Course Id: CS204

Total Marks: 60

1. Each question has 2 marks. 2X6=12

a) Which of the following is true?
   i) $n= o(n^2)$ and $n^2 = o(n^2)$ ii) $n= o(n^2)$ and $n \neq O(n^2)$
   iii) $n= o(n^2)$ and $n = O(n^2)$

b) Which of the following is true:
   i) Standard Mergesort (in an array), quicksort and heapsort all are in-place
   ii) Quicksort and heapsort are in-place but standard Mergesort (in an array) is not
   iii) Standard Mergesort (in an array) is in-place but quicksort is not.

c) What is the rank bound for Fibonacci Heap?
   i) $\log_2 n$ ii) $\log_k n$ where $k=(1+\sqrt{5})/2$ iii) $\log_k n$ where $k=(\sqrt{5}-1)/2$

d) Apply quicksort to the sequence of numbers
   6 8 3_1 4 9 3_2 5
   What will be the result?
   i) 3_1 3_2 4 5 6 8 9 ii) 3_2 3_1 4 5 6 8 9

e) Time complexity of which sorting algorithm is $\Theta(n^2)$ for a problem of size n?
   i) Bubblesort ii) Selectionsort iii) Insertionsort

f) What are the amortized timing requirement of deletemin and decrease-key for fibanacci heap
   i) O(logn) and O(1) ii) O(1) and O(1) iii) O(logn) and O(logn)

2. Each question carries 8 marks 8X6=48

a) Compute the time complexity of Prim's algorithm using binary heap and Fibonacci heap. 4+4

b) Consider the sequence of operations: Insert(25), Insert(10), Insert(15), Deletemin, Insert(45), Insert(60), Insert(4), Deletemin, Deletemin, Insert(8).
   Construct the binomial heap with eager meld and lazy meld showing all intermediate steps. 4+4

c) Negative weight edge cannot be handled with Dijkstra's algorithm for general graph, why? It is possible with Bellman-ford algorithm, why? For what kind of graphs, Dijkstra's algorithm can handle negative weight edge and why? Give reason in each case. 3+3+2

d) Deduce the worst case time complexity of standard quicksort? How it can be reduced? Deduce the complexity of that algorithm which you have to apply to reduce the worst case complexity of quicksort? 1+1+6

e) Explain the steps of an efficient divide-and-conquer algorithm to multiply two integers X and Y (with n-bit binary representation) with the example where X=12 and Y=13. Deduce the complexity of this divide-and-conquer algorithm for Integer Multiplication. 4+4

f) Deduce the amortized time for decrease-key operation for Fibonacci Heap. Deduce the rank bound for the same. 4+4