2} - 6$$

or $p\left(\frac{1}{2}\right) = 0$

Hence, 2, 3, and $\frac{1}{2}$ are the zeroes of $p(x)$.

2. If the sum and product of the zeroes of the polynomial $ax^2 - 5x + c$ are equal to 10 each, find the value of 'a' and 'c'.

Ans : [Board Term-1, 2011, Set-25]

We have $f(x) = ax^2 - 5x + c$

Let the zeroes of $f(x)$ be α and β , then,

Sum of zeroes $\alpha + \beta = -\frac{-5}{a} = \frac{5}{a}$

Product of zeroes $\alpha\beta = \frac{c}{a}$

According to question, the sum and product of the zeroes of the polynomial $f(x)$ are equal to 10 each.

Thus $\frac{5}{a} = 10$... (1)

and $\frac{c}{a} = 10$... (2)

Dividing (2) by eq. (1) we have

$$\frac{c}{5} = 1 \Rightarrow c = 5$$

Substituting $c = 5$ in (2) we get $a = \frac{1}{2}$

Hence $a = \frac{1}{2}$ and $c = 5$.

3. If one the zero of a polynomial $3x^2 - 8x + 2k + 1$ is seven times the other, find the value of k .

Ans : [Board Term-1, 2011, Set-40]

We have $f(x) = 3x^2 - 8x + 2k + 1$

Let α and β be the zeroes of the polynomial, then

$$\beta = 7\alpha$$

Sum of zeroes, $\alpha + \beta = -\left(-\frac{8}{3}\right)$

$$\alpha + 7\alpha = 8\alpha = \frac{8}{3}$$

So $\alpha = \frac{1}{3}$

Product of zeroes, $\alpha \times 7\alpha = \frac{2k+1}{3}$

$$7\alpha^2 = \frac{2k+1}{3}$$

$$7\left(\frac{1}{3}\right)^2 = \frac{2k+1}{3}$$

$$7 \times \frac{1}{9} = \frac{2k+1}{3}$$

$$\frac{7}{3} - 1 = 2k$$

$$\frac{4}{3} = 2k \Rightarrow k = \frac{2}{3}$$

Sum of zeroes of new polynomial $g(y)$

$$\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{7/6}{2/6} = \frac{7}{2}$$

and product of zeroes of new polynomial $g(y)$,

$$\frac{1}{\alpha} \times \frac{1}{\beta} = \frac{1}{\alpha\beta} = \frac{1}{1/3} = 3$$

The required polynomial is

$$g(x) = y^2 - \frac{7}{2}y + 3$$

$$= \frac{1}{2}[2y^2 - 7y + 6]$$

6. Show that $\frac{1}{2}$ and $-\frac{3}{2}$ are the zeroes of the polynomial $4x^2 + 4x - 3$ and verify relationship between zeroes and coefficients of the polynomial.

Ans : [Board Term-1, 2011, Set-21]

We have $p(x) = 4x^2 + 4x - 3$
If $\frac{1}{2}$ and $-\frac{3}{2}$ are the zeroes of the polynomial $p(x)$, then these must satisfy $p(x) = 0$

$$p\left(\frac{1}{2}\right) = 4\left(\frac{1}{4}\right) + 4\left(\frac{1}{2}\right) - 3$$

$$= 1 + 2 - 3 = 0$$

and $p\left(-\frac{3}{2}\right) = 4\left(\frac{9}{4}\right) + 4\left(-\frac{3}{2}\right) - 3$

$$= 9 - 6 - 3 = 0$$

Thus $\frac{1}{2}, -\frac{3}{2}$ are zeroes of polynomial $4x^2 + 4x - 3$.

$$\text{Sum of zeroes} = \frac{1}{2} - \frac{3}{2} = -1 = \frac{-4}{4}$$

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

$$\text{Product of zeroes} = \left(\frac{1}{2}\right)\left(-\frac{3}{2}\right) = \frac{-3}{4}$$

$$= \frac{\text{Constan term}}{\text{Coefficient of } x^2} \quad \text{Verified}$$

7. Find the zeroes of the quadratic polynomial $x^2 - 2\sqrt{2}x$ and verify the relationship between the zeroes and the coefficients.

