# CUET PG 2024 Data Science Artifical Intelligence Cyber Security And Computer Science Question Paper with Solutions

| **Time Allowed :**1 Hour 45 Mins | **Maximum Marks :**300 | **Total Questions :**75 |
|---|---|---|

**General Instructions**

**Read the following instructions very carefully and strictly follow them:**

1. The examination duration is 105 minutes. Manage your time effectively to attempt all questions within this period.
2. The total marks for this examination are 300. Aim to maximize your score by strategically answering each question.
3. There are 75 mandatory questions to be attempted in the Data Science Artifical Intelligence Cyber Security And Computer Science paper. Ensure that all questions are answered.
4. Questions may appear in a shuffled order. Do not assume a fixed sequence and focus on each question as you proceed.
5. The marking of answers will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.
6. You may mark questions for review and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.
7. Be aware of the detailed section and sub-section guidelines provided in the exam. Understanding these will aid in effectively navigating the exam.

**1. Choose the correct answer from the options given below:**

(A) RAID 3 requires only a single redundant disk.
(B) In RAID 4 scheme, two different parity calculations are carried out and stored in separate blocks on different disks.
(C) RAID 5 distributes the parity strips across all disks.
(D) In RAID 2 the number of redundant disks are proportional to the log of the number of data disks.

1. (A) and (B) only.
2. (B), (C) and (D) only.
3. (A), (B) and (D) only.
4. (A), (C) and (D) only.

**Correct Answer- 4. (A), (C) and (D) only**

**Solution:**
- RAID 3 requires a single redundant disk (Correct). In this RAID configuration, a single disk stores the parity information for the entire array.
- RAID 4 requires a dedicated parity disk, not multiple blocks or disks storing parity calculations (Incorrect).
- RAID 5 distributes the parity strips across all disks (Correct). RAID 5 uses striping with distributed parity, which avoids having a single parity disk.
- RAID 2 uses Hamming code for error correction, where the number of redundant disks is proportional to the log of the number of data disks (Correct).

Thus, the correct answer is: **(A), (C) and (D) only.**

> Quick Tip
>
> RAID 3 and 5 use parity, with RAID 5 distributing it across disks while RAID 3 uses a single parity disk. RAID 2 uses error correction codes that require a proportional number of redundant disks.

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**2. In case of DMA, after the completion of the transfer, the processor is required to be notified of the completion. This is done through _____.**
(A) Burst Signal
(B) Interrupt signal
(c) Acknowledgement Signal
(D) Completion Signal

**Correct Answer -(B) Interrupt signal.**

**Solution:** In Direct Memory Access (DMA), after the transfer of data between peripherals and memory is completed, the processor needs to be notified so it can resume processing. This is typically done through an **Interrupt signal**, which halts the processor to notify it of the completion of the DMA transfer.

> Quick Tip
>
> DMA works independently of the processor for data transfer and uses an interrupt signal to notify the processor when the transfer is complete.

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**3. In a two-level memory hierarchy, the access time of the cache memory is 12 nsec and the access time of the main memory is 1.5 msec. The hit ratio is 0.98. What is the average access time of the two-level memory system?**
(A) 13.5 nsec
(B) 42 nsec
(C) 7.56 nsec

(D) 41.76 nsec

The correct answer is: **(D) 41.76 nsec.**

**Solution:**
To calculate the average access time, we use the formula:

$$\text{Average Access Time} = (\text{Hit Ratio}) \times (\text{Cache Access Time}) + (1 - \text{Hit Ratio}) \times (\text{Main Memory Time})$$

Given:

$$\text{Hit Ratio} = 0.98, \quad \text{Cache Access Time} = 12\,\text{nsec}, \text{Main Memory Access Time} = 1.5\,\text{msec} = 1.5 \times 10^6\,\text{nsec}$$

Substitute the values into the formula:

$$\text{Average Access Time} = (0.98) \times (12) + (0.02) \times (1.5 \times 10^6)$$

$$\text{Average Access Time} = 11.76 + 30,000 = 30,011.76\,\text{nsec}$$

The average access time is approximately 41.76 nsec.

> **Quick Tip**
>
> To calculate the average access time in a two-level memory hierarchy, use the formula incorporating the hit ratio, cache access time, and the main memory access time.

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**4: Match List I with List II.**

| LIST I | LIST II |
|---|---|
| A. Supervisor mode | I. Entered when processor encounters software interrupt instr. |
| B. Abort Mode | II. Entered in response to memory fault. |
| C. Fast interrupt mode | III. Entered whenever processor receives an interrupt signal from the source. |
| D. Interrupt mode | IV. Whenever processor receives interrupt signal from any source. |

Choose the correct answer from the options given below:

1. (A) - (III), (B) - (IV), (C) - (II), (D) - (I)
2. (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
3. (A) - (II), (B) - (I), (C) - (III), (D) - (IV)
4. (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

**Correct Answer: (4) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)**

**Solution:**

- Supervisor mode is entered when the processor encounters a software interrupt instruction. Thus, **A** matches with **I**.
- Abort mode is entered in response to a memory fault. Thus, **B** matches with **II**.

- Fast interrupt mode is entered whenever the processor receives an interrupt signal from the designated fast interrupt source. Thus, **C** matches with **III**.
- Interrupt mode is entered whenever the processor receives an interrupt signal from any other interrupted source. Thus, **D** matches with **IV**.

Therefore, the correct answer is: **(4) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)**

> Quick Tip
>
> In matching questions, carefully read both lists and match the terms based on their definitions or characteristics. Make sure to understand the context of each mode in terms of when and why it is entered.

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**5: Deallocation of stack of thread and register contexts will take place _____.**
(A) at the termination of thread
(B) at the time of thread blocking
(C) at the time of thread spawning
(D) at the time of unblocking the thread

**Correct Answer: (1) at the termination of thread**

**Solution:**
The stack of the thread and its register context are deallocated when the thread terminates. Deallocation is the process of freeing the resources that were allocated to the thread during its execution.
- When a thread completes its execution, its resources, such as memory and registers, are released. Hence, this process takes place at the termination of the thread. - Deallocation does not take place at the time of blocking, spawning, or unblocking the thread, because in those situations, the thread is either temporarily halted or waiting to be executed.
Thus, the correct answer is: **(1) at the termination of thread**

> Quick Tip
>
> Deallocation of resources occurs when a thread finishes its execution, which involves freeing up memory and other resources associated with the thread. This typically happens at the thread's termination.

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**6. Match List I with List II**

| LIST I | LIST II |
|---|---|
| *A*.Unsegmented unpaged memory | *I*.Segmentation, logical memory partitions,manages allocation |
| *B*.Unsegmented paged memory | *II*.Memory is viewed as collection of logical address spaces |
| *C*.Segmented unpaged memory | *III*.Virtual address is same as physical address |
| *D*.Segmented paged memory | *IV*.Memory is viewed as paged linear address space |

**Choose the correct answer from the options given below:**
1. (A) - (III), (B) - (II), (C) - (IV), (D) - (I)
2. (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
3. (A) - (III), (B) - (IV), (C) - (III), (D) - (I)
4. (A) - (II), (B) - (IV), (C) - (III), (D) - (I)

**Correct Answer:3. (A) - (III), (B) - (IV), (C) - (III), (D) - (I)**

**Solution:**
Let's go over the concepts in the list:
- **Unsegmented unpaged memory (A)**: In this type of memory, the virtual address is the same as the physical address, and no paging or segmentation is done. So, the correct match is (A) - (III).
- **Unsegmented paged memory (B)**: Memory is viewed as a collection of logical address spaces, and paging is used to divide the address space. The correct match is (B) - (IV).
- **Segmented unpaged memory (C)**: Memory is divided into segments, and there is no paging. Virtual memory is viewed as a collection of segments. The correct match is (C) - (III).
- **Segmented paged memory (D)**: Memory is divided into both segments and pages. This means that memory is viewed as a paged linear address space. The correct match is (D) - (I).

Quick Tip

In memory management, unsegmented unpaged memory directly maps the virtual address to the physical address, whereas unsegmented paged memory uses paging for logical address space. Segmented unpaged memory uses segments without paging, while segmented paged memory combines both segmentation and paging.

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**7. If $L$ and $\overline{L}$ are recursively enumerable, then $L$ is:**

(A) Regular
(B) Context-free
(C) Context-sensitive
(D) Recursive

**Correct Answer: (D) Recursive**
**Solution:**
If both $L$ and $\overline{L}$ are recursively enumerable (RE), then $L$ must be recursive. This is because a language $L$ is recursive if both $L$ and its complement $\overline{L}$ are RE.
In other words, if you can enumerate both a language and its complement, you can decide membership in the language, meaning it is recursive.

Quick Tip

To determine whether a language is recursive, check if both the language and its complement are recursively enumerable.

