

## EE466 Fall 2019 HW 1

Lewis Collum (0621539) EE/CE

Due: September 18, 2019

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### 1.2

Letter	Matching Idea
a	Performance via Pipelining
b	Dependability via Redundancy
c	Performance via Prediction
d	Performance via Parallelism
e	Hierarchy of Memories
f	Make the Common Case Fast
g	Design for Moore's Law
h	Use Abstraction to Simplify Design

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### 1.5

```
import pint
from collections import namedtuple

unit = pint.UnitRegistry()
unit.define('cycles=')
unit.define('instructions=')

Processor = namedtuple('Processor', ['cyclesPerSecond', 'cyclesPerInstruction'])
processors = {
    'p1': Processor(3e9 * unit.cycles/unit.seconds, 1.5*unit.cycles/unit.instructions),
    'p2': Processor(2.5e9 * unit.cycles/unit.seconds, 1.5*unit.cycles/unit.instructions),
    'p3': Processor(4e9 * unit.cycles/unit.seconds, 1.5*unit.cycles/unit.instructions)}

programExecutionTime = 10 * unit.seconds
for name, processor in processors.items():
    performance = processor.cyclesPerSecond / processor.cyclesPerInstruction
    instructions = performance * programExecutionTime
    cycles = processor.cyclesPerSecond * programExecutionTime
    newClockRate = instructions*processor.cyclesPerInstruction*(1+0.2) / (programExecutionTime*(1-0.3))

    print((f"{name}:\n"
           f"  performance = {performance:.2E}\n"
           f"  instructions (#) = {instructions:.2E}\n"
           f"  cycles (#) = {cycles:.2E}\n"
           f"  new clock rate for 30% reduction in execution time = {newClockRate:.2E}"))

p1:
    performance = 2.00E+09 instructions / second
    instructions (#) = 2.00E+10 instructions
    cycles (#) = 3.00E+10 cycles
    new clock rate for 30% reduction in execution time = 5.14E+09 cycles / second
p2:
    performance = 1.67E+09 instructions / second
    instructions (#) = 1.67E+10 instructions
    cycles (#) = 2.50E+10 cycles
    new clock rate for 30% reduction in execution time = 4.29E+09 cycles / second
p3:
    performance = 2.67E+09 instructions / second
```

instructions (#) = 2.67E+10 instructions  
cycles (#) = 4.00E+10 cycles  
new clock rate for 30% reduction in execution time = 6.86E+09 cycles / second

a.

p3 has the highest performance at  $2.67 \times 10^9$  instructions/second.

b.

*refer to code results*

c.

*refer to code results*

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### 1.8.1

Equation ID	Processor Name	Clock Rate	Voltage	Dynamic Power
1	Pentium 4 Prescott Processor	3.6GHz	1.25V	90W
2	Core i5 Ivy Bridge	3.4GHz	0.9V	40W

$$P = \frac{1}{2} CV^2 F \rightarrow$$

$$C = \frac{P}{2V^2 F}$$

$$C_1 = \frac{90}{2 \cdot 1.25^2 \cdot 3.6 \times 10^9} = 8 \times 10^{-9} \text{F}$$

$$C_2 = \frac{40}{2 \cdot 0.9^2 \cdot 3.4 \times 10^9} = 1.6 \times 10^{-9} \text{F}$$

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### 1.10.1 & 1.10.2

```
from collections import namedtuple
import pint
import math
```

```
def areaFromDiameter(diameter: float) -> float:
    radius = diameter/2
    return math.pi*radius**2
```

```
unit = pint.UnitRegistry()
unit.define('defects=')
```

```
Wafer = namedtuple('Wafer', ['diameter', 'cost', 'dieCount', 'defectRatio'])
wafers = {
    'w1': Wafer(
        diameter = 15 * unit.cm,
        cost = 12,
        dieCount = 84,
        defectRatio = 0.020 * unit.defects/unit.cm**2),
    'w2': Wafer(
        diameter = 20 * unit.cm,
        cost = 15,
        dieCount = 100,
```

```

        defectRatio = 0.031 * unit.defects/unit.cm**2)
    }

    for name, wafer in wafers.items():
        waferArea = areaFromDiameter(wafer.diameter)
        dieArea = waferArea/wafer.dieCount

        waferYield = 1/(1+(wafer.defectRatio * dieArea/2))**2
        costPerDie = wafer.cost / (wafer.dieCount * waferYield)

        print((f"{name}:\n"
                f"  yield = {waferYield.magnitude:.3}\n"
                f"  cost per die = {costPerDie.magnitude:.3}\n"))

```

```

w1:
  yield = 0.959
  cost per die = 0.149

```

```

w2:
  yield = 0.909
  cost per die = 0.165

```

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## 1.11

```

1
2
3
4

```

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### 1.12.1

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### 1.13