

**Entrance Examinations - 2022**  
**Ph.D. in Computer Science**

**Time: 2 Hours**

**Max. Marks: 70**

**Hall Ticket Number:**

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**INSTRUCTIONS**

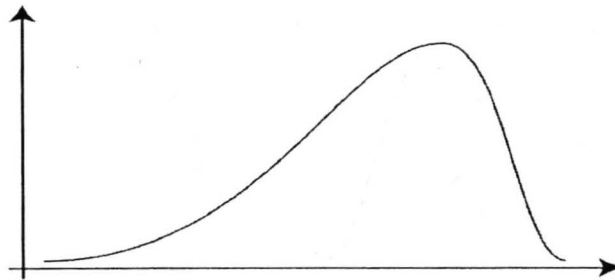
1. Write your Hall Ticket Number in the above box **and** on the OMR Sheet.
2. This test is for **2 hours duration** carrying **70 marks**.
3. Every correct answer gets **1 (one) mark**. **There is NO NEGATIVE MARKING**.
4. This test is objective type and has two parts: Part A contains 35 questions on Research Methodology (including general aptitude), and Part B contains 35 questions on Computer Science. Please make sure that all the questions are clearly printed in your paper.
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 or on the sheets provided with the question paper at the end.
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.

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**PART – A (QUESTIONS 1 – 35)**

**B-3**

1. There are two datasets A and B. A is a clean dataset and B is a Noisy data set. Which of the following is true?
  - A. Entropy of A greater than Entropy of B
  - B. Entropy of B is greater than Entropy of A
  - C. It can be either A or B
  - D. B always has a greater mean than A
2. Consider the graph given below which is a distribution of the data samples. Which of the statements about its mean, median and mode is true?



- A. Mean < Median < Mode
  - B. Mean > Median > Mode
  - C. Mean < Median and Mean > Mode
  - D. Mode > Mean and Mode < Median
3. In data processing, which of the following is defined an outlier
    - A. A type of variable that cannot be quantified and thus left out from the processing
    - B. A missing data which is left out for processing
    - C. A data which is not relevant to the problem and so left out
    - D. A data value which is extreme and remains at either end of the distribution of the data values
  4. Let  $x$  be a real number such that  $x^2 > 16$ . Choose the most precise true statement.
    - A.  $x > 4$
    - B.  $-4 < x < 4$
    - C.  $x > -4$
    - D.  $x < -4$  and  $x > 4$
  5. Let  $R$  be a relation on the set of natural numbers  $N$  such that  $xRy$  iff  $x + 2y = 10$ . Then the range of the relation  $R$  is
    - A.  $(-\infty, 5)$
    - B.  $\{1, 2, 3, 4\}$
    - C.  $\{1, 2, 3, 4, 5\}$
    - D.  $N$

Questions 6 – 9 are based on the following text. Read carefully and answer the questions.

Through the years, the database community has periodically looked at developments in technology and engaged in hand-wringing over the idea that we are becoming irrelevant. The cry “have we missed the boat – again” is common. My goal in this essay is to argue that the database field and the techniques that have come from this research are still essential for “data science,” that is, for the exploitation of data to solve problems of importance in application fields – science, commerce, medicine and such. I believe, as I assume most readers of this article believe, that the field of database systems has always had at its core the study of how to deal with the largest amounts of data possible at the time, whether that be megabytes of corporate payroll data, terabytes of genomic information, or petabytes of satellite output. Thus, whatever study of data is necessary at the time – that’s our job. Several years ago, I was invited to a panel of the National Research Council called the “Data-Science-Education Roundtable”. It was organized not by the computer-science wing of the NRC but the statistics branch. The participants were roughly equally divided between statisticians and computer scientists, plus a few from other disciplines. Part of my experience was seeing how statisticians thought about the world of data and its application. The most obvious point was that the field of statistics views data science as its own. To be fair, let’s be clear at the outset that I have great respect for statisticians and the work they do. Statistics has become increasingly important to the modern study of data, including, but not limited to machine learning. Many statisticians are starting to focus on computation and data analysis in the same way as we do in the database community or in computer science more generally. Just to offer one small example, one of my favorite techniques is locality-sensitive hashing, which is an idea that came squarely out of the database community. Yet one of my colleagues in the Statistics Department at Stanford, Art Owen, showed me something about a key step, minhashing, that speeds up the process by a very large factor – something we should have been able to figure out years ago, but didn’t. However, my experience in the roundtable also gave me the sense that there is an effort on the part of some in the statistics community to define statistics as the central component of data science. I, in contrast, would see the algorithms and techniques for processing large-scale data efficiently as the center of data science. There is a general sense that data science is a discipline that combines the knowledge of several fields, and I agreed completely. But what are those fields, and how do they interact? The question is considered so important that competing communities have published Venn diagrams to justify their own centrality in data science.