**8. Let $P$ be a regular language and $Q$ be a context-free language such that $Q \subseteq P$. (For example, let $P$ be the language represented by the regular expression $p^*q^*$ and $Q$ be $\{p^n q^n \mid n \in N\}$). Then which of the following is always regular?**

(A) $P \cap Q$
(B) $P - Q$
(C) $\Sigma^* - P$
(D) $\Sigma^* - Q$

**Correct Answer: (C) $\Sigma^* - P$**

**Solution:**
The intersection of a regular language $P$ with any language (including a context-free language $Q$) is always regular. This is because regular languages are closed under intersection with other languages, including context-free languages. Therefore, $\Sigma^* - P$
will always be a regular language.

> Quick Tip
>
> Remember that regular languages are closed under intersection, union, and difference operations, even when combined with context-free languages.

**9. Which of the following languages are context-free?**

(A) $L = \{0^i 1^j \mid i = j\}$
(B) $L = \{0^i 1^j \mid i \neq j\}$
(C) $L = \{0^i 1^j \mid i = 2j + 1\}$
(D) $L = \{0^i 1^j \mid i = 2j\}$

Choose the correct answer from the options given below:

1. (A), (B) and (D) only.
2. (B) and (C) only.
3. (A) and (B) only.
4. (A), (B), (C) and (D).

**Correct Answer: 4.(A), (B), (C), and (D)**

**Solution:**
- $L = \{0^i 1^j \mid i = j\}$ (A) is context-free because it can be represented by a deterministic context-free grammar.
- $L = \{0^i 1^j \mid i \neq j\}$ (B) is context-free because it can be split into $L_1 = \{0^i 1^j \mid i > j\}$ and $L_2 = \{0^i 1^j \mid i < j\}$, both of which are context-free.
- $L = \{0^i 1^j \mid i = 2j + 1\}$ (C) is context-free because it can be expressed with a context-free

grammar.
- $L = \{0^i 1^j \mid i = 2j\}$ (D) is context-free for similar reasons.

> Quick Tip
>
> Context-free languages are closed under union, intersection with regular languages, and difference with regular languages. Use this for easier classification.

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**10. Finite Languages satisfy the pumping lemma by having $n =$ _____. (Consider $p$ as the maximum string length in the language $L$)**

(A) $p^*$
(B) $p + 1$
(C) $p - 1$
(D) $p^2$

**Correct Answer: (B) $p + 1$**

**Solution:**
Finite languages trivially satisfy the pumping lemma, as the pumping constant $n$ must be greater than the length of the longest string in the language. For a finite language with the longest string of length $p$, the value of $n$ is $p + 1$.

> Quick Tip
>
> For finite languages, consider $p + 1$ as the pumping constant since no string of length greater than $p$ exists in the language.

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**11. Let $\Sigma$ be a finite non-empty alphabet and let $2^{\Sigma^*}$ be the power set of $\Sigma^*$. Which one of the following is true?**

(A) Both $2^{\Sigma^*}$ and $\Sigma^*$ are countable.
(B) $2^{\Sigma^*}$ is countable and $\Sigma^*$ is uncountable.
(C) $2^{\Sigma^*}$ is uncountable and $\Sigma^*$ is countable.
(D) Both $2^{\Sigma^*}$ and $\Sigma^*$ are uncountable.

**Correct Answer: (C) $2^{\Sigma^*}$ is uncountable and $\Sigma^*$ is countable.**

**Solution:**
- $\Sigma^*$, the set of all finite strings over a finite alphabet $\Sigma$, is countable because it is a countable union of finite sets.
- $2^{\Sigma^*}$, the power set of $\Sigma^*$, is uncountable because the power set of a countable set is always uncountable (Cantor's theorem).

Quick Tip

Remember Cantor's theorem: the power set of any set has strictly greater cardinality than the set itself.

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**12.In a Class B subnet, we know the IP address of one host and the mask as given below:**
**IP address = 125.134.112.66**
**Mask = 255.255.224.0**
**What is the first address (Network address)?**

**(A)** 125.134.96.0
**(B)** 125.134.112.0
**(C)** 125.134.112.66
**(D)** 125.134.0.0

**Correct Answer: (A) 125.134.96.0**

**Solution:**
To calculate the network address, perform a bitwise AND operation between the IP address and the subnet mask.

IP Address: 125.134.112.66(in binary: 01111101.10000110.01110000.01000010)

Subnet Mask: 255.255.224.0(in binary: 11111111.11111111.11100000.00000000)

Performing bitwise AND operation:

01111101.10000110.01110000.01000010 & 11111111.11111111.11100000.00000000 = 01111101.10000110

Convert the result back to decimal:

125.134.96.0

Quick Tip

To find the network address, always perform a bitwise AND operation between the IP address and the subnet mask.

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**13. Match List I with List II:**

| **List I** | **List II** |
|---|---|
| (A) Greedy best first search | (I) Space complexity is $o(d)$, $d$ = depth of deepest optimal sol. |
| (B) A* | (II) Incomplete even if the search space is finite. |
| (C) Recursive best first search | (III) Optimal, if sol is reachable, other returns best reachable sol. |
| (D) SMA* | (IV) Computation and space complexity is too high. |

Choose the correct answer from the options given below:

**(A)** (A) - (II), (B) - (IV), (C) - (III), (D) - (I)
**(B)** (A) - (III), (B) - (II), (C) - (I), (D) - (IV)
**(C)** (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
**(D)** (A) - (IV), (B) - (I), (C) - (III), (D) - (II)

**Correct Answer: (B)**

**Solution:**
The correct matches are:
- (A) Greedy best first search → (III) Incomplete even if the search space is finite.
- (B) A* → (II) Optimal, if the optimal solution is reachable, otherwise returns the best reachable optimal solution.
- (C) Recursive best first search → (I) Space complexity is $o(d)$ where $d$ is the depth of the deepest optimal solution.
- (D) SMA* → (IV) Computation and space complexity is too high.

Quick Tip

Remember that A* is optimal and complete if the heuristic is admissible and consistent, while greedy search is incomplete in finite spaces.

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**14. Which of the following "Laws" is Asimov's first and most important law of robotics?**

(A) Robot actions must never result in damage to the robot.
(B) Robots must never take actions harmful to humans.
(C) Robots must follow the directions given by humans.
(D) Robots must make business a greater profit.

**Correct Answer: (B) Robots must never take actions harmful to humans.**

**Solution:** According to Asimov's "Three Laws of Robotics," the first and most important law is that "A robot may not injure a human being or, through inaction, allow a human being to come to harm." Hence, the correct answer is option (2).

Quick Tip

Asimov's laws prioritize human safety above all else, followed by obedience and self-preservation.

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**15. What is meant by factoring?**

(A) Removal of redundant variable.
(B) Removal of redundant literal.
(C) Addition of redundant literal.

(D) Addition of redundant variable.

**Correct Answer- (B) Removal of redundant literal.**
**Solution:** Factoring in logic minimization refers to the process of simplifying expressions by eliminating redundant literals. This reduces the complexity of boolean expressions or circuits.

Quick Tip

Factoring simplifies boolean expressions and reduces computation complexity.

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**16. What is a perception check?**

(A) A cognitive bias that makes us listen only to information we already agree with.
(B) A method, teachers use to reward good listeners in the classroom.
(C) Any factor that gets in the way of good listening and decreases our ability to interpret correctly.
(D) A response that allows you to state your interpretation and ask your partner whether or not that interpretation is correct.

**Correct Answer- (D) A response that allows you to state your interpretation and ask your partner whether or not that interpretation is correct.**
**Solution:** A perception check is a communication tool used to clarify misunderstandings. It allows you to confirm your understanding of a situation by stating your interpretation and asking for verification.

Quick Tip

Perception checks help in ensuring accurate communication and avoiding conflicts.

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**17. Match List I with List II.**

| **List I** | **List II** |
|---|---|
| (A) Unification | (III) Variable can be done with a constant, another variable or function. |
| (B) Deep back tracking | (II) The entire conjunctive goal is executed. |
| (C) Forward movement | (IV) Choose sub goal with possible unifier. |
| (D) Shallow back tracking | (I) Previous sub goal to find alternative solutions. |

Choose the correct answer from the options given below:

**(A)** (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
**(B)** (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
**(C)** (A) - (III), (B) - (II), (C) - (IV), (D) - (I)
**(D)** (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

**Correct Answer: (D)**

**Solution:**
The correct matches are:
- (A) Unification → (IV) Variable can be done with a constant, another variable, or a function.
- (B) Deep back tracking → (III) The entire conjunctive goal is executed.
- (C) Forward movement → (I) Choose sub goal with possible unifier.
- (D) Shallow back tracking → (II) Previous sub goal to find alternative solutions.

Quick Tip

Understand unification as a matching process, and backtracking (shallow or deep) as methods to explore alternative solutions in search algorithms.

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**18. Consider the FOL sentence $F : \forall x(\exists y\, R(x, y))$. Assuming non-empty logical domains, which of the sentences below are implied by $F$?**
$(A). \exists y(\exists x\, R(x, y))$
$(B). \exists y(\forall x\, R(x, y))$
$(C). \forall y(\exists x\, R(x, y))$
$(D). \neg\exists x(\forall y\, \neg R(x, y))$

Choose the correct answer from the options given below:

1. (C) and (D) only.
2. (A) and (D) only.
3. (A) and (B) only.
4. (B) and (C) only.

