

Department of Mathematical and Computational Sciences
National Institute of Technology Karnataka

First-Quiz
January 2019

Roll No:

Course No: MA204

Course Name: Linear Algebra and Matrices

Max Mark:10

Time: 1hr

Answer all questions.

1. True or false? $S = \{(x, y, z) : x = y^2 + 2\}$ is a subspace of \mathbb{R}^3 . Justify your answer. 2
2. Let $S = \{u_1, u_2, \dots, u_n\}$ be linearly independent and let $x \in L(S)$. Then prove that $S \cup \{x\}$ is linearly dependent. 3
3. Find a basis for the set of all symmetric 3×3 matrices 2
4. The vectors v_1, v_2, \dots, v_n in V forms a basis of V if and only if every $v \in V$ can be written as a unique linear combination of v_1, v_2, \dots, v_n . 3

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

MID SEMESTER EXAMINATION, FEBRUARY 2019

IT252: DESIGN AND ANALYSIS OF ALGORITHMS

Class: IV SEM B.TECH (IT)

Date: 11/02/2019

Time: 1½ Hrs.

Marks: 25

Register No.

1	7	3	7	2	4	8
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NOTE:

1. Both sides of this paper contain questions.

2. Use Pseudo-code to describe algorithms, unless asked otherwise.

Problem 1: [1+1=2 marks] State if the following statements are True/False. Briefly justify your answer. A correct answer with no or incorrect justification will only get partial credit.

(a) In every instance of the Stable Matching Problem, there is a stable matching containing a pair (m, w) such that m is ranked first on the preference list of w and w is ranked first on the preference list of m . ✓

(b) Consider an instance of the Stable Matching Problem in which there exists a man m and a woman w such that m is ranked first on the preference list of w and w is ranked first on the preference list of m . Then in every stable matching S for this instance, the pair (m, w) belongs to S .

Problem 2: [2+5=7 marks]

(a) Consider the deterministic algorithm for the Selection problem which uses the median of medians subroutine. Suppose median of median subroutine divides the n elements into $\lfloor n/5 \rfloor$ groups of 5 elements each. Do a precise analysis to argue that the runtime of selection algorithm satisfies $T(n) \leq O(n) + T(n/5) + T(7n/10)$. Solve this recurrence. ✓

(b) Consider the following generalization of the previous algorithm, which divides the input array into $\lfloor n/b \rfloor$ groups of size b each (instead of $\lfloor n/5 \rfloor$ groups of size 5), but is otherwise the same. The pseudo-code of this algorithm is given below:

```

MOMbSELECT(A[1..n], k):
    if  $n \leq b^2$ 
        use brute force
    else
         $m \leftarrow \lfloor n/b \rfloor$ 
        for  $i \leftarrow 1$  to  $m$ 
             $M[i] \leftarrow \text{MEDIANOFB}(A[b(i-1)+1..bi])$ 
         $\text{mom}_b \leftarrow \text{MOM}_b\text{SELECT}(M[1..m], \lfloor m/2 \rfloor)$ 
         $r \leftarrow \text{PARTITION}(A[1..n], \text{mom}_b)$ 
        if  $k < r$ 
            return MOMbSELECT(A[1..r-1], k)
        else if  $k > r$ 
            return MOMbSELECT(A[r+1..n], k-r)
        else
            return momb
    
```

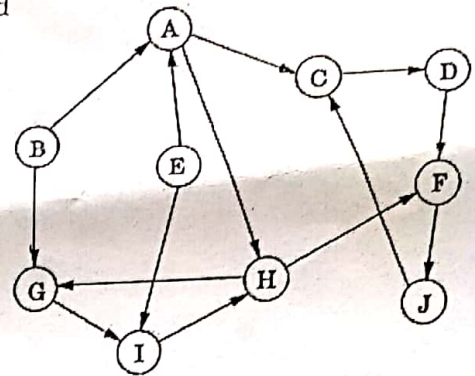
(i) Is the above algorithm correct for all values of b ? Give reasons for your answer.

(ii) State a recurrence for the running time of MOM_bSELECT, assuming that b is a constant (so the subroutine MedianOfB runs in $O(1)$ time). In particular, how do the sizes of the recursive subproblems depend on the constant b ? Consider even b and odd b separately.

(iii) What is the running time of MOM₃SELECT?

Problem 3: [6 marks]

Run the strongly connected components algorithm on the directed graph shown on the right. Whenever there is a choice of vertices to explore in the DFS, use the lexicographic order.



