Master of Computer Applications
Department of Computer Science & Engineering,
Motilal Nehru National Institute of Technology Allahabad.

End Semester Examination 2016-17 (odd)

Subject: Analysis of Algorithms (CA 3304) **Duration:** 3 HRS **Max. Marks:** 60

Note: Be specific and **to the point** in your answers. Make assumptions wherever necessary and quote it. All questions are compulsory. Neat answers, without cuttings will be appreciated. It is advisable to **design the solution in rough before writing the final answer**. Answer the questions **serially**.

Q1. *k*-WAY MERGE algorithm or MULTIWAY MERGES are a specific type of sequence merge algorithms that specialize in taking in multiple sorted lists and merging them into a single sorted list. These merge algorithms take in a number of sorted lists greater than two. In the context of *k*-WAY MERGE design a fast algorithm for merging *k* sorted lists with complexity analysis. (Do not write code, write only steps with example). **[10]**

Q2. Write an algorithm to find the second smallest or second largest of n elements in $n + \lceil \log n \rceil - 2$ comparisons. Support your answer with examples. **[10]**

Q3. Prove that the time complexity of function *fun()* is $\Theta(nlgn)$. ***[10]***

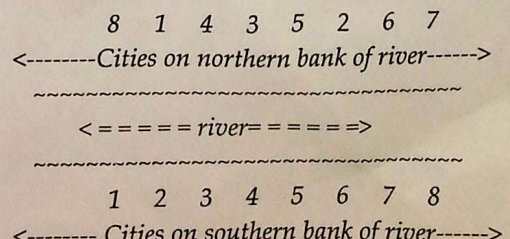
```
void fun()
{ for (int i=1; i<=n; i++)
    for (int j=1; j<=log(i); j++)
      printf("LIFE IS SHORT  ENJOY IT");
}
```

Q4. Although merge sort runs in $\Theta(n\log_2 n)$ worst-case running time and insertion sort runs in $\Theta(n^2)$ worst-case time, the constant factors in insertion sort can make it faster in practice for small problem sizes on many machines. Thus, it makes sense to coarsen the leaves of the recursion by using insertion sort within merge sort when sub-problems become sufficiently small ($\leq k$). Consider a modification to merge sort in which n/k sub-lists of length k are sorted using insertion sort and then merged using the *k*-WAY MERGE algorithm, where k is a value to be determined by the developer. In context of the above scenario answer the following questions:

a) Show that insertion sort can sort the n/k sublists, each of length k, in $\Theta(nk)$ worst-case time. **[3]**
b) Write the time complexities of modified algorithm and standard merge sort. **[3]**
c) What is the largest value of k as a function of n, for which the modified algorithm has the same running time as standard merge sort, in terms of Θ notation? **[3]**
d) Let us assume that for inputs of size n, insertion sort runs at $8n^2$ while merge sort runs at $64n\lg_2 n$. As a developer find the values of n for which insertion sort beat merge sort? **[3]**
e) What accounts for the difference in worst case running times of merge sort and quick sort? **[3]**

Q5. Consider a *2-D* map with a horizontal river passing through its center. There are n cities on the southern bank with x-coordinates $a(1)$ ... $a(n)$ and n cities on the northern bank with x-coordinates $b(1)$ ... $b(n)$. You want to connect as many *north-south* pairs of cities as possible with bridges such that **no two bridges cross**. When connecting cities, you can only connect city i on the northern bank to city i on the southern bank. Propose a dynamic programming solution (recursive structure) for finding the maximum number of bridges that can be built. Also find the solution for sample data. **[15]**

Sample data:
Cities you can connect via bridges are:
(8,1), (1,2), (4,3), (3,4), (5,5), (2,6), (6,7), (7,8).
However, you cannot build bridge (4,3) and (3,4) simultaneously because they will cross. In the same way (3,4) and (2,6) cannot be constructed together. Many other cases like these may exist.



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Master of Computer Applications
Department of Computer Science & Engineering,
Motilal Nehru National Institute of Technology Allahabad.