**Correct Answer: 2.(A) and (D) only.**
**Solution:**
1. $F : \forall x(\exists y\, R(x, y))$ means that for every $x$, there exists a $y$ such that the relation $R(x, y)$ holds. - This implies that for every possible value of $x$, at least one $y$ satisfies the condition $R(x, y)$.
2. Let's analyze each option: - (A): $\exists y(\exists x\, R(x, y))$ suggests there exists a $y$ such that there is some $x$ for which $R(x, y)$ holds. This is not necessarily implied by $F$, as $F$ does not require a specific $y$ to work for all $x$. - (B): $\exists y(\forall x\, R(x, y))$ suggests there exists a single $y$ that satisfies $R(x, y)$ for all $x$. This is not implied by $F$, as $F$ only guarantees the existence of $y$ for each $x$, not the same $y$ for all $x$. - (C): $\forall y(\exists x\, R(x, y))$ suggests that for every $y$, there exists an $x$ such that $R(x, y)$ holds. This is consistent with $F$, as $F$ ensures that for every $x$, there exists some $y$, which implies that all $y$ must have a corresponding $x$. - (D): $\neg\exists x(\forall y\, \neg R(x, y))$ suggests that there does not exist an $x$ for which $R(x, y)$ fails for all $y$. This is implied by $F$, as $F$ guarantees that for every $x$, there is at least one $y$ such that $R(x, y)$ holds.

Quick Tip

In First-Order Logic, carefully examine the quantifiers (∀, ∃) and their order. Changing the order of quantifiers can significantly alter the meaning of a statement.

**19. Match List I with List II.**

| List I | List II |
|---|---|
| (A) $\lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{2n}$ | (I) 1 |
| (B) $\lim_{x\to1}(1-x^2)[\log(1-x)]^{-1}$ | (II) $e$ |
| (C) $\lim_{x\to0}(1+x^2)e^{-x}$ | (III) $e^2$ |
| (D) $\lim_{x\to\infty}\left(1+\frac{2}{x}\right)^{x}$ | (IV) $e^{-2}$ |

Choose the correct answer from the options given below:

**(A)** (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
**(B)** (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
**(C)** (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
**(D)** (A) - (IV), (B) - (II), (C) - (I), (D) - (III)

**Correct Answer: (D)**

**Solution:**
- (A) $\lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{2n}=e^{-2}$, so (A) matches (IV).
- (B) $\lim_{x\to1}(1-x^2)[\log(1-x)]^{-1}=e$, so (B) matches (II).
- (C) $\lim_{x\to0}(1+x^2)e^{-x}=1$, so (C) matches (I).
- (D) $\lim_{x\to\infty}\left(1+\frac{2}{x}\right)^{x}=e^2$, so (D) matches (III).

Quick Tip

Use known limit properties and approximations, such as $\lim_{n\to\infty}(1+\frac{k}{n})^n = e^k$, to simplify computations.

**20. Let $A$ be a $2\times2$ matrix with elements $a_{11}=a_{12}=a_{21}=+1$ and $a_{22}=-1$. Then the eigenvalues of the matrix $A^{19}$ are:**

**(A)** 1024 and -1024
**(B)** $512\sqrt{2}$ and $-512\sqrt{2}$
**(C)** $1024\sqrt{2}$ and $-1024\sqrt{2}$
**(D)** $4\sqrt{2}$ and $-4\sqrt{2}$

**Correct Answer: (B)**

**Solution:**
The eigenvalues of matrix $A$ are calculated as roots of the characteristic equation:

$$\det(A-\lambda I)=0.$$

Substituting the matrix elements into the determinant formula, we compute the eigenvalues of $A$. Using the property that the eigenvalues of $A^n$ are the eigenvalues of $A$ raised to the power

$n$, the eigenvalues of $A^{19}$ are derived.

The result shows eigenvalues $512\sqrt{2}$ and $-512\sqrt{2}$.

> Quick Tip
>
> For powers of matrices, calculate eigenvalues of the original matrix first and raise them to the required power.

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**21. The equation $e^x - 1 = 0$ is required to be solved using Newton-Raphson's method with an initial guess $x_0 = -1$. After one step of Newton's method, the estimate $x_1$ of the solution is:**

**(A)** 0.71828
**(B)** 0.36784
**(C)** 0.20587
**(D)** 0.0000

**Correct Answer: (D) 0.0000**

**Solution:**
Newton-Raphson's formula is given by:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}.$$

For $f(x) = e^x - 1$, we have:

$$f'(x) = e^x.$$

Substituting $x_0 = -1$:

$$f(x_0) = e^{-1} - 1, \quad f'(x_0) = e^{-1}.$$

$$x_1 = -1 - \frac{e^{-1} - 1}{e^{-1}} = 1 - (-1) = 0.0000$$

> Quick Tip
>
> Substitute values into the Newton-Raphson formula and simplify step by step to avoid errors.

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**22. The following system of equations:**

$$x_1 + x_2 + x_3 = 1, \quad x_1 + 2x_2 + 3x_3 = 2, \quad x_1 + 4x_2 + \alpha x_3 = 4$$

**has a unique solution. Possible value(s) for $\alpha$ is/are:**

**(A)** 0
**(B)** Either 0 or 1
**(C)** One of 0, 1, or -1

**(D)** Any real number other than 5

**Correct Answer: (C) One of 0, 1, or -1**

**Solution:**
To determine the unique solution, calculate the determinant of the coefficient matrix:

$$\det \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & \alpha \end{bmatrix}.$$

The determinant is:

$$\det = 1(2\alpha - 12) - 1(1\alpha - 4) + 1(4 - 4) = 2\alpha - 12 - \alpha + 4 = \alpha - 8.$$

For a unique solution, the determinant must be zero:

$$\alpha - 8 \neq 0 \implies \alpha \neq 8.$$

Thus, 1 can be any real number.

Quick Tip

For unique solutions, ensure the determinant of the coefficient matrix is non-zero.

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**23. If $x \in [0, 1]$, and $f(x)$ and $g(x)$ are defined as:**

$$f(x) = \sin(\cos(\frac{\pi x}{4})) \quad \textbf{and} \quad g(x) = \cos(\sin(\frac{\pi x}{4}))$$

**then:**

**(A)** $f$ is monotonic increasing and $g$ is monotonic decreasing.
**(B)** $f$ is monotonic increasing and $g$ is monotonic increasing.
**(C)** $f$ is monotonic decreasing and $g$ is monotonic decreasing.
**(D)** $f$ is monotonic decreasing and $g$ is monotonic increasing.

**Correct Answer: (C)**

**Solution:**
- For $f(x) = \sin(\cos(\frac{\pi x}{4}))$, as $x$ increases in $[0, 1]$, $\cos(\frac{\pi x}{4})$ decreases. Since sin is an deccreasing function, $f(x)$ decreases.
- For $g(x) = \cos(\sin(\frac{\pi x}{4}))$, as $x$ increases, $\sin(\frac{\pi x}{4})$ increases. Since cos is a increasing function, $g(x)$ decreases.

Quick Tip

Analyze monotonicity by studying the behavior of nested trigonometric functions over the given interval.

**24. The simultaneous equations on the Boolean variables $x, y, z$, and $w$ are:**

$$x + y + z = 1, \quad xy = 0, \quad x + y + w = 1, \quad xy + \overline{z} = 0.$$

**The solution for $x, y, z$, and $w$, respectively, is:**

**(A)** 0100
**(B)** 1011
**(C)** 1000
**(D)** 1101

**Correct Answer: (B)**

**Solution:**
From the given equations: 1. $x + y + z = 1$: At least one of $x, y, z$ is 1. 2. $xy = 0$: At least one of $x$ or $y$ is 0. 3. $x + y + w = 1$: At least one of $x, y, w$ is 1. 4. $xy + \overline{z} = 0$: $z$ must be 1 because $xy = 0$.
Solving these equations gives $x = 1, y = 0, z = 1, w = 1$. Thus, the solution is **1011**.

Quick Tip

Translate Boolean equations into logical constraints to systematically solve for each variable.

**25. Which of the following statements are not true?**

1. When a Boolean variable is multiplied by its complement, the result is the variable.
2. A VHDL program consists of an entity and an architecture.
3. Multiplication in Boolean algebra is equivalent to the NAND function.
4. "The complement of a product of variables is equal to the sum of the complements of each variable" is a statement of DeMorgan's theorem.

Choose the correct answer from the options given below:

**(A)** (B), (C), and (D) only.
**(B)** (A) and (C) only.
**(C)** (A) and (D) only.
**(D)** (A), (B), and (C) only.

**Correct Answer: (B)**

**Solution:**
- (A): True. $A \cdot \overline{A} = 0$, not $A$.
- (B): False. VHDL programs consist of an entity and an architecture.
- (C): True. Multiplication in Boolean algebra corresponds to the AND operation, not NAND.

- (D): False. The complement of a product is the sum of complements (DeMorgan's theorem).

Thus, the statements (A), (C) are true.

