1. (16) The four steps in transforming a high-level program (like C) into a program running on a computer includes using Loader, Assembler, Linker and Complier. Explain their translation sequence (relationship) and the operations in each step.

2. (14) Modern CPU (Central Processing Unit) use pipeline concept and structure to improve the performance.
   (a) Describe the principle of pipeline scheme (4)
   (b) Write down the pipeline stage and their function in modern CPU (6)
   (c) Show an example of pipeline instruction execution and make a time chart to show the execution (4)

3. (14) Briefly answer the following questions
   (a) Arrange the following storage devices of computer according to their access time (fastest to slowest) and typical capacity, KB (largest to smallest): Cache, optical disk, hard magnetic disk and DRAM.(4)
   (b) Explain the following I/O operations: programmed I/O, Interrupt-driven I/O and direct memory access (DMA)(6)
   (c) Express 49 and –49 by using 8-bit 2's complement system (4)

4. (16) For 1-bit full adder with inputs A, B, Cin and outputs S (sum) and Cout (carry).
   (a) Write down its truth table and express S and Cout in sum-of-minterms (4)
   (b) Using K-maps to obtain the minimal sum-of-product form (4)
   (c) Design the 1-bit full adder using only 2 and 3 inputs NAND gates. Draw its logic diagram.(4)
   (d) Using 1-bit full adder as a functional block design an 8-bit ripple adder (4)

5. (10) A stack arithmetic processor has the following instructions
   push X ; Put X value on the top of the stack. The size of the stack is increased by one.
   pop X ; Get X value from the top of the stack. The size of the stack is decreased by one.
   add ; Get two values from the top of the stack, then perform an addition operation. Put the results (sum of the two numbers) back to the top of the stack. That is, the instruction of add performs (i) pop X, (ii) pop Y, (iii) compute $Z = Y+X$, (vi) push Z.
   sub; The operation is similar to add but it performs subtraction $Z = Y-X$
   mul; The operation is similar to add but it performs multiplication , $Z = Y*X$
   div ; The operation is similar to add but it performs division $Z = Y/X$

Based on the above seven instructions, you are asked to write Assembly programs to compute $A+B*(C/D-E*F)-G$

6. (12) Trace the tree of Fig. 6 using
    (a) Inorder scheme (4)
    (b) Preorder schemes (4)
    (c) Write a structured pseudo code to perform Inorder scheme (4)

7. (18) A 4x4 matrix A is shown in Fig. 7. Suppose we store all elements in an array $A[i,j]$, $i = 1,2,3,4$, $j = 1,2,3,4$. Write down a **structured pseudo program code** to

    (a) Compute the sum of all diagonal elements in the matrix (denote as DM in Fig.7) (3)
    (b) Compute the sum of all elements in upper triangle matrix (denote as UTM in Fig.7) (3)
    (c) Compute the sum of all elements in lower triangle matrix (denote as LTM in Fig.7) (3)
    (d) You are asked to plot the **flowchart** and write down the **program segment** to transpose the matrix, *i.e.*, the elements of the transposed matrix, **A'**, has the property: $A'[j,i] = A[i,j]$. Can not use two matrices to do the operation. The only extra storage available is a temporary variable. (9)

    Try to use Do Loop and/or recursive calls in your program. You only need to show the key segment of the program.
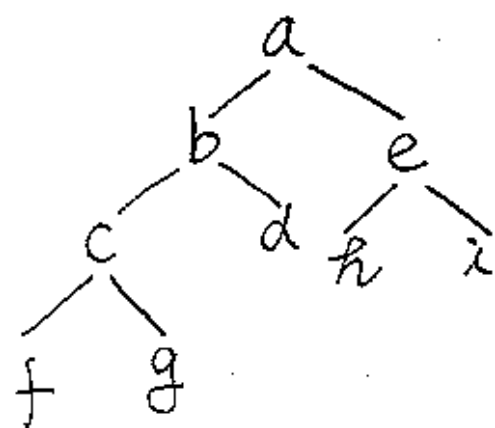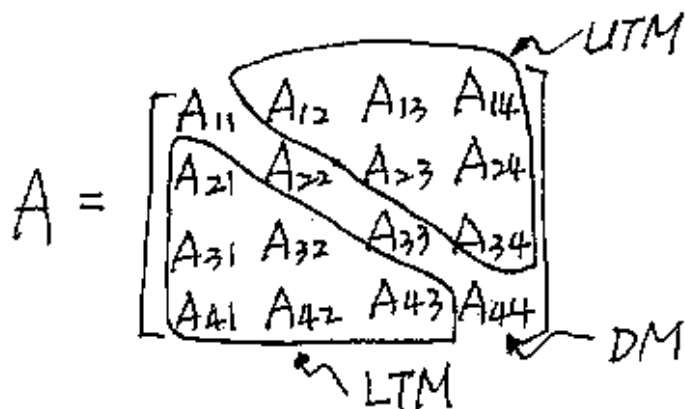

Fig. 6

Fig. 7