A Previous CS310 Mid-Term Exam.

June 23, 2004

Print Your Name:

Read the following now.

- You can use one page of double-sided, letter-size cheating sheet.
- Print your name clearly on this page.
- Print your initials on the top of every page.
- Write down your answers clearly. I reserve the right to take off points due to poor writing or English structures.
- One blank page is provided at the end for your convenience.

STOP! Do not turn to the next page until instructed to do so.
1. (10pt) Write a (small) segment of C++ code to re-organize a binary tree as depicted below.

```
struct Binary_node {
    int data;
    Binary_node *left, *right;
};
```

Variables root, a, b, and c in the figure are Binary_node pointers. In your answer, you can update these variables and the left and right pointers of tree nodes but are not allowed to touch the data part of tree nodes. Notice that you are NOT creating a general-purpose function. Just write down a sequence of C++ statements to carry out the above reorganization by manipulation pointers.
2. (total 20pt) Consider the following C++ code:

```cpp
class X {
public:
    int a;
    X () {a=1;};
    void f () {a += 1;};
    virtual void g () {a += 10;}
    virtual void h () = 0;
};

class Y : public X {
public:
    int b;
    Y () {a = 10; b=20;}
    void h () {b += 10;}
};

class Z : public Y {
public:
    Z () {a = -1; b = -2;}
    void f () {a -= 10;}
    void g () {b += 100;}
};

class W : public Y {
public:
    W () {a=100; b=200;}
    void g () {a += 150;}
};
```

Answer the following questions.

(a) (5pt) Circle abstract class(es): X, Y, Z, W
(b) (5pt) Circle base class(es): X, Y, Z, W
(c) (10pt) Show the outcome of the following code segment.

```cpp
Z z, *z_ptr=&z;
z.f(); z.g(); z.h();
X *x_ptr=&z;
x_ptr->f(); x_ptr->g(); x_ptr->h();
cout << z.a << ',' << z.b << '\n';
```
3. (5pt) Consider the *circular* linked list shown below.

Circle the expression(s) that is/are true.

(a) \( p->next->data > q->prev->prev->data \)
(b) \( p->next == q->next->next->next \)
(c) \( p->prev->prev->data > q->next->data \)
(d) \( p->next->next == q->prev->prev->prev \)
(e) \( p == p->next->next->next \)

4. (10pt) Draw the binary tree whose inorder and postorder traversals are given below.

Inorder: \( P A R T S C Q B V \)
Postorder: \( P R A C S Q V B T \)
5. (15pt) Starting with the AVL tree shown below, show the tree after inserting 51.
6. (10pt) Consider the binary search tree shown below. Show the tree after removing 70.
7. (total 30pt) Consider a heap whose array representation is shown below. Answer the following questions.

84 20 80 5 15 60 40 1 2 3 4 50

(a) (10pt) Draw the heap as a complete binary tree.

(b) (10pt) Show the heap, as a tree, after removing the largest element, 84.
(c) (10pt) Starting from the original heap, show the heap after inserting 90.
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