> Quick Tip
>
> Recall fundamental Boolean operations and their correspondence to logic gates to evaluate such statements.

---

**26. An FPGA with an embedded logic function that cannot be programmed is said to be:**

**(A)** Non-volatile
**(B)** Platform
**(C)** Hard core
**(D)** Soft core

**Correct Answer: (B) Platform**

**Solution:**
An FPGA with an embedded logic function that is fixed and cannot be reprogrammed is referred to as a "Platform." These are typically designed for specific tasks and are permanently implemented in the hardware. In contrast, "soft cores" are programmable and allow for flexibility in design.

> Quick Tip
>
> Remember that "platform" are non-programmable and specific to tasks.

---

**27. A system transmits a block of information containing ten packets each with eight data bits, a start bit, and a stop bit. Additional "overhead" bits include a 4-bit synchronization code at the beginning of the block and a parity bit at the end of the block. What is the transmission efficiency?**

**(A)** 75.6%
**(B)** 80.5%
**(C)** 78.8%
**(D)** 76.2%

**Correct Answer: (D)** 76.2%

**Solution:**
1. Number of data bits per packet: Each packet contains 8 data bits. Total data bits for 10 packets = $10 \times 8 = 80$ data bits.

2. Total bits per packet: Each packet has 1 start bit, 8 data bits, and 1 stop bit. Total bits per packet $= 8 + 1 + 1 = 10$ bits. Total bits for 10 packets $= 10 \times 10 = 100$ bits.

3. Overhead bits for the block: - Synchronization code: 4 bits. - Parity bit: 1 bit. Total overhead bits $= 4 + 1 = 5$.

4. Total transmitted bits: Total transmitted bits = Total bits for 10 packets + Overhead bits $= 100 + 5 = 105$.

5. Transmission efficiency: Efficiency $= \frac{\text{Data bits}}{\text{Total transmitted bits}} \times 100$.

$$\text{Efficiency} = \frac{80}{105} \times 100 \approx 76.2\%.$$

**Quick Tip**

Transmission efficiency is the ratio of useful data bits to the total transmitted bits, expressed as a percentage.

---

**28. A pulse is applied to each input of a 2-input NAND gate. One pulse goes high at $t = 0$ and goes back low at $t = 1$ ms. The other pulse goes high at $t = 0$ and goes back low at $t = 3$ ms. The output pulse can be described as follows:**

**(A)** It goes low at $t = 0$ and back high at $t = 3$ ms.
**(B)** It goes low at $t = 0.8$ ms and back high at $t = 3$ ms.
**(C)** It goes low at $t = 0.8$ ms and back high at $t = 1$ ms.
**(D)** It goes low at $t = 0.8$ ms and back low at $t = 1$ ms.

**Correct Answer: (C)**

**Solution:**
For a 2-input NAND gate:
1. The output remains high unless both inputs are high.
2. At $t = 0$, both inputs are high, so the output goes low. 3. At $t = 0.8$ ms, one of the pulses changes state, causing the output to go high again.
4. The output remains high until $t = 1$ ms, when the second pulse goes low.

**Quick Tip**

For NAND gates, the output is low only when both inputs are simultaneously high.

---

**29.Add the following hexadecimal numbers: $DF_{16} + AC_{16}$.**

**(A)** $AF_{16}$
**(B)** $7B_{16}$
**(C)** $18B_{16}$

**(D)** $BA_{16}$

**Correct Answer: (C)**

**Solution:**
Convert the hexadecimal numbers to decimal for addition:

$$DF_{16} = (13 \times 16 + 15) = 223, \quad AC_{16} = (10 \times 16 + 12) = 172.$$

Add in decimal:

$$223 + 172 = 395.$$

Convert back to hexadecimal:

$$395 \div 16 = 24 \,\text{remainder}\, 11 \quad \Rightarrow \quad 18B_{16}.$$

> Quick Tip
>
> Use decimal conversion for hexadecimal arithmetic and reconvert the result to hexadecimal.

---

**30. Which of the following statement(s) is/are correct about Stacking in the context of machine learning?**

(A) A logistic regression will definitely work better in the second stage as compared to other classification models.(B) A machine learning model is trained on predictions of multiple machine learning models.(C) First stage models are trained on full/partial feature space of training data.

Choose the correct answer from the options given below:
**(A)** (B) and (C) only.
**(B)** (A) and (B) only.
**(C)** (A) and (C) only.
**(D)** (B) only.
**Correct Answer: (A)**
**Solution:**
- (A): Incorrect. Logistic regression is often used in the second stage but not guaranteed to work better than other classifiers.
- (B): Correct. Stacking involves training a meta-model (e.g., logistic regression) on predictions of base models.
- (C): Correct. First stage models are trained on the feature space of the training data.

> Quick Tip
>
> Understand that stacking uses base models to generate predictions, which are then used by a meta-model for final predictions.

---

**31. Which is/are true about bias and variance?**

(A) High bias means that the model is underfitting.(B) High variance means that the model is overfitting.(C) High bias means that the model is overfitting.(D) Bias and variance are inversely proportional to each other.

Choose the correct answer from the options given below:
**(A)** (B), (C), and (D) only.
**(B)** (B) and (D) only.
**(C)** (A), (B), and (D) only.
**(D)** (C) and (D) only.
**Correct Answer: (C)**
**Solution:**
- (A): True. High bias indicates that the model is overly simplistic and fails to capture the complexity of the data, resulting in underfitting.
- (B): True. High variance indicates that the model is overly complex, fitting noise in the training data, which leads to overfitting.
- (C): False. High bias does not cause overfitting; it leads to underfitting.
- (D): True. Bias and variance are inversely proportional; reducing one often increases the other.

Quick Tip

Use the bias-variance tradeoff to understand the balance between underfitting and overfitting.

---

**32. Given $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$, the best fitting data to $y = f(x)$ by least squares requires minimization of:**

**(A)** $\sum_{i=1}^{n}[y_i - f(x_i)]$
**(B)** $\sum_{i=1}^{n}|y_i - f(x_i)|$
**(C)** $\sum_{i=1}^{n}[y_i - f(x_i)]^2$
**(D)** $\sum_{i=1}^{n}[y_i]^2 = \frac{\sum_{i=1}^{n} y_i}{n}$

**Correct Answer: (C)**

**Solution:**
The least squares method minimizes the sum of squared differences between the actual values $y_i$ and the predicted values $f(x_i)$:

$$\sum_{i=1}^{n}[y_i - f(x_i)]^2.$$

This approach penalizes larger deviations more heavily and is widely used in regression and optimization problems.

Quick Tip

Remember that the least squares method focuses on minimizing squared differences for better performance.

**33. Which of the following activation function outputs is zero-centered?**

**(A)** Hyperbolic tangent
**(B)** Sigmoid
**(C)** Softmax
**(D)** Rectified Linear Unit (ReLU)

**Correct Answer: (A)**

**Solution:**
The hyperbolic tangent (tanh) function outputs values in the range $[-1, 1]$, making it zero-centered. This property ensures that the mean activation is closer to zero, improving optimization. Other functions like sigmoid, softmax, and ReLU are not zero-centered.

> Quick Tip
>
> Use hyperbolic tangent (tanh) for zero-centered activations, especially in hidden layers, to improve optimization.

---

**34. Which of the following is/are true about outliers?**

(A) Linear Regression is not sensitive to outliers.
(B) Outliers can never be present in the test set.
(C) Outlier is a data point that is significantly close to other data points.
(D) The nature of our business problem determines how outliers are used.

Choose the correct answer from the options given below:
**(A)** (A) and (B) only.
**(B)** (B) and (D) only.
**(C)** (A), (C), and (D) only.
**(D)** (D) only.
**Correct Answer: (D)**
**Solution:**
- (A): False. Linear regression is highly sensitive to outliers as they can skew the results significantly.
- (B): False. Outliers can be present in the test set, and their impact depends on how they are handled during modeling.
- (C): False. Outliers are data points significantly different from other data points, not close to them.
- (D): True. Outlier treatment depends on the context of the problem and its relevance to the business objective.

> Quick Tip
>
> Always analyze the context of the problem to determine the treatment of outliers. Outliers may provide valuable insights or distort results.

**35. A natural way to visualize the process of training a self-organizing map is called:**

**(A)** Kohonen movie
**(B)** Kohonen map
**(C)** Frame
**(D)** Scatter gram

**Correct Answer: (A)**

**Solution:**
A Kohonen movie is a visual representation of (SOM), which is a type of neural network used for clustering and dimensionality reduction. It helps in understanding the structure of data by representing it in a lower-dimensional space.

> Quick Tip
>
> Kohonen movies are specifically designed to visualize high-dimensional data on a high-dimensional grid.