6. Which field, the author associates himself to?
  - A. Database community
  - B. Statistician
  - C. Machine learning expert
  - D. Bureaucrat in Education Roundtable
7. As per the author, which of the following statements is true
  - A. The field of statistics falsely views data science as its own
  - B. Statistics field can own data science
  - C. Statistics is the central component of data science
  - D. None of the above
8. Which of the following statements is correct?
  - A. Locality-Sensitive Hashing (LSH) was first conceived by Jeffrey D. Ullman

- B. LSH was invented by Art Owen  
C. LSH was brain-child of statisticians  
D. None of the above
9. The discussion further goes towards Machine Learning. Going by the tone of the paragraphs, which of the following statements is correct?
- A. Machine learning is really what data science is all about  
B. There are many problems involving "big data" that are not really machine-learning problems  
C. Machine-learning methods always produce models that do support explanation or justification  
D. None of the above
10. The coefficient of  $X^{16}$  in  $(1 + X^4 + X^8)^{10}$  is
- A. 615  
B. 1001  
C. 6  
D. None of the above
11. Suppose the statement "If God exists then the sky is blue" is true. What can be logically inferred from this statement:
- A. God exists  
B. As the sky is blue hence God exists  
C. If the sky is not blue then God does not exist  
D. The sky is not blue
12. Which of the following points does not lie on the curve
- $$y = x^3 + 2x^2 - 4x + 1$$
- A. (1, 0)  
B. (2, 9)  
C. (3, 34)  
D. (4, 12)
13. Two non-concentric circles can intersect at
- A. At most two points  
B. Exactly two points  
C. At least two points  
D. None of the above
14. A shopkeeper is offering discounts as shown in a partially displayed board. The discounts are based on a series. How much is the discount for a purchase of Rs. 26,800?

Purchase Amt (Rs)	Discount (Rs)
> 200 and $\leq$ 400	10
> 400 and $\leq$ 800	30
> 800 and $\leq$ 1600	70
> 1600 and $\leq$ 3200	150
> 3200 and $\leq$ 6400	310

- A. 1280
- B. 1290
- C. 2550
- D. 3200

15. A  $3 \times 3$  grid is filled with the numbers from 21 to 29 according to the following rules.

- (I) 28 is above 29 and to the right of 22
- (II) 23 is to the right of 27 and above 29 which is to the left of 24
- (III) 22 is to the left of 25
- (IV) 27 is above 26 and 22
- (V) 21 is above 25

'Left' and 'Right' mean that the numbers are in the same row while 'Above' and 'Below' means that they are in the same column.

What is the sum of the numbers in the middle row?

- A. 71
- B. 75
- C. 77
- D. 79

16. Four idioms in English involving animals are given below

- (I) The elephant in the room
- (II) Hold your horses
- (III) Wild goose chase
- (IV) Go to the dogs

Which of the following word sequences are nearest to their meanings in the correct order?

- A. Obvious, animals, rubbish, seafood
- B. Large, speedy, flying, barking
- C. Indoors, racing, bird-watching, pet
- D. Obvious, patience, useless, rubbish

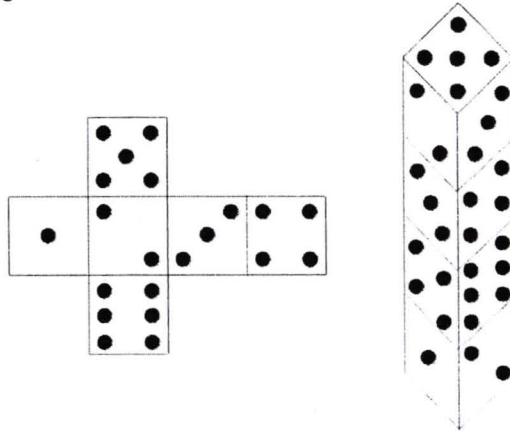
17. Think of the logos of the following famous IT companies: Google, Microsoft, IBM, Facebook. Which two logos have almost the same colours?

