Discussion 2

01/15/2024

Today's outline

1. Discuss about the first dinocpu assignment
2. Walk through the first quiz

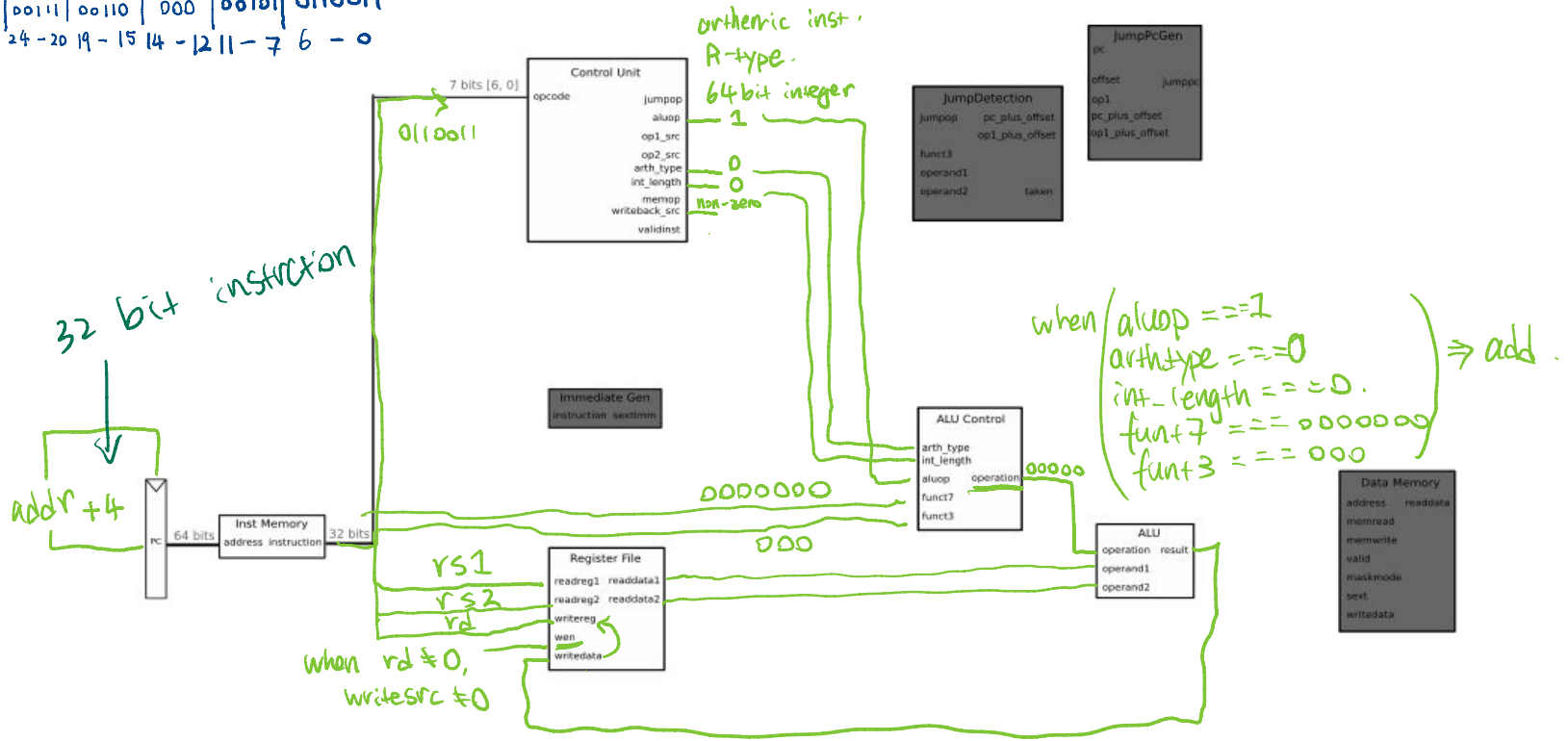
Dinocpu assignment 1

add rd, rs1, rs2

Reg[x5] = Reg[x6] + Reg[x7].

add x5, x6, x7.

funct7	rs2	rs1	funct3	rd	opcode
0000000	00111	00110	000	00101	0110011
31 - 25	24 - 20	19 - 15	14 - 12	11 - 7	6 - 0



Pipelined DINO CPU

Week 2 quiz

In the next questions, you'll be asked to do some math to calculate the power and energy of a system.

Note: These numbers somewhat come from information on Intel's Website. However, some of the information is missing, so I made it up. Specifically, I completely made up the static vs dynamic power splits :).

The Pentium 4 Prescott, released in 2004, has a clock rate of 3.6 GHz and voltage of 1.6 V. Assume that, on average, it consumed 10 W of static power and 90 W of dynamic power.

The Core i7-3770 (Ivy Bridge), released in 2012, has a clock rate of 3.4 GHz and voltage of 1.2 V. Assume that, on average, it consumed 30 W of static power and 47 W of dynamic power.

The Core i3-530, released in 2010, has a clock rate of 2.93 GHz and voltage of 1.4 V. Assume that, on average, it consumed 10 W of static power and 63 W of dynamic power.

The Core i5-5675R (Broadwell), released in 2015, has a clock rate of 3.4 GHz and voltage of 1.0 V. Assume that, on average, it consumed 20 W of static power and 45 W of dynamic power.

The Core i7-1065G7 (Ice Lake), released in 2019, has a clock rate of 1.3 GHz and voltage of 0.8 V. Assume that, on average, it consumed 5 W of static power and 20 W of dynamic power.

