**NCERT solutions for class 11 maths chapter 5 Complex Numbers and Quadratic Equations-Exercise: 5.1**

**Question:1** Express each of the complex number in the form $a + ib$ .

$(5i)\left(-\frac{3}{5}i\right)$

**Answer:**

On solving

$(5i)\left(-\frac{3}{5}i\right)$

we will get

$(5i)\left(-\frac{3}{5}i\right) = 5 \times (-\frac{3}{5}) \times i \times i$

$= -3 \times i^2 \, (\because i^2 = -1)$

$= -3 \times -1$

$= 3$

Now, in the form of $a + ib$ we can write it as

$= 3 + 0i$

**Question:2** Express each of the complex number in the form $a + ib$ .

$i^9 + i^{19}$

**Answer:**

We know that $i^4 = 1$

Now, we will reduce $i^9 + i^{19}$ into

$i^9 + i^{19} = (i^4)^2.i + (i^4)^3.i^3$

$= (1)^2.i + (1)^3.(-i)\,(\because i^4 = 1, i^3 = -i \; and \; i^2 = -1)$

$= i - i = 0$

Now, in the form of $a + ib$ we can write it as

$o + io$

Therefore, the answer is $o + io$

**Question:3** Express each of the complex number in the form a+ib.

$i^{-39}$

**Answer:**

We know that $i^4 = 1$

Now, we will reduce $i^{-39}$ into

$i^{-39} = (i^4)^{-9}.i^{-3}$

$= (1)^{-9}.(-i)^{-1}\,(\because i^4 = 1, i^3 = -i)$

$= \frac{1}{-i}$

$= \frac{1}{-i} \times \frac{i}{i}$

$= \frac{i}{-i^2}\,(\because i^2 = -1)$

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

$= i$

Now, in the form of $a + ib$ we can write it as

$o + i1$

Therefore, the answer is $o + i1$

**Question:4** Express each of the complex number in the form a+ib.

$3(7 + 7i) + i(7 + 7i)$

**Answer:**

Given problem is

$3(7 + 7i) + i(7 + 7i)$

Now, we will reduce it into

$3(7 + 7i) + i(7 + 7i) = 21 + 21i + 7i + 7i^2$

$= 21 + 21i + 7i + 7(-1) \, (\because i^2 = -1)$

$= 21 + 21i + 7i - 7$

$= 14 + 28i$

Therefore, the answer is $14 + i28$

**Question:5** Express each of the complex number in the form $a + ib$ .

$(1 - i) - (-1 + 6i)$

**Answer:**

Given problem is

$(1 - i) - (-1 + 6i)$

Now, we will reduce it into

$(1-i)-(-1+6i)= 1-i+1-6i$

$= 2-7i$

Therefore, the answer is $2-7i$

**Question:6** Express each of the complex number in the form $a+ib$ .

$$\left(\frac{1}{5}+i\frac{2}{5}\right)-\left(4+i\frac{5}{2}\right)$$

**Answer:**

Given problem is
$$\left(\frac{1}{5}+i\frac{2}{5}\right)-\left(4+i\frac{5}{2}\right)$$

Now, we will reduce it into

$$=\frac{1-20}{5}+i\frac{(4-25)}{10}$$
$$=-\frac{19}{5}-i\frac{21}{10}$$

Therefore, the answer is $-\frac{19}{5}-i\frac{21}{10}$

**Question:7** Express each of the complex number in the form $a+ib$ .

**Answer:**

Given problem is

Now, we will reduce it into

$= \frac{1+4+12}{3} + i\frac{(7+1-3)}{3}$
$= \frac{17}{3} + i\frac{5}{3}$

Therefore, the answer is $\frac{17}{3} + i\frac{5}{3}$

**Question:8** Express each of the complex number in the form $a + ib$ .

$(1-i)^4$

**Answer:**

The given problem is

$(1-i)^4$

Now, we will reduce it into

$(1-i)^4 = ((1-i)^2)^2$

$= (1^2 + i^2 - 2.1.i)^2 \,(using\ (a-b)^2 = a^2 + b^2 - 2ab)$

$= (1 - 1 - 2i)^2 \,(\because i^2 = -1)$

$= (-2i)^2$

$= 4i^2$

$= -4$

Therefore, the answer is $-4 + i0$

**Question:9** Express each of the complex number in the form $a + ib$ .

$$\left(\frac{1}{3}+3i\right)^3$$

**Answer:**

Given problem is

$$\left(\frac{1}{3}+3i\right)^3$$

Now, we will reduce it into

$$(using\ (a+b)^3=a^3+b^3+3a^2b+3ab^2)$$
$$=\frac{1}{27}+27i^3+i+9i^2$$
$$=\frac{1}{27}+27(-i)+i+9(-1)(\because i^3=-i\ and\ i^2=-1)$$
$$=\frac{1}{27}-27i+i-9$$
$$=\frac{1-243}{27}-26i$$
$$=-\frac{242}{27}-26i$$

Therefore, the answer is

$$-\frac{242}{27}-26i$$

**Question:10** Express each of the complex number in the form $a+ib$ .

$$\left(-2-\frac{1}{3}i\right)^3$$

**Answer:**

Given problem is
$$\left(-2-\frac{1}{3}i\right)^3$$

Now, we will reduce it into

$$(using\ (a+b)^3 = a^3+b^3+3a^2b+3ab^2)$$
$$= -\left(8+\frac{1}{27}i^3+3.4.\frac{1}{3}i+3.\frac{1}{9}i^2.2\right)$$
$$= -\left(8+\frac{1}{27}(-i)+4i+\frac{2}{3}(-1)\right)(\because i^3=-i\ and\ i^2=-1)$$
$$= -\left(8-\frac{1}{27}i+4i-\frac{2}{3}\right)$$
$$= -\left(\frac{(-1+108)}{27}i+\frac{24-2}{3}\right)$$
$$= -\frac{22}{3}-i\frac{107}{27}$$

