CMPE 120 Homework #3 Solution

3.4. Use a truth table to show that X =(X AND Y) OR (X AND NOT Y).

X	Y	NOT Y	X AND Y	X AND NOT Y	(X AND Y) OR (X AND NOT Y)
0	0	1	0	0	0
0	1	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1

3.24. A computer with a 32-bit wide data bus uses 1M × 1 dynamic RAM memory chips. What is the smallest memory (in bytes) that this computer can have?

Each chip supports 1 bit of data, so 32-bit data bus has 32 chips. Each chip has 1Mbits.

$1M \times 32 \ = \ 32 \ Megabits$

Each byte is 8 bits, converting bits to byte:

$\frac{32 \ megabits}{8} = 4 \ Megabytes$

∴ Smallest memory this computer can have is 4 Megabytes.

3.35. A 64-bit computer with a 400-MHz bus requires four cycles to read a 64-bit word. How much bus bandwidth does the CPU consume in the worst case, that is, assuming back-to-back reads or writes all the time?

Total bytes for one word = $\frac{64 \ bits}{8} = 8 \ bytes$

Period of computer with 400-MHz for one cycle = $\frac{1}{400\times10^{6}} sec \ = \ 2.5 \ nsec$

Period for four cycles = $2.5 \ nsec \times 4 \ = \ 10 \ nsec$

The computer needs 10nsec to read a word which is 8 bytes.

Rate for computer to read 1 byte = $\frac{8 \ bytes}{10\times10^{-9} sec} \ = \ 8\times10^{8} \ bytes/sec$

1000000 bytes is 1 megabyte, converting bytes to Megabytes:

$\frac{8\times10^{8} \ bytes/sec}{1000000 \ bytes} = 800 \ Megabytes/sec$

∴ bus bandwidth in the worst case is 800 Megabytes/sec

3.37. A 32-bit CPU with address lines A2–A31 requires all memory references to be aligned. That is, words have to be addressed at multiples of 4 bytes, and half-words have to be addressed at even bytes. Bytes can be anywhere. How many legal combinations are there for memory reads, and how many pins are needed to express them? Give two answers and make a case for each one.

32 bits = 4 bytes

Legal combinations within 4 bytes:

1. Word addressed at multiple of 4 bytes which is 32-bits, one possible word.
2. Half-word addressed at even bytes which is 2 bytes, two possible half-words.
3. Byte can be anywhere, and it requires 1 byte, because the CPU is 32-bit which is 4 bytes, so four possible bytes.

Total possible combination = 7

Total pins needed to express them:

There are word, half-word and byte, each requires 1 pin, so total pins needed are 3 pins.

The 2 cases are:

1. 3 pins are required for the 7 combinations if using complete encoding.
2. 2 pins are required if bytes are excluded, only 3 combinations possible which are 1 word and 2 half-words.

3.40. Calculate the bus bandwidth needed to display 1280 × 960 color video at 30 frames/sec. Assume that the data must pass over the bus twice, once from the CDROM to the memory and once from the memory to the screen.

Total bytes for one frame = $1280 \times 960 \times 3 (colors\ per\ pixel)$ = 3686400 bytes

Total bytes for 30 frames for one second = 3686400×30 = 110592000 bytes

Total bytes of data pass over the bus twice = 110592000×2 = 221184000 bytes

Converting bytes to Megabytes:

$$\frac{221184000\ bytes}{1000000} = 221.184\ Megabytes$$

∴ bus bandwidth needed is 221.184 Megabytes