# GATE 3rd Feb 2024 S1

| Candidate ID | DA24S13015222 |
|---|---|
| Candidate Name | ROHAN |
| Test Center Name | IPS Digital Centre |
| Test Date | 03/02/2024 |
| Test Time | 9:30 AM - 12:30 PM |
| Subject | DA Data Science and Artificial Intelligence |

Section : **General Aptitude**

**Q.1** The 15 parts of the given figure are to be painted such that no two adjacent parts with shared boundaries (excluding corners) have the same color. The minimum number of colors required is
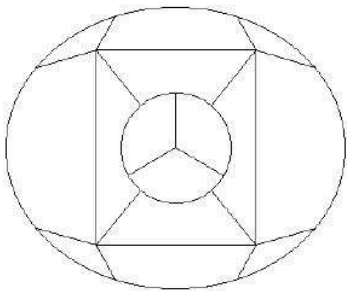


**Options**

A. 3

B. 6

C. 4

D. 5

Question Type : **MCQ**
Question ID : **6420085094**
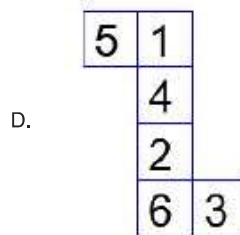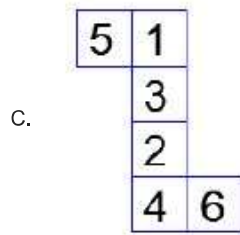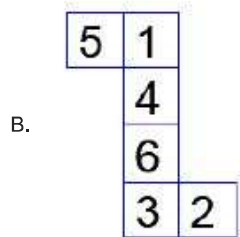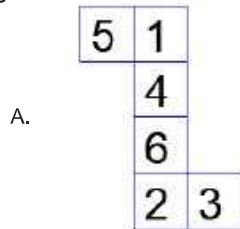Status : **Answered**
Chosen Option : **C**

**Q.2** Three different views of a dice are shown in the figure below.



The piece of paper that can be folded to make this dice is

**Options**

A.


B.


C.


D.


Question Type : **MCQ**
Question ID : **6420085101**
Status : **Answered**
Chosen Option : **C**

**Q.3**     The probability of a boy or a girl being born is 1/2. For a family having only three children, what is the probability of having two girls and one boy?

**Options**

A.   1/8

B.   1/2

C.   1/4

D.   3/8

Question Type : **MCQ**
Question ID : **6420085099**
Status : **Answered**
Chosen Option : **C**

**Q.4**     Thousands of years ago, some people began dairy farming. This coincided with a number of mutations in a particular gene that resulted in these people developing the ability to digest dairy milk.

Based on the given passage, which of the following can be inferred?

**Options**

A.   Digestion of dairy milk is essential for human beings.

B.
In human beings, digestion of dairy milk resulted from a mutated gene.

C.   No human being can digest dairy milk.

D.   All human beings can digest dairy milk.

Question Type : **MCQ**
Question ID : **6420085098**
Status : **Answered**
Chosen Option : **B**

**Q.5**     Visualize two identical right circular cones such that one is inverted over the other and they share a common circular base. If a cutting plane passes through the vertices of the assembled cones, what shape does the outer boundary of the resulting cross-section make?

**Options**

A.   A rhombus

B.   A triangle

C.   A hexagon

D.   An ellipse

Question Type : **MCQ**
Question ID : **6420085102**
Status : **Answered**
Chosen Option : **B**

**Q.6**  Person 1 and Person 2 invest in three mutual funds A, B, and C. The amounts they invest in each of these mutual funds are given in the table.

|  | Mutual fund A | Mutual fund B | Mutual fund C |
|---|---|---|---|
| Person 1 | ₹10,000 | ₹20,000 | ₹20,000 |
| Person 2 | ₹20,000 | ₹15,000 | ₹15,000 |

At the end of one year, the total amount that Person 1 gets is ₹500 more than Person 2. The annual rate of return for the mutual funds B and C is 15% each. What is the annual rate of return for the mutual fund A?

**Options**

A.  15%

B.  7.5%

C.  20%

D.  10%

Question Type : **MCQ**
Question ID : **6420085100**
Status : **Answered**
Chosen Option : **B**

**Q.7**  How many 4-digit positive integers divisible by 3 can be formed using only the digits {1, 3, 4, 6, 7}, such that no digit appears more than once in a number?

**Options**

A.  48

B.  24

C.  12

D.  72

Question Type : **MCQ**
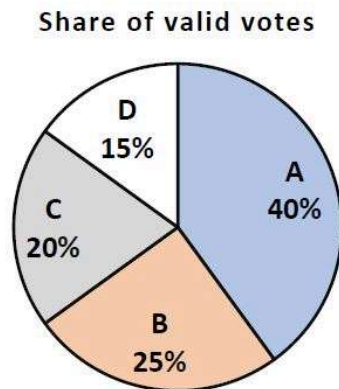Question ID : **6420085095**
Status : **Answered**
Chosen Option : **A**

**Q.8**   If '→' denotes increasing order of intensity, then the meaning of the words

[sick → infirm → moribund] is analogous to [silly → _____ → daft].

Which one of the given options is appropriate to fill the blank?

Options  A.  vein

B.  frown

C.  fawn

D.  vain

Question Type : **MCQ**
Question ID : **6420085093**
Status : **Answered**
Chosen Option : **A**

**Q.9**   In an election, the share of valid votes received by the four candidates A, B, C, and D is represented by the pie chart shown. The total number of votes cast in the election were 1,15,000, out of which 5,000 were invalid.

