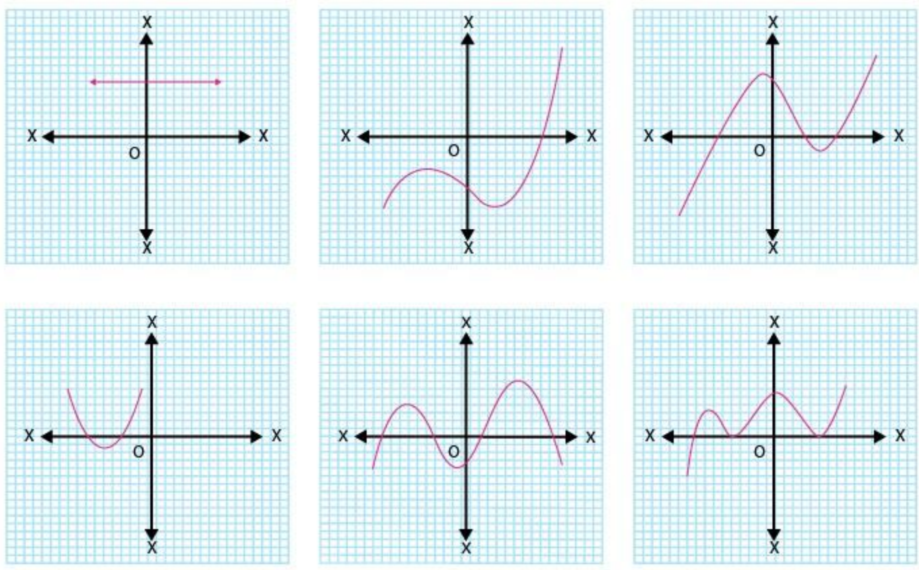
# NCERT Solution For Class 10 Maths Chapter 2- Polynomials

## Exercise 2.1 Page: 28

**1. The graphs of y = p(x) are given in Fig. 2.10 below, for some polynomials p(x). Find the number of zeroes of p(x), in each case.**




**Solutions:**

**Graphical method to find zeroes:-**

Total number of zeroes in any polynomial equation = total number of times the curve intersects x-axis.

(i) In the given graph, the number of zeroes of p(x) is 0 because the graph is parallel to x-axis does not cut it at any point.

(ii) In the given graph, the number of zeroes of p(x) is 1 because the graph intersects the x-axis at only one point.

(iii) In the given graph, the number of zeroes of p(x) is 3 because the graph intersects the x-axis at any three points.

(iv) In the given graph, the number of zeroes of p(x) is 2 because the graph intersects the x-axis at two points.

(v) In the given graph, the number of zeroes of p(x) is 4 because the graph intersects the x-axis at four points.

(vi) In the given graph, the number of zeroes of p(x) is 3 because the graph intersects the x-axis at three points.

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## Exercise 2.2 Page: 33

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

**Solutions:**

**(i)** $x^2–2x–8$

$\Rightarrow x^2– 4x+2x–8 = x(x–4)+2(x–4) = (x-4)(x+2)$

Therefore, zeroes of polynomial equation $x^2–2x–8$ are (4, -2)

Sum of zeroes = 4–2 = 2 = -(-2)/1 = -(Coefficient of x)/(Coefficient of $x^2$)

Product of zeroes = 4×(-2) = -8 =-(8)/1 = (Constant term)/(Coefficient of $x^2$)

**(ii)** $4s^2–4s+1$

$\Rightarrow 4s^2–2s–2s+1 = 2s(2s–1)–1(2s-1) = (2s–1)(2s–1)$

Therefore, zeroes of polynomial equation $4s^2–4s+1$ are (1/2, 1/2)

Sum of zeroes = (½)+(1/2) = 1 = -4/4 = -(Coefficient of s)/(Coefficient of $s^2$)

Product of zeros = (1/2)×(1/2) = 1/4 = (Constant term)/(Coefficient of $s^2$ )

**(iii)** $6x^2–3–7x$

$\Rightarrow 6x^2–7x–3 = (3x+1)(2x-3)$

Therefore, zeroes of polynomial equation $6x^2–3–7x$ are (-1/3, 3/2)

Sum of zeroes = -(1/3)+(3/2) = (7/6) = -(Coefficient of x)/(Coefficient of $x^2$)

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Product of zeroes = -(1/3)×(3/2) = -(3/6) = (Constant term) /(Coefficient of $x^2$ )

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

⇒4u(u+2)
Therefore,zeroes of polynomial equation $4u^2 + 8u$ are (0, -2).