Ans : [Board Term-1, 2015, Set-FHN8MG0]

We have $p(x)x^2 - 2\sqrt{2}x = 0$

$$x(x - 2\sqrt{2}) = 0$$

Thus zeroes are 0 and $2\sqrt{2}$.

$$\text{Sum of zeroes} \quad 2\sqrt{2} = -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$$

and product of zeroes $0 = \frac{\text{Constan term}}{\text{Coefficient of } x^2}$

Hence verified

8. Find the zeroes of the quadratic polynomial $5x^2 + 8x - 4$ and verify the relationship between the zeroes and the coefficients of the polynomial.

Ans : [Board Term-1, 2013, Set LK-59]

We have $p(x) = 5x^2 + 8x - 4 = 0$

$$= 5x^2 + 10x - 2x - 4 = 0$$

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4. Quadratic polynomial $2x^2 - 3x + 1$ has zeroes as α and β . Now form a quadratic polynomial whose zeroes are 3α and 3β .

Ans : [Board Term-2, 2015, Set-DDE-E]

We have $f(x) = 2x^2 - 3x + 1$
If α and β are the zeroes of $2x^2 - 3x + 1$, then

$$\text{Sum of zeroes} \quad \alpha + \beta = \frac{-b}{a} = \frac{3}{2}$$

$$\text{Product of zeroes} \quad \alpha\beta = \frac{c}{a} = \frac{1}{2}$$

New quadratic polynomial whose zeroes are 3α and 3β is,

$$p(x) = x^2 - (3\alpha + 3\beta)x + 3\alpha \times 3\beta$$

$$= x^2 - 3(\alpha + \beta)x + 9\alpha\beta$$

$$= x^2 - 3\left(\frac{3}{2}\right)x + 9\left(\frac{1}{2}\right)$$

$$= x^2 - \frac{9}{2}x + \frac{9}{2}$$

$$= \frac{1}{2}(2x^2 - 9x + 9)$$

Hence, required quadratic polynomial is $\frac{1}{2}(2x^2 - 9x + 9)$

5. If α and β are the zeroes of the polynomial $6y^2 - 7y + 2$, find a quadratic polynomial whose zeroes are $\frac{1}{\alpha}$ and $\frac{1}{\beta}$.

Ans : [Board Term-1, 2011, Set-39]

We have $p(y) = 6y^2 - 7y + 2$

$$\text{Sum of zeroes} \quad \alpha + \beta = -\left(-\frac{7}{6}\right) = \frac{7}{6}$$

$$\text{Product of zeroes} \quad \alpha\beta = \frac{2}{6} = \frac{1}{3}$$

$$= 5x(x+2) - 2(x+2) = 0$$

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

Substituting $p(x) = 0$ we get zeroes as -2 and $\frac{2}{5}$.

Verification :

$$\text{Sum of zeroes} = -2 + \frac{2}{5} = \frac{-8}{5}$$

$$\text{Product of zeroes} = (-2) \times \left(\frac{2}{5}\right) = \frac{-4}{5}$$

Now from polynomial we have

$$\text{Sum of zeroes} \quad -\frac{b}{a} = -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = \frac{-8}{5}$$

$$\text{Product of zeroes} \quad \frac{c}{a} = \frac{\text{Constant term}}{\text{Coefficient of } x^2} = \frac{-4}{5}$$

Hence Verified.

9. If α and β are the zeroes of a quadratic polynomial such that $\alpha + \beta = 0$ and $\alpha - \beta = 8$. Find the quadratic polynomial having α and β as its zeroes.

Ans : [Board Term-1, 2011, Set-44]

$$\text{We have} \quad \alpha + \beta = 24 \quad \dots(1)$$

$$\alpha - \beta = 8 \quad \dots(2)$$

Adding equations (1) and (2) we have

$$2\alpha = 32 \Rightarrow \alpha = 16$$

Subtracting (1) from (2) we have

$$2\beta = 24 \Rightarrow \beta = 12$$

Hence, the quadratic polynomial

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

$$= x^2 - (16 + 8)x + (16)(8)$$

$$= x^2 - 24x + 128$$

10. If α, β and γ are zeroes of the polynomial $6x^3 + 3x^2 - 5x + 1$, then find the value of $\alpha^{-1} + \beta^{-1} + \gamma^{-1}$.

