COSMOS BOOKHIVE
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MATHEMATICS

CHAPTER WISE STUDY MATERIAL
EXAMPLES & MCQ'S WITH SOLUTIONS

FOR

NDA & CDS

MATHEMATICS

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COMPLEX NUMBERS

Important formulae and results essential for problems :

1. $\sqrt{-1}$ is not a real number.
2. $\sqrt{-1} = i$ i.e., $i^2 = -1$
3. $i^3 = i^2 i = -1, i^4 = (i^2)^2 = (-1)^2 = 1, i^5 = (i^2)^2 i$
   $= (-1)^2 . i = i$ etc.
4. If x and y are real numbers then x + iy is called a complex number. x is called the real part and y the imaginary part of x + iy if y = 0, number is called purely real and when x = 0, number is called purely imaginary.
5. If x + iy = a + ib, then x = a and y = b.
6. The complex number x – iy is called conjugate of the complex number x + iy.
7. Modulus of the complex number x + iy
   $= + \sqrt{x^2 + y^2}$ and is denoted by | x + iy |.
8. Argument or amplitude of the complex number x + iy :
   There is one and only one value of θ which satisfies the eq^n. $\cos\theta = \frac{x}{\sqrt{x^2+y^2}}$ and $\sin\theta = \frac{y}{\sqrt{x^2+y^2}}$ this value of θ is called argument or amplitude of x + iy.
   If $-\pi < \theta \le \pi$, this angle θ is called the principal value of argument or amplitude of the complex number x + iy.
9. Every complex number z = x + iy can always be put in the form r ($(\cos\theta + i\sin\theta)$, where r is the modulus and θ the argument. This form is called polar form or modulus amplitude form.
10. The cube roots of unity are $1, \omega, \omega^2$ where
    $\omega = -\frac{1+\sqrt{3}i}{2}$, $\omega^2 = \frac{-1-\sqrt{3}i}{2}$
11. $1 + \omega + \omega^2 = 0$ and $\omega^3 = 1$
12. If z_1, z_2 be two complex numbers
    (i) $|z_1 z_2| = |z_1||z_2|$
    (ii) $\left|\frac{z_1}{z_2}\right| = \frac{|z_1|}{|z_2|}$
    Where $(z_2) \neq 0$
    (iii) $|z^n| = |z|^n$
    (iv) $|z_1 + z_2| \le |z_1| + |z_2|$,
    (v) $|z_1 - z_2| \ge |z_1| - |z_2|$
13. $\arg.(z_1 z_2) = \arg. z_1 + \arg. z_2$.
    $\arg.\left(\frac{z_1}{z_2}\right) = \arg. z_1 - \arg. z_2$
14. (i) $\overline{z_1 z_2} = \overline{z_1}\ \overline{z_2}$
    (ii) $\left(\overline{\frac{z_1}{z_2}}\right) = \frac{z_1}{\overline{z_2}}$ (iii) $\overline{z^n} = \bar{z}^n$
    (iv) $z\bar{z} = |z|^2$ (v) $\overline{z_1 \pm z_2} = \overline{z_1} \pm \overline{z_2}$

Subjective Problems

1. Express $\left(\frac{1}{1-2i} + \frac{3}{1+i}\right)\left(\frac{3+4i}{2-4i}\right)$ in the form A + i B.

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

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

$$= \frac{4-5i}{(1-i-2i^2)} \cdot \frac{3+4i}{2-4i} = \frac{(4-5i)(3+4i)}{(3-i)(2-4i)}$$

$$= \frac{12+i-20i^2}{6-14i+4i^2} = \frac{32+i}{2-14i}$$

$$= \left(\frac{32+i}{2-14i}\right)\left(\frac{2+14i}{2+14i}\right)$$

$$= \frac{64+450i+14i^2}{2^2+14^2} = \frac{50+450i}{200}$$

$$= \frac{1}{4}+\frac{9}{4}i.$$

2. If $x = -2 - i\sqrt{3}$, find the value of y where $y = 2x^4 + 5x^3 + 7x^2 - x + 41$.

Sol. $\because\ x + 2 = -i\sqrt{3}$

$\therefore\ (x+2)^2 = -3\ \ \therefore\ x^2 + 4x + 7 = 0$ ..(1)

