Precalculus
Polynomial inequalities

Todor Milev

2019

Outline

Example

Solve the inequality.

$$2x^2 + 3x - 5 \geq 0$$

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$$\begin{array}{rcl} 2x^2+3x-5 & \geq & 0 \\ (\mathbf{?} \qquad)(\mathbf{?} \qquad) & \geq & 0 \end{array}$$

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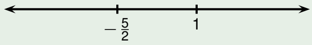

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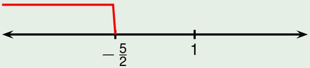

Interval	Factor signs	Final sign	
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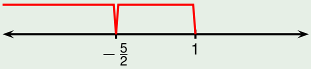

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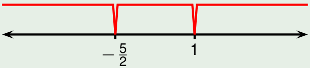

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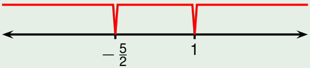

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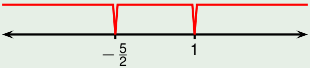

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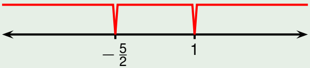

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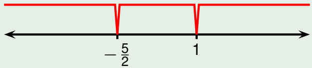

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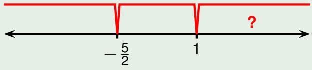

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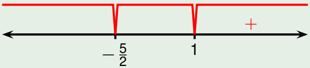

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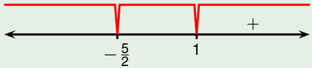

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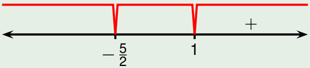

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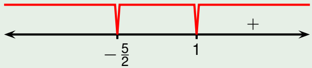

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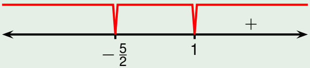

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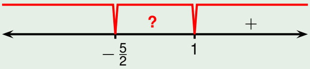

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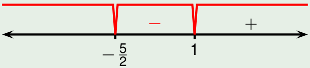

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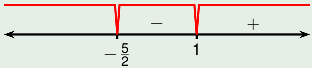

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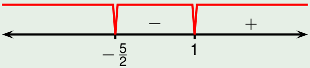

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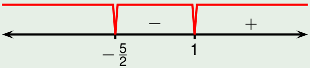

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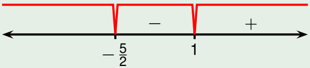

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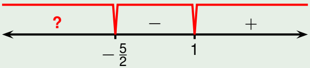

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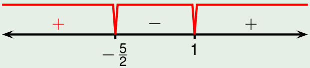

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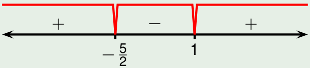

Interval	Factor signs	Final sign	Sample pt	Value at sample pt
$\left(-\infty,-\frac{5}{2}\right)$	$(-)(-)$	$+$	-100	$f(-100)>0$
$\left(-\frac{5}{2},1\right)$	$(+)(-)$	$-$	0	$f(0)=-5<0$
$(1,\infty)$	$(+)(+)$	$+$	100	$f(100)>0$

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$x \in \textbf{?}$

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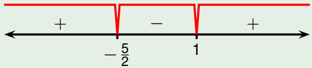

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$$\begin{aligned} 2x^2 + 3x - 5 &\geq 0 \\ (2x+5)(x-1) &\geq 0 \\ x \in \left(-\infty, -\tfrac{5}{2}\right] &\cup [1, \infty) \end{aligned}$$

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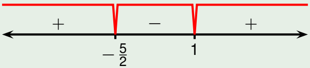

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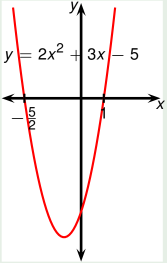

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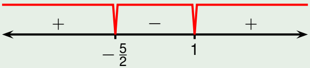

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Example

Plot the function $2x^3 - 5x^2 + x + 2$. Solve the inequality.

$$2x^3 - 5x^2 + x + 2 \quad > \quad 0$$

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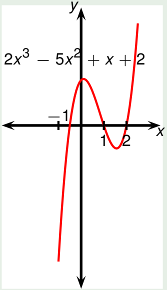
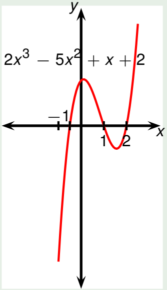


Plot the function $2x^3-5x^2+x+2$. Solve the inequality.

$$2x^3-5x^2+x+2 \quad > \quad 0$$

Example



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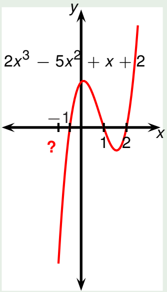
$$
\begin{array}{rcl}
2x^3 - 5x^2 + x + 2 & > & 0 \\
\textbf{?}\ (x - \quad\quad)(x - \quad)(x - \quad) & > & 0
\end{array}
$$

Example



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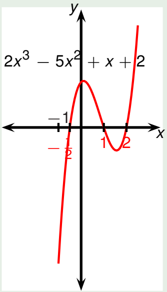
$$\begin{aligned} 2x^3 - 5x^2 + x + 2 &> 0 \\ \textbf{?}\left(x - \textbf{?} \qquad\right)(x - \textbf{?})(x - \textbf{?}) &> 0 \end{aligned}$$

Example

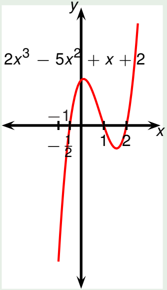


Plot the function $2x^3 - 5x^2 + x + 2$. Solve the inequality.

