

$V(x) = \begin{cases} 0, & x < 0 \\ V_0, & x \geq 0 \end{cases}$
 $\sigma_x \sigma_p \geq \frac{\hbar}{2}$
 $E = h\nu$
 $E = \frac{\hbar^2 k^2}{2m}$

$\psi_1(x) = \frac{1}{\sqrt{k_1}} (A_+ e^{ik_1 x} + A_- e^{-ik_1 x})$
 $x < 0$

$\psi_2(x) = \frac{1}{\sqrt{k_2}} (B_+ e^{ik_2 x} + B_- e^{-ik_2 x})$
 $x > 0$

$T|j, m\rangle \equiv |T(j, m)\rangle = (-1)^{j-m} |j, -m\rangle$

$i\hbar \frac{\partial}{\partial t} \Psi(r, t) = \hat{H} \Psi(r, t)$
 $|\Psi\rangle AB = \sum_{i,j} c_{ij} |i\rangle A \otimes |j\rangle B$

$P[a \leq X \leq b] = \int_a^b \int_{-\infty}^{\infty} W(x, p) dp dx$
 $H_n(x) = (-1)^n e^{x^2} \frac{d^n}{dx^n} (e^{-x^2})$

$\frac{\hbar^2}{2m} \frac{d^2 \Psi}{dx^2} = E \Psi$
 $\Psi(x) = A e^{ikx} + B e^{-ikx}$
 $U(t) = \exp(-\frac{iHt}{\hbar})$
 $i\hbar \frac{d}{dt} |\Psi(t)\rangle = H |\Psi(t)\rangle$
 $A(x) = \exp(\frac{1}{\hbar} \int X(t) dt)$

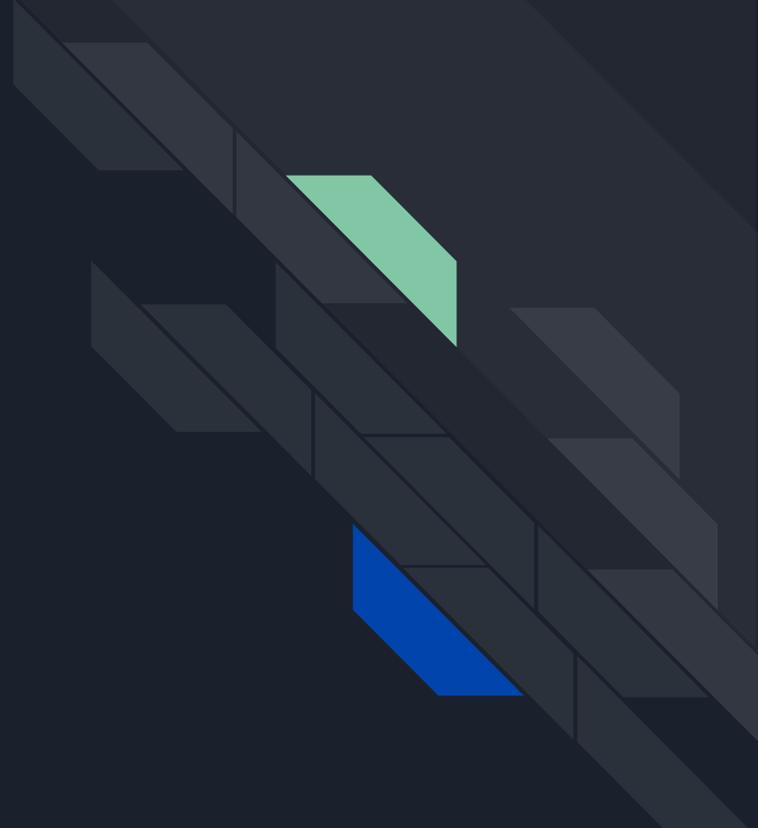
$P(a, b) = \int d\lambda \cdot \rho(\lambda) \cdot p_a(a, \lambda) \cdot p_b(b, \lambda)$

