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Practice: Spring 2022 Midterm

⚠ This is a preview of the draft version of the quiz

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Quiz Type	Graded Quiz
Points	100
Assignment Group	Midterm Exam (Homeworks #6 and #7)
Shuffle Answers	No
Time Limit	No Time Limit
Multiple Attempts	Yes
Score to Keep	Highest
Attempts	Unlimited
View Responses	Always
Show Correct Answers	After Aug 28, 2023 at 12am
One Question at a Time	No

Require Respondus LockDown Browser	No
Required to View Quiz Results	No
Webcam Required	No

Due	For	Available from	Until
May 3	Everyone	Jan 16 at 12pm	May 3 at 11:59pm

Preview

Score for this attempt: 0 out of 100
Submitted Aug 24 at 9:13am
This attempt took less than 1 minute.

Question 1: Integers

1. (15 points, 3 points per blank) **Integers**

This question is based upon the following declaration on a **machine using 6-bit two's complement arithmetic for signed integers.**

Fill in the empty boxes in the table below.

- **Show all digits for the "Binary" column, including any leading 0s.**
- You need not fill in entries marked with "–".
- TMax denotes the largest positive two's complement number
- TMin denotes the smallest negative two's complement number.
- Hint: Be careful with the promotion rules that C uses for signed and unsigned ints, i.e. how the C Language handles implicit casts between the types.

Expression	Decimal Representation	Binary Representation
-	-5	(A)
-	(B)	001010
Tmin	(C)	-
-	-1	(D)
--	-16	(E)

UnansweredQuestion 1

0 / 3 pts

You Answered

Correct Answers

111011

UnansweredQuestion 2

0 / 3 pts

You Answered

Correct Answers

10

0xA

0xa

A

a

UnansweredQuestion 3

0 / 3 pts

You Answered

Correct Answers

-32

UnansweredQuestion 4

0 / 3 pts

You Answered

Correct Answers

111111

UnansweredQuestion 5

0 / 3 pts

You Answered

Correct Answers

110000

Question 2: Floats

This question is based upon an IEEE-like floating point format with the following specification:

- 6-bit width
- There is s = 1 sign bit
- There are k = 3 exponent bits
- There are n = 2 fraction bits
- Wherever rounding is necessary, round-to-even should be In addition, you should give the rounded value of the encoded floating point number.

(12 points, 3 points each) Fill in the following:

Value	Binary Representation	Rounded Value
5	(A)	(B)
$\frac{1}{-16}$	(C)	--
$\frac{1}{32}$	(D)	--

(3 points, 1.5 point each) How many numbers could be represented using this representation in the following ranges?

Range	Count of numbers
Normalized	(E)
Denormalized	(F)

UnansweredQuestion 6
0 / 3 pts
You Answered

Correct Answers

010101

UnansweredQuestion 7

0 / 3 pts

You Answered

Correct Answers

010101

5

UnansweredQuestion 8

0 / 3 pts

You Answered

Correct Answers

100001

UnansweredQuestion 9

0 / 3 pts

You Answered

Correct Answers

000000

UnansweredQuestion 10

0 / 1.5 pts

You Answered

Correct Answers

48

UnansweredQuestion 11

0 / 1.5 pts

You Answered

Correct Answers

6

8

Question 3: Assembly

Please consider the following assembly code:

```
loopquestion:
        cmpl    %esi, %edi
        movl    %esi, %eax
        cmovle  %edi, %eax
        cmpl    %edx, %eax
        jge     .L1
        cmpl    %edx, %edi
        jge     .L3
.L4:
        addl    $1, %edi
        cmpl    %edi, %edx
        jne     .L4
.L3:
        cmpl    %esi, %edx
        jle     .L1
.L5:
        addl    $1, %esi
```

```
        cmpl    %esi, %edx
        jne     .L5
.L1:
        ret
```

- (A) (3 points) How many loops are within this question?

- (B) (3 points) How many if statements are within this question (that can't be considered part of the pre-test for an if or while loop)?

- (C) (3 points) Do two or more loops share the same loop control variable (a variable which is updated by the body of the loop and used as part of the test for the loop)?

- (D) (3 points) Do two or more loops share the same end point? In other words, do they stop when the loop control variable reaches the same value or condition?