- A. Google and Facebook
- B. Microsoft and IBM
- C. Google and Microsoft

## D. Facebook and Microsoft

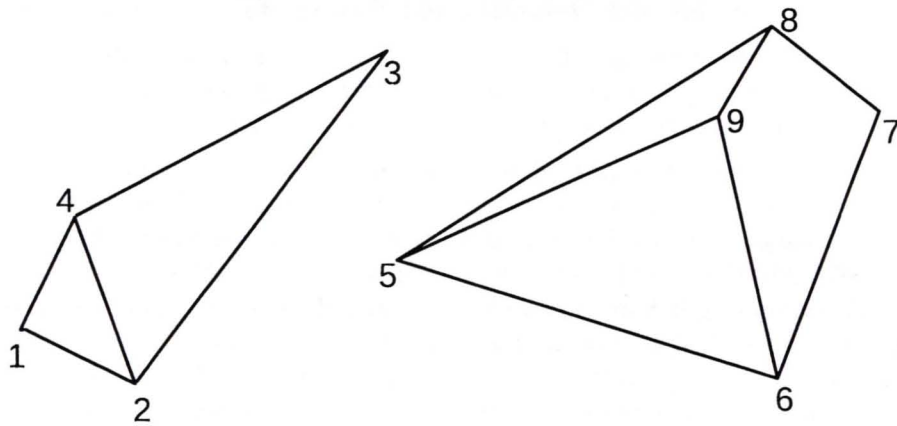
18.  $\clubsuit \times \clubsuit = \diamond \heartsuit$  and  $\diamond + \heartsuit = \clubsuit$ . If each of the symbols  $\clubsuit, \diamond, \heartsuit$  stand for distinct digits, what digit is represented by  $\heartsuit$ ?
- A. 0  
B. 1  
C. 8  
D. 9
19. Given below is the write-up on the discovery of the computer Mouse in randomly-ordered sentences.
- (I) We use the mouse today because it is the pointing device that is the easiest to use compared to others such as joysticks, light-pens, trackballs, etc.
- (II) Doug Engelbart was bored at a conference and started thinking about tracking movement on a plane using two sets of wheels moving in orthogonal directions.
- (III) Doug Engelbart remembered these notes when he was trying to come up with a device to select objects on a computer screen.
- (IV) Doug Engelbart tells the story of how he invented the mouse.
- What is the correct sequence of the above sentences?
- A. IV, II, III, I  
B. I, II, III, IV  
C. IV, III, II, I  
D. I, IV, II, III
20. Select the option that best describes the relation between the following two statements.
- (I) The fictional character, Hercule Poirot, created by Agatha Christie, is very popular.  
(II) All his books are sold in millions and many are made into movies.
- A. The first contradicts the second  
B. The second provides evidence for the first  
C. The first provides evidence for the second  
D. The second explains the meaning of the first
21. In the famous story of the king's gift to the inventor of the chess game, the chess inventor asks for one grain of rice on the first square, two grains of rice on the second square, four grains of rice on the third square, doubling the grains of rice on each square until the last (i.e., 64th square). The king, unable to realise the power of a geometric progression, thinks that the gift is trivial. However, he soon realises his mistake. Can we too see the magnitude of the king's mistake? Assuming that there are about a billion grains in each 25 kg bag of rice, the number of bags asked for by the chess inventor is approximately
- A. 100  
B. 1,00,000  
C. 10,00,00,00,000  
D. 10,00,00,00,00,00,00,00,00,00,000

22. The figure on the left shows an unfolded die. If four such dice are stacked on top of each other as shown in the figure on the right, what is sum of the numbers appearing on the faces parallel to the ground?



- A. 29  
 B. 32  
 C. 37  
 D. 39
23. Amicable numbers are a pair of distinct natural numbers  $(x, y)$  such that the sum of the proper factors of  $x$  equals  $y$  and the sum of the proper factors of  $y$  equals  $x$ . Given that  $(220, y)$  is a pair of amicable numbers,  $y =$
- A. 225  
 B. 284  
 C. 404  
 D. 768
24. The last digit in the decimal expansion of  $2^{91}$  is
- A. 2  
 B. 4  
 C. 6  
 D. 8
25. In 2021, a person spent half the time working in office, a third in sleeping and one-eighth in daily activities, and the rest of the time in exercising. How many hours were spent in exercising?
- A. 1  
 B. 182.5  
 C. 365  
 D. 730
26. Consider the two pieces below. Pair the numbered corners to form a tetrahedron, i.e, if you pair the corners  $(1,9)$ , then it means that the corner numbered 1 is on top of the corner numbered 9.