- 6
- Show the time-stamps of each vertex after the DFS on the reverse graph.
 - What are the vertices in each SCC?
 - In what order are these SCCs discovered?
 - Draw the SCC meta-graph of the graph.
 - If a directed edge from vertex G to F is added to the graph, draw the resulting SCC meta-graph.
 - What is the minimum number of edges you must add to this graph to make it strongly connected? *G to F already added.*

Problem 4: [2+3=5 marks]

You are given an array of n numbers, sorted in increasing order.

(a) Describe an $O(n)$ -time algorithm for the following problem:

Find two numbers from the list that add up to zero, or report that there is no such pair, that is, find two numbers a and b such that $a + b = 0$.

(b) Describe an $O(n^2)$ -time algorithm for the following problem:

Find three numbers from the list that add up to zero, or report that there is no such triple, that is, find three numbers a , b , and c , such that $a + b + c = 0$.

Problem 5: [2+3=5 marks]

2 (a) Show precisely how to implement the algorithm for computing SCCs in linear time. Given a directed graph $G=(V,E)$, argue that all the steps in the algorithm can be done in $O(V+E)$ time.

3 (b) The police department in Mangalore city has made all streets one-way, so it might no longer be possible to go from a given intersection to all other intersections in the city. The mayor insists that if you start driving from town hall intersection, navigating one-way streets, then no matter where you reach, there is always a way to drive legally back to the town hall intersection. Formulate this property as a graph-theoretic problem, and carefully show how it can be checked in linear time.

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DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHIKAL  
MID SEMESTER EXAMINATION, FEBRUARY 2019