Now $y = 2x^4 + 5x^3 + 7x^2 - x + 4$.

$$= (2x^2 - 3x + 5)(x^2 + 4x + 7) + 6$$

$$= (2x^2 - 3x + 5)(0) + 6 = 6.$$

3. Find the principal value of the argument of $\frac{1+i}{1-\sqrt{3}i}$

Sol. Let. $z = \frac{1+i}{1-\sqrt{3}i} = \frac{(1+i)(1+\sqrt{3}i)}{(1-\sqrt{3}i)(1+\sqrt{3}i)}$

$$= \frac{1-\sqrt{3}+(1+\sqrt{3})i}{1+3}$$

$$= \frac{1-\sqrt{3}}{4}+\frac{1+\sqrt{3}}{4}i = x + iy\,(\text{say})$$

Now $\tan\theta = \left|\frac{y}{x}\right| = \left|\frac{1+\sqrt{3}}{1-\sqrt{3}}\right| = \frac{\sqrt{3}+1}{\sqrt{3}-1}$

$$= \frac{1+1\sqrt{3}}{1-1\sqrt{3}} = \tan(45°+30°) = \tan\frac{5\pi}{12}$$

$\therefore\ \theta = \frac{5\pi}{12}$

Since $\left(\frac{1-\sqrt{3}}{4}, \frac{1+\sqrt{3}}{4}\right)$ lies in the 2nd quadrant,

$\therefore$ arg. $z = \pi - \theta = \pi = \frac{5\pi}{12} = \frac{7\pi}{12}$

Principal value of arg. $z = \frac{7x}{12}$

4. Express $-1 + i\sqrt{3}$ in the form $r\,(\cos\theta + i\sin\theta)$

Sol. Let. $z = -1 + \sqrt{3}i$. Here. $x = -1,\ y = \sqrt{3}$

Now $r = |z| = \sqrt{(-1)^2 + (\sqrt{3})^2} = 2$

$\tan\theta = \left|\frac{y}{x}\right| = \left|\frac{\sqrt{3}}{-1}\right| = \sqrt{3}\ \ \therefore\ \theta = \frac{\pi}{3}$

Since $z = -1 + \sqrt{3}i$ lies in the 2nd quadrant,

$\therefore$ arg. $z = \pi - \theta = \pi - \frac{\pi}{3} = \frac{2\pi}{3}$

Now polar form of $z = r\,(\cos\theta + i\sin\theta)$

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

5. Find two complex numbers which satisfy the equations

$$3\left|\frac{z-12}{z-8i}\right| = 5 \text{ and } \left|\frac{z-4}{z-8}\right| = 1.$$

Sol. From the first equation, we have

$$3|z-12| = 5|z-8i|$$

or, $3|(x-12)+iy| = 5|x+i(y-8)|$

or, $9\left[(x-12)^2 + y^2\right| = 25|x^2 + (y-8)^2\big]$

or, $2x^2 + 2y^2 + 27x - 50y + 38 = 0$ ...(A)

From the second equation,

$$|z-4| = |z-8|$$

or, $|(x-4)+iy| = |(x-8)+iy|$

or, $(x-4)^2 + y^2 = (x-8)^2 + y^2$

or, $x = 6$ ...(B)

putting x = 6 in (A), we get y = 8, 17

Hence the tow complex numbers are $z_1=6+8i$, $z_2=6+17i$.

6. Find the smallest positive integer n for which

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

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

Now $\frac{(1+i)^n}{(1-i)}=(i)^n=1$

when n = 1, $i^n=i$

when n = 2, $i^n=i^2=-1$

when n = 3, $i^n=i^3=-i$

when n = 4, $i^n=i^4=1$

$\therefore$ least positive value of n = 4.

