

CENG3420 Homework 1

Due: Feb. 15, 2023

All solutions should be submitted to the blackboard in the format of **PDF/MS Word**.

Q1 (10%) This is a question about integrated circuit cost. Assume that a wafer contains 4096 dies and a die has 0.125 defects on average, please answer the following sub-questions.

1. Calculate the yield of this wafer. (5%)
2. Assume that you wanted to spend 8 millions HKD on manufacturing, how much money can you save for manufacturing the same number of dies if the average defects of a die can be reduced to 0.1? (5%)

Q2 (5%) Sort the computational performance of the following computers (from low to high):

1. Embedded computer
2. Personal computer
3. Mobile phone
4. Quad-CPU Server
5. Warehouse scale computer

Q3 (5%) Suppose we developed a new processor that has 75% of the capacitive load of the older processor. Further, it can reduce voltage 15% compared to previous generation, which results in a 15% shrink in frequency. What is the impact on dynamic power? Give the ratio of $\frac{\text{Power}_{\text{new}}}{\text{Power}_{\text{old}}}$.

Q4 (20%) We have an `int` (32 bits) array named `arr0`. The pointer of `arr0`'s first element stored in register `a1`. Please answer the following questions.

1. How to put the fourth element of `arr0` to register `t1`? (5%)
2. How to calculate `t1 + 16`? Please store the result in register `t2` (5%)
3. Find an efficient way to calculate `t2 / 16` and `t2 % 16`. Please store the results in `t3` and `t4`, respectively. Note that `/` is an integer division and `%` is the modulo operation. (hint: using shift and logical operations) (10%)

Q5 (20%) We have an `int` (32 bits) array named `arr1`. The pointer of `arr1`'s first element stored in register `a2`. We also have the registers `t1 = 0xAAAAAAAA`, `t2 = 0xFEDCBA98`

Please answer the following questions:

1. For the register values shown above, what is the value of `t3` for the following sequence of instructions? (5%)

```
slli t3, t1, 4
srli t3, t3, 4
```

2. What is the value of `t3` for the following sequence of instructions? (5%)

```
slli t3, t2, 3
srai t3, t3, 3
```

3. Write a piece of assembly program to: (10%)

- Store the result of `t1` & `t2` to register `t4`; (3%)
- Store `t4` to the first element of `arr1`; (3%)
- Store the lowest 8 bits of `t4` to the second element of `arr1`. (4%)

Q6 (20%) Consider the following RISC-V instructions:

```
li t1, 0
li t2, 1
li t3, 1
li t4, 10
LOOP:
beq t1, t4, DONE
add t5, t2, t3
addi t2, t3, 0
addi t3, t5, 0
addi t1, t1, 1
jal x0, LOOP
DONE:
# end of the program
```

1. How many times is the loop executed (between `LOOP` and `DONE`)? (5%)
2. List the value of `t2` at each loop iteration. (5%)
3. List the value of `t3` at each loop iteration. (5%)
4. What does this program do? (5%)

Q7 (20%) Write RISC-V instructions to implement the following functionalities.

1. $t2 = t1 * 4 + 7$ (5%)
2. $t3 = (t1 + t2) \% 16$ (5%)
3. $t2 = t1!$ (hint: assume multiply instruction `mul` is available) (10%)

$$Q1) \quad 4096 \times 0.125 = 512$$

$$\text{Yield} = \frac{4096 - 512}{4096} = 0.875 //$$

$$b) \quad \frac{8000000}{4096} = 1953.125 \$ \text{ per die}$$

$$(512 \times 1953.125) - (4096 \times 0.1 \times 1953.125) \\ = 200000 \$ //$$

\therefore it can save 200000 by lowering the defect from 0.125 to 0.1 //

Q2)

- 1) Embedded computer
- 2) Mobile phone
- 3) Personal computer
- 4) Quad-CPU server
- 5) Warehouse scale computer

$$Q3) \quad p = C V^2 F$$

$$P_n = 0.75 (0.85)^2 (0.85)$$

$$P_0 = 1 (1)^2 (1)$$

$$\frac{P_n}{P_0} = \frac{0.460}{1} = 0.46 \%$$

$$4) a) \text{ offset} = 4 * \text{size of (int)} \\ \text{lw t1, offset(a)}$$

$$b) \text{ addi t2, t1, 16}$$

$$c) \text{ shl t3, t2, 4} \\ \text{andi t4, t2, 0xF} //$$

5a) 0XAAAAAAAA

5/2) 0X FEDCBA98

5/3) and t4, t1, t2

sw t4, 0(a2)

andi t4, t4, 0xff

sw t4, 4(a2) //

Q6) 10

2&3) t5 v2 t3

1 2 1 2

2 3 2 3

3 5 3 5

4 8 5 8

5 13 8 13

6 21 13 21

7 34 21 34

8 55 34 55

9 89 55 89

10 144 89 144 //

4) The is Fibonacci sequence

7)

$$t2 = t1 * 4 + 7$$

1)

slli t2, t1, 2

addi t2, t2, 7

2)

$$t3 = (t1 + t2) \% 16$$

add t3, t1, t2

andi t3, t3, 0x0F

3)

li t2, 1

li t3, 1

LOOP:

beq t1, t3, DONE

mul t2, t2, t3

addi t3, t3, 1

jal x0, LOOP

DONE: //