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"Finding the Roots of a Polynomial using info from DRS & RRT"

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Oct-25-2011

$$\boxed{f(x) = x^4 - x^3 - 9x^2 - 3x - 36}$$

find the roots or Zeros

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* DRS $\Rightarrow$ $\boxed{\text{1 +ve root}}$ ✓
$\boxed{\text{1 or 3 -ve roots}}$

* RRT $\Rightarrow$ $\boxed{\pm(1, 2, 3, 4, 6, 9, 12, 18, 36)}$

1°

$f(1) = 1 - 1 - 9 - 3 - 36 = -48$ NoGo!

$f(2) = 2^4 - 2^3 - 9 \cdot 2^2 - 6 - 36 = -70$ NoGo!

$f(3) = 81 - 27 - 81 - 9 - 36 = -72$

$f(4) = 256 - 64 - 144 - 12 - 36 = 0$ ← Bingo!

No need to look for +ve roots because from DRS there is only 1 +ve root.

$\boxed{x = 4}$ ← Zero

[2]

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$f(-1) = 1 + 1 - 9 + 3 - 36 = -46$ No Go!

$f(-2) = 16 + 8 - 36 + 6 - 36 = -42$ No Go!

$f(-3) = 81 + 27 - 81 + 9 - 36 = 0 \leftarrow$ Bingo!

Continue looking because from $\boxed{x = -3} \leftarrow$ Zero
DRS we could have 1 or 3 -ve roots --

$f(-4) = 256 + 64 - 144 + 12 - 36 = 152 \leftarrow$ No Go!

$f(-6) = 1296 + 216 - 324 + 18 - 36 = 1153 \leftarrow$ No Go!

$f(-9) = 6561 + 729 - 729 + 27 - 36 = 6552 \leftarrow$ No Go!

$f(-12) = 20736 + 1728 - 1296 + 36 - 36 = 21168 \leftarrow$ No Go!

$f(-18) = 104976 + 5832 - 2916 + 54 - 36 = 107910 \leftarrow$ No Go!

$f(-36) = 1679616 + 46656 - 11664 + 108 - 36 = 1714680$

$\uparrow$ No Go!

2° So far we got 2 roots $\longrightarrow \boxed{(x-4)(x+3)}$

find the rest by long division $= x^2 + 3x - 4x - 12$

$= \boxed{x^2 - x - 12}$

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3° long division:

$$\frac{f(x)}{(x^2-x-12)} = x^2+3$$

$$\begin{array}{l|l} \cancel{x^4}-\cancel{x^3}-9x^2-3x-36 & x^2-x-12 \\ \hline -(\cancel{x^4}-\cancel{x^3}-12x^2) & x^2+3 \\ \hline -9x^2+12x^2-3x-36 & \\ \hline 3x^2-3x-36 & \\ -(3x^2-3x-36) & \\ \hline 0 & \end{array}$$

answer

factor

$$\boxed{f(x) = (x+3)(x-4)(x-\sqrt{3}j)(x+\sqrt{3}j)}$$

roots

$$\boxed{\begin{array}{ll} x=3 & x=\sqrt{3}j \\ x=4 & x=-\sqrt{3}j \end{array}}$$

$$\therefore f(x) = (x^2-x-12)(x^2+3)$$

$$= (x-4)(x+3)\underbrace{(x^2+3)}_{\text{find zeros}}$$

zeros

4° $x^2+3=0 \longrightarrow x^2=-3 \longrightarrow \boxed{x} = \pm\sqrt{-3} = \boxed{\pm\sqrt{3}j}$

— the end