7. Show that a real vaule of x will satisfy the equation

$$\frac{1-ix}{1+ix}=a-ib \text{ if } a^2+b^2=1.$$

Sol. $\frac{1-ix}{1+ix}=a-ib$ or, $1-ix=a-ib+ix(a-ib).$

or, $1-a+ib=ix(1+a-ib)$

or, $ix=\frac{1-a+ib}{1+a-ib}=\frac{(1-a+ib)(1+a+ib)}{(1+a-ib)1+a+ib)}$

$$=\frac{(1-a^2-b^2)+i2b}{(1+a)^2+b^2}$$

$$=\frac{1-a^2-b^2}{(1+a)^2-b^2}+\frac{i2b}{(1+a)^2+b^2}$$

or, $x=\frac{2b}{(1+a)^2-b^2}-i\frac{1-a^2-b^2}{(1+a)^2+b^2}$ ...(i)

(dividng by (i))

For x to be real,

$$\frac{1-a^2-b^2}{(1+a)^2+b^2}=0 \text{ i.e., } a^2+b^2=1.$$

8. Find θ such that $\frac{3+2i\sin\theta}{1-2i\sin\theta}$ is (a) real (b) purely imaginary.

Sol.

Let $y=\frac{3+2i\sin\theta}{1-2i\sin\theta}=\frac{3+2i\sin\theta}{1-2i\sin\theta}\times\frac{1+2i\sin\theta}{1+2i\sin\theta}$

$$=\frac{3-4\sin^2\theta+8i\sin\theta}{1+4\sin^2\theta}$$

If y is real, than imaginary, part of y must vanish. Hence

$$8\sin\theta=0$$

or, $\sin\theta=0\Rightarrow\theta=n\pi, n=0,\pm1,\pm2,.....,$

If y is purely imaginary, than real part of y must vanish.

Hence $3-4\sin^2\theta=0$

or, $\sin\theta=\pm\frac{\sqrt{3}}{2}$

or, $\theta=n\pi\pm\frac{\pi}{3}$, n = 0, ± 1, ± 2.....

9. If $(x+iy)=\sqrt{\frac{a+ib}{c+id}}$ prove that

$(x^2+y^2)^2=\frac{a^2+b^2}{c^2+d^2}$.

Sol. Taking modulus, we get

$$\sqrt{x^2+y^2}=\sqrt{\frac{\sqrt{a^2+b^2}}{\sqrt{c^2+d^2}}}$$

or, $x^2+y^2=\frac{\sqrt{a^2+b^2}}{\sqrt{c^2+d^2}}$

or, $(x^2+y^2)=\frac{a^2+b^2}{c^2+d^2}$

10. Find the square root of –8 –6i.

Sol. Let $\sqrt{-8-6i}=x+iy$

Squaring, we get, $-8-6i=x^2+i^2y^2+2ixy$

or, $-8-6i=x^2+y^2+2ixy$

Equating real and imaginary parts, we get,

$x^2-y^2=-8$ ... (i)

and $2xy=-6$ ... (ii)

Now, $(x^2+y^2)^2=(x^2-y^2)^2+4x^2y^2$

$=(x^2-y^2)^2+(2xy)^2$

$=(-8)^2+(-6)^2$

$=100$

$\therefore$ $x^2+y^2=\pm10$

But x^2+y^2 cannot be negative,

$\therefore$ $x^2+y^2=10$ ...(iii)

Adding (i) and (iii), we get $2x^2=2$ or , $x^2=1$

$\therefore$ $x=\pm1$

Subtracting (i) from (iii), we get $2y^2=18$

or, $y^2 = 9 \quad \therefore \ y = \pm 3$

From (ii), xy is negative ; therefore, when x = 1, y = –3 and when x = –1, y =3

Now,

$\sqrt{-8-6i} = x+iy = 1-3i$ and $-1+3i = -(1-3i)$

Hence $\sqrt{-8-6i} = \pm(1-3i)$.

