# Computer Science \& IT 

## GATE 100 Most Important Questions with Solutions

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1. What is the worst-case time complexity of inserting $n$ elements into an empty linked list, if the linked list needs to be maintained in sorted order?
A. $\Theta\left(n^{2}\right)$
B. $\Theta(1)$
C. $\Theta(n \log n)$
D. $\Theta(n)$

Ans. A
Sol. Question marks two key points here.

1. Sorted order is to be maintained.
2. ' $n$ ' elements to be inserted in a linked list.

Hence, for each element, we need to search its correct position for every insertion. After the search is complete, insertion will take constant time (i.e. mapping the correct pointers)

Now, considering the worst case where the inserting is made in last node (we'll have to scan entire list every time)
For inserting first element, no. of elements scanned=0
For inserting second element, no. of elements scanned $=1$
For inserting third element, no. of elements scanned $=2$ .
.

For inserting nth element, no. of elements scanned $=n-1$
Total scans $=1+2+3+\ldots(n-1)$
Total scans $=n / 2((n-1)+1) ">\frac{n}{2}((n-1)+1) \approx n^{2}$
We can conclude is worst case as $\mathrm{O}\left(\mathrm{n} 2\right.$ " $\left.>\mathrm{n}^{2}\right)$
2. Match the following :

| Applications | Data structure Used |
| :--- | :--- |
| P. Postfix Evaluation | W. Operator Stack |
| Q. Breadth First Traversal | X. Operand Stack |
| R. Infix to Postfix conversion | Y. Vertex Stack |
| S. Depth First Traversal | Z. Queue |

A. $P-W, Q-Z, R-X, S-Y$
B. $P-X, Q-Z, R-W, S-Y$
C. $P-X, Q-Z, R-Y, S-W$
D. $P-Y, Q-Z, R-X, S-W$

Ans. B

## Sol.

| Applications | Data structure Used |
| :--- | :--- |
| P. Postfix Evaluation | Operand Stack |
| Q. Breadth First Traversal | Queue |
| R. Infix to Postfix conversion | Operator Stack |
| S. Depth First Traversal | Vertex Stack |

Hence $B$ is right.
3. Consider a circular queue where the empty spaces are utilized in a queue in an effective manner. Now circular queues maintain two pointers front and rear. What is the condition for the circular queue to be full?
A. (front $==0 \& \&$ rear $==$ size-1) || (rear == (front-1) \%(size-1))
B. front $==$ rear
C. front $=$ rear -1
D. rear $=$ front -1

Ans. A
Sol. In a circular queue pointer front is maintained to keep trace of insertions and rare is to maintain the deletion. As soon as the elements are inserted the front won't change the position but the rear will do. For circular queue to be full the condition in circular queue is A. As two options are there, either the front is at first position and rear at last otherwise we use mod operator which operates in circular manner.
4. Consider the following $C$ fragment:

Void F (int n)
\{
if( $n<=1$ )
Print(1);
else
\{
$F(n / 2)$;
$F(n / 4)$;
\}
\}
Find how many times 1 is printed by the above code if $F(16)$ is called ?
A. 10
B. 8
C. 6
D. 12

Ans. B

## Sol.


$\therefore$ [No. of times ' 1 ' get printed $=8$ ]
5. Consider the following code:

```
static int }x=3
int f(int a)
{
    x = x - a;
    return x;
}
int g(int b)
{
        x = x - b;
        return x;
}
void main()
    {
        int a = 1, b = 2;
        int i=0;
        for (i=0;f(a) *f(b)>0;i++);
        printf("%d", x);
    }
```

What is the output of the above program?
A. 0
B. 1
C. 2
D. 3

Ans. A
Sol. $\mathrm{i}=0 \Rightarrow \mathrm{f}(\mathrm{a})^{*} \mathrm{f}(\mathrm{b})>0 \Rightarrow \mathrm{f}(1)^{*} \mathrm{f}(2)>0 \Rightarrow 0>0$ fails
$f(a)$ and $f(b)$ can be executed in any order.