The correct pairing of corners for forming the tetrahedron is

- A. (1,9) (2,8) (3,5)
- B. (3,5) (4,9) (1,6)
- C. (2,9) (1,6) (3,5)
- D. (1,5) (2,6) (4,9)

27. An A4 paper is folded and cut as follows:

- (I) At the beginning, the four quadrants of the front side are numbered 1, 2, 3 and 4 from left to right row-wise.
- (II) The four quadrants on the back are numbered 5, 6, 7 and 8 from left to right row-wise so that 6 is behind 1, 5 is behind 2, 8 is behind 3 and 7 is behind 4.
- (III) The paper is now folded upwards along the line between 1,2 and 3,4.
- (IV) It is again folded in half along the line between 7,8.
- (V) The folds at the bottom are cut to result in an 8-page booklet.

The correct ordering of the quadrants (pages) is ( $\bar{2}$  means that the quadrant 2 is inverted with respect to its original orientation)

- A. 6, 1,  $\bar{3}$ , 8,  $\bar{7}$ , 4, 2,  $\bar{1}$
- B. 6,  $\bar{1}$ , 3,  $\bar{8}$ , 7,  $\bar{4}$ ,  $\bar{2}$ , 1
- C. 6, 1,  $\bar{3}$ ,  $\bar{8}$ ,  $\bar{7}$ ,  $\bar{4}$ , 2, 1
- D.  $\bar{6}$ ,  $\bar{1}$ ,  $\bar{3}$ ,  $\bar{8}$ , 7, 4, 2, 1

28. An unbiased die is thrown 1000 times and the number of times a '6' occurs is counted and noted in a book. The same experiment is repeated 500 times. A histogram of the number of times '6' occurs in these 500 experiments is plotted. Which of the following best describes the resulting plot?

- A. It will be a normal distribution centred at  $\approx 167$
- B. It will be a normal distribution centred at  $\approx 200$
- C. It will be uniform distribution with a height of  $\approx 167$  and a width of  $\approx 6$
- D. It will be an exponential distribution starting with a maximum value of  $\approx 167$

Questions 29 – 31 are based on the following text. Read carefully and answer the questions.

Software-Defined Networking (SDN) is an approach to networking that uses software-based controllers or Application Programming Interfaces (APIs) to communicate with underlying hardware infrastructure and direct traffic on a network.

This model differs from that of traditional networks, which use dedicated hardware devices (i.e., routers and switches) to control network traffic. SDN can create and control a virtual network – or control a traditional hardware – via software. The key difference between SDN and traditional networking is infrastructure: SDN is software-based, while traditional networking is hardware-based. Because the control plane is software-based, SDN is much more flexible than traditional networking. It allows administrators to control the network, change configuration settings, provision resources, and increase network capacity — all from a centralized user interface, without the need for more hardware.

There are also security differences between SDN and traditional networking. Thanks to greater visibility and the ability to define secure pathways, SDN offers better security in many ways. However, because software-defined networks use a centralized controller, securing the controller is crucial to maintaining a secure network.

29. Which of these devices control network traffic in a traditional network?
- A. Host and Destination
  - B. Sensors and Ports
  - C. Ethernet and Wifi
  - D. Switches and Routers
30. The weakness in SDN from a security perspective is due to
- A. Software based control
  - B. Centralised controller
  - C. Distributed control
  - D. Increased network capacity
31. Which of the following is/are easily done in SDN?
- A. Network control
  - B. Network configuration
  - C. Adding and removing resources
  - D. All of the above.
32. Consider the series 13, 26, 20, 40, 34, 68, . . . . What is the next number in this series?
- A. 50
  - B. 56
  - C. 62
  - D. 136
33. Let  $P$ ,  $Q$  and  $R$  be three statements such that  $(P \vee Q)$  is true and  $(Q \wedge R)$  is false then
- A. If  $P$  is true then  $R$  is always false
  - B. If  $R$  is false then  $P$  is always false
  - C. If  $R$  is true then  $P$  is always true

