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XII - Maths Complex Numbers

Simplify the following: Unit II English Medium.

$$\begin{array}{r} 102 \\ \times 11 \\ \hline \end{array}$$

- 1) Define Rectangular form of a complex number
- 2) Find the real number x and y , The complex number $(2+i)x + (1-i)y + 2i - 3$ and $x + (-1+2i)y + 1+i$ are equal.
- 3) $z_1 = 1-3i$, $z_2 = -4i$ and $z_3 = 5$ show that
 $(i) (z_1 + z_2) + z_3 = z_1 + (z_2 + z_3)$
- 4) If $z_1 = 3$, $z_2 = -7i$ and $z_3 = 5+4i$ show that $(z_1 + z_2)z_3 = z_1z_3 + z_2z_3$
- 5) A complex number z is purely imaginary if and only if $z = \bar{z}$
- 6) Simplify $\left(\frac{1+i}{1-i}\right)^3 - \left(\frac{1-i}{1+i}\right)^3$.
- 7) If $\frac{2+3}{z-5i} = \frac{1+4i}{2}$, find the complex number z .
- 8) Find z^{-1} if $z = (2+3i)(1-i)$
- 9) The complex numbers u, v, w are related $\frac{1}{u} = \frac{1}{v} + \frac{1}{w}$
 If $v = 3-4i$ and $w = 4+3i$. find u in Rectangular form.

Maths XII -
Complex Numbers
Unit II

1) $\sum_{n=1}^{102} i^n$ simplify:

$$\sum_{n=1}^{102} i^n = i^1 + i^2 + i^3 + i^4 + i^5 + i^6 + i^7 + i^8 + \dots + i^{97} + i^{98} + i^{99} + i^{100} + i^{101} + i^{102}$$

$$= i^1 + i^2 + i^3 + i^4 + i^1 + i^2 + i^3 + i^4 + \dots + i^1 + i^2 + i^3 + i^4 + i^1 + i^2 + i^3 + i^4 + i^{101} + i^{102}$$

$$\therefore i^1 + i^2 + i^3 + i^4 = i - 1 - i + 1 = 0$$

$$= i^1 + i^2 + i^3 + i^4 + i^4 [i^1 + i^2 + i^3 + i^4] + \dots + i^4 [i^1 + i^2 + i^3 + i^4] + i^{101} + i^{102}$$

$$= 0 + 4(0) + \dots + 4(0) + i^{101} + i^{102}$$

$$= i^{101} + i^{102}$$

$$= i^{[25 \times 4] + 1} + i^{(25 \times 4) + 2}$$

$$= (i^4)^{25} \cdot (i)^1 + [(i^4)^{25} \cdot (i)^2]$$

$$= (1)^{25} (i) + (1)^{25} (-1)$$

$$= i - 1$$

$$\boxed{\sum_{n=1}^{102} i^n = -1 + i}$$

2) Define Rectangular form of compound:

A complex number is in the form of $x + iy$ or $x + yi$ where the x and y are real numbers. x is the real part and y is the Imaginary Part of the

Complex number.

3) Find the real number of x and y

$$z_1 = (2+i)x + (1-i)y + 2i - 3$$

$$z_2 = x + (-1+2i)y + 1+i$$

$$z_1 = (2+i)x + (1-i)y + 2i - 3$$

$$= 2x + ix + y - iy + 2i - 3$$

$$z_1 = (2x + y - 3) + (x - y + 2)i$$

$$z_2 = x + (-1+2i)y + 1+i$$

$$= x - y + 2yi + 1 + i$$

$$z_2 = (x - y + 1) + (1 + 2y)i$$

By the given $z_1 = z_2$

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

$$2x + y - 3 = x - y + 1$$

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

$$x + 2y - 4 = 0$$

$$x + 2y = 4 \rightarrow (1)$$

$$(x - y + 2)i = (1 + 2y)i$$

$$x - y + 2 - 1 - 2y = 0$$

$$x - 3y + 1 = 0$$

$$x - 3y = -1 \rightarrow (2)$$

From equ (1) and (2)

$$x + 2y = 4$$

$$x - 3y = -1$$

$$\begin{array}{r} (-) \quad (+) \quad (+) \\ \hline \end{array}$$

$$5y = 5$$

$$\boxed{y = 1}$$

x value sub in equ (1)

$$x + 2y = 4$$

$$x + 2 = 4$$

$$\boxed{x = 2}$$

4)

$$z_1 = 1 - 3i, z_2 = -4i, z_3 = 5 \quad (i) \quad (z_1 + z_2) + z_3 = z_1 + (z_2 + z_3)$$

LHS:-

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

$$\boxed{(z_1 + z_2) = 1 - 7i}$$

$$(z_1 + z_2) + z_3 = (1 - 7i) + 5$$

$$= 1 - 7i + 5$$

$$\boxed{(z_1 + z_2) + z_3 = 6 - 7i}$$

RHS:-

$$(z_2 + z_3) = -4i + 5$$

$$(z_2 + z_3) + z_1 = (-4i + 5) + (1 - 3i)$$

$$= -4i + 5 + 1 - 3i$$

$$(z_2 + z_3) + z_1 = 6 - 7i$$

$\therefore$ LHS = RHS Proved.