**Share of valid votes**



Based on the data provided, the total number of valid votes received by the candidates B and C is

Options  A.  45,000

B.  51,750

C.  54,000

D.  49,500

Question Type : **MCQ**
Question ID : **6420085097**
Status : **Answered**
Chosen Option : **D**

**Q.10**

The sum of the following infinite series is

$$2 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{8} + \frac{1}{9} + \frac{1}{16} + \frac{1}{27} + \cdots$$

**Options**

A. $11/3$

B. $9/2$

C. $7/2$

D. $13/4$

Question Type : **MCQ**
Question ID : **6420085096**
Status : **Answered**
Chosen Option : **D**

Section : **DA Data Science and Artificial Intelligence**

**Q.1**

The sample average of 50 data points is 40. The updated sample average after including a new data point taking the value of 142 is _____.

Given Answer : **113.6**

Question Type : **NAT**
Question ID : **6420085126**
Status : **Answered**

**Q.2**

Consider the following statements:

(i)    The mean and variance of a Poisson random variable are equal.
(ii)   For a standard normal random variable, the mean is zero and the variance is one.

Which **ONE** of the following options is **correct**?

**Options**

A. (ii) is true and (i) is false

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

C. (i) is true and (ii) is false

D. Both (i) and (ii) are false

Question Type : **MCQ**
Question ID : **6420085103**
Status : **Answered**
Chosen Option : **C**

**Q.3**   Match the items in **Column 1** with the items in **Column 2** in the following table:

| Column 1 | Column 2 |
|---|---|
| (p) Principal Component Analysis | (i) Discriminative Model |
| (q) Naïve Bayes Classification | (ii) Dimensionality Reduction |
| (r) Logistic Regression | (iii) Generative Model |

**Options**

A. $(p) - (iii), (q) - (i), (r) - (ii)$

B. $(p) - (ii), (q) - (i), (r) - (iii)$

C. $(p) - (ii), (q) - (iii), (r) - (i)$

D. $(p) - (iii), (q) - (ii), (r) - (i)$

Question Type : **MCQ**
Question ID : **6420085110**
Status : **Answered**
Chosen Option : **C**

**Q.4**   Consider five random variables $U, V, W, X,$ and $Y$ whose joint distribution satisfies:

$$P(U, V, W, X, Y) = P(U)P(V)P(W|U,V)P(X|W)P(Y|W)$$

Which **ONE** of the following statements is **FALSE**?

**Options**

A. $X$ is conditionally independent of $U$ given $W$

B. $U$ and $V$ are conditionally independent given $W$

C. $Y$ is conditionally independent of $V$ given $W$

D. $Y$ and $X$ are conditionally independent given $W$

Question Type : **MCQ**
Question ID : **6420085116**
Status : **Answered**
Chosen Option : **C**

**Q.5** Consider the following two tables named Raider and Team in a relational database maintained by a Kabaddi league. The attribute *ID* in table Team references the primary key of the Raider table, *ID*.

| Raider | | | |
|---|---|---|---|
| ID | Name | Raids | RaidPoints |
| 1 | Arjun | 200 | 250 |
| 2 | Ankush | 190 | 219 |
| 3 | Sunil | 150 | 200 |
| 4 | Reza | 150 | 190 |
| 5 | Pratham | 175 | 220 |
| 6 | Gopal | 193 | 215 |

| Team | | |
|---|---|---|
| City | ID | BidPoints |
| Jaipur | 2 | 200 |
| Patna | 3 | 195 |
| Hyderabad | 5 | 175 |
| Jaipur | 1 | 250 |
| Patna | 4 | 200 |
| Jaipur | 6 | 200 |

The SQL query described below is executed on this database:

```
SELECT *
FROM Raider, Team
WHERE Raider.ID=Team.ID AND City="Jaipur" AND
RaidPoints > 200;
```

The number of rows returned by this query is _____.

Given Answer : **1**

Question Type : **NAT**
Question ID : **6420085123**
Status : **Answered**

**Q.6** Consider performing uniform hashing on an open address hash table with load factor $\alpha = \frac{n}{m} < 1$, where $n$ elements are stored in the table with $m$ slots. The expected number of probes in an unsuccessful search is at most $\frac{1}{1-\alpha}$.

Inserting an element in this hash table requires at most _____ probes, on average.

**Options**

A. $\ln\left(\dfrac{1}{1-\alpha}\right)$

B. $1 + \dfrac{\alpha}{2}$

C. $\dfrac{1}{1-\alpha}$

D. $\dfrac{1}{1+\alpha}$

Question Type : **MCQ**
Question ID : **6420085113**
Status : **Not Answered**
Chosen Option : **--**

**Q.7**  Let $x$ and $y$ be two propositions. Which of the following statements **is a tautology /are tautologies**?

**Options**

A. $(\neg x \wedge y) \Rightarrow (y \Rightarrow x)$

B. $(\neg x \wedge y) \Rightarrow (\neg x \Rightarrow y)$

C. $(x \wedge \neg y) \Rightarrow (\neg x \Rightarrow y)$

D. $(x \wedge \neg y) \Rightarrow (y \Rightarrow x)$

Question Type : **MSQ**
Question ID : **6420085121**
Status : **Answered**
Chosen Option : **C**

**Q.8**  Three fair coins are tossed independently. $T$ is the event that two or more tosses result in heads. $S$ is the event that two or more tosses result in tails.

What is the probability of the event $T \cap S$ ?

**Options**  A.  1

B.  0.5

C.  0.25

D.  0

Question Type : **MCQ**
Question ID : **6420085104**
Status : **Answered**
Chosen Option : **B**

**Q.9**  Consider sorting the following array of integers in ascending order using an in-place Quicksort algorithm that uses the last element as the pivot.

| 60 | 70 | 80 | 90 | 100 |

The minimum number of swaps performed during this Quicksort is _____.

Given Answer : **0**

Question Type : **NAT**
Question ID : **6420085122**
Status : **Answered**

**Q.10**  Let $h_1$ and $h_2$ be two admissible heuristics used in $A^*$ search.

Which **ONE** of the following expressions is always an admissible heuristic?