Therefore, the answer is $-\frac{22}{3}-i\frac{107}{27}$

**Question:11** Find the multiplicative inverse of each of the complex numbers.

$4-3i$

**Answer:**

Let $z=4-3i$

Then,

$\bar{z}=4+3i$

And

$|z|^2=4^2+(-3)^2=16+9=25$

Now, the multiplicative inverse is given by

$$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{4+3i}{25} = \frac{4}{25} + i\frac{3}{25}$$

Therefore, the multiplicative inverse is

$$\frac{4}{25} + i\frac{3}{25}$$

**Question:12** Find the multiplicative inverse of each of the complex numbers.

$$\sqrt{5} + 3i$$

**Answer:**

Let $z = \sqrt{5} + 3i$

Then,

$$\bar{z} = \sqrt{5} - 3i$$

And

$$|z|^2 = (\sqrt{5})^2 + (3)^2 = 5 + 9 = 14$$

Now, the multiplicative inverse is given by

$$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{\sqrt{5} - 3i}{14} = \frac{\sqrt{5}}{14} - i\frac{3}{14}$$

Therefore, the multiplicative inverse is $\frac{\sqrt{5}}{14} - i\frac{3}{14}$

**Question:13** Find the multiplicative inverse of each of the complex numbers.

$$-i$$

**Answer:**

Let $z = -i$

Then,

$\bar{z} = i$

And
$|z|^2 = (0)^2 + (1)^2 = 0 + 1 = 1$

Now, the multiplicative inverse is given by
$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{i}{1} = 0 + i$

Therefore, the multiplicative inverse is $0 + i1$

**Question:14** Express the following expression in the form of $a + ib$ :

$$\frac{(3 + i\sqrt{5})(3 - i\sqrt{5})}{(\sqrt{3} + \sqrt{2}i) - (\sqrt{3} - i\sqrt{2})}$$

**Answer:**

Given problem is
$$\frac{(3 + i\sqrt{5})(3 - i\sqrt{5})}{(\sqrt{3} + \sqrt{2}i) - (\sqrt{3} - i\sqrt{2})}$$

Now, we will reduce it into

$$(using\ (a - b)(a + b) = a^2 - b^2)$$
$$= \frac{9 - 5i^2}{\sqrt{3} + \sqrt{2}i - \sqrt{3} + \sqrt{2}i}$$
$$= \frac{9 - 5(-1)}{2\sqrt{2}i} \quad (\because i^2 = -1)$$
$$= \frac{14}{2\sqrt{2}i} \times \frac{\sqrt{2}i}{\sqrt{2}i}$$
$$= \frac{7\sqrt{2}i}{2i^2}$$

$$= -\frac{7\sqrt{2}i}{2}$$

Therefore, answer is $0 - i\frac{7\sqrt{2}}{2}$

## NCERT solutions for class 11 maths chapter 5 Complex Numbers and Quadratic Equations-Exercise: 5.2

**Question:1** Find the modulus and the arguments of each of the complex numbers.

$z = -1 - i\sqrt{3}$

**Answer:**

Given the problem is

$z = -1 - i\sqrt{3}$

Now, let

$r\cos\theta = -1 \quad and \quad r\sin\theta = -\sqrt{3}$

Square and add both the sides

$r^2(\cos^2\theta + \sin^2\theta) = (-1)^2 + (-\sqrt{3})^2 \, (\because \cos^2\theta + \sin^2\theta = 1)$

$r^2 = 1 + 3$

$r^2 = 4$

$r = 2 \, (\because r > 0)$

Therefore, the modulus is 2

Now,

$2\cos\theta = -1 \quad and \quad 2\sin\theta = -\sqrt{3}$

$\cos\theta = -\frac{1}{2} \quad and \quad \sin\theta = -\frac{\sqrt{3}}{2}$

Since, both the values of $\cos\theta \ and \ \sin\theta$ is negative and we know that they are negative in III quadrant

Therefore,

Argument = $-\left(\pi-\frac{\pi}{3}\right)=-\frac{2\pi}{3}$

Therefore, the argument is

$-\frac{2\pi}{3}$

**Question:2** Find the modulus and the arguments of each of the complex numbers.

$z=-\sqrt{3}+i$

**Answer:**

Given the problem is

$z=-\sqrt{3}+i$

Now, let

$r\cos\theta=-\sqrt{3}\quad and\quad r\sin\theta=1$

Square and add both the sides

$r^2(\cos^2\theta+\sin^2\theta)=(-\sqrt{3})^2+(1)^2\,(\because\cos^2\theta+\sin^2\theta=1)$

$r^2=1+3$

$r^2=4$

$r=2\,(\because r>0)$

Therefore, the modulus is 2

Now,

$2\cos\theta=-\sqrt{3}\quad and\quad 2\sin\theta=1$

$\cos\theta=-\frac{\sqrt{3}}{2}\quad and\quad \sin\theta=\frac{1}{2}$

Since values of $\cos\theta$ is negative and value $\sin\theta$ is positive and we know that this is the case in II quadrant

Therefore,

Argument = $\left(\pi - \frac{\pi}{6}\right) = \frac{5\pi}{6}$

Therefore, the argument is

$$\frac{5\pi}{6}$$

**Question:3** Convert each of the complex numbers in the polar form:

$$1 - i$$

**Answer:**

Given problem is

$z = 1 - i$

Now, let

$r\cos\theta = 1 \quad and \quad r\sin\theta = -1$

Square and add both the sides

$r^2(\cos^2\theta + \sin^2\theta) = (1)^2 + (-1)^2 \, (\because \cos^2\theta + \sin^2\theta = 1)$

$r^2 = 1 + 1$

$r^2 = 2$

$r = \sqrt{2} \, (\because r > 0)$

Therefore, the modulus is $\sqrt{2}$

Now,

$\sqrt{2}\cos\theta = 1 \quad and \quad \sqrt{2}\sin\theta = -1$

$\cos\theta = \frac{1}{\sqrt{2}} \quad and \quad \sin\theta = -\frac{1}{\sqrt{2}}$

Since values of $\sin\theta$ is negative and value $\cos\theta$ is positive and we know that this is the case in the IV quadrant