Sum of zeroes = 0+(-2) = -2 = -(8/4) = = -(Coefficient of u)/(Coefficient of $u^2$)

Product of zeroes = 0×-2 = 0 = 0/4 = (Constant term)/(Coefficient of $u^2$ )

**(v)** $t^2-15$

⇒$t^2$= 15 or t = ±√15 Therefore zeroes of polynomial equation $t^2 -15$ are (√15, -√15)

Sum of zeroes =√15+(-√15) = 0= -(0/1)= -(Coefficient of t) / (Coefficient of $t^2$)

Product of zeroes = √15×(-√15) = -15 = -15/1 = (Constant term) / (Coefficient of $t^2$ )

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

⇒ $3x^2-4x+3x-4$ = x(3x-4)+1(3x-4) = (3x - 4)(x + 1)
Therefore,zeroes of polynomial equation $3x^2 - x - 4$ are (4/3, -1)

Sum of zeroes = (4/3)+(-1) = (1/3)= -(-1/3) = -(Coefficient of x) / (Coefficient of $x^2$)

Product of zeroes=(4/3)×(-1) = (-4/3) = (Constant term) /(Coefficient of $x^2$ )

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

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**(i) 1/4 , -1**

**Solution:**

From the formulas of sum and product of zeroes, we know,
Sum of zeroes = α+β
Product of zeroes = α β
Sum of zeroes = α+β = 1/4
Product of zeroes = α β = -1

∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:- $x^2–(α+β)x +αβ = 0$

$x^2–(1/4)x +(-1) = 0$

$4x^2–x-4 = 0$

Thus, $4x^2–x–4$ is the quadratic polynomial.

**(ii)**√2, 1/3

**Solution:**

Sum of zeroes = α + β =√2
Product of zeroes = α β = 1/3

∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:-

$x^2–(α+β)x +αβ = 0$

$x^2 –(\sqrt{2})x + (1/3) = 0$

$3x^2-3\sqrt{2}x+1 = 0$

Thus, $3x^2-3\sqrt{2}x+1$ is the quadratic polynomial.

**(iii) 0, √5**

**Solution:**

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Given,
Sum of zeroes = $\alpha+\beta = 0$
Product of zeroes = $\alpha\beta = \sqrt{5}$
∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:-

$x^2-(\alpha+\beta)x+\alpha\beta = 0$

$x^2-(0)x+\sqrt{5}= 0$

Thus, $x^2+\sqrt{5}$ is the quadratic polynomial.

**(iv)1, 1**

**Solution:**

Given,
Sum of zeroes = $\alpha+\beta = 1$
Product of zeroes = $\alpha\beta = 1$

∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:- $x^2-(\alpha+\beta)x+\alpha\beta=0$

$x^2-x+1 = 0$

Thus, $x^2-x+1$ is the quadratic polynomial.

**(v) -1/4, 1/4**

**Solution:**

Given,
Sum of zeroes = $\alpha+\beta = -1/4$
Product of zeroes = $\alpha\beta = 1/4$

∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:-

$x^2-(\alpha+\beta)x+\alpha\beta = 0$

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$x^2-(-1/4)x+(1/4) = 0$

$4x^2+x+1 = 0$

Thus, $4x^2+x+1$ is the quadratic polynomial.

**(vi) 4, 1**

**Solution:**

Given,
Sum of zeroes = $\alpha+\beta$ = 4
Product of zeroes = $\alpha\beta$ = 1

∴ If α and β are zeroes of any quadratic polynomial, then the quadratic polynomial equation can be written directly as:-

$x^2-(\alpha+\beta)x+\alpha\beta=0$

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

Thus, $x^2-4x+1$ is the quadratic polynomial.

