$$\lim_{x \to -1} \frac{x^3 - 4x^2 + x + 6}{2x^3 - 5x^2 - 22x - 15}$$

try plugging in $x = -1$

$\to \frac{0}{0}$

$\Rightarrow$ need to simplify

We know it's something like

$$\lim_{x \to -1} \frac{(x+1)(\quad\quad)}{(x+1)(\quad\quad)}$$

We just need to figure out what goes in those ( ).

Do either long division or synthetic division. (I'll do one of each.)

Long division (for numerator)

$$x+1 \overline{)\, x^3 - 4x^2 + x + 6}$$

$x^2 - 5x + 6$

$-(x^3 + x^2)$

$-5x^2 + x$

$-(-5x^2 - 5x)$

$6x + 6$

$-(6x + 6)$

0

Synthetic Division (for denominator)

$(2x^3 - 5x^2 - 22x - 15) \div (x+1)$

-1	2	-5	-22	-15
		-2	7	15
	2	-7	-15	0

$\Rightarrow 2x^3 - 5x^2 - 22x - 15 = (x+1)(2x^2 - 7x - 15)$

$$\Rightarrow \lim_{x \to -1} \frac{(x+1)(x^2-5x+6)}{(x+1)(2x^2-7x-15)}$$

$$= \lim_{x \to -1} \frac{x^2-5x+6}{2x^2-7x-15}$$

plug in $x=-1$ now

$$= \frac{(-1)^2 - 5(-1) + 6}{2(-1)^2 - 7(-1) - 15}$$

$$= \frac{1+5+6}{2+7-15} = \frac{12}{-6} = \boxed{-2}$$