$W \rightarrow \frac{1}{(\pi \hbar)^3} \exp[-\alpha^2 (x - \frac{pt}{m})^2]$

Dynamic Partial Reconfigurable Calculator Module

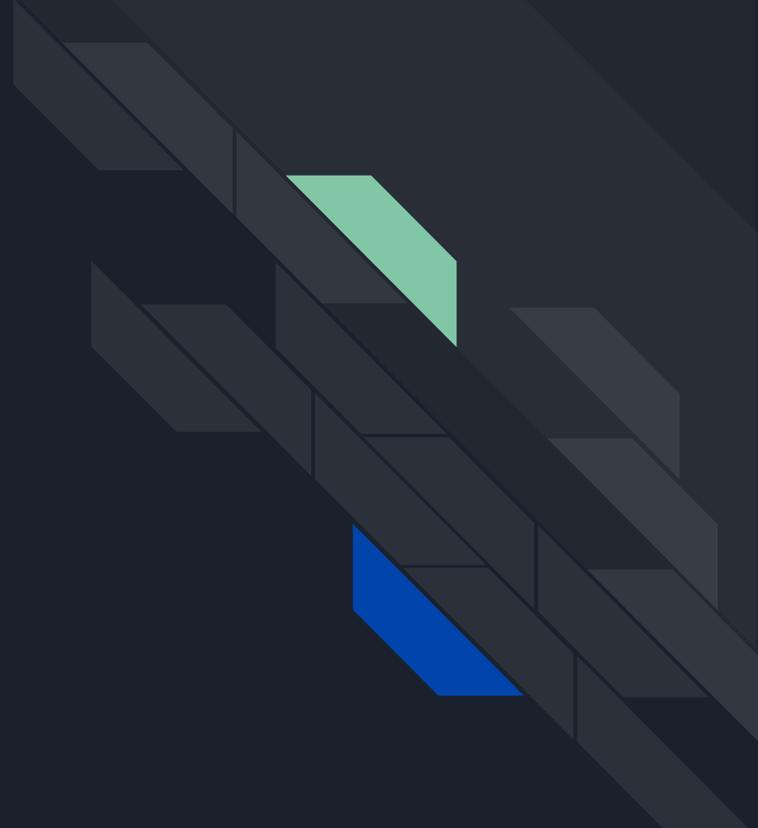
By Jeanne Beau and Zachary Martin

A DPR calculator design with a serial monitor based user interface to achieve a scalable arithmetic logic unit at a consistent size