5). $z_1 = 3$ $z_2 = -7i$ $z_3 = 5+4i$ Show that $(z_1+z_2)z_3 = z_1z_3$

LHS:

$$(z_1+z_2) = (3-7i)$$

$$(z_1+z_2)(z_3) = (3-7i)(5+4i)$$

$$= 15 + 12i - 35i - 28(i)^2$$

$$= 15 + 12i - 35i + 28$$

$$(z_1+z_2)(z_3) = 43 - 23i$$

RHS:

$$z_1z_3 = 3 \times (5+4i) \quad z_2z_3 = -7i \times (5+4i)$$

$$z_1z_3 = 15 + 12i$$

$$z_2z_3 = -35i + 28$$

$$z_1z_3 + z_2z_3 = 15 + 12i - 35i + 28$$

$$z_1z_3 + z_2z_3 = 43 - 23i$$

$\therefore$ LHS = RHS Proved.

6)

A complex number z is purely imaginary if and only if $z = \bar{z}$

Let us consider $z = x+iy$

The given is $z = -\bar{z}$

$$(x+iy) = \overline{-(x+iy)}$$

$$(x+iy) = -(x-iy)$$

$$x+iy = -x+iy$$

$$x + iy + x - iy = 0$$

$$2x = 0$$

$$x = 0$$

∴ The z is an purely imaginary.

7) Simplify

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

$$\begin{aligned} \left(\frac{1+i}{1-i}\right)^3 &= \left(\frac{1+i}{1-i} \times \frac{1+i}{1+i}\right) = \frac{(1+i)^2}{(1-i)(1+i)} = \frac{1+i^2+2i}{(1)^2-(i)^2} = \frac{1-1+2i}{1+1} \\ &= \frac{2i}{2} = i \end{aligned}$$

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

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

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

$$\begin{aligned} \therefore \left(\frac{1+i}{1-i}\right)^3 - \left(\frac{1-i}{1+i}\right)^3 &= (i)^3 - (-i)^3 \\ &= (i)^3 + (i)^3 \\ &= -i - i \end{aligned}$$

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

$$8) \frac{z+3}{z-5i} = \frac{1+4i}{2}, \text{ find } z.$$

$$2(z+3) = (1+4i)(z-5i)$$

$$2z+6 = z-5i+4zi+20(i)^2$$

$$2z+6 = (1+4i)z-5i+20$$

$$2z(-1-4i)z = -5i+20-6$$

$$(2-1-4i)z = 14-5i$$

$$(1-4i)z = 14-5i$$

$$z = \frac{14-5i}{(1-4i)}$$

$$z = \frac{14-5i}{1-4i} \times \frac{1+4i}{1+4i} = \frac{(14-5i)(1+4i)}{(1)^2 - (4i)^2} = \frac{14+56i-5i+20}{1+16}$$

$$z = \frac{51i+34}{17}$$

$$z = \frac{51}{17}i + \frac{34}{17}$$

$$z = 2+3i$$

$$9) \text{ Find } z^{-1} \text{ if } z = (2+3i)(1-i)$$

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

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

$$= 2-2i+3i+3$$

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

$$z = 5+i$$

$$\frac{1}{z} = \frac{1}{5+i}$$

$$\frac{1}{5+i} = \frac{1}{(5+i)} \times \frac{(5-i)}{(5-i)} = \frac{(5-i)}{(25)+1} = \frac{5-i}{26}$$

$$\frac{1}{5+i} = \frac{5}{26} - i \frac{1}{26}$$

$$z^{-1} = \frac{5}{26} - i \frac{1}{26}$$

10) The complex numbers u, v, w are related $\frac{1}{u} = \frac{1}{v} + \frac{1}{w}$
If $v = 3-4i$ and $w = 4+3i$, find u in rectangular form.

$$\frac{1}{u} = \frac{1}{3-4i} + \frac{1}{4+3i}$$

$$\frac{1}{v} = \frac{1}{3-4i} \times \frac{3+4i}{3+4i} = \frac{3+4i}{(3)^2 - (4i)^2} = \frac{3+4i}{9-16(-1)} = \frac{3+4i}{9+16} = \frac{3+4i}{25}$$

$$\frac{1}{w} = \frac{1}{4+3i} \times \frac{4-3i}{4-3i} = \frac{4-3i}{(4)^2 - (3i)^2} = \frac{4-3i}{16+9} = \frac{4-3i}{25}$$

$$\frac{1}{u} = \frac{1}{v} + \frac{1}{w}$$

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

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

$$\frac{1}{u} = \frac{7+i}{25}$$

$$u = \frac{7+i}{7+i} \times \frac{7-i}{7-i}$$

$$u = \frac{25 \times (7-i)}{49+1}$$

$$u = \frac{175 - 25i}{50}$$

$$u = \frac{7}{50} - \frac{1}{50}i$$

$$u = \frac{1}{2}(7-2i)$$

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