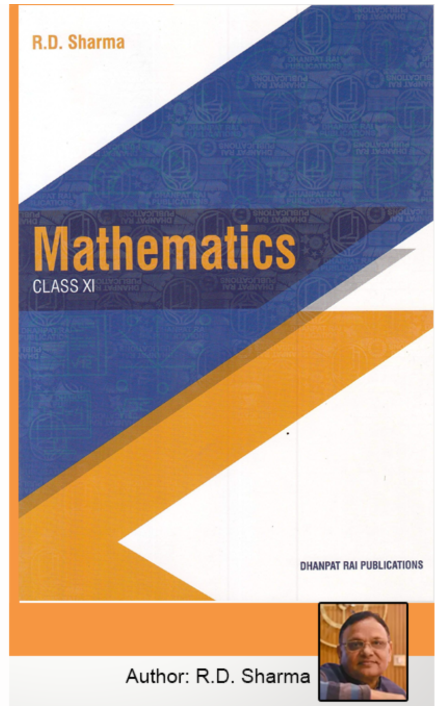
Class 11 - Chapter 14 Quadratic Equations



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EXERCISE 14.1 PAGE NO: 14.5

Solve the following quadratic equations by factorization method only:

1. $x^2 + 1 = 0$

Solution:

Given: $x^2 + 1 = 0$

We know, $i^2 = -1 \Rightarrow 1 = -i^2$

By substituting $1 = -i^2$ in the above equation, we get

$x^2 - i^2 = 0$[By using the formula, $a^2 - b^2 = (a + b)(a - b)$]

$(x + i)(x - i) = 0$

$x + i = 0$ or $x - i = 0$

$x = -i$ or $x = i$

∴ The roots of the given equation are i, -i

2. $9x^2 + 4 = 0$

Solution:

Given: $9x^2 + 4 = 0$

$9x^2 + 4 \times 1 = 0$

We know, $i^2 = -1 \Rightarrow 1 = -i^2$

By substituting $1 = -i^2$ in the above equation, we get

So,

$9x^2 + 4(-i^2) = 0$

$9x^2 - 4i^2 = 0$

$(3x)^2 - (2i)^2 = 0$[By using the formula, $a^2 - b^2 = (a + b)(a - b)$]

$(3x + 2i)(3x – 2i) = 0$

$3x + 2i = 0$ or $3x – 2i = 0$

$3x = –2i$ or $3x = 2i$

$x = -2i/3$ or $x = 2i/3$

∴ The roots of the given equation are $2i/3$, $-2i/3$

3. $x^2 + 2x + 5 = 0$

Solution:

Given: $x^2 + 2x + 5 = 0$

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

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

$(x + 1)^2 + 4 = 0$ [since, $(a + b)^2 = a^2 + 2ab + b^2$]

$(x + 1)^2 + 4 \times 1 = 0$

We know, $i^2 = –1 \Rightarrow 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$(x + 1)^2 + 4(–i^2) = 0$

$(x + 1)^2 – 4i^2 = 0$

$(x + 1)^2 – (2i)^2 = 0$[By using the formula, $a^2 – b^2 = (a + b)(a – b)$]

$(x + 1 + 2i)(x + 1 – 2i) = 0$

$x + 1 + 2i = 0$ or $x + 1 – 2i = 0$

$x = –1 – 2i$ or $x = –1 + 2i$

∴ The roots of the given equation are $-1+2i$, $-1-2i$

4. $4x^2 – 12x + 25 = 0$

Solution:

Given: $4x^2 – 12x + 25 = 0$

$4x^2 – 12x + 9 + 16 = 0$

$(2x)^2 – 2(2x)(3) + 3^2 + 16 = 0$

$(2x – 3)^2 + 16 = 0$ [Since, $(a + b)^2 = a^2 + 2ab + b^2$]

$(2x – 3)^2 + 16 × 1 = 0$

We know, $i^2 = –1 ⇒ 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$(2x – 3)^2 + 16(–i^2) = 0$

$(2x – 3)^2 – 16i^2 = 0$

$(2x – 3)^2 – (4i)^2 = 0$[By using the formula, $a^2 – b^2 = (a + b) (a – b)$]

$(2x – 3 + 4i) (2x – 3 – 4i) = 0$

$2x – 3 + 4i = 0$ or $2x – 3 – 4i = 0$

$2x = 3 – 4i$ or $2x = 3 + 4i$

$x = 3/2 – 2i$ or $x = 3/2 + 2i$

∴ The roots of the given equation are $3/2 + 2i$, $3/2 – 2i$

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

Solution:

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

$x^2 + x + ¼ + ¾ = 0$

$x^2 + 2 (x) (1/2) + (1/2)^2 + ¾ = 0$

$(x + 1/2)^2 + ¾ = 0$ [Since, $(a + b)^2 = a^2 + 2ab + b^2$]

$(x + 1/2)^2 + ¾ × 1 = 0$

We know, $i^2 = –1 \Rightarrow 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$(x + ½)^2 + ¾ (-1)^2 = 0$