Therefore,

$\theta = -\frac{\pi}{4} \qquad (lies\ in\ IV\ quadrant)$

Therefore,

$$1 - i = r\cos\theta + ir\sin\theta$$
$$= \sqrt{2}\cos\left(-\frac{\pi}{4}\right) + i\sqrt{2}\sin\left(-\frac{\pi}{4}\right)$$
$$= \sqrt{2}\left(\cos\left(-\frac{\pi}{4}\right) + i\sin\left(-\frac{\pi}{4}\right)\right)$$

Therefore, the required polar form is $\sqrt{2}\left(\cos\left(-\frac{\pi}{4}\right) + i\sin\left(-\frac{\pi}{4}\right)\right)$

**Question:4** Convert each of the complex numbers in the polar form:

$-1 + i$

**Answer:**

Given the problem is

$z = -1 + i$

Now, let

$r\cos\theta = -1 \quad and \quad r\sin\theta = 1$

Square and add both the sides

$$r^2(\cos^2\theta + \sin^2\theta) = (1)^2 + (-1)^2\ (\because \cos^2\theta + \sin^2\theta = 1)$$

$$r^2 = 1 + 1$$

$$r^2 = 2$$

$$r = \sqrt{2}\ (\because r > 0)$$

Therefore, the modulus is $\sqrt{2}$

Now,

$$\sqrt{2}\cos\theta = -1 \quad and \quad \sqrt{2}\sin\theta = 1$$
$$\cos\theta = -\frac{1}{\sqrt{2}} \quad and \quad \sin\theta = \frac{1}{\sqrt{2}}$$

Since values of $\cos\theta$ is negative and value $\sin\theta$ is positive and we know that this is the case in II quadrant

Therefore,

Therefore,

$$-1+i = r\cos\theta + ir\sin\theta$$
$$= \sqrt{2}\cos\left(\frac{3\pi}{4}\right) + i\sqrt{2}\sin\left(\frac{3\pi}{4}\right)$$
$$= \sqrt{2}\left(\cos\left(\frac{3\pi}{4}\right) + i\sin\left(\frac{3\pi}{4}\right)\right)$$

Therefore, the required polar form is $\sqrt{2}\left(\cos\left(\frac{3\pi}{4}\right) + i\sin\left(\frac{3\pi}{4}\right)\right)$

**Question:5** Convert each of the complex numbers in the polar form:

$-1-i$

**Answer:**

Given problem is

$z = -1-i$

Now, let

$r\cos\theta = -1 \quad and \quad r\sin\theta = -1$

Square and add both the sides

$r^2(\cos^2\theta + \sin^2\theta) = (-1)^2 + (-1)^2 \; (\because \cos^2\theta + \sin^2\theta = 1)$

$r^2 = 1+1$

$r^2 = 2$

$r = \sqrt{2}$ &nbsnbsp; $(\because r > 0)$

Therefore, the modulus is $\sqrt{2}$

Now,

$$\sqrt{2}\cos\theta = -1 \quad and \quad \sqrt{2}\sin\theta = -1$$
$$\cos\theta = -\frac{1}{\sqrt{2}} \quad and \quad \sin\theta = -\frac{1}{\sqrt{2}}$$

Since values of both $\cos\theta$ and $\sin\theta$ is negative and we know that this is the case in III quadrant

Therefore,

Therefore,

$$-1 - i = r\cos\theta + ir\sin\theta$$
$$= \sqrt{2}\cos\left(-\frac{3\pi}{4}\right) + i\sqrt{2}\sin\left(-\frac{3\pi}{4}\right)$$
$$= \sqrt{2}\left(\cos\left(-\frac{3\pi}{4}\right) + i\sin\left(-\frac{3\pi}{4}\right)\right)$$

Therefore, the required polar form is $\sqrt{2}\left(\cos\left(-\frac{3\pi}{4}\right) + i\sin\left(-\frac{3\pi}{4}\right)\right)$

**Question:6** Convert each of the complex numbers in the polar form:

$-3$

**Answer:**

Given problem is

$z = -3$

Now, let

$$r\cos\theta = -3 \quad and \quad r\sin\theta = 0$$

Square and add both the sides

$$r^2(\cos^2\theta + \sin^2\theta) = (-3)^2 + (0)^2 \; (\because \cos^2\theta + \sin^2\theta = 1)$$

$r^2 = 9 + 0$

$r^2 = 9$

$r = 3 \, (\because r > 0)$

Therefore, the modulus is **3**

Now,

$3\cos\theta = -3 \quad and \quad 3\sin\theta = 0$

$\cos\theta = -1 \quad and \quad \sin\theta = 0$

Since values of $\cos\theta$ is negative and $\sin\theta$ is Positive and we know that this is the case in II quadrant

Therefore,

$\theta = \pi \qquad\qquad (lies\ in\ II\ quadrant)$

Therefore,

$-3 = r\cos\theta + ir\sin\theta$

$= 3\cos(\pi) + i3\sin(\pi)$

$= 3(\cos\pi + i\sin\pi)$

Therefore, the required polar form is $3(\cos\pi + i\sin\pi)$

**Question:7** Convert each of the complex numbers in the polar form:

$\sqrt{3} + i$

**Answer:**

Given problem is

$z = \sqrt{3} + i$

Now, let

$r\cos\theta = \sqrt{3} \quad and \quad r\sin\theta = 1$

Square and add both the sides

$r^2(\cos^2\theta + \sin^2\theta) = (\sqrt{3})^2 + (1)^2 \, (\because \cos^2\theta + \sin^2\theta = 1)$

$r^2 = 3 + 1$

$r^2 = 4$

$r = 2 \, (\because r > 0)$

Therefore, the modulus is **2**

Now,

$$2\cos\theta = \sqrt{3} \quad and \quad 2\sin\theta = 1$$
$$\cos\theta = \frac{\sqrt{3}}{2} \quad and \quad \sin\theta = \frac{1}{2}$$

Since values of Both $\cos\theta$ and $\sin\theta$ is Positive and we know that this is the case in I quadrant

Therefore,

$$\theta = \frac{\pi}{6} \qquad (lies\ in\ I\ quadrant)$$

Therefore,

$$\sqrt{3} + i = r\cos\theta + ir\sin\theta$$
$$= 2\cos\left(\frac{\pi}{6}\right) + i2\sin\left(\frac{\pi}{6}\right)$$
$$= 2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$$