Ans : [KVS practice Test 2017, CBSE Board 2010]

$$\text{We have} \quad p(x) = 6x^3 + 3x^2 - 5x + 1$$

Since α, β and γ are zeroes polynomial $p(x)$, we have

$$\alpha + \beta + \gamma = -\frac{b}{c} = -\frac{3}{6} = -\frac{1}{2}$$

$$\alpha\beta + \beta\gamma + \gamma\alpha = \frac{c}{a} = -\frac{5}{6}$$

$$\text{and} \quad \alpha\beta\gamma = -\frac{d}{a} = -\frac{1}{6}$$

$$\text{Now} \quad \frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma} = \frac{\alpha\beta + \beta\gamma + \gamma\alpha}{\alpha\beta\gamma}$$

$$= \frac{-5/6}{-1/6} = \frac{-5}{6} \times \frac{6}{-1} = 5$$

Hence $\alpha^{-1} + \beta^{-1} + \gamma^{-1} = 5$.

by $x^2 + 7x + 12$, then find the value of p and q .

Ans : [Board Term-1, 2015, Set-DDE-M]

$$\text{We have} \quad f(x) = x^4 + 7x^3 + 7x^2 + px + q$$

$$\text{Now} \quad x^2 + 7x + 12 = 0$$

$$x^2 + 4x + 3x + 12 = 0$$

$$x(x+4) + 3(x+4) = 0$$

$$(x+4)(x+3) = 0$$

$$x = -4, -3 \quad \dots(i)$$

Since $f(x) = x^4 + 7x^3 + 7x^2 + px + q$ is exactly divisible by $x^2 + 7x + 12$, then $x = -4$ and $x = -3$ must be its zeroes and these must satisfy $f(x) = 0$

So putting $x = -4$ and $x = -3$ in $f(x)$ and equating to zero we get

$$f(-4) : (-4)^4 + 7(-4)^3 + 7(-4)^2 + p(-4) + q = 0$$

$$+ 112 - 4p + q = 0$$

$$-4p + q - 80 = 0$$

$$4p - q = -80 \dots(1)$$

$$p(-3) : (-3)^4 + 7(-3)^3 + 7(-3)^2 + p(-3) + q = 0$$

$$81 - 189 + 63 - 3p + q = 0$$

$$-3p + q - 45 = 0$$

$$3p - q = -45 \dots(2)$$

Subtracting eq, (2) from (1) we have

$$p = -35$$

On putting the value of p in eq. (1) we have

$$4(-35) - q = -80$$

$$-140 - q = -80$$

$$-q = 140 - 80$$

$$\text{or} \quad -q = 60$$

$$q = -60$$

Hence, $p = -35$ and $q = -60$.

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2. If α and β are the zeroes of the polynomial $p(x) = 2x^2 + 5x + k$ satisfying the relation, $\alpha^2 + \beta^2 + \alpha\beta = \frac{21}{4}$, then find the value of k .

Ans : [Board Term-1, 2012, Set-50]

$$\text{We have} \quad p(x) = 2x^2 + 5x + k$$

$$\text{Sum of zeroes,} \quad \alpha + \beta = -\frac{b}{a} = -\left(\frac{5}{2}\right)$$

$$\text{Product of zeroes} \quad \alpha\beta = \frac{c}{a} = \frac{k}{2}$$

According to the question,

$$\alpha^2 + \beta^2 + \alpha\beta = \frac{21}{4}$$

$$\alpha^2 + \beta^2 + 2\alpha\beta - \alpha\beta = \frac{21}{4}$$

$$(\alpha + \beta)^2 - \alpha\beta = \frac{21}{4}$$

Substituting values we have

$$\left(\frac{-5}{2}\right)^2 - \frac{k}{2} = \frac{21}{4}$$

$$\frac{k}{2} = \frac{25}{4} - \frac{21}{4}$$

LONG ANSWER TYPE QUESTIONS

1. Polynomial $x^4 + 7x^3 + 7x^2 + px + q$ is exactly divisible

$$\alpha\beta = \frac{k}{6} = \frac{1}{2} \times \frac{1}{3}$$

Hence, $k = 1$.