1. If $f(a)$ is executed first $\Rightarrow x$ value will be 2

If $f(b)$ is executed second $\Rightarrow x$ value will be 0
2. If $f(b)$ is executed first $\Rightarrow x$ value will be 1

If $f(a)$ is executed second $\Rightarrow x$ value will be 0
In both orders, $x$ value will be zero.
One of the functions $f(1)$ and $g(2)$ definitely returns 0 .
So, $f(1) * f(2)$ will be evaluated as 0 .
$x$ value will be '0'.
6. In static programming languages like $C$, which of the following depends on the runtime environment for memory creation?
A. Static variables of the program
B. Activation records
C. Both $A$ and $B$
D. Neither A nor B

Ans. B
Sol. Static variables depend on the scope which will be decided before runtime. During compilation all static variables scope is known, and memory is allotted in data region.

Activation records are created during runtime. Based on the calling sequence of functions, each function call requires separate activation record. So, activation records are created during runtime.
7. void main( )
\{
static char *s[] = \{"Raj", "Ram", "Sri", "Sai", "Vinay"\};
static char ${ }^{* *}$ ptr[] $=\{s+2, s+1, s, s+3, s+4\}$;
char ${ }^{* * *}$ p $=$ ptr;
printf("\%s", **++p);
\}
What is the output?
A. Ram
B. Raj
C. Sri
D. Sai

Ans. A

## Sol.


$* *++\mathrm{p} \Rightarrow * * 302 \Rightarrow * 202 \Rightarrow 200$
$\therefore$ printf("\%s", **++p);
output is Ram.
8. The sorting algorithm which requires the least number of swaps in the worst case is?
A. Insertion sort
B. Bubble Sort
C. Selection Sort
D. Quick Sort

Ans. C
Sol. Insertion Sort $\Rightarrow \mathrm{O}\left(\mathrm{n}^{2}\right)$
Selection Sort $\Rightarrow O(n)$
Bubble Sort $\Rightarrow O\left(n^{2}\right)$
Quick Sort $\Rightarrow \mathrm{O}\left(\mathrm{n}^{2}\right)$
Amongst all these algorithms, selection sort requires the least number of swaps.
9. Consider the following statements:
$\mathrm{S}_{1}$ : When in any application the number of insertions are very large but number of deletion are very less. Then unordered array data structure gives better performance than ordered array data structure.
$\mathrm{S}_{2}$ : When in any application the number of insertion and number of deletion are same then binary search tree data structure give better performance than max heap data structure.
Which of the following is correct?
A. S1 is true only
B. S2 is true only
C. Both S1 and S2 true
D. Neither S1 nor S2 is true

Ans. A
Sol. $\mathrm{S}_{1}$ : Since number of insertions are high, hence in unordered array every insertion can be done at end which will take $O(1)$ time, but in an unordered array, all the insertions will be done somewhere in there right positions which will take $O(\log n)$ time. Hence unordered array will give better performance than ordered array data structures.
$\mathrm{S}_{2}$ : All the operations in a binary search tree take $\mathrm{O}(\operatorname{logn})$ time where the height can go till $\mathrm{O}(\mathrm{n})$, which is not the case in max heap. Hence the statement is false:
10. The following problems are solved using Divide and Conquer. Match these problems to their respective recurrence relation:

| Problems | Recurrence Relation |
| :--- | :--- |
| P. Binary Search | W. $T(n)=T(n-1)+T(1)+O(n)$ |
| Q. Merge Sort worst case | $X . T(n)=2 T(n / 2)+2$ |
| R. Quick Sort worst case | $Y . T(n)=T(n / 2)+2$ |
| S. Maximum/Minimum | $Z . T(n)=2 T(n / 2)+O(n)$ |

A. P-Y, Q -Z , R-X, S-W
B. $P-Y, Q-Z, R-W, S-X$
C. $P-Z, Q-Y, R-X, S-W$
D. P-Y, $Q-X, R-Z, S-W$

## Ans. B

## Sol.

| Problems | Answers |
| :--- | :--- |
| P. Binary Search | $T(n)=T(n / 2)+2$ |
| Q. Merge Sort worst case | $T(n)=2 T(n / 2)+O(n)$ |
| R. Quick sort worst case | $T(n)=T(n-1)+T(1)+O(n)$ |
| S. Maximum/Minimum | $T(n)=2 T(n / 2)+2$ |