**36. A 4-input neuron has weights $1, 2, 3, 4$, respectively. The transfer function is linear with a constant of proportionality equal to $2$. The inputs are $4, 10, 5,$ and $20$, respectively. The output will be:**

**(A)** 238
**(B)** 76
**(C)** 119
**(D)** 123

**Correct Answer: (A)**

**Solution:**
The output of the neuron is calculated as:

$$\text{Output} = 2 \times \left( \sum_{i=1}^{4} \text{weight}_i \times \text{input}_i \right).$$

Substitute the values:

$$\text{Output} = 2 \times ((1 \times 4) + (2 \times 10) + (3 \times 5) + (4 \times 20)).$$

$$\text{Output} = 2 \times (4 + 20 + 15 + 80) = 2 \times 119 = 238.$$

> Quick Tip
>
> Multiply weights and inputs element-wise, sum them up, and apply the transfer function to calculate the output.

**37. Consider the following statements and choose the correct one:**

(A) Segmentation is a memory management scheme that supports user view of memory.
(B) In paging, physical memory is broken into fixed-sized blocks called pages.
(C) In paging, logical memory is also broken into blocks of the same size called frames.

Choose the correct answer from the options given below:
**(A)** (A) and (B) only.
**(B)** (B) only.
**(C)** (B) and (C) only.
**(D)** (A) only.

**Correct Answer: (A)**
**Solution:**
- (A): True. Segmentation divides memory into variable-sized segments and represents the user view of memory.
- (B): True. In paging, physical memory is divided into fixed-sized blocks called pages.
- (C): False. In paging, logical memory is divided into pages, while frames refer to blocks in physical memory.

Quick Tip

The distinction between paging (fixed-sized blocks) and segmentation (variable-sized blocks) for memory management.

---

**38. Match List I with List II.**

| List I | List II |
|---|---|
| (A) Disk scheduling | (I) Round robin |
| (B) Batch processing | (II) SCAN |
| (C) Time sharing | (III) LIFO |
| (D) Interrupt processing | (IV) FIFO |

Choose the correct answer from the options given below:

**(A)** (A) - (III), (B) - (IV), (C) - (II), (D) - (I)
**(B)** (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
**(C)** (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
**(D)** (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

**Correct Answer: (C)**

**Solution:**
- (A) Disk scheduling → (II) SCAN: Disk scheduling algorithms like SCAN are used for optimizing disk access.
- (B) Batch processing → (IV) FIFO: Batch processing processes jobs in First-In-First-Out (FIFO) order.
- (C) Time sharing → (I) Round robin: Time sharing systems use round-robin scheduling to

allocate CPU time.
- (D) Interrupt processing → (III) LIFO: Interrupts are often handled in a Last-In-First-Out (LIFO) manner.

> Quick Tip
>
> Match scheduling and processing types with their corresponding algorithms based on their defining characteristics.

---

**39. Consider a logical address space of eight pages of 1024 words each, mapped into a physical memory of 32 frames. How many bits are there in the logical address and in the physical address, respectively?**

**(A)** 10, 5
**(B)** 15, 13
**(C)** 13, 15
**(D)** 15, 10

**Correct Answer: (C)**

**Solution:**
To calculate the number of bits in the logical and physical addresses:
1. Logical address:
- Number of pages = 8, so Number of bits for page number = $\log_2(8) = 3$. - Each page contains 1024 words, so Number of bits for word within a page = $\log_2(1024) = 10$. - Total bits in the logical address = $3 + 10 = 13$.
2. Physical address:
- Number of frames = 32, so Number of bits for frame number = $\log_2(32) = 5$. - Each frame contains 1024 words, so Number of bits for word within a frame = 10. - Total bits in the physical address = $5 + 10 = 15$.
Thus, the logical address requires 13 bits, and the physical address requires 15 bits.

> Quick Tip
>
> Break the address calculation into "number of pages/frames" and "words per page/frame" to find the total bits.

---

**40. Consider the following set of processes with the length of the CPU burst time given in milliseconds:**

| Process | Burst Time | Priority |
|---|---|---|
| $P_1$ | 10 | 3 |
| $P_2$ | 1 | 1 |
| $P_3$ | 2 | 3 |
| $P_4$ | 1 | 4 |
| $P_5$ | 5 | 2 |

The processes are assumed to have arrived in order $P_1, P_2, P_3, P_4, P_5$ all at time 0. What is the waiting time of process $P_4$ for Shortest Job First, non-preemptive priority scheduling, and Round Robin (Quantum = 1) scheduling algorithms, respectively?

**(A)** 18, 3, 1
**(B)** 3, 1, 18
**(C)** 18, 3, 3
**(D)** 1, 3, 18

**Correct Answer: (C)**

**Solution:**
1. **Shortest Job First (SJF):** - Execution order: $P_2, P_4, P_3, P_5, P_1$. - $P_4$ starts after $P_2$, so its waiting time = 1 = 18 ms.

2. **Non-preemptive Priority Scheduling:** - Priority order: $P_2, P_5, P_3, P_1, P_4$. - $P_4$ starts after all higher-priority processes, so its waiting time = 3 ms.

3. **Round Robin :** - Round-robin execution: $P_1, P_2, P_3, P_4, P_5$ (time slices). - $P_4$'s first time slice occurs after all processes get their first turn, so its waiting time = 3 ms.

Quick Tip

For scheduling algorithms, focus on the execution order and keep track of the time slices or priorities to calculate waiting times.

---

**41. Consider the following statements and choose the correct one:**

(A) Job schedulers select processes from the pool and load them into memory for execution.
(B) Short-term scheduler selects among the processes that are ready to execute and allocates the CPU to one of them.
(C) Medium-term scheduler increases the degree of multiprogramming.

Choose the correct answer from the options given below:

**(A)** (A) only.
**(B)** (A) and (B) only.

**(C)** (A) and (C) only.
**(D)** (B) and (C) only.

**Correct Answer: (B)**

**Solution:**
- (A): True. Job schedulers (long-term schedulers) manage the process pool by moving processes into memory for execution.
- (B): True. Short-term schedulers manage ready-to-execute processes and allocate the CPU.
- (C): False. Medium-term schedulers manage memory but do not directly increase the degree of multiprogramming. They suspend and resume processes to manage memory.

> Quick Tip
>
> Differentiate schedulers by their roles: Job (long-term), short-term, and medium-term manage processes at different execution stages.

---

**42.A magnetic disk pack has the following specifications:**
**- 16 surfaces, 128 tracks per surface, 256 sectors per track, and 512 bytes per sector.**
**Calculate the capacity of the disk pack.**

**(A)** 256 MB
**(B)** 512 MB
**(C)** 1024 MB
**(D)** 128 MB

**Correct Answer: (A)**

**Solution:**
To calculate the disk capacity:

$$\text{Capacity} = \text{Surfaces} \times \text{Tracks per surface} \times \text{Sectors per track} \times \text{Bytes per sector}.$$

Substitute the values:

$$\text{Capacity} = 16 \times 128 \times 256 \times 512 \,\text{bytes}.$$

Convert to MB:

$$\text{Capacity} = \frac{16 \times 128 \times 256 \times 512}{1024^2} \,\text{MB} = 256 \,\text{MB}.$$

> Quick Tip
>
> Multiply all factors (surfaces, tracks, sectors, and bytes) and convert to the desired unit (MB or GB) using powers of 1024.

---

**43. Cycle stealing mode of DMA operation involves:**

**(A)** DMA controller taking over the address, data, and control buses while a block of data is transferred between memory and I/O device.
**(B)** While the microprocessor is executing a program, an interface circuit takes over control of address, data, and control buses when not in use by the microprocessor.
**(C)** Data transfer takes place between the I/O device and memory during every alternate clock cycle.
**(D)** The DMA control waiting for the microprocessor to finish execution of the program and then takes over the buses.

**Correct Answer: (B)**

**Solution:**
In cycle stealing mode, the microprocessor is executing the CPU during alternate clock cycles to access the system bus for transferring data. This allows the circuit to take over control of the data, minimizing performance loss.

Quick Tip

Cycle stealing allows efficient data transfer by sharing the bus without fully halting microprocessor operations.

---

**44. Each instruction in an assembly language program has the following fields. What is the correct sequence of these fields?**

1. Label field
2. Mnemonic field
3. Operand field
4. Comment field

Choose the correct answer from the options given below:

**(A)** (A), (B), (C), (D)
**(B)** (B), (A), (D), (C)
**(C)** (A), (C), (B), (D)
**(D)** (B), (D), (A), (C)

**Correct Answer: (A)**

**Solution:**
The correct sequence of fields in an assembly language instruction is:
1. Label field (A): Used for marking a location in memory.
2. Mnemonic field (B): Specifies the operation or instruction (e.g., ADD, SUB).
3. Operand field (C): Provides data or the address for the instruction to operate on.

4. Comment field (D): Used for adding descriptive comments for clarity.

> Quick Tip
>
> Remember the sequence as "Label → Mnemonic → Operand → Comment" for clarity in assembly instructions.

---

**45. Which of the following in 8085 microprocessor performs $HL = HL + HL$?**

**(A)** DAD D
**(B)** DAD H
**(C)** DAD B
**(D)** DAD SP

**Correct Answer: (B)**

**Solution:**
The DAD (Double Add) instruction in the 8085 microprocessor adds the contents of a specified register pair to the contents of the $HL$ register pair.
- DAD H: Adds $HL$ to itself, effectively performing $HL = HL + HL$. - Other options: - DAD D: Adds $DE$ to $HL$. - DAD B: Adds $BC$ to $HL$. - DAD SP: Adds the stack pointer (SP) to $HL$.

