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THE NATIONAL UNIVERSITY OF IRELAND, CORK

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UNIVERSITY COLLEGE, CORK

Summer Examinations 2011

Fourth Science Computer Science

CS4407: Algorithms

Sample Final Exam

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(Instructions –Answer all Questions.)

Time 1.5 Hours

CS4407: Algorithms

Sample Final

Please answer all questions; Total marks: 100

Points for each question are indicated by [xx]

1. [20] Consider the *BubbleSort* algorithm.
 - (a) [15] Use the loop invariance approach to analyse this algorithm.
 - (b) [5] Use this approach to specify the complexity of the algorithm.

2. [20] Assume that Not All Equal 3SAT (a variant of 3SAT) is NP-Complete. Prove that Not All Equal 3SAT can be reduced to Set Splitting, thus proving that Set Splitting is NP-complete.

Not All Equal 3SAT

INSTANCE: Set U of variables, collection C of clauses over U such that each clause has 3 variables.

QUESTION: Is there a truth assignment for U such that each clause in C has at least one true literal and at least one false literal?

Set Splitting

INSTANCE: Collection C of subsets of a finite set S .

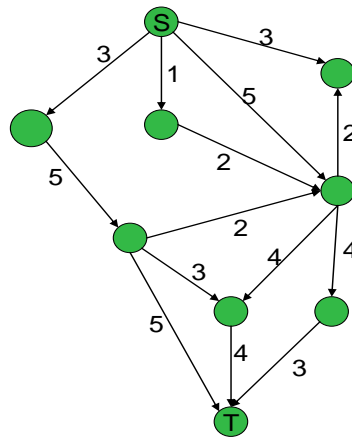
QUESTION: Is there a partition of S into two subsets S_1 and S_2 such that no subset in C is entirely contained in either S_1 or S_2 ?

3. [20] Consider the Travelling Salesman Problem on a complete undirected graph G with a length $L(i,j) \geq 0$ for each edge (i,j) . Suppose the lengths satisfy
$$L(i,j) \leq L(i,k) + 2 L(k,j) \text{ for all } i, j, k.$$

(a) [10] Provide an approximation algorithm for G .

(b) [10] What is the approximation ratio?

4. [20] Consider a graph $G(V,E)$, with source node S and sink node T . For the instance of a flow network shown below, compute the maximum flow. Give the actual flow as well as its value. Justify your answer.



5. [20] Given the weighted directed graph G shown below,
- [10] Describe an algorithm that can be used to test the graph below for cycles
 - [10] Can a greedy algorithm be used to compute min-cost paths from a node s to all other nodes? If not, show why. If yes, show the algorithm you can use.

