

Name_____ Student ID_____ Department/Year_____

Mid-term Examination

Introduction to Computer Science
Class#: 901 E10110, Session#: 03
Spring 2006

15:40-17:20 Wednesday
April 26, 2006

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 **only English** 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 table.**”

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 ORS 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 $4 \frac{5}{8}$?
- (b) What is the base-ten representation of 10.011?

ANSWER: (a) 100.101, (b) $2 \frac{3}{8}$

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 5 in two's complement notation?
- (b) What is the bit pattern representing the value -5 in two's complement notation?

ANSWER: (a) 00000101, (b) 11111011

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

- (a) 7F (b) 55 (c) A6 (d) 08

ANSWER: (c)

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

(a) 10000

(b) 0110

ANSWER: (a) 0 (b) -2

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) $2 \frac{1}{2} + 1 \frac{3}{8}$

(b) $7 + \frac{3}{4}$

ANSWER: (a) and (b)

6. The following message was compressed using LZ77 (5%).

1010101(4,4,0)(8,7,0)(16,8,1)(8,6,0)

- (a) How long was the original message?
- (b) Decompress the message.

ANSWER:

- (a) 36
- (b) 1010101 01010 10101010 101010101 0101010

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 (10%).

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

- (a) 000011
- (b) 101001
- (c) 111000
- (d) 101111

ANSWER: C, F, H, B

8. Encode each of the following commands in terms of the machine language described in the language description table (10%).

- (a) ROTATE the contents of register 7 to the right 5 bit positions.
- (b) JUMP to the instruction at address B2 if the content of register 2 equals that of register 0.
- (c) ADD the contents of registers 5 and 6 as though they were values in floating-point notation and leave the result in register 4.
- (d) AND the contents of registers 5 and 6, leaving the result in register 4.

ANSWER: (a) A705 (b) B2B2 (c) 6456 (or 6465) (d) 8456 (or 8465)

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

- (a) A502 A506 A50A
- (b) 9555 2500 1500

ANSWER: (a) A506, (b) 1500

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 00. (10%)

address	content	address	content
00	25	07	00
01	03	08	C0
02	20	09	00
03	F9	0A	C0
04	53	0B	00
05	05	0C	C0
06	33	0D	00

- (a) What bit pattern will be in register 5 when the machine halts?
- (b) What bit pattern will be in register 0 when the machine halts?
- (c) What bit pattern will be in register 3 when the machine halts?
- (d) What bit pattern will be at memory location 00 when the machine halts?

ANSWER: (a) 03 (b) F9 (c) FC (d) FC

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

ANSWER:

2X80

1YA0

7YXY

3YA0

(where X and Y can be any distinct registers)

12. What is the difference between batch processing and interactive processing (5%)?

ANSWER: see exercise solution

13. What problem arises as the lengths of the time slices in a time-sharing system are made shorter and shorter? What about as they become longer and longer (5%)?

ANSWER: see exercise solution

14. What is the difference between virtual memory and main memory (5%)?

ANSWER: see exercise solution

15. Describe a scenario that leads to a deadlock in real life (5%).

ANSWER: 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.