Therefore, the required polar form is $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$

**Question:8** Convert each of the complex numbers in the polar form:

$i$

**Answer:**

Given problem is

$z = i$

Now, let

$r\cos\theta = 0 \quad and \quad r\sin\theta = 1$

Square and add both the sides

$r^2(\cos^2\theta + \sin^2\theta) = (0)^2 + (1)^2\,(\because \cos^2\theta + \sin^2\theta = 1)$

$r^2 = 0 + 1$

$r^2 = 1$

$r = 1\,(\because r > 0)$

Therefore, the modulus is **1**

Now,

$1\cos\theta = 0 \quad and \quad 1\sin\theta = 1$

$\cos\theta = 0 \quad and \quad \sin\theta = 1$

Since values of Both $\cos\theta$ and $\sin\theta$ is Positive and we know that this is the case in I quadrant

Therefore,

$\theta = \frac{\pi}{2} \qquad (lies\ in\ I\ quadrant)$

Therefore,

$$i = r\cos\theta + ir\sin\theta$$
$$= 1\cos\left(\frac{\pi}{2}\right) + i1\sin\left(\frac{\pi}{2}\right)$$
$$= \cos\frac{\pi}{2} + i\sin\frac{\pi}{2}$$

Therefore, the required polar form is $\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}$

## NCERT solutions for class 11 maths chapter 5 Complex Numbers and Quadratic Equations-Exercise: 5.3

**Question:1** Solve each of the following equations: $x^2+3=0$

**Answer:**

Given equation is

$x^2+3=0$

Now, we know that the roots of the quadratic equation is given by the formula

$$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

In this case value of **a = 1 , b = 0 and c = 3**

Therefore,

$$\frac{-0\pm\sqrt{0^2-4.1.(3)}}{2.1}=\frac{\pm\sqrt{-12}}{2}=\frac{\pm2\sqrt{3}i}{2}=\pm\sqrt{3}i$$

Therefore, the solutions of requires equation are $\pm\sqrt{3}i$

**Question:2** Solve each of the following equations: $2x^2+x+1=0$

**Answer:**

Given equation is

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

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

In this case value of **a = 2 , b = 1 and c = 1**

Therefore,

$$\frac{-1\pm\sqrt{1^2-4.2.1}}{2.2}=\frac{-1\pm\sqrt{1-8}}{4}=\frac{-1\pm\sqrt{-7}}{4}=\frac{-1\pm\sqrt{7}i}{4}$$

Therefore, the solutions of requires equation are

$$\frac{-1\pm\sqrt{7}i}{4}$$

**Question:3** Solve each of the following equations: $x^2+3x+9=0$

**Answer:**

Given equation is

$x^2+3x+9=0$

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

In this case value of **a = 1 , b = 3 and c = 9**

Therefore,

$$\frac{-3\pm\sqrt{3^2-4.1.9}}{2.1}=\frac{-3\pm\sqrt{9-36}}{2}=\frac{-3\pm\sqrt{-27}}{2}=\frac{-3\pm3\sqrt{3}i}{2}$$

Therefore, the solutions of requires equation are

$$\frac{-3\pm3\sqrt{3}i}{2}$$

**Question:4** Solve each of the following equations: $-x^2+x-2=0$

**Answer:**

Given equation is

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

Now, we know that the roots of the quadratic equation is given by the formula

$$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

In this case value of **a = -1 , b = 1 and c = -2**

Therefore,

Therefore, the solutions of equation are

$$\frac{-1 \pm \sqrt{7}i}{-2}$$

**Question:5** Solve each of the following equations: $x^2 + 3x + 5 = 0$

**Answer:**

Given equation is

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

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case value of **a = 1 , b = 3 and c = 5**

Therefore,

$$\frac{-3 \pm \sqrt{3^2 - 4.1.5}}{2.1} = \frac{-3 \pm \sqrt{9 - 20}}{2} = \frac{-3 \pm \sqrt{-11}}{2} = \frac{-3 \pm \sqrt{11}i}{2}$$

Therefore, the solutions of the equation are $\frac{-3 \pm \sqrt{11}i}{2}$

**Question:6** Solve each of the following equations: $x^2 - x + 2 = 0$

**Answer:**

Given equation is

$x^2 - x + 2 = 0$

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case value of **a = 1 , b = -1 and c = 2**

Therefore,

Therefore, the solutions of equation are $\frac{1 \pm \sqrt{7}i}{2}$

**Question:7** Solve each of the following equations: $\sqrt{2}x^2 + x + \sqrt{2} = 0$

**Answer:**

Given equation is

$\sqrt{2}x^2 + x + \sqrt{2} = 0$

Now, we know that the roots of the quadratic equation is given by the formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case the value of $a = \sqrt{2}, b = 1 \ and \ c = \sqrt{2}$

Therefore,

Therefore, the solutions of the equation are $\frac{-1 \pm \sqrt{7}i}{2\sqrt{2}}$

**Question:8** Solve each of the following equations: $\sqrt{3}x^2 - \sqrt{2}x + 3\sqrt{3} = 0$

**Answer:**

Given equation is

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

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case the value of $a = \sqrt{3}, b = -\sqrt{2}\ and\ c = 3\sqrt{3}$

Therefore,
$$= \frac{\sqrt{2} \pm \sqrt{34}i}{2\sqrt{3}}$$

Therefore, the solutions of the equation are $\dfrac{\sqrt{2} \pm \sqrt{34}i}{2\sqrt{3}}$

**Question:9** Solve each of the following equations: $x^2 + x + \dfrac{1}{\sqrt{2}} = 0$

**Answer:**

Given equation is
$$x^2 + x + \frac{1}{\sqrt{2}} = 0$$

Now, we know that the roots of the quadratic equation is given by the formula
$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case the value of $a = 1, b = 1\ and\ c = \dfrac{1}{\sqrt{2}}$

Therefore,
$$\frac{-1 \pm \sqrt{1^2 - 4.1.\frac{1}{\sqrt{2}}}}{2.1} = \frac{-1 \pm \sqrt{1 - 2\sqrt{2}}}{2} = \frac{-1 \pm \sqrt{-(2\sqrt{2} - 1)}}{2}$$
$$= \frac{-1 \pm \sqrt{(2\sqrt{2} - 1)}i}{2}$$