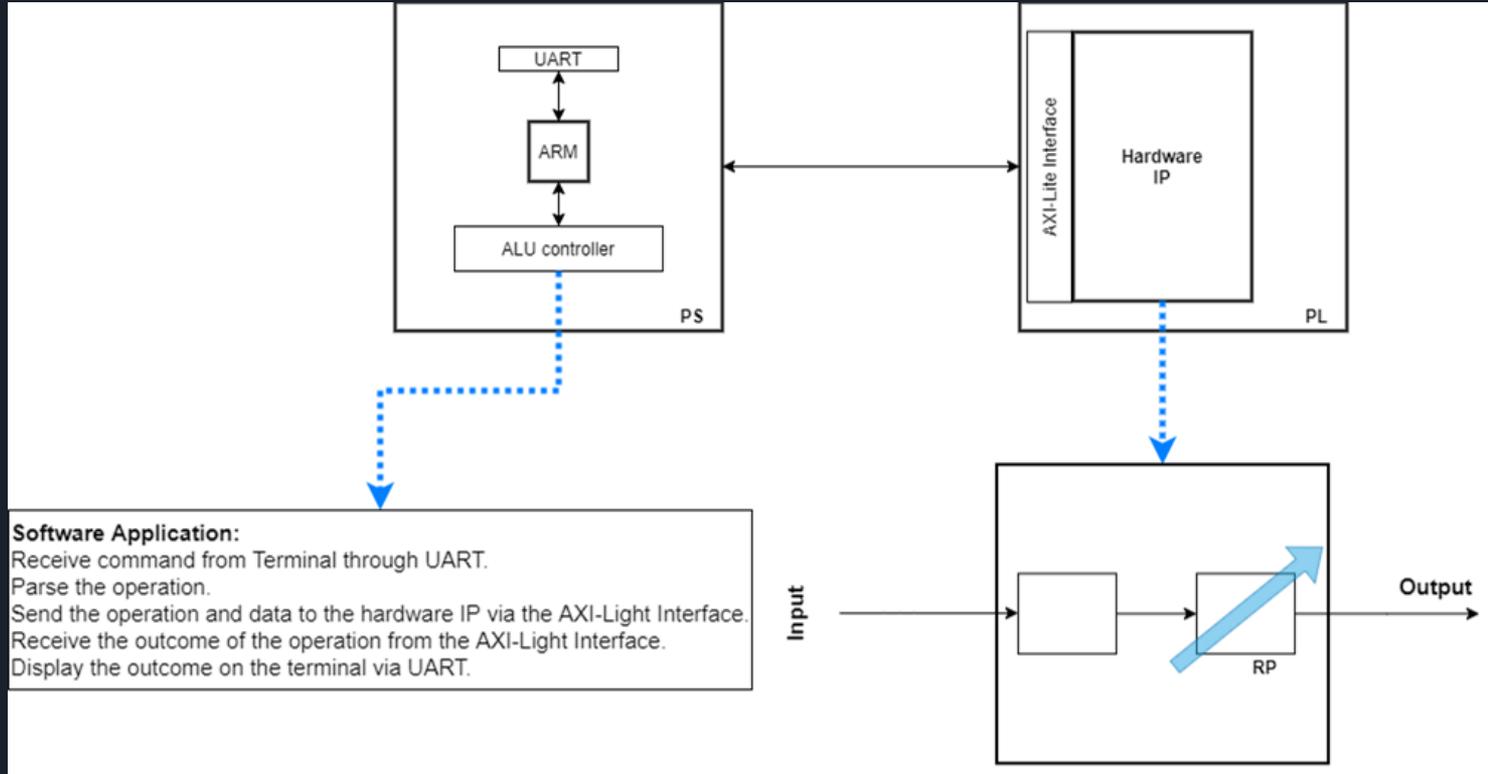


This system will:

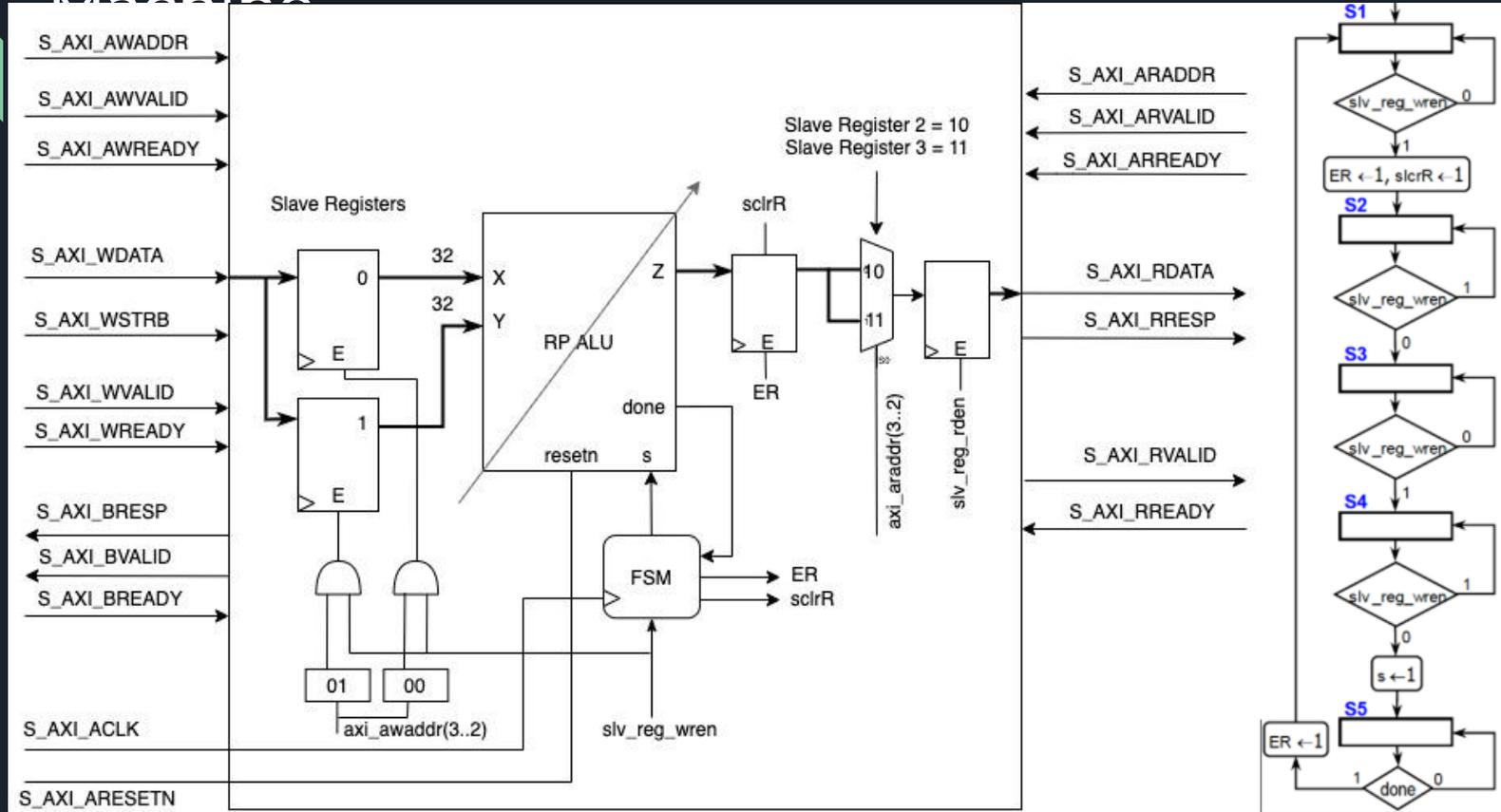
- Receive a selected operator and two operands from the user
- Reconfigure itself to perform the operation
- Display the result of the operation on a serial terminal.