- (E) (3 points) Where do the data values for the loop(s)' starting and stopping conditions come from?
  1. Function arguments
  2. Constants
  3. Runtime inputs
  4. More than one of the above
  5. None of the above

UnansweredQuestion 12
0 / 3 pts

You Answered

Correct Answers

2

two

Two

UnansweredQuestion 13

0 / 3 pts

You Answered

Correct Answers

1

one

One

2

two

Two

UnansweredQuestion 14

0 / 3 pts

- Yes

Correct Answer

- No
- Unknowable

UnansweredQuestion 15

0 / 3 pts

Correct Answer

- Yes
- No
- Unknowable

UnansweredQuestion 16

0 / 3 pts

Correct Answer

- Function arguments
- Constants
- Runtime inputs

- More than one of the above
- None of the above

Question 4: Structs and Alignment

Consider the following struct:

```
struct {
    short s; // 2-byte type
    int i;   // 4-byte type
    char c;  // 1-byte type
} exam;
```

Assume a system which requires “natural alignment”, i.e. each type needs to be aligned to a multiple of its size (width).

- (A) (3 points) How many bytes of padding would the compiler place immediately before s?
- (B) (3 points) How many bytes of padding would the compiler place immediately before i?
- (C) (3 points) How many bytes of padding would the compiler place immediately before c?
- (D) (3 points) How many bytes of padding would the compiler place immediately after c?
- (E) (3 points) Given the declaration, “struct exam array[4]”, what would be returned by “sizeof(array)”?

UnansweredQuestion 17
0 / 3 pts

You Answered

Correct Answers

0

0x0

zero

Zero

UnansweredQuestion 18
0 / 3 pts

You Answered

Correct Answers

2

two

Two

0x2

UnansweredQuestion 19

0 / 3 pts

You Answered

Correct Answers

0

0x0

zero

Zero

UnansweredQuestion 20

0 / 3 pts

You Answered

Correct Answers

3

three

Three

0x3

UnansweredQuestion 21

0 / 3 pts

You Answered

Correct Answers

48

0x30

Question 5: Caching and the Memory Hierarchy

Part A: Caching (10 points)

Given a model described as follows:

- Number of sets: 4
- Total size: 48 bytes (not counting meta data)
- Block size: 4 bytes/block
- Replacement policy: Set-wise LRU
- 8-bit addresses

5(A) (2 point) How many bits for the block offset?

5(B) (2 point) How many blocks per set?

5(C) (2 point) How many bits for the tag?

(8 points, 1 point each): For each of the following addresses, please indicate if it hits, or misses, and if it misses, if it suffers from a capacity miss, a conflict miss, or a cold miss:

Question Number	**Address**	**Circle one (per row):**
5(D)	0xA0	Hit Miss Unknowable
5(E)	0xAE	Hit Miss Unknowable
5(F)	0x52	Hit Miss Unknowable
5(G)	0XFC	Hit Miss Unknowable
5(H)	0XC2	Hit Miss Unknowable

5(I)	0XA2	Hit	Miss	Unknowable
5(J)	0XA0	Hit	Miss	Unknowable
5(K)	0X50	Hit	Miss	Unknowable

Part B: Locality (6 points)

Consider the following code:

```
int array[SIZE1][SIZE2];
int sum=0;
for (int outer=0; outer<SIZE1; outer+=STEP)
   for (int inner=0; inner<(SIZE2-1); inner++)
     sum += array[inner][outer] + 2*array[inner][outer+1];
```

5(L) (3 points): Imagine arrays extremely large in all dimensions, an int size of 4 bytes, and a cache block size of 16 bytes. To the nearest whole percent or simple fraction, what would you expect the combined miss rate for accesses to “array” and “array2” within the inner loop to be?

Part C: Memory Hierarchy and Effective Access Time

Imagine a system with a main memory layered beneath a cache:

- The cache has a 5nS access time.
- The main memory has an access time of 10nS.
- The cache miss rate is 1%.
- In the event of a miss, memory access time and cache access time do not overlap: They occur 100% sequentially, one after the other.

5(M) (3 points) Which of the following is closest to the effective, overall access time?

