Additional Exam Review Problems - Solutions

1

C1CF0000 (hex)

(a)

$$\underset{S}{1}\,\underbrace{100\ 0001\ 1}_{E=128+2+1=131}\,\underbrace{100\ 1111\ 0\cdots0}_{F} \text{ (bin)}$$

$$\Rightarrow (-1)^1\, 1.1001111 \times 2^{131-127}$$

$$= -1.1001111 \times 2^4$$

$$= -11001.111$$

$$= -(16+8+1+0.5+0.25+0.125)$$

$$= \boxed{-25.875}$$

(b) -1.1001111×2^4

$\Rightarrow S = 1, \quad E - 1023 = 4$

$\Rightarrow E = 1027 = 1024 + 2 + 1$

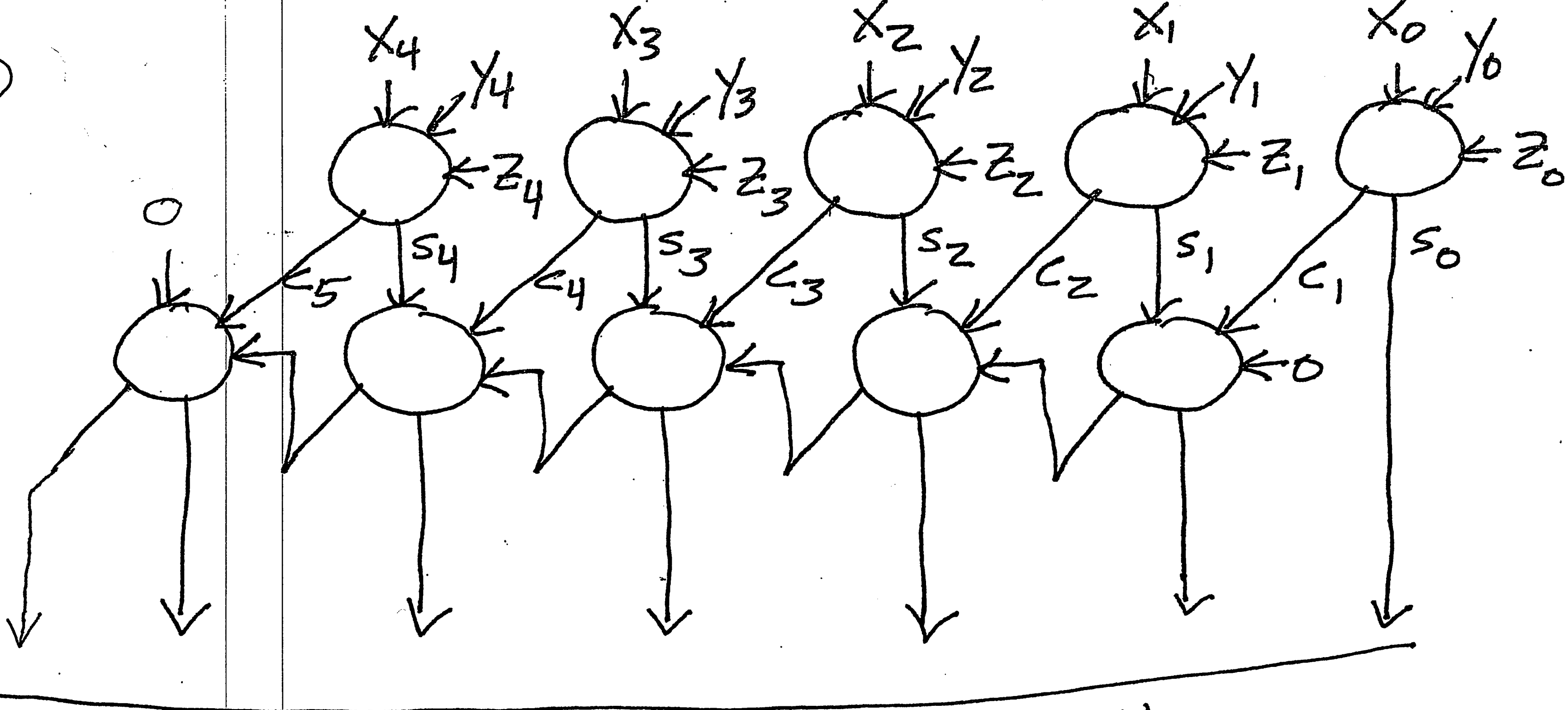
$= 10000000011$

$1\,10000000011\,1001111\,0\cdots0$

$\Downarrow$

$\boxed{C039E00000000000}$

2 (a)



final 7-bit unsigned result

Note: The assignment of signals to the 3 inputs of any full adder is arbitrary ⇒ any order is ok as long as the same 3 inputs as shown above are applied to each full adder.

