



OLD EXAM SERVICE

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Question 1

(Part a) Determine, and prove using induction, the best function $f(n)$ such that $T(n)$ is $O(f(n))$ of the following recurrence relation.

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$$T(n) = \sqrt{n} + T(n-1)$$

$$T(0) = 0$$

(Part b) Solve the following recurrence relation:

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$$T(n) = 2n^2 + 9T\left(\frac{n}{3}\right)$$

$$T(0) = 1$$

Question 2: Recall that on programming questions, your mark will depend on the space and time efficiency of your solution! Optimize for code to be given in this question.

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(Part a) Give a type declaration for an implementation of an ordered tree.

(Part b) Give a procedure that takes a single parameter T , the root of an ordered tree and does a DFS (preorder) traversal of an ordered tree.

Question 3: (a) Add the following elements in turn to an AVL tree: 13 8 12 5 2 9 10 7 6 11

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(b) Show the AVL tree that would result if the 2 was deleted.

Question 4

The following are the Huffman codes for the characters 'a' to 'h', codes for other characters ('i', 'j', 'k', 'l') are not given (and may not be needed). You must assume that the frequencies of the characters 'i', 'j', ... decrease as the character gets closer to 'z'. Fill in the blanks with appropriate values such that the number of characters with codes is minimal.

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Char	Frequency	Code
a		000
b		00100
c		00101
d		00110
e		11
f		00111
g		1010
h		100
i	27	
j		
k		
l		

Question 5

Short Answers. Give the best, shortest answer.

- A left heavy tree is a binary tree where the number of nodes in the left subtree is at least as many as the number of nodes in the right subtree and at most one plus twice the number of nodes in the right subtree. What is the maximum height of a left heavy tree with n nodes?
- How many different free trees are there with 5 nodes?
- How could you use a priority queue as a stack?
- List the important property (properties) of a good hash function.
- Draw the graph with the fewest number of edges that contains a cycle and has diameter 5.
- Draw the tree with degree sequence representation $2, 4, 0, 3, 0, 0, 0, 0, 1, 0, 1, 1, 0$
- Give the preorder enumeration of weights representation for the tree from part (f).
- Give the bitsequence representation of the tree given in part (f).

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Question 6

Write a function that takes three parameters, a graph and two vertices, u and v , and returns the value true if there is a path from u to v . If you assume the existence of any queue routines you will lose 3 marks. You may want to consider a function in a function. Although you need not write your code in Pascal, you may assume the following datatype in the language you use:

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```
type
  ptr = ^cell;
  cell = record
    vertex: integer;
    next: ptr;
  end;
  Graph = Record
    Size: integer;
    Adj: array[1..100] of ptr;
  end;
```

Question 7

Write a function, called AVL, that takes a single parameter and, the root of a binary tree and returns the value true if the tree is an AVL tree and returns the value false otherwise. Hint, you may want to have a function with additional parameters inside the function AVL. You will lose three marks if your solution is not $O(n)$.

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Question 8

(a) Give the type declaration for the array representation of a complete binary tree.

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(b) Write a procedure that takes the array representation of a complete binary tree and does a level order traversal of the tree. Note that you may use any queue or stack routines that you would like.