V-61

ENTRANCE EXAMINATIONS – 2019

(Ph.D. Admissions - January 2020 Session)

Ph.D. in Computer Science

Time: 2 Hours | Max. Marks: 70

Hall Ticket Number:

INSTRUCTIONS

1. Write your Hall Ticket Number in the above box **and** on the OMR Sheet.
2. This test is for **2 hours duration** carrying **70 marks**.
3. This test is objective type and has two parts: Part A contains 35 questions on Research Methodology, and Part B contains 35 questions on Computer Science. Please make sure that all the questions are clearly printed in your paper.
4. Every correct answer gets **1 (one) mark**. **There is negative marking of 0.33 marks for every wrong answer.**
5. All answers should be marked clearly in the OMR answer sheet only.
6. Do not use any other paper, envelope etc. for writing or doing rough work. All the rough work should be done in your question paper.
7. During the examination, anyone found indulging in copying or have any discussions will be asked to leave the examination hall.
8. Use of non-programmable calculator and log-table are allowed.
9. Use of mobile phone is **strictly prohibited** inside the hall.
10. Submit the OMR sheet to the invigilator before leaving the examination hall.

Part A – Research Methodology

Read the following text and answer Questions(Q1-Q4) below. In this text, Leslie Lamport, Turing Award winner in 2013 for his seminal work on distributed computing, describes his fundamental paper on maintaining global time on distributed systems.

Jim Gray once told me that he had heard two different opinions of this paper: that it's trivial and that it's brilliant. I can't argue with the former, and I am disinclined to argue with the latter.

The origin of this paper was the note *The Maintenance of Duplicate Databases* by Paul Johnson and Bob Thomas. I believe their note introduced the idea of using message timestamps in a distributed algorithm. I happen to have a solid, visceral understanding of special relativity. Special relativity teaches us that there is no invariant total ordering of events in space-time; different observers can disagree about which of two events happened first. I realized that the essence of Johnson and Thomas's algorithm was the use of timestamps to provide a total ordering of events that was consistent with the causal order. This realization may have been brilliant. Having realized it, everything else was trivial. Because Thomas and Johnson didn't understand exactly what they were doing, they didn't get the algorithm quite right; their algorithm permitted anomalous behavior that essentially violated causality. I quickly wrote a short note pointing this out and correcting the algorithm.

It didn't take me long to realize that an algorithm for totally ordering events could be used to implement any distributed system. A distributed system can be described as a particular sequential state machine that is implemented with a network of processors. The ability to totally order the input requests leads immediately to an algorithm to implement an arbitrary state machine by a network of processors, and hence to implement any distributed system. So, I wrote this paper, which is about how to implement an arbitrary distributed state machine. As an illustration, I used the simplest example of a distributed system I could think of–a distributed mutual exclusion algorithm.

This is my most often cited paper. Many computer scientists claim to have read it. But I have rarely encountered anyone who was aware that the paper said anything about state machines. People seem to think that it is about either the causality relation on events in a distributed system, or the distributed mutual exclusion problem. People have insisted that there is nothing about state machines in the paper. I've even had to go back and reread it to convince myself that I really did remember what I had written.

The paper describes the synchronization of logical clocks. As something of an afterthought, I decided to see what kind of synchronization it provided for real-time clocks. So, I included a theorem about real-time synchronization. I was rather surprised by how difficult the proof turned out to be.

1. What does Lamport's classic paper *really* talk about?

   A. Theorem on real-time synchronisation.
   B. Distributed state machines.
   C. Special Relativity and causality relations.
   D. None of the above

2. What is the main idea contained in the note, "The Maintenance of Duplicate Databases"?

   A. Use of time-stamps to provide total ordering that does not violate causality.
   B. There is no invariant total ordering of events in space-time.
   C. Solid understanding of the theory of Special Relativity.
   D. None of the above