System	Clock Rate (GHz)	Voltage (V)	Static Power (W)	Dynamic Power (W)
Pentium 4 Prescott	3.6	1.6	10	90
Core i7-3770 (Ivy Bridge)	3.4	1.2	30	47
Core i3-530	2.93	1.4	10	63
Core i5-5675R (Boardwell)	3.4	1.0	20	45
Core i7-1065G7 (Ice Lake)	1.3	0.8	5	20

Question 1 1 pts

Which processor has the larger capacitive load the Core i3-530 or the Pentium 4 Prescott?

- ○ Core i3-530
- ○ Pentium 4 Prescott

System	Clock Rate (GHz)	Voltage (V)	Static Power (W)	Dynamic Power (W)
Pentium 4 Prescott	3.6	1.6	10	90
Core i7-3770 (Ivy Bridge)	3.4	1.2	30	47
Core i3-530	2.93	1.4	10	63
Core i5-5675R (Boardwell)	3.4	1.0	20	45
Core i7-1065G7 (Ice Lake)	1.3	0.8	5	20

Dynamic Power = ½ * C*V^2*f
= ½ * Capacitive Load * (Voltage)^2 * Clock Rate

Thus,

Capacitive load = 2* Dynamic Power / ((Voltage)^2 * Clock Rate)

Core i3-530.

$$\frac{2 * 63}{(1.4)^2 * 2.93} = 29.94$$

$$\frac{2 * 90}{(1.6)^2 * 3.6} = 19.53.$$

Question 3 — 1 pts

Find the percentage of the total dissipated power comprised by static power for the Pentium 4 Prescott. (Give answers out of 100. I.e. 30 is 30%.)

System	Clock Rate (GHz)	Voltage (V)	Static Power (W)	Dynamic Power (W)
Pentium 4 Prescott	3.6	1.6	10	90
Core i7-3770 (Ivy Bridge)	3.4	1.2	30	47
Core i3-530	2.93	1.4	10	63
Core i5-5675R (Boardwell)	3.4	1.0	20	45
Core i7-1065G7 (Ice Lake)	1.3	0.8	5	20

Total Power = Static Power + Dynamic Power

$$\frac{10}{10+90} = 10$$

Question 5

2 pts

If you wanted to reduce the power for the Core i3-530 system, which of the following would you try to reduce by 10%?

- ○ Voltage
- ○ Frequency
- ○ Capacitive load
- ○ Dynamic Power
- ○ Static Power

⇒ 16.4%.
8.6%
8.6%
91.4% ⇒ 8.6%
98.6% ⇒ 1.4%.

System	Clock Rate (GHz)	Voltage (V)	Static Power (W)	Dynamic Power (W)
Pentium 4 Prescott	3.6	1.6	10	90
Core i7-3770 (Ivy Bridge)	3.4	1.2	30	47
Core i3-530	2.93	1.4	10	63
Core i5-5675R (Boardwell)	3.4	1.0	20	45
Core i7-1065G7 (Ice Lake)	1.3	0.8	5	20

Total Power = Static Power + Dynamic Power
= Static Power + ½ * C * V^2 * f

$\frac{1}{2} * C * (90\% \cdot V)^2 * f$.

$\frac{1}{2} * C * 81\% \cdot V^2 * f$

Question 6 — 2 pts

Intel is working on the successor to the Core i7-3770 (Ivy Bridge). The engineers can reduce the voltage by 10% (i.e., the new voltage is 0.9 time the old voltage). What percentage can you increase the frequency keeping the same power?

The answer should be something like "50" for "50% more" and "1.5 times higher frequency".

$\frac{1}{0.81} = 1.23 \Rightarrow 23.$

System	Clock Rate (GHz)	Voltage (V)	Static Power (W)	Dynamic Power (W)
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Core i3-530	2.93	1.4	10	63
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Dynamic Power = ½ * C * V^2 * f

If voltage reduced by 10%, then
new Dynamic Power = ½ * C * (0.9 * V)^2 * f
= ½ * C * 0.81 * V^2 * f

Dynamic Power = new DP * x.

= new DP * $\frac{1}{0.81}$

Question 7

1 pts

Which of the following is true about Moore's Law?

- [ ] Describes the scaling factors for voltage, area, delay, etc. for transistors (devices) as they are scaled.
- [ ] Only talks about number of transistors per processor
- [ ] Specifically calls out processor performance
- [ ] Describes an exponential

Question 8

1 pts

Technology is a constant, and thus the best design today will always be the best design.

- ○ True
- ○ False

For a different application, libquantum which is a quantum chemistry benchmark, I get the following results from the AMD Epyc and Intel i7 systems.

	AMD Epyc	Intel i7
Cycles	949429232883	900190883413
Instructions	1653448268698	1643600607577
Time	313.053s	230.4s

Using this data, answer the following questions.

	AMD Epyc	Intel i7
Cycles	949429232883	900190883413
Instructions	1653448268698	1643600607577
Time	313.053s	230.4s

For question 9 - 15, it is all related to the iron law.

(cycle / instruction)

Iron Law:

Execution time = # of instructions * (~~instruction per cycle~~)* cycle time

313.053 = architecture micro-architecture technology.

313.053 = 1653448268698 *.

Question 14 2 pts

cycle time = execution time / cycle

What is the (average) frequency of the Intel i7 in GHz?

$\frac{1}{\text{cycle time}}$

second. $f \Rightarrow \frac{1}{s}$

Question 16

2 pts

Assume you run a different application on the **AMD Epyc** which has a CPI of 1.93 and executes 2887000000 instructions (note that is *billions*).

What is the time it takes to execute this application in seconds?

Execution time = # of instructions * (~~instruction per cycle~~ CPI) * cycle time

2887000000 * 1.93 *