2nd Method : $\left[\frac{\text{Imaginary part}}{2} = 3 \text{ (numerically)}\right.$ factors of 3 are 1 and 3. Since real part is negative, therefore, we will take i with greater factor 3.$\left.\right]$

Sol. $-8-6i = 1^2 + (3i)^2 - 2.1.3i = (1-3i)^2$

$\therefore \ \sqrt{-8-6i = \pm(1-3i)}.$

11. Prove that

$$\left(\frac{\sqrt{3}+i}{2}\right)^6 + \left(\frac{i-\sqrt{3}}{2}\right)^6 = -2$$

Sol. $\because \ \frac{\sqrt{3}+i}{2} = -i\left(\frac{-1+\sqrt{3i}}{2}\right) = 1-\omega^2$

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

Hence, L.H.S $= (-i\omega)^6 + (-i\omega^2)^6$

$= i^6(\omega^6 + \omega^{12}) = (-1)(1+1)$

$= -2 = \text{R.H.S.}$

12. If w be an imaginary cube root of unity, prove that $(1-w+w^2)^5 + (1+w-w^2)^5 = 32$

Sol. $(1-w+w^2)^5 + (1+w-w^2)^5$

$= (1+w^2-w)^5 + (1+w-w^2)^5$

$= (-2w)^5 + (-2w^2)^5$

$\left[\because 1+w+w^2 = 0\right.$

$\left. \therefore \ 1+w = -w^2, 1+w^2 = -w\right]$

$= -32w^5 - 32w^{10}$

$= -32[w^2 + w]$

$\left[\because w^5 = w^2.w^3 = w^2; \ w^{10} = w(w^3)^3 = w\right]$

$= -32(-1) = 32.$

13. Show that

Sol. L.H.S. $(1-\omega)(1-\omega^2)(1-\omega^4)(1-\omega^5) = 9.$

$= (1-\omega)(1-\omega^2)(1-\omega^4)(1-\omega^5)$

$= (1-\omega)(1-\omega^2)(1-\omega^3.\omega)(1-\omega 3.\omega^2)$

$= (1-\omega)(1-\omega^2)(1-\omega)(1-\omega^2) \ [\because \omega^3 = 1]$

$= (1-\omega)^2(1-\omega^2)^2$

$= (1+\omega^2-2\omega)(1+\omega^4-2\omega^2)$

$= (-\omega-2\omega)(1+\omega-2\omega^2), \left[\because H\omega^2 = -\omega\right]$

$= (-3\omega)(-\omega^2-2\omega^2) = 9 \left[\because 1+\omega = -\omega^2\right]$

14. Show that

$x^3+y^3 = (x+y)(\omega x+\omega^2 y)(\omega^2 x+\omega y).$

Sol. R.H.S. $= (x+y)(\omega x+\omega^2 y)(\omega^2 x+\omega y)$

$= (x+y)\left[\omega^3 x^2 + (\omega^2+\omega^4)xy + \omega^3 y^2\right]$

$= (x+y)\left[x^2 + (\omega^2+\omega)xy + y^2\right]$

$= (x+y)+(x^2-xy+y^2) = x^3+y^3 = \text{L.H.S.}$

15. If $x = a+b$, $y = a\propto+\beta$ and $z = \alpha\beta = b\alpha$ where α and β are complex cube roots of unity, show that

$xyz = a^3+b^3$.

Sol. Let $\propto = \omega$ then $\beta = \omega^2$

Now $xyz = (a+b)(a\omega+b\omega^2)(a\omega^2+b\omega) = a^3+b^3$.

16. If $x = a+b, y = a\omega+b\omega^2, z = a\omega^2+b\omega$,

prove that $x^3+y^3+z^3 = 3(a^3+b^3)$,

Sol. Here

$x+y+z = (a+b)+(a\omega+b\omega^2)+(a\omega^2+b\omega)$

$= a(1+\omega+\omega^2)+b(1+\omega^2+\omega)$

$= a\times 0 + b\times 0 = 0 \qquad ...(i)$

Now $x^3+y^3+z^3-3xyz$

$(x+y+z)(x^2+y^2+z^2-xy-yz-zx) = 0$

[From (i)]

$\therefore \ x^3+y^3+z^3 = 3xyz = 3(a^3+b^3)$

17. If α, β are complex cube roots of unity, show that

(i) $1+\alpha^n+\beta^n = 3$, when $n = 3k$

(ii) $1+\alpha^n+\beta^n=0$, when $n \neq 3k$.