Mid Semester Examination 2016-17 (odd)

Subject: Analysis of Algorithms (CA 3304) **Duration:** 1.5 HRS **Max. Marks:** 20

Note: Be specific and **to the point** in your answers. Make assumptions wherever necessary and quote it. All questions are compulsory. Neat answers, without cuttings will be appreciated. It is advisable to design the solution in rough before writing the final answers. Answer the questions serially.

```
RANDOMIZED-SELECT (A, p, r, i)
1  if p == r
       return A[p]
2  q = RANDOMIZED-PARTITION (A, p, r)
3  k = q-p+1 // total elements on the left of the partition +1
4  if i == k   // the pivot value is the answer
       return A[q]
5  else if i < k
       return RANDOMIZED-SELECT (A, p, q-1, i)
6  else
       return RANDOMIZED-SELECT (A, q+1, r, i-k)
```

Q1. Answer following questions in context of algorithm RANDOMIZED-SELECT: **[3x2=6]**

a. If $T(n)$ be the running time of the algorithm, write the recurrence relation for $T(n)$ and solve it using Master's Method.

b. Provide an iterative version of RANDOMIZED-SELECT.

Q2. COUNTING SORT algorithm assumes that each of the n input elements is an integer in the range 0 to k, for some integer k. When $k=O(n)$, the sort runs in $\Theta(n)$ time. Change COUNTING SORT algorithm for the numbers lying in the range p to q where $(q-p)$ is still $O(n)$. Also analyze the new complexity. **[6]**

Q3. *K*-WAY MERGE algorithms or MULTIWAY MERGES are a specific type of sequence merge algorithms that specialize in taking in multiple sorted lists and merging them into a single sorted list. These merge algorithms take in a number of sorted lists greater than two. Design a fast algorithm for merging k sorted lists with its complexity analysis. **[6]**

Q4. Justify that the complexity of *BUILD-MAX-HEAP* over an array of size n is $O(n)$. **[2]**

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Motilal Nehru National Institute of Technology Allahabad
Department of Computer Science and Engineering
MCA III-Sem, End-Sem Exam, December 2016
Operating System (CA3301)

Time 3 Hour **M.M. 60**

All questions are compulsory. Assume any missing data and mention it at the top of answer.

Q 1 Consider a pre-emptive priority scheduling algorithm based on dynamically changing priorities. Larger priority numbers imply higher priority. When a process is waiting for the CPU (in the ready queue, but not running), its priority changes at a rate δ; when it is running, its priority changes at a rate μ. All processes are given a priority of 0 when they enter the ready queue. The parameters δ and μ can be set to give many different scheduling algorithms. **2+2 marks**

1. What is the algorithm that results from $\mu > \delta > 0$?
2. What is the algorithm that results from $\delta < \mu < 0$?

Q 2 Consider a memory system with a cache access time of 10ns and a memory access time of 200ns, including the time to check the cache. What hit rate H would be required in order to achieve an effective access time 10% greater than the cache access time? **4 marks**

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Q 3 Consider the following page reference string: **2*3 marks**

1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6.

How many page faults would occur for the following replacement algorithms, assuming five frames? Remember all frames are initially empty, so your first unique pages will all cost one fault each.

- LRU replacement
- FIFO replacement
- *Optimal replacement*

Q 4 Suppose that you wish to design a virtual memory system with the following characteristics: **3*2 marks**

- The size of a page table entry is 4 bytes.
- Each page table must fit into a single physical frame.
- The system must be able to support virtual address spaces as large as 256 GB.

1. Suppose that you decide to use a multi-level paging scheme with no more than two levels of page tables. What is the minimum page size that your system must have?
2. Suppose instead that you are willing to use a three-level paging scheme. What is the minimum page size that your system must have in this case?