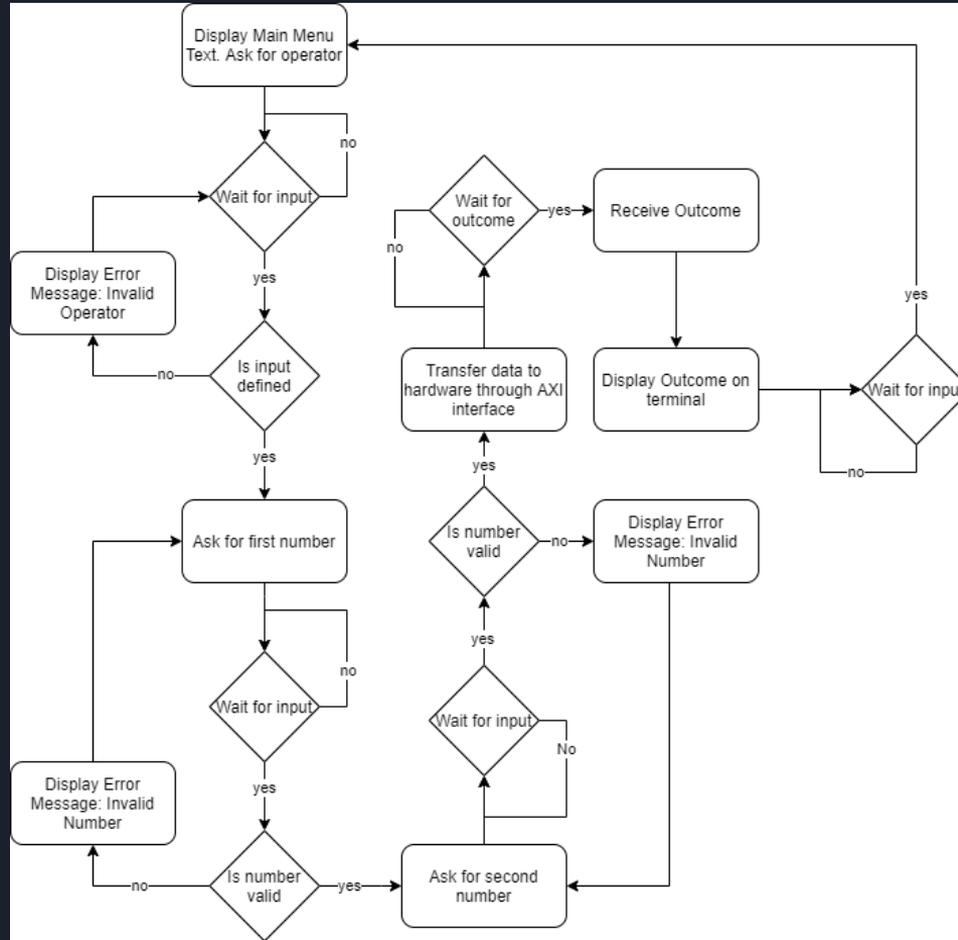
High-Level Architecture



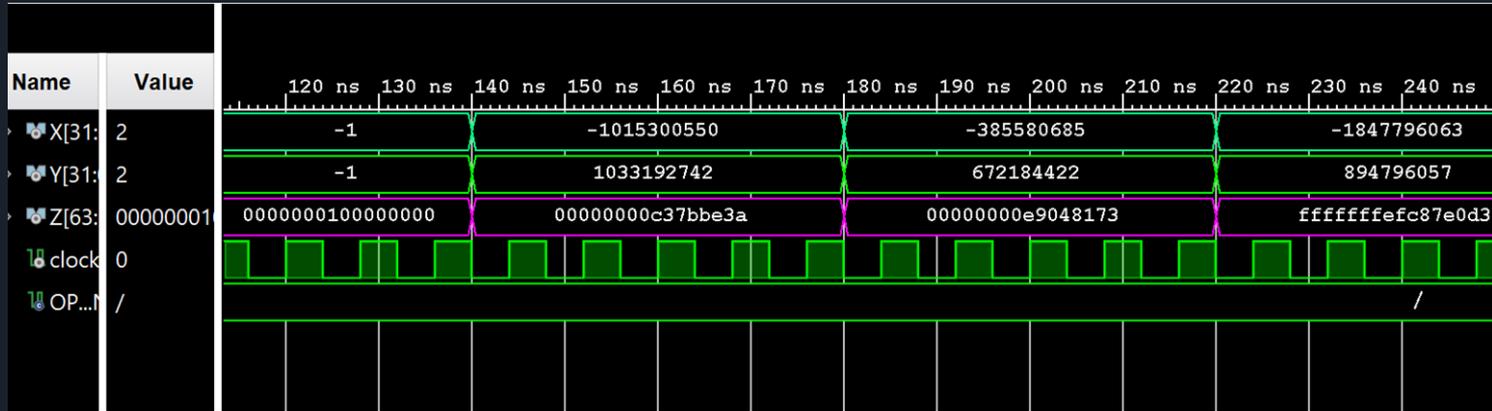
AXI4-Lite Datapath & State Machine



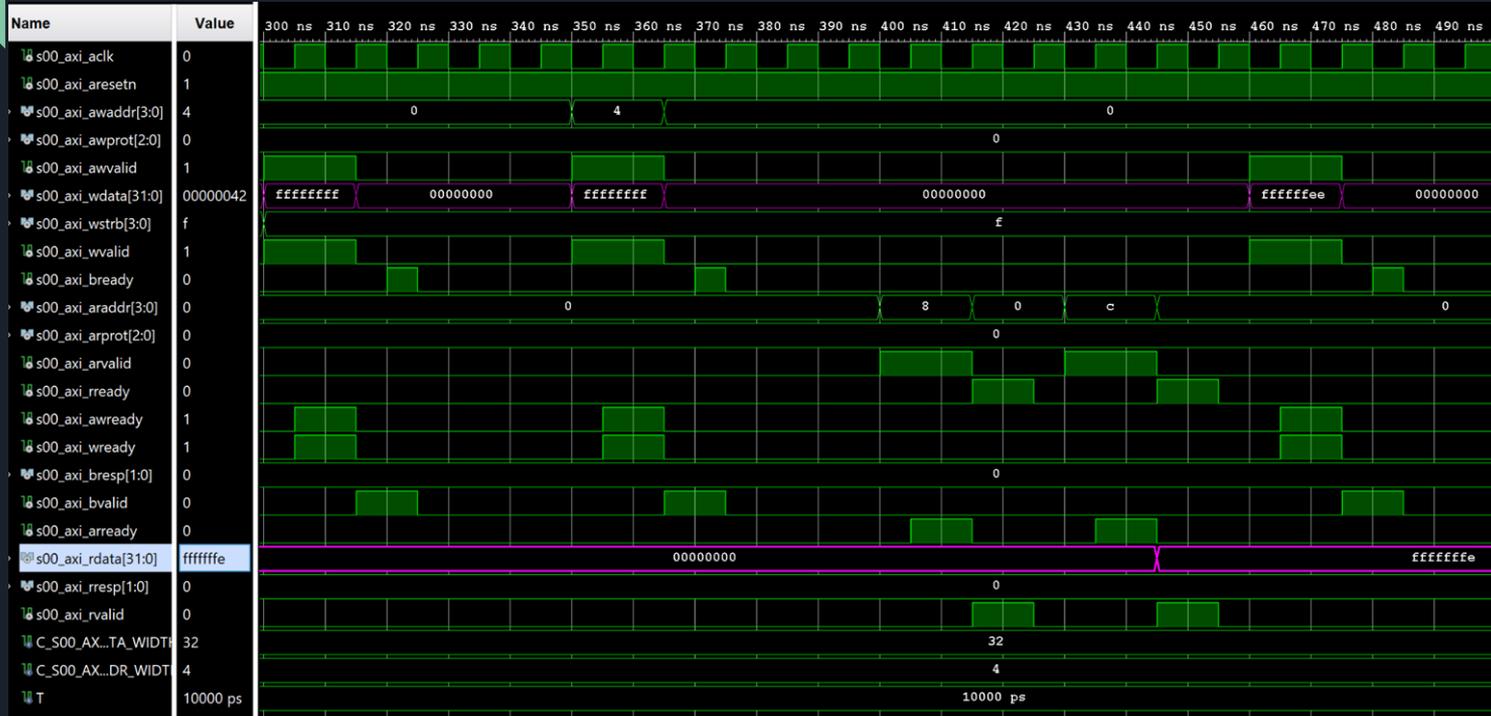
Software Control Logic



ALU Component - Division



ALU Axi4-Lite - Addition





DEMO





Revelations & Conclusion

- Design Flow - floor plan constraints
 - 1st iteration - created fplan with division RM and multiplication needed DSP48 cells
 - 2nd iteration - created fplan with multiplication and division needed a larger size (more carry cells)
 - Ended up drawing a much larger block which included DSP48 cells
 - This might not be ideal because the hardware requirements are significantly varied for multiplication and division.
- Division operation limitations
 - Division results were inconsistent in software testing. This was previously simulated successfully in Vivado.
 - Results were correct when the data was written a second time. We now do this as a work around.
 - We speculate that the number of clock cycles needed is unpredictable, not given enough time to complete the computation by the time we're ready to read the data.
 - The circuit is mostly combinational and we may be able to solve this with a more synchronous design, as discussed in a previous lecture about less clock cycles vs. combinational timing constraints.