11. Consider the modified quicksort in which $(n / 10)^{\text {Th }}$ Element in the array is selected as pivot element for the first time and afterwards follows the normal procedure for selecting the pivot element. What is the worst-case time complexity of this quick sort to sort the given array?
A. $O(n \log n)$
B. $\mathrm{O}\left(\mathrm{n}^{2}\right)$
C. $\mathrm{O}\left(\mathrm{n}^{3}\right)$
D. None of these

## Ans. B

Sol. When we are selecting the $(n / 10)^{\text {Th }}$ Element as a pivot element, it is similar to selecting the pivot element randomly. So, the time taken in the worst case will be time taken to sort the data with worst-case partitioning. So, Worst case time complexity $=O\left(n^{2}\right)$
12. Which of the following algorithm(s) shows minimum time complexity to sort the array in best case?
A. Quick Sort
B. Insertion Sort
C. Count Sort
D. Both $B$ and $C$

## Ans. D

Sol. Insertion Sort in best case takes $O(n)$ time. Count Sort always sorts in $O(n)$ time.

Hence both b and c are correct.
13. Consider a scenario, where the standard Quick Sort algorithm is run on the following 2 inputs to keep in ascending order.
(i) $1,4,5,7,10$, $\qquad$ n (already sorted in ascending order)
(ii) $n, n-1, n-2, n-3$ $\qquad$ . $3,2,1$ (sorted in descending order)

Let c 1 and c 2 be the number of swaps required for the inputs (i) and (ii) respectively. Then find the relation between $c 1$ and $c 2$ ?
A. $\mathrm{c} 1<\mathrm{c} 2$
B. $\mathrm{c} 1>\mathrm{c} 2$
C. $\mathrm{c} 1=\mathrm{c} 2$
D. $c 1>=c 2$

## Ans. A

Sol. In the first case, where the input is sorted in the exact order which is needed. So, in every pass of total $n$ pass, exactly one swap is there. So total $O(n)$ swaps for (i). So $c 1=O(n)$.

In the second input, there are $\mathrm{n}-1$ and 1 swap in alternate steps. So, total there are $\mathrm{O}\left(\mathrm{n}^{2}\right)$ swaps. So $c 2=O\left(n^{2}\right)$.
14. In the Worst case, in Selection Sort, the total number of moves represented in order of $\qquad$ ?
A. $\mathrm{O}(\log n)$
B. $\mathrm{O}(\mathrm{n})$
C. $O\left(n^{2}\right)$
D. $O\left(n^{3}\right)$

Ans. B
Sol. In selection sort, we exchange one by one by a minimum element of a subarray.
So, the total moves here we need is ( $n-1$ ).
So, it's of $O(n)$.
15. Which of the following sorting algorithms has the lowest worst-case complexity?
A. Merge sort
B. Bubble sort
C. Quick sort
D. Selection sort

Ans. A
Sol. Merge sort take a time of $O(n \log n)$ in all cases of input.
Whereas other sorting techniques have complexity of $\mathrm{O}\left(\mathrm{n}^{2}\right)$ in worst case.
16. Identify the minimal product of the sum function described by the $K$-map given in the figure.

A. $C B$
B. $C^{\prime} B^{\prime}$
C. $C+B$
D. $C^{\prime}+B^{\prime}$

Ans. D

## Sol.


$C^{\prime}+B^{\prime}$ is the minimum POS.
17. A logic circuit has the following logical inputs and output:

Inputs: A, B, C
Output: Y
The output is high only when a majority of the input is high. Which one of the following is the correct relation between inputs and output?
A. $Y=B C+A C+A B$
B. $Y=A+B C$
C. $Y=A B C$
D. $Y=A B+C$

Ans. A
Sol. Inputs: A, B, C
Output: Y
The output is high only when a majority of the input is high.

| $\mathbf{A}$ | $\mathbf{B}$ | $\mathbf{C}$ | $\mathbf{Y}$ |
| :---: | :---: | :---: | :---: |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

$y(A, B, C)=\Sigma m_{3}, m_{5}, m_{6}, m_{7}$

$y=A B+B C+A C$
18. The output of a logic gate is 1 when all its inputs are at logic 0 . The gate is either.
A. a NAND or an EX-OR
B. an OR or an EX-NOR
C. an AND or an EX-OR
D. a NOR or an EX-NOR