Q 5 Consider a system with three smoker processes and one agent process. Each smoker continuously rolls a cigarette and then smokes it. But to roll and smoke a cigarette the smoker needs three ingredients: tobacco, paper and matches. One of the smoker processes has paper another has tobacco and the third has matches. The agent has an infinite supply of all three materials. The agent places two of the ingredients on the table. The smoker who has the remaining ingredient then makes and smokes a cigarette, signalling the agent on completion. The agent then puts out another two of the three ingredients, and the cycle repeats. Write a program to synchronize the agent and the smokers using synchronization. **10 marks**

Q 6 Consider a demand-paged computer system where the degree of multiprogramming is currently fixed at four. The system was recently measured to determine utilization of CPU and the paging disk. The results are one of the following alternatives. For each **3*2 marks**

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case, what is happening? Can the degree of multiprogramming be increased to increase the CPU utilization? Is the paging helping?

1. CPU utilization 13 percent; disk utilization 97 percent
2. CPU utilization 87 percent; disk utilization 3 percent
3. CPU utilization 13 percent; disk utilization 3 percent

Q 7 Name and explain the four conditions of the deadlock. **4 marks**

Q 8 Assume that a task is divided into four equal-sized segments and that the system builds an eight-entry page descriptor table for each segment. Thus, the system has a combination of segmentation and paging. Assume also that the page size is 2 Kbytes. **1+2+2 marks**

a. What is the maximum size of each segment?
b. What is the maximum logical address space for the task?
c. Assume that an element in physical location 00021ABC is accessed by this task. What is the format of the logical address that the task generates for it? What is the maximum physical address space for the system?

Q 9 Explain the following. **1*5 marks**

1. Thrashing
2. Working set model
3. Multiprogramming vs. timesharing
4. TLB
5. ULT and KLT

Q 10 You have been hired by Allahabad Development Authority (ADA) to automate the flow of traffic on a one-lane bridge between Jhunsi and Allahabad that has been the site of numerous collisions. ADA wants you to implement the following rules: ***10 marks***

- Traffic can flow in only a single direction on the bridge at a time.
- Any number of cars can be on the bridge at the same time, as long as they are all traveling in the same direction.
- To avoid starvation, you must implement the "five car rule": once 5 or more consecutive Allahabad bound cars have entered the bridge, if there are any Jhunsi bound cars waiting then no more Allahabad bound cars may enter the bridge until some Jhunsi bound cars have crossed. A similar rule also applies once 5 or more consecutive Jhunsi bound cars have entered the bridge.

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Motilal Nehru National Institute of Technology Allahabad
Department of Computer Science and Engineering
MCA III-Sem Mid-Sem Exam, September 2016
Operating System (CA 3301)

Time 1.5 Hour **M.M.20**

All questions are compulsory. Assume any missing data and mention it at the top of answer.

Ques 1 Recall the various deadlock detection and prevention algorithms we've discussed in the class, and consider the following snapshot of a system with five processes (P1, P2, P3, P4, P5) and four resources (R1, R2, R3, R4). There are no current outstanding queued unsatisfied requests.

Currently Available Resources

RI	R2	R3	R4
2	1	2	0

	Current allocation				Max need				Still needs			
Process	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**
P1	0	0	1	2	0	0	3	2	0	0	2	0
P2	2	0	0	0	2	7	5	0	0	7	5	0
P3	0	0	3	4	6	6	5	6	6	6	2	2
P4	2	3	5	4	4	3	5	6	2	0	0	2
P5	0	3	3	2	0	6	5	2	0	3	2	0

a) Is this system currently deadlocked, or can any process become deadlocked? Why or why not? If not deadlocked, give an execution order. **3 marks**

b) If a request from a process P1 arrives for (0, 4, 2, 0), can the request be immediately granted? Why or why not? If yes, show an execution order. **3 marks**

Ques 2 A barbershop has a cutting room with one chair and a waiting room with "n" chairs. Customers enter the waiting room one at a time if the space is available; otherwise they go to another shop. Each time the barber finishes a haircut the customer leaves to go out to another store, and a waiting customer, if there is one, enters the cutting room and has a haircut. Customers may enter the waiting room one at a time, or waiting customers may enter the (empty) cutting room one at a time, but these events are mutually exclusive. If the barber discovers that the waiting room is empty, the barber falls asleep in the waiting room. An arriving customer finding the barber asleep wakes the barber and has a haircut; otherwise the arriving customer waits. Use semaphores to coordinate the operation of the barber and the clients. **10 marks**

