

# CPEG 222 Spring 2014 Homework 4 Solution

Chen Liu

May 19, 2014

**Solution of Question 1:**

- a) Wafer area= $\pi*(d/2)^2$ , Die area= wafer area/dies per wafer, yield=  $1/(1 + (\text{defect per area} * \text{die area})/2)^2$
- a. Wafer area<sub>a</sub>=  $\pi*(15/2)^2=176.7\text{cm}^2$ , die area<sub>a</sub>= $176.7/84=2.10\text{cm}^2$ , yield<sub>a</sub>= $1/(1 + (0.02*2.10)/2)^2=0.96$
  - b. Wafer area<sub>b</sub>=  $\pi*(20/2)^2=314.2\text{cm}^2$ , die area<sub>b</sub>= $314.2/100=3.14\text{cm}^2$ , yield<sub>b</sub>= $1/(1 + (0.031*3.14)/2)^2=0.91$
- b) Cost per die = cost per wafer/(dies per wafer \* yield)
- a. Cost per die<sub>a</sub>= $12/(84*0.96)=0.15$
  - b. Cost per die<sub>b</sub>= $15/(100*0.91)=0.16$
- c)
- a. die area<sub>a</sub>= $176.7/(84*1.1)=1.91\text{cm}^2$ , yield<sub>a</sub>= $1/(1 + (0.02*1.15*1.91)/2)^2=0.96$ , Cost per die<sub>a</sub>= $12/(84*1.1*0.96)=0.14$
  - b. die area<sub>b</sub>= $314.2/(100*1.1)n=2.85\text{cm}^2$ , yield<sub>b</sub>= $1/(1 + (0.031*1.15*2.85)/2)^2=0.91$ , Cost per die<sub>b</sub>= $15/(100*1.1*0.91)=0.15$

**Solution of Question 2:**

$P=C*V^2*\text{Clock rate}$ ,  $C = 10^{-8}$  per core

Processor	Clock rate	Voltage	Dynamic Power
80286(1982)	12.5 MHz	5	3.125
80386(1985)	16 MHz	5	4
80496(1989)	25 MHz	5	6.25
Pentium (1993)	66 MHz	5	16.5
Pentium Pro (1997)	200 MHz	3.3	21.78
Pentium 4 W (2001)	2 GHz	1.75	61.25
Pentium 4 P (2004)	3.6 GHz	1.25	56.25
Core 2 (2007)	2.67 GHz	1.1	64.61

**Solution of Question 3:**

- a) Leakage power is 64.61,  $I_{\text{leak}}=64.61/1.1=58.7$
- b) Leakage power is 2.178,  $I_{\text{leak}}=2.178/3.3=0.66$

**Solution of Question 4:**

Minimum execution time schedule:

Each task is executed on the fastest core. The core assignment is shown in the Table.

Task	1	2	3	4	5
HW	1	1	2	3	2

Cost = sum of the cost of HW1, 2, and 3 = \$20+\$16+\$14=\$50

Task 2 and 3 are executed in parallel by different units. Therefore:

Execution time =  $9+\max(8,7)+7+8=32$

Minimum cost:

Run everything on HW4, the cheapest core.

Cost = \$10

Execution time = 16+18+13+12+11=70

Minimum cost meeting the deadline:

First, we try to use one core to execute all the tasks. Clearly HW1 is the fastest among all the cores. The execution time = 9+8+12+10+9 = 48. It exceeds the deadline. Therefore one core is insufficient.

Next, we try to use two cores. This allows us to execute T2 and T3 in parallel. We use the cheapest core, HW4, in addition to H1. The core assignment is shown in the Table.

Cost = \$20+\$10=\$30

Execution time: 9+max(8,13)+10+9=41

Task	1	2	3	4	5
HW	1	1	4	1	1

Alternatively, we can use HW2 and HW3 together with the core assignment shown in the table.

Cost= \$16+\$14=\$30

Execution time: 11+max(7,13)+7+8=39

Task	1	2	3	4	5
HW	2	3	2	3	2

**Solution of Question 5:**

OR	0	1	X	D	D'
0	0	1	X	D	D'
1	1	1	1	1	1
X	X	1	X	X	X
D	D	1	X	D	1
D'	D'	1	X	1	D'

XOR	0	1	X	D	D'
0	0	1	X	D	D'
1	1	0	X	D'	D
X	X	X	X	X	X
D	D	D'	X	0	1
D'	D'	D	X	1	0

**Solution of Question 6:**

The test vectors are: 11X1 and X001.