$(x + ½)^2 + ¾ i^2 = 0$

$(x + ½)^2 – (\sqrt{3}i/2)^2 = 0$[By using the formula, $a^2 – b^2 = (a + b) (a – b)$]

$(x + ½ + \sqrt{3}i/2) (x + ½ – \sqrt{3}i/2) = 0$

$(x + ½ + \sqrt{3}i/2) = 0$ or $(x + ½ – \sqrt{3}i/2) = 0$

$x = -1/2 – \sqrt{3}i/2$ or $x = -1/2 + \sqrt{3}i/2$

∴ The roots of the given equation are $-1/2 + \sqrt{3}i/2$, $-1/2 – \sqrt{3}i/2$

6. $4x^2 + 1 = 0$

Solution:

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

We know, $i^2 = –1 \Rightarrow 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$4x^2 – i^2 = 0$

$(2x)^2 – i^2 = 0$[By using the formula, $a^2 – b^2 = (a + b) (a – b)$]

$(2x + i) (2x – i) = 0$

$2x + i = 0$ or $2x – i = 0$

$2x = –i$ or $2x = i$

$x = -i/2$ or $x = i/2$

∴ The roots of the given equation are $i/2, -i/2$

7. $x^2 - 4x + 7 = 0$

Solution:

Given: $x^2 - 4x + 7 = 0$

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

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

$(x - 2)^2 + 3 = 0$ [Since, $(a - b)^2 = a^2 - 2ab + b^2$]

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

We know, $i^2 = -1 \Rightarrow 1 = -i^2$

By substituting $1 = -i^2$ in the above equation, we get

$(x - 2)^2 + 3(-i^2) = 0$

$(x - 2)^2 - 3i^2 = 0$

$(x - 2)^2 - (\sqrt{3}i)^2 = 0$[By using the formula, $a^2 - b^2 = (a + b)(a - b)$]

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

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

$x = 2 - \sqrt{3}i$ or $x = 2 + \sqrt{3}i$

$x = 2 \pm \sqrt{3}i$

∴ The roots of the given equation are $2 \pm \sqrt{3}i$

8. $x^2 + 2x + 2 = 0$

Solution:

Given: $x^2 + 2x + 2 = 0$

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

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

$(x + 1)^2 + 1 = 0$ [∵ $(a + b)^2 = a^2 + 2ab + b^2$]

We know, $i^2 = –1 \Rightarrow 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$(x + 1)^2 + (–i^2) = 0$

$(x + 1)^2 – i^2 = 0$

$(x + 1)^2 – (i)^2 = 0$[By using the formula, $a^2 – b^2 = (a + b) (a – b)$]

$(x + 1 + i) (x + 1 – i) = 0$

$x + 1 + i = 0$ or $x + 1 – i = 0$

$x = –1 – i$ or $x = –1 + i$

$x = -1 \pm i$

∴ The roots of the given equation are $-1 \pm i$

9. $5x^2 – 6x + 2 = 0$

Solution:

Given: $5x^2 – 6x + 2 = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{}(b^2 – 4ac))/2a$

Here, $a = 5, b = -6, c = 2$

So,

$x = (-(-6) \pm\sqrt{}(-6^2 – 4 (5)(2)))/ 2(5)$

$= (6 \pm \sqrt{}(36-40))/10$

$= (6 \pm \sqrt{}(-4))/10$

$= (6 \pm \sqrt{}4(-1))/10$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$x = (6 \pm \sqrt{4i^2})/10$

$= (6 \pm 2i)/10$

$= 2(3 \pm i)/10$

$= (3 \pm i)/5$

$x = 3/5 \pm i/5$

∴ The roots of the given equation are $3/5 \pm i/5$

10. $21x^2 + 9x + 1 = 0$

Solution:

Given: $21x^2 + 9x + 1 = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm \sqrt{(b^2 - 4ac)})/2a$

Here, a = 21, b = 9, c = 1

So,

$x = (-9 \pm \sqrt{(9^2 - 4 (21)(1))})/ 2(21)$

$= (-9 \pm \sqrt{(81-84)})/42$

$= (-9 \pm \sqrt{(-3)})/42$

$= (-9 \pm \sqrt{3(-1)})/42$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$x = (-9 \pm \sqrt{3i^2})/42$

$= (-9 \pm \sqrt{(\sqrt{3}i)^2}/42$

$= (-9 \pm \sqrt{3}i)/42$

$= -9/42 \pm \sqrt{3}i/42$

$= -3/14 \pm \sqrt{3}i/42$

∴ The roots of the given equation are $-3/14 \pm \sqrt{3}i/42$

11. $x^2 - x + 1 = 0$

Solution:

Given: $x^2 - x + 1 = 0$

$x^2 - x + ¼ + ¾ = 0$

$x^2 - 2 (x) (1/2) + (1/2)^2 + ¾ = 0$

$(x - 1/2)^2 + ¾ = 0$ [Since, $(a + b)^2 = a^2 + 2ab + b^2$]