**Options**
  A. $h_1 + h_2$

  B. $h_1/h_2, (h_2 \neq 0)$

  C. $h_1 \times h_2$

  D. $|h_1 - h_2|$

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Question Type : **MCQ**

Question ID : **6420085115**

Status : **Answered**

Chosen Option : **B**

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**Q.11**  The fundamental operations in a double-ended queue D are:

`insertFirst(e)` – Insert a new element e at the beginning of D.
`insertLast(e)` – Insert a new element e at the end of D.
`removeFirst()` – Remove and return the first element of D.
`removeLast()` – Remove and return the last element of D.

In an empty double-ended queue, the following operations are performed:

`insertFirst(10)`

`insertLast(32)`

**a** ←`removeFirst()`

`insertLast(28)`

`insertLast(17)`

**a** ←`removeFirst()`

**a** ← `removeLast()`


The value of **a** is _____.

Given **17**
Answer :

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Question Type : **NAT**

Question ID : **6420085124**

Status : **Answered**

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**Q.12**  Consider the dataset with six datapoints: $\{(x_1, y_1), (x_2, y_2), \ldots, (x_6, y_6)\}$, where $x_1 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, $x_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $x_3 = \begin{bmatrix} 0 \\ -1 \end{bmatrix}$, $x_4 = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$, $x_5 = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$, $x_6 = \begin{bmatrix} -2 \\ -2 \end{bmatrix}$ and the labels are given by $y_1 = y_2 = y_5 = 1$, and $y_3 = y_4 = y_6 = -1$. A hard margin linear support vector machine is trained on the above dataset.

Which **ONE** of the following sets is a possible set of support vectors?

**Options**

A. $\{x_4, x_5\}$

B. $\{x_1, x_2, x_5\}$

C. $\{x_3, x_4, x_5\}$

D. $\{x_1, x_2, x_3, x_4\}$

| | |
|---|---|
| Question Type : | **MCQ** |
| Question ID : | **6420085109** |
| Status : | **Answered** |
| Chosen Option : | **C** |

**Q.13**  Consider the matrix $M = \begin{bmatrix} 2 & -1 \\ 3 & 1 \end{bmatrix}$.

Which **ONE** of the following statements is **TRUE**?

**Options**

A. The eigenvalues of $M$ are complex conjugate pairs.

B. One eigenvalue of $M$ is non-negative and real, and another eigenvalue of $M$ is negative and real.

C. One eigenvalue of $M$ is positive and real, and another eigenvalue of $M$ is zero.

D. The eigenvalues of $M$ are non-negative and real.

| | |
|---|---|
| Question Type : | **MCQ** |
| Question ID : | **6420085105** |
| Status : | **Answered** |
| Chosen Option : | **D** |

**Q.14**    Consider the following statement:

In adversarial search, $\alpha-\beta$ pruning can be applied to game trees of any depth where $\alpha$ is the ___(m)___ value choice we have formed so far at any choice point along the path for the MAX player and $\beta$ is the ___(n)___ value choice we have formed so far at any choice point along the path for the MIN player.

Which **ONE** of the following choices of **(m)** and **(n)** makes the above statement valid?

**Options**

A. **(m)** = lowest, **(n)** = highest

B. **(m)** = highest, **(n)** = lowest

C. **(m)** = lowest, **(n)** = lowest

D. **(m)** = highest, **(n)** = highest

Question Type : **MCQ**

Question ID : **6420085117**

Status : **Not Answered**

Chosen Option : **--**

**Q.15**    Match the items in **Column 1** with the items in **Column 2** in the following table:

| Column 1 | | Column 2 | |
|---|---|---|---|
| (p) | First In First Out | (i) | Stacks |
| (q) | Lookup Operation | (ii) | Queues |
| (r) | Last In First Out | (iii) | Hash Tables |

**Options**

A. $(p) - (ii), (q) - (iii), (r) - (i)$

B. $(p) - (ii), (q) - (i), (r) - (iii)$

C. $(p) - (i), (q) - (ii), (r) - (iii)$

D. $(p) - (i), (q) - (iii), (r) - (ii)$

Question Type : **MCQ**

Question ID : **6420085108**

Status : **Answered**

Chosen Option : **A**

**Q.16** Consider a database that includes the following relations:

Defender(*name, rating, side, goals*)

Forward(*name, rating, assists, goals*)

Team(*name, club, price*)

Which **ONE** of the following relational algebra expressions checks that every name occurring in Team appears in either Defender or Forward, where $\phi$ denotes the empty set?

Options A.

$(\Pi_{name}(\text{Defender}) \cap \Pi_{name}(\text{Forward})) \setminus \Pi_{name}(\text{Team}) = \phi$

B.

$\Pi_{name}(\text{Team}) \setminus (\Pi_{name}(\text{Defender}) \cup \Pi_{name}(\text{Forward})) = \phi$

C.

$\Pi_{name}(\text{Team}) \setminus (\Pi_{name}(\text{Defender}) \cap \Pi_{name}(\text{Forward})) = \phi$

D.

$(\Pi_{name}(\text{Defender}) \cup \Pi_{name}(\text{Forward})) \setminus \Pi_{name}(\text{Team}) = \phi$

Question Type : **MCQ**

Question ID : **6420085118**

Status : **Not Answered**

Chosen Option : **--**

**Q.17** Euclidean distance based $k$-means clustering algorithm was run on a dataset of 100 points with $k = 3$. If the points $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$ and $\begin{bmatrix} -1 \\ 1 \end{bmatrix}$ are both part of cluster 3, then which **ONE** of the following points is necessarily also part of cluster 3?