3. What do you think is the great contribution of Leslie Lamport's paper?

   A. Finding and correcting the main error in Johnson and Thomas's algorithm.

B. The idea that an algorithm for total ordering leads to the realisation of any distributed system.

C. Proving a theorem on real-time synchronisation in distributed systems.

D. None of the above

4. With whom is Leslie Lamport "disinclined to argue"?

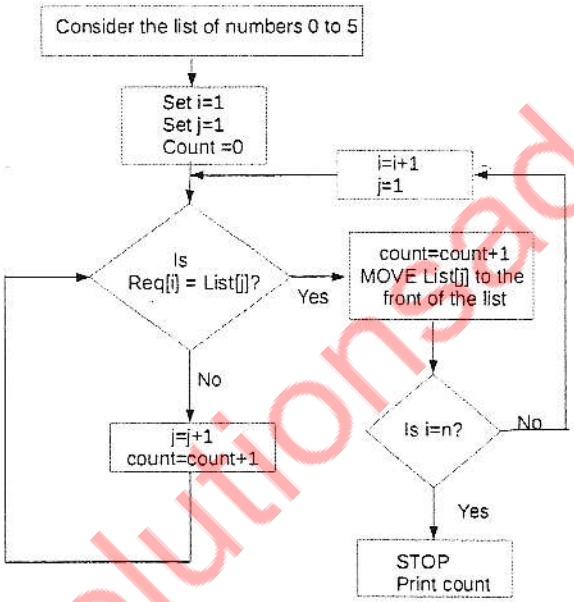
A. People who think that his paper is trivial.

B. Jim Gray

C. Paul Johnson and Bob Thomas.

D. People who think that his paper is brilliant.

Consider a list of numbers List[1:6]= 0 to 5 and a request sequence Req[1:n]. For example Req[1]=5 means search for 5 in the List. Use the flowchart to answer the questions(Q5-Q7).



5. Consider the request sequence Req[1:4]=4,5,4,2. What is the value of count after accessing the List for this request sequence?

A. 19

B. 20

C. 18

D. 21

6. What is the ordering of the list after the request sequence is accessed?

A. 0 1 2 3 4 5

B. 2 5 4 0 1 3

C. 2 4 5 0 1 3

D. 5 4 0 1 2 3

7. If the requested element is not moved to the front of the list, what is the value of count after processing the request sequence Req[1:4]=5,4,4,5?

A. 19

B. 22

C. 20

D. 21

Based on the following table concerning the speeds of different types of transport.Answer the following questions(Q8-Q10):

Transport	Speed
Running	10 m/s
Horse	23 m/s
Bicycle	16 m/s
Electric Car	32 m/s
Car	50 m/s

8. If the electric car starts ahead of the car, what is the cars closing speed.

   A. 18 m/s

   B. 32 m/s

   C. 50 m/s

   D. 82 m/s

9. If all the forms of transports pass the start together at their given speeds, how much further will the car have gone compared to the horse after one minute.

   A. 3000m

   B. 1380m

   C. 1620m

   D. 960m

10. How many metres head start should the horse give the bicycle if they are to finish the 100m together

    A. 7m

    B. 70m

    C. 29.25m

    D. 30.43m

11. Let $Q1$,$Q2$ and $Q3$ be the quintiles and $H = Q3 - Q1$, them of an observation $X0 > Q3 + 3 * H$ will be located in Box-Whisker plot at

    A. the Box part

    B. Extreme value upper side

    C. Whisker part

    D. Outlier part

12. A factory is supplied electrical components.The quality inspector of the factory says that by past supplies 0.98 is the probability of satisfactory parts being supplied. A vendor is supplying a batch of five components.The probability of getting two or more defective components is

A. 0.98

B. 0.002

C. 0.004

D. None of above

13. The shift wages on a hourly basis in Rupees for different factory workers taken at random are 83, 111, 127, 96, 124, 103, 82, 99, 173, 137, 102, 106.Given this data what can be said about the sample mean and median? (i) The sample mean is less representative of the data than the sample median. (ii) The median is less representative of the data than the sample mean. (iii) Neither the mean nor the sample median here are representative of the data.

A. only (i) is true.

B. only (ii) is true

C. only (iii) is true

D. None of the above.

14. Find the sample variance and standard deviation of the following data:

```
3.4 2.5 4.8 2.9 3.6
2.8 3.3 5.6 3.7 2.8
4.4 4.0 5.2 3.0 4.8
```

A. sample variance =0.94284; standard deviation= 0.971;

B. sample variance = 1.94284;standard deviation= 2.971;

C. sample variance = 0.94284;standard deviation= 1.971;

D. sample variance =2.94284; standard deviation= 0.971;

15. In one year, three awards (research, teaching and service) will be given to a class of 25 graduate students in a statistics department. If each student can receive at most one award, how many possible selections are there?

A. 18,800

B. 13,800

C. 12,800

D. 14,800

16. Select the right sequence of steps (pattern) in introduction (the common structure of introductions) of research writings:

A. Step1: Establish common ground (contextualized background) Step2: State your problem Step3: State your response

B. Step1: Establish common ground Step2: State your response Step3: State your problem

C. Step1: State your response Step2: State your problem Step3: Give the contextualized background

D. Step1: Establish common ground Step2: State the gist of your solution Step3: State your problem

17. If an experiment consists of throwing a die (6 sides) and then drawing a letter at random from the English alphabet, how many points are there in the sample space?