$(x - 1/2)^2 + ¾ \times 1 = 0$

We know, $i^2 = -1 \Rightarrow 1 = -i^2$

By substituting $1 = -i^2$ in the above equation, we get

$(x - ½)^2 + ¾ (-1)^2 = 0$

$(x - ½)^2 + ¾ (-i)^2 = 0$

$(x - ½)^2 - (\sqrt{3}i/2)^2 = 0$[By using the formula, $a^2 - b^2 = (a + b) (a - b)$]

$(x - ½ + \sqrt{3}i/2) (x - ½ - \sqrt{3}i/2) = 0$

$(x - ½ + \sqrt{3}i/2) = 0$ or $(x - ½ - \sqrt{3}i/2) = 0$

$x = 1/2 - \sqrt{3}i/2$ or $x = 1/2 + \sqrt{3}i/2$

∴ The roots of the given equation are $1/2 + \sqrt{3}i/2$, $1/2 - \sqrt{3}i/2$

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

Solution:

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

$x^2 + x + ¼ + ¾ = 0$

$x^2 + 2 (x) (1/2) + (1/2)^2 + ¾ = 0$

$(x + 1/2)^2 + ¾ = 0$ [Since, $(a + b)^2 = a^2 + 2ab + b^2$]

$(x + 1/2)^2 + ¾ \times 1 = 0$

We know, $i^2 = -1 \Rightarrow 1 = -i^2$

By substituting $1 = -i^2$ in the above equation, we get

$(x + ½)^2 + ¾ (-1)^2 = 0$

$(x + ½)^2 + ¾ i^2 = 0$

$(x + ½)^2 - (\sqrt{3}i/2)^2 = 0$[By using the formula, $a^2 - b^2 = (a + b) (a - b)$]

$(x + ½ + \sqrt{3}i/2) (x + ½ - \sqrt{3}i/2) = 0$

$(x + ½ + \sqrt{3}i/2) = 0$ or $(x + ½ - \sqrt{3}i/2) = 0$

$x = -1/2 - \sqrt{3}i/2$ or $x = -1/2 + \sqrt{3}i/2$

∴ The roots of the given equation are $-1/2 + \sqrt{3}i/2$, $-1/2 - \sqrt{3}i/2$

13. $17x^2 - 8x + 1 = 0$

Solution:

Given: $17x^2 - 8x + 1 = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{(b^2 - 4ac)})/2a$

Here, a = 17, b = -8, c = 1

So,

$x = (-(-8) \pm \sqrt{(-8^2 - 4(17)(1))}) / 2(17)$

$= (8 \pm \sqrt{(64-68)})/34$

$= (8 \pm \sqrt{(-4)})/34$

$= (8 \pm \sqrt{4(-1)})/34$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$x = (8 \pm \sqrt{(2i)^2})/34$

$= (8 \pm 2i)/34$

$= 2(4 \pm i)/34$

$= (4 \pm i)/17$

$x = 4/17 \pm i/17$

∴ The roots of the given equation are $4/17 \pm i/17$

EXERCISE 14.2 PAGE NO: 14.13

1. Solving the following quadratic equations by factorization method:

(i) $x^2 + 10ix - 21 = 0$

(ii) $x^2 + (1 - 2i)x - 2i = 0$

(iii) $x^2 - (2\sqrt{3} + 3i) x + 6\sqrt{3}i = 0$

(iv) $6x^2 - 17ix - 12 = 0$

Solution:

(i) $x^2 + 10ix - 21 = 0$

Given: $x^2 + 10ix - 21 = 0$

$x^2 + 10ix – 21 × 1 = 0$

We know, $i^2 = –1 ⇒ 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$x^2 + 10ix – 21(–i^2) = 0$

