1. (5%, 5%) (A) Some of the smart phones are marked IP55 capable and some of them are IP67 capable. Can you explain what the difference between IP55 and IP67 is?
   (B) In addition, some high end smart phone has the 4K video recording capability. Please explain what 4K video recording is.

2. (5%, 5%) Local Binary Pattern (*LBP*) is a simple yet very efficient operator. Due to its discriminative power and computational simplicity, *LBP* operator has become a popular approach in various applications. It can be seen as a unifying approach to the traditionally divergent statistical and structural model analysis.
   The value of *LBP* for a 3×3 integer array can be calculated as following:

$$LBP = \sum_{P=1}^{8} s(Z_P - Z_0) \times 2^P \quad \text{where}$$

$$s(x) = \begin{cases} 1, \text{if } x \geq 0 \\ 0, \text{otherwise} \end{cases}$$

| | | |
|---|---|---|
| $Z_6$ | $Z_7$ | $Z_8$ |
| $Z_5$ | $Z_0$ | $Z_1$ |
| $Z_4$ | $Z_3$ | $Z_2$ |

Therefore, (A) what is the value of *LBP* for the following 3×3 integer array?
(B) how to make minimal number changes for the following 3×3 integer array to achieve *LBP* value equal to 100? Please show your new 3×3 integer array with explanation.

| | | |
|---|---|---|
| 47 | 51 | 65 |
| 62 | 70 | 70 |
| 80 | 83 | 78 |

3. (5%) What is the difference between HyperMedia and Multimedia?

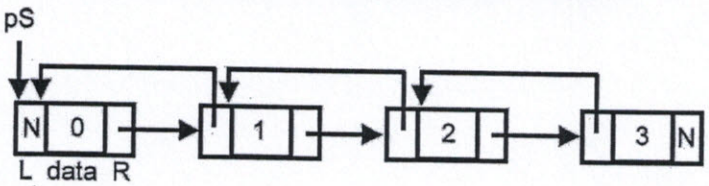
4. (5%) Please explain why the binary search is good to be implemented in the contiguous lists but not in the linked lists.

5. (7%) Explain how the Virtual Private Network (VPN) works.

6. (7%) Suppose we use the Caesar cipher to encrypt the content of a text file. Caesar cipher involves replacing each letter of the alphabet with the letter standing a few places away from the original alphabet. Assume we intercept the ciphertext "ZNOY OY G ZKYZ UL TKZCUXQ". Please compromise it using the **brute-force attack** and recover the plaintext.

7. (3%, 3%) Find the subnetwork or network address for the following networks.
   (a) IP address: 12.18.16.188, subnetwork mask: 255.255.255.128
   (b) IP address: 173.117.12.210, network mask: 255.240.0.0

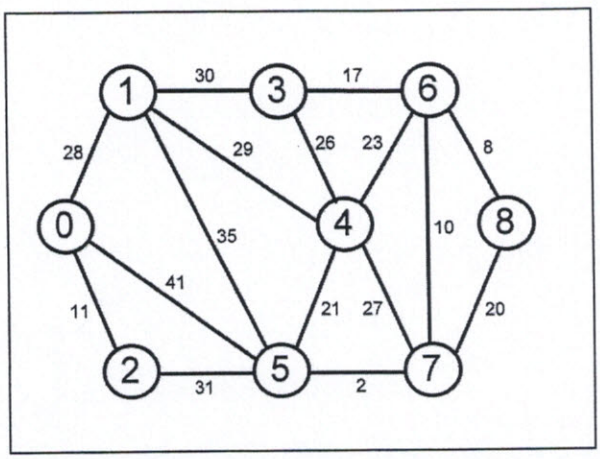
8. (10%) Given a doubly linked list as the figure, select and reorder the following codes to delete the node 1 and maintain the linked list structure.




(A) pS->R->L = pS;
(B) pS->R->R->L = pS;
(C) delete pS->R->L;
(D) delete pS->R;
(E) pS->R->R = pS->R;
(F) pS->R->L = pS->R;
(G) pS->R = pS->R->R;
(H) pS->R = pS->R->L;

9. (10%) About the undirected graph, please choose the **incorrect** descriptions from the following items and use real graphical cases to explain your answers.
   (A)Any undirected graph without cycle is a tree
   (B)Any undirected graph with n nodes and (n-1) edges, where n>=1, is a tree
   (C)Any undirected graph where every node connects to at least one other node is a tree
   (D)Any connected undirected graph is a tree
   (E)A single undirected graph can have many different spanning trees

10. (5%) Consider the graph below. Please use Kruskal's algorithm step-by-step to find the minimum-spanning tree.




11. (3%, 5%) Denote by T(n) the number of binary search trees of n distinct integers. We have T(1)=1, T(2)=2, and T(3)=5. (A) Use the abovementioned information to find T(4) in a recursive way. (B) Give a recurrence formula of T(n).

12. (4%, 4%) (A) Explain what priority queues are and suggest their applications. (B) Give appropriate data structures for implementing priority queues. Justify your answers.

13. (4%, 5%) Let $A=[a_{ij}]$ be an $n$x$n$ invertible matrix of integers. Applying a row operation to $A$ is to "multiply some row with a number" or "multiply some row with a number and then add the result to another row". We want to apply a series of row operations to matrix $A$ to derive a new $n$x$n$ matrix $B=[b_{ij}]$ such that $b_{ii}=1$ for $1 \le i \le n$ and $b_{ij}=0$ for $1 \le i < j \le n$. Design an algorithm to derive the matrix $B$, and draw a flowchart corresponding to your algorithm.