Computer Science, an Overview

Mid-Term Exam (a)

November 16,

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Read First Please

- There are **6** problems, for a total of 100 points.
- You should work alone and **MUST NOT** copy others'.
- Dictionaries are **PERMITTED** while books or notes are **PROHIBITED**.

1		2		3		4		5		6	

1. (3') Warming Up

Apes is a programmer, and he has got tired of an ocean of Single Day these years. Now Novem
of 2011 is approaching, he decides to show some **Surprise** to Ada, a female programmer h
been carrying a torch for a long time. Now you are sent by Cupid to help him. Firstly, please c
check whether you have written down all your personal information well.

2. (25') Quiz on Computer Science

Apes will take part in a TV program named "*Who can become a millionaire*" to earn some fundi
the special gift.

1) Please **list** those machines in the order that they appear in the history: d b c d b a

a. EDVAC (Electronic Discrete Variable Automatic Computer)
b. ENIAC (Electronic Numerical Integrator And Calculator)
c. Pascal's Pascaline
d. Harvard Mark I

2) There are 2 algorithms to calculate the factorial of integer *n*: B is recursive.

A. $factorial(n) = \begin{cases} 1, & \text{if } n = 0 \\ n(n-1)(n-2)\ldots \times 2 \times 1, & \text{if } n > 0 \end{cases}$

B. $factorial(n) = \begin{cases} 1, & \text{if } n = 0 \\ n \times factorial(n-1), & \text{if } n > 0 \end{cases}$

3) When you download a high-definition action movie from Japan, the content of the movie will be split into several packets. Do these packets have to follow the same route path to the destination? B

A. Yes **B.** No

4) Which of the following encoding formats could simplify the design of Adder? D

A. True Form Notation **B.** Excess Notation

C. One's complement Notation **D.** Two's complement Notation

5) A computer of Von Neumann architecture executes instructions sequentially. Meanwhile, it also supports multi-tasking through D.

A. Storing the bootstrap program in non-volatile ROM

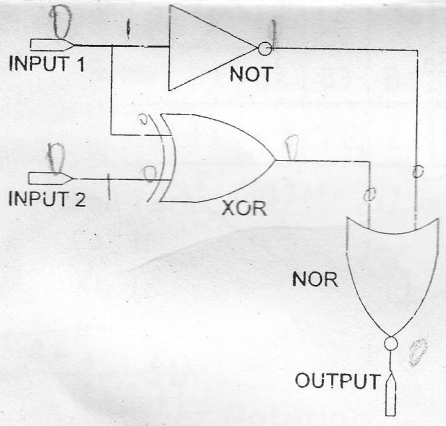
B. Direct Memory Access for a controller to access main memory

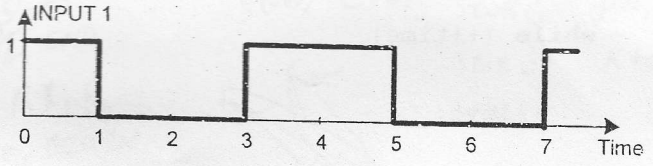
C. CPU fetches its instructions from memory over a central bus

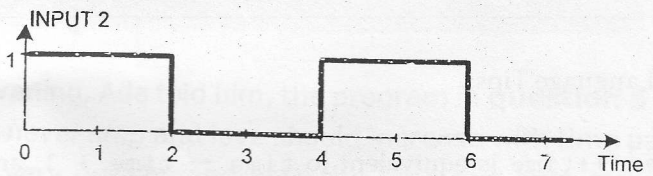
D. Time-sharing among processes

3. (16') Bits and Circuits

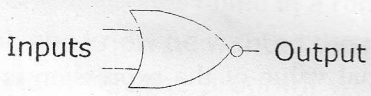
Apes decides to make an electronic gift to Ada. You will help him check whether his circuit works well. Now given the INPUTs of the circuit, draw the OUTPUT of the circuit on the output graph.