Therefore, the solutions of the equation are

$$\frac{-1 \pm \sqrt{(2\sqrt{2} - 1)}i}{2}$$

**Question:10** Solve each of the following equations:

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

**Answer:**

Given equation is

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

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case the value of $a = 1, b = \frac{1}{\sqrt{2}}\ and\ c = 1$

Therefore,

$$= \frac{-1 \pm \sqrt{7}i}{2\sqrt{2}}$$

Therefore, the solutions of the equation are

$$\frac{-1 \pm \sqrt{7}i}{2\sqrt{2}}$$

## NCERT solutions for class 11 maths chapter 5 Complex Numbers and Quadratic Equations-Miscellaneous Exercise

**Question:1** Evaluate $\left[i^{18} + \left(\frac{1}{i}\right)^{25}\right]^3$.

**Answer:**

The given problem is

$$\left[i^{18} + \left(\frac{1}{i}\right)^{25}\right]^3$$

Now, we will reduce it into

$= \left[1^4.(-1) + \frac{1}{1^6.i}\right]^3 \ (\because i^4 = 1, i^2 = -1)$

$= \left[-1 + \frac{1}{i}\right]^3$

$= \left[-1 + \frac{1}{i} \times \frac{i}{i}\right]^3$

$= \left[-1 + \frac{i}{i^2}\right]^3$

$= \left[-1 + \frac{i}{-1}\right]^3 = [-1-i]^3$

Now,

$-(1+i)^3 = -(1^3 + i^3 + 3.1^2.i + 3.1.i^2)$

$(using\ (a+b)^3 = a^3 + b^3 + 3.a^2.b + 3.a.b^2)$

$= -(1 - i + 3i + 3(-1))\ (\because i^3 = -i, i^2 = -1)$

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

$= 2 - 2i$

Therefore, answer is $2 - 2i$

**Question:2** For any two complex numbers $z_1$ and $z_2$, prove that $Re(z_1 z_2) = Re\ z_1\ Re\ z_2 - Imz_1\ Imz_2$

**Answer:**

Let two complex numbers are

$z_1 = x_1 + iy_1$

$z_2 = x_2 + iy_2$

Now,

$z_1.z_2 = (x_1 + iy_1).(x_2 + iy_2)$

$= x_1x_2 + ix_1y_2 + iy_1x_2 + i^2y_1y_2$

$= x_1x_2 + ix_1y_2 + iy_1x_2 - y_1y_2 (\because i^2 = -1)$

$= x_1x_2 - y_1y_2 + i(x_1y_2 + y_1x_2)$

$Re(z_1z_2) = x_1x_2 - y_1y_2$

$= Re(z_1z_2) - Im(z_1z_2)$

**Hence proved**

**Question:3** Reduce $\left(\frac{1}{1-4i} - \frac{2}{1+i}\right)\left(\frac{3-4i}{5+i}\right)$ to the standard form.

**Answer:**

Given problem is

$\left(\frac{1}{1-4i} - \frac{2}{1+i}\right)\left(\frac{3-4i}{5+i}\right)$

Now, we will reduce it into

$$= \left(\frac{1+i-2+8i}{1-4i+i-4i^2}\right)\left(\frac{3-4i}{5+i}\right)$$
$$= \left(\frac{-1+9i}{1-3i-4(-1)}\right)\left(\frac{3-4i}{5+i}\right)$$
$$= \left(\frac{-1+9i}{5-3i}\right)\left(\frac{3-4i}{5+i}\right)$$

Now, multiply numerator an denominator by $(14+5i)$

$$\Rightarrow \frac{33+31i}{2(14-5i)} \times \frac{14+5i}{14+5i}$$
$$\Rightarrow \frac{462+165i+434i+155i^2}{2(14^2-(5i)^2)} \quad (using\ (a-b)(a+b) = a^2 - b^2)$$

$$\Rightarrow \frac{462+599i-155}{2(196-25i^2)}$$
$$\Rightarrow \frac{307+599i}{2(196+25)} = \frac{307+599i}{2\times 221} = \frac{307+599i}{442} = \frac{307}{442} + i\frac{599}{442}$$

Therefore, answer is $\frac{307}{442} + i\frac{599}{442}$

**Question:4** If $x - iy = \sqrt{\frac{a-ib}{c-id}}$, prove that $(x^2+y^2)^2 = \frac{a^2+b^2}{c^2+d^2}$.

**Answer:**

the given problem is

$$x - iy = \sqrt{\frac{a-ib}{c-id}}$$

Now, multiply the numerator and denominator by

$$\sqrt{c+id}$$
$$x - iy = \sqrt{\frac{a-ib}{c-id} \times \frac{c+id}{c+id}}$$
$$= \sqrt{\frac{(ac+bd)+i(ad-bc)}{c^2-i^2d^2}} = \sqrt{\frac{(ac+bd)+i(ad-bc)}{c^2+d^2}}$$

Now, square both the sides

$$(x-iy)^2 = \left(\sqrt{\frac{(ac+bd)+i(ad-bc)}{c^2+d^2}}\right)^2$$
$$= \frac{(ac+bd)+i(ad-bc)}{c^2+d^2}$$
$$x^2 - y^2 - 2ixy = \frac{(ac+bd)+i(ad-bc)}{c^2+d^2}$$

On comparing the real and imaginary part, we obtain

$$x^2 - y^2 = \frac{ac+bd}{c^2+d^2} \quad and \quad -2xy = \frac{ad-bc}{c^2+d^2} \qquad -(i)$$

Now,

$$(x^2+y^2)^2 = (x^2-y^2)^2 + 4x^2y^2$$
$$= \left(\frac{ac+bd}{c^2+d^2}\right)^2 + \left(\frac{ad-bc}{c^2+d^2}\right)^2 \qquad (using\ (i))$$
$$= \frac{a^2c^2+b^2d^2+2acbd+a^2d^2+b^2c^2-2adbc}{(c^2+d^2)^2}$$
$$= \frac{a^2c^2+b^2d^2+a^2d^2+b^2c^2}{(c^2+d^2)^2}$$
$$= \frac{a^2(c^2+d^2)+b^2(c^2+d^2)}{(c^2+d^2)^2}$$
$$= \frac{(a^2+b^2)(c^2+d^2)}{(c^2+d^2)^2}$$
$$= \frac{(a^2+b^2)}{(c^2+d^2)}$$