(b) $11_{10} = 01011_2$

$21_{10} = 10101_2$

$31_{10} = 11111_2$

sum vector is the odd parity function at each bit position:

$$\boxed{(s_4, s_3, s_2, s_1, s_0) = (0, 0, 0, 0, 1)}$$

carry vector is the majority function at each bit position:

$$\boxed{(c_5, c_4, c_3, c_2, c_1) = (1, 1, 1, 1, 1)}$$

Adding these two vectors gives:

$$\begin{array}{r} 00001 \\ +\,11111 \\ \hline 0111111 \end{array}$$

(also OK if just give: 111111)

check:

$0111111_2 = 63_{10} = 11_{10} + 21_{10} + 31_{10}$ ✓

③ $P = BFC00000$ (hex)

$$= 1\underbrace{011\ 1111\ 1}_{PE}\underbrace{100\cdots 0}_{PF}$$

$PS = 1$

$PE = 64+32+16+8+4+2+1 = 127$

$m1 = \boxed{1100}$

$\Rightarrow pval = (-1)(8+4) = \boxed{-12}$

$Q = 40100000$ (hex)

$$= 0\underbrace{100\ 0000\ 0}_{QE}\underbrace{001\ 0000 \cdots 0}_{QF}$$

$QS = 0$

$QE = 128$

$m2 = \boxed{1001}$

$\Rightarrow qval = (8+1)(2) = \boxed{18}$

$m3 = m1 \times m2 = (12)(9) = 108$

$= 64 + 32 + 8 + 4$

$= \boxed{01101100}$

$m3[7] = 0 \Rightarrow f = 1011000$

$\Rightarrow m4 = \boxed{11011000}$

$$RE = 0 + PE + QE + 769$$
$$= 127 + 128 + 769 = 1024$$

$$\Rightarrow rval = m4 * 2$$
$$= (128 + 64 + 16 + 8)(2)$$
$$= (216)(2) = \boxed{432}$$

$$RS = 0, \quad RE = 1024 = 10000000000$$
$$RF = 1011000000 \cdots 0$$

$$\Rightarrow R = \underbrace{0\,100}\,\underbrace{0000}\,\underbrace{0000}\;\underbrace{1011}\;\underbrace{0 \cdots 0}$$
$$= \boxed{400B000000000000}$$

$\Rightarrow$ The \$display statement outputs are:

1100 , 1001 , 01101100 , 11011000

-12 , 18 , 432

400b000000000000

NOTE: It is OK if the commas between values are omitted. Also, it is OK to use either upper-case B or lower-case b in the hex value for R.

(4)

$$z_6 \qquad z_2$$

$$Y = 1\,1\,1\,0\,1\,0\,1\,0\,1\,1$$

$$z_8 \qquad z_4 \qquad z_0$$

$$\Rightarrow \boxed{z_0 = -1,\quad z_2 = -1,\quad z_4 = -1,\quad z_6 = -1,\quad z_8 = 0}$$

$$P = X(-1\cdot 2^0 - 1\cdot 2^2 - 1\cdot 2^4 - 1\cdot 2^6 + 0\cdot 2^8)$$

$$= X(-1-4-16-64)$$

$$= X(-85)$$

$$X = \underbrace{11111111}_{\text{"de-sign-extend"}}100$$

$$\Rightarrow X = 100 = -4$$

$$\Rightarrow P = (-4)(-85) = \boxed{340}$$

<u>check:</u>

$Y = 10101011$ (after de-sign-extend)

$$= -128 + 32 + 8 + 2 + 1 = -85$$

$$P = (-4)(-85) = 340 \checkmark$$

(5) $A = 0\ 1\ 1\ 0$

$B = 1\ 1\ 0\ 1$

$P = 1\ 1\ 1\ 1$

$G = 0\ 1\ 0\ 0$

$P_{sum} = 1\ 0\ 1\ 1$

$$\boxed{\begin{aligned}
P_{1:0} &= P_1 P_0 = 1 \cdot 1 = 1 \\
G_{1:0} &= G_1 + P_1 G_0 = 0 + 1 \cdot 0 = 0 \\
P_{2:1} &= P_2 P_1 = 1 \cdot 1 = 1 \\
G_{2:1} &= G_2 + P_2 G_1 = 1 + 1 \cdot 0 = 1 \\
P_{3:2} &= P_3 P_2 = 1 \cdot 1 = 1 \\
G_{3:2} &= G_3 + P_3 G_2 = 0 + 1 \cdot 1 = 1 \\
P_{2:0} &= P_{2:1} P_0 = 1 \cdot 1 = 1 \\
G_{2:0} &= G_{2:1} + P_{2:1} G_0 = 1 + 1 \cdot 0 = 1 \\
P_{3:0} &= P_{3:2} P_{1:0} = 1 \cdot 1 = 1 \\
G_{3:0} &= G_{3:2} + P_{3:2} G_{1:0} = 1 + 1 \cdot 0 = 1
\end{aligned}}$$