Ans. D
Sol. Use the truth table of NOR and Ex-NOR to answer this.
19. If $f(\mathrm{a}, \mathrm{b}, \mathrm{c})=\Sigma(0,1,6,7)$
$f 2(a, b, c)=\Sigma(2,3,4,5)$. Then what are the variable that $f 1+f 2$ is free from?
A. $a, b$
B. b, c
C. a, c
D. $a, b, c$

Ans. D
Sol. It is free from all variables i.e., a, b, c


20. Consider $\mathrm{Y}=\mathrm{A} \oplus \overline{\mathrm{A}} \oplus \overline{\mathrm{A}} \oplus \mathrm{A} \oplus \mathrm{A} \oplus \overline{\mathrm{A}} \oplus \overline{\mathrm{A}} \oplus \mathrm{A} \oplus \mathrm{A}$ then Y is equivalent to:
A. 1 OR E
B. A EXOR 1
C. A EXOR 0
D. A AND A

## Ans. C

Sol. Since, $A \oplus A=0$
$A \oplus A^{\prime}=1$.
We get, $Y=A \oplus 0$.
21. In a pipelined processor, while executing a program with more than one thousand instructions, each stage takes only one clock cycle. The processor is designed with 5 number of ALUs, operand forwarding technique is used and all branch instructions are overlapped. In this situation, the maximum speed up of the pipelined processor is equal to
A. Number of instructions to be executed
B. Number of stages available in the processor
C. Clock frequency of the processor
D. Insufficient data

Ans. B
Sol. When there is no Hazard, only one clock cycle time is sufficient to execute one instruction.
Speedup $=\frac{t_{n}}{t_{p}}=\frac{\mathrm{Kclk}}{1 \mathrm{clk}}=\mathrm{K}$
$\mathrm{t}_{\mathrm{n}}=$ sum of all stage delays, let $\mathrm{K}=$ number of stages
$t_{p}=$ one stage delay
22. In Pipeline Stage of RISC processor, in which stage, the values are taken from the register?
A. Instruction Fetch
B. Instruction Decode
C. Write Back
D. Instruction Execute

## Ans. B

Sol. In instruction decode stage, instruction is decoded, and the register file is accessed to get the values from the registers used in the instruction.
In instruction fetch stage, CPU fetch the instruction from the memory based on PC. Simultaneously the PC will be incremented to next sequential instruction address.
23. Consider 2 pipelines $A \& B$ where pipeline $A$ is having 8 stages of uniform delay of $2 n s$. Pipeline $B$ has 5 stages with respective stages delay of $5 n s, 6 n s, 2 n s, 1 n s, 3 n s$. How much time is saved when the 100 tasks are pipelined using $A$ instead of $B$ ?
A. 320 ns
B. 410 ns
C. 570 ns
D. 645 ns

Ans. B
Sol. Pipe A: $K$ (number of stages) $=8, n$ (instructions) $=100, T p($ clock time $)=2 n s$
So, time taken to execute ' $n$ ' instructions in a pipelined processor: ETpipeline
$E T_{A}=(k+n-1) T p$
$=(8+100-1) 2$
$=214 \mathrm{~ns}$
Pipe B $k=5, n=100$
$\mathrm{Tp}=\operatorname{MAX}(5,6,2,1,3)=6 \mathrm{~ns}$
$E T_{B}=(5+100-1) * 6$
$=624 \mathrm{~ns}$
Time save $=E T_{B}-E T_{A}=624-214=410 \mathrm{~ns}$
24. Consider a 5-stage instruction pipeline having latencies (in ns) 1, 2, 3, 4 and 5 respectively. Find average CPI of non-pipeline CPU when speed up achieved with respect to pipeline is 4 (assume ideal case for pipelining)?
A. 1.23
B. 1.33
C. 1.66
D. 1.73

Ans. B
Sol. Speed up
$T_{\text {non-pipeline }}=$ sum of all stages delay $=15 \mathrm{~ns}$
$\mathrm{T}_{\text {pipeline }}=\max$ delay among all stages delay $=5 n s$
Given speedup $=4$
Execution of non-pipelined $=$ CPI $_{\text {non-pipelined }} *$ Cycle time
Execution of non-pipelined $=C P I_{\text {non-pipelined }}{ }^{*} 15 \mathrm{~ns}$
Now,