6. If β and $\frac{1}{\beta}$ are zeroes of the polynomial $(a^2 + a)x^2 + 61x + 6a$. Find the value of β and α .

Ans :

We have $p(x) = (a^2 + a)x^2 + 61x + 6$

Since β and $\frac{1}{\beta}$ are the zeroes of polynomial, $p(x)$

Sum of zeroes,
$$\beta + \frac{1}{\beta} = -\frac{61}{a^2 + a}$$

or,
$$\frac{\beta^2 + 1}{\beta} = -\frac{61}{a^2 + a} \quad \dots(1)$$

Product of zeroes
$$\beta \frac{1}{\beta} = \frac{6a}{a^2 + a}$$

or,
$$1 = \frac{6}{a + 1}$$

$$a + 1 = 6$$

$$a = 5$$

Substituting this value of a in (1) we get

$$\frac{\beta^2 + 1}{\beta} = \frac{-61}{5^2 + 5} = -\frac{61}{30}$$

$$30\beta^2 + 30 = -61\beta$$

$$30\beta^2 + 61\beta + 30 = 0$$

Now
$$\beta = \frac{-61 \pm \sqrt{(-61)^2 \times 4 \times 30 \times 30}}{2 \times 30}$$

$$= \frac{-61 \pm \sqrt{3721 - 3600}}{60}$$

$$\frac{-61 \mp 11}{60}$$

Thus $\beta = \frac{-5}{6}$ or $\frac{-6}{5}$

Hence, $\alpha = 5, \beta = \frac{-5}{6}, \frac{-6}{5}$

Hence $g(x) = x^2 - 2x$.

2. Find the quotient and remainder on dividing $p(x)$ by $g(x)$:

$$p(x) = 4x^3 + 8x^2 + 8x + 7; g(x) = 2x^2 - x + 1$$

Ans : [Board Term-1, 2012, Set-55]

$$2x^2 - x + 1 \overline{) 4x^3 + 8x^2 + 8x + 7}$$

$$\underline{4x^3 - 2x^2 + 2x} $$

$$10x^2 + 6x + 7$$

$$\underline{10x^2 - 5x + 7}$$

$$11x + 2$$

Thus, Quotient = $2x + 5$

and Remainder = $11x + 2$

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3. Check whether the polynomial $g(x) = x^2 + 3x + 1$ is a factor of the polynomial $f(x) = 3x^4 + 5x^3 - 7x^2 + 2x + 4$.

Ans : [Board Term-1, 2012, Set-48]

$$x^2 + 3x + 1 \overline{) 3x^4 + 5x^3 - 7x^2 + 2x + 4}$$

$$\underline{3x^4 + 9x^3 + 3x^2} $$

$$-4x^3 - 10x^2 + 2x $$

$$\underline{-4x^3 - 12x^2 - 4x} $$

$$2x^2 + 6x + 4$$

$$\underline{2x^2 + 6x + 2}$$

$$2$$

Since remainder is not zero, polynomial $g(x) = x^2 + 3x + 1$ is not a factor of the polynomial $f(x) = 3x^4 + 5x^3 - 7x^2 + 2x + 4$.

4. What should be added in the polynomial $x^3 - 6x^2 + 11x + 8$ so that is completely divisible by $x^2 - 3x + 2$?

Ans : [Board Term-1, Set, 2015]

$$x^2 - 3x + 2 \overline{) x^3 - 6x^2 + 11x + 8}$$

$$\underline{x^3 - 3x^2 + 2x} $$

$$-3x^2 + 9x + 8$$

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

$$14$$

Since Remainder = 14 to make it 0 - 14 should be added.

5. If the polynomial $6x^4 + 8x^3 + 17x^2 + 21x + 7$ is divided by another polynomial $3x^2 + 4x + 1$, the remainder comes out to be $(ax + b)$, find the values of a and b .

Ans : [Board Term-1, Set FHN8MGI, 2015]

$$3x^2 + 4x + 1 \overline{) 6x^4 + 8x^3 + 17x^2 + 21x + 7}$$

$$\underline{6x^4 + 8x^3 + 2x^2} $$

$$15x^2 + 21x + 7$$

$$\underline{15x^2 + 20x + 5}$$

Comparing both the sides we get $a = 1$ and $b = 2$

SHORT ANSWER TYPE QUESTIONS - I

1. On dividing $x^3 - 5x^2 + 6x + 4$ by a polynomial $g(x)$, the quotient and the remainder were $x - 3$ and 4 respectively. Find $g(x)$.