A. 456

B. 356

C. 256

D. 156

Read the following text and answer the questions(Q18-Q19) below:

Several experiments on an apparatus were performed. Data for each experiment was collected and plotted.The three experiments are labelled as experiments P,Q and R. For experiments Q and R the observations were plotted and they were found to be close to a line. However, for experiments Q the slope of the line was negative and for experiment R the slope of the line was positive. For experiment P no such relationships could be plotted.

18. From the above text, which of the following may be inferred: (i) The variables in experiment R only are correlated. (ii) The variables in experiment Q are negatively correlated. (iii) The variables in both the experiments Q and R are correlated.

A. only (i) is true

B. only (ii) is true

C. (iii) is False

D. both (ii) and (iii) are true.

19. Which of the following is more accurate. (i)The variables in experiment P are uncorrelated (ii)The variables in experiment Q are uncorrelated (iii)The variables in experiment R are uncorrelated.

A. only (i) is true

B. both (i) and (ii) are true

C. only (ii) and (iii) are true

D. both (i) and (iii) are true.

20. Which of the following is a most accurate description of the Spearman's rank correlation coefficient

A. It evaluates the linear relationship between two continuous variables

B. It is a parametric measure of rank correlation

C. It assess how well the relationship between two variables can be described using a monotonic function

D. None of the above..

21. Choose an option that is always true for the statement: If n objects are distributed over m places, and $n < m$, then some of the places receive:

A. at least 2 objects

B. at most 2 objects

C. no object

D. aproximatly m/n objects

22. The coefficient of variation (CV) and skewness (SK) of the following data:50 55 60 65 70 75 80 85 90 95 100

A. CV=52.70462767, SK=0

B. CV=21.08185107, SK=0

C. CV=0, SK=3

D. CV=333.3333333, SK=0

23. A reasoning where we start with certain particular statements and conclude with a universal statement is called

A. Deductive Reasoning

B. Transcendental Reasoning

C. Inductive Reasoning

D. None of the above

24. Venn diagram is used to

A. represent and assess the truth of elementary inferences of syllogistic form

B. assess but not represent the truth of elementary inferences of syllogistic form

C. represent and assess the validity of elementary inferences of syllogistic form

D. represent but not assess the validity of elementary inferences of syllogistic form

25. Scientific Research process involves

A. exploring new knowledge

B. verifying the old knowledge

C. filling the gap between knowledge

D. all of these

26. When a research problem is related to heterogeneous population, the most suitable sampling method is

A. Cluster Sampling

B. Stratified Sampling

C. Convenient Sampling

D. Lottery Method

27. Ethical norms in research involve guidelines for

A. copyright

B. patenting policy

C. data sharing policies

D. all of the above

28. Consider the graph of $y = \frac{\log x}{x}$ then which of the following statements are true (i) x is bounded for values of x, as $x \to \infty$.(ii) For $x > e$ it is a decreasing function.(iii)The maximum value of this graph is at $x = e$.

A. only (i)

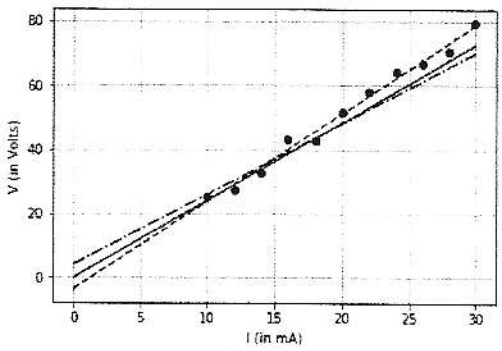
B. only (ii)

C. only (iii)

D. (ii) and (iii) only.

Look at the graph plotting the famous Ohm's Law between Current (I in mA) and Voltage (V in Volts). Ohm's law states that $V = IR$ where R is the resistance. The filled circles indicate the values measured in the experiment; the three lines are the lines drawn by three students to illustrate the relationship between V and I.

Answer the next two questions(Q29-Q30) based on the graph.