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## Exercise 2.3 Page: 36

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

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

**Solution:** Given,
Dividend = $p(x) = x^3-3x^2+5x-3$
Divisor = $g(x) = x^2-2$

$$
\begin{array}{r|rrrr}
 & x & -3 & & \\
\hline
x^2-2 & x^3 & -3x^2 & +5x & -3 \\
- & x^3 & +0x^2 & -2x & \\
\hline
 & & -3x^2 & +7x & -3 \\
 & - & -3x^2 & +0x & +6 \\
\hline
 & & & 7x & -9
\end{array}
$$

Therefore, upon division we get,
Quotient = $x-3$
Remainder = $7x-9$

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

**Solution:** Given,
Dividend = $p(x) = x^4 - 3x^2 + 4x + 5$
Divisor = $g(x) = x^2 + 1 - x$

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$$
\begin{array}{r|l}
 & x^2 \quad +x \quad -3 \\
x^2 - x + 1 & x^4 \quad +0x^3 \quad -3x^2 \quad +4x \quad +5 \\
 & -\;(x^4 \quad -x^3 \quad +x^2) \\
\hline
 & x^3 \quad -4x^2 \quad +4x \quad +5 \\
 & -\;(x^3 \quad -x^2 \quad +x) \\
\hline
 & -3x^2 \quad +3x \quad +5 \\
 & -\;(-3x^2 \quad +3x \quad -3) \\
\hline
 & 8
\end{array}
$$

Therefore, upon division we get,
Quotient = $x^2 + x - 3$
Remainder = 8

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

Dividend = p(x) =$x^4$ - 5x + 6 = $x^4 + 0x^2 - 5x + 6$
Divisor = g(x) = $2 - x^2$ = $-x^2 + 2$

$$
\begin{array}{r|l}
 & -x^2 \quad -2 \\
-x^2 + 2 & x^4 \quad +0x^3 \quad +0x^2 \quad -5x \quad +6 \\
 & -\;(x^4 \quad +0x^3 \quad -2x^2) \\
\hline
 & 2x^2 \quad -5x \quad +6 \\
 & -\;(2x^2 \quad +0x \quad -4) \\
\hline
 & -5x \quad +10
\end{array}
$$

Therefore, upon division we get,

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Quotient = $-x^2-2$
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) $t^2-3$, $2t^4+3t^3-2t^2-9t-12$**
**Solutions:** Given,

First polynomial = $t^2-3$
Second polynomial = $2t^4+3t^3-2t^2-9t-12$

$$
\begin{array}{rrrrrr}
 & 2t^2 & +3t & +4 & & \\
\cline{2-6}
t^2-3 & \big) 2t^4 & +3t^3 & -2t^2 & -9t & -12 \\
 & - & & & & \\
 & 2t^4 & +0t^3 & -6t^2 & & \\
\hline
 & & 3t^3 & +4t^2 & -9t & -12 \\
 & & - & & & \\
 & & 3t^3 & +0t^2 & -9t & \\
\hline
 & & & 4t^2 & +0t & -12 \\
 & & & - & & \\
 & & & 4t^2 & +0t & -12 \\
\hline
 & & & & & 0
\end{array}
$$

As we can see, the remainder is left as 0. Therefore, we say that, $t^2-3$ is a factor of $2t^2+3t+4$.

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

**Solutions:** Given,

First polynomial = $x^2+3x+1$

Second polynomial = $3x^4+5x^3-7x^2+2x+2$

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$$
\begin{array}{llllll}
 & 3x^2 & -4x & +2 & & \\
x^2+3x+1 & \big)\,3x^4 & +5x^3 & -7x^2 & +2x & +2 \\
 & - & & & & \\
 & 3x^4 & +9x^3 & +3x^2 & & \\
\hline
 & & -4x^3 & -10x^2 & +2x & +2 \\
 & & - & & & \\
 & & -4x^3 & -12x^2 & -4x & \\
\hline
 & & & 2x^2 & +6x & +2 \\
 & & & - & & \\
 & & & 2x^2 & +6x & +2 \\
\hline
 & & & & & 0
\end{array}
$$

As we can see, the remainder is left as 0. Therefore, we say that, $x^2 + 3x + 1$ is a factor of $3x^4+5x^3-7x^2+2x+2$.