Execution of pipelined $=$ CPI $_{\text {pipelined }}{ }^{*}$ cycle time
In pipelined ideally CPI $_{\text {pipelined }}=1$
Execution of pipelined $=1 * 5 \mathrm{~ns}$
$4=\left(\mathrm{CPI}_{\text {non-pipelined }} * 15\right) /(1 * 5)$
CPInon-pipelined $=4 / 3$
$\mathrm{CPI}_{\text {non-pipelined }}=1.33$
Answer is 1.33
25. Register renaming is done in pipelined processor to eliminate $\qquad$ hazards.
A. Data dependency
B. Resource conflict
C. Structural dependency
D. Anti dependency

Ans. C
Sol. Register renaming is done to remove the structural dependency in the data.
26. Consider the following IEEE single precision floating point number shown below:

$$
01000011110100000000000000000000
$$

What is the octal equivalent of above number?
A. 640
B. 520
C. 340
D. 650

Ans. A
Sol. Format of single precision floating point is


| 0 | 100001111 | 101000000000.00 |
| :---: | :---: | :---: |

$$
\begin{aligned}
\text { Value } & =1 . \mathrm{M} \times 2^{\mathrm{E}-127} \\
& =1.1010 \times 2^{135-127} \\
& =(1.1010)_{2} \times 2^{8} \\
& =1.625 \times 2^{8} \\
& =(416)_{10}
\end{aligned}
$$

Octal representation


Octal representation is (640).
27. Consider we have a half-duplex channel with a bandwidth of 1.6 mbps and we need to send a packet of size 500 bytes. The length of the channel is 2.7 km . Then the capacity of the channel will be (Assume velocity of data in the transmission link $=2.7 \times 10^{6} \mathrm{~m} / \mathrm{s}$ )
A. 2100 bytes
B. 1600 bytes
C. 200 bytes
D. 700 bytes

Ans. C
Sol. we know that for half duplex channel.
Channel capacity $=$ Bandwidth*propagation delay
$=B W * T_{p}=B W * d / v=1.6^{*} 10^{6 * 2.7 * 10^{3} / 2.7 * 10^{6}=1600 \text { bits }=200 \text { bytes } . ~ . ~ . ~}$
28. Suppose a router has built up the routing table shown below. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4

| SubnetNumber | SubnetMask | NextHop |
| :--- | :--- | :--- |
| 128.96 .39 .0 | 255.255 .255 .128 | Interface 0 |
| 128.96 .39 .128 | 255.255 .255 .128 | Interface 1 |
| 128.96 .40 .0 | 255.255 .255 .128 | R2 |
| 192.4 .153 .0 | 255.255 .255 .192 | R3 |
| $\langle$ default $\rangle$ |  | R4 |
|  |  |  |

Consider the following statements:

1) For a packet addressed to the destination 128.96.40.151, router uses R4 as the next hop.
2) For a packet addressed to the destination 192.4.153.17, router uses R4 as the next hop.

Which of the above is/are correct?
A. Only 1
B. Only 2
C. Both
D. None

## Ans. A

Sol. Apply each subnet mask and if the corresponding subnet number matches the Subnet Number column, then use the entry in Next-Hop.
(a) 128.96.40.151: All subnet masks give 128.96 .40 .128 as the subnet number. Since there is no match, use the default entry. Next hop is R4.
(b) 192.4.153.17: Next hop is R3. Because when you subnet 192.4.153.17 with 192.4.153.192 it gives you 192.4.153.0 which matches with R3.
So, only statement 1 is true and statement 2 is false. Hence, option B is the correct answer.
29. Assume host $A$ having an IP address of 125.32 .16 .5 with a subnet mask of 255.255 .255 .128 . Also, assume another host $B$, having an IP address of 125.32 .16 .120 with a subnet mask of 255.255.255. 192. Which of the following is correct ?
A. A assumes $B$ to be on the same network.
$B$. $B$ assumes $A$ to be on the same network.
C. Both $A$ and $B$ assume each other to be on the same network.
D. Neither of the two assume themselves to be on the same network.

