國立臺灣大學 105 學年度碩士班招生考試試題

※ 注意：請於試卷內之「非選擇題作答區」作答，並應註明作答之題號。

Please use one of C, C++, and Java languages for all programming questions.

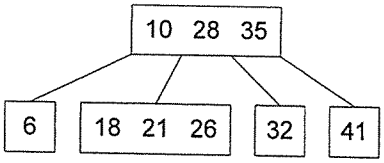
1. **(10 %)** Consider an array of length n containing positive and negative integers in random order. Write a O(n) program that rearranges the integers so that the negative integers appear before the positive integers.

2. **(10 %)** Let $f(n)$, $g(n)$, and $h(n)$ be three different functions of n that have positive values for all $n > 0$. Their relationships can be expressed as $f(n) \in \Theta(h(n))$ and $g(n) \in \Theta(h(n))$. With the formal definitions of big-Oh, big-Omega, and big-Theta notations, show that there exist positive constant numbers α and β such that $\alpha f(n) - \beta g(n) \in \Omega(h(n))$.

3. **(10 %)** Write a program that accepts a singly linked list, traverses it, and returns the data in the node with the minimum key value.

4. **(15 %)** Binary search tree.
   a. (5 %) Draw a new binary search tree created by inserting the following keys in order:
      6 13 9 1 15 4 10 7 2 8
   b. (5 %) Write the sequence of nodes visited in postorder traversal of the tree you just drew.
   c. (5 %) Redraw the binary tree after removing its root.

5. **(15 %)** 2-3-4 tree.
   a. (7 %) Draw the following 2-3-4 tree after execution of the operation insert(15).



   b. (8 %) What would the tree you just drew look like after remove(32).

6. **(10 %)** A perfect number is a number that is the sum of its factors. For example, 6 is a perfect number because $6 = 1 + 2 + 3$. Write a recursive program that calculates all perfect numbers smaller than a given integer.

7. **(10 %)** Suppose a particular dictionary needs only a retrieval operation such that the user types a word and the program provides the word's definition. Describe all possible implementations of this ADT dictionary as an English dictionary and compare their efficiency.

8. **(10 %)** Suppose there are two different algorithms or implementations that sort the edges in Kruskal's algorithm and both are correct and bug-free. Do these two algorithms produce the same minimum spanning tree on the same graph? Justify your answer.

9. **(10 %)** Show how the in-place, array-based quicksort sorts the following array:
   5 9 2 1 3 7 4 6 8
   Always choose the last element of any subarray to be the pivot. Draw the array after each swap.

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