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

**Solutions:** Given,

First polynomial $= x^3-3x+1$

Second polynomial $= x^5-4x^3+x^2+3x+1$

$$
\begin{array}{lllllll}
 & x^2 & -1 & & & & \\
x^3-3x+1 & \big)\,x^5 & +0x^4 & -4x^3 & +x^2 & +3x & +1 \\
 & - & & & & & \\
 & x^5 & +0x^4 & -3x^3 & +x^2 & & \\
\hline
 & & & -x^3 & +0x^2 & +3x & +1 \\
 & & & - & & & \\
 & & & -x^3 & +0x^2 & +3x & -1 \\
\hline
 & & & & & & 2
\end{array}
$$

As we can see, the remainder is not equal to 0. Therefore, we say that, $x^3-3x+1$ is not a factor of $x^5-4x^3+x^2+3x+1$ .

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

**Solutions:** Since this is a polynomial equation of degree 4, hence there will be total 4 roots.

$\sqrt{(5/3)}$ and $-\sqrt{(5/3)}$ are zeroes of polynomial f(x).

$\therefore (x-\sqrt{(5/3)})(x+\sqrt{(5/3)}) = x^2-(5/3) = 0$

$(3x^2-5)=0$, is a factor of given polynomial f(x).

Now, when we will divide f(x) by $(3x^2-5)$ the quotient obtained will also be a factor of f(x) and the remainder will be 0.

$$x^2+2x+1$$

$$3x^2-5 \,\big)\, 3x^4+6x^3-2x^2-10x-5$$

$$3x^4 \quad -5x^2$$

$$(-) \quad (+)$$

$$+6x^3+3x^2-10x-5$$

$$-6x^3 \quad -10x$$

$$(+) \quad (-)$$

$$3x^2 \quad -5$$

$$3x^2 \quad -5$$

$$(-) \quad (+)$$

$$0$$

Therefore, $3x^4+6x^3-2x^2-10x-5 = (3x^2-5)(x^2+2x+1)$

Now, on further factorizing $(x^2+2x+1)$ we get,

$x^2+2x+1 = x^2+x+x+1 = 0$

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

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

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So, its zeroes are given by: x= −1 and x = −1.

Therefore, all four zeroes of given polynomial equation are:

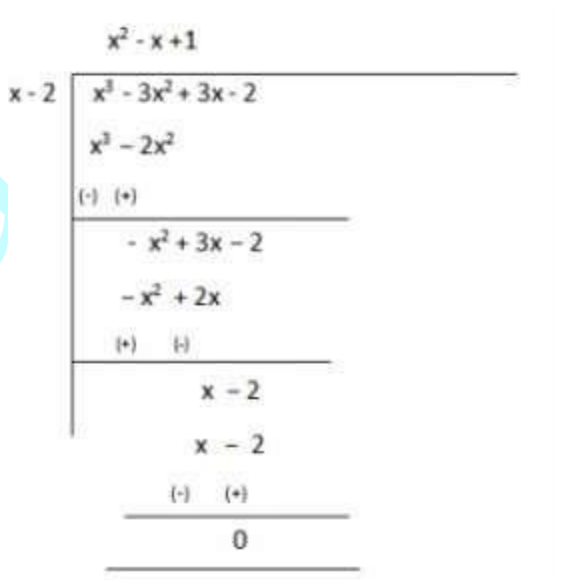
**√(5/3),- √(5/3)** , −1 and −1**.**

Hence, is the answer.

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

**Solutions:**Given,
Dividend, p(x) = $x^3-3x^2+x+2$
Quotient = x-2
Remainder = –2x+4
We have to find the value of Divisor, g(x) =?