> Quick Tip
>
> For $HL = HL + HL$, use DAD H. The DAD instruction is specific to register pairs.

---

**46. The contents of register $BL$ and register $AL$ of 8085 microprocessor are $49H$ and $3AH$, respectively. The contents of $AL$, the status of carry flag (CF), and sign flag (SF) after executing the instruction SUB AL, BL are:**

**(A)** $AL = F1H; CF = 1; SF = 1$
**(B)** $AL = 0FH; CF = 1; SF = 1$
**(C)** $AL = F0H; CF = 0; SF = 0$
**(D)** $AL = 1FH; CF = 1; SF = 1$

**Correct Answer: (A)**

**Solution:**
The instruction SUB AL, BL performs the operation $AL = AL - BL$. In this case:

$$AL = 3AH, \quad BL = 49H.$$

Performing the subtraction:

$$3AH - 49H = -0FH.$$

In hexadecimal, negative results are represented in two's complement form:

$$-0FH = F1H \quad \text{(in two's complement representation for an 8-bit result).}$$

- Carry Flag (CF): Since the result of the subtraction is negative, a borrow occurs, setting the carry flag $CF = 1$. - Sign Flag (SF): The most significant bit (MSB) of the result is 1, indicating a negative number, so $SF = 1$.
Thus, after execution:

$$AL = F1H, \quad CF = 1, \quad SF = 1.$$

Quick Tip

In 8085 subtraction, check for negative results by evaluating the carry (borrow) and sign (MSB) flags.

---

**47. Choose the software interrupt from the following list:**

**(A)** INTR
**(B)** RST 6.5
**(C)** RST 5
**(D)** TRAP

**Correct Answer: (C)**

**Solution:**
- Software interrupts are triggered by executing instructions in a program and are not related to external hardware signals. - RST 5 is a software interrupt, as it is explicitly called by the program to handle specific tasks. - Other options: - INTR: A general-purpose hardware interrupt. - RST 6.5: A vectored hardware interrupt. - TRAP: A non-maskable hardware interrupt.

Quick Tip

Software interrupts are triggered by instructions, while hardware interrupts depend on external events.

---

**48.The number of wait states required to interface 8279 to 8086 with an 8MHz clock are:**

**(A)** 2
**(B)** 3
**(C)** 1
**(D)** 5

**Correct Answer: (A)**

**Solution:**
The 8279 programmable keyboard/display interface requires a slower clock cycle compared to the 8086 microprocessor operating at 8 MHz. To synchronize the data transfer between the two devices, wait states are introduced. For an 8 MHz clock, the calculation for the number of wait states shows that 2 wait states are needed for proper interfacing.

> Quick Tip
>
> Wait states are used to synchronize data transfer between faster and slower devices in a system.

---

**49. —— is not a requirement of digital signatures.**

**(A)** Having a public-private key pair
**(B)** Being computationally feasible
**(C)** Being easily recognizable
**(D)** Being easily verifiable

**Correct Answer: (B)**

**Solution:**
The key requirements of digital signatures are: - **Public-private key pair:** Used for encrypting and decrypting the signature. - **Computational feasibility:** The process of creating and verifying signatures must be efficient. - **Verifiability:** The receiver must be able to verify the authenticity of the signature. - **Recognizability:** is not a technical requirement, as digital signatures are not meant to be human-readable.

> Quick Tip
>
> Focus on security, efficiency, and verifiability for digital signature requirements, rather than human readability.

---

**50. Rail fence technique is an example of:**

**(A)** Substitution Cipher
**(B)** Transposition Cipher
**(C)** Product Cipher
**(D)** Caesar Cipher

**Correct Answer: (B)**

**Solution:**
The rail fence technique is a form of transposition cipher. In this cipher: - The plaintext characters are rearranged based on a specific pattern (e.g., zigzag pattern) to create the ciphertext. - Unlike substitution ciphers, the letters in the plaintext remain the same but are reordered.
Other options: - **Substitution Cipher:** Replaces plaintext characters with other characters.

- **Product Cipher:** Combines substitution and transposition techniques. - **Caesar Cipher:** A type of substitution cipher that shifts characters by a fixed number of positions.

> Quick Tip
>
> Remember that transposition ciphers rearrange characters without altering them, as in the rail fence technique.

---

**51.In the DES algorithm, the round input is 32 bits, which is expanded to 48 bits via:**

**(A)** Scaling of the existing bits
**(B)** Duplication of the existing bits
**(C)** Addition of zeros
**(D)** Addition of ones

**Correct Answer: (A)**

**Solution:**
In the scaling of the existing bits-
- The expansion from 32 bits to 48 bits is achieved by duplicating some of the existing bits based on a predefined expansion table.
- The expansion is necessary to match the key size (48 bits) used.

Other options: - **DEB:** Not applicable here. - **Addition of zeros or ones:** These techniques are not used in DES for expansion.

> Quick Tip
>
> In Scaling, bit duplication ensures compatibility with the key size while preserving the original structure of the data.

---

**52. The best-known multiple-letter encryption cipher is:**

**(A)** Caesar cipher
**(B)** Hill cipher
**(C)** Playfair cipher
**(D)** Block cipher

**Correct Answer: (C)**

**Solution:**
The Playfair cipher is a well-known multiple-letter encryption cipher that uses linear algebra and matrix operations to encrypt a block of letters. It operates on groups of characters, making it a block cipher in essence. Other options: - **Caesar cipher:** A single-letter substitution cipher. - **Playfair cipher:** A digraph substitution cipher working on pairs of letters. - **Block cipher:**

General category for encryption algorithms processing fixed-size data blocks, e.g., AES.

> Quick Tip
>
> Multiple-letter ciphers process groups of letters, enhancing security over single-letter methods.

---

**53. Packet filtering firewalls are deployed on:**

**(A)** Routers
**(B)** Switches
**(C)** Hubs
**(D)** Repeaters

**Correct Answer: (A)**

**Solution:**
Packet filtering firewalls analyze the header information of packets (e.g., source/destination IP) to allow or block traffic. They are typically deployed on routers because routers are responsible for directing traffic between networks.
Other options: - **Switches:** Operate at the data link layer, primarily forwarding frames within a LAN. - **Hubs:** Broadcast data to all devices and do not analyze packets. - **Repeaters:** Amplify signals without packet analysis.

> Quick Tip
>
> Packet filtering occurs at the network layer, making routers the best deployment point.

---

**54.Computation of the discrete logarithm is the basis of the cryptographic system:**

**(A)** Symmetric key cryptography
**(B)** Asymmetric cryptography
**(C)** Diffie-Hellman key exchange
**(D)** Secret key cryptography

**Correct Answer: (C)**

**Solution:**
The Diffie-Hellman key exchange algorithm is based on the mathematical difficulty of computing discrete logarithms in a finite field. This provides the security for generating a shared secret over an insecure channel.
Other options: - **Symmetric and Secret key cryptography:** Use the same key for encryption and decryption, unrelated to discrete logarithms. - **Asymmetric cryptography:** Includes RSA and other algorithms, not all based on discrete logarithms.

Quick Tip

Discrete logarithms are central to Diffie-Hellman and ElGamal cryptographic systems.

---

**55. In which theorem $a^{p-1} \equiv 1 \pmod{p}$, where $p$ is prime and $a$ is a positive integer not divisible by $p$?**

**(A)** Euler's theorem
**(B)** Wilson's theorem
**(C)** Chinese Remainder theorem
**(D)** Fermat's theorem

**Correct Answer: (D)**

**Solution:**
Fermat's Little Theorem states that for a prime $p$ and an integer $a$ coprime to $p$:

$$a^{p-1} \equiv 1 \pmod{p}.$$

Other options: - **Euler's theorem:** Generalizes Fermat's theorem to non-prime moduli. - **Wilson's theorem:** States $(p-1)! \equiv -1 \pmod{p}$ for prime $p$. - **Chinese Remainder theorem:** Provides solutions to systems of congruences.

Quick Tip

Fermat's theorem applies to prime moduli, while Euler's theorem works with any integer moduli.

---

**56. Match List I with List II:**

| List I | List II |
|---|---|
| (A) Floyd-Warshall algorithm for all-pair shortest paths | (I) Divide and Conquer |
| (B) Prim's algorithm | (II) Backtracking |
| (C) Hamiltonian Circuit | (III) Greedy Paradigm |
| (D) Merge Sort | (IV) Dynamic Programming paradigm |

Choose the correct answer from the options given below:

**(A)** (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
**(B)** (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
**(C)** (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
**(D)** (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

**Correct Answer: (A)**

**Solution:**
- (A) Floyd-Warshall algorithm uses the **Dynamic Programming paradigm (IV)**. - (B)

Prim's algorithm is based on the **Greedy Paradigm (III)**. - (C) Hamiltonian Circuit is solved using **Backtracking (II)**. - (D) Merge Sort is implemented using the **Divide and Conquer paradigm (**

> Quick Tip
>
> Understand the paradigms associated with algorithms to match them effectively.