29. Which of the following statements is TRUE about the graph.

A. The solid line shows the correct relationship.

B. The dashed line shows the correct relationship.

C. The dash-dot line shows the correct relationship.

D. None of the above

30. The resistance of the circuit is approximately

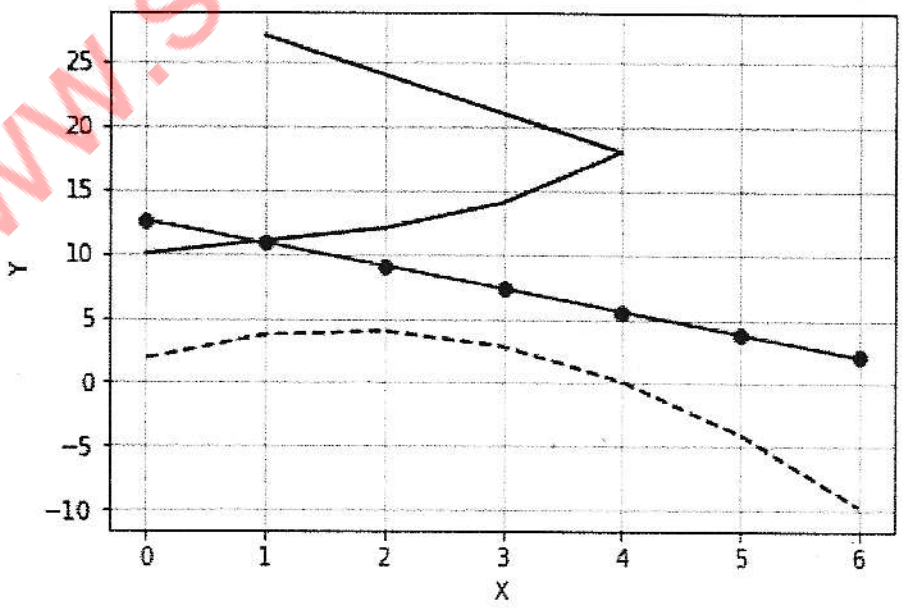
A. 0.4K Ohms

B. 2.5K Ohms

C. 3K Ohms

D. None of the above

31. In the graph below, which of the following is **NOT** a function $Y(X)$?



A. Solid line with circles.

B. Dashed line.

C. Solid line without circles.

D. None of the above

32. Given a set of $(2N+1)$ measurements of a random variable X, which of the following statements is **TRUE**?

A. The mean is always one of the measured values.

B. The median is always one of the measured values.

C. The mean is always less than the median.

D. None of the above

33. A Normal distribution is

A. Symmetric and unimodal.

B. Skewed to the left and unimodal.

C. Symmetric with two modes.

D. None of the above

34. Deleting the maximum value from measurements of a random variable

A. always changes its sample mean.

B. always changes its median.

C. always changes its mode.

D. None of the above

35. In a certain code, COMPUTER is written as RFUVQNPC. How is MEDICINE written in the same code?

A. MFEDJJOE

B. EOJDEJFM

C. MFEJDJOE

D. EOJDJEFM

TURN THE PAGE FOR PART B ⟶

Part – B: Computer Science

36. What is the output of the following program?

```
#include <stdio.h>
int main(){
int* p=NULL;
int* q=0;
if (p+q==1){
printf("Sum One");
}else if(p==q){
printf("Equal");
}else{
printf("Not Equal");
}
return 0;
}
```

A. Equal
B. Compilation Error
C. Not Equal
D. Sum One

37. What is the output of the following program:

```
#include <stdio.h>
int sayHello(){
return printf("Hello ");
}
int main(){
int k=sayHello();
printf("%d", k);
return 0;
}
```

A. Compilation Error (Reason: Argument for return is not valid)
B. Compilation Error (Reason: sayHello function is expected to return an integer value)
C. Hello 0
D. Hello 6

38. With respect to a '*C*' language program if 'calloc' is successful then the block of memory address space is allocated from which of the following:

A. Stack
B. Data
C. Heap
D. BSS

39. Is it possible for network application to enjoy reliable data transfer although the application runs over UDP? (i) Not possible (ii)Possible with application layer protocol (iii) UDP does not allow

A. (i) only
B. (ii) only
C. (i) and (iii)
D. None of the above

40. A digital signaling system operates at 152000 bps. It uses a signal element that encodes a 4-bit word. The minimum required bandwidth of the channel is

A. 19000Hz
B. 14000Hz
C. 16000Hz
D. 12000Hz

41. The Polynomial code checksum (CRC) for a frame 1101011011 using the generator $G(x) = x^4 + x + 1$ is

A. 1111
B. 1110
C. 1101
D. 1100

42. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B. Determine the transmission time of the packet, *dtrans*, in terms of L and R.

