Introduction to Computer Science (2017-11-07)
Midterm Exam (Closed Book)

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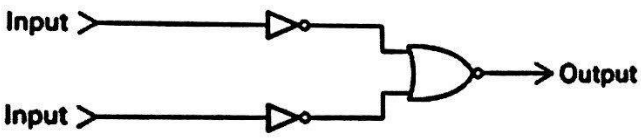
10 1. (10%) Perform each of the following additions assuming the bit strings represent values in two's complement notation. Identify each case in which the answer is incorrect because of overflow.

a. 00101+01000 b. 11111+00001 c. 01111+00001 d. 10111+11010 e. 11111+11111

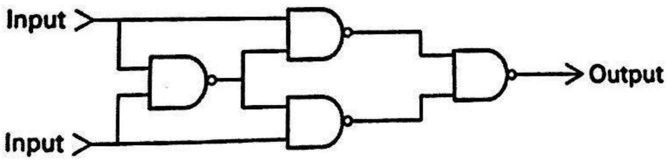
15 2. (15%) Convert each of the following binary representations into its equivalent base 10 representation:

a. 11.11 b. 100.0101 c. 0.1101 d. 1.0 e. 10.01

10 3. (a) (5%) What Boolean operation does the circuit compute? AND



(b) (5%) What Boolean operation does the circuit compute? XOR



4. (6%) (a) In what way are general-purpose registers and main memory cells similar? (b) In what way do general-purpose registers and main memory cells differ?

6 5. (8%) Identify both the mask and the logical operation needed to accomplish each of the following objectives:

(a) Put 1s in the upper 4 bits of an 8-bits pattern without disturbing the other bits.

(b) Complement the most significant bit of an 8-bits pattern without changing the other bits.

(c) Complement a pattern of 8-bits.

(d) Put 1s in all but the most significant bit of an 8-bits pattern without disturbing the most significant bit.

△ 6. (6%) (a) List four activities of a typical operating system.

(b) What's the difference between time-sharing and multitasking?

7. (6%) (a) Summarize the booting procedure. (b) How is firmware difference from hardware and software? (c) What do you mean by a firmware update?

8. (9%) In each of the following case, write a short program in the machine language described (Table 1) to perform the requested activities. Assume that each of your programs is placed in memory starting at address 00.
   (a) Move the value at memory location D8 to memory location B3.
   (b) Interchange the values stored at memory location D8 and B3.
   (c) If the value stored in memory location 44 is 00, then place the value 01 in memory location 46; otherwise, put the value FF in memory location 46.

△ 9. (14%) Define the following malware: virus, worm, Trojan horse, spyware, phishing, denial of service, and spam?

10. (a) (2%) Summarize the principles of "public-key encryption".
    (b) (2%) Briefly summarize what is meant by the term "Digital signature."
    (c) (2%) How to use public and private keys in the technique of "Digital signature."

11. (a) (2%) Please explain the hidden terminal problem?
    (b) (4%) Draw a figure that shows two scenarios of the hidden terminal problem, and indicate them obviously in this figure.
    (c) (4%) Describe a technique for solving it.

12. (5%) Suppose each nonsharable resource in a computer system is classified as a level 1, level 2, or level 3 resource. Moreover, suppose each process in the system is required to request the resources it needs according to this classification. That is, it must request all the required level 1 resources at once before requesting any level 2 resources. Once it receives the level 1 resources, it can request all the required level 2 resources, and so on. Can deadlock occur in such a system? Why or why not?

Table 1. The following "language description table" is from Appendix C of the textbook.

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.