Ans : [Board Term-1, 2012, Set-55]

We have $x^3 - 5x^2 + 6x + 4 = g(x)(x - 3) + 4$

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

or,
$$g(x) = \frac{x^3 - 5x^2 + 6x}{x - 3}$$

Now we divide $x^3 - 5x^2 + 6x$ by $x - 3$ as follows.

$$x - 3 \overline{) x^3 - 5x^2 + 6x}$$

$$\underline{x^3 - 3x^2} $$

$$-2x^2 + 6x$$

$$\underline{2x^2 + 6x}$$

$$0$$

$$x^2 + 7x + 9 = g(x)(x + 2) - 1$$

$$\text{or, } g(x) = \frac{x^2 + 7x + 10}{x + 2} = \frac{(x + 2)(x + 5)}{(x + 2)} = x + 5$$

Thus $g(x) = x + 5$

6. Check by divisible, algorithm whether $x^2 - 2$ is a factor of $x^4 + x^3 + x^2 - 2x - 3$.

Ans : [Board Term-1, 2011, Set-39]

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

Since Remainder $\neq 0$ hence $x^2 - 2$ is not a factor of the given polynomial.

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

Ans : [Board Term-1, 2015, Set-CJTOQ]

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

$$\begin{aligned} x^4 - x^3 - 3x^2 + 3x + 2 &= (x^2 - x - 2)g(x) + 2x \\ g(x)(x^2 - x - 2) &= (x^4 - x^3 - 3x^2 + 3x + 2) - 2x \\ g(x) &= \frac{x^4 - x^3 - 3x^2 + x + 2}{x^2 - x - 2} \end{aligned}$$

Hence, $g(x) = x^2 - 1$

8. What should be added in the polynomial $x^3 + 2x^2 - 9x + 1$ so that it is completely divisible by $x + 4$.

Ans : [Board Term-1, 2015, Set-DDE-M]

Let k be added.

$$\begin{array}{r} x^2 - 2x - 1 \\ x + 4 \overline{) x^3 + 2x^2 - 9x + 1} \\ \underline{x^3 + 4x^2} \\ -2x^2 - 9x + 1 \\ \underline{-2x^2 - 8x} \\ -x + 1 \\ \underline{-x - 4} \\ 5 \end{array}$$

Remainder should be zero

$$5 + k = 0$$

Hence -5 should be added.

9. If the polynomial $f(x) = 3x^4 + 3x^3 - 11x^2 - 5x + 10$ is completely divisible by $3x^2 - 5$, find all its zeroes.

Ans : [Board Term-1, 2013, FFC; 2011, Set-13]

Ans :

Since $3x^2 - 5$ divides $f(x)$ completely, $(3x^2 - 5)$ is a factor of $f(x)$.

$$\text{Thus } 3x^2 - 5 = 0$$

$$x^2 = \frac{5}{3}$$

$$x = \pm \sqrt{\frac{5}{3}}$$

$$\begin{array}{r} x^2 + x - 2 \\ 3x^2 - 5 \overline{) 3x^4 + 3x^3 - 11x^2 - 5x + 10} \\ \underline{3x^4 - 5x^2} \\ 3x^3 - 6x^2 - 5x + 10 \\ \underline{3x^3 - 5x} \\ -6x^2 + 10 \\ \underline{-6x^2 } \\ 0 \end{array}$$

Since $(x^2 + x - 2)$ is a factor of $p(x)$

$$x^2 + x - 2 = 0$$

Factorising it, we get

$$x = -2 \text{ and } 1$$

Thus -2 and 1 are zeroes of $p(x)$.

All the zeroes of $p(x)$ are $\sqrt{\frac{5}{3}}$, $-\sqrt{\frac{5}{3}}$, -2 and 1 .

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LONG ANSWER TYPE QUESTIONS

1. If two zeroes of a polynomial $x^3 + 5x^2 + 7x + 3$ are -1 and -3 , then find the third zero.

Ans : [Board Term-1, 2016 Set MV98HN3]

$$\begin{array}{r} x + 1 \\ x^2 + 4x + 3 \overline{) x^3 + 5x^2 + 7x + 3} \\ \underline{x^3 + 4x^2 + 3x} \\ x^2 + 4x + 3 \\ \underline{x^2 + 4x + 3} \\ 0 \end{array}$$

$x = -1$ and $x = -3$ are zeroes.