A. *dtrans*= R+L seconds
B. *dtrans*= (R-L) seconds
C. *dtrans*= R*L seconds
D. *dtrans*= L/R seconds

43. Floyd-Warshall algorithm that finds the shortest paths between every pair of vertices adopts which of the following design strategy:

A. Greedy
B. Dynamic Programming
C. Divide and Conquer
D. Backtracking

44. The solution to the recurrence relation $a_n = 5a_{n-1} - 6a_{n-2},\ a_0, a_1 > 0$ is of the order

A. $O(n^2)$
B. $O(n^3)$
C. $O(nlogn)$
D. $O(3^n)$

45. Hash function f is defined as *f(key) = (key) mod 7*. If linear probing is used to insert the key 37, 38, 72, 48, 98, 11, 56 into a table indexed from 0 to 6. 11 will be stored at the location

A. 3

B. 4

C. 5

D. 6

46. Average successful search time for sequential search on n items is

A. $n/2$

B. $(n-1)/2$

C. $(n+1)/2$

D. $Log(n)+1$

47. A 3-ary tree is the tree in which every internal node has exactly 3 children. Number of leaf nodes in such a tree with 6 internal nodes will be

A. 10

B. 23

C. 17

D. 13

48. The best and the worst case time complexities for searching an element using linear search is

A. $\mathcal{O}(n)$,$\mathcal{O}(1)$

B. $\mathcal{O}(n)$,$\mathcal{O}(n)$

C. $\mathcal{O}(n)$,$\mathcal{O}(logn)$

D. $\mathcal{O}(1)$,$\mathcal{O}(n)$

49. Let $N = \{1, 2, 3 \dots\}$. Then $f : N \to N$ defined by $f(n) = n + 1$ is

A. Onto but not one-to-one

B. Both one-to-one and onto

C. Neither one-to-one nor onto

D. One-to-one but not onto

50. For the regular expression $a^*(baa^*)^*b^*$, a string of minimum length in $\{a, b\}^*$ (i)not in the language and (ii)in the language are.

A. bba, ϵ

B. ba, ϵ

C. baa, ϵ

D. baa, b

51. Suppose problem X is NP-complete, problem Y is in class P, and $X \leq_P Y$ (problem X polynomial reduces to Y). Which of the following must be true?

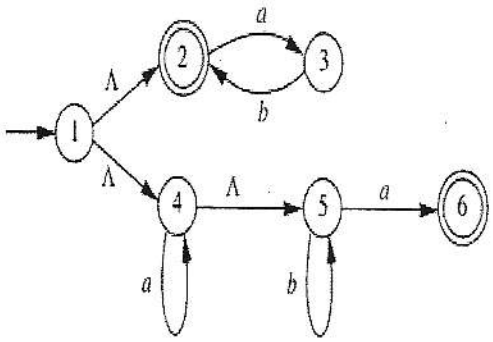
A. Problem X is in class P.

B. Problem Y is NP–complete

C. P = NP.

D. All of the above.

52. The language accepted by the NFA as shown in the following Figure is



A. $\epsilon + (ab)^* + a^*b^*a$

B. $\epsilon + (ab)^*a^*b^*a$

C. $(ab)^*a^*b^*a$

D. $\epsilon + (ab)^* + (ab)^*a$

53. Consider the relation Emp(Empid, Name, Street, City, State, Pincode). For any Pincode, there is only one City and State. Also for a given Street, City and State there is just one Pincode. The relation Emp is in

A. 1NF only

B. 2NF

C. 3NF

D. BCNF

54. In which of the following index mechanism, the index record appears for only some of the search key values

A. Straight

B. Continuous

C. Dense

D. Sparse

55. In one of the following join operations, unmatched tuples from either of the tables can be returned irrespective of satisfying the join condition.

A. Equi-Join

B. Non Equi-Join

C. Outer Join

D. Theta Join

56. Whenever the transaction completes successfully, its results must be retained irrespective of subsequent failures, this property of database transaction is referred as

A. Atomicity

B. Consistency

C. Isolation

D. Durability

57. A computer system has the Main Memory capacity of a total is 1M 16 bits words. It also has a 4K words cache organized in the block set associative manner, with 4 blocks per set and 64 words per block. Then the number of bits calculated for each the TAG, SET and WORD filed of Main Memory address format are

A. 4,6,4
B. 4,6,10
C. 10,4,6
D. 4,6,10

58. Expand of the LBA in operating system interface is

A. Low Block Address
B. Logical Bit Address
C. Low Bit Access
D. Logical Block Address

59. The vertex v is a cut vertex of the connected graph G if and only if there exist two vertices u and w in the graph G such that

A. $v = u$, $v \neq w$, $u = w$ and v is not in u–w path.
B. $v = u$, $v = w$, $u = w$ and v is on every u–w path.
C. $v \neq u$, $v \neq w$, $u \neq w$ and v is on every u–w path.
D. $v \neq u$, $v = w$, $u \neq w$ and v is not in u–w path.