Ques 3 Consider a code segment given below:

```
int main()
{
pid_t child_pid;
child_pid=fork();
if(child_pid>0)
{
sleep(120);
}
else
{exit(0);
}
return 0;
}
```

What would be the ps listing in the following cases:

1. If you run ps within 2 minutes of the execution. **2 marks**
2. If you run ps after the 2 minutes of the execution. **2 marks**

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Motilal Nehru National Institute of Technology Allahabad

Department of Computer Science & Engineering

MCA Third Semester, Ph.D

End Semester Examination 2016

Subject Code/Name: CA3303/Soft Computing

Duration: **3 Hours** MaximumMarks:**60**

Note: Be brief while answering the questions. Answer all parts of question in continuous pages. Write your assumptions before answering any question with missing data (*if you find one*).

Good Luck.

Q 1. **a)** Give the classification tree of optimization techniques. (2 Marks)
b) Give the working principle of Genetic Algorithms. (2 Marks)
c) What two requirements should a problem satisfy in order to be suitable for solving it by a GA? (2 Marks)
b) Draw following activation functions of a neuron (2 Marks)
Step function, Signum function, Sigmoid function, and Linear function

Q 2. **a)** Can a fuzzy membership be True and False at the same time? Answer with suitable example. (2 Marks)
b) Write down the meaning of the membership degree for a fuzzy set. (2 Marks)
c) Design networks using M-P neurons for 3-input NOR and NAND logic gates. (2 Marks)
d) Give two examples of pattern recognition tasks to illustrate the superiority of the biological neural network over a conventional computer system. (2 Marks)

Q3. Show that if A and B are sets, then
a) $B - A = B \cap A'$. (2 Marks)
b) $(A \cap B) \cup (A \cap B) = A$. (2 Marks)
c) Let A and B be subsets of a universal set U. Show that $A \subseteq B$ if and only if $B' \subseteq A'$. (2 Marks)

Q 4. **a)** Suppose that $A \times B = \varnothing$ where A and B are sets. What can you conclude? (2 Marks)
b) Use a Venn diagram to illustrate the set of all months of the year whose names do not contain the letter R in the set of all months of the year. (2 Marks)
c) List at least four applications of Genetic Algorithms. (2 Marks)
d) Consider a fuzzy set Age as defined below
Age={(20,0),(30,0.2),(40,0.4),(50,0.6),(60,0.8),(70,1),(80,1)}. Give the alpha cut for α=0.4 for the set Age. (2 Marks)

P.T.O.

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Q 5. **a)** Define the terms chromosome, fitness function, crossover and mutation as used in genetic algorithms. (2 Marks)

b) Give the predicate logic statements for the following (4 Marks)

i) Ram likes all kinds of food.

ii) Sita likes anything which Ram likes.

iii) Raj likes those which Sita and Ram both like.

iv) Ali likes some of which Ram likes.

Q 6. Consider the following real variables from everyday life: (6 Marks)

- Income measured in ₹
- Speed measured in meters per second.
- A TV show measured in how much you are interested watching it.
- A meal measured in how much you like to eat it.
- A traffic light measured in what colour is on.

In each case, suggest a fuzzy variable corresponding to these real variables.
For which of these five variables the use of a fuzzy variable is not really necessary? Why?

Q 7. **a)** Define following operations on fuzzy sets suitable example (8 Marks)
Product of two fuzzy sets, equality of fuzzy sets, product of a fuzzy set with a crisp no, and power of a fuzzy set.

b) Find the sets A and B if $A - B = \{1, 5, 7, 8\}$, $B - A = \{2, 10\}$, and $A \cap B = \{3, 6, 9\}$. (2 Marks)

Q 8. **a)** Write an iterative method (algorithm) to find the intersection and union of two given fuzzy sets. (4 Marks)

b) What is an optimization problem? How a minimization problem can be converted to a maximization problem, explain with an example. (4 Marks)

End of question paper.