Ans. A
Sol. IP address of ' A ' $=125.32 .16 .5$
Subnet mask of 'A' = 255.255.255.128
Subnet ID of $A$ according to ' A ' $=125.32$. 16.0
IP address of ' B ' $=125.32 .16 .120$
Subnet ID of $B$ according to ' A ' $=125.32$. 16.0

## Hence 'A' assumes 'B' to be on the same network.

IP address of ' B ' = 125.32.16.120
Subnet mask of 'B' = 255.255.255.192
Subnet ID of $B$ according to ' B ' $=125.32 .16 .64$
Subnet ID of $A$ according to $' \mathrm{~B} '=125.32$. 16.0
Hence 'B' assumes 'A' to be on a different network.
30. Assume in TCP client is sending segment to server. Once the ACK containing window size=0 reaches to the client and the next ACK is lost then the sender is waiting for the ACK and receiver is waiting for data this situation is known as deadlock. Which timer is used and who will initiate the probe segment to resolve this deadlock respectively?
A. Keep alive timer, server
B. Retransmission timer, client
C. Persistent timer, client
D. Keep alive timer, client

Ans. C
Sol. Persistent timer will be used, and probe segment is issued by client to resolve this deadlock as shown below:


So, option C is the correct answer.
31. Packets of the same session may be routed through different paths in:
A. TCP, but not UDP
B. TCP and UDP
C. UDP, but not TCP
D. Neither TCP nor UDP

Ans. B

Sol. Packets of the same session may be routed through different paths in TCP and UDP. They are both protocols of Transport layer. Same session packets can be routed by different routes.
The static routing is not used by most networks. It uses some kind of routing that is adaptive to where two packet paths are routed for a similar session which can be different.

Routing happens in Network layer and hence has no dependency with the the transport layer protocols TCP and UDP. The transport layer protocol- whether TCP or UDP is hidden to the router and the routing path is determined based on the the network configuration at the time and hence can change even during a session.

TCP (Transmission Control Protocol) is connection oriented, whereas UDP (User Datagram Protocol) is connection-less protocol. Both are transport layer protocol. Networks do not use static routing and use dynamic(adaptive) routing where packets of same session may get routed via different paths. This is done to avoid congestion in some paths.

So, option B is the correct answer.
32. Which of the following applications uses TCP as transport protocol?
A. SMTP
B. SNMP
C. DHCP
D. DNS

Ans. A
Sol. SMTP uses TCP, Others use UDP.
33. An Internet Service Provider (ISP) has a block 219.50.0.0/16. There are 3 groups, Group1 has 128 customers, and each requires 64 IP addresses. Group 2 has 64 customers, and each requires 256 IP addresses. Group3 has $X$ customers, and each requires Y IP addresses. After successful completion, customer requests only 38 K IP address left with (ISP). What can be the possible value of $X$ and $Y$ respectively.
A. 64,128
B. 32,16
C. 32,128
D. 64,32

## Ans. D

Sol. $38 \times 2^{10}=\left[2^{16}-[\right.$ Group1 + Group2 + Group3 $\left.]\right]$
$38 \times 2^{10}=\left[2^{16}-\left[2^{7} \times 2^{6}+2^{6} \times 2^{8}+2^{m} \times 2^{n}\right]\right]$
$2^{\mathrm{x}} \times 2^{\mathrm{y}}=2^{16}-2^{13}-2^{14}-38 \times 2^{10}$
$=2^{10}\left[2^{6}-2^{3}-2^{4}-38\right]$
$=2^{10}[64-8-16-38]=2^{10} \times 2^{1}$
$2^{x} \times 2^{y}=2^{11}$
Option (d), which $2^{6} \times 2^{5}=2^{11}$
So, $2^{6}$ is 64 and $2^{5}$ is 32 , hence option $D$ is the correct answer.
34. Consider the following functional dependencies on the relation $R(A, B, C, D, E)$
$A \rightarrow B C$
$B C \rightarrow A D$
$D \rightarrow E$
What is the highest Normal Form the above Relation Satisfies?
A. 1 NF
B. 2 NF
C. 3 NF
D. BCNF

