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THE NATIONAL UNIVERSITY OF IRELAND, CORK

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UNIVERSITY COLLEGE, CORK

Midterm Examination

Fourth Science Computer Science

CS4407 : Algorithms

Sample Final Exam

Professor C. Shankland
Professor G. Provan

(**Instructions** –Answer all Questions.)

Time 60 minutes

CS4407 : Algorithms
Sample MidTerm, Period 2

Please answer all questions; Total marks: 100
Points for each question are indicated by [xx]

1. **[25]** 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. **[25]** 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

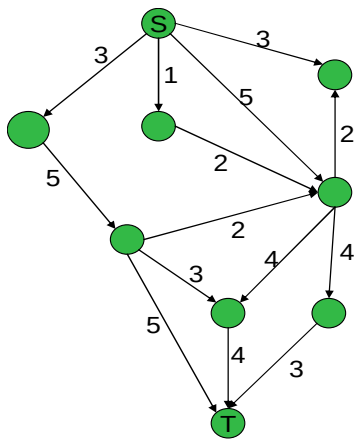
   INSTANCE: Collection C of subsets of a finite set S.
   QUESTION: Is there a partition of S into two subsets S1 and S2 such that no subset in C is entirely contained in either S1 or S2?

3. **[25]** Consider the Travelling Salesman Problem on a complete undirected graph G with a length L(i.j)≥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.**[25]** 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.