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

$\frac{\pm 1}{\pm 1}$ or $\frac{\pm 3}{\pm 1} = \pm 1$ or ± 3

possible rational zeros of P

$\frac{\text{Factor of constant term}}{\text{factor of leading coefficient}}$

$\frac{\pm 1, \pm 3}{\pm 1}$

(6) $Q(x) = x^4 - 3x^3 - 6x + 8$

$\frac{\pm 1 \pm 2 \pm 4 \pm 8}{\pm 1}$

possible rational zeros of Q

$\frac{P}{q}$ $\frac{\text{Factors of constant}}{\text{factors of Leading coefficient}}$

$\pm 1, \pm 2, \pm 4, \pm 8$

(7) $R(x) = 2x^5 + 3x^3 + 4x^2 - 8$

possible ration zeros of R

$\frac{P}{q}$ $\frac{\text{Factors of constant}}{\text{factors of Leading coefficient}}$ $\frac{\pm 1, \pm 2, \pm 4, \pm 8}{\pm 1, \pm 2}$

$\pm 1, \pm 2, \pm 4, \pm 8, \pm \frac{1}{2}$

(8) $S(x) = 6x^4 - x^2 + 2x + 12$

Possible Rational zeros of S

$\frac{P}{q}$ $\frac{\text{Factors of constant}}{\text{Factors of Leading Coefficient}}$ $\frac{\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 12}{\pm 1, \pm 2, \pm 3, \pm 6}$

$\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 12, \pm \frac{1}{6}, \pm \frac{1}{2}, \pm \frac{3}{2}, \pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{4}{3}$

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(9) $T(x) = 4x^4 - 2x^2 - 7$

Rational zero Factors of T are

$\frac{p}{q}$ $\frac{\text{Factors of constant term}}{\text{Factors of leading coefficient}}$ $\frac{\pm 1, \pm 7}{\pm 1, \pm 2, \pm 4}$

$\pm 1, \pm 7$

$\pm \frac{1}{2}, \pm \frac{7}{2}$

$\pm \frac{1}{4}, \pm \frac{7}{4}$

(10) $U(x) = 12x^5 + 6x^3 - 2x - 8$

Possible Rational zero Factors of U

$\frac{p}{q}$ $\frac{\text{Factors of constant}}{\text{Factors of leading coefficient}}$ $\frac{\pm 1, \pm 2, \pm 4, \pm 8}{\pm 1, \pm 2, \pm 3, \pm 4, \pm 6, \pm 12}$

$\pm 1, \pm 2, \pm 4, \pm 8$

$\pm \frac{1}{2}$, Duplicates

$\pm \frac{1}{3}, \pm \frac{2}{3}, \pm \frac{4}{3}, \pm \frac{8}{3}$

$\pm \frac{1}{4}$, Duplicates

$\pm \frac{1}{6}$, Duplicates

$\pm \frac{1}{12}$

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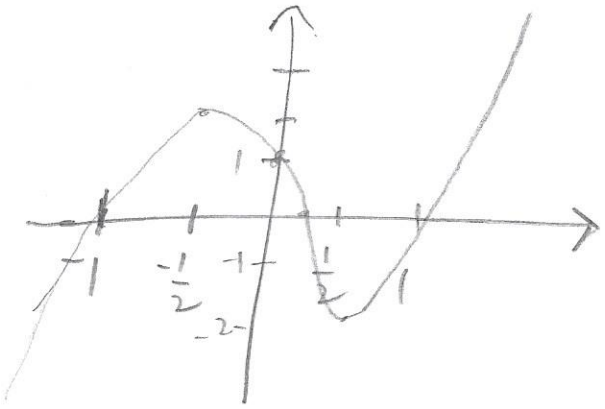
(11) $P(x) = 5x^3 - x^2 - 5x + 1$

Possible rational zeros of P

$\frac{p}{q}$ $\frac{\text{Constant factors}}{\text{Leading coefficient factors}}$ $\frac{\pm 1}{\pm 1 \cdot \pm 5}$

a) $\pm 1, \pm \frac{1}{5}$

b) $-1, \frac{1}{5}, 1$



(15) $x^3 + 3x^2 - 4 = P(x)$

possible zero factors of P

$\frac{p}{q}$ $\frac{\text{Factors of } a_0}{\text{Factor of } a_n}$ $\frac{\pm 1 \cdot \pm 4, \pm 2}{\pm 1}$

Possible
$\pm 1, \pm 4$

$P(x)$ has one variation in sign

$P(-x) = -x^3 + 3x^2 - 4$ has two variations in sign

∴ one pos zero & two neg zeros

1 | 1 3 0 -4
1 4 4
1 4 4 0 1 is a zero factor

4 | 1 3 0 -4
4 28
1 7 28 NOT

2 | 1 3 0 -4
2 5 10
1 5 5 6 NOT

-1 | 1 3 0 -4
-1 -2 2
1 2 -2 -2 NOT

-4 | 1 3 0 -4
-4 4 -16
1 -1 4 -20 NOT

-2 | 1 3 0 -4
-2 -2 4
1 1 -2 0 Yes

$P(x) = (x-1)(x+2)^2$

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(17) $P(x) = x^3 - 3x - 2$ one pos factor $\quad P(-x) = -x^3 + 3x - 2$ two neg factors or zero

$\frac{p}{q}$ $\frac{\pm 1, \pm 2}{\pm 1}$

$\pm 1, \pm 2$

$1 \mid 1 \;\; 0 \;\; -3 \;\; -2$ (1, 1, −2, −4 NO)

$-1 \mid 1 \;\; 0 \;\; -3 \;\; -2$ (1, −1, −2, 0 Factor)

$2 \mid 1 \;\; 0 \;\; -3 \;\; -2$ (1, 2, 1, 0 Factor)

$-2 \mid 1 \;\; 0 \;\; -3 \;\; -2$ (1, −2, 1, −4 NO)

$\boxed{P(x) = (x-2)(x+1)^2}$

(19) $P(x) = x^3 - 6x^2 + 12x - 8$ three sign changes 3 or 1 $\quad P(-x) = -x^3 - 6x - 12x - 8$ two sign changes 2 or 0

$\frac{p}{q}$ $\frac{\pm 1, \pm 2, \pm 4, \pm 8}{\pm 1}$ $\quad \pm 1, \pm 2, \pm 4, \pm 8$

$\boxed{P(x) = (x-2)^3}$

$1 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −5, 7 NO)

$-1 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −7, 19 NO)

$2 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −4, 4, 0 Yes)

$-2 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −8, 28 NO)

$4 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −2, −4 NO)

$-4 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −10, 52 NO)

$8 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −2, 28 NO)

$-8 \mid 1 \;\; -6 \;\; 12 \;\; -8$ (1, −14 NO)

$\boxed{P(x) = (x-2)^3}$