(iii) $\alpha^4+\beta^4+\alpha^{-1}\beta^{-1}=0$

Sol. (i) $1+\alpha^n+\beta^n=1+\omega^n+(\omega^2)^n$

$=1+\omega^3 k+\omega^{6k}$

$=1+(\omega)^{3k}+(\omega^3)^{2k}$

$=1+1k+2^{2k}=1+1+1=3$

(ii) If $n \neq 3k$, then let $n=3k+1$ or, $3k+2$

Case I : If $n=3k+1$, then

$1+\alpha^n+\beta^n=1+(\omega)^{3k+1}+(\omega^2)^{3k+1}$

$=1+(\omega^3)^k \times \omega+(\omega^3)^{2k} \times \omega^2$

$=1+\omega+\omega^2=0$

Case II : If $n=3k+2$, then $1+\alpha^n+\beta^n$

$=1+(\omega)^{3k+2}+(\omega^2)^{3k+2}$

$=1+(\omega^3)^k \times \omega^2+(\omega^3)^{2k} \times \omega^4$

$=1+\omega^2+\omega^4=1+\omega^2+\omega^3 \times \omega$

$=1+\omega^2+\omega=0$

(iii) $\alpha^4+\beta^4+\alpha^{-1}\beta^{-1}=\omega^4+(\omega^2)^4+(\omega)^{-1}(\omega^2)^{-1}$

$=\omega^4+\omega^8+\dfrac{1}{\omega.\omega^2}$

$=\omega+\omega^2+1=0$.

18. If p, q, r are positve integers, show that $x^{3p}+x^{3q+1}+x^{3r+2}$ is divisible by x^2+x+1.

Sol. When $x^2+x+1=0$, $x=\dfrac{-1 \pm \sqrt{3}i}{2}$

$=\omega$ or ω^2

Now when $x=\omega, x^{3p}+x^{3q+1}+x^{3r+2}$

$=\omega^{3p}+\omega^{3q+1}+\omega^{3r+2}$

$=1+\omega+\omega^2=0$

and when $x=\omega^2$, $x^{3p}+x^{3q+1}+x^{3r+2}$

$=\omega^{6p}+\omega^{6q+2}+\omega^{6r+4}$

$=1+\omega^2+\omega^4=1+\omega^2+\omega=0$

Hence $x^{3p}+x^{3q+1}+x^{3r+2}$ is divisible by x^2+x+1 .

19. Find real values of x and y for which the following equations are satisfied :—

(i) $\dfrac{(1+i)x-2i}{3+i}+\dfrac{(2-3i)y+i}{3-i}=i$

(ii) $(x+iy)(2-3i)=4+i$

(iii) $(3x-2iy)(2+i)^2=10(1+i)$

Sol. (i) $\dfrac{(1+i)x-2i}{3+i}+\dfrac{(2-3i)y+i}{3-i}=i$

or, $(1+i)(3-i)x-2i(3-i)+(2-3i)(3+i)$

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

or, $(4+2i)x-6i-2+(9-7i)y+3i-1=10i$

or, $(4x+9y-3)+i(2x-7y-3)=10i$

Equating real and imaginary parts, we get

$4x+9y-3=0$ ... (1)

$2x-7y-3=10$

or, $2x-7y-13=0$ ... (2)

Solving (1) and (2), we get $x=3, y=-1$.

(ii) $(x+iy)(2-3i)=4+i$

or, $(2x+3y)+i(-3x+2y)=4+i$

Equating real and imaginary parts, we get

$2x+3y=4, -3x+2y=1$

Solving these, we get $x=\dfrac{5}{13}$, $y=\dfrac{14}{13}$.

(iii) $(3x-2iy)(2+i)^2=10(1+i)$

or, $(3x-2iy)(3+4i)=10+10i$

or, $9x+8y+i(12x-6y)=10+10i$

Equating real and imaginary parts we get,

$9x+8y=10$ ...(i)

and $12x-6y=10$ ...(ii)

Solving (i) and (ii), we get $x=\dfrac{14}{15}, y=\dfrac{1}{5}$.

20. Show that the points on the Argand diagram representing the complex numbers.

$-4+3i, 2-3i, -i$ are collinear.