Since $c_0 = 0$, we have:

$$c_1 = G_0 = 0$$
$$c_2 = G_{1:0} = 0$$
$$c_3 = G_{2:0} = 1$$
$$c_4 = G_{3:0} = 1$$

$$S_i = Psum_i \oplus c_i$$

$$\Rightarrow \quad S_0 = 1 \oplus 0 = 1$$
$$S_1 = 1 \oplus 0 = 1$$
$$S_2 = 0 \oplus 0 = 0$$
$$S_3 = 1 \oplus 1 = 0$$

check (not required):

$$\begin{array}{r} \overset{1}{0}\,1\,1\,0 \\ +\;1\,1\,0\,1 \\ \hline \underset{c_4}{1}\,\underbrace{0\,0\,1\,1}_{S_{3:0}} \end{array} \quad \checkmark$$

6

flow dependence from instruction I1 to instruction I3 through r4

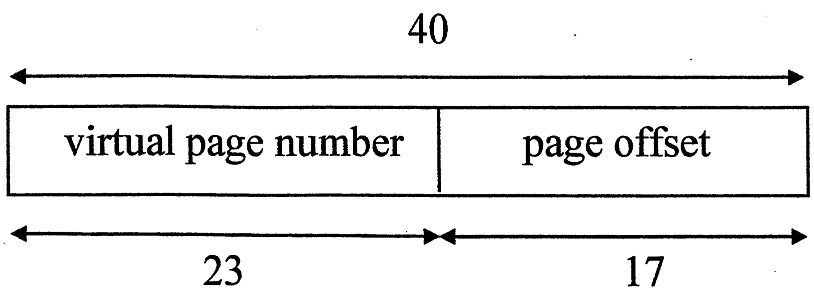
flow dependence from instruction I2 to instruction I3 through r6

instruction I1 is anti-dependent on instruction I2 through r6

instructions I1 and I3 are output dependent through r4

7

page size of 128K bytes => 17-bit page offset => 40 – 17 = 23-bit virtual page number:



=> number of page table entries is 2^{23}

each entry is 48 bits = 6 bytes

=> total size of the page table = (2^{23})(6 bytes) = 48 Mbytes

8

4
5
~~12~~ 18
10
20
21
13
2

can list in any order

4-miss, 5-miss, 12-miss, 10-miss,
4-hit, 20-miss, 21-miss, 13-miss,
2-miss, 5-hit, 20-hit, 18-miss,

(At this point, the LRU address is 12, so it gets replaced by 18)

2-hit, 4-hit, 10-hit, 21-hit

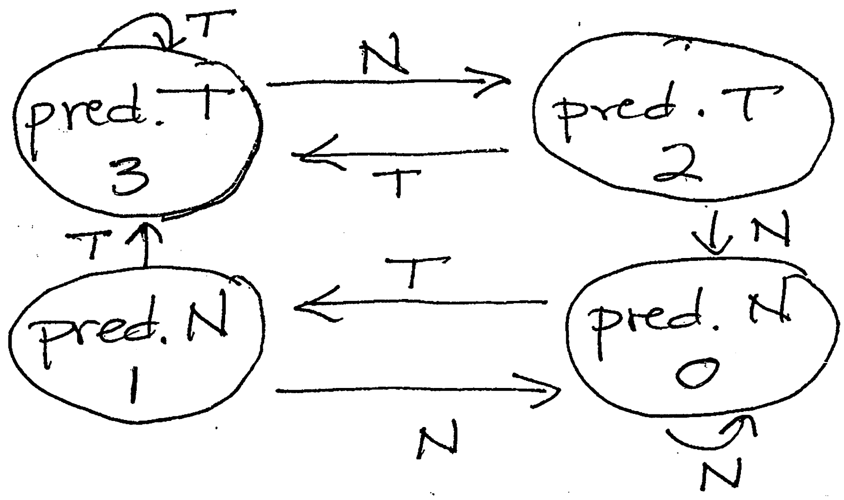
9 (a)

predicts:	N	T	N	T	T	N	N	T	N	T
actual:	T	N	T	T	N	N	T	N	T	T
	×	×	×	✓	×	✓	×	×	×	✓

⇒ 3 right, 7 wrong

⇒ $\boxed{\text{accuracy} = 30\%}$

(b)



state:	1	3	2	3	3	2	0	1	0	1
predicts:	N	T	T	T	T	T	N	N	N	N
actual:	T	N	T	T	N	N	T	N	T	T
	×	×	✓	✓	×	×	×	✓	×	×

⇒ 3 right, 7 wrong

⇒ $\boxed{\text{accuracy} = 30\%}$

10. (a)

$$\left(\frac{2\times 10^9\ cyles}{sec}\right)\left(\frac{8\,instructions}{cycle}\right) = 16\times 10^9\ instructions/sec = 16\ billion\ instructions/sec$$

either is OK

(b) best case CPI = (1 cycle)/(8 instructions) = 0.125

(c) best case IPC = 1/(best case CPI) = 8

(d) (8 pipelines)(5 stages per pipeline) = 40 instructions