Midterm Exam for Introduction to Computer Science, Spring 1999

Prof. Wanjiun Liao, 3:10-5:00pm, 04/21/1999

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[1] (10%) The three bit patterns 01101000, 10000010, and 00000010 are representations of the same value in two's complement, excess, and floating-point notation, but not necessarily in that order. What is the common value, and which pattern is in which notation?

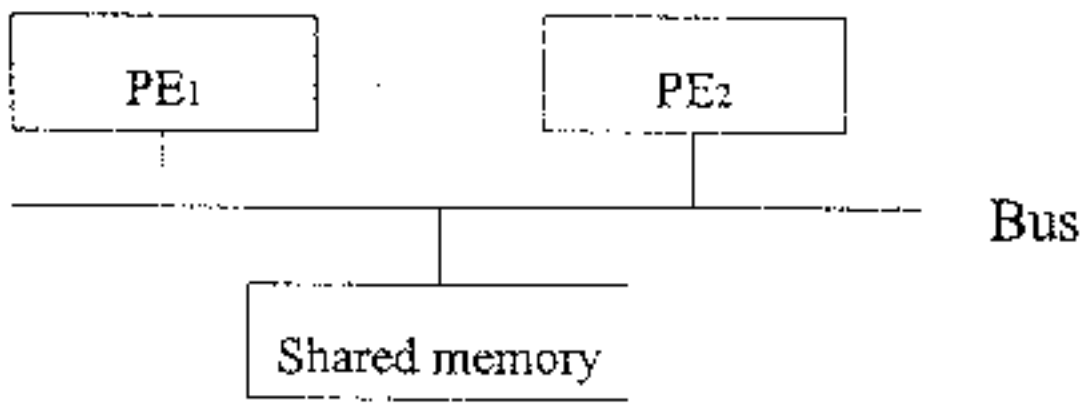
[2] Speed and capacity

(a) (5%) Suppose that a machine has 1.2 GB of storage space available in a hard disk, and receives data over a telephone connection at a rate of 14.4Kbps. At this rate, how long does it take to fill the available storage space?

(b) (5%) What would be the hexadecimal representation of the largest memory address in a memory consisting of 4MB if each cell had a one-byte capacity?

(c) (5%) If a floppy disk with 100 tracks per surface, 16 sectors per track and 512 bytes per sectors spins at the rate of 300 revolutions per minute, at approximately what rate, measured in bytes per second, does data pass by the read/write head? What is the worse case access time for this disk, assuming that the head arm moves to an adjacent track in any direction is 0.5 ms?

[3] A multiprocessor machine refers to the machine in which more than one processing unit is applied to the task at hand. Suppose that there were two processing units attached to the same memory and executing different programs. Furthermore, suppose that one of the processing unit needs to add one to the contents of a memory cell at roughly the same time that the other needs to subtract one from the same cell. The net effect (i.e., correct result) should be that the cell ends up with the same value with it starts.



(a) (5%) Describe a sequence in which these activities would result in the cell's ending up with a value one less than its starting value.

(b) (5%) Describe a sequence in which these activities would result in the cell's ending up with a value one greater than its starting value.

[4] Data Manipulation

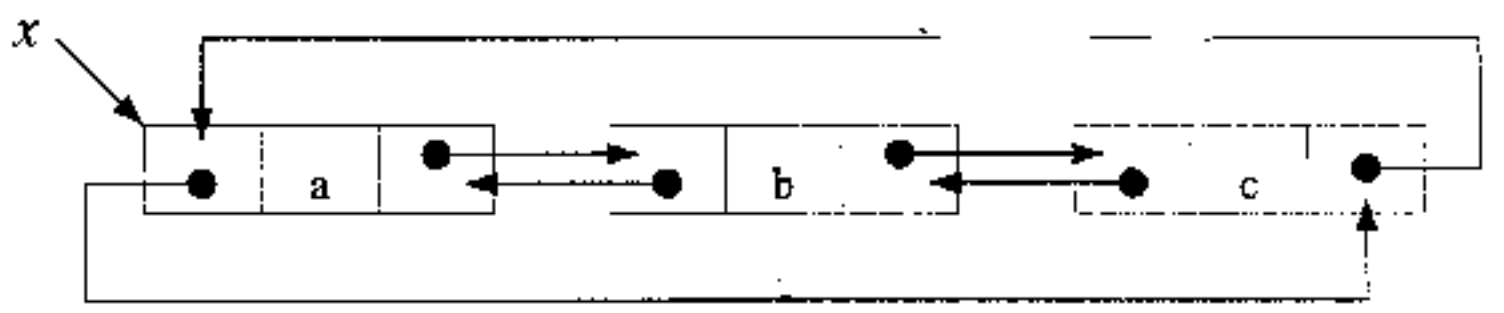
(a) (15%) Write a program in the machine language of Appendix A to compute the sum of the two's complement values stored at memory location A1, A2, A3, and A4. Your program should store the final result at memory location A5.