2. Given that $x - \sqrt{5}$ is a factor of the polynomial $x^3 - 3\sqrt{5}x^2 - 5x + 15\sqrt{5}$, find all the zeroes of the polynomial.

Ans : [Board Term-1, 2014] [Board Term-1, 2012, Set-39]

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

Factorising the quotient we get

$$\begin{aligned}
 x^2 - 2\sqrt{5}x - 15 &= x^2 - 3\sqrt{5}x + \sqrt{5}x - 15 \\
 &= x(x - 3\sqrt{5}) + \sqrt{5}(x - 3\sqrt{5}) \\
 &= (x + \sqrt{5})(x - 3\sqrt{5})
 \end{aligned}$$

$$(x + \sqrt{5})(x - 3\sqrt{5}) = 0 \Rightarrow x = \sqrt{5}, 3\sqrt{5}$$

All the zeroes are $\sqrt{5}$, $-\sqrt{5}$ and $3\sqrt{5}$.

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

Ans : [Board Term-1, 2012, Set-35]

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

Given, remainder = $x + a$

Comparing the multiples of x

$$(2k - 9)x = 1 \times x$$

$$2k - 9 = 1$$

$$k = \frac{10}{2} = 5$$

Substituting this value of k into other portion of remainder, we get

$$\text{and } a = 10 - 8k + k^2 = 10 - 40 + 25 = -5$$

4. Find the other zeroes of the polynomial $x^4 - 5x^3 + 2x^2 + 10x - 8$ if it is given that two zeroes are $-\sqrt{2}$ and $\sqrt{2}$.

Ans : [Board Term-1, 2012, Set-35]

We have two zeroes $\sqrt{2}$ and $-\sqrt{2}$.

Two factors are $(x + \sqrt{2})$ and $(x - \sqrt{2})$

$g(x) = (x + \sqrt{2})(x - \sqrt{2}) = x^2 - 2$ is a factor of the given polynomial

$$\begin{array}{r}
 x^2 - 5x + 4 \\
 x^2 - 2 \overline{) x^4 - 5x^3 + 2x^2 + 10x - 8} \\
 \underline{x^4 - 2x^2} \\
 -5x^3 + 4x^2 + 10x - 8 \\
 \underline{-5x^3 + 10x^2 - 10x} \\
 4x^2 - 8 \\
 \underline{4x^2 - 8} \\
 0
 \end{array}$$

$$\text{Quotient} = x^2 - 5x + 4 = (x - 4)(x - 1)$$

Hence other zeroes are 4 and 1.

5. Show that 3 is a zero of the polynomial $2x^2 - x^2 - 13x - 6$. Hence find all the zeroes of this polynomial.

Ans :

$$\begin{array}{r}
 2x^2 + 5x + 2 \\
 x - 3 \overline{) 2x^3 - x^2 - 13x - 6} \\
 \underline{2x^3 - 6x^2} \\
 5x^2 - 13x - 6 \\
 \underline{5x^2 - 15x} \\
 2x - 6 \\
 \underline{2x - 6} \\
 0
 \end{array}$$

$$\begin{aligned}
 p(x) &= 2x^2 - x^2 - 13x - 6 \\
 &= 2(3)^2 - (3)^2 - 13(3) - 6 \\
 &= 2(27) - 9 - 39 - 6 \\
 &= 54 - 54 = 0
 \end{aligned}$$

So, $x - 3$ is a factor of $p(x)$.

by long division

Factorising the quotient, we get

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

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

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

Hence, All the zeroes of $p(x)$ are $-\frac{1}{2}, -2, 3$

6. Obtain all other zeroes of the polynomial $x^4 + 6x^3 + x^2 - 24x - 20$, if two of its zeroes are $+2$ and -5 .

Ans : [Board Term-1, 2015, Set-DDE-E] [NCERT]

$$\begin{array}{r}
 x^2 + 3x + 2 \\
 x^2 + 3x - 10 \overline{) x^4 + 6x^3 + x^2 - 24x - 20} \\
 \underline{x^4 + 3x^3 - 10x^2} \\
 3x^3 + 11x^2 - 24x - 20 \\
 \underline{3x^3 + 9x^2 - 30x} \\
 2x^2 + 6x - 20 \\
 \underline{2x^2 + 6x - 20} \\
 0
 \end{array}$$

As $x = 2$ and -5 are the zeroes of $x^4 + 6x^3 + x^2 - 24x - 20$.