60. Consider a disk pack with 16 surfaces, 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively:

A. 256 Mbyte, 19 bits
B. 256 Mbyte, 28 bits
C. 512 Mbyte, 20 bits
D. 64 Gbyte, 28 bit

61. In UNIX operating system, */dev/null*

A. is an invalid destination
B. is pointing to the monitor
C. is the UNIX built in dustbin
D. can point to any I/O device

62. A process has been allocated 3 page frames. Assume that none of the pages of the process are available in the memory initially. The process makes the following sequence of page references (reference string):1, 2, 1, 3, 7, 4, 5, 6, 3, 1. If optimal page replacement policy is used, how many page faults occur for the above reference string?

A. 7
B. 8
C. 9
D. 10

63. Consider the methods used by processes P1 and P2 for accessing their critical sections whenever needed, as given below. The initial values of shared Boolean variables S1 and S2 are randomly assigned.

Method Used by P1	Method Used by P2
While (S1==S2); *Critical Section* *S1=S2*	*While (S1 !=S2);* *Critical Section* *S2=!(S1)*

Which one of the following statements describes the properties achieved?

A. Mutual exclusion but not progress
B. Progress but not mutual exclusion
C. Neither mutual exclusion nor progress
D. Both mutual exclusion and progress

64. Match the following run levels of *init* process in UNIX with corresponding resulting system state:

init_runlevel	System_State
0	(i) Single User Mode
1	(ii) Reboot
5	(iii) System Halt
6	(iv) Multiple user mode with GUI

A. 0-(ii),1-(iv),5-(i),6-(iii)
B. 0-(iii),1-(iv),5-(ii),6-(i)
C. 0-(iii),1-(i),5-(iv),6-(ii)
D. 0-(ii),1-(iv),5-(iii),6-(i)

65. Which of the following graph representation method has lower space complexity. (i) Adjacency List (ii) Incidence Matrix (iii) AdjacencyMatrix

A. only (i)
B. only (ii)
C. only (iii)
D. both (ii) and (iii)

66. If $T(n) = \sqrt{n}T(\sqrt{n}) + n$, then the closed form of $T(n)$ is ?

A. $T(n) = \theta(nlogn)$
B. $T(n) = \theta(nloglogn)$
C. $T(n) = \theta(n^2)$
D. $T(n) = \theta(n)$

67. Which among the asymptotic algorithmic notations $\mathcal{O}$, o, Ω, ω and θ are reflexive and symmetric?

A. $\mathcal{O}$,Ω
B. only θ

C. only $\mathcal{O}$,Ω,θ

D. only o,ω,θ

68. Consider the following C program segment

```
struct Node
{
struct Node *left;
struct Node *right;
void  *data;
};

int doSomething(struct Node* root)
{
if(root == NULL) return 0;
if(root->left == NULL && root->right == NULL)
return 0;
return (1 + doSomething(root->left) + doSomething(root->right));
}
```

What the function doSomething will compute, if we pass the root of a non-empty binary tree.

A. The number of nodes in the binary tree

B. The height of the binary tree

C. Number of non-leaf nodes of the binary tree.

D. Number of leaf nodes of the binary tree

69. The most appropriate matching for the following pairs

```
X: m=malloc(10); m= NULL;        1: using dangling pointers
Y: free(m); m[2]=5;              2: using uninitialized pointers
Z: int *p; *p = 20;              3: lost memory
```

A. X–1, Y–3, Z–2

B. X–3, Y–1, Z–2

C. X–2, Y–3, Z–1

D. X–3, Y–2, Z–1

70. Consider the following statements: Statement A: Every Non-deterministic TM has an equivalent Deterministic TM. Statement B: Every Non-deterministic PDA has an equivalent Deterministic PDA. Choose the correct option here.

A. Both statements A and B are True

B. Statement A is True but Statement B is not True

C. Statement B is True but Statement A is not True

D. Both statements A and B are False

THE END