Options

A. $\begin{bmatrix} 0 \\ 2 \end{bmatrix}$

B. $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$

C. $\begin{bmatrix} 2 \\ 0 \end{bmatrix}$

D. $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Question Type : **MCQ**

Question ID : **6420085111**

Status : **Not Answered**

Chosen Option : **--**

**Q.18** Let $f: \mathbb{R} \to \mathbb{R}$ be the function $f(x) = \frac{1}{1+e^{-x}}$.

The value of the derivative of $f$ at $x$ where $f(x) = 0.4$ is _____ (rounded off to **two** decimal places).

**Note**: $\mathbb{R}$ denotes the set of real numbers.

Given 1.4
Answer :

Question Type : **NAT**
Question ID : **6420085125**
Status : **Answered**

**Q.19** For any twice differentiable function $f: \mathbb{R} \to \mathbb{R}$, if at some $x^* \in \mathbb{R}$, $f'(x^*) = 0$ and $f''(x^*) > 0$, then the function $f$ necessarily has a _____ at $x = x^*$.

**Note**: $\mathbb{R}$ denotes the set of real numbers.

Options
A. local maximum

B. global maximum

C. global minimum

D. local minimum

Question Type : **MCQ**
Question ID : **6420085107**
Status : **Answered**
Chosen Option : **B**

**Q.20** Let the minimum, maximum, mean and standard deviation values for the attribute *income* of data scientists be ₹46000, ₹170000, ₹96000, and ₹21000, respectively. The $z$-score normalized *income* value of ₹106000 is closest to which **ONE** of the following options?

Options
A. 0.623

B. 0.217

C. 2.304

D. 0.476

Question Type : **MCQ**
Question ID : **6420085119**
Status : **Answered**
Chosen Option : **D**

**Q.21**  Given a dataset with $K$ binary-valued attributes (where $K > 2$) for a two-class classification task, the number of parameters to be estimated for learning a naïve Bayes classifier is

**Options**

A. $2K + 1$

B. $2^{K+1} + 1$

C. $K^2 + 1$

D. $2^K + 1$

Question Type : **MCQ**
Question ID : **6420085112**
Status : **Answered**
Chosen Option : **A**

**Q.22**  For any binary classification dataset, let $S_B \in \mathbb{R}^{d \times d}$ and $S_W \in \mathbb{R}^{d \times d}$ be the between-class and within-class scatter (covariance) matrices, respectively. The Fisher linear discriminant is defined by $u^* \in \mathbb{R}^d$, that maximizes

$$J(u) = \frac{u^T S_B u}{u^T S_W u}$$

If $\lambda = J(u^*)$, $S_W$ is non-singular and $S_B \neq 0$, then $(u^*, \lambda)$ must satisfy which **ONE** of the following equations?

**Note**: $\mathbb{R}$ denotes the set of real numbers.

**Options**

A. $S_W^{-1} S_B u^* = \lambda u^*$

B. $u^{*T} u^* = \lambda^2$

C. $S_W u^* = \lambda S_B u^*$

D. $S_B S_W u^* = \lambda u^*$

Question Type : **MCQ**
Question ID : **6420085114**
Status : **Answered**
Chosen Option : **B**

**Q.23**  Consider performing depth-first search (DFS) on an undirected and unweighted graph $G$ starting at vertex $s$. For any vertex $u$ in $G$, $d[u]$ is the length of the shortest path from $s$ to $u$. Let $(u, v)$ be an edge in $G$ such that $d[u] < d[v]$. If the edge $(u, v)$ is explored first in the direction from $u$ to $v$ during the above DFS, then $(u, v)$ becomes a _____ edge.

Options  A.  gray

B.  back

C.  tree

D.  cross

Question Type : **MCQ**
Question ID : **6420085106**
Status : **Answered**
Chosen Option : **A**

**Q.24**  Consider the following tree traversals on a full binary tree:

(i)    Preorder
(ii)   Inorder
(iii)  Postorder

Which of the following traversal options **is/are** sufficient to uniquely reconstruct the full binary tree?

Options  A.  (ii) only

B.  (i) and (iii)

C.  (ii) and (iii)

D.  (i) and (ii)

Question Type : **MSQ**
Question ID : **6420085120**
Status : **Answered**
Chosen Option : **B**

**Q.25**

Consider the $3 \times 3$ matrix $M = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 1 & 3 \\ 4 & 3 & 6 \end{bmatrix}$.

The determinant of $(M^2 + 12M)$ is _____.

Given **12**
Answer :

Question Type : **NAT**
Question ID : **6420085127**
Status : **Answered**

**Q.26**  Let $X$ be a random variable uniformly distributed in the interval $[1, 3]$ and $Y$ be a random variable uniformly distributed in the interval $[2, 4]$. If $X$ and $Y$ are independent of each other, the probability $P(X \geq Y)$ is _____ (rounded off to **three** decimal places).

Given 0.2
Answer :

| |
|---|
| Question Type : **NAT** |
| Question ID : **6420085148** |
| Status : **Answered** |

**Q.27**  Consider the following Python code:

```python
def count(child_dict, i):
    if i not in child_dict.keys():
        return 1
    ans = 1
    for j in child_dict[i]:
        ans += count(child_dict, j)
    return ans

child_dict = dict()
child_dict[0] = [1,2]
child_dict[1] = [3,4,5]
child_dict[2] = [6,7,8]
print(count(child_dict,0))
```

Which **ONE** of the following is the output of this code?

Options
A. 9

B. 6

C. 1

D. 8

| |
|---|
| Question Type : **MCQ** |
| Question ID : **6420085130** |
| Status : **Answered** |
| Chosen Option : **C** |

**Q.28**

Let $u = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{bmatrix}$, and let $\sigma_1, \sigma_2, \sigma_3, \sigma_4, \sigma_5$ be the singular values of the matrix

$M = uu^T$ (where $u^T$ is the transpose of $u$). The value of $\sum_{i=1}^{5} \sigma_i$ is _____.

