

**Indian Institute of Technology Kharagpur**  
**Dept. Computer Science and Engineering**

Subject No.: CS31005

Subject Name: Algorithms II

Total marks: 30

Duration: 1 hour

Class Test 2

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**Answer all questions.**

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1. Adapt the Karger's min-cut algorithm to output the minimum cut of an edge-weighted undirected graph. The weights of the edges are positive integers. The runtime of your algorithm should be the same as or better than the runtime of Karger's algorithm.
    - (a) 3 points Explain your approach in English language.
    - (b) 3 points Write the pseudo-code of your algorithm.
    - (c) 3 points Analyze the error probability of your algorithm.
    - (d) 3 points Analyze the running time of your algorithm.
  
  2. 3 points Prove or disprove: There is a decision problem that is NP-complete but not NP-hard.
  
  3. 7.5 points The Exact 3-SAT problem takes as input a 3-SAT formula on  $n$  variables and  $m$  clauses, and decides if there is a satisfying assignment such that each clause has exactly one literal set to true. Show that Exact 3-SAT is NP-complete.
  
  4. 7.5 points A dominating set of a graph  $G$  is a vertex subset  $S \subseteq V(G)$  such that for every vertex  $v$  of the graph either  $v \in S$  or there is a neighbour of  $v$  in  $S$ . The Dominating Set problem takes as input a graph  $G$  and a positive integer  $k$  and decides if there is a Dominating Set in  $G$  of size at most  $k$ . Show that this problem is NP-complete.
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