

EASTERN UNIVERSITY, SRI LANKA
SECOND EXAMINATION IN SCIENCE 2002/2003
FIRST SEMESTER (June/July, 2003)
CS201 Data Structures and Design of Algorithms

Answer all questions

Time allowed: 2 Hours

Q1 Describe briefly what an array data structure is and how it would be used to store and retrieve data.

A tri-diagonal matrix is a square matrix $A = (a_{ij})$ in which $a_{ij} = 0$ if $|i - j| > 1$.

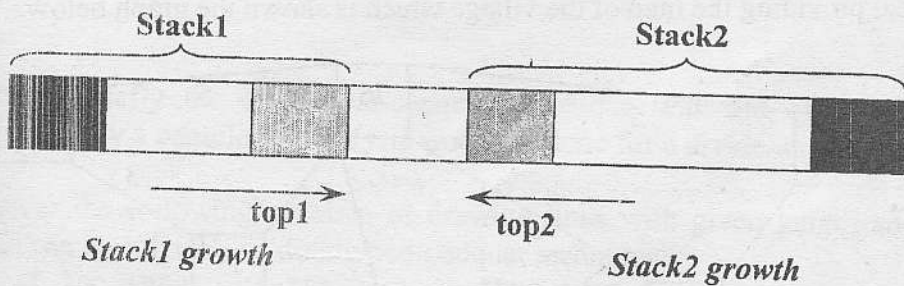
Describe briefly how such matrices can be represented by means of sequential allocation.

Write down the number of non-trivial elements in an $M \times M$ tri-diagonal matrix.

Represent a tri-diagonal matrix as a one-dimensional array in row-major fashion, and find its row sums and diagonal sums using this representation.

Q2 Define the ADT stack data structure.

An array can be used to store two stacks, one growing up from the left end, and the other growing up from the right end.



Write down the conditions for stack1 and stack2 to become empty.

Write down the conditions for stack1 and stack2 to become full.

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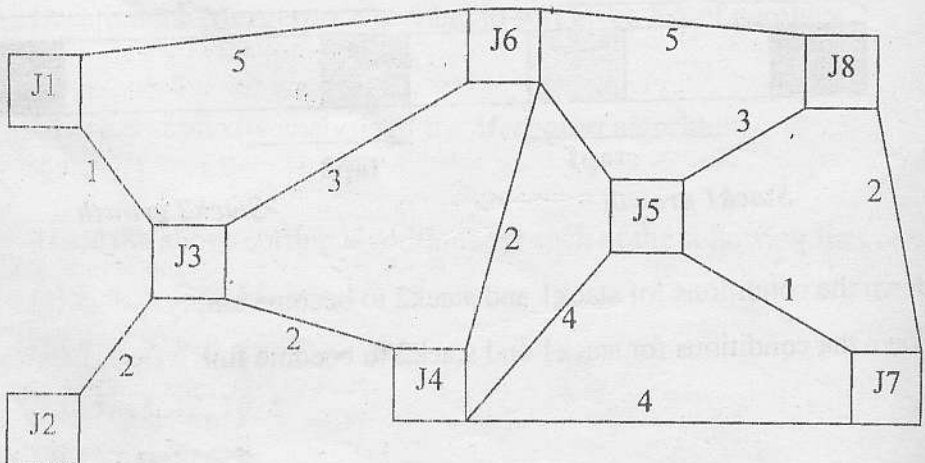
Implement the class DualStack whose declaration is given by

```
Const int MaxDualStackSize=200;
Class DualStack
{
    private:
        int top1, top2;
        DataType StackStorage[MaxDualStackSize ];
    public:
        DualStack(void);
        void Push(DataType elt, int n); // push elt on stack n
        DataType Pop(int n); // pop from stack n
        DataType Peek(int n); // peek at stack n
        int StackIsEmpty(int n); // is stack n empty?
        int StackIsFull(int n); // is stack n full?
        void ClearStack(int n);
};
```

Write a main program that can do the following:

- (i) read a sequence of integers and to push the even ones on stack1 and the odds on stack2.
- (ii) print an appropriate message if any stack becomes full.
- (iii) print the contents of each stack with an appropriate message if a stack is empty.

Q3 The CEB plans to put powerful bulbs at each junction of the Vantharumoolai village. CEB wishes to install a separate cable system to supply electricity for this purpose with minimum cable length. The programmer of the CEB is requested to compute the minimum length required, providing the map of the village which is shown the graph below:



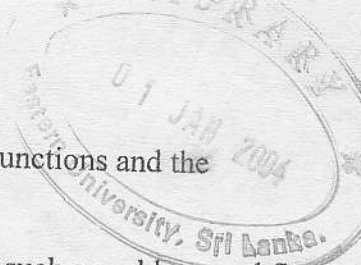
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Continuation...

In the above graph, nodes $J_1, J_2, J_3, J_4, J_5, J_6, J_7, J_8$ represent junctions and the numbers on the edges are the distances between junctions.

If you are the programmer, describe briefly how you would solve such a problem, and find the minimum cable length for this particular problem stated above.

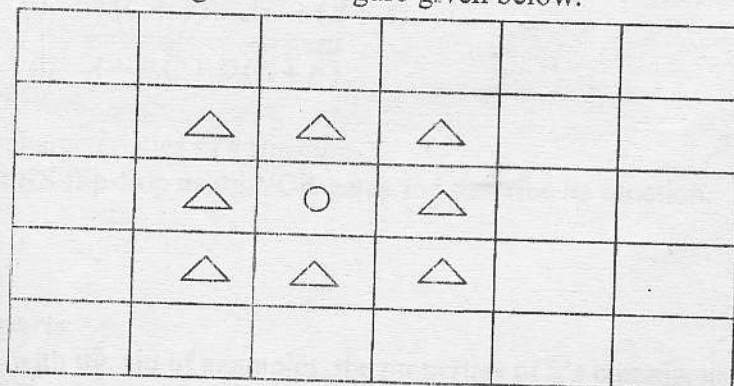
If there is a new junction J_9 situated at a distance of X from J_2 , state clearly how the value of X would alter your answer.



Q4 Answer either (a) or (b) but not both:

- (a). Describe briefly the backtracking technique with aid of a suitable example. Suppose you are asked to colour a map that comprises of many region such that no two adjacent regions have the same colour. Write an algorithm to solve this problem with the minimum number of colours.

Consider a rectangle consisting of many smaller rectangular cells with 8-way adjacency. For example the cell marked with a circle will have 8 adjacent cells that are marked with triangles in the figure given below.



Apply your algorithm to such a rectangle and find out the minimum number of colours required to colour it.

- (b). Describe briefly the divide-and-conquer technique with aid of suitable examples. Describe how a complexity analysis would be done for a divide-and-conquer algorithm.

Consider the following problem of drawing lines with given length and angle theta which can be solved by a divide-and-conquer technique:

If the length of the line is less than a given minimum length the line is drawn of the length at an angle theta from the current position.

If the length of the line is more than the minimum length the length is split into three equal portions. The drawing of the first portion will be solved with theta, and the drawing of the second portion will be solved with theta+60, and drawing of the third portion will be solved with theta-60.

Rewrite the above as a divide-and-conquer algorithm, and do a complexity analysis.