Given **5**
Answer :

Question Type : **NAT**
Question ID : **6420085153**
Status : **Answered**

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**Q.29**  Details of ten international cricket games between two teams "Green" and "Blue" are given in Table C. This table consists of matches played on different pitches, across formats along with their winners. The attribute *Pitch* can take one of two values: spin-friendly (represented as $S$) or pace-friendly (represented as $F$). The attribute *Format* can take one of two values: one-day match (represented as $O$) or test match (represented as $T$).

A cricket organization would like to use the information given in Table C to develop a decision-tree model to predict outcomes of future games between these two teams.

To develop such a model, the computed InformationGain(C, *Pitch*) with respect to the Target is _____ (rounded off to **two** decimal places).

**Table C**

| Match Number | Pitch | Format | Winner (Target) |
|---|---|---|---|
| 1 | S | T | Green |
| 2 | S | T | Blue |
| 3 | F | O | Blue |
| 4 | S | O | Blue |
| 5 | F | T | Green |
| 6 | F | O | Blue |
| 7 | S | O | Green |
| 8 | F | T | Blue |
| 9 | F | O | Blue |
| 10 | S | O | Green |

Given **5**
Answer :

Question Type : **NAT**
Question ID : **6420085154**
Status : **Answered**

**Q.30** Consider the function $f: \mathbb{R} \to \mathbb{R}$ where $\mathbb{R}$ is the set of all real numbers.

$$f(x) = \frac{x^4}{4} - \frac{2x^3}{3} - \frac{3x^2}{2} + 1$$

Which of the following statements is/are **TRUE**?

**Options**

A. $x = 0$ is a local maximum of $f$

B. $x = 3$ is a local minimum of $f$

C. $x = -1$ is a local maximum of $f$

D. $x = 0$ is a local minimum of $f$

Question Type : **MSQ**
Question ID : **6420085142**
Status : **Answered**
Chosen Option : **D**

**Q.31** Select all choices that are subspaces of $\mathbb{R}^3$.

**Note**: $\mathbb{R}$ denotes the set of real numbers.

**Options**

A. $\left\{ \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in \mathbb{R}^3 : \ 5x_1 + 2x_3 + 4 = 0 \right\}$

B. $\left\{ \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in \mathbb{R}^3 : \ \mathbf{x} = \alpha \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} + \beta \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, \alpha, \beta \in \mathbb{R} \right\}$

C.

$\left\{ \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in \mathbb{R}^3 : \ 5x_1 + 2x_3 = 0, 4x_1 - 2x_2 + 3x_3 = 0 \right\}$

D. $\left\{ \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \in \mathbb{R}^3 : \ \mathbf{x} = \alpha^2 \begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix} + \beta^2 \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}, \alpha, \beta \in \mathbb{R} \right\}$
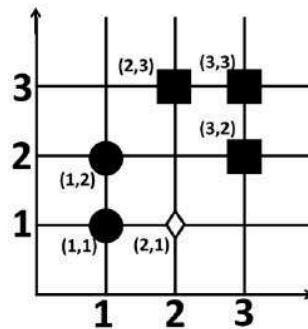
Question Type : **MSQ**
Question ID : **6420085139**
Status : **Answered**
Chosen Option : **B**

**Q.32** Given the two-dimensional dataset consisting of 5 data points from two classes (circles and squares) and assume that the Euclidean distance is used to measure the distance between two points. The minimum odd value of $k$ in $k$-nearest neighbor algorithm for which the diamond ($\diamond$) shaped data point is assigned the label square is _____.



Given
Answer : **2**

Question Type : **NAT**
Question ID : **6420085155**
Status : **Answered**

**Q.33** Consider a state space where the start state is number 1. The successor function for the state numbered $n$ returns two states numbered $n+1$ and $n+2$. Assume that the states in the unexpanded state list are expanded in the ascending order of numbers and the previously expanded states are not added to the unexpanded state list.

Which **ONE** of the following statements about breadth-first search (BFS) and depth-first search (DFS) is true, when reaching the goal state number 6?

Options
A. BFS expands more states than DFS.

B. DFS expands more states than BFS.

C.
Both BFS and DFS do not reach the goal state number 6.

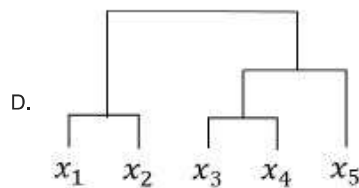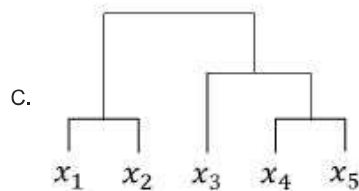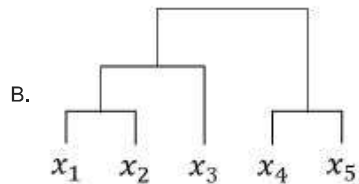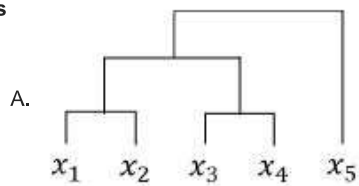D. Both BFS and DFS expand equal number of states.

Question Type : **MCQ**
Question ID : **6420085136**
Status : **Answered**
Chosen Option : **A**

**Q.34** Consider the table below, where the $(i, j)^{th}$ element of the table is the distance between points $x_i$ and $x_j$. Single linkage clustering is performed on data points, $x_1, x_2, x_3, x_4, x_5$.

|     | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
|-----|-------|-------|-------|-------|-------|
| $x_1$ | 0 | 1 | 4 | 3 | 6 |
| $x_2$ | 1 | 0 | 3 | 5 | 3 |
| $x_3$ | 4 | 3 | 0 | 2 | 5 |
| $x_4$ | 3 | 5 | 2 | 0 | 1 |
| $x_5$ | 6 | 3 | 5 | 1 | 0 |

Which **ONE** of the following is the correct representation of the clusters produced?