IT251: Computer Communication and Networking

Class: IV Semester.  
Date: 13/02/2019

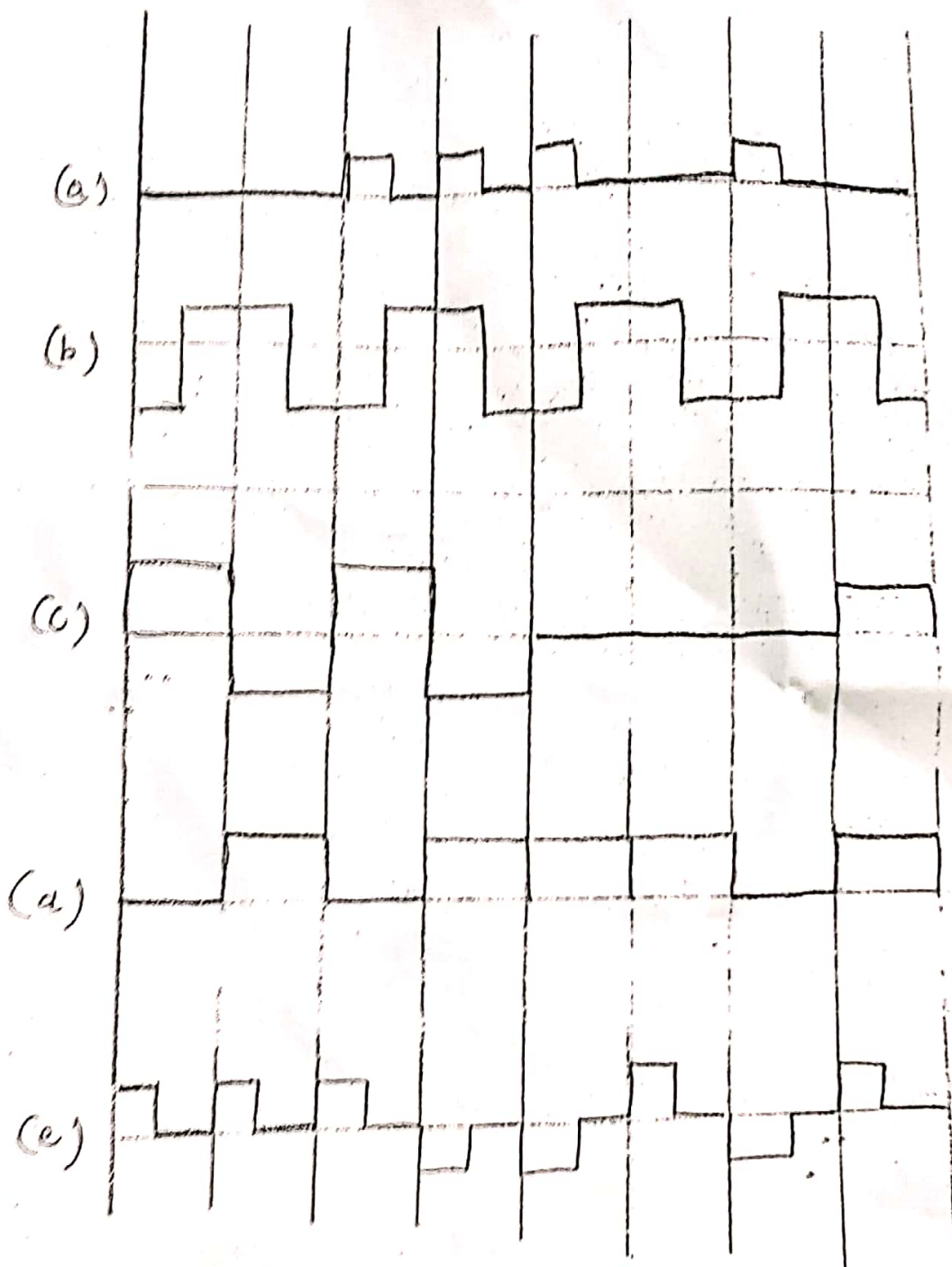
Time: 1 Hr 30. Min.  
Marks: 40

Register No.

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Answer all the questions.

1. (a) Why in Wireless Network the geographical area is divided in to hexagonal shape ? why not round, square , triangle ? (2)  
(b) Define the situations where a systems may have multiple IP addresses. (2)  
(c) Given an IP address 216.128.3.0/26 find the subnet mask, total number of networks possible and total number of host IP addresses in each network. Also find the total number of actual IP addresses which can be used in the network. (4)
2. (a) Find out the parity bit and the associated data bits for 9 bit hamming code. (4)  
(b) Test if the following hamming code word is correct, assuming they were created using an odd parity Hamming Code . If it is incorrect, indicate the error bit and what bit it should have been. Also, indicate what the original data was. (4)  
0100110    0100010
3. Define the efficiency formula for TDM. Find the efficiency and effective bandwidth for the input values  $T_t = 1\text{ms}$   $T_p = 3\text{ms}$  Bandwidth = 7 mbps. Further find total number of systems which can be connected to such network if each system required 10 kbps and 2.5 kbps. (8)
4. (a) Explain how "Go Back N" works. Also find the window size if the k value is 5. (3)  
(b) Find the total transmissions required to transmit 10 packets in GB3 if (i) every 6th packet drops (ii) every 7th packet drops (5)
5. (a) For the data bits 10011001 write Unipolar (RZ and NRZ) , Polar(RZ and NRZ) Bipolar, and Manchester line coding (4)  
(b) Decode the following line codes. (4)





## PART - B (Maximum Mark: 30)

1. If  $A$  and  $B$  are subspaces of  $V$ , show that  $A + B = \{v \in V \mid v = a + b, \text{ where } a \in A, b \in B\}$  is a subspace of  $V$ . Also show that  $A + B$  is the smallest subspace of  $V$  containing  $A$  and  $B$ . [6]
2. If  $S = \{v_1, v_2, \dots, v_n\}$  is a linearly dependent set of non-zero vectors in a vector space  $V$ , then show that there exists a vector  $v_k \in S$  where  $(2 \leq k \leq n)$  such that  $v_k$  is a linear combination of its preceding elements. [6]
3. State and prove Cauchy-Schwartz inequality. [6]
4. If  $S = \{(1, 2, 0), (-1, 1, 2), (3, 0, -4)\}$ , then find the condition on  $a, b, c$  so that the vector  $(a, b, c) \in L(S)$ . Does  $S$  span  $\mathbb{R}^3$ ? Justify your answer. [6]
5. Determine whether the following set of polynomials is linearly dependent or independent in  $P(t)$  over  $\mathbb{R}$ :  $\{u = t^3 - 4t^2 + 3t + 3, v = t^3 + 2t^2 + 4t - 1, w = 2t^3 - t^2 - 3t + 5\}$ . [6]

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DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL  
MID SEMESTER EXAMINATION, FEBRUARY 2019  
IT254: COMPUTER GRAPHICS

Class: IV SEM B.TECH (IT)  
Date: 14/02/2019

Time: 1 1/2 Hrs.  
Marks: 40

Register No.

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NOTE: Answer ~~All~~ the Questions to the Point only.