EFFECTIVE_ACCESS_TIME=

UnansweredQuestion 22

0 / 2 pts

You Answered

Correct Answers

2

two

Two

0x2

UnansweredQuestion 23

0 / 2 pts

You Answered

Correct Answers

3

0x3

three

Three

UnansweredQuestion 24

0 / 2 pts

You Answered

Correct Answers

4

0x4

Four

four

UnansweredQuestion 25

0 / 1 pts

Correct Answer

- Miss
- Hit
- Unknowable

UnansweredQuestion 26

0 / 1 pts

Correct Answer

- Miss
- Hit
- Unknowable

UnansweredQuestion 27

0 / 1 pts

Correct Answer

- Miss
- Hit
- Unknowable

UnansweredQuestion 28

0 / 1 pts

Correct Answer

- Miss
- Hit
- Unknowable

UnansweredQuestion 29

0 / 1 pts

Correct Answer

- Miss
- Hit
- Unknowable

UnansweredQuestion 30

0 / 1 pts

- Miss

Correct Answer

- Hit
- Unknowable

UnansweredQuestion 31

0 / 1 pts

- Miss

Correct Answer

- Hit
- Unknowable

UnansweredQuestion 32

0 / 1 pts

- Miss

Correct Answer

- Hit
- Unknowable

UnansweredQuestion 33

0 / 3 pts

You Answered

0.5 (with margin: 0.05)

UnansweredQuestion 34

0 / 3 pts

- 3ns

Correct Answer

- 5ns
- 7ns
- 9ns
- 11ns

Question 6: Virtual Memory

Consider a virtual address system with the following parameters:

- The memory is byte
- Virtual addresses are 16 bits
- Physical addresses are 16 bits
- The page size is 1024
- The TLB is fully associative with 16 total
- *Hint*: Recall that a fully associative cache has just one set of entries.

In the following tables, all numbers are given in hexadecimal. The contents of the TLB and the page table for the first 16 virtual pages are as follows. If a VPN is not listed in the page table, assume it generates a page fault.

TLB

Tag	PPN	Valid
03	1B	1
06	06	0
28	23	1
01	18	0
31	01	1

12	00	0
07	3D	1
0B	11	1
2A	2C	0
11	1C	0
1F	03	1
08	14	1
09	2A	1
3F	30	0
10	0D	0
32	11	0

Page Table

VPN	PPN	Valid
00	27	1
01	0F	1
02	19	1
03	1B	1

04	06	0
05	03	1
06	06	0
07	3D	0
08	14	1
09	2A	1
0A	21	1
0B	11	1
0C	1C	1
0D	2D	0
0E	0E	0
0F	04	1

- (2 points) What is the maximal physical memory size in bytes (decimal)? _

In the three rows below, mark the bits that constitute the indicated part of the virtual address with a Y and the other bits with an N. Enter your solution as a string, e.g. NNNNNNNNNNNNYYYY

(b) Virtual Page Number (2 points)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VPN																

(c) Virtual Page Offset (2 points)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VPO																

(d) TLB Tag (2 points)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
TLBT																

(e) Rewrite the virtual address 0x05DD in binary using only 1s and 0s, e.g. 0000000011111111 (2 points)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Please complete the following table for virtual address 0x05DD (2 points each)

Parameter	Value
6(F) VPN (hex)	
6(G) TLB Tag (hex)	
6(H) TLB Hit? (Y/N)	
6(I) Page Fault? (Y/N)	
6(J) PPN (hex)	

UnansweredQuestion 35

0 / 2 pts

- ~16kB
- ~32kB

Correct Answer

- ~64kB
- ~128kB

UnansweredQuestion 36

0 / 2 pts

You Answered

Correct Answers

YYYYYYNNNNNNNNNN

yyyyyynnnnnnnnnn

UnansweredQuestion 37

0 / 2 pts

You Answered

Correct Answers

NNNNNNYYYYYYYYYY

nnnnnnyyyyyyyyyy

UnansweredQuestion 38

0 / 2 pts

You Answered

Correct Answers

YYYYYYNNNNNNNNNN

yyyyyynnnnnnnnnn

UnansweredQuestion 39

0 / 2 pts

You Answered

Correct Answers

0000 0101 1101 1101

0000010111011101

UnansweredQuestion 40

0 / 2 pts

You Answered

Correct Answers

1

0x01

0x1

UnansweredQuestion 41

0 / 2 pts

You Answered

Correct Answers

1

0x1

0x01

0X1

0X01

UnansweredQuestion 42

0 / 2 pts

- Yes

Correct Answer

- No
- Unknowable

UnansweredQuestion 43

0 / 2 pts

- Yes

Correct Answer

- No
- Unknowable

UnansweredQuestion 44

0 / 2 pts

You Answered

Correct Answers

F

0xF

0XF

0F

0x0F

0X0F

Quiz Score: 0 out of 100