$x^2 + 10ix + 21i^2 = 0$

$x^2 + 3ix + 7ix + 21i^2 = 0$

$x(x + 3i) + 7i(x + 3i) = 0$

$(x + 3i) (x + 7i) = 0$

$x + 3i = 0$ or $x + 7i = 0$

$x = –3i$ or $–7i$

∴ The roots of the given equation are –3i, –7i

(ii) $x^2 + (1 – 2i)x – 2i = 0$

Given: $x^2 + (1 – 2i)x – 2i = 0$

$x^2 + x – 2ix – 2i = 0$

$x(x + 1) – 2i(x + 1) = 0$

$(x + 1) (x – 2i) = 0$

$x + 1 = 0$ or $x – 2i = 0$

$x = –1$ or $2i$

∴ The roots of the given equation are –1, 2i

(iii) $x^2 – (2\sqrt{3} + 3i) x + 6\sqrt{3}i = 0$

Given: $x^2 – (2\sqrt{3} + 3i) x + 6\sqrt{3}i = 0$

$x^2 – (2\sqrt{3}x + 3ix) + 6\sqrt{3}i = 0$

$x^2 – 2\sqrt{3}x – 3ix + 6\sqrt{3}i = 0$

$x(x – 2\sqrt{3}) – 3i(x – 2\sqrt{3}) = 0$

$(x – 2\sqrt{3}) (x – 3i) = 0$

$(x – 2\sqrt{3}) = 0$ or $(x – 3i) = 0$

$x = 2\sqrt{3}$ or $x = 3i$

∴ The roots of the given equation are $2\sqrt{3}$, 3i

(iv) $6x^2 – 17ix – 12 = 0$

Given: $6x^2 – 17ix – 12 = 0$

$6x^2 – 17ix – 12 \times 1 = 0$

We know, $i^2 = –1 \Rightarrow 1 = –i^2$

By substituting $1 = –i^2$ in the above equation, we get

$6x^2 – 17ix – 12(–i^2) = 0$

$6x^2 – 17ix + 12i^2 = 0$

$6x^2 – 9ix – 8ix + 12i^2 = 0$

$3x(2x – 3i) – 4i(2x – 3i) = 0$

$(2x – 3i) (3x – 4i) = 0$

$2x – 3i = 0$ or $3x – 4i = 0$

$2x = 3i$ or $3x = 4i$

$x = 3i/2$ or $x = 4i/3$

∴ The roots of the given equation are 3i/2, 4i/3

2. Solve the following quadratic equations:

(i) $x^2 – (3\sqrt{2} + 2i) x + 6\sqrt{2}i = 0$

(ii) $x^2 – (5 – i) x + (18 + i) = 0$

(iii) $(2 + i)x^2 – (5- i)x + 2 (1 – i) = 0$

(iv) $x^2 – (2 + i)x – (1 – 7i) = 0$

(v) $ix^2 – 4x – 4i = 0$

(vi) $x^2 + 4ix – 4 = 0$

(vii) $2x^2 + \sqrt{15}ix – i = 0$

(viii) $x^2 – x + (1 + i) = 0$

(ix) $ix^2 – x + 12i = 0$

(x) $x^2 – (3\sqrt{2} – 2i)x – \sqrt{2}i = 0$

(xi) $x^2 – (\sqrt{2} + i)x + \sqrt{2}i = 0$

(xii) $2x^2 – (3 + 7i)x + (9i – 3) = 0$

Solution:

(i) $x^2 – (3\sqrt{2} + 2i) x + 6\sqrt{2}i = 0$

Given: $x^2 – (3\sqrt{2} + 2i) x + 6\sqrt{2}i = 0$

$x^2 – (3\sqrt{2}x + 2ix) + 6\sqrt{2}i = 0$

$x^2 – 3\sqrt{2}x – 2ix + 6\sqrt{2}i = 0$

$x(x – 3\sqrt{2}) – 2i(x – 3\sqrt{2}) = 0$

$(x – 3\sqrt{2}) (x – 2i) = 0$

$(x – 3\sqrt{2}) = 0$ or $(x – 2i) = 0$

$x = 3\sqrt{2}$ or $x = 2i$

∴ The roots of the given equation are $3\sqrt{2}$, $2i$

(ii) $x^2 – (5 – i) x + (18 + i) = 0$

Given: $x^2 – (5 – i) x + (18 + i) = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm \sqrt{(b^2 – 4ac)})/2a$

Here, a = 1, b = -(5-i), c = (18+i)

So,

$$x = \frac{-(-(5-i)) \pm \sqrt{(-(5-i))^2 - 4(1)(18+i)}}{2(1)}$$

$$= \frac{(5-i) \pm \sqrt{(5-i)^2 - 4(18+i)}}{2}$$

$$= \frac{(5-i) \pm \sqrt{25 - 10i + i^2 - 72 - 4i}}{2}$$

$$= \frac{(5-i) \pm \sqrt{-47 - 14i + i^2}}{2}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{(5-i) \pm \sqrt{-47 - 14i + (-1)}}{2}$$

$$= \frac{(5-i) \pm \sqrt{-48 - 14i}}{2}$$

$$= \frac{(5-i) \pm \sqrt{(-1)(48 + 14i)}}{2}$$

$$= \frac{(5-i) \pm \sqrt{i^2(48 + 14i)}}{2}$$

$$= \frac{(5-i) \pm i\sqrt{48 + 14i}}{2}$$

We can write 48 + 14i = 49 – 1 + 14i

So,

$48 + 14i = 49 + i^2 + 14i$ [∵ $i^2 = -1$]

$= 7^2 + i^2 + 2(7)(i)$

$= (7 + i)^2$ [Since, $(a + b)^2 = a^2 + b^2 + 2ab$]

By using the result $48 + 14i = (7 + i)^2$, we get

$x = 2 + 3i$ or $3 - 4i$

∴ The roots of the given equation are $3 - 4i$, $2 + 3i$

(iii) $(2 + i)x^2 - (5- i)x + 2 (1 - i) = 0$

Given: $(2 + i)x^2 - (5- i)x + 2 (1 - i) = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{(b^2 - 4ac)})/2a$

