함수가 증가 또는 감소가 아니다.

(A function isn't increasing or decreasing.)

A function isn't increasing or decreasing.

Start

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Theorem

f isn’t increasing or decreasing on $[a, b]$.

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$\Leftrightarrow \exists\, x_1, x_2, x_3$

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$$\begin{aligned} &\neg\{f(x_1) < f(x_2) < f(x_3) \vee f(x_1) > f(x_2) > f(x_3)\} \\ &\Leftrightarrow \neg\{f(x_1) < f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) > f(x_3)\} \\ &\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\} \\ &\Leftrightarrow \{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\} \wedge \{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\} \\ &\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\} \\ &\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\} \end{aligned}$$

▸ Start

Theorem

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$$\Leftrightarrow \exists\, x_1,\, x_2,\, x_3 \in (a,b)\ s.t\,. \left[\begin{array}{l} x_1 < x_2 < x_3 \\ \quad and \\ f(x_2) \notin \left(\min\{(x_1),f(x_3)\}\,,\max\{f(x_1),f(x_3)\}\right) \end{array}\right]$$

$$\begin{aligned}
&\neg\{f(x_1) < f(x_2) < f(x_3) \vee f(x_1) > f(x_2) > f(x_3)\}\\
&\Leftrightarrow \neg\{f(x_1) < f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) > f(x_3)\}\\
&\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\}\\
&\Leftrightarrow \{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\} \wedge \{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\}\\
&\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\}\\
&\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\}\\
&\Leftrightarrow
\end{aligned}$$

Start

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&\Leftrightarrow \{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\} \wedge \{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\} \\
&\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\} \\
&\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\} \\
&\Leftrightarrow \{f(x_1) = f(x_2)\}
\end{aligned}$$

A function isn't increasing or decreasing.

▸ Start

Theorem

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$$\Leftrightarrow \exists\, x_1,\, x_2,\, x_3 \in (a,b) \ s.t\,. \left[\begin{array}{c} x_1 < x_2 < x_3 \\ and \\ f(x_2) \notin \left(\min\left\{(x_1), f(x_3)\right\}, \max\left\{f(x_1), f(x_3)\right\}\right) \end{array}\right]$$

$$\begin{aligned}
&\neg\left\{f(x_1) < f(x_2) < f(x_3) \vee f(x_1) > f(x_2) > f(x_3)\right\} \\
&\Leftrightarrow \neg\left\{f(x_1) < f(x_2) < f(x_3)\right\} \ \wedge \neg\left\{f(x_1) > f(x_2) > f(x_3)\right\} \\
&\Leftrightarrow \neg\left\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\right\} \ \wedge \neg\left\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\right\} \\
&\Leftrightarrow \ \left\{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\right\} \ \wedge \ \left\{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\right\} \\
&\Leftrightarrow \ \left\{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\right\} \ \vee \ \left\{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\right\} \\
&\qquad \vee \left\{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\right\} \ \vee \ \left\{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\right\} \\
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Start

Theorem

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&\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\} \\
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&\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\} \\
&\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\} \\
&\Leftrightarrow \{f(x_1) = f(x_2)\} \vee [f(x_2) \leq \min\{f(x_1), f(x_3)\}]
\end{aligned}$$

Start

Theorem

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&\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\} \\
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&\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\} \\
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&\qquad \vee
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Start

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$$\Leftrightarrow \neg\{f(x_1) < f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) > f(x_3)\}$$
$$\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) \ge f(x_2) \vee f(x_2) \ge f(x_3)\} \wedge \{f(x_1) \le f(x_2) \vee f(x_2) \le f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) \ge f(x_2) \wedge f(x_1) \le f(x_2)\} \vee \{f(x_1) \ge f(x_2) \wedge f(x_2) \le f(x_3)\}$$
$$\vee \{f(x_2) \ge f(x_3) \wedge f(x_1) \le f(x_2)\} \vee \{f(x_2) \ge f(x_3) \wedge f(x_2) \le f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) = f(x_2)\} \vee [f(x_2) \le \min\{f(x_1), f(x_3)\}]$$
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Start

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&\Leftrightarrow \{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\} \wedge \{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\} \\
&\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\} \\
&\qquad \vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\} \\
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Start

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$$\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\} \wedge \{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\}$$
$$\vee \{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\} \vee \{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) = f(x_2)\} \vee [f(x_2) \leq \min\{f(x_1), f(x_3)\}]$$
$$\vee [f(x_2) \geq \max\{f(x_1), f(x_3)\}] \vee \{f(x_2) = f(x_3)\}$$

Start

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$$\Leftrightarrow \neg\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\} \wedge \neg\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\}$$
$$\Leftrightarrow \{f(x_1) \ge f(x_2) \vee f(x_2) \ge f(x_3)\} \wedge \{f(x_1) \le f(x_2) \vee f(x_2) \le f(x_3)\}$$
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$$\vee \{f(x_2) \ge f(x_3) \wedge f(x_1) \le f(x_2)\} \vee \{f(x_2) \ge f(x_3) \wedge f(x_2) \le f(x_3)\}$$
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$$\vee [f(x_2) \ge \max\{f(x_1), f(x_3)\}] \vee \{f(x_2) = f(x_3)\}$$

$$\Leftrightarrow$$

Start

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$$\neg\left\{f(x_1) < f(x_2) < f(x_3) \vee f(x_1) > f(x_2) > f(x_3)\right\}$$
$$\Leftrightarrow \neg\left\{f(x_1) < f(x_2) < f(x_3)\right\} \wedge \neg\left\{f(x_1) > f(x_2) > f(x_3)\right\}$$
$$\Leftrightarrow \neg\left\{f(x_1) < f(x_2) \wedge f(x_2) < f(x_3)\right\} \wedge \neg\left\{f(x_1) > f(x_2) \wedge f(x_2) > f(x_3)\right\}$$
$$\Leftrightarrow \left\{f(x_1) \geq f(x_2) \vee f(x_2) \geq f(x_3)\right\} \wedge \left\{f(x_1) \leq f(x_2) \vee f(x_2) \leq f(x_3)\right\}$$
$$\Leftrightarrow \left\{f(x_1) \geq f(x_2) \wedge f(x_1) \leq f(x_2)\right\} \vee \left\{f(x_1) \geq f(x_2) \wedge f(x_2) \leq f(x_3)\right\}$$
$$\vee \left\{f(x_2) \geq f(x_3) \wedge f(x_1) \leq f(x_2)\right\} \vee \left\{f(x_2) \geq f(x_3) \wedge f(x_2) \leq f(x_3)\right\}$$
$$\Leftrightarrow \left\{f(x_1) = f(x_2)\right\} \vee \left[f(x_2) \leq \min\left\{f(x_1), f(x_3)\right\}\right]$$
$$\vee \left[f(x_2) \geq \max\left\{f(x_1), f(x_3)\right\}\right] \vee \left\{f(x_2) = f(x_3)\right\}$$
$$\Leftrightarrow f(x_2) \notin \left(\min\left\{(x_1), f(x_3)\right\}, \max\left\{f(x_1), f(x_3)\right\}\right)$$

Home

END