Name: B SHAMALA DEVI
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4. The number of zeroes is 1. (Why?)

5. The number of zeroes is 1. (Why?)

6. The number of zeroes is 4. (Why?)

EXERCISE 2.1

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

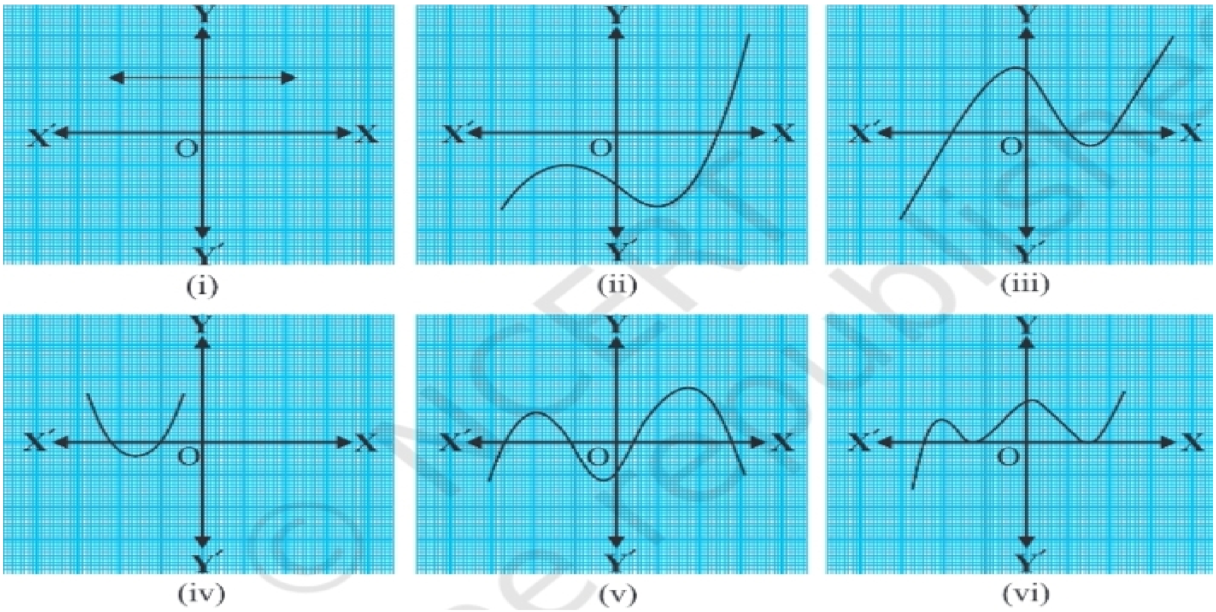

fig. 2.10

2.3 Relationship between Zeroes and Coefficients of a Polynomial

You have already seen that zero of a linear polynomial $ax + b$ is $-\frac{b}{a}$.We will now try to answer the question raised in Section 2.1 regarding the relationship between zeroes and coefficients of a q7adratic polynomial.For this, let us take a quadratic polynomial, say$p(x) = 2x^2 - 8x + 6$.In Class IX, you have learnt how to factorise quadratic polynomials by splitting the middle term.So, here we need to split the middle term $-8x$' as a sum of two terms,whose product is $6 \times 2x^2 = 12x^2$.So, we write:

$$2x^2 - 8x + 6 = 2x^2 - 6x - 2x + 6 \qquad = 2x(x-3) - 2(x-3)$$
$$= (2x-2)(x-3) \qquad = 2(x-1)(x-3)$$

EXERCISE 2.2

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

(i) $x^2 - 2x - 8$ $\quad$ $(ii) 4s^2 - 4s + 1$ $\quad$ $(iii) 6x^2 - 3 - 7x$
$(iv) 4u^2 + 8u$ $\quad$ $(v) t^2 - 15$ $\quad$ $(vi) 3x^2 - x - 4$

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

(i) ($1_{\overline{4,-1}}$ $\quad$,(ii) ($\sqrt{2}, \frac{1}{3}$) $\quad$ $(iii)(, \sqrt{5})$
$(iv)(, 1)$ $\quad$ $(v)(-\frac{1}{4}, \frac{1}{4})$ $\quad$ $(vi)(, 1)$

2.4 Division Algorithm for Polynomials

You know that a cubic polynomial has at most three zeroes. However, if you are given

only one zero, can you find the other two? For this, let us consider the cubic polynomial $x^3 - 3x^2 - x + 3$\$. If we tell you that one of its zeroes is 1, then you know that $x - 1$ is a factor of $x^3 - 3x^2 - x + 3$. So, you can divide x3 $- 3x^2 - x + 3$ by $x - 1$, as you have learnt in Class IX, to get the quotient $x^2 - 2x - 3$.

Next, you could get the factors of $x^2 - 2x - 3$, by splitting the middle term, as (x + 1)(x - 3). This would give you

$$\begin{aligned} x^3 - 3x^2 - x + 3 &= (x - 1)(x^2 - 2x - 3) \\ &= (x - 1)(x + 1)(x - 3) \end{aligned}$$

So , all the three zeroes of the cubic polynomial are now known to you as 1, -1, 3.

Let us discuss the method of dividing one polynomial by another in some detail. Before noting the steps formally, consider an example.

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

Example 6: Divide $2x^2 + 3x + 1$ by $x + 2$.

Solution: Note that we stop the division process when either the remainder is zero or its degree is less than the degree of the divisor. So, here the quotient is 2x - 1 and the remainder is 3 . Also,
$(2x - 1)(x + 2) + 3 = 2x^2 + 3x - 2 + 3 = 2x^2 + 3x + 1$
i.e., $\quad 2x^2 + 3x + 1 = (x + 2)(2x - 1) + 3$

Therefore, Dividend = Divisor × Quotient + Remainder

Let us now extend this process to divide a polynomial by a quadratic polynomial.

So, $2x^4 - 3x^3 - 3x^2 + 6x - 2 = (x^2 - 2)(2x^2 - 3x + 1)$.

Now, by splitting $-3x$, we factorise $2x^2 - 3x + 1$ as $(2x - 1)(x - 1)$. So, its zeroes are given by

$x = \frac{1}{2}$ and $x = 1$. Therefore, the zeroes of the given polynomial are

$(\sqrt{2}, \quad -\sqrt{2}, \quad \frac{1}{2}, \quad$ and 1.

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:

   (a) $p(x) = x^3 - 3x^2 + 5x - 3, \quad g(x) = x^2 - 2$
   (b) $p(x) = x^4 - 3x^2 + 4x + 5, \quad g(x) = x^2 + 1 - x$
   (c) $p(x) = x^4 - 5x + 6, \quad g(x) = 2 - x$

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

   (a) $t^2 - 3, \quad 2t^4 + 3t^2 - 2t^2 - 9t - 12$
   (b) $x^2 + 3x + 1, \quad 3x^4 + 5x^3 - 7x^2 + 2x + 2$
   (c) $x^3 - 3x + 1, \quad x^5 - 4x^3 + x^2 + 3x + 1$

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

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

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

   (a) $\deg p(x) = \deg q(x)$ (ii)$\deg q(x) = \deg r(x)$ (iii) $\deg r(x) = 0$

EXERCISE 2.4 (Optional*)

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:$2x^3 + x^2 - 5x + 2$; ; $\frac{1}{2}, 1, -2$ (ii)$x^3 - 4x^2 + 5x - 2$; $2, 1, 1$

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.

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*. Theseexercises are not from point of view