**Hence proved**

**Question:5(i)** Convert the following in the polar form:

$$\frac{1+7i}{(2-i)^2}$$

**Answer:**

Let

$$z = \frac{1+7i}{(2-i)^2} = \frac{1+7i}{4+i^2-4i} = \frac{1+7i}{4-1-4i} = \frac{1+7i}{3-4i}$$

Now, multiply the numerator and denominator by $3+4i$

$$\Rightarrow z=\frac{1+7i}{3-4i}\times\frac{3+4i}{3+4i}=\frac{3+4i+21i+28i^2}{3^2+4^2}=\frac{-25+25i}{25}=-1+i$$

Now,

let

$r\cos\theta=-1 \quad and \quad r\sin\theta=1$

On squaring both and then add

$r^2(\cos^2\theta+\sin^2\theta)=(-1)^2+1^2$

$r^2=2$

$r=\sqrt{2} \qquad\qquad (\because r>0)$

Now,

$\sqrt{2}\cos\theta=-1 \quad and \quad \sqrt{2}\sin\theta=1$

$\cos\theta=-\frac{1}{\sqrt{2}} \quad and \quad \sin\theta=\frac{1}{\sqrt{2}}$

Since the value of $\cos\theta$ is negative and $\sin\theta$ is positive this is the case in II quadrant

Therefore,

$$\begin{aligned}z&=r\cos\theta+ir\sin\theta\\&=\sqrt{2}\cos\frac{3\pi}{4}+i\sqrt{2}\sin\frac{3\pi}{4}\\&=\sqrt{2}\left(\cos\frac{3\pi}{4}+i\sin\frac{3\pi}{4}\right)\end{aligned}$$

Therefore, the required polar form is

$$\sqrt{2}\left(\cos\frac{3\pi}{4}+i\sin\frac{3\pi}{4}\right)$$

**Question:5(ii)** Convert the following in the polar form:

$$\frac{1+3i}{1-2i}$$

**Answer:**

Let
$$z = \frac{1+3i}{1-2i}$$

Now, multiply the numerator and denominator by $1+2i$
$$\Rightarrow z = \frac{1+3i}{1-2i} \times \frac{1+2i}{i+2i} = \frac{1+2i+3i-6}{1+4} = \frac{-5+5i}{5} = -1+i$$

Now,

let

$$r\cos\theta = -1 \quad and \quad r\sin\theta = 1$$

On squaring both and then add
$$r^2(\cos^2\theta + \sin^2\theta) = (-1)^2 + 1^2$$

$$r^2 = 2$$
$$r = \sqrt{2} \qquad\qquad (\because r > 0)$$

Now,
$$\sqrt{2}\cos\theta = -1 \quad and \quad \sqrt{2}\sin\theta = 1$$
$$\cos\theta = -\frac{1}{\sqrt{2}} \quad and \quad \sin\theta = \frac{1}{\sqrt{2}}$$

Since the value of $\cos\theta$ is negative and $\sin\theta$ is positive this is the case in II quadrant

Therefore,

$$z = r\cos\theta + ir\sin\theta$$
$$= \sqrt{2}\cos\frac{3\pi}{4} + i\sqrt{2}\sin\frac{3\pi}{4}$$
$$= \sqrt{2}\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$$

Therefore, the required polar form is

$$\sqrt{2}\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$$

**Question:6** Solve each of the equation: $3x^2 - 4x + \frac{20}{3} = 0$

**Answer:**

Given equation is
$3x^2 - 4x + \frac{20}{3} = 0$

Now, we know that the roots of the quadratic equation are given by the formula
$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

In this case the value of

$a = 3, b = -4 \ and \ c = \frac{20}{3}$

Therefore,
$$\frac{-(-4) \pm \sqrt{(-4)^2 - 4.3.\frac{20}{3}}}{2.3} = \frac{4 \pm \sqrt{16 - 80}}{6} = \frac{4 \pm \sqrt{-64}}{6} = \frac{4 \pm 8i}{6} = \frac{2}{3} \pm i\frac{4}{3}$$

Therefore, the solutions of requires equation are

$\frac{2}{3} \pm i\frac{4}{3}$

**Question:7** Solve each of the equation: $x^2 - 2x + \frac{3}{2} = 0$

**Answer:**

Given equation is
$x^2 - 2x + \frac{3}{2} = 0$

Now, we know that the roots of the quadratic equation are given by the formula
$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

In this case the value of $a = 1, b = -2 \ and \ c = \frac{3}{2}$

Therefore,
$$\frac{-(-2) \pm \sqrt{(-2)^2 - 4.1.\frac{3}{2}}}{2.1} = \frac{2 \pm \sqrt{4-6}}{2} = \frac{2 \pm \sqrt{-2}}{2} = \frac{2 \pm i\sqrt{2}}{2} = 1 \pm i\frac{\sqrt{2}}{2}$$

Therefore, the solutions of requires equation are

$$1 \pm i\frac{\sqrt{2}}{2}$$

**Question:8** Solve each of the equation: $27x^2 - 10x + 1 = 0$ **.**

**Answer:**

Given equation is

$$27x^2 - 10x + 1 = 0$$

Now, we know that the roots of the quadratic equation are given by the formula
$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

In this case the value of $a = 27, b = -10 \ and \ c = 1$

Therefore,
$$\frac{-(-10) \pm \sqrt{(-10)^2 - 4.27.1}}{2.27} = \frac{10 \pm \sqrt{100 - 108}}{54} = \frac{10 \pm \sqrt{-8}}{54}$$
$$= \frac{10 \pm i2\sqrt{2}}{54} = \frac{5}{27} \pm i\frac{\sqrt{2}}{27}$$

Therefore, the solutions of requires equation are $\frac{5}{27} \pm i\frac{\sqrt{2}}{27}$