1. For conducting an online gaming tournament called PUBG Arena, large number of cost effective portable gaming units have to be manufactured. Assume that you are in charge of display design, which display is most apt for the gaming units. Discuss its working and advantages. (5M)
2. (a) Write the pixels to be considered to draw a line between  $(-5, -1)$  and  $(-9, 4)$  using Bresenham's line drawing algorithm. Mention the initial values of the required parameters as well as the change in values of the necessary parameters. How will it overcome the drawbacks of the DDA algorithm? (8M)  
(b) Trace the Midpoint circle algorithm with the radius 6 and centre at  $(-10, 8)$  using the second order derivative. (7M)
3. (a) Is there any issue in redrawing line segments using midpoint line drawing algorithm for shallow lines with horizontal edge of the clip rectangle? If yes, how will you handle this issue? (4M)  
(b) Suppose you are drawing the solar system and want to show earth's orbit, considering major axis as 10(y-axis) and minor axis as 6(x-axis). Show the pixels that will be selected using midpoint criteria. (8M)

4. (a) What is the refresh rate of a  $1024 \times 1024$  frame buffer if it can access 32 pixels in a group simultaneously, in an access time of 200 nanoseconds? (3M)
- (b) What is refresh rate of  $512 \times 512$  frame buffer, if access time for each pixel is 200 ns? (2M)
- (c) If the frame buffer has 8 bits per pixel and 8 bits are allocated for each of the R, G, B components, what would be the size of the Lookup table? (3M)

-----ALL THE BEST-----



DEPARTMENT OF INFORMATION TECHNOLOGY, NITK  
SURATHKAL

MID SEMESTER EXAMINATION, FEBURARY 2019

IT253: PARADIGMS OF PROGRAMMING - II

Class: IV SEM B.TECH (IT)

Date: 14/02/2019

Time: 1½ Hrs.

Marks: 25

Register No.

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NOTE:1. Answer All Questions with suitable steps/procedure

1. Explain Language Evaluation Criteria with respect to Readability/Writability. [5M]
2. Discuss briefly the various Programming Domains. [4M]
3. Give DFA for the following languages, over the alphabet {0,1}
  - a) Every string accepted must start and end with different symbol. [5M]
  - b) Set of all strings that do not contain the substring 1010.
4. Consider the grammar given below
$$\begin{aligned} \langle \text{pop} \rangle &::= [ \langle \text{lop} \rangle , \langle \text{pop} \rangle ] \mid \langle \text{lop} \rangle \\ \langle \text{lop} \rangle &::= \langle \text{loop} \rangle \mid ( \langle \text{pop} \rangle ) \\ \langle \text{loop} \rangle &::= x \mid y \mid z \end{aligned}$$
  - (a) What are the non-terminal symbols?
  - (b) What are the terminal symbols?
  - (c) What is the start symbol?
  - (d) Draw a parse tree for the sentence (x).
  - (e) Draw a parse tree for the sentence [(x),[y,x]]. [7M]
5. Write regular expressions for the following:
  - a) The number must either be a one-digit number, a two-digit number different from 22 or have atleast three significant digits.
  - b) A valid register number of 7 digits for all the branches of B.Tech, NITK. [Ex: 16IT101] [4M]



DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL  
MID SEMESTER EXAMINATION, FEBRUARY 2019

IT250: OPERATING SYSTEMS

Class: IV SEM B.TECH (IT)  
Date: 15/02/2019

Time: 1½ Hrs.  
Marks: 50

Register No.

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NOTE: 1. Answer All Questions to the Point only

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- 1) i) Consider there are various processes (say system calls, event or trap) running in an Operating system, how will the operating system differentiate a user process and a kernel process. Give a neat sketch of the same. (2.5)
- ii) A program that is being executed by the operating system is stuck in an infinite loop. Give an ideal solution to this with an appropriate example. (2.5)
- 2) i) Give the snippet for compiling and loading a newly created kernel module into the existing one. (5)
- ii) Design an Exokernel and detail various characteristics of it with appropriate differentiation among the other kernels. (5)
- 3) A Hard Disk Drive (HDD) is too large and slow at processing data to and from any I/O device. Give a better solution to this with all the necessary techniques incorporated with the same. (10)
- 4) i) `<stdarg.h>` is a header file that enables certain types of system calls. List out all those system calls. (3)
- ii) Actual system calls are more complicated in its functionalities. Consider yourself as an application programmer for Windows kernel and give a solution to the same with appropriate example. (3)



iii) Give the Application Programming Interface (API) for creating a thread pool in windows. Articulate various thread models and justify the most scalable model for thread programming. (4)

- 5) i) User 'A' initiates a process 'P<sub>1</sub>' to be assigned to various computing resources (say CPU, Memory). Design the queuing strategies the process can go through with a neat sketch. (2)
- ii) Design a calling function for a process 'P<sub>1</sub>' to invoke procedures on a remote server 'X' with a neat sketch. Briefly list out the tasks of all the components involved in it. (3)
- iii) Consider there are two processes namely, 'P<sub>1</sub>' and 'P<sub>2</sub>' running in a multiprocessing environment. Discuss the various ways these processes could internally communicate with each other. Sketch the techniques appropriately. (10)

\*\*\*\*ALL THE BEST\*\*\*\*