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Motilal Nehru National Institute of Technology Allahabad

Department of Computer Science & Engineering

MCA Third Semester, Ph.D Course Work

Mid Semester Examination

Subject Code/Name: CA3303/Soft Computing

Duration: **90 Minutes** MaximumMarks:**20**

Note: Be brief while answering the questions. Write your assumptions before answering any question with missing data (*if you find one*). **Good Luck.**

I Answer all Questions. 4 × 1 Marks

1. Give at least five applications of Soft Computing.
2. Design networks using M-P neurons for binary OR and AND logic gates.
3. Describe some attractive features of the biological neural network.
4. What is feature extraction? Answer in terms of Pattern Classification task.

II Answer all Questions. 4 × 4 Marks

1. (a) Briefly explain about Supervised and Unsupervised learning with examples. **(2 Marks)**

   (b) What is a training set and how is it used to train neural networks? **(2 Marks)**

2. (a) *Figure 1* shows a single artificial neuron. The node has three inputs x =(x1, x2, x3) that receive only binary signals (either 0 or 1). How many different input patterns this node can receive? What if the node had four inputs? Five? Can you give a formula that computes the number of binary input patterns for a given number of inputs? **(2 Marks)**

   (b) Explain classification and clustering. State the difference between these two. **(2 Marks)**

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3. (a) Design networks using M-P neurons to realize the following logic functions using (+1 and -1) as the weights.**(2 Marks)**

$$s(a_1, a_2, a_3) = \bar{a}_1 a_2 \bar{a}_3$$

(b) Prove one of the De Morgan's Law using the properties of sets. **(2 Marks)**

4. Give the logic functions (using truth tables) performed by the following networks with MP neurons given in Figure 2

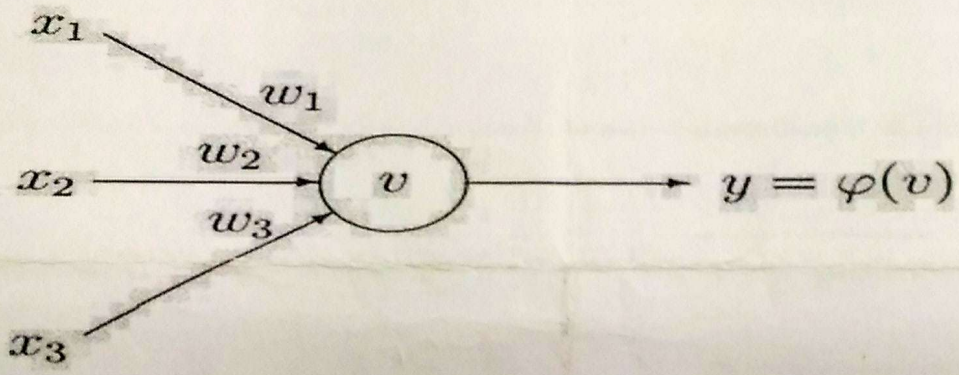

Figure 1: Single unit with three inputs. (For qn II 2.)

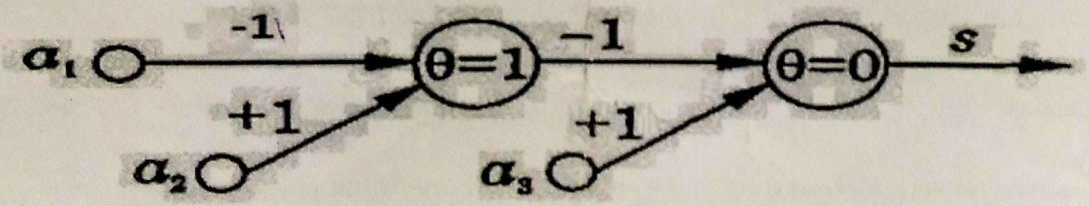

Figure 2: (For qn II 4.)

End of question paper.

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