Name____________ Student ID__________________ Department/Year________

Mid-term Examination

Introduction to Computer Science
Class#: 901 E10110, Session#: 03
Spring 2012

15:40-17:20 Wednesday
April 18, 2012

Prohibited

1. You are not allowed to write down the answers using pencils. Use only black- or blue-inked pens.
2. You are not allowed to read books or any references not on the question sheets.
3. You are not allowed to use calculators or electronic devices in any form.
4. You are not allowed to use extra sheets of papers.
5. You are not allowed to have any oral, visual, gesture exchange about the exam questions or answers during the exam.

Cautions

1. Check if you get **10** pages (including this title page), **15** questions.
2. Write your name (in Chinese), student ID, and department/year down on top of the cover page.
3. There are in total **100** points to earn. You have **100** minutes to answer the questions. Skim through all questions and start from the questions you feel more confident with.
4. You are allowed to use **English only** to answer the questions. Misspelling and grammar errors will be tolerated, but you want to make sure with those errors your answers will still make sense.
5. If you have any extra-exam emergency or problem regarding the exam questions, raise your hand quietly. The exam administrator will approach you and deal with the problem.

The following table is from Appendix C of the text. It is included here so for your reference. Questions in this exam refer to this table as the "**language description tabl**e."

Op-Code	Operand	Description
1	RXY	LOAD the register R with the bit pattern found in the memory cell whose address is XY. *Example:* 14A3 would cause the contents of the memory cell located at address A3 to be placed in register 4.
2	RXY	LOAD the register R with the bit pattern XY. *Example:* 20A3 would cause the value A3 to be placed in register 0.
3	RXY	STORE the bit pattern found in register R in the memory cell whose address is XY. *Example:* 35B1 would cause the contents of register 5 to be placed in the memory cell whose address is B1.
4	0RS	MOVE the bit pattern found in register R to register S. *Example:* 40A4 would cause the contents of register A to be copied into register 4.
5	RST	ADD the bit patterns in registers S and T as though they were two's complement representations and leave the result in register R. *Example:* 5726 would cause the binary values in registers 2 and 6 to be added and the sum placed in register 7.
6	RST	ADD the bit patterns in registers S and T as though they represented values in floating-point notation and leave the floating-point result in register R. *Example:* 634E would cause the values in registers 4 and E to be added as floating-point values and the result to be placed in register 3.
7	RST	OR the bit patterns in registers S and T and place the result in register R. *Example:* 7CB4 would cause the result of ORing the contents of registers B and 4 to be placed in register C.
8	RST	AND the bit patterns in register S and T and place the result in register R. *Example:* 8045 would cause the result of ANDing the contents of registers 4 and 5 to be placed in register 0.
9	RST	EXCLUSIVE OR the bit patterns in registers S and T and place the result in register R. *Example:* 95F3 would cause the result of EXCLUSIVE ORing the contents of registers F and 3 to be placed in register 5.
A	R0X	ROTATE the bit pattern in register R one bit to the right X times. Each time place the bit that started at the low-order end at the high-order end. *Example:* A403 would cause the contents of register 4 to be rotated 3 bits to the right in a circular fashion.
B	RXY	JUMP to the instruction located in the memory cell at address XY if the bit pattern in register R is equal to the bit pattern in register number 0. Otherwise, continue with the normal sequence of execution. (The jump is implemented by copying XY into the program counter during the execute phase.) *Example:* B43C would first compare the contents of register 4 with the contents of register 0. If the two were equal, the pattern 3C would be placed in the program counter so that the next instruction executed would be the one located at that memory address. Otherwise, nothing would be done and program execution would continue in its normal sequence.
C	000	HALT execution. *Example:* C000 would cause program execution to stop.

1. Answer the following questions about binary and base-ten representation conversion (5%):

(a) What is the binary representation of 7 13/32?

(b) What is the base-ten representation of 1101.0111?

Ans:

(a) 111.01101

(b) 13 7/16

2. Answer the following questions about two's complement notation for an 8-bit system (using 8 bits to represent a number) (5%):

(a) What is the bit pattern representing the value 1 in two's complement notation?

(b) What is the bit pattern representing the value -1 in two's complement notation?

Ans:

(a) 00000001

(b) 11111111

3. Which of the following bit patterns (in hexadecimal notation) represents a negative number in two's complement notation in an 8-bit system (5%)?

(a) 09 (b) 90 (c) 67 (d) 76

Ans:

(b)

4. What decimal integer value is represented by each of the following patterns in excess notation (5%)?

(a) 111111

(b) 00000

Ans:

(a) 31

(b) -16

5. Which of the following addition problems cannot be solved accurately when using a floating-point system in which each value is encoded by a byte whose most significant bit is the sign bit, the next three bits represent the exponent field in excess notation, and the last four bits represent the mantissa (5%) ?

(a) 1 1/2 + 1 3/8

(b) 2 1/4+ 3/8

Ans:

Both (a) and (b)

6. The following is a LZ77-compressed message (5%).

101010 (4,4,1)(0,0,0)(8,4,1)(10,8,0)(8,6,1)

(a) How long was the original message?

(b) Decompress the message.

Ans:

(a) 33

(b) 101010 10101 0 10101 010101010 1010101

7. The following is an error-correcting code in which any two patterns differ by a Hamming distance of at least three. Decode each of the following patterns (5%).

Symbol	Representation
A	000000
B	001111
C	010011
D	011100
E	100110
F	101001
G	110101
H	111010

(a) 000000

(b) 000111

(c) 111000

(d) 010101

Ans:

(a) A, (b) B, (c) H, (d) G

8. Encode each of the following commands in terms of the machine language described in the language description table (5%).

(a) XOR (EXCLUSIVE OR) the contents of registers 3 and 4, leaving the result in register 2.

(b) JUMP to the instruction at address 45.

Ans:

(a) 9234

(b) B045

9. Below shows two sets of instructions. For each set, point out the instruction that will not produce the same result as the other two (10%)? (Refer to the language description table.)

(a) 5000	7000	8000
(b) 2000	9000	C000

Ans:

(a) 5000

(b) C000

10. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Answer the questions below assuming that the machine is started with its program counter containing 20. (10%)

address	content	address	content
20	12	25	21
21	22	26	32
22	32	27	C0
23	32	28	00
24	B0		

(a) What bit pattern will be in register 1 and 2 when the machine halts?

(b) What bit pattern will be at memory location 32 and B0 when the machine halts?

Ans:

(a) 32, 32

(b) 32, 32

11. Using the machine language described in the language description table, write a sequence of instructions that will place a 1 in all bits of the memory cell at address A0 without disturbing the other bits (10%).

2XFF
3XA0
(where X can be any distinct registers)

12. What is BIOS (5%)?

Ans: refer to exercise solution

13. What is virtual memory (5%)?

Ans: refer to exercise solution

14. Describe the similarity and difference between deadlock and starvation (10%)?

Ans: refer to exercise solution

15. Describe a scenario that leads to a deadlock in real life (10%).

Ans:
There are many possible answers. It involves generally two entities, each of which needs additional resources to complete its task that is occupied by the other entity. The resource must be non-sharable.