## Ans. B

Sol. first find out the candidate keys in...
$A \rightarrow B C$
$B C \rightarrow A D$
$\mathrm{D} \rightarrow \mathrm{E}$
candidate keys are $=\{A, B C\}$ now, $B$ and $C$ are prime attributes here and $D$ and $E$ are non-prime attributes..
so D->E is a transitive dependency (means non-prime attribute deriving non-prime attribute).so highest normal form is 2NF only.
Note- "If a relation to be in 3NF then Non-Prime Attributes MUST NOT determine non-prime attributes."
35. Consider $A(P, Q, R, S, T, V, W)$ and the following FD's:

W $\rightarrow$ VS
$\mathrm{T} \rightarrow \mathrm{S}$
WS $\rightarrow$ RT
QS $\rightarrow P$
Which of the following is minimal cover of the given FD's?
A. $\{W \rightarrow V, T \rightarrow S, W \rightarrow R, W S \rightarrow T, Q S \rightarrow P\}$
B. $\{\mathrm{W} \rightarrow \mathrm{V}, \mathrm{W} \rightarrow \mathrm{S}, \mathrm{T} \rightarrow \mathrm{S}, \mathrm{W} \rightarrow \mathrm{R}, \mathrm{QS} \rightarrow \mathrm{P}\}$
C. $\{W \rightarrow V, T \rightarrow S, W \rightarrow R, W S \rightarrow R, Q S \rightarrow P\}$
D. $\{\mathrm{W} \rightarrow \mathrm{V}, \mathrm{T} \rightarrow \mathrm{S}, \mathrm{W} \rightarrow \mathrm{R}, \mathrm{W} \rightarrow \mathrm{T}, \mathrm{QS} \rightarrow \mathrm{P}\}$

## Ans. D

Sol. Checking $\mathrm{QS} \rightarrow \mathrm{P}, \mathrm{Q}^{+}=\mathrm{Q}, \mathrm{S}^{+}=\mathrm{S}$, Hence $\mathrm{QS} \rightarrow \mathrm{P}$ is essential.
Checking WS $\rightarrow$ R, WS $\rightarrow T$
$\mathrm{W}^{+} \rightarrow$ WVSRT, hence it can be decomposed to $\mathrm{W} \rightarrow \mathrm{R}, \mathrm{W} \rightarrow \mathrm{T}$
So, the dependencies remained are.
$\mathrm{W} \rightarrow \mathrm{V}, \mathrm{W} \rightarrow \mathrm{S}, \mathrm{T} \rightarrow \mathrm{S}, \mathrm{W} \rightarrow \mathrm{R}, \mathrm{W} \rightarrow \mathrm{T}, \mathrm{QS} \rightarrow \mathrm{P}$
Now, $\{\mathrm{W} \rightarrow \mathrm{T}, \mathrm{T} \rightarrow \mathrm{S}\}$ by transitive rule $\mathrm{W} \rightarrow \mathrm{S}$ can be obtained.
Hence minimal cover is: $W \rightarrow V, T \rightarrow S, W \rightarrow R, W \rightarrow T, Q S \rightarrow P$.
36. Consider a relation $R(A, B, C, D, E)$ with the following functional dependencies:
$\mathrm{ABC} \rightarrow \mathrm{DE}$
$D \rightarrow A B$

The number of super keys of $R$ is:
A. 2
B. 7
C. 10
D. 12

Ans. C
Sol. A super key is a combination of columns that uniquely identifies any row within a relational database management system (RDBMS) table.
The candidate keys are DC, ABC so super keys possible:
$D C=2^{3}=8$
$A B C=2^{2}=4$
$A B C D=2^{1}=2$, union of $A B C$ and DC i.e. the common keys formed in $A B C$ and $D C$.
So, $8+4-2=10$