**Question:9** Solve each of the equation: $21x^2 - 28x + 10 = 0$

**Answer:**

Given equation is

$$21x^2 - 28x + 10 = 0$$

Now, we know that the roots of the quadratic equation are given by the formula

$$\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

In this case the value of $a = 21, b = -28 \ and \ c = 10$

Therefore,
$$\frac{-(-28) \pm \sqrt{(-28)^2-4.21.10}}{2.21} = \frac{28 \pm \sqrt{784-840}}{42} = \frac{28 \pm \sqrt{-56}}{42}$$
$$= \frac{28 \pm i2\sqrt{14}}{42} = \frac{2}{3} \pm i\frac{\sqrt{14}}{21}$$

Therefore, the solutions of requires equation are

$$\frac{2}{3} \pm i\frac{\sqrt{14}}{21}$$

**Question:10** If $z_1 = 2 - i, z_2 = 1 + i$, find $\left|\frac{z_1 + z_2 + 1}{z_1 - z_2 + 1}\right|$.

**Answer:**

It is given that

$z_1 = 2 - i, z_2 = 1 + i$

Then,

Now, multiply the numerator and denominator by $1 + i$

Now,
$$|1 + i| = \sqrt{1^2 + 1^2} = \sqrt{1+1} = \sqrt{2}$$

Therefore, the value of

$\left|\frac{z_1 + z_2 + 1}{z_1 - z_2 + 1}\right|$ is $\sqrt{2}$

**Question:11** If $a + ib = \frac{(x+i)^2}{2x^2+1}$, prove that $a^2 + b^2 = \frac{(x^2+1)^2}{(2x^2+1)^2}$.

**Answer:**

It is given that

$$a + ib = \frac{(x+i)^2}{2x^2+1}$$

Now, we will reduce it into

On comparing real and imaginary part. we will get

$$a = \frac{x^2-1}{2x^2+1} \ and \ b = \frac{2x}{2x^2+1}$$

Now,

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

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

$$= \frac{x^4+1+2x^2}{(2x^2+1)^2}$$

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

**Hence proved**

**Question:12(i)** Let $z_1 = 2 - i, z_2 = -2 + i.$ Find

$$Re\left(\frac{z_1 z_2}{\bar{z_1}}\right)$$

**Answer:**

It is given that

$$z_1 = 2 - i \ and \ z_2 = -2 + i$$

Now,

$z_1 z_2 = (2-i)(-2+i) = -4+2i+2i-i^2 = -4+4i+1 = -3+4i$

And

$\bar{z}_1 = 2+i$

Now,

$$= \frac{-2+11i}{5} = -\frac{2}{5} + i\frac{11}{5}$$

Now,

$$Re\left(\frac{z_1 z_2}{z_1}\right) = -\frac{2}{5}$$

Therefore, the answer is

$$-\frac{2}{5}$$

**Question:12(ii)** Let $z_1 = 2-i, z_2 = -2+i.$ Find

$$Im\left(\frac{1}{z_1 \bar{z_1}}\right)$$

**Answer:**

It is given that

$z_1 = 2-i$

Therefore,

$\bar{z}_1 = 2+i$

NOw,

$z_1 \bar{z}_1 = (2-i)(2+i) = 2^2 - i^2 = 4+1 = 5\,(using\ (a-b)(a+b) = a^2 - b^2)$

Now,

$$\frac{1}{z_1 \bar{z}_1} = \frac{1}{5}$$

Therefore,

$$Im\left(\frac{1}{z_1\bar{z}_1}\right) = 0$$

Therefore, the answer is **0**

**Question:13** Find the modulus and argument of the complex number $\frac{1+2i}{1-3i}$ .

**Answer:**

Let

$$z = \frac{1+2i}{1-3i}$$

Now, multiply the numerator and denominator by $(1+3i)$

$$= -\frac{1}{2} + i\frac{1}{2}$$

Therefore,

$$r\cos\theta = -\frac{1}{2} \quad and \quad r\sin\theta = \frac{1}{2}$$

Square and add both the sides

$$r^2\cos^2\theta + r^2\sin^2\theta = \left(-\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2$$

$$r^2(\cos^2\theta + \sin^2\theta) = \left(\frac{1}{4}\right) + \left(\frac{1}{4}\right)$$

$$r = \frac{1}{\sqrt{2}} \qquad (\because r > 0)$$

Therefore, the modulus is $\frac{1}{\sqrt{2}}$

Now,

$$\frac{1}{\sqrt{2}}\cos\theta = -\frac{1}{2} \quad and \quad \frac{1}{\sqrt{2}}\sin\theta = \frac{1}{2}$$

$$\cos\theta = -\frac{1}{\sqrt{2}} \quad and \quad \sin\theta = \frac{1}{\sqrt{2}}$$

Since the value of $\cos\theta$ is negative and the value of $\sin\theta$ is positive and we know that it is the case in II quadrant

Therefore,

Argument $= \left(\pi - \frac{\pi}{4}\right) = \frac{3\pi}{4}$

Therefore, Argument and modulus are $\frac{3\pi}{4} \quad and \quad \frac{1}{\sqrt{2}}$ respectively

**Question:14** Find the real numbers x andy if $(x - iy)(3 + 5i)$ is the conjugate of $-6 - 24i$ .

**Answer:**

Let

$z = (x - iy)(3 + 5i) = 3x + 5xi - 3yi - 5yi^2 = 3x + 5y + i(5x - 3y)$

Therefore,

$\bar{z} = (3x + 5y) - i(5x - 3y) \qquad\qquad - (i)$

Now, it is given that

$\bar{z} = -6 - 24i \qquad\qquad - (ii)$

Compare (i) and (ii) we will get

$(3x + 5y) - i(5x - 3y) = -6 - 24i$

On comparing real and imaginary part. we will get

$3x + 5y = -6 \quad and \quad 5x - 3y = 24$

On solving these we will get

$x = 3 \quad and \quad y = -3$

Therefore, the value of x and y are 3 and -3 respectively

**Question:15** Find the modulus of $\frac{1+i}{1-i} - \frac{1-i}{1+i}$ .

**Answer:**

Let

$z = \frac{1+i}{1-i} - \frac{1-i}{1+i}$

Now, we will reduce it into

$z = \frac{1+i}{1-i} - \frac{1-i}{1+i} = \frac{(1+i)^2 - (1-i)^2}{(1+i)(1-i)} = \frac{1^2 + i^2 + 2i - 1^2 - i^2 + 2i}{1^2 - i^2}$

