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4) Classification of number system

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    graph TD
      Number[Number] --> Real[Real number]
      Number --> Complex[Complex number]
      Real --> Rational[Rational]
      Real --> Irrational[Irrational]
      Complex --> PurelyReal[Purely real]
      Complex --> PurelyImaginary[Purely imaginary]
      Rational --> Integers[Integers]
      Rational --> Fraction[Fraction]
      Irrational --> Negative[Negative]
      Irrational --> Zero[Zero]
      Irrational --> Positive[Positive]
      Integers --> Prime[Prime]
      Integers --> Composite[Composite]
      Integers --> Neither[Neither prime nor composite]
      Fraction --> Proper[Proper]
      Fraction --> Improper[Improper]
      Fraction --> Mixed[Mixed]
      Fraction --> Decimal[Decimal]
      Fraction --> Finite[Finite]
      Fraction --> Infinite[Infinite]
  
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2) Tree diagram

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    graph TD
      40[40] --> 2[2]
      40 --> 5[5]
      2 --> 20[20]
      2 --> 10[10]
      5 --> 8[8]
      5 --> 4[4]
      20 --> 4[4]
      20 --> 5[5]
      10 --> 2[2]
      10 --> 5[5]
      8 --> 2[2]
      8 --> 4[4]
      4 --> 2[2]
      4 --> 2[2]
  
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3) $\sqrt{40} = 1 \times \sqrt{40} = 18 \times 90$
 $= 2 \times \sqrt{20} = 20 \times 20$
 $= 3 \times \sqrt{180} = 90 \times 18$
 $= 4 \times \sqrt{135} = 36 \times 15$
 $= 5 \times \sqrt{108} = 6 \times 90$
 $= 6 \times 90$
 $= 9 \times 60$
 $= 10 \times \sqrt{64} = 12 \times \sqrt{96}$
 $= 15 \times 96$

\therefore The prime factors are: 1, 2, 3, 4, 5, 6, 9, 10, 12, 15, 18, 20, 30, 36, 45, 60, 90, 108, 135, 180, 270, 360.

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4) GCD and LCM of 240 and 140:

240: $2 \mid 240$
 $2 \mid 120$
 $2 \mid 60$
 $2 \mid 30$
 $3 \mid 15$
 $5 \mid 5$

140: $2 \mid 140$
 $2 \mid 70$
 $5 \mid 35$
 $7 \mid 7$
 $7 \mid 1$

\therefore prime factorization of 240 = $2^4 \cdot 3 \cdot 5$

\therefore prime factorization of 140 = $2^2 \cdot 5 \cdot 7$

Therefore,
 $GCD = 2^2 \cdot 5 = 20$
 $LCM = 2^4 \cdot 3 \cdot 5 \cdot 7 = 1680$

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5) HCF and LCM of 42, 63, 140

$42 = 2 \times 3 \times 7$
 $63 = 3 \times 3 \times 7$
 $140 = 2 \times 2 \times 5 \times 7$

Therefore,
 $HCF = 7$, $LCM = 2^2 \cdot 3^2 \cdot 5 \cdot 7 = 1260$

6) Finding the LCM and HCF of $\frac{2}{3}, \frac{8}{9}, \frac{16}{81}, \frac{10}{27}$

Numerator side,
 $2 = 2^1$
 $8 = 2 \times 4 = 2 \times 2 \times 2 = 2^3$
 $16 = 2 \times 8 = 2 \times 2 \times 4 = 2 \times 2 \times 2 \times 2 = 2^4$
 $10 = 2 \times 5 = 2^1 \cdot 5^1$
 $\therefore LCM = 2^4 \cdot 5 = 80$
 $HCF = 2$

Denominator side,
 $3 = 3^1$
 $9 = 3 \times 3 = 3^2$
 $81 = 9 \times 9 = 3 \times 3 \times 3 \times 3 = 3^4$
 $27 = 3 \times 9 = 3 \times 3 \times 3 = 3^3$
 $\therefore HCF = 3$
 $LCM = 3^4 = 81$

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therefore, LCM of $\frac{2}{3}, \frac{8}{9}, \frac{16}{81}$ and $\frac{10}{27} = \frac{80}{3}$
 HCM of $\frac{2}{3}, \frac{8}{9}, \frac{16}{81}$ and $\frac{10}{27} = \frac{2}{81}$

8) Find the Modulus, Argument and Polar:

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

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

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

$$= \frac{1+2i\sqrt{3}+i^2 3}{1+3}$$

$$= \frac{1+2i\sqrt{3}-3}{4}$$

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

$$= -\frac{1}{2} + \frac{i\sqrt{3}}{2} \quad (x+iy); \text{ so, } x = -\frac{1}{2}, y = \frac{\sqrt{3}}{2}$$

Modulus $|z| = \sqrt{x^2+y^2}$
 $= \sqrt{\left(-\frac{1}{2}\right)^2 + \left(\frac{\sqrt{3}}{2}\right)^2}$
 $= \sqrt{\frac{1}{4} + \frac{3}{4}} = 1$

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Argument,
 $\theta = \tan^{-1}\left(\frac{y}{x}\right)$
 $= \tan^{-1}\left(\frac{\frac{\sqrt{3}}{2}}{-\frac{1}{2}}\right)$
 $= \tan^{-1}(-\sqrt{3})$
 $= \tan^{-1}(\sqrt{3})$
 $= 60^\circ$
 $= \pi - \frac{\pi}{3} = \frac{2\pi}{3}$

Polar form,
 $z = r(\cos \theta + i \sin \theta)$
 $= 1\left(\cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3}\right)$
 $= \cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3}$

Ans:

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8) Evaluate:
 $\sqrt{-16} \times \sqrt{-9}$
 $= i\sqrt{16} \times i\sqrt{9}$
 $= i \times 4 \times i \times 3$
 $= 8i^2$
 $= 8(-1)$
 $= -8$

9) Evaluate modulus and argument,
 $z = z^2$
 $= (2+i) - (2+i)^2$ [$z = 2+i$]
 $= 16+8i-2^2-2 \cdot 2 \cdot i + i^2$
 $= 16+8i-4-4i+1$
 $= 12+4i+1$
 $= 13+4i$
 so, $x=13, y=4$

therefore,
 Modulus $|z| = \sqrt{x^2+y^2}$
 $= \sqrt{13^2+4^2}$
 $= \sqrt{185}$

Argument,
 $\theta = \tan^{-1}\left(\frac{y}{x}\right)$
 $= \tan^{-1}\left(\frac{4}{13}\right)$

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10) Express $z = \pi(\cos \theta + i \sin \theta)$ from $1+i\sqrt{3}$
 so, $x=1, y=\sqrt{3}$

We know,
 $\theta = \tan^{-1}\left|\frac{y}{x}\right|$
 $= \tan^{-1}\left|\frac{\sqrt{3}}{1}\right|$
 $= \tan^{-1} \sqrt{3}$
 $= \tan^{-1} 60^\circ$
 $= \frac{\pi}{3}$

so, $z = \pi(\cos \theta + i \sin \theta)$
 $= 1\left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$

therefore from,
 form of $1+i\sqrt{3} = \left(\cos \frac{\pi}{3} + i \sin \frac{\pi}{3}\right)$