As we know,
Dividend = Divisor×Quotient + Remainder
∴ $x^3-3x^2+x+2 = g(x)\times(x-2)+(-2x+4)$
$x^3-3x^2+x+2-(-2x+4) = g(x)\times(x-2)$
Therefore, g(x) × (x-2) = $x^3-3x^2+x+2$
Now, for finding g(x) we will divide $x^3-3x^2+x+2$ with (x-2)




Therefore, **g(x) = ($x^2$–x+1)**

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**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**

**Solutions:** According to the division algorithm, dividend p(x) and divisor g(x) are two polynomials, where $g(x)\neq0$. Then we can find the value of quotient q(x) and remainder r(x), with the help of below given formula;

Dividend = Divisor×Quotient+Remainder
$\therefore$ $p(x) = g(x)\times q(x)+r(x)$
Where r(x) = 0 or degree of r(x)< degree of g(x).
Now let us proof the three given cases as per division algorithm by taking examples for each.

**(i):deg p(x) = deg q(x)**
Degree of dividend is equal to degree of quotient, only when the divisor is a constant term.
Let us take an example, $3x^2+3x+3$ is a polynomial to be divided by 3.
So, $(3x^2+3x+3)/3 = x^2+x+1 = q(x)$
Thus, you can see, the degree of quotient is equal to the degree of dividend. Hence, division algorithm is satisfied here.

**(ii):deg q(x) = deg r(x)**
Let us take an example , $p(x)=x^2+x$ is a polynomial to be divided by g(x)=x. So,
$(x^2+x)/x = x+1 = q(x)$
Also, remainder, r(x) = 0
Thus, you can see, the degree of quotient is equal to the degree of remainder. Hence, division algorithm is satisfied here.

**(iii):deg r(x) = 0**
The degree of remainder is 0 only when the remainder left after division algorithm is constant. Let us take an example, $p(x) = x^2+1$ is a polynomial to be divided by g(x)=x.
So,( $x^2+1)/x= x=q(x)$
And r(x)=1
Clearly, the degree of remainder here is 0.
Hence, division algorithm is satisfied here.

## Exercise 2.4 Page: 36

**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) $2x^3+x^2-5x+2$; -1/2, 1, -2**

**Solutions:** Given, $p(x) = 2x^3+x^2-5x+2$ And

zeroes for p(x) are = 1/2, 1, -2

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∴ $p(1/2) = 2(1/2)^3+(1/2)^2-5(1/2)+2 = (1/4)+(1/4)-(5/2)+2 = 0$

$p(1) = 2(1)^3+(1)^2-5(1)+2 = 0$ p(-2)

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

Hence, proved 1/2, 1, -2 are the zeroes of $2x^3+x^2-5x+2$.

Now, comparing the given polynomial with general expression, we get;

∴ $ax^3+bx^2+cx+d = 2x^3+x^2-5x+2$

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

As we know, if α, β, γ are the zeroes of the cubic polynomial $ax^3+bx^2+cx+d$ ,then;

$\alpha+\beta+\gamma = -b/a$

$\alpha\beta+\beta\gamma+\gamma\alpha = c/a$ α

$\beta\gamma = -d/a$.

Therefore, putting the values of zeroes of the polynomial,

$\alpha+\beta+\gamma = ½+1+(-2) = -1/2 = -b/a$ $\alpha\beta+\beta\gamma+\gamma\alpha = (1/2$
$\times1)+(1\times-2)+(-2\times1/2) = -5/2 = c/a$ $\alpha\beta\gamma = ½$
$\times1\times(-2) = -2/2 = -d/a$

Hence, the relationship between the zeroes and the coefficients are satisfied.

