1. An arithmetic expression is: ((((3+1) * 3) / ((9-5) + 2)) – ((3 * (7-4)) +6))
   a) An arithmetic expression can be represented by a binary tree whose external nodes are associated with variable or constants, and whose internal nodes are associated with the operators +, -, *, /. Please convert the above expression to the binary tree structure. [4 pts.]
   b) Please describe an algorithm to evaluate the arithmetic expression tree in (a) [6 pts.]
   c) Please convert the above expression to postfix expression [4 pts.]
   d) Describe an algorithm how to use the *stack* data structure to evaluate the arithmetic expression with the postfix expression? [6. pts.]

2. S is a general *sequence* implemented with either an array or a linked list. The elements of S are pairs (k,e), where e is an element and k is its key.

A *priority queue* P is an abstract data type for storing a collection of prioritized elements that supports arbitrary elements insertion but supports removal of elements in order of priority. Let the primary methods of the priority queue P be the **InsertItem**(.) and **RemoveMin**(.) operations. **InsertItem**(P, k, e): Insert a new element e with a key k into priority queue P. **RemoveMin**(P): Remove from priority queue P and return an element with smallest key.

A *heap* H is implemented with a complete binary tree that stores a collection of keys. A minimum key is always stored at the root of H.

   a) Describe an algorithm how you implement a priority queue with an unsorted sequence S. (Design the algorithms for the **InsertItem**(.) and **RemoveMin**(.) operations with the unsorted sequence S.) What is the time complexity of the operations? [6 pts.]
   b) Describe an algorithm how you implement a priority queue with the heap H. (Design the algorithms for the **InsertItem**(.) and **RemoveMin**(.) operations with the heap structure.) What is the time complexity of the operations? [7 pts.]
   c) Describe an algorithm to do the sorting for an unsorted sequence S by using the heap H. What is the time complexity of the sorting? [7 pts.]

3. Describe in pseudo-code a recursive algorithm for enumerating all permutations of the number {1, 2, … , n} [10 pts.]

4. Please answer the following questions:
   a) Explain "Virtual address" and "Physical address" in Virtual system. [4 pts.]
   b) Discuss the difference between "RISC" and "CISC". [4 pts.]
   c) Explain "DMA" (Direct Memory Access) and "Interrupt". [4 pts.]

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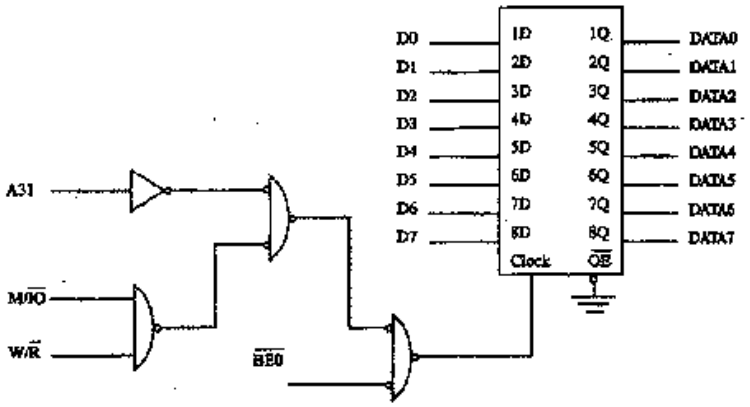
5. Please answer the following questions:
   a) What is Pipeline, Superpipeline, Superscaler, VLIW(Very Long Instruction Word). [12 pts.]
   b) In view of low power design, is there any gain for pipeline or not? Please explain the reasons. [3 pts.]
   c) What is the main advantages and disadvantages of pipeline? [3 pts.]

6. Referring to the following figure:
   a) Discuss the difference between "memory-mapped I/O" and "I/O-mapped I/O". [6 pts.]
   b) Is this port I/O or memory mapped? [2 pts.]
   c) What is the size of the port (8, 16 or 32 bits)? [2 pts.]
   d) What range of addresses will the port respond to? How many ports are in this range? [2 pts.]



7. Please describe the handshakig sequence between a host and a peripheral. [8 pts.]