**ES242** **Name:** _____
**29/11/2018** **Roll Number** _____
**Time Limit: 150 Minutes**

---

**Important Instructions**

1. **Please write your answers in the space provided in this paper only.**
2. **You can first do the rough work on the rough sheets provided to you and when you are confident about your answer, then you can write the answer in the main answer script.**
3. **Please write pseudocode for the algorithmic questions asked in the paper. Also prove the correctness and running time of your algorithm.**
4. **There is no need to give proof of algorithms done in the class**

Grade Table (for instructor use only)

| Question | Points | Score |
|---|---|---|
| 1 | 5 | |
| 2 | 10 | |
| 3 | 10 | |
| 4 | 10 | |
| Total: | 35 | |

---

1. (5 points) **Binary Search Tree**

   Given a binary tree $T$ on $n$ numbers, we wish to check whether $T$ is a binary search tree or not. Design an algorithm that can perform the above task in $O(n)$ time.

.

2. (10 points) **Graph Traversal-1**

   Suppose a CS curriculum consists of $n$ courses, all of them mandatory. The prerequisite graph $G$ has a node for each course, and an edge from course $v$ to course $w$ if and only if $v$ is a prerequisite for $w$. Find an algorithm that works directly with this graph representation, and computes the minimum number of semesters necessary to complete the curriculum (assume that a student can take any number of courses in one semester). The running time of your algorithm should be $O(m + n)$.

.

3. (10 points) **Graph Traversal-2**

   Given a strongly connected directed graph, find if there exists a cycle of odd length in it in $O(m + n)$ time.

.

4. (10 points) **Shortest paths**

   When there are many shortest path from $s$ to $t$ in a directed graph $G$ (with positive edge weights), it is natural to choose the shortest path with fewest edges. Design and analyze an algorithm which can the shortest path with fewest edges from $s$ to $t$.

.

.