Exam Review Solutions

(1) In binary:

(a)

$$X = \underset{S}{0}\underbrace{000\ 0000\ 0}_{E}\underbrace{111\ 0 \cdots 0}_{F}$$

$E = 0,\ F \neq 0 \Rightarrow$ denormalized number

$$\Rightarrow X = (-1)^S (0.F)\, 2^{-126}$$
$$= 0.111 \times 2^{-126}$$
$$= (2^{-1} + 2^{-2} + 2^{-3})(2^{-126})$$
$$= \boxed{2^{-127} + 2^{-128} + 2^{-129}}$$

$$Y = \underset{S}{0}\underbrace{000\ 0000\ 0}_{E}\underbrace{100\ 1000\ 0 \cdots 0}_{F}$$

$$\Rightarrow Y = (-1)^S (0.F)\, 2^{-126}$$
$$= 0.1001 \times 2^{-126}$$
$$= (2^{-1} + 2^{-4})(2^{-126})$$
$$= \boxed{2^{-127} + 2^{-130}}$$

(b) $8X = 2^3 \cdot X = 2^3(2^{-127} + 2^{-128} + 2^{-129})$

$= 2^{-124} + 2^{-125} + 2^{-126}$

$16Y = 2^4 \cdot Y = 2^4(2^{-127} + 2^{-130})$

$= 2^{-123} + 2^{-126}$

$\Rightarrow 8X + 16Y = 2^{-124} + 2^{-125} + 2^{-126} + 2^{-123} + 2^{-126}$

$= 2^{-126}(4 + 2 + 1 + 8 + 1)$

$= 2^{-126}(16) = 2^{-122}$

$\Rightarrow -(8X + 16Y) = -2^{-122}$

$= -(1.0)2^{5-127}$

$\Rightarrow$ normalized number with:

$S = 1,\ E = 5,\ F = 0$

$E = 5 = 00000101$ (binary)

$$\underbrace{1\,000}_{8}\,\underbrace{0\,010}_{2}\,\underbrace{1\,000}_{8}\,\underbrace{0 \cdots 0}_{0 \cdots 0}$$

$\Rightarrow \boxed{82800000}$

(2)

set	address
0	8
1	5
	~~9~~ 1
2	~~10~~ ~~22~~ ~~10~~ 2
	~~14~~ 22
3	7

7-miss, 8-miss, 10-miss, 14-miss,
22-miss, 5-miss, 8-hit, 14-hit,
7-hit, 9-miss, 10-miss, 22-miss
5-hit, 2-miss, 1-miss

3(a): (CS1 = code sequence 1; CS2 = code sequence 2)

CS1: # of instructions = 3 + 1 + 1 = 5
CS2: # of instructions = 2 + 3 + 5 = 10

3(b):

CS1: CPU clock cycles = 3*1 + 1*3 + 1*4 = 10
CS2: CPU clock cycles = 2*1 + 3*3 + 5*4 = 31

3(c):

CS1: CPI = 10/5 = 2
CS2: CPI = 31/10 = 3.1

(4) page size of 128K bytes

$\Rightarrow$ $\boxed{\text{17-bit page offset}}$

$\Rightarrow$ $44-17=$ $\boxed{\text{27-bit virtual page \#}}$

44	
virtual page #	page offset
27	17

$\Rightarrow$ # of page table entries is $\boxed{2^{27}}$

each entry is 24 bits = 3 bytes

$\Rightarrow$ total size of page table is:

$$(2^{27})(3 \text{ bytes})$$

$$= 2^{7} \cdot 3 \text{ Mbytes}$$

$$= \boxed{384 \text{ Mbytes}}$$

5. (a) flow dependence from instruction 1 to instruction 2 through R24

flow dependence from instruction 3 to instruction 4 through R19

instruction 5 is anti-dependent on instruction 1 through R12

instruction 5 is anti-dependent on instruction 2 through R12

instructions 2 and 4 are output dependent through R25

(b)

cycle	IF	ID	EX	MEM	WB
51	XOR				
52	DADD	XOR			
53	DSUB	DADD	XOR		
54	AND	DSUB	DADD	XOR	
55	OR	AND	DSUB	DADD	XOR
56		OR	AND	DSUB	DADD
57			OR	AND	DSUB
58				OR	AND
59					OR