- D. None of the above
34. The difference, the sum and the product of two numbers are in the ratio, 1 : 5 : 12. The product of the two numbers is
- A. 60
  - B. 36
  - C. 24
  - D. 12
35. If a number of researchers publications are increased by 25% and afterwards decreased by 25%, what is the net change in the number of reseachers publications?
- A. Increase of 4%
  - B. Decrease of 4%
  - C. Decrease of 6.25%
  - D. Increase of 6.25%

○ ○ ○ END OF PART A. PART B FROM NEXT PAGE ○ ○ ○

**PART – B (QUESTIONS 36 – 70)**

**B-3**

36. Assume that the memory address consists of 64 bits, and a 64 KiB 4-way set associative cache with 64-byte cache blocks is used. Which of the following is true?
- A. Number of tag bits are 6
  - B. Number of index bits are 8
  - C. Number of offset bits are 50
  - D. All of these options are true
37. The IEEE754 single precision representation of -15.0 in hexadecimal is
- A. C1700000
  - B. 417C0000
  - C. C17C0000
  - D. None of these
38. A counting semaphore has a value of 10 at a given point in time. Later 12P and  $xV$  operations were performed on the semaphore. What is the value of  $x$  if the semaphore final value is 12?
- A. 15
  - B. 14
  - C. 13
  - D. 12
39. Which type of shared system components forms a host and does not need an operating system for each service
- A. Virtual Machine
  - B. Spooled
  - C. Docker
  - D. Fork
40. On average, a multi-user operating system receives 24 requests every hour to access a specific resource. Assuming the Poisson distribution, the likelihood of no requests being submitted in 15 minutes is
- A.  $e^{-6}$
  - B.  $e^{-5}$
  - C.  $1 - e^{-6}$
  - D.  $1 - e^{-5}$
41. Consider the following definition:

```
const classInfo = {  
    strength: 48,  
    benches: 24,  
    blackBoard:02  
}
```

```
const {strength:classStrength,  
    benches:classBenches,  
    blackBoard:classBlackBoard } = classInfo;
```

According to the object destructuring process, the output of the variables, classStrength, classBenches and classBlackboard are:

- A. 0, 0, 0
- B. 48, 24, 02
- C. null, null, null
- D. 02, 24, 48

42. Consider the following script related to the web programming :

```
x = 23;
let x;
function anotherRandomFunc() {
  message = "Hello";
  let message;
  x=message;
}
anotherRandomFunc();
```

What will be the output of  $x$  as given in the script:

- A. 23
- B. Hello
- C. Null
- D. Throws a reference error

43. Consider the following code fragment:

```
var x = 13;
(myfunction() {
  var x = 23;
  (function random() {
    x++;
    console.log(x);
    var x = 11;
  })();
})();
```

The output of this myfunction is:

- A. NaN
- B. 3
- C. 13
- D. 11

44. Which of the following sorting algorithms can be used to sort a random linked list with minimum time complexity?

- A. Insertion Sort

- B. Quick Sort  
 C. Heap Sort  
 D. Merge Sort
45. The postorder traversal of a binary tree is -31, -30, -33, -32, -35, -34, -37, -36, -38. The inorder traversal of the same tree is -31, -33, -30, -35, -32, -37, -34, -38, -36. The height of a tree is the length of the longest path from the root to any leaf. What is the height of this binary tree?
- A. 2  
 B. 3  
 C. 4  
 D. 5
46. The test you are taking now has 70 questions. There are four possible choices for each question. In how many ways can a student answer the questions on the test if every question is answered?
- A.  $4^{70}$   
 B.  $70 * {}^4C_1$   
 C.  ${}^{70}C_4$   
 D. None of the above
47. Number of one-to-one functions from a set with 7 elements to a set with 10 elements is equal to
- A.  ${}^{10}C_7$   
 B. 604800  
 C.  ${}^{10}P_7$   
 D. None
48. Number of bit strings of length 10 that contains equal number of 0's and 1's is equal to
- A. 252  
 B. 512  
 C.  ${}^{10}C_2$   
 D. 1024
49. Let S be a set of all non-negative integers less than or equal to 25 and let R be the congruence modulo 4 relation on elements of the set S. Then
- A. R is not an equivalence relation and hence there are no equivalence classes  
 B. R is an equivalence relation and the equivalence classes are {0, 1, 2, 3, 4}, {5, 6, 7, 8}, {9, 10, 11, 12}, {13, 14, 15, 16}, {17, 18, 19, 20}, {21, 22, 23, 24}  
 C. R is an equivalence relation and the equivalence classes are {0, 4, 8, 12, 16, 20, 24}, {1, 5, 9, 13, 17, 21, 25}, {2, 6, 10, 14, 18, 22}, and {3, 7, 11, 15, 19, 23}  
 D. R is an equivalence relation and the equivalence classes are {4, 8, 12, 16, 20, 24}, {1, 5, 9, 13, 17, 21}, {2, 6, 10, 14, 18, 22}, {3, 7, 11, 15, 19, 23}
50. The time complexities of finding a Fibonacci number  $n$  using a recursive procedure and dynamic programming are respectively