$$2x^3 - 5x^2 + x + 2 > 0$$

$$\textbf{?}\ \left(x - \left(-\tfrac{1}{2}\right)\right)(x-1)(x-2) > 0$$

Example



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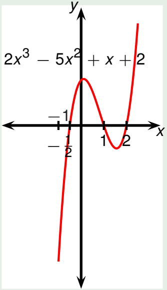
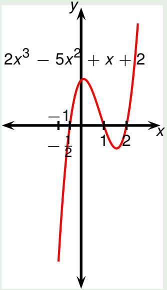


Plot the function $2x^3 - 5x^2 + x + 2$. Solve the inequality.

$$
\begin{aligned}
2x^3 - 5x^2 + x + 2 &> 0\\
2\left(x - \left(-\tfrac{1}{2}\right)\right)(x-1)(x-2) &> 0
\end{aligned}
$$

Example



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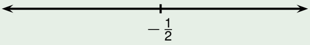
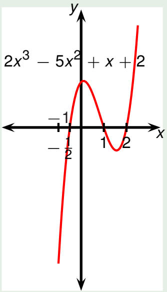
Left hand side vanishes when $x = -\frac{1}{2}$, when $x = 1$ and when $x = 2$.



Example



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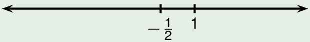
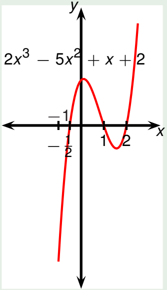


Example



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\begin{aligned}
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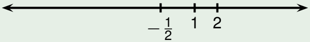
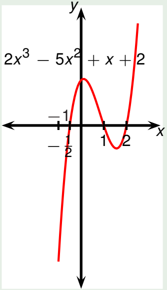


Example



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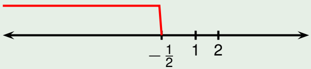
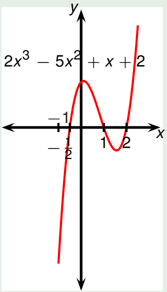
Left hand side vanishes when $x = -\frac{1}{2}$, when $x = 1$ and when $x = 2$. The two roots split the real line into four intervals: $\left(-\infty, -\frac{1}{2}\right), \left(-\frac{1}{2}, 1\right), (1, 2), (2, \infty)$.



Interval	Factor signs	Final sign from plot
$\left(-\infty, -\frac{1}{2}\right)$		

Example



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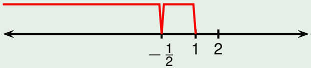
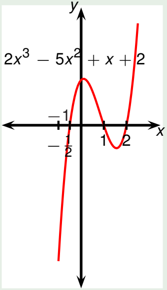


Interval	Factor signs	Final sign from plot
$\left(-\infty, -\frac{1}{2}\right)$		
$\left(-\frac{1}{2}, 1\right)$		

Example



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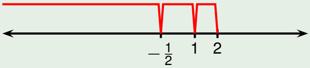

Interval	Factor signs	Final sign from plot
$\left(-\infty,-\frac{1}{2}\right)$		
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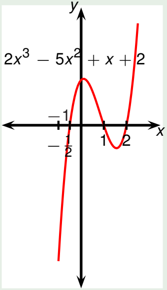
$(1,2)$		

Example



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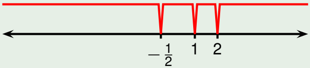

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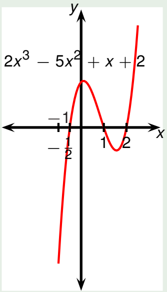
Example



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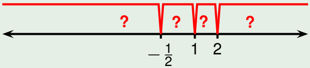
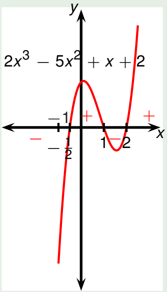


Interval	Factor signs	Final sign from plot
$\left(-\infty, -\frac{1}{2}\right)$	?	?
$\left(-\frac{1}{2}, 1\right)$	?	?
$(1, 2)$	?	?
$(2, \infty)$	?	?

Example



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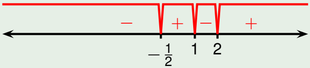
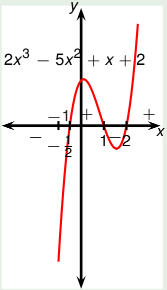


Interval	Factor signs	Final sign from plot
$\left(-\infty, -\frac{1}{2}\right)$	$(-)(-)(-)$	$-$
$\left(-\frac{1}{2}, 1\right)$	$(+)(-)(-)$	$+$
$(1, 2)$	$(+)(+)(-)$	$-$
$(2, \infty)$	$(+)(+)(+)$	$+$

Example



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$x \in$ **?**

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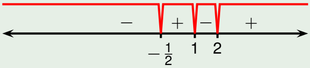

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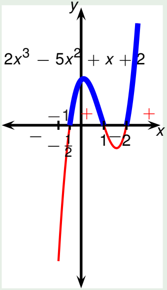
Example



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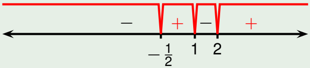

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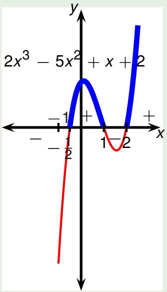

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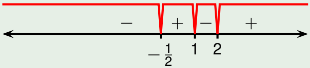

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