Sunday, 3 March 2024

Total marks: 100

Duration: 1 hour

CSE 102 - Data Structures and Algorithms
Mid-semester Examination, Winter 2024

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*Calculators are allowed to use. Use of mobile devices/ computers/ tablets is prohibited. Using books/ notes or any other reference material is not permitted. Attempt **all** questions; options are provided within questions, if any. Show all of your working.*

Question 1:

(a) Define a doubly linked list. Write pseudocode for operations: Insert, Delete, and Search. [20 marks]

(b) Explain the Counting sort ~~linear search~~ algorithm and derive its time complexity. [20 marks]

Question 2:

Solve using recursion tree method (without using Master's theorem):

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

Show all your working and calculations. [25 marks]

OR

Prove by induction that the i^{th} Fibonacci number satisfies the equation:

$$F_i = \frac{(\varphi^i - \hat{\varphi}^i)}{\sqrt{5}}$$

where ϕ is the golden ratio and $\hat{\phi}$ is its conjugate given by:

$$\varphi = \frac{1+\sqrt{5}}{2}, \hat{\varphi} = \frac{1-\sqrt{5}}{2}.$$ [25 marks]

Question 3:

Describe an algorithm that, given n integers in the range 0 to k, preprocesses its input and then answers any query about how many of the n integers fall into a range $[a : b]$ in $O(1)$ time. Your algorithm should use $\theta(n + k)$ preprocessing time. [35 marks]

OR

For a given expression string, 'exp' develop an algorithm to determine if the pairs and orderings of brackets '{', '}', '(', ')', '[', and ']' are correct within the expression. Write pseudocode for your algorithm. [35 marks]

Example:

For Input: exp = "[0]{}{00}"
Output: Balanced
Explanation: All brackets are correctly paired and ordered.

For Input: exp = "[()"
Output: Not Balanced
Explanation: The brackets at positions 1 and 4 are not correctly balanced because there's a closing ']' before the closing '('.