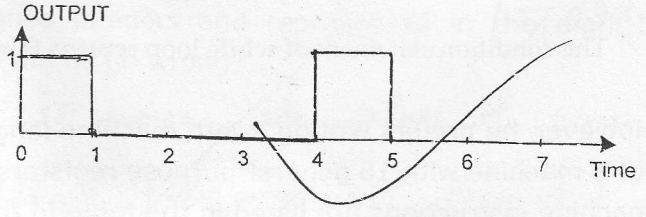




NOR



Inputs		Output
0	0	1
0	1	0
1	0	0
1	1	0



Op-code	Operand	Description
1	RXY	**LOAD** the register R with the bit pattern found in the memory cell whose address is XY.
2	RXY	**LOAD** the register R with the bit pattern XY.
3	RXY	**STORE** the bit pattern found in register R in the memory cell whose address is XY.
4	0RS	**MOVE** the bit pattern found in register R to register S.
5	RST	**ADD** the bit pattern in registers S and T as though they were two's complement representations and leave the result in register R.
6	RST	**ADD** the bit pattern in registers S and T as though they represented values in floating-point notation and leave the floating-point result in register R.
7	RST	**OR** the bit patterns in registers S and T and place the result in register R.
8	RST	**AND** the bit patterns in registers S and T and place the result in register R.
9	RST	**XOR** the bit patterns in registers S and T and place the result in register R.
A	R0X	**ROTATE** the bit pattern in register R one bit to the right X times.
B	RXY	**JUMP** to the instruction located in memory address XY if the bit pattern in register R is equal to the bit pattern in register 0.
C	000	**HALT** execution.

Suppose the parameter **time** is stored in memory unit **11** and parameter **love** is stored in memory unit **1E**, and both have been initialized as 0. The program will start at address A0. Can you help Apes write the program in machine language above? You can leave blocks blank if unnecessary. (Please fill the table carefully, drafting ahead is suggested.)

Address	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
Contents	10	11	11	1E	92	22	23	01	50	03	B2	B0	51	13	B0	A8
Address	**B0**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**	**BA**	**BB**	**BC**	**BD**	**BE**	**BF**
Contents	30	11	31	1E	C0	00										

You can draft here:

```
A0: Load  R0, 11
A2: load  R1, 1E
    Add   R2, R1, R2
    load  R3, $0
    load  R4, 11
(A8) BEGIN: add   R0, R0, R3
    Jmp   R2, R2, END
    add   R1, R1, R3
    Jmp   R2, R0, BEGIN
(B0) END:  store  R0, 11
    store  R1, 1E
    HALT
```

6. (8') Integer Notation

... Unfortunately, Apes failed in a romantic evening. Ada told him, the program in **question 5** seemed very cool, she knew he wanted the program *never stop* and love should increase with time passed by forever. However, the program would exit very quickly, and both the time and love could not be *sustained eternality*.

Suppose all of these parameters are signed integers and represented in the eight-bit two's complement format. Please tell Apes where did he go wrong?

When love has been added 255 times, the values of time and love both become 0xFF ($(-1)_{10}$ in two's complement format), and then after ++ time it becomes 0 and the loop stops. In fact, when time = 127, after ++ time it becomes -128, which is an overflow, and then time gets to +1 and 0 an

4. (18') Passing Parameters in Procedures

After confirmation of basic circuits, Apes decides to write and test some codes. Suppose procedures Test and Shapeshift are defined as the following:

```
procedure Test
assign string X the value "You";
assign string Y the value "Love";
apply Shapeshift (X, Y);
print the value of Y;
print the value of X;
```

```
procedure Shapeshift (X, Y)
assign string X the value Y + X;
assign string Y the value "I";
assign string X the value Y + X;
print the value of X;
```

Here the sum of two strings means the concatenation of them. (E.g. "Hello"+"World" equ "HelloWorld".) The double quotation marks are used to identify a string; they would be omit when printing the string.

a) What will be printed when *Test* is called in the main procedure if parameters are passed **value**?

b) What will be printed when *Test* is called in the main procedure if parameters are passed **reference**?

a) ~~Love You~~
I Love You Love You

b) I Love You I I Love You

5. (30') Machine Language

Finally, Apes decides to write a beautiful "poem" to Ada.

```
procedure (int time, int love)

while (++time)

   ++love;

end procedure
```

Language Tips:

- `++time` is equivalent to `time ← time + 1`, and the final value of the expression is the value after increment. E.G. if `time` is 5, then the value of `++time` is 6 and `time` will become 6 after this line of cod executed.

- The condition statement of **while** loop returns **false** if the value equals 0, **true** otherwise.

However, he prefers writing it into machine language. Here is a typical machine language design for a machine with 16 general-purpose registers (numbered 0-F). Each register is one-byte long. machine instructions are listed in the table in the right page (each is two-bytes long).