Sol. The points written as ordered pairs are A (– 4, 3) , B (2, – 3), C (0, – 1).

Area of $\Delta ABC=\dfrac{1}{2}[-4(-3+1)+2(-1-3)$

$+0(3+3)]=0$

Therefore the given points are collinear.

21. Find the region in the Argand diagram enclosed by

$3 \le (z-2i) \le 5$

Sol. Consider first $3 \le z-2i$

or, $z-2i \ge 3$

or, $x+(y-2)i \ge 3$

or, $|x+(y-2)i| \ge |3|$

or, $x^2+(y-2)^2 \ge 9$ ....(1)

Next consider $(z-2i) \le 5$

or, $x+(y-2)i \le 5$

or, $|x+(y-2)i| \le 5$

or, $x^2+(y-2)^2 \le 25$ ...(ii)

Hence the given relations enclosed the region bounded by two concentric circles whose centre is at (0, 2) and radii are 3 and 5.

22. If z_1, z_2, z_3 be the vertices of an equilateral triangle, show that $z_1^2+z_2^2+z_3^2 = z_1z_2+z_2z_3+z_3z_1$.

Sol. Let the equilateral triangle be ABC and let A, B, C represent complex numbers z_1, z_2 and z_3 respectively. Let middle point O of BC be taken as origin and OC and OA as x and y axes respectively. Let AB = BC = CA = 2a. Then co- ordinates of A, B, C ar $(0,\sqrt{3}a)(-a,0)$ and (a, 0).

Then $z_1 = 0+\sqrt{3}\,ai = \sqrt{3}\,ai, z_2 = -a+0i = a$

and $z_3 = a+0i = a$

Now L.H.S. $= z_1^2+z_2^2+z_3^2$

$= -3a^2+a^2+a^2 = -a^2$

R.H.S. $= z_1z_2+z_2z_3+z_3z_1$

$= -\sqrt{3}\,a^2i-a^2+\sqrt{3}\,a^2i = -a^2$

$\therefore$ L.H.S. = R.H.S.

Objective Question

1. If $z_1, z_2, z_3 \in C$, then

(A) $z_1+z_3 = z_2+z_3 \Rightarrow z_1 = -z_2$

(B) $z_1+z_3 = z_2+z_3 \Rightarrow -z_1 = z_2$

(C) $z_1+z_3 = z_2+z_3 \Rightarrow z_1 = z_2$

(D) None of these

2. If $z_1 = a+ib$ and $z_2 = c+id$ are complex number such that $|z_1| = |z_2| = 1$ and $\text{Re}(z_1\overline{z_2}) = 0$, then the pair of complex numbers $w_1 = a+ic$ and $w_2 = b+id$ satisfies.

(A) $|w_1| = 1$ (B) $|w_2| = 1$

(C) $\text{Re}(w_1\overline{w_2}) = 0$ (D) None of these

3. If a, b, c, and u, v, w are complex numbers representing the vertices of two triangles such that $c = (1-r)a+rb$ and $w = (1-r)u+rv$, where r is a complex number, then the two triangles.

(A) have the same area (B) are similar

(C) are congruent (D) None of these

4. If the complex numbers z_1, z_2, z_3 represent the vertices of an equilateral triangle such that $|z_1| = |z_2| = |z_3|$. Then $z_1+z_2+z_3 \ne 0$

(A) True (B) False

5. The points z_1, z_2, z_3, z_4 in the complex plane are the vertices of the parallelogram taken in order if and only if.

