Homework 1 Solutions

Chapter 1

51. According to the equation, the "Defects per area' needs to decrease in order to counter the "Die area" increase.

52. Solving the yield equation on p. 48 for "Defects per area", we get:

"Defects/area" = (1/sqrt("yield") – 1) * 2 / "Die Area"

53. Using the equation above:

Defects/area (1980) = (1/sqrt(.48) – 1) * 2 / .16 = 5.5/unit area (sq. cm)
Defects/area (1992) = (1/sqrt(.48) – 1) * 2 / .97 = .914/unit area (sq. cm)

Improvement = 5.5/.914 = 6.017 = 601.7% improvements

Chapter 2

3. M1: 200e6 cycles/s * 10 s * 1/200e6 inst = 10 cycles/inst
M2: 300e6 cycles/s * 5 s * 1/160e6 inst = 9.375 cycles/inst

15. MFP: .1*6 + .15*4 + .05*20 + .7*2 = 3.6 CPI
1000 * 1/3.6 = 277.8 MIPS

MNFP: .1*60 + .15*40 + .05*100 + .7*2 = 18.4 CPI (
1000 * 1/18.4 = 54.3 MIPS

(Note: the values used for MNFP is 60 instead of 30 etc. because the values indicated in the book are # of integer instructions and each integer instructions take 2 cycles)

16. (.1*300*30 + .15*300*20 + .05*300*50 +.7*300*1) * 1e6 = 2.76e9 instructions

18. CPI(a): 2*.4 + 3*.25 + 3*.25 + 5*.1 = 2.8 CPI
CPI(b): 2*.4 + 2*.25 + 3*.25 + 4*.1 = 2.45 CPI

24. Performance of M(base) = 500e6/2.8 = 178 MIPS
Performance of M(opt) = 600e6/2.45 = 245 MIPS

That's a performance gain of 245/178 = 1.37 (37%) in 6 month.
If performance improves at 3.4%/month, in the 6 months necessary to optimize, CPU performance will have gone up by 1.034^6 = 1.22 (22%).

Thus, optimizing exceed the normal growth rate of performance and the hardware optimization should be undertaken.

32. Assume machine is running at 1 Hz (it doesn't matter, just pick a number)

Performance(old): 1 cycles/s * 1/(12*.1 + 4*.9) = .21 inst/s
Performance(new): 1 cycle/1.2s * 1/(6*.1 + 4*.9) = 4.2 CPI = .198 inst/s

Since performance is lower, the modification should not be taken.

41. After improvement, execution time = (5s/5 + 5s) = 6s. Speedup = 10s/6s = 1.67

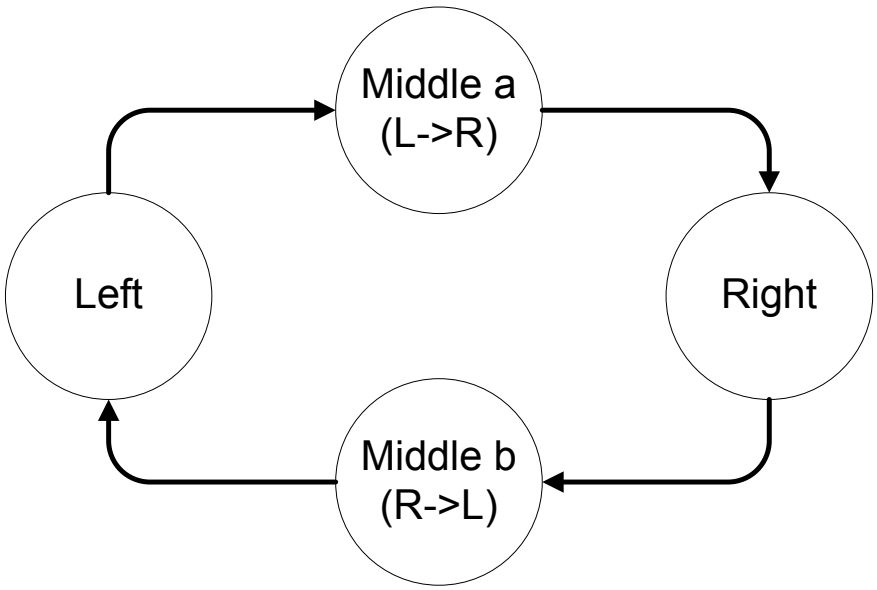
44. Multiplication: (20s/4 + 80s) = 85s; Speedup = 100/85 = 1.18
Memory: (50s/2 + 50s) = 75s; Speedup = 1.33
Both: (20s/4 + 50s/2 + 30s) = 60s; Speedup = 100/60 = 1.67

Appendix B

15. The even parity function outputs 1 when there are even # of 1s in the input

A	B	C	D	Out
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

21.



22. State Assignments: Left (00), Middle a (01), Right (10), Middle b (11)

S1	S0	S1'	S0'
0	0	0	1
0	1	1	0
1	0	1	1
1	1	0	0

Solving the K-Maps for S1' and S0', you get:

S1' = XOR (S1, S0)
S0' = NOT (S0)

The Outputs are associated with the state (where both Middle a, b output Middle)