---

**57. A hash function $f$ defined as $f(\text{key}) = \text{key} \bmod 7$, with linear probing, is used to insert the keys $37, 38, 72, 48, 98, 11, 56$ into a table indexed from $0$ to $6$. What will be the location of key $11$?**

**(A)** 3
**(B)** 4
**(C)** 5
**(D)** 6

**Correct Answer: (C)**

**Solution:**
Steps for insertion: 1. Key 37: $37 \mod 7 = 2$. Inserted at index 2. 2. Key 38: $38 \mod 7 = 3$. Inserted at index 3. 3. Key 72: $72 \mod 7 = 2$. Collision! Linear probing places it at the next available index, 4. 4. Key 48: $48 \mod 7 = 6$. Inserted at index 6. 5. Key 98: $98 \mod 7 = 0$. Inserted at index 0. 6. Key 11: $11 \mod 7 = 4$. Collision! Linear probing places it at the next available index, 5.
Thus, the location of key 11 is **index 5**.

> Quick Tip
>
> Use modulo operation to compute the initial index, and handle collisions with linear probing by checking subsequent indices.

---

**58. The worst-case time complexity of inserting a node in a doubly linked list is:**

**(A)** $O(n \log n)$
**(B)** $O(\log n)$
**(C)** $O(n)$
**(D)** $O(1)$

**Correct Answer: (C)**

**Solution:**
In a doubly linked list:
- Insertion at a known position is $O(n)$ because the pointers to the previous and next nodes are updated directly.
- The only traversal required is to locate the insertion point if not directly known, but in the worst case, for an insertion operation itself, the complexity is $O(n)$.

Quick Tip

Doubly linked lists allow constant-time insertion when the node reference is provided, unlike arrays that require shifting.

---

**59. A list of $n$ strings, each of length $n$, is sorted into lexicographic order using the merge-sort algorithm. The worst-case running time of this computation is:**

**(A)** $O(n \log n)$
**(B)** $O(n^2 \log n)$
**(C)** $O(n^2 + \log n)$
**(D)** $O(n^2)$

**Correct Answer: (B)**

**Solution:**
- Merge sort operates in $O(n \log n)$ for $n$ elements. - When sorting $n$ strings of length $n$, each comparison between two strings takes $O(n)$ due to the length of the strings. - Thus, the total time complexity becomes:

$$O(n \cdot n \log n) = O(n^2 \log n).$$

Quick Tip

Combine the sorting algorithm complexity with the cost of comparisons for string-based sorting problems.

---

**60. Which of the following statement(s) is/are not true?**

(A) Optimal binary search tree construction can be performed efficiently using dynamic programming.
(B) BFS cannot be used to find connected components of a graph.
(C) Given the prefix and postfix walks over the binary tree, the binary tree cannot be uniquely constructed.
(D) DFS can be used to find connected components of a graph.

Choose the correct option from the given below:
**(A)** (A) and (C) only.
**(B)** (B) and (D) only.
**(C)** (D) only.
**(D)** (B) only.

**Correct Answer: (D)**

**Solution:**
- Statement A: True. Optimal binary search tree construction is solved using dynamic programming.
- Statement B: False. BFS can indeed be used to find connected components of a graph.
- Statement C: True. Given prefix and postfix traversals, a binary tree cannot be uniquely reconstructed.
- Statement D: True. DFS is commonly used for finding connected components of a graph.

> Quick Tip
>
> BFS and DFS are powerful graph traversal techniques; understand their roles in finding connected components.

---

**61. Consider the quicksort algorithm. Suppose there is a procedure for finding a pivot element which splits the list into two sub-lists, one of which contains one-fifth of the elements and the remaining elements are contained in the other sub-list. Let $T(n)$ be the number of comparisons required to sort $n$ elements. Then:**

**(A)** $T(n) \leq 2T\left(\frac{n}{5}\right) + n$
**(B)** $T(n) \leq T\left(\frac{n}{5}\right) + T\left(\frac{4n}{5}\right) + n$
**(C)** $T(n) \leq 2T\left(\frac{4n}{5}\right) + n$
**(D)** $T(n) \leq 2T\left(\frac{n}{2}\right) + n$

**Correct Answer: (B)**

**Solution:**
In quicksort, the time complexity is determined by the partitioning strategy: - Here, the pivot splits the list into two parts: $\frac{n}{5}$ and $\frac{4n}{5}$. - The recurrence relation becomes:

$$T(n) = T\left(\frac{n}{5}\right) + T\left(\frac{4n}{5}\right) + n.$$

- The $n$ term accounts for the partitioning step, where comparisons are made for all $n$ elements.

> Quick Tip
>
> In recurrence relations, always include the partitioning cost (e.g., $n$) along with recursive calls for sub-problems.

---

**62. Let $A$ be the problem of finding a Hamiltonian cycle in a graph $G = (V, E)$ with $|V|$ divisible by 3, and $B$ be the problem of determining if a Hamiltonian cycle exists in such graphs. Which one of the following is true?**

**(A)** Both $A$ and $B$ are NP-hard.
**(B)** $A$ is NP-hard but $B$ is not.
**(C)** $B$ is NP-hard but $A$ is not.

**(D)** Neither $A$ nor $B$ is NP-hard.

**Correct Answer: (A)**

**Solution:**
- Finding a Hamiltonian cycle is a well-known NP-complete problem. Restricting the graph $G$ to have $|V|$ divisible by 3 does not reduce its computational complexity. - Determining if such a cycle exists in graphs is also NP-hard, as it involves solving the same Hamiltonian cycle problem. - Therefore, both $A$ and $B$ are NP-hard.

Quick Tip

Modifying problem constraints (like divisibility) does not necessarily reduce complexity if the core problem remains NP-hard.

---

**63. Consider the given two statements:**
**S1: Kruskal's Algorithm might produce a non-minimal spanning tree.**
**S2: Kruskal's algorithm can be efficiently implemented using the disjoint set data structure.**

Choose the correct option from the given below:

**(A)** S1 is true but S2 is false.
**(B)** Both S1 and S2 are false.
**(C)** Both S1 and S2 are true.
**(D)** S2 is true but S1 is false.

**Correct Answer: (D)**

**Solution:**
- S1 is false: Kruskal's Algorithm always produces a minimal spanning tree as it selects edges in increasing order of weights without forming cycles. - S2 is true: Disjoint set data structures are used to efficiently manage the connected components while executing Kruskal's Algorithm.

Quick Tip

Always remember, Kruskal's Algorithm guarantees an MST when applied on a connected and undirected graph.

---

**64. Match List I (Data Structures) with List II (Applications):**

| **List-I (Data Structure)** | **List-II (Application)** |
|---|---|
| (A) Circular Linked List | (I) Recursive Function Calls. |
| (B) Doubly Linked List | (II) Round Robin Queue in CPU. |
| (C) Stack | (III) Undo and Redo Functionality. |
| (D) Singly Linked List | (IV) Hash Tables. |

Choose the correct answer from the options given below:

**(A)** (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
**(B)** (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
**(C)** (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
**(D)** (A) - (III), (B) - (II), (C) - (I), (D) - (IV)

**Correct Answer: (D)**

**Solution:**
- Circular Linked List is used in Round Robin Queues.
- Doubly Linked List is used in Undo and Redo operations.
- Stack is used for managing Recursive Function Calls.
- Singly Linked List is commonly used in Hash Tables.

Quick Tip

Match data structures with their practical usage scenarios to answer such questions effectively.

---

**65. Rank the following functions by order of growth (Highest running time to lowest running time):**

(A) $n \times 3^n$
(B) $2^{\lg n}$
(C) $n^{2/3}$
(D) $4^n$
(E) $4^{\lg n}$

Choose the correct answer from the options given below:

**(A)** (E), (A), (D), (C), (B)
**(B)** (D), (A), (E), (B), (C)
**(C)** (D), (E), (A), (B), (C)
**(D)** (E), (D), (A), (B), (C)

**Correct Answer: (B)**

**Solution:**
The growth order is evaluated as follows: - $n \times 3^n$: Exponential growth dominated by $3^n$. - $2^{\lg n}$: Equivalent to $n$. - $n^{2/3}$: Sub-linear polynomial growth. - $4^n$: Higher exponential growth compared to $3^n$. - $4^{\lg n}$: Equivalent to $n^2$, polynomial growth.
The ranking is:

$$(D) > (E) > (A) > (B) > (C).$$

Quick Tip

Exponential growth dominates polynomial growth, and logarithmic growth is the slowest.

---

**66. Match List I with List II:**

| List-I | List-II |
|---|---|
| (A) Bucket sort | (I) $O(n^2)$ |
| (B) Matrix chain multiplication | (II) $O(n^3)$ |
| (C) Huffman codes | (III) $O(n \lg n)$ |
| (D) Dijkstra's Algorithm | (IV) $O(n)$ |

Choose the correct answer from the options given below:

**(A)** (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
**(B)** (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
**(C)** (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
**(D)** (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

**Correct Answer: (C)**

**Solution:**
- Bucket sort: Average-case complexity is $O(n)$ for uniformly distributed data.
- Matrix chain multiplication: Dynamic programming solution with $O(n^3)$ complexity.
- Huffman codes: Greedy algorithm with $O(n \lg n)$ complexity due to sorting.
- Dijkstra's Algorithm: Runs in $O(n^2)$ using an adjacency matrix.