Here, $a = (2+i)$, $b = -(5-i)$, $c = 2(1-i)$

So,

$$x = \frac{-(-(5-i)) \pm \sqrt{(-(5-i))^2 - 4(2+i)(2(1-i))}}{2(2+i)}$$

$$= \frac{(5-i) \pm \sqrt{(5-i)^2 - 8(2+i)(1-i)}}{2(2+i)}$$

$$= \frac{(5-i) \pm \sqrt{25 - 10i + i^2 - 8(2 - 2i + i - i^2)}}{2(2+i)}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{(5-i) \pm \sqrt{25 - 10i + (-1) - 8\big(2 - i - (-1)\big)}}{2(2+i)}$$

$$= \frac{(5-i) \pm \sqrt{24 - 10i - 8(3-i)}}{2(2+i)}$$

$$= \frac{(5-i) \pm \sqrt{24 - 10i - 24 + 8i}}{2(2+i)}$$

$$= \frac{(5-i) \pm \sqrt{-2i}}{2(2+i)}$$

We can write –2i = –2i + 1 – 1

–2i = –2i + 1 + i^2 [Since, $i^2 = -1$]

= 1 – 2i + i^2

= $1^2 - 2(1)(i) + i^2$

= $(1 - i)^2$ [By using the formula, $(a - b)^2 = a^2 - 2ab + b^2$]

By using the result $-2i = (1 - i)^2$, we get

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

$$= \frac{(5-i) \pm (1-i)}{2(2+i)}$$

$$= \frac{(5-i) + (1-i)}{2(2+i)} \text{ or } \frac{(5-i) - (1-i)}{2(2+i)}$$

$$= \frac{5 - i + 1 - i}{2(2+i)} \text{ or } \frac{5 - i - 1 + i}{2(2+i)}$$

$$= \frac{6 - 2i}{2(2+i)} \text{ or } \frac{4}{2(2+i)}$$

$$= \frac{3-i}{2+i} \text{ or } \frac{2}{2+i}$$

Let us multiply and divide by (2 - i), we get

$$= \frac{3-i}{2+i} \times \frac{2-i}{2-i} \text{ or } \frac{2}{2+i} \times \frac{2-i}{2-i}$$

$$= \frac{(3-i)(2-i)}{(2+i)(2-i)} \text{ or } \frac{2(2-i)}{(2+i)(2-i)}$$

$$= \frac{6-3i-2i+i^2}{2^2-i^2} \text{ or } \frac{4-2i}{2^2-i^2}$$

$$= \frac{6-5i+(-1)}{4-(-1)} \text{ or } \frac{4-2i}{4-(-1)}$$

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

$$= \frac{5(1-i)}{5} \text{ or } \frac{4-2i}{5}$$

x = (1 – i) or 4/5 – 2i/5

∴ The roots of the given equation are (1 – i), 4/5 – 2i/5

(iv) x^2 – (2 + i)x – (1 – 7i) = 0

Given: x^2 – (2 + i)x – (1 – 7i) = 0

We shall apply discriminant rule,

Where, x = (-b ±√(b^2 – 4ac))/2a

Here, a = 1, b = -(2+i), c = -(1-7i)

So,

$$x = \frac{-(-(2+i)) \pm \sqrt{(-(2+i))^2 - 4(1)(-(1-7i))}}{2(1)}$$

$$= \frac{(2+i) \pm \sqrt{(2+i)^2 + 4(1-7i)}}{2}$$

$$= \frac{(2+i) \pm \sqrt{4 + 4i + i^2 + 4 - 28i}}{2}$$

$$= \frac{(2+i) \pm \sqrt{8 - 24i + i^2}}{2}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{(2+i) \pm \sqrt{8 - 24i + (-1)}}{2}$$

$$= \frac{(2+i) \pm \sqrt{7 - 24i}}{2}$$

We can write $7 - 24i = 16 - 9 - 24i$

$7 - 24i = 16 + 9(-1) - 24i$

$= 16 + 9i^2 - 24i$ [$\because i^2 = -1$]

$= 4^2 + (3i)^2 - 2(4)(3i)$

$= (4 - 3i)^2$ [$\because (a - b)^2 = a^2 - b^2 + 2ab$]

By using the result $7 - 24i = (4 - 3i)^2$, we get

$$x = \frac{(2+i) \pm \sqrt{(4-3i)^2}}{2}$$

We can write $7 - 24i = 16 - 9 - 24i$

$7 - 24i = 16 + 9(-1) - 24i$

$= 16 + 9i^2 - 24i$ [$\because i^2 = -1$]

$= 4^2 + (3i)^2 - 2(4)(3i)$

$= (4 - 3i)^2$ [$\because (a - b)^2 = a^2 - b^2 + 2ab$]