Options

A. (dendrogram with leaves $x_1$ $x_2$ $x_3$ $x_4$ $x_5$)

B. (dendrogram with leaves $x_1$ $x_2$ $x_3$ $x_4$ $x_5$)

C. (dendrogram with leaves $x_1$ $x_2$ $x_3$ $x_4$ $x_5$)

D. (dendrogram with leaves $x_1$ $x_2$ $x_3$ $x_4$ $x_5$)

Question Type : **MCQ**
Question ID : **6420085134**
Status : **Answered**
Chosen Option : **D**

**Q.35** Let $F(n)$ denote the maximum number of comparisons made while searching for an entry in a sorted array of size $n$ using binary search.

Which **ONE** of the following options is **TRUE**?

Options
A. $F(n) = F(\lfloor n/2 \rfloor) + F(\lceil n/2 \rceil)$

B. $F(n) = F(n - 1) + 1$

C. $F(n) = F(\lfloor n/2 \rfloor)$

D. $F(n) = F(\lfloor n/2 \rfloor) + 1$

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Question Type : **MCQ**

Question ID : **6420085132**

Status : **Answered**

Chosen Option : **A**

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**Q.36** Consider two events $T$ and $S$. Let $\bar{T}$ denote the complement of the event $T$. The probability associated with different events are given as follows:

$$P(\bar{T}) = 0.6, \qquad P(S|T) = 0.3, \qquad P(S|\bar{T}) = 0.6$$

Then, $P(T|S)$ is _____ (rounded off to **two** decimal places).

Given Answer : **0.6**

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Question Type : **NAT**

Question ID : **6420085150**

Status : **Answered**

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**Q.37** Which of the following statements is/are **TRUE**?

**Note**: $\mathbb{R}$ denotes the set of real numbers.

Options A.

There exist $M \in \mathbb{R}^{3 \times 3}, p \in \mathbb{R}^3$, and $q \in \mathbb{R}^3$ such that $Mx = p$ has a unique solution and $Mx = q$ has infinite solutions.

B.

There exist $M \in \mathbb{R}^{3 \times 2}, p \in \mathbb{R}^3$, and $q \in \mathbb{R}^3$ such that $Mx = p$ has a unique solution and $Mx = q$ has no solutions.

C.

There exist $M \in \mathbb{R}^{2 \times 3}, p \in \mathbb{R}^2$, and $q \in \mathbb{R}^2$ such that $Mx = p$ has a unique solution and $Mx = q$ has infinite solutions.

D.

There exist $M \in \mathbb{R}^{3 \times 3}, p \in \mathbb{R}^3$, and $q \in \mathbb{R}^3$ such that $Mx = p$ has no solutions and $Mx = q$ has infinite solutions.

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Question Type : **MSQ**

Question ID : **6420085140**

Status : **Answered**

Chosen Option : **C**

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**Q.38**    Let $f: \mathbb{R} \to \mathbb{R}$ be a function. **Note**: $\mathbb{R}$ denotes the set of real numbers.

$$f(x) = \begin{cases} -x, & \text{if } x < -2 \\ ax^2 + bx + c, & \text{if } x \in [-2, 2] \\ x, & \text{if } x > 2 \end{cases}$$

Which **ONE** of the following choices gives the values of $a, b, c$ that make the function $f$ continuous and differentiable?

**Options**

A. $a = \dfrac{1}{4}, b = 0, c = 1$

B. $a = 1, b = 1, c = -4$

C. $a = \dfrac{1}{2}, b = 0, c = 0$

D. $a = 0, b = 0, c = 0$

Question Type : **MCQ**
Question ID : **6420085129**
Status : **Answered**
Chosen Option : **A**

**Q.39**    Let *game(ball, rugby)* be true if the ball is used in rugby and false otherwise.

Let *shape(ball, round)* be true if the ball is round and false otherwise.

Consider the following logical sentences:

*s1:* $\forall ball \ \neg \ game(ball, rugby) \Rightarrow shape(ball, round)$

*s2:* $\forall ball \ \neg \ shape(ball, round) \Rightarrow game(ball, rugby)$

*s3:* $\forall ball \ game(ball, rugby) \Rightarrow \neg \ shape(ball, round)$

*s4:* $\forall ball \ shape(ball, round) \Rightarrow \neg \ game(ball, rugby)$

Which of the following choices is/are logical representations of the assertion,
        "All balls are round except balls used in rugby"?

**Options**

A. $s2 \wedge s3$

B. $s1 \wedge s3$

C. $s3 \wedge s4$

D. $s1 \wedge s2$

Question Type : **MSQ**
Question ID : **6420085146**
Status : **Answered**
Chosen Option : **B**

**Q.40** Two fair coins are tossed independently. $X$ is a random variable that takes a value of 1 if both tosses are heads and 0 otherwise. $Y$ is a random variable that takes a value of 1 if at least one of the tosses is heads and 0 otherwise.

The value of the covariance of $X$ and $Y$ is _____ (rounded off to **three** decimal places).

Given **4**
Answer :

| |
|---|
| Question Type : **NAT** |
| Question ID : **6420085157** |
| Status : **Answered** |

**Q.41** Consider the function **computeS** ($X$) whose pseudocode is given below:

```
computeS (X)
S[1] ← 1
for i ←2 to length(X)
    S[i] ← 1
    if X[i − 1] ≤ X[i]
        S[i] ← S[i] + S[i − 1]
    end if
end for
return S
```

Which **ONE** of the following values is returned by the function **computeS** ($X$) for $X = [6, 3, 5, 4, 10]$?