$\lim_{n \rightarrow \infty} a_n = a_1 + \frac{1}{3} \cdot (n-1) = -4 + \frac{1}{3}n = a_n = 4\frac{1}{3} + \frac{1}{3}n$ $S_n = \frac{1}{3} \cdot \frac{n(n+1)}{2} = \frac{1}{6}n(n+1)$
 $a_n = a_1 + d(n-1)$ $f(x) = 13$ $S = 9M$ $f(x) = \frac{1}{x} + c = x$ $f(x) = 4x^2 - 6x$ $f(x) = 4 \cdot 2x - 6x - 8x = -6 \cdot 2 - 3x - 8$
 $a_n = -4 + \frac{1}{3}(n-1)$ $e_k = \frac{3n_0}{3n_0}$ $f(x) = \frac{1}{x} + c = x$ $S_2 = -3^2 - 3 \cdot 0 + 12 = 0$ $(-3)^2 - 4 = 9 - 4 = 5$
 $a_n = \frac{1}{3}$ $2 = 1 + 3 \cdot S$ $e_k = \frac{3n_0}{2 \cdot v}$ $5 \cdot 10^5$ $v = 0.75$ $\frac{1}{x} + c = x$ $p = 10^5 / 13 - 2 = 11 \cdot 2 = 24 - 3 = 21$
 $a = 16 = e = -2$ $2 \cdot 4 = 8 = 1 \cdot 4 - 2 \cdot 3 = 3^2$ $f(x) = \begin{cases} 5x + 1 & x > 1 \\ x^2 + 1 & x < 1 \end{cases}$ $\lim_{x \rightarrow 1} x = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $f(x) = 2x$
 $S = \lim_{a \rightarrow c} \frac{1}{a} \cdot (a - c) = c$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (x - x_0) = 0$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$

Questions?

$-3 \cdot 1 \cdot 3 \cdot f'(1) = 2 \cdot 1 \cdot x - 3 \cdot 1 \cdot 4$ $y = \sin(t) \cdot x$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $D = A \cdot B$ $(1, 1)$ $A \cdot B \cdot C \cdot D = A \cdot B \cdot C \cdot D$ $R = 1 - n - 5 = 3$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $3x_1 - x_2 - 5 - 2x_1 + 4x - 2x - 3 + 5 - 3 + 1 + 1 - 0 = 15$ $2x - 1 = 0$ $2x = 1$ $x = 0.5$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $x_3 = 1 - 2 = -1$ $3x_0 = 3 \cdot 0 = 0$ $5x_2 + 3 - 5 = 10 - 5x_2 + 0 = 5x_2 = 5$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $2x^2 - 4x - 1 = 3 + 3x^2 + 6x$ $2 \cdot 6^2 - 4 \cdot 6 - 1 = 3 + 3 \cdot 6^2 + 6 \cdot 6$ $2 \cdot 36 - 24 - 1 = 3 + 3 \cdot 36 + 36$ $72 - 25 = 47$ $3 + 3 \cdot 36 + 36 = 129$ $47 = 129$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $16x - 5 = 11 - 2 = 9$ $f(x) = \sin x + \cos x$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $\vec{r} = a\vec{i} - b\vec{j}$ $\vec{r} = x_1 + y_1 \vec{e} = m \vec{c}$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $y = \frac{x}{a}$ $y = \frac{b}{a} x^2$ $v = a_1 v_1 - a_2 v_2 = 2a_1 b$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $\Delta^2 = \Delta x^2 - \Delta y^2$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $v = \sqrt{2x}$ $S = \frac{1}{2} \cdot 2 \cdot 2 = 2$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $f(x) = [(x-2)^5] \cdot (2x+3)^3 + [(2x-2)^5]$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $f(x) = 5(x-2)^4 \cdot (2+3)^3 + 12x^2 \cdot 2 \cdot (x-2)^5$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $f(x) = 5(x-2)^4 \cdot (2+3)^3 + 6(2x+3)^2 \cdot (x-2)^5$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$
 $f(x) = 2 \cdot 3 - x - 2 \cdot 1 + 2 \cdot 3 = (1) \cdot 3 - 1 = 2$ $\lim_{x \rightarrow 1} \frac{1}{x} = 1$ $\lim_{x \rightarrow 1} (5x + 1) = 6$ $\lim_{x \rightarrow 1} (x^2 + 1) = 2$ $\lim_{x \rightarrow 1} f(x) = 2x$