$= \frac{4i}{1+1} = \frac{4i}{2} = 2i$

Now,

$r\cos\theta = 0 \quad and \quad r\sin\theta = 2$

square and add both the sides. we will get,

$r^2\cos^2\theta + r^2\sin^2\theta = 0^2 + 2^2$

$r^2(\cos^2\theta + \sin^2\theta) = 4$

$r^2 = 4 \qquad\qquad (\because \cos^2\theta + \sin^2\theta = 1)$

$r = 2 \qquad\qquad (\because r > 0)$

Therefore, modulus of

$\frac{1+i}{1-i} - \frac{1-i}{1+i}$ is **2**

**Question:16** If $(x+iy)^3 = u + iv$ , then show that $\frac{u}{x} + \frac{v}{y} = 4(x^2 - y^2)$.

**Answer:**

it is given that

$(x+iy)^3 = u + iv$

Now, expand the Left-hand side

$$x^3 + (iy)^3 + 3.(x)^2.iy + 3.x.(iy)^2 = u + iv$$

$$x^3 + i^3y^3 + 3x^2iy + 3xi^2y^2 = u + iv$$

$$x^3 - iy^3 + 3x^2iy - 3xy^2 = u + iv\,(\because i^3 = -i \quad and \quad i^2 = -1)$$

$$x^3 - 3xy^2 + i(3x^2y - y^3) = u + iv$$

On comparing real and imaginary part. we will get,

$$u = x^3 - 3xy^2 \quad and \quad v = 3x^2y - y^3$$

Now,

$$\frac{u}{x} + \frac{v}{y} = \frac{x(x^2 - 3y^2)}{x} + \frac{y(3x^2 - y^2)}{y}$$

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

$$= 4x^2 - 4y^2$$

$$= 4(x^2 - y^2)$$

**Hence proved**

**Question:17** If $\alpha$ and $\beta$ are different complex numbers with $|\beta| = 1$, then find $\left|\frac{\beta - \alpha}{1 - \bar{\alpha}\beta}\right|$.

**Answer:**

Let

$\alpha = a + ib$ and $\beta = x + iy$

It is given that

$$|\beta| = 1 \Rightarrow \sqrt{x^2 + y^2} = 1 \Rightarrow x^2 + y^2 = 1$$

and

$$\bar{\alpha} = a - ib$$

Now,

$$= \left|\frac{(x-a)+i(y-b)}{(1-ax-yb)-i(bx-ay)}\right|$$
$$= \frac{\sqrt{(x-a)^2+(y-b)^2}}{\sqrt{(1-ax-yb)^2+(bx-ay)^2}}$$
$$= \frac{\sqrt{x^2+a^2-2xa+y^2+b^2-yb}}{\sqrt{1+a^2x^2+b^2y^2-2ax+2abxy-by+b^2x^2+a^2y^2-2abxy}}$$
$$= \frac{\sqrt{(x^2+y^2)+a^2-2xa+b^2-yb}}{\sqrt{1+a^2(x^2+y^2)+b^2(x^2+y^2)-2ax+2abxy-by-2abxy}}$$
$$= \frac{\sqrt{1+a^2-2xa+b^2-yb}}{\sqrt{1+a^2+b^2-2ax-by}} (\because x^2+y^2=1 \ given)$$
$$= 1$$

Therefore, value of $\left|\frac{\beta-\alpha}{1-\bar{\alpha}\beta}\right|$ is **1**

**Question:18** Find the number of non-zero integral solutions of the equation $|1-i|^x = 2^x$.

**Answer:**

Given problem is
$$|1-i|^x = 2^x$$

Now,
$$(\sqrt{1^2+(-1)^2})^x = 2^x$$
$$(\sqrt{1+1})^x = 2^x$$
$$\left(\sqrt{2}\right)^x = 2^x$$
$$2^{\frac{x}{2}} = 2^x$$
$$\frac{x}{2} = x$$
$$\frac{x}{2} = 0$$

**x = 0** is the only possible solution to the given problem

Therefore, there are **0** number of non-zero integral solutions of the equation $|1-i|^x = 2^x$

**Question:19** If $(a+ib)(c+id)(e+if)(g+ih) = A+iB$, then show that $(a^2+b^2)(c^2+d^2)(e^2+f^2)(g^2+h^2) = A^2+B^2$

**Answer:**

It is given that

$(a+ib)(c+id)(e+if)(g+ih) = A+iB,$

Now, take mod on both sides

$|(a+ib)(c+id)(e+if)(g+ih)| = |A+iB|$

$|(a+ib)||(c+id)||(e+if)||(g+ih)| = |A+iB| (\because |z_1 z_2| = |z_1||z_2|)$

$(\sqrt{a^2+b^2})(\sqrt{c^2+d^2})(\sqrt{e^2+f^2})(\sqrt{g^2+h^2}) = (\sqrt{A^2+B^2})$

Square both the sides. we will get

$(a^2+b^2)(c^2+d^2)(e^2+f^2)(g^2+h^2) = (A^2+B^2)$

**Hence proved**

**Question:20** If $\left(\frac{1+i}{1-i}\right)^m = 1,$ then find the least positive integral value of $m$ .

**Answer:**

Let

$z = \left(\frac{1+i}{1-i}\right)^m$

Now, multiply both numerator and denominator by $(1+i)$

We will get,

$$z = \left(\frac{1+i}{1-i} \times \frac{1+i}{1+i}\right)^m$$

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

$$= \left(\frac{1^2 + i^2 + 2i}{1+1}\right)^m$$

$$= \left(\frac{1 - 1 + 2i}{2}\right)^m \quad (\because i^2 = -1)$$

$$= \left(\frac{2i}{2}\right)^m$$

$$= i^m$$

We know that $i^4 = 1$

Therefore, the least positive integral value of $m$ is **4**