(b) (5%) Translate the following machine language program segment into a C++ programming language. Assume that it starts at memory address A0.

2005
1111
B1AE
1201
5112
3110
B0A2

[5] Data structure – linked list and queue

(1) A double linked list is defined as a linked list in which each node contains two link fields, one in each direction (i.e., forward and backward). An example of a double linked circular list is shown as follows:



where x is a pointer to the list.

(a) (5%) Write a C++ function for inserting node p to the right of node q into a double linked circular list pointed by pointer r.

(b) (5%) Write a C++ function for deleting node s from a double linked circular list pointed by pointer r.

Please consider all possible problems for such insertion and deletion. (For example, empty list, the node does not exist in the list, or already in the list, etc.)

(2) (5%) Please write a C++ function to insert item into circular queue stored in

int midterm_que[0 .. n-1];

Again, please consider all possible problems.

[6] (10%) The following table represents a tree stored in a machine's memory. Each node of the tree consists of three cells. The first cell contains the data (a letter), the second contains a pointer to the left child of the node, and the third contains a pointer to the right child. A value of 0 represents a NIL pointer. If the value of the root pointer is 55, draw a picture of the tree represented.

Address	Contents	Address	Contents
40	G	49	M
41	0	50	0
42	0	51	0
43	X	52	F
44	0	53	43
45	0	54	40
46	J	55	W
47	49	56	46
48	0	57	52

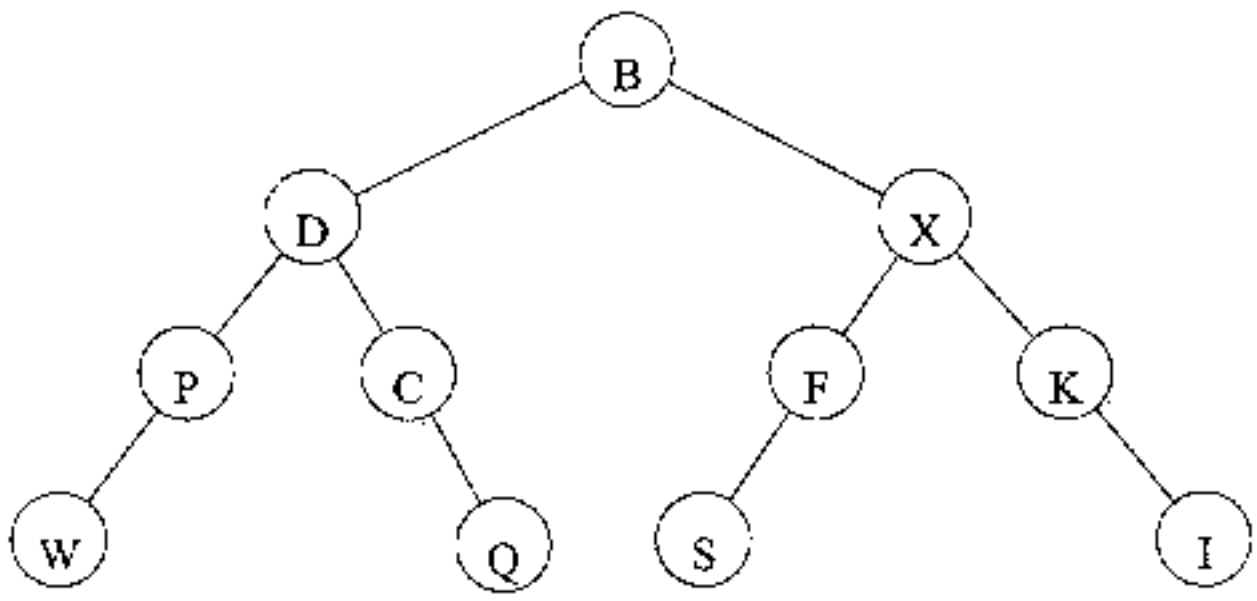
] Data Structure -- binary tree

(a) (5%) Please construct the corresponding binary search tree for each ordered sequence of values:

(37, 24, 42, 7, 2, 40, 32, 120) and (120, 42, 7, 2, 32, 37, 24, 40)

If you think both trees are identical, just draw one tree.

(b) (5%) Please write down the postorder sequence for the following binary tree.



(c) (5%) Please demonstrate all possible distinct binary trees obtainable from a 3-node binary tree having the preorder sequence 1,2,3.

(d) (5%) Please determine the maximum number of nodes in a binary tree of depth k. (Assume the root node is on level 0)