※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Do the following tasks. Show your work.
   a) Convert the decimal numbers 15 and -9 into 8-bit 2's complement numbers and hexadecimal numbers. (6%)
   b) What is an overflow? Provide an example using 4-bit numbers. (4%)

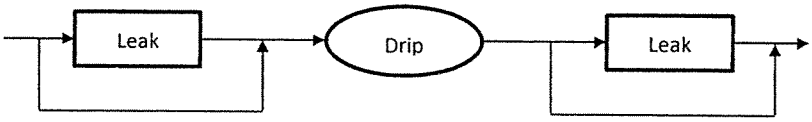
2. Consider a decimal number -47.375.
   a) Convert it into a binary scientific notation (i.e., $\pm 1.xxxx \times 2^{Y}$). (4%)
   b) Find the equivalent binary single-precision floating-point representation. (6%)

3. Give the truth table in the right, where x, y, and z are input of a logic circuit and c is the output.
   a) Simplify the truth table using Karnaugh map. Show your work. What is the simplified logic between the inputs and output? (5%)
   b) Build a circuit using AND, OR, and XOR gates to implement the simplified logic. (5%)

x	y	z	c
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

4. Suppose for an RSA key, n is 187 and e is 107. (Note: 187 = 11 × 17.)
   a) Find the d. (7%)
   b) You observe a ciphertext c = 2. What is the plaintext? (3%)

5. Show that the grammar below is ambiguous by drawing two distinct parse trees for the string "Drip Drip Drip". (10%)



6. Binary tree.
   a) Insert the following sequence of elements into a binary search tree, starting with an empty tree. (8%)
      70, 35, 40, 90, 20, 50, 45, 60, 80, 95, 85
   b) A binary tree is called height-balanced if, for every node in the tree, the height of its left and right subtrees differ by at most 1. Is the binary tree from a) height-balanced? Explain. (2%)

7. Consider a Turing machine that has the following two instructions.
   (1,1,0,2,R)　(2,1,1,1,R)
   Determine it's output when it is run on the following tape. Remember that a Turing machine starts in state 1, reading the leftmost nonblank cell. (10%)

.	.	.	b	1	1	1	b	.	.	.	.	.	.	.	.	.	.

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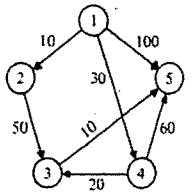
8. Consider the directed graph in the right.



   a) Give the adjacency matrix for the directed graph. (5%)
   b) Represent the directed graph as an adjacency list. Assume the numerical order on each list of adjacent vertices. (5%)

9. Suppose you run the following assembly program on a computer. The computer consists of 8 memory registers (`M[1]` to `M[8]`), 2 input registers (`I[A]` and `I[B]`), and one output register (`OUT`). Consider the operations and controls for the assembly.

```
12 MOV I[A] M[1]
13 MOV I[B] M[2]
14 ADD I[A] I[B]
15 MOV I[A] OUT
16 MOV I[B] M[3]
17 ADD I[A] I[B]
18 MOV M[4] OUT
19 HALT
```

OPERATIONS AND CONTROLS
1: MOVE X Y: X = Y
2: ADD X Y: OUT = X + Y
3: SUB X Y: OUT = X - Y
4: HALT: halt

Suppose the initial contents of the registers are: `M[1]` = 0010; `M[2]` = 0001; `M[3]` = 0010; `M[4]` = 0000. Answer the questions below. Write your answers in the format of 4-digit decimal numbers.

   a) What is the value of `OUT` after the instruction at location 15 completes? (3%)
   b) What is the value of `OUT` when the program halts? (2%)
   c) What is the value of `M[4]` after the instruction at location 16 completes? (2%)
   d) What is the value of `M[4]` when the program halts? (3%)

10. The following C program contains bugs. Identify the line number where the bugs appear and give a correct version of the codes. (10%)

```
1  %include <stdio.h>
2  int main(void)
3  {
4     int i;
5     int f_n2, f_n1, f_n;
6     int num;
7     printf(Please input a number(>=2):);
8     scanf(%d, num);
9     f_n2 = 0;
10    f_n1 = 1;
11    for(i = 2, i <= num, i++)
12    {
13       f_n = f_n2 + f_n1;
14       f_n2 = f_n1;
15       f_n1 = f_n;
16    }
17    printf(The %dth number is %d, num, f_n)
18    return 0;
19 }
```

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