By using the result $7 - 24i = (4 - 3i)^2$, we get

$$x = \frac{-(-(2+i)) \pm \sqrt{(-(2+i))^2 - 4(1)(-(1-7i))}}{2(1)}$$

$$= \frac{(2+i) \pm \sqrt{(2+i)^2 + 4(1-7i)}}{2}$$

$$= \frac{(2+i) \pm \sqrt{4+4i+i^2+4-28i}}{2}$$

$$= \frac{(2+i) \pm \sqrt{8-24i+i^2}}{2}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{(2+i) \pm \sqrt{8-24i+(-1)}}{2}$$

$$= \frac{(2+i) \pm \sqrt{7-24i}}{2}$$

We can write $7 - 24i = 16 - 9 - 24i$

$7 - 24i = 16 + 9(-1) - 24i$

$= 16 + 9i^2 - 24i$ [$\because i^2 = -1$]

$= 4^2 + (3i)^2 - 2(4)(3i)$

$= (4 - 3i)^2$ [$\because (a - b)^2 = a^2 - b^2 + 2ab$]

By using the result $7 - 24i = (4 - 3i)^2$, we get

$$x = \frac{(2+i) \pm \sqrt{(4-3i)^2}}{2}$$

x = 3 – i or -1 + 2i

∴ The roots of the given equation are (-1 + 2i), (3 – i)

(v) $ix^2 - 4x - 4i = 0$

Given: $ix^2 - 4x - 4i = 0$

$ix^2 + 4x(-1) - 4i = 0$ [We know, $i^2 = -1$]

So by substituting $-1 = i^2$ in the above equation, we get

$ix^2 + 4xi^2 – 4i = 0$

$i(x^2 + 4ix – 4) = 0$

$x^2 + 4ix – 4 = 0$

$x^2 + 4ix + 4(–1) = 0$

$x^2 + 4ix + 4i^2 = 0$ [Since, $i^2 = –1$]

$x^2 + 2ix + 2ix + 4i^2 = 0$

$x(x + 2i) + 2i(x + 2i) = 0$

$(x + 2i) (x + 2i) = 0$

$(x + 2i)^2 = 0$

$x + 2i = 0$

$x = –2i, -2i$

∴ The roots of the given equation are –2i, –2i

(vi) $x^2 + 4ix – 4 = 0$

Given: $x^2 + 4ix – 4 = 0$

$x^2 + 4ix + 4(–1) = 0$ [We know, $i^2 = –1$]

So by substituting $–1 = i^2$ in the above equation, we get

$x^2 + 4ix + 4i^2 = 0$

$x^2 + 2ix + 2ix + 4i^2 = 0$

$x(x + 2i) + 2i(x + 2i) = 0$

$(x + 2i) (x + 2i) = 0$

$(x + 2i)^2 = 0$

$x + 2i = 0$

x = –2i, -2i

∴ The roots of the given equation are –2i, –2i

(vii) $2x^2 + \sqrt{15}ix - i = 0$

Given: $2x^2 + \sqrt{15}ix - i = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{(b^2 - 4ac)})/2a$

Here, a = 2, b = √15i, c = -i

So,

$$x = \frac{-(\sqrt{15}i) \pm \sqrt{(\sqrt{15}i)^2 - 4(2)(-i)}}{2(2)}$$

$$= \frac{-\sqrt{15}i \pm \sqrt{15i^2 + 8i}}{4}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{-\sqrt{15}i \pm \sqrt{15(-1) + 8i}}{4}$$

$$= \frac{-\sqrt{15}i \pm \sqrt{8i - 15}}{4}$$

$$= \frac{-\sqrt{15}i \pm \sqrt{(-1)(15 - 8i)}}{4}$$

$$= \frac{-\sqrt{15}i \pm \sqrt{i^2(15 - 8i)}}{4}$$

$$= \frac{-\sqrt{15}i \pm i\sqrt{15 - 8i}}{4}$$

We can write 15 – 8i = 16 – 1 – 8i

15 – 8i = 16 + (–1) – 8i

= 16 + i^2 – 8i [∵ i^2 = –1]

= 4^2 + $(i)^2$ – 2(4)(i)

= $(4 – i)^2$ [Since, $(a – b)^2 = a^2 – b^2 + 2ab$]

By using the result 15 – 8i = $(4 – i)^2$, we get

$$x = \frac{-\sqrt{15}i \pm i\sqrt{(4-i)^2}}{4}$$

$$= \frac{-\sqrt{15}i \pm i(4-i)}{4}$$

$$= \frac{-\sqrt{15}i + i(4-i)}{4} \text{ or } \frac{-\sqrt{15}i - i(4-i)}{4}$$

$$= \frac{-\sqrt{15}i + 4i - i^2}{4} \text{ or } \frac{-\sqrt{15}i - 4i + i^2}{4}$$

$$= \frac{-\sqrt{15}i+4i-(-1)}{4} \text{ or } \frac{-\sqrt{15}i-4i+(-1)}{4}$$

$$= \frac{-\sqrt{15}i + 4i + 1}{4} \text{ or } \frac{-\sqrt{15}i - 4i - 1}{4}$$

$$= \frac{1 + (4-\sqrt{15})i}{4} \text{ or } \frac{-1 - (4+\sqrt{15})i}{4}$$

$$x = \frac{1}{4} + \left(\frac{4-\sqrt{15}}{4}\right)i \text{ or } -\frac{1}{4} - \left(\frac{4+\sqrt{15}}{4}\right)i$$