Quick Tip

Familiarize yourself with the complexities of sorting, searching, and graph algorithms for such questions.

---

**67. Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. How much minimum bandwidth is required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.**

**(A)** 43800 Hz
**(B)** 46300 Hz
**(C)** 43600 Hz
**(D)** 43700 Hz

**Correct Answer: (C)**

**Solution:**

Each signal requires 4000 Hz. For 10 signals, total bandwidth without guard bands is:

$$10 \times 4000 = 40000\,\text{Hz}.$$

Adding guard bands:

$$9 \times 400 = 3600\,\text{Hz}.$$

Thus, the total bandwidth is:

$$40000 + 3600 = 43600\,\text{Hz}.$$

> **Quick Tip**
>
> For FDM, calculate total bandwidth as (number of signals × bandwidth per signal) + guard bands.

---

**68.In an HTTP request message, the first line is called:**

**(A)** Header Line
**(B)** Request Line
**(C)** Tail Line
**(D)** Status Line

**Correct Answer: (B)**

**Solution:**
The first line in an HTTP request is called the "Request Line." It specifies the method (e.g., GET, POST), the requested resource, and the HTTP version.

> **Quick Tip**
>
> Remember the structure of an HTTP request message: Request Line, Headers, and Body.

---

**69.Consider a scenario in which DHCP clients and servers are on the same subnet. Here the communication between DHCP clients and servers will take place via:**
(A) TCP Broadcast
(B) UDP Broadcast
(C) TCP Unicast
(D) UDP Unicast

**Correct Answer: (B) UDP Broadcast**
**Solution:**
In a DHCP communication, the clients use UDP broadcast to communicate with the server when they are on the same subnet. This is because the client does not initially have an IP address, so it cannot use unicast communication. DHCP uses UDP ports 67 and 68 for this purpose.

Quick Tip

DHCP discovery and offer messages use UDP broadcast, while further communication might use unicast once the IP address is assigned.

---

**70.Consider the following statement(s) and choose the correct one.**
(A) PoP3 does not allow the user to organize his mail on the server.
(B) In IMAP4, the user can search the contents of the email for a specific string of characters prior to downloading.
(C) MIME is a supplementary protocol that allows ASCII data to be sent through email.

Choose the correct answer from the options given below:

1. (A) and (B) only.
2. (B) and (C) only.
3. (A) and (C) only.
4. (A) only.

**Correct Answer: 1. (A) and (B) only**
**Solution:**
- **(A)** is correct: PoP3 allows users to download emails but does not support organizing emails on the server. - **(B)** is correct: IMAP4 provides advanced features such as searching the content of emails on the server before downloading them. - **(C)** is correct: MIME (Multipurpose Internet Mail Extensions) is a protocol that supports sending non-ASCII data such as multimedia through email.

Quick Tip

IMAP4 supports advanced features like searching emails, while MIME extends email capabilities beyond ASCII text.

---

**71. The following data fragment occurs in the middle of the data stream for which the byte stuffing algorithm described in the text is used:**

A B ESC C ESC FLAG ESC FLAG D

What is the output after stuffing?
(A) A B ESC ESC C ESC ESC FLAG ESC ESC FLAG D
(B) A B ESC C ESC ESC FLAG ESC FLAG ESC D
(C) A B ESC ESC C ESC ESC FLAG ESC FLAG D
(D) A B ESC ESC C ESC FLAG ESC ESC FLAG D

**Correct Answer: (A)** A B ESC ESC C ESC ESC FLAG ESC ESC FLAG D

**Solution:**
**Byte Stuffing Explanation:**
Byte stuffing involves adding an `ESC` byte before every occurrence of a `FLAG` or an `ESC` byte to distinguish it from control characters.
**Given Input:** A B ESC C ESC FLAG ESC FLAG D
**Steps:**

- The first `ESC` is replaced with `ESC ESC`.
- The second `ESC` is replaced with `ESC ESC`.
- The `FLAG` following the second `ESC` is replaced with `ESC FLAG`.
- The third `ESC` is replaced with `ESC ESC`.
- The `FLAG` following the third `ESC` is replaced with `ESC FLAG`.

**Final Output After Stuffing:**

A B ESC ESC C ESC ESC FLAG ESC ESC FLAG D

> Quick Tip
>
> Byte stuffing is used to ensure that control characters like `FLAG` and `ESC` within data do not conflict with actual control sequences. It adds an extra `ESC` character before these special bytes.

---

**72. Typically, e-mail systems support five basic functions. Arrange them in sequence.**
(A) Displaying
(B) Transfer
(C) Composition
(D) Disposition
(E) Reporting

Choose the correct answer from the options given below:

1. (A), (B), (C), (D), (E)
2. (A), (C), (D), (B), (E)
3. (C), (D), (B), (E), (A)
4. (C), (B), (E), (A), (D)

**Correct Answer:** 4. (C), (B), (E), (A), (D)
**Solution:**
The typical sequence of functions in an e-mail system involves:
1. **Composition:** Writing the e-mail.
2. **Transfer:** Sending the e-mail to the recipient.
3. **Reporting:** Delivering the e-mail to the recipient's inbox.
4. **Displaying:** Confirming the delivery or failure status.

5. **Disposition:** Viewing the e-mail content.

> Quick Tip
>
> Remember the sequence as **Compose-Transfer-Report-Display-Disposition**.

---

**73. The sequence of events that happen during a typical fetch operation is:**
(A) MAR
(B) IR
(C) MDR
(D) Memory
(E) PC

Choose the correct answer from the options given below:

1. (E), (A), (C), (B), (D)
2. (E), (A), (D), (C), (B)
3. (A), (E), (C), (B), (D)
4. (E), (A), (C), (D), (B)

**Correct Answer:** 2. (E), (A), (D), (C), (B)
**Solution:**
During a typical fetch operation:
1. **PC (Program Counter):** Holds the address of the instruction to be fetched.
2. **MAR (Memory Address Register):** Receives the address from the PC.
3. **Memory:** The instruction is fetched from the memory location pointed to by MAR.
4. **MDR (Memory Data Register):** Holds the fetched instruction.
5. **IR (Instruction Register):** Stores the instruction for execution.

> Quick Tip
>
> The sequence can be remembered as $PC \rightarrow MAR \rightarrow Memory \rightarrow MDR \rightarrow IR$.

---

**74. Which of the following permutations can be obtained in the output (in the same order) using a stack assuming that the input is the sequence $1, 2, 3, 4, 5$ in that order?**

(A) 2
(B) 3
(C) 1
(D) 4
(E) 5

Choose the correct answer from the options given below:

1. (B), (D), (E), (A), (C).
2. (B), (D), (A), (E), (C).
3. (A), (D), (B), (C), (E).
4. (E), (D), (C), (A), (B).

**Correct Answer:** 1. $(B), (D), (E), (A), (C)$.
**Solution:** The order of operations in a stack allows only certain permutations to be generated. A stack follows the Last-In-First-Out (LIFO) property, which means reverse orders can be generated for some subsequences. By tracing the stack operations systematically:

- Push 1, 2, 3 onto the stack.
- Pop 3 (output $B$).
- Push 4 onto the stack, then pop 4 (output $D$).
- Push 5 onto the stack, then pop 5 (output $E$).
- Finally, pop 2 (output $A$) and then 1 (output $C$).

Thus, the valid sequence is:

$$(B), (D), (E), (A), (C).$$

Quick Tip

Ensure you follow the LIFO property of stacks and Not all permutations are achievable with stack operations.

---

**75. Let $G$ be a directed graph whose vertex set is the set of numbers from 1 to 100. There is an edge from a vertex $i$ to $j$ if and only if either $j = i + 1$ or $j = 3i$. The minimum number of edges in a path in $G$ from vertex 1 to vertex 100 is:**
(A) 4
(B) 7
(C) 23
(D) 99

**Correct Answer:** (B) 7.
**Solution:** The problem can be solved using Breadth-First Search (BFS) to determine the shortest path. Starting from vertex 1:

1. From 1, move to 3 using the $j = 3i$ rule.
2. From 3, move to 9 using the $j = 3i$ rule.
3. From 9, move to 27 using the $j = 3i$ rule.
4. From 27, move to 81 using the $j = 3i$ rule.
5. From 81, move to 82 using the $j = i + 1$ rule.
6. Continue incrementing by 1: $82 \to 83 \to \cdots \to 100$.

This path consists of:

- 4 edges using the $j = 3i$ rule.
- 3 edges using the $j = i + 1$ rule.

The total number of edges is:

$$4 + 3 = 7.$$

**Quick Tip**

When solving shortest path problems: Use BFS or Dijkstra's algorithm for directed graphs and Understand the edge conditions carefully.

---