- A.  $O(n^2), O(2^n)$   
 B.  $O(n^2), O(n)$   
 C.  $O(n), O(n^2)$   
 D.  $O(2^n), O(n)$
51. How many subproblems need to be solved in a maximum subarray problem of size  $n$ ? (Maximum subarray problem is that a sequence of numbers including negative numbers is given to find a subsequence where the sum of the numbers in the subsequence is maximum)
- A.  $O(2^n)$   
 B.  $O(n^2)$   
 C.  $O(n \log n)$   
 D.  $O(n^3)$
52. What is the average search time taken to find the elements processed in the order 5, 78, 16, 22, 23, 7 using linear search on the list 4, 81, 56, 23, 5, 34, 66, 22, 7, 45, 22, 15, 78, 21 and 16.
- A. 3.6  
 B. 9  
 C. 3.1  
 D. 8.4
53. There are 45 elements in an array. What is the number of elements that can be accommodated in a linked list within the same storage if each element is 8 bytes and each pointer is 4 bytes?
- A. 30  
 B. 36  
 C. 45  
 D. 28
54. Identify the correct statement from the following statements related to a database.
- A. Logical level Abstraction: hide details of data types  
 B. Logical level Abstraction: describes how a record is stored  
 C. Logical level Abstraction: describes accessibility of the database by an individual user  
 D. Logical level Abstraction: describes how schema is stored in a data base
55. The table 'weather' contains several attributes related to weather of which two are 'humidity' and 'temperature'. Which of the following statements is correct to display all the cities whose humidity is in the range of 60 to 75 from the 'weather' table?
- A. `SELECT * FROM weather WHERE humidity IN (60 to 75)`  
 B. `SELECT * FROM weather WHERE humidity BETWEEN 60 AND 75`  
 C. `SELECT * FROM weather WHERE humidity NOT IN (60 AND 75)`  
 D. `SELECT * FROM weather WHERE humidity NOT BETWEEN 60 AND 75`
56. What is the effect of the UNDO operation corresponding to a log record  $\langle T_i, X, V1, V2 \rangle$ , where  $T_i$  is the transaction, and  $V1$  and  $V2$  are the old and new values respectively of a data location  $X$ ?

- A. No change to  $X$
  - B. Writes the value  $V2$  to  $X$
  - C. Writes the value  $V1$  to  $X$
  - D. Sets  $X$  to 0
57. Which of the following is true regarding Referential Integrity?
- A. Every primary-key value must match a primary-key value in an associated table
  - B. Every primary-key value must match a foreign-key value in an associated table
  - C. Every foreign-key value must match a primary-key value in an associated table
  - D. Every foreign-key value must match a foreign-key value in an associated table
58. Which of the following Functional Dependency (FD) can't be implied from FD set:  $A \rightarrow B$ ,  $A \rightarrow BC$ ,  $C \rightarrow D$  ?
- A.  $A \rightarrow C$
  - B.  $B \rightarrow D$
  - C.  $BC \rightarrow D$
  - D. All of the above
59. How can you change "Thomas" into "Michel" in the "LastName" column in the Users table?
- A. `UPDATE User SET LastName = 'Thomas' INTO LastName = 'Michel'`
  - B. `MODIFY Users SET LastName = 'Michel' WHERE LastName = 'Thomas'`
  - C. `MODIFY Users SET LastName = 'Thomas' INTO LastName = 'Michel'`
  - D. `UPDATE Users SET LastName = 'Michel' WHERE LastName = 'Thomas'`
60. Which of the following scenarios may lead to an irrecoverable error in a database system?
- A. A transaction reads a data item after it is written by an uncommitted transaction
  - B. A transaction writes a data item after it is read by an uncommitted transaction
  - C. A transaction reads a data item after it is read by an uncommitted transaction
  - D. A transaction reads a data item after it is written by a committed transaction
61. In a UNIX environment, If a command path is set to `:/usr/x:/usr/bin`, then it means that
- A. The command one types will be first checked in the current directory, then `/usr/x` and `/usr/bin`
  - B. If the command is found in both `/usr/x` and `usr/bin`, then the one in `/usr/x` will be executed
  - C. If the command is found in both `/usr/x` and `usr/bin`, then the one in `/usr/bin` will be executed
  - D. It is unpredictable
62. A cycle in which of the following graphs indicates a possible deadlock?
- A. Resource Allocation Graph
  - B. Process Node Graph
  - C. Resource Limited Graph



