Name_____ Student ID_____ Department/Year_____

Mid-term Examination

Introduction to Computer Science
Class#: 901 E10110, Session#: 03
Spring 2016

15:30-17:10 Wednesday
April 20, 2016

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 **12** pages (including this title page), **13** 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 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	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 11/16?

(b) What is the base-ten representation of 101.11?

Sample Ans:

(a) 111.1011

(b) 5 3/4

2. Which(s) of the following bit patterns (in hexadecimal notation) represents a positive number in excess notation in an 8-bit system (5%)?

(a) 01 (b) BD (c) 81 (d) A0

Sample Ans:

(b)(c)(d)

3. (1) Represent the following two numbers in the binary 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%). (2) Which one(s) is truncated after the conversion (5%)?

(a) 4 3/4

(b) 1/32

Sample Ans:

(1)

4 ¾ = 100.11 = 01111001 (exponent: 3, mantissa: 0.10011)

1/32 = 0.00001 = 00001000 (exponent: -4, mantissa: 0.1000)

(2)

(a)

4. 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) 000011

(b) 001100

(c) 101111

(d) 110000

Sample Ans:

(a) C (b) D (c) B (d) can't be sure (A, G, or H)

5. Compress the following message with Run-Length encoding and Adaptive Dictionary encoding LZ77 with a look-ahead buffer of 4 and text window of 2 (10%).

AAAABBC

Sample Ans:

Run-Length: (A, 4) (B, 2) (C, 1)

LZ77: AAAA (0,0,B) (1,1,C)

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

(a) LOAD register A with the value BC

(b) LOAD program counter with value BC when the value in register A equals the value in register 0

Sample Ans:

(a) 2ABC

(b) BABC

7. The following table shows a portion of a machine's memory containing a program written in the language described in the language description table. Write the sequence of instructions executed in order assuming that the machine is started with its program counter containing 05 (5%).

address	content	address	content	address	content
00	03	09	12	A3	31
01	03	0A	02	A4	54
02	01	0B	13	A5	42
03	00	0C	03	A6	B0
04	EE	0D	14	A7	A0
05	10	0E	03	A8	33
06	00	A0	B4	A9	04
07	11	A1	A8	AA	C0
08	01	A2	53	AB	00

Sample Ans:

1000 -> 1101 -> 1202 -> 1303 -> 1403 (R0=03, R1=03, R2=01, R3=00, R4=00)
-> B4A8 -> 5331 -> 5442 -> B0A0 (R3=03, R4=01)
-> B4A8 -> 5331 -> 5442 -> B0A0 (R3=06, R4=02)
-> B4A8 -> 5331 -> 5442 -> B0A0 (R3=09, R4=03)
-> B4A8 -> 3304 -> C000

8. Using the machine language described in the language description table, write a sequence of instructions that will compare the value in memory cell address AA to value 4. If the values are the same, jump to instructions in memory cell CC (5%). Write another sequence of instructions that will compare the value in memory cell AA to value 4. If the value in memory cell address AA is smaller than 4, jump to instructions in memory cell address CC (10%).

Sample Ans:
1XAA
2004
BXCC
(where X can be any distinct registers)

1XAA
2YFC
8ZXY
2000
BZCC
(where X, Y, Z can be any distinct registers)

9. Using the machine language described in the language description table, write a machine language program that will multiply content in memory cell address AA to content in memory cell address BB, and store the result to memory cell address CC. Assume the content in memory cell address AA and BB are positive integers. Assume also the instructions of your program are loaded into the memory and starts from memory cell 00 (10%).

Sample Ans:

Address	Content
00	10BB
02	2100
04	2200
06	2301
08	14AA
0A	B112
0C	5113
0E	5224
10	B00A
12	32CC
14	C000

10. Suppose there is a computer system, in which the physical memory space is only 4 pages large. Suppose also that there is a process requiring 5 pages of memory space to store all data needed. Let the process start on the computer system, and the data are loaded page by page on to the physical memory in the following order: 2, 2, 1, 1, 1, 3, 4, 4, 4, 4, 2, 5, 4, 5.

(a) Which data pages are swapped out subsequently if the computer system's swapping policy is Oldest First (5%)?

(b) Which data pages are swapped out subsequently if the computer system's swapping policy is Least (Frequently) Used (5%)?

(c) Which data pages are swapped out subsequently if the computer system's swapping policy is Least Recently Used (5%)?

Sample Ans:
2, 2, 1, 1, 1, 3, 4, 4, 4, 4, 2, 5, 4, 5
(a)
-, -, -, -, -, -, -, -, -, -, -, -, 2, -, -
(b)
-, -, -, -, -, -, -, -, -, -, -, -, 3, -, -
(c)
-, -, -, -, -, -, -, -, -, -, -, -, 1, -, -

11. Describe a way to break an existing deadlock and a way to prevent a deadlock from happening (5%)?

Sample Ans:
To break: kill the process(es) involved in the deadlock
To prevent: allocate all non-sharable resources at once. Or, spool – diverting the use of the non-sharable resources for later.

12. Describe a scenario that leads to a deadlock in real life. Please specify the processes and the resources they compete for (5%).

Sample 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.

13. Which of the following emails are likely scam emails to phish your username and password and why does it appear suspicious to you (5%)? What would you do to confirm whether such a mail is authentic or malicious (5%)?

Email (a)

Sender: Apple Support. [case@appleid-notification.com] / [noreply@appleid-notification.com] / [support.center@appleid-notification.com]
Subject: Your Apple ID will be locked until we receive respond from you

Valued Customer,
We just need to verify that this email address belongs to you.
Simply click the link below and sign in using your Apple ID and password.
Verify Now >>>
….

Email (b)

Sender: upgradeadmin@ntu.edu.tw
Subject: Re: Last Reminder-Upgrade Your ntu.edu.tw Mailbox

Dear ntu.edu.tw server account user,
Please note that we want to upgrade your MAIL service within 72 hours and your account may not function properly afterwards if it is not upgraded in time.
To upgrade your account, you need to log into your account again using the following upgrade link.
UPGRADE LINK: CLICK HERE
….

Sample Ans:
Pick and justify yourself.
Tell what you'd do to confirm.

Both are actually known scam emails alerted by NTU computing center under the subject: "(緊急通知）計資中心緊急通知，請留意詐騙信件！" Translated: (Emergency Alert) Computing Center Emergency Alert, be aware of the scam email!