## Alternate way:-

ABC->DE
D->AB
Candidate keys of these FD's are ABC and CD
Number of super keys with ABC are $\mathrm{ABC}_{\sim_{-}}=4$
Number of superkeys with CD are _ $C D_{-}=8$
Total number of superkeys $=n(A B C \cup C D)=n(A B C)+n(C D)-n(A B C \cap C D)$
since $A B C D, A B C D E$ are common in both keys so $n(A B C \cap C D)=2$

$$
=4+8-2=10
$$

Therefore total number of superkeys are 10
37. Consider the following FD set:
$\{A B \rightarrow C, C \rightarrow A, B C \rightarrow D, A C D \rightarrow B, B E \rightarrow C, E C \rightarrow F A, C F \rightarrow B D, D \rightarrow E\}$
Which of the following FD set is minimal cover of given FD set?
A. $\{A B \rightarrow C, C \rightarrow A, B C \rightarrow D, B E \rightarrow C, E C \rightarrow F, C F \rightarrow D, D \rightarrow E\}$
B. $\{A B \rightarrow C, C \rightarrow A, B C \rightarrow D, B E \rightarrow C, E C \rightarrow F, C F \rightarrow B, D \rightarrow E\}$
C. $\{A B \rightarrow C, C \rightarrow A, C D \rightarrow B, E C \rightarrow F, C F \rightarrow B, D \rightarrow E\}$
D. $\{A B \rightarrow C, C \rightarrow A, B C \rightarrow D, B E \rightarrow C, E C \rightarrow A, C F \rightarrow B, D \rightarrow E\}$

## Ans. B

Sol.

| $[A B \rightarrow C$ |  | $[A B \rightarrow C$ |  | $[A B \rightarrow C$ |
| :---: | :---: | :---: | :---: | :---: |
| $\mathbf{C} \rightarrow \mathbf{A}$ |  | $\mathbf{C} \rightarrow \mathbf{A}$ |  | $\mathbf{C} \rightarrow \mathbf{A}$ |
| BC $\rightarrow$ D |  | BC $\rightarrow$ D |  | BC $\rightarrow$ D |
| ACD $\rightarrow$ B | $\xrightarrow{\text { After }}$ | CD $\rightarrow$ B |  | $B E \rightarrow C$ |
| $B E \rightarrow C$ | removal of | $\mathrm{BE} \rightarrow \mathrm{C}$ | removal of | $\mathrm{EC} \rightarrow \mathrm{F}$ |
| $\mathrm{EC} \rightarrow \mathrm{F}$ | extraneous attributes | $\mathrm{EC} \rightarrow \mathrm{F}$ | redundant FD's | CF $\rightarrow$ B |
| $\mathrm{EC} \rightarrow \mathrm{A}$ |  | $\mathrm{EC} \rightarrow \mathbf{A}$ |  | D $\rightarrow$ E] |
| CF $\rightarrow$ B |  | CF $\rightarrow$ B |  | Minimal |
| CF $\rightarrow$ D |  | CF $\rightarrow$ D |  | cover |
| D $\rightarrow$ E] |  | D $\rightarrow$ E] |  |  |

38. What techniques are used to retrieve data based on more than one table in a single SQL statement?
A. joins
B. union
C. nested query
D. all of the above

Ans. D
Sol. With join, union and nested query we retrieve data based on more than one table in a single SQL.
39. In SQL the statement Select * From $R, S$ is equivalent to?
A. Select * From R natural join $S$
B. Select * From R cross join $S$
C. Select * From R union join $S$
D. Select * From R inner join S

Ans. B
Sol. Even though the R and S may have common attributes it would give output as cross-product unless we give explicit condition for tuple matching.
To make it equivalent to natural join we have to use WHERE condition to match the common attributes.
40. This Query can be replaced by which one of the following.

SELECT name, course_id
FROM instructor, teaches
WHERE instructor_ID= teaches_ID;
A. Select name, course_id from instructor natural join teaches
B. Select name,course_id from teaches,instructor where instructor_id=course_id;
C. Select name, course_id from instructor;
D. Select course_id from instructor join teaches;

## Ans. A

Sol. Join clause joins two tables by matching the common column.
41. Selection sort, quick sort is a stable sorting method.
A. True, True
B. False, False
C. True, False
D. False, True

## Ans. B

Sol. Both Selection sort and Quick sort are unstable. A sorting algorithm is said to be stable if two objects with equal or same keys appear in the same order in sorted output as they appear in the input array to be sorted.

Selection sort works by finding the minimum element and then inserting it in its correct position by swapping with the element which is in the position of this minimum element. This is what makes it unstable.

Quick Sort is an unstable algorithm because we do swapping of elements according to pivot's position (without considering their original positions).
42. Find the number of spanