1. Explain the following terminologies: (18%)
   (a) Multiprogramming
   (b) Interrupt
   (c) System call
   (d) Direct memory access (DMA)
   (e) Real time system
   (f) Peer-to-peer system

2. (a) Given a polynomial \( \text{poly} = 15x^{10} + 21x^6 + 17x^5 + 6x^2 + 7 \). Suppose you want to use a singly linked list to store the polynomial. Each node in the linked list stores the coefficient and exponent of a non-zero term. Write the C (or C++) declarations of the data structure for a node. (5%)
   (b) Assume that the terms are stored in descending order according to their exponents. Please write a C (or C++) function that deletes a term with exponent \( \text{exp} \) from the linked list \( \text{poly} \). (10%)

3. Suppose an expression is represented by a binary tree which is stored in the following array.

   + − / * 5 * 6 2 3 3 8 __

   (a) Draw the binary tree of the expression. (4%)
   (b) Show the prefix and postfix form of the expression? (6%)
   (c) Evaluate the expression. (2%)

4. Given a list of data: 30, 5, 35, 38, 16, 71, 12, 56, 62
   (a) Suppose you are using a recursive quick sort function to sort the list, and median-of-three method is used to choose pivot. Show the result after each pass (i.e. each call of the function). Please indicate the pivot of each pass. (16%)
   (b) What is the time complexity of the best case of quick sort? Justify your answer. (5%)
   (c) What is the time complexity of the worst case of quick sort? Justify your answer. (5%)

5. Consider the following hash table with size 17. Each bucket contains one slot. Suppose the division hash function is used for hashing and linear probing is used to handle overflow.

   | 37 | | 24 | | | | | | | | | | | | | |

   (a) Assume that the elements with key 57, 34, 17, 33, 41, 36, 74, 80 and 16 are sequentially inserted into the hash table. Please show the content of the hash table after all elements are inserted. (5%)
   (b) What is the number of collisions in (a)? (2%)

6. What are the three transport layer protocols in TCP/IP protocol suite? What is the advantage of having three transport layer protocols? (12%)

7. (a) Why caches are useful? What problems do caches solve? (5%)
   (b) What problems do caches cause? (5%)