So $(x - 2)$ and $(x + 5)$ are two factors of $x^4 + 6x^3 + x^2 - 24x - 20$ and the product of factors is

$$(x - 2)(x + 5) = x^2 + 3x - 10 = 0$$

Dividing $x^4 + 6x^3 + x^2 - 24x - 20$ by $x^2 + 3x - 10$

$$\begin{aligned}
 x^4 + 6x^3 + x^2 - 24x - 20 \\
 &= (x^2 + 3x - 10)(x^2 + 3x + 2) \\
 &= (x - 2)(x + 5)(x + 2)(x + 1)
 \end{aligned}$$

Hence other two zeroes are -2 and 1 .

7. Obtain all other zeroes of the polynomial $4x^4 + x^3 - 72x^2 - 18x$, if two of its zeroes are $3\sqrt{2}$ and $-3\sqrt{2}$.

Ans : [Board Term-1, 2015, Set-C3TOQ]

Ans :

As $3\sqrt{2}$ and $-3\sqrt{2}$ are the zeroes of $4x^4 + x^3 - 72x^2 - 18x$, So $(x - 3\sqrt{2})$ and $(x + 3\sqrt{2})$ are its two factors

Now, $(x - 3\sqrt{2})(x + 3\sqrt{2}) = 0$

or, $x^2 - 18 = 0$

On Factorising quotient $4x^2 + 2$

We get, $x = 0$ and $\frac{1}{4}$

$$= (x^2 - 18)x(4x + 1)$$

$$= (x - 3\sqrt{2})(x + 3\sqrt{2})(x)(4x + 1)$$

Hence, other two zeroes are 0 and $-\frac{1}{4}$.

8. Obtain all other zeroes of the polynomial $9x^4 - 6x^3 - 35x^2 + 24x - 4$, if two of its zeroes are 2 and -2 .

Ans : [Board Term-1, 2015, Set -DDE -M]

As 2 and -2 are the zeroes of $9x^4 - 6x^3 - 35x^2 + 24x - 4$, So $(x - 2)$ and $(x + 2)$ are its two factors

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

Dividing $9x^4 - 6x^3 - 35x^2 + 24x - 4$ by $x^2 - 4$

$$\begin{array}{r} 9x^2 - 6x + 1 \\ x^2 - 4 \overline{) 9x^4 - 6x^3 - 35x^2 + 24x - 4} \\ \underline{9x^4 - 36x^2} \\ -6x^3 + x^2 + 24x - 4 \\ \underline{-6x^3 + 24x} \\ x^2 - 4 \\ \underline{x^2 - 4} \\ 0 \end{array}$$

Factorising this quotient

$$= [9x^2 - 6x - 3x + 1]$$

$$= [3x(3x - 1) - 1(3x - 1)]$$

$$= [(3x - 1)(3x - 1)]$$

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

Hence, other two zeroes are $\frac{1}{3}, \frac{1}{3}$. 1

9. Find all the zeros of the polynomial $3x^4 + 6x^3 - 2x^2 - 10x - 5$ if two of its zeroes are $\sqrt{\frac{5}{3}}$ and $-\sqrt{\frac{5}{3}}$

Ans : [Sample Paper 2017]

$$\begin{array}{r} x^2 + 2x + 1 \\ 3x^2 - 5 \overline{) 3x^4 + 6x^3 - 2x^2 - 10x - 5} \\ \underline{3x^4 - 5x^2} \\ 6x^3 + 3x^2 - 10x - 5 \\ \underline{-6x^3 - 10x} \\ 3x^2 - 5 \\ \underline{3x^2 - 5} \\ 0 \end{array}$$

Since $\sqrt{\frac{5}{3}}$ and $-\sqrt{\frac{5}{3}}$ are two zeroes of the given polynomial.

So, $(x - \sqrt{\frac{5}{3}}), (x + \sqrt{\frac{5}{3}})$ will be its two factors

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

is a factor of given polynomial

Now, dividing it by $3x^2 - 5$.