## D. Process Resource Graph

63. What is the number of edges present in a complete graph having  $n$  vertices?
- $(n*(n+1))/2$
  - $(n*(n-1))/2$
  - $n$
  - Information given is insufficient
64. Let  $A = \{1, 2, 3, 4\}$  and  $R$ , a relation on  $A$  defined by  $xRy$  iff  $3x + 2y \leq 11$ . Which of the following statements is true?
- $R$  is reflexive
  - $R$  is symmetric
  - $R$  is transitive
  - None of the above
65. The minimum number of states in a deterministic finite automata (DFA) that will accept the language over the alphabet  $\Sigma = \{0, 1\}$  consisting of all the strings of 0 and 1 except 010 is
- 3
  - 4
  - 5
  - None of the above
66. Let  $L_1$  is a regular language and  $L_2$  is a context free language over the alphabet  $\Sigma$  such that  $L_2 \subset L_1$ . Consider the following statements:
- $L_1 \setminus L_2$  is always regular
  - $\Sigma^* \setminus L_2$  is always regular
- Which of the following is correct about above two statements?
- I is true, but II is false
  - II is true, but I is false
  - Both I and II are false
  - Both I and II are true
67. Let  $s$  be a string of length  $\ell$  over the alphabet  $\Sigma = \{a, b, c\}$  and  $S_s$  be the set of all substrings of  $s$ . A non-deterministic finite automata accepting all the strings in  $S_s$  has at least
- $\ell$  states
  - $3\ell + 1$  states
  - $3^\ell$  states
  - $\ell + 1$  states
68. Let  $s$  be any string then  $reverse(s)$  is the string obtained by writing the characters of  $s$  in reverse order, e.g. if  $s = abbab$  then  $reverse(s) = babba$ . Let  $L$  be a regular language and let  $L^R = \{reverse(w) \mid w \in L\}$  then

- A.  $L^R$  is regular  
B.  $L^R$  is non-regular and a deterministic pushdown automata can accept it  
C.  $L^R$  is non-regular and only a non-deterministic pushdown automata can accept it  
D.  $L^R$  is non-context free and only a Turing machine can accept it
69. Which of the following is always true about a language and its complement?
- I. At most one of them can be finite  
II. At most one of them can be infinite  
III. Their union is always regular
- A. I only  
B. II only  
C. I and III only  
D. II and III only
70. Which of the following is not regular language over the alphabet  $\Sigma = \{a, b\}$
- A. Language with finite strings  
B. Language with strings of bounded length  
C.  $a^n b^m$   
D. Language with strings that have more a's than b's

○ ○ ○ END OF QUESTION PAPER ○ ○ ○

**University of Hyderabad**  
**Ph.D. Entrance Examinations - 2022**

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Course : Ph.D.

: *SCIS*  
Subject : *CS*

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1	B	26	A	51	B
2	A	27	C	52	B
3	D	28	A	53	A
4	D	29	D	54	D
5	B	30	B	55	B
6	A	31	D	56	C
7	A	32	C	57	C
8	D	33	C	58	B
9	B	34	C	59	D
10	A	35	C	60	A
11	C	36	D	61	A
12	D	37	A	62	A
13	A	38	B	63	B
14	C	39	C	64	D
15	B	40	A	65	C
16	D	41	B	66	C
17	C	42	D	67	D
18	B	43	A	68	A
19	A	44	D	69	C
20	B	45	C	70	D
21	C	46	A		
22	C	47	B		
23	B	48	A		
24	D	49	C		
25	C	50	D		

Note/Remarks :

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23/11/2022