Name____________ Student ID_________________ Department/Year________

Mid-term Examination

Introduction to Computer Science
Class#: 901 E10110, Session#: 03
Spring 2017

15:30-17:10 Wednesday
April 19, 2017

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 **16** 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 **105** 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 8 1/32?

(b) What is the base-ten representation of 1111.101?

Sample solution:

(a) 1000.00001

(b) 15 5/8

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

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

Sample solution:

(a)

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) 9 1/2

(b) 1/32

Sample solution:

(1)

9 1/2 = 1001.1 = 0???1001 (exponent: 4 exceeding allowed max, 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) 001110

(b) 101111

(c) 000111

(d) 111111

Sample solution:

(a) B (b) B (c) B (d) Not sure (B or G or H)

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

AABCBCC

Sample solution:

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

LZ77: AABC (2,2,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 10111100

(b) LOAD register A with the value in memory cell address 10111100

(c) LOAD program counter with value 10111100 when the value in register A equals the value in register 0

Sample solution:

(a) 2ABC

(b) 1ABC

(c) 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. Let the program counter start from 05. (a) What’s the content in memory cell address 04 when the program halts (5%)? (b) If the content in memory cell address 00 is 04 and the content in memory cell address 01 is 05, what will be the content in memory cell address 04 when the program halts (5%)?

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

Sample solution:

(a)

09

(c)

14

8. Using the machine language described in the language description table, (a) write a sequence of instructions that will compare the value in memory cell AA to value 0. If the value in memory cell address AA does not equal 0, jump to instruction in memory cell address CC; otherwise, jump to instruction memory cell address DD (5%). (b) Write another sequence of instructions that checks whether the value in memory cell address AA is larger than 3. If so, jump to instructions in memory cell address CC; otherwise, jump to instructions in memory cell address DD (5%).

Sample solution:

(a)

1XAA

2000

BXDD

B0CC

(where X can be any distinct registers)

(b)

1XAA

2YFC

8ZXY

2000

BZDD

B0CC

(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 subtract content in memory cell address BB from content in memory cell address AA, and store the result to memory cell address CC. Assume the Simple Machine uses an 8-bit two's complement notation for signed integers. Assume the content in memory cell address AA and BB are non-negative integers. Assume also the instructions of your program are loaded into the memory and starts from memory cell 00 (5%).

Sample solution:

Address	Content
00	2XFF
02	1YBB
04	1ZAA
06	2000
08	BY10
0A	5YYX
0C	5ZZX
0E	B008
10	3ZCC
12	C000

(where X, Y, Z can be any distinct registers, other than register 0)

10. Continue from Problem 9. Revise your machine language program so that it will integer-divide (fraction part discarded) content in memory cell address AA to content in memory cell address BB, and store the result to memory cell address CC (10%).

Sample solution:

Address	Content
00	2XFF
02	1YBB
04	1ZAA
06	2000
08	2T00
0A	2U01
0C	2V80
0E	BY16 (when Y=0, jump to increment # of subtraction loop)
10	5YYX
12	5ZZX
14	B00E (go back to check whether to decrement until Y=0)
16	8WVZ (if Z < 0, then W≠0)
18	BW1E (W=0, jump to increment # of subtraction loop)
1A	3TCC (otherwise, write # of subtraction loop out)
1C	C000
1E	5TTU (adding number of subtraction loop by 1)
20	1YBB (restore value of Y)
22	B00E (back to subtraction loop)

(where T, U, V, W, X, Y, Z can be any distinct registers other than register 0)

11. Describe what physical memory and virtual memory is respectively (5%). Furthermore, explain what 'paging' and 'swapping' does respectively (5%).

Sample solution:
Please refer to exercise solutions and lecture slides.

12. Describe a scenario that leads to a deadlock in real life. Please specify the processes and the resources they compete for (5%). Describe a way to break this particular deadlock and a way to prevent the deadlock from happening (5%).

Sample solution:
There are many possible answers. Justify your own answer.

13. Which of the following emails are likely scam emails to phish you into clicking on links containing malicious programs/scripts 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: AppleID Store <wazyr.lia@confirmations-delivery.com>
Subject: Invoice#M2MNSYJKSD

Invoice

Thank you for buying		
INVOICE DATE 18 March 2017	BILLED TO Apple Store	TOTAL $69,99
ORDER ID M2MNSYJ056	DOCUMENT NO. 175116838085	

App Store		TYPE	PURCHASED FROM	PRICE
	**Clash of Clans, Box of Gems** Cancel Order	Purchase In-App	iPhone	**$69,99**
			TOTAL	**$69,99**

If you did not authorize this purchase, please visit iTunes Payment Cancellation

Apple ID Summary Ã¢â,¬Â¢ Purchase History Ã¢â,¬Â¢ Terms of Sale Ã¢â,¬Â¢ Privacy Policy

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

Both are actually known scam emails. Google them up.