**Options**
A. $[1, 1, 2, 3, 3]$

B. $[1, 1, 2, 1, 5]$

C. $[1, 1, 2, 3, 4]$

D. $[1, 1, 2, 1, 2]$

| |
|---|
| Question Type : **MCQ** |
| Question ID : **6420085131** |
| Status : **Answered** |
| Chosen Option : **B** |

**Q.42**   Consider the following Python function:

```
def fun(D, s1, s2):
        if s1 < s2:
            D[s1], D[s2] = D[s2], D[s1]
            fun(D, s1+1, s2-1)
```

What does this Python function `fun ()` do? Select the **ONE** appropriate option below.

**Options A.**

It swaps the elements in D at indices s1 and s2, and leaves the remaining elements unchanged.

B.

It reverses the list D between indices s1 and s2, both inclusive.

C.

It finds the smallest element in D from index s1 to s2, both inclusive.

D.

It performs a merge sort in-place on this list D between indices s1 and s2, both inclusive.

> Question Type : **MCQ**
> Question ID : **6420085133**
> Status : **Answered**
> Chosen Option : **B**

**Q.43**   Let $X$ be a random variable exponentially distributed with parameter $\lambda > 0$. The probability density function of $X$ is given by:

$$f_X(x) = \begin{cases} \lambda\, e^{-\lambda x}, & x \geq 0 \\ 0, & otherwise \end{cases}$$

If $5E(X) = Var(X)$, where $E(X)$ and $Var(X)$ indicate the expectation and variance of $X$, respectively, the value of $\lambda$ is _____ (rounded off to **one** decimal place).

Given Answer : **0**

> Question Type : **NAT**
> Question ID : **6420085149**
> Status : **Answered**

**Q.44**   Consider a joint probability density function of two random variables $X$ and $Y$

$$f_{X,Y}(x,y) = \begin{cases} 2xy, & 0 < x < 2, \quad 0 < y < x \\ 0, & otherwise \end{cases}$$

Then, $E[Y|X = 1.5]$ is _____.

Given Answer : **1**

> Question Type : **NAT**
> Question ID : **6420085151**
> Status : **Answered**

**Q.45** Evaluate the following limit:

$$\lim_{x \to 0} \frac{\ln\left((x^2+1)\cos x\right)}{x^2} = \underline{\hspace{2cm}}.$$

Given
Answer : **0**

Question Type : **NAT**
Question ID : **6420085152**
Status : **Answered**

**Q.46** Let $\mathbb{R}$ be the set of real numbers, $U$ be a subspace of $\mathbb{R}^3$ and $M \in \mathbb{R}^{3\times3}$ be the matrix corresponding to the projection on to the subspace $U$.

Which of the following statements is/are **TRUE**?

Options A.
If $U$ is a 1-dimensional subspace of $\mathbb{R}^3$, then the null space of $M$ is a 1-dimensional subspace.

B. $M^2 = M$

C. $M^3 = M$

D.
If $U$ is a 2-dimensional subspace of $\mathbb{R}^3$, then the null space of $M$ is a 1-dimensional subspace.

Question Type : **MSQ**
Question ID : **6420085141**
Status : **Answered**
Chosen Option : **D**

**Q.47**  An OTT company is maintaining a large disk-based relational database of different movies with the following schema:

```
Movie(ID, CustomerRating)
Genre(ID, Name)
Movie_Genre(MovieID, GenreID)
```

Consider the following SQL query on the relation database above:

```
SELECT *
FROM Movie, Genre, Movie_Genre
WHERE
    Movie.CustomerRating > 3.4 AND
    Genre.Name = "Comedy" AND
    Movie_Genre.MovieID = Movie.ID AND
    Movie_Genre.GenreID = Genre.ID;
```

This SQL query can be sped up using which of the following indexing options?

**Options A.**

Hash index on Movie.CustomerRating and $B^+$ tree on the remaining attributes.

B. $B^+$ tree on all the attributes.

C. Hash index on all the attributes.

D.

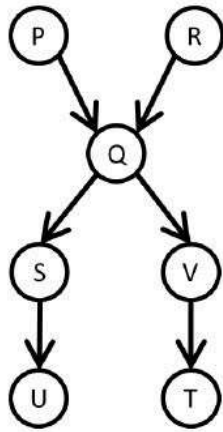Hash index on Genre.Name and $B^+$ tree on the remaining attributes.

| | |
|---|---|
| Question Type : | **MSQ** |
| Question ID : | **6420085147** |
| Status : | **Answered** |
| Chosen Option : | **C** |

**Q.48** Consider the directed acyclic graph (DAG) below:



Which of the following is/are valid vertex orderings that can be obtained from a topological sort of the DAG?

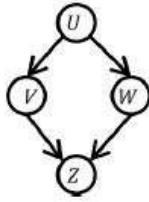**Options**

A. P R Q S V T U

B. P Q R S V U T

C. P R Q V S U T

D. P Q R S T U V

| | |
|---|---|
| Question Type : | **MSQ** |
| Question ID : | **6420085143** |
| Status : | **Answered** |
| Chosen Option : | **B** |

**Q.49** Given the following Bayesian Network consisting of four Bernoulli random variables and the associated conditional probability tables:



|  | $P(\cdot)$ |
|---|---|
| $U = 0$ | 0.5 |
| $U = 1$ | 0.5 |

|  | $P(V = 0\mid \cdot)$ | $P(V = 1\mid \cdot)$ |
|---|---|---|
| $U = 0$ | 0.5 | 0.5 |
| $U = 1$ | 0.5 | 0.5 |

|  | $P(W = 0\mid \cdot)$ | $P(W = 1\mid \cdot)$ |
|---|---|---|
| $U = 0$ | 1 | 0 |
| $U = 1$ | 0 | 1 |

|  |  | $P(Z = 0\mid \cdot)$ | $P(Z = 1\mid \cdot)$ |
|---|---|---|---|
| $V = 0$ | $W = 0$ | 0.5 | 0.5 |
| $V = 0$ | $W = 1$ | 1 | 0 |
| $V = 1$ | $W = 0$ | 1 | 0 |
| $V = 1$ | $W = 1$ | 0.5 | 0.5 |

The value of $P(U = 1, V = 1, W = 1, Z = 1) = $ _____ (rounded off to **three** decimal places).