(A) $z_1+z_4 = z_2+z_3$ (B) $z_1+z_3 = z_2+z_4$

(C) $z_1+z_2 = z_3+z_4$ (D) None of these

6. The modulus of the sum of two complex numbers is.....the sum of their moduli

(A) never greater than

(B) greater than

(C) never less than

(D) greater than or equal to

7. The modulus of the difference of two complex numbers is.....the difference of their moduli

(A) never be greater than

(B) never be less than

(C) not equal to (D) less than

8. The modulus of the product of two complex numbers is equal to the ..... of their moduli

(A) sum (B) difference

(C) product (D) quotient

9. The amplitude of the product of two complex numbers is equal to the ..... of their amplitudes

(A) sum (B) difference

(C) product (D) quotient

10. The amplitude of the quotient of two complex numbers is equal to the .....of their amplitudes

(A) sum (B) difference

(C) product (D) quotient

11. What is the neutral element for addition in C ?
(A) (1, 0) (B) (0, 1)
(C) (0, 0) (D) (1, 1)

12. What is the additive inverse of complex number (a, b) ?
(A) (a, b) (B) (0, 0)
(C) (– a, b) (D) (–a, –b)

13. What is the neutral element for multiplication in C ?
(A) (0, 0) (B) (1, 0)
(C) (0, 1) (D) (1, 1)

14. What is that complex number α whose additive inverse is α itself ?
(A) 0 (B) 1
(C) – 1 (D) None of these

15. If z_1 and z_2 are any two complex numbers, then $R(z_1 + z_2)$ will be
(A) $> R(z_1) + R(z_2)$ (B) $= R(z_1) + R(z_2)$
(C) $< R(z_1) + R(z_2)$ (D) None of these

16. If z_1, z_2 are any two complex numbers, then $\overline{(z_1 - z_2)}$
(A) $> \bar{z}_1 - \bar{z}_2$ (B) $= \bar{z}_1 - \bar{z}_2$
(C) $< \bar{z}_1 - \bar{z}_2$ (D) None of these

17. If z is any complex number, then $\overline{(\bar{z})}$ will be
(A) $= \bar{z}$ (B) $= z$
(C) R (z) (D) $= 0$

18. If z_1, z_2, z_3 are purely real numbers, then $|z_1 + z_2 + z_3|$ will be
(A) $= |z_1| + |z_2| + |z_3|$ (B) $\le |z_1| + |z_2| + |z_3|$
(C) $\ge |z_1| + |z_2| + |z_3|$ (D) None of these

19. If z_1, z_2 are any two complex numbers, then $|z_1 - z_2|$
(A) $\le |z_1| - |z_2|$ (B) $= |z_1| - |z_2|$
(C) $\ge |z_1| - |z_2|$ (D) $\le |z_1| + |-z_2|$

20. If $|z| = r$ then what is the modulus of z^n, n being a positive integer ?
(A) r – n (B) r^n
(C) r/n (D) r + n

21. The amplitude of z + amplitude of $\bar{z}$ =....., where z and $\bar{z}$ are conjugate complex numbers
(A) π (B) 2π
(C) $n\pi$ (D) $2n\pi$

22. One of the values of $(\cos\theta + i\sin\theta)^n$ is $\cos n\theta + i \sin n\theta$, for all ..... values of n.
(A) positive integral (B) fractional
(C) negative integral
(D) positive of negative integral

23. The locus of $|z| = 1$ is
(A) straight line (B) circle
(C) ellipse (D) parabola

24. The locus of z, if $\left|\frac{z-1}{z-i}\right| = 1$ is
(A) straight line (B) circle
(C) ellipse (D) parabola

25. The locus z, if $\left|\frac{z-\alpha}{z-\beta}\right| = k$ is a
(A) straight line (B) circle
(C) ellipse (D) parabola

26. The locus of the point z which satisfies the equation arg. $z = \frac{\pi}{6}$ is
(A) circle (B) parabola
(C) hyperbola (D) None of these

27. The locus of the point z satisfying $\left|\frac{z-1}{z-2}\right| = 2$ is
(A) circle (B) straight line
(C) a pair of st. line (D) None of these

28. If z = x + iy and $\omega = \frac{1-iz}{z-i}$ then $|\omega| = 1$ implies that in the complex plane
(A) z lies on the imaginary axis
(B) z lies on the real axis
(C) z lies on the unity circle
(D) None of these

29. Let z = x + iy, then locus of z when $\frac{z+i}{z+2}$ is real is
(A) a straight line (B) circle
(C) parabola (D) ellipse

30. The inequality $|z-4| < |z-2|$ represents the region given by
(A) Re (z) > 0 (B) Re (z) > 0
(C) Re (z) > 3 (D) None of these

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