MASTER OF COMPUTER SCIENCE AND ENGINEERING EXAMINATION, 2017

(1st Semester)

ADVANCED ALGORITHMS

Time: Three Hours

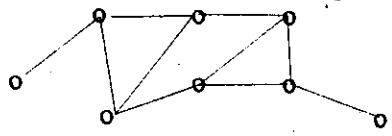
Full Marks 100

Answer any 5 questions.

1. (a) Write an algorithm to find both the smallest and largest elements in a set containing n entries. Try to find a method that does at most roughly $1.5n$ comparisons of elements.
(b) Can the master method be applied to the recurrence $T(n) = 4T(n/2) + n^2 \lg n$? Why or why not? Give an asymptotic upper bound for this recurrence.
(c) What is amortized analysis? Show how *accounting method* can be applied for analysis of binary counter.

8+6+(2+4)=20

2. (a) What is the importance of *approximation algorithms?* What is an *approximation ratio*? What do you mean by a *PTAS* and *FPTAS*? Give an example of each.
(b) Discuss an approximate algorithm for *Vertex Cover* problem. What is the approximation ratio for your algorithm? Prove your answer.
(c) Find the exact vertex cover of the following graph. (suitably name the vertices). Also find the approximate vertex cover using the algorithm discussed in question 2(b).



(2+2+2+2)+(3+4)+5=20

3. (a) Discuss the *Trim* function for the approximate algorithm of subset sum problem. Using the subroutine show how the lists of integers are reduced in case of the following input: {0,4,5,8}. Consider all the iterations. Take a suitable value of ε for the Trim function.
(b) Discuss *Polynomial Reduction.* What is its implication? What is NP-completeness? How do you prove that a problem is NP-complete?

(3+9)+8=20

4. (a) A company makes two products (X and Y) using two machines (A and B). Each unit of X that is produced requires 50 minutes processing time on machine A and 30 minutes processing time on machine B. Each unit of Y that is produced requires 24 minutes processing time on machine A and 33 minutes processing time on machine B.
At the start of the current week there are 30 units of X and 90 units of Y in stock. Available processing time on machine A is forecast to be 40 hours and on machine B is forecast to be 35

hours. The demand for X in the current week is forecast to be 75 units and for Y is forecast to be 95 units. Company policy is to maximise the combined sum of the units of X and the units of Y in stock at the end of the week (i.e. the company must be able to fulfill the demand of the current week and still will be able to maximise the stock at the end of the week.)
Formulate a problem of deciding how much of each product to make in the current week as a linear program.
(b) Write the standard form of the problem.
(c) Find its dual.
(d) Briefly explain how the optimal solution can be found using simplex algorithm (No solution of the above problem is required. Just mention the general idea).

10+3+3+4=20

5. (a) Draw the KMP flowchart with fail indexes for the pattern "EINSTEIN".
(b) Use the flowchart to find the pattern "Einstein" in the text "Ich bin kein Einstein". Ignore cases and show all the steps.
(c) Compare the number of comparisons required in the above case with the number of comparisons required by a *SimpleScan* algorithm.

8+8+4=20

6. (a) Using Boyer-Moore first heuristic, find how many comparisons are required to locate the pattern "Einstein" in the following text: "Du bist kein Einstein". (ignore cases)
(b) List the values in the charjump array for Boyer-Moore algorithm for the pattern "Einstein".
(c) Discuss the PRAM model of parallel computation. What are the different types of PRAM model?
(d) What are the disadvantages of PRAM model? How are they overcome in BSP model?

8+4+4+4=20

7. (a) Discuss the *Hire-Assistant* problem. Explain how the problem can be randomized. What is the expected cost of hiring an assistant in a random *Hire-Assistant* problem?
(b) What is a non-deterministic algorithm? Give an example of non-deterministic algorithm.
(c) "For a given problem X, algorithm A performs better than algorithm B". Discuss how do you prove or disprove the statement.

(3+3+3)+(2+4)+5=20