Given **1**
Answer :

Question Type : **NAT**
Question ID : **6420085156**
Status : **Answered**

**Q.50** Consider the following sorting algorithms:

(i)      Bubble sort
(ii)    Insertion sort
(iii)   Selection sort

Which **ONE** among the following choices of sorting algorithms sorts the numbers in the array [4, 3, 2, 1, 5] in increasing order after **exactly two** passes over the array?

**Options**

A. (i) only

B. (i) and (iii) only

C. (ii) and (iii) only

D. (iii) only

Question Type : **MCQ**
Question ID : **6420085137**
Status : **Answered**
Chosen Option : **D**

**Q.51**  Let $H, I, L,$ and $N$ represent height, number of internal nodes, number of leaf nodes, and the total number of nodes respectively in a rooted binary tree.

Which of the following statements is/are always **TRUE**?

**Options**

A. $H \leq L \leq 2^{H-1}$

B. $H \leq I \leq 2^H - 1$

C. $H + 1 \leq N \leq 2^{H+1} - 1$

D. $L \leq I + 1$

> Question Type : **MSQ**
> Question ID : **6420085144**
> Status : **Answered**
> Chosen Option : **C**

**Q.52**  Given the relational schema $R = (U, V, W, X, Y, Z)$ and the set of functional dependencies:

$$\{U \rightarrow V, U \rightarrow W, WX \rightarrow Y, WX \rightarrow Z, V \rightarrow X\}$$

Which of the following functional dependencies can be derived from the above set?

**Options**

A. $VW \rightarrow Y$

B. $VW \rightarrow YZ$

C. $VW \rightarrow U$

D. $WX \rightarrow YZ$

> Question Type : **MSQ**
> Question ID : **6420085138**
> Status : **Answered**
> Chosen Option : **A**

**Q.53**   A fair six-sided die (with faces numbered 1, 2, 3, 4, 5, 6) is repeatedly thrown independently.

What is the expected number of times the die is thrown until **two** consecutive throws of even numbers are seen?

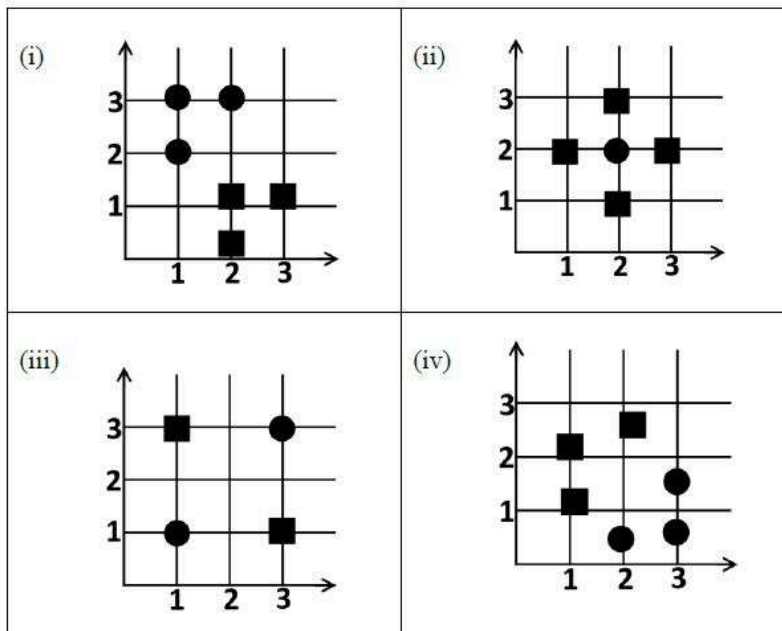**Options**   A. 4

B. 8

C. 6

D. 2

Question Type : **MCQ**
Question ID : **6420085128**
Status : **Answered**
Chosen Option : **D**

**Q.54**   Consider the following figures representing datasets consisting of two-dimensional features with two classes denoted by circles and squares.



Which of the following is/are **TRUE**?

**Options**   A. (ii) is linearly separable.

B. (iii) is linearly separable.

C. (iv) is linearly separable.

D. (i) is linearly separable.

Question Type : **MSQ**
Question ID : **6420085145**
Status : **Answered**
Chosen Option : **D**

**Q.55** Consider the two neural networks (NNs) shown in Figures 1 and 2, with *ReLU* activation $(ReLU(z) = \max\{0, z\}, \forall z \in \mathbb{R})$. The connections and their corresponding weights are shown in the Figures. The biases at every neuron are set to 0.

For what values of $p, q, r$ in Figure 2 are the two NNs equivalent, when $x_1, x_2, x_3$ are positive?
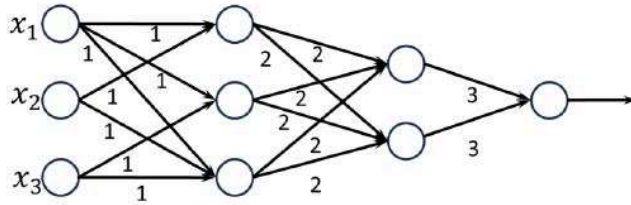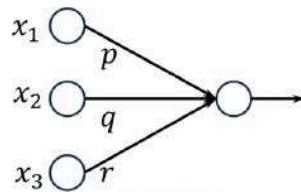
**Figure 1**

**Figure 2**

**Note**: $\mathbb{R}$ denotes the set of real numbers.

Options

A. $p = 24, q = 24, r = 36$

B. $p = 36, q = 24, r = 24$

C. $p = 36, q = 36, r = 36$

D. $p = 18, q = 36, r = 24$

Question Type : **MCQ**
Question ID : **6420085135**
Status : **Answered**
Chosen Option : **B**