∴ The roots of the given equation are [1+ (4 – √15)i/4] , [-1 -(4 + √15)i/4]

(viii) $x^2 – x + (1 + i) = 0$

Given: $x^2 – x + (1 + i) = 0$

We shall apply discriminant rule,

Where, x = (-b **±**√(b^2 – 4ac))/2a

Here, a = 1, b = -1, c = (1+i)

So,

$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(1+i)}}{2(1)}$$
$$= \frac{1 \pm \sqrt{1 - 4(1+i)}}{2}$$
$$= \frac{1 \pm \sqrt{1 - 4 - 4i}}{2}$$

We can write 3 + 4i = 4 – 1 + 4i

$3 + 4i = 4 + i^2 + 4i$ [∵ $i^2 = -1$]

$= 2^2 + i^2 + 2(2)(i)$

$= (2 + i)^2$ [Since, $(a + b)^2 = a^2 + b^2 + 2ab$]

By using the result $3 + 4i = (2 + i)^2$, we get

$$x = \frac{1 \pm i\sqrt{(2+i)^2}}{2}$$
$$= \frac{1 \pm i(2+i)}{2}$$
$$= \frac{1 + i(2+i)}{2} \text{ or } \frac{1 - i(2+i)}{2}$$
$$= \frac{1 + 2i + i^2}{2} \text{ or } \frac{1 - 2i - i^2}{2}$$
$$= \frac{1+2i+(-1)}{2} \text{ or } \frac{1-2i-(-1)}{2}$$
$$= \frac{1 + 2i - 1}{2} \text{ or } \frac{1 - 2i + 1}{2}$$

x = 2i/2 or (2 – 2i)/2

x = i or 2(1-i)/2

$x = i$ or $(1 – i)$

∴ The roots of the given equation are (1-i), i

(ix) $ix^2 – x + 12i = 0$

Given: $ix^2 – x + 12i = 0$

$ix^2 + x(–1) + 12i = 0$ [We know, $i^2 = –1$]

so by substituting $–1 = i^2$ in the above equation, we get

$ix^2 + xi^2 + 12i = 0$

$i(x^2 + ix + 12) = 0$

$x^2 + ix + 12 = 0$

$x^2 + ix – 12(–1) = 0$

$x^2 + ix – 12i^2 = 0$ [Since, $i^2 = –1$]

$x^2 – 3ix + 4ix – 12i^2 = 0$

$x(x – 3i) + 4i(x – 3i) = 0$

$(x – 3i) (x + 4i) = 0$

$x – 3i = 0$ or $x + 4i = 0$

$x = 3i$ or $–4i$

∴ The roots of the given equation are -4i, 3i

(x) $x^2 – (3\sqrt{2} – 2i)x – \sqrt{2}i = 0$

Given: $x^2 – (3\sqrt{2} – 2i)x – \sqrt{2}i = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{(b^2 – 4ac)})/2a$

Here, $a = 1$, $b = -(3\sqrt{2} – 2i)$, $c = –\sqrt{2}i$

So,

$$x = \frac{-\left(-\left(3\sqrt{2}-2i\right)\right) \pm \sqrt{\left(-\left(3\sqrt{2}-2i\right)\right)^2 - 4(1)\left(-\sqrt{2}i\right)}}{2(1)}$$

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{\left(3\sqrt{2}-2i\right)^2 + 4\sqrt{2}i}}{2}$$

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{18 - 12\sqrt{2}i + 4i^2 + 4\sqrt{2}i}}{2}$$

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{18 - 8\sqrt{2}i + 4i^2}}{2}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{18 - 8\sqrt{2}i + 4(-1)}}{2}$$

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{18 - 8\sqrt{2}i - 4}}{2}$$

$$= \frac{\left(3\sqrt{2}-2i\right) \pm \sqrt{14 - 8\sqrt{2}i}}{2}$$

$$= \frac{(3\sqrt{2} - 2i) \pm \sqrt{18 - 8\sqrt{2}i - 4}}{2}$$

$$= \frac{(3\sqrt{2} - 2i) \pm \sqrt{14 - 8\sqrt{2}i}}{2}$$

We can write 14 - 8√2i = 16 – 2 - 8√2i

14 - 8√2i = 16 + 2(-1) - 8√2i

= 16 + $2i^2$ - 8√2i [Since, i^2 = -1]

= 4^2 + $(\sqrt{2}i)^2$ – 2(4) (√2i)

= $(4 - \sqrt{2}i)^2$ [By using the formula, $(a – b)^2 = a^2 – 2ab + b^2$]

