1. Using 10 bits to represent the mantissa (sign/magnitude) and 6 bits for the exponent (also sign/magnitude), show the internal representation of the following two values: (10%)

   (1). $-16\frac{1}{8}$

   (2). +0.25

2. Build and draw a circuit using AND, OR, and NOT gates to implement the following truth table. This is called a full-ON/full-OFF circuit. It is true if and only if all three of its inputs are OFF (0) or all three are ON (1). What is the Boolean expression for this truth table? (10%)

a	b	c	Output
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

3. Show how run-length encoding can be used to compress the following text stream. What is the compression ratio? (Assume each digit and letter requires 8 bits.) (10%)

   AAAABBBBBBBCCCCDDDAAABBBBBDDDDDD

4. For the following list, perform a selection sort and show the list after each exchange that has an effect on the list ordering. How many comparisons are required to sort the list? How many exchanges? (10%)

   12, 3, 6, 8, 2, 5, 7

5. Using the grammar of the following figure, show the parse tree for the below assignment statements. (10%)

   (1). x = x + y

   (2). x = x + y + z

Number	Rule
1	<assignment statement> ::= <variable> = <expression>
2	<expression> ::= <variable> | <expression> | <variable>
3	<variable> ::= x | y | z

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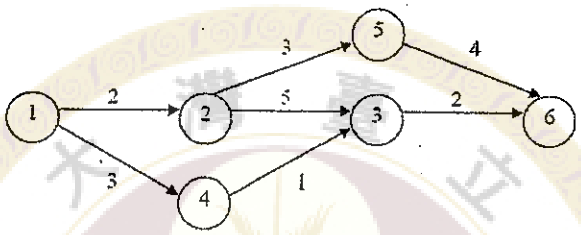
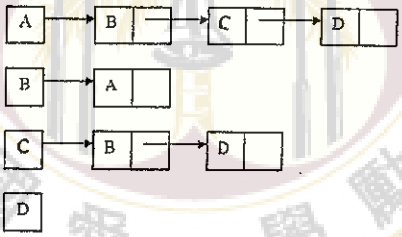
6. Consider the following directed graph. We want to use Dijkstra's algorithm to determine the shortest path from vertex 1 to each of the other vertices. The initial values for the distances are given for you. List vertices in the order they are processed by the algorithm. Show the searching steps as the algorithm is executed. (10%)



7. Here is an adjacency list representation of a directed graph where there are no weights assigned to the edges. (10%)
(1). Draw a picture of the directed graph that has the above adjacency list representation.
(2). Draw the adjacency matrix for this graph.



8. Given the following processes and burst times, calculate the average wait times when: (A) the round-robin scheduling algorithm; (B) shortest-job-first scheduling algorithm; (C) first-come-first-serve scheduling algorithm are used, respectively. Assume that a quantum of 8 is being used. (10%)

Process	Burst Time
P1	10
P2	6
P3	23
P4	9
P5	31
P6	3
P7	19

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9. Assume that the variables *a*, *b*, *c*, and *d* are stored in memory locations 100, 101, 102, and 103, respectively. Using the sample machine language instructions given in the following table, translate the following pseudo-code operations into machine language instruction sequences. (10%)

Set ***a*** to the value of (***b*** x ***d***) – (***c*** / ***d***)

Operation	*Meaning*
LOAD X	Load register R with the content of memory cell X.
STORE X	Store the content of register R into memory cell X.
ADD X	Add the contents of memory cell X to the contents of register R. Put the result back into register R.
SUBTRACT X	Subtract the contents of register R from the content of memory cell X. Put the result back into register R.
MULTIPLY X	Multiply the contents of memory cell X with the contents of register R. Put the result back into register R.
DIVIDE X	Divide the contents of register R by the content of memory cell X. Put the result back into register R.

10. Design and Implement a computer program function removeDuplicates() that processes an integer array of N elements and returns an integer value indicating the number of duplicate items in the array that were removed. When you are done with this function call, there should be no two elements the same in the processed integer array. (10%)

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