請照題號次序作答
**Use C, C++ or Java programming language to design your computer programs.**

1. (25%) Huffman coding
   a. (10%) According to the sentence **"this is an example of a huffman tree"**, please generate the Huffman code table and encode the above sentence with your code table.
   b. (15%) Given a string S which consist of space char and lower case letters (i.e.,' ', 'a', ..., 'z'), write a program `huffman_code(str)` which can output the huffman code table which is optimized to the input string S and convert the `str` into a bit pattern according to the generated huffman code table.

2. (20%) Permutation. There are 6 permutations of the set {a, b, c}, namely (a, b, c), (a, c, b), (b, a, c), (b, c, a), (c, a, b), (c, b, a). Given a list of *k* different symbols, write a program `permute(list)` to generate all the permutations of such a list.

3. (20%)
   a. (5%) Why the **insertion sort** is one of the fastest algorithms for sorting very small arrays, even faster than **quicksort**?
   b. (15%) Implement a **quicksort** with **insertion sort** for arrays smaller than a 20 elements.

4. (20%) Given 2 different strings, please write a program `lcs(str1, str2)` to find the **longest common subsequence** (LCS).
   For examples:
   LCS for input Sequences "ABCDGH" and "AEDFHR" is "ADH" of length 3.
   LCS for input Sequences "AGGTAB" and "GXTXAYB" is "GTAB" of length 4.

5. (15%) A multiprogramming operating system uses **paging**. The available main memory is 4096KB, and each frame is 4KB. The program A needs 215KB. The program B needs 133KB. The program C needs 759KB. The program D needs 520KB. The program E needs 287KB. User 1 loads program A, B and executes them. User 2 loads program B, C and executes. User 3 loads program B, D, E and executes. These processes do not share memory.
   a. How many **frames** are unused?
   b. How much memory is wasted in **internal fragmentation**?
   c. If the system has only 1024KB main memory, at least how large the **swap space** is needed in hard disk to run all the programs?
   d. If a data locate in physical memory address 0x035738, what is the frame number of this address? (hint: the size of frame/page is 4KB, the physical memory address 0x000000 is the starting address of frame 0x000)
   e. One program contains two pages. After loading to the memory, the page 0x000 is mapped to frame 0x005, the page 0x001 mapped to frame 0x022. What is the physical memory address of the 4735th instruction (count from the beginning) in this program?

試題隨卷繳回