By using the result 14 - 8√2i = $(4 - \sqrt{2}i)^2$, we get

$$x = \frac{(3\sqrt{2} - 2i) \pm \sqrt{(4 - \sqrt{2}i)^2}}{2}$$

$$= \frac{(3\sqrt{2} - 2i) \pm (4 - \sqrt{2}i)}{2}$$

$$= \frac{3\sqrt{2} - 2i}{2} \pm \frac{4 - \sqrt{2i}}{2}$$

∴ The roots of the given equation are $\frac{3\sqrt{2} - 2i}{2} \pm \frac{4 - \sqrt{2i}}{2}$

(xi) x^2 – (√2 + i)x + √2i = 0

Given: x^2 – (√2 + i)x + √2i = 0

x^2 – (√2x + ix) + √2i = 0

x^2 – √2x – ix + √2i = 0

x(x – √2) – i(x – √2) = 0

(x – √2) (x – i) = 0

(x – √2) = 0 or (x – i) = 0

x = √2 or x = i

∴ The roots of the given equation are i, √2

(xii) $2x^2 – (3 + 7i)x + (9i – 3) = 0$

Given: $2x^2 – (3 + 7i)x + (9i – 3) = 0$

We shall apply discriminant rule,

Where, $x = (-b \pm\sqrt{(b^2 – 4ac)})/2a$

Here, a = 2, b = -(3 **+ 7**i), c = (9i – 3)

So,

$$x = \frac{-(-(3+7i)) \pm \sqrt{(-(3+7i))^2 - 4(2)(9i-3)}}{2(2)}$$

$$= \frac{(3+7i) \pm \sqrt{(3+7i)^2 - 8(9i-3)}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{9 + 42i + 49i^2 - 72i + 24}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{33 - 30i + 49i^2}}{4}$$

We have $i^2 = -1$

By substituting $-1 = i^2$ in the above equation, we get

$$= \frac{(3+7i) \pm \sqrt{33 - 30i + 49(-1)}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{33 - 30i - 49}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{-16 - 30i}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{(-1)(16+30i)}}{4}$$

$$= \frac{(3+7i) \pm \sqrt{i^2(16+30i)}}{4}$$

$$= \frac{(3+7i) \pm i\sqrt{16+30i}}{4}$$

We can write 16 + 30i = 25 – 9 + 30i

16 + 30i = 25 + 9(–1) + 30i

= $25 + 9i^2 + 30i$ [∵ $i^2 = -1$]

= $5^2 + (3i)^2 + 2(5)(3i)$

= $(5 + 3i)^2$ [∵ $(a + b)^2 = a^2 + b^2 + 2ab$]

By using the result 16 + 30i = $(5 + 3i)^2$, we get

$$x = \frac{(3+7i) \pm i\sqrt{(5+3i)^2}}{4}$$

$$= \frac{(3+7i) \pm i(5+3i)}{4}$$

$$= \frac{(3+7i) + i(5+3i)}{4} \text{ or } \frac{(3+7i) - i(5+3i)}{4}$$

$$= \frac{3 + 7i + 5i + 3i^2}{4} \text{ or } \frac{3 + 7i - 5i - 3i^2}{4}$$

$$= \frac{3 + 12i + 3i^2}{4} \text{ or } \frac{3 + 2i - 3i^2}{4}$$

$$= \frac{3+12i+3(-1)}{4} \text{ or } \frac{3+2i-3(-1)}{4}$$

$$= \frac{3 + 12i - 3}{4} \text{ or } \frac{3 + 2i + 3}{4}$$

$$= \frac{12}{4}i \text{ or } \frac{6+2i}{4}$$

$$= 3i \text{ or } \frac{6}{4} + \frac{2}{4}i$$

$$x = 3i \text{ or } \frac{3}{2} + \frac{1}{2}i$$

$= 3i$ or $(3 + i)/2$

∴ The roots of the given equation are $(3 + i)/2$, $3i$

Chapterwise RD Sharma Solutions for Class 11 Maths :

- Chapter 21–Some Special Series
- Chapter 22–Brief review of Cartesian System of Rectangular Coordinates
- Chapter 23–The Straight Lines
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About RD Sharma

RD Sharma i*sn't the kind of author you'd bump into at lit fests. But his bestselling books have helped many* CBSE *students lose their dread of* maths. *Sunday Times profiles the tutor turned internet star*

He dreams of algorithms that would give most people nightmares. And, spends every waking hour thinking of ways to explain concepts like 'series solution of linear differential equations'. Meet Dr Ravi Dutt Sharma — mathematics teacher and author of 25 reference books — whose name evokes as much awe as the subject he teaches. And though students have used his thick tomes for the last 31 years to ace the dreaded maths exam, it's only recently that a spoof video turned the tutor into a YouTube star.

R D Sharma had a good laugh but said he shared little with his on-screen persona except for the love for maths. "I like to spend all my time thinking and writing about maths problems. I find it relaxing," he says. When he is not writing books explaining mathematical concepts for classes 6 to 12 and engineering students, Sharma is busy dispensing his duty as vice-principal and head of department of science and humanities at Delhi government's Guru Nanak Dev Institute of Technology.