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

**Solutions:** Given, $p(x) = x^3-4x^2+5x-2$
∴ $p(2)= 2^3-4(2)^2+5(2)-2 = 0$
And zeroes for p(x) are 2,1,1.
$1^3- 4\times1^2 + 5\times1 -2 = 0$ p(1) = ( ) ( )
Hence proved, 2, 1, 1 are the zeroes of $x^3-4x^2+5x-2$

Now, comparing the given polynomial with general expression, we get;

∴ $ax^3+bx^2+cx+d = x^3-4x^2+5x-2$
a = 1, b = -4, c = 5 and d = -2

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As we know, if α, β, γ are the zeroes of the cubic polynomial $ax^3+bx^2+cx+d$, then;

α + β + γ = –b/a αβ
+ βγ + γα = c/a α β
γ = – d/a.

Therefore, putting the values of zeroes of the polynomial,

α +β+γ = 2+1+1 = 4 = -(-4)/1 = –b/a

αβ+βγ+γα = 2×1+1×1+1×2 = 5 = 5/1= c/a

αβγ = 2×1×1 = 2 = -(-2)/1 = -d/a
Hence, the relationship between the zeroes and the coefficients are satisfied.

**2. Find a cubic polynomial with the sum, sum of the product of its zeroes taken two at a time, and the product of its zeroes as 2, –7, –14 respectively.**

**Solutions:** Let us consider the cubic polynomial is $ax^3+bx^2+cx+d$ and the values of the zeroes of the polynomials be α, β, γ.

As per the given question,

α+β+γ = -b/a = 2/1

αβ +βγ+γα = c/a = -7/1

α βγ = -d/a = -14/1

Thus, from above three expressions we get the values of coefficient of polynomial.
a = 1, b = -2, c = -7, d = 14

Hence, the cubic polynomial is $x^3-2x^2-7x+14$

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

**Solutions:** We are given with the polynomial here, p(x)
= $x^3-3x^2+x+1$

And zeroes are given as a – b, a, a + b

Now, comparing the given polynomial with general expression, we get;

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$\therefore px^3+qx^2+rx+s = x^3-3x^2+x+1$

p = 1, q = -3, r = 1 and s = 1

Sum of zeroes = a – b + a + a + b

-q/p = 3a

Putting the values q and p.

-(-3)/1 = 3a

a=1

Thus, the zeroes are 1-b, 1, 1+b.

Now, product of zeroes = 1(1-b)(1+b)

$-s/p = 1-b^2$

$-1/1 = 1-b^2$

$b^2 = 1+1 = 2$

b = √2

Hence,1-√2, 1 ,1+√2 are the zeroes of $x_3-3x_2+x+1$.

**4. If two zeroes of the polynomial $x^4-6x^3-26x^2+138x-35$ are 2 ±√3, find other zeroes.**

**Solutions:** Since this is a polynomial equation of degree 4, hence there will be total 4 roots.

Let $f(x) = x^4-6x^3-26x^2+138x-35$

Since 2 +√**3** and 2-√**3** are zeroes of given polynomial f(x).

$\therefore [x-(2+\sqrt{3})]\ [x-(2-\sqrt{3})] = 0$

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

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On multiplying the above equation we get,

$x^2$-4x+1, this is a factor of a given polynomial f(x).

Now, if we will divide f(x) by g(x), the quotient will also be a factor of f(x) and the remainder will be 0.

Quotient: $x^2 - 2x - 35$

Divisor: $x^2 - 4x + 1$, Dividend: $x^4 - 6x^3 - 26x^2 + 138x - 35$

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

(-) (+) (-)

$$-2x^3 - 27x^2 + 138x - 35$$

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

(+) (-) (+)

$$-35x^2 + 140x - 35$$

$$-35x^2 + 140x - 35$$

(+) (-) (+)

$$0$$

So, $x^4$-6$x^3$-26$x^2$+138x-35 = ($x^2$-4x+1)($x^2$ –2x−35)

Now, on further factorizing ($x^2$–2x−35) we get,

$x^2$–(7−5)x −35 = $x^2$– 7x+5x+35 = 0 x(x

−7)+5(x−7) = 0

(x+5)(x−7) = 0

So, its zeroes are given by: x=

−5 and x = 7.

Therefore, all four zeroes of given polynomial equation are: 2+√**3** , 2-√**3,** −5 and 7.

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