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

two other zeroes = -1 and -1

Hence all the zeroes of given polynomial

$$= \sqrt{\frac{5}{3}}, \sqrt{\frac{5}{3}}, -1 \text{ and } -1$$

HOTS QUESTIONS

1. Find the value for k for which $x^4 + 10x^3 + 25x^2 + 15x + k$ is exactly divisible by $x + 7$.

Ans :

We have $f(x) = x^4 + 10x^3 + 25x^2 + 15x + k$

If $x + 7$ is a factor then -7 is a zero of $f(x)$ and $x = -7$ satisfy $f(x) = 0$.

Thus substituting $x = -7$ in $f(x)$ and equating to zero we have,

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

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

$$3626 - 3535 + k = 0$$

$$91 + k = 0$$

$$k = -91$$

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

Ans :

We have

As $2 \pm \sqrt{3}$ are the zeroes of $p(x)$, so $x - (2 \pm \sqrt{3})$ are the factor of $p(x)$. 1

and the product of zeros,

$$\{x - (2 + \sqrt{3})\}\{x - (2 - \sqrt{3})\}$$

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

$$= (x - 2)^2 - (\sqrt{3})^2$$

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

Dividing $p(x)$ by $x^2 - 4x + 1$

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

Factorising $(x^2 - 2x - 35)$ we get

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

$$x = -5, 7$$

Hence, other two zeroes of $p(x)$ are -5 and 7 . 1

3. If α and β are the zeroes the polynomial $2x^2 - 4x + 5$, find the values of

(i) $\alpha^2 + \beta^2$

(ii) $\frac{1}{\alpha} + \frac{1}{\beta}$

(iii) $(\alpha - \beta)^2$

(iv) $\frac{1}{\alpha^2} + \frac{1}{\beta^2}$

(v) $\alpha^2 + \beta^2$

Ans :

We have $p(x) = 2x^2 - 4x + 5$
If α and β are then zeroes of $p(x) = 2x^2 - 4x + 5$, then

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

and $\alpha\beta = \frac{c}{a} = \frac{5}{2}$

(i) $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$
 $= 2^2 - 2 \times \frac{5}{2}$

$$= 4 - 5 = -1$$

(ii) $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{2}{\frac{5}{2}} = \frac{4}{5}$

(iii) $(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta$
 $= 2^2 - \frac{4 \times 5}{2}$

$$4 - 10 = -6$$

(iv) $\frac{1}{\alpha^2} + \frac{1}{\beta^2} = \frac{\alpha^2 + \beta^2}{(\alpha\beta)^2} = \frac{-1}{(\frac{5}{2})^2} = \frac{-4}{25}$

(v) $(\alpha^3 + \beta^3) = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$

$$= 2^3 - 3 \times \frac{5}{2} \times 2 = 8 - 15 = -7$$

4. On dividing the polynomial $4x^2 - 5x^3 - 39x^2 - 46x - 2$ by the polynomial $g(x)$, the quotient is $x^2 - 3x - 5$ and the remainder is $-5x + 8$. Find the polynomial $g(x)$.

Ans :

$$\text{Dividend} = (\text{Divisor} \times \text{Quotient}) + \text{Remainder}$$

$$4x^4 - 5x^3 - 39x^2 - 46x - 2$$

$$= g(x)(x^2 + 3x - 5) + (-5x + 8)$$

or, $4x^4 - 5x^3 - 39x^2 - 46x - 2 + 5x - 8$

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

or, $4x^4 - 5x^3 - 39x^2 - 41x - 10$

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

$$g(x) = \frac{4x^4 - 5x^3 - 39x^2 - 41x - 10}{(x^2 - 3x - 5)}$$

Hence, $g(x) = 4x^2 + 7x + 2$

5. If the squared difference of the zeroes of the quadratic

polynomial $f(x) = x^2 + px + 45$ is equal to 144, find the value of p .

Ans :

We have $f(x) = x^2 + px + 45$

Let α and β be the zeroes of the given quadratic polynomial.

Sum of zeroes, $\alpha + \beta = -p$

Product of zeroes $\alpha\beta = 45$

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

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

Substituting value of $\alpha + \beta$ and $\alpha\beta$ we get

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

$$p^2 - 180 = 144$$

$$p^2 = 144 + 180 = 324$$

Thus $p = \pm \sqrt{324} = \pm 18$

Hence, the value of p is ± 18 .

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