(no bubbles are inserted because of the forwarding logic in the pipelined MIPS64 implementation). Thus:

instruction 1 will be in the WB stage during cycle 55

instruction 2 will be in the WB stage during cycle 56

instruction 3 will be in the WB stage during cycle 57

instruction 4 will be in the WB stage during cycle 58

instruction 5 will be in the WB stage during cycle 59

⑥ (a) 409ffc 0 ... 0_{hex}

$$0\underbrace{100\ 0000\ 1001}_{b.e. = 2^{10}+9}\ \underbrace{1111\ 1111\ 11}_{frac}00 \cdots 0_2$$

$\boxed{+}$

$\Rightarrow exp = (2^{10}+9) - (2^{10}-1)$

$= \boxed{10}$

$\Rightarrow$ significand is:

$m = 1.1111111111$

$m = = 1 + 2^{-1} + \cdots + 2^{-10}$

$\Rightarrow \underline{2^{-1}m} = \underline{2^{-1} + \cdots + 2^{-11}}$

$m - 2^{-1}m = 1 - 2^{-11}$

$m(1-\frac{1}{2}) = 1 - 2^{-11} \quad \Rightarrow m = \dfrac{1-2^{-11}}{(1/2)}$

$= 2 - 2^{-10}$

$\Rightarrow$ decimal value is:

$(2-2^{-10})(2^{10}) = 2^{11} - 1$

$= 2048 - 1$

$= \boxed{2047}$

(b) -1023

$\boxed{\text{sign} = 1}$

$$1023 = 1024 - 1$$
$$= 2^{10} - 1$$
$$= 1 + 2 + \cdots + 2^9$$
$$= \underbrace{2^9}_{} \underbrace{(2^{-9} + 2^{-8} + \cdots + 1)}_{}$$

significand is:

$1.\underbrace{111111111}_{\text{fraction}}{}_2$

exponent $= 9$

$\Rightarrow$ b.e. $= 9 + 1023$
$= 8 + 1024$
$= 2^3 + 2^{10}$
$= \boxed{10000001000_2}$

$\Rightarrow$ double prec. format is:

$$\underbrace{1\,100}_{c}\ \underbrace{0000}_{0}\ \underbrace{1000}_{8}\ \underbrace{1111}_{f}\ \underbrace{1111}_{f}\ \underbrace{1000}_{8}\ \underbrace{0\ldots0}_{0\ldots0}$$

$= \boxed{c08ff80000000000_{\text{hex}}}$

(ok to use upper- or lower-case hex letters)

7

r is an 8-bit random value
s is the one's complement of r
$t = 11111111_{bin}$
u is the one's complement of s, which is r
$v = r - r = 0$
$w = t*(0 + 1) = t = 11111111_{bin}$
So, the output produced by the $display statement will be:

```
10 255
20 255
30 255
40 255
50 255
```

(8) $i=0=00$ (binary):

$a = 000011 = 3$
$b = 000011 = 3$
$c = 001100 = 12$
$d = 000000 = 0$
$t = 1$
$r = 110011 = 51$

$i=1 = 01$ (binary):

$a = 011110 = 30$
$b = 010010 = 18$
$c = 111000 = 56$
$d = 000010 = 2$
$t = 0$
$r = 111010 = 58$

$i=2 = 10$ (binary):

$a = 100001 = 33$
$b = 101101 = 45$
$c = 000100 = 4$
$d = 000101 = 5$
$t = 0$
$r = 000001 = 1$

$i = 3 = 11$ (binary):

$a = 111100 = 60$

$b = 111100 = 60$

$c = 110000 = 48$

$d = 000111 = 7$

$t = 0$

$r = 110111 = 55$

So, the output will be:

```
10  3  3 12  0 51
20 30 18 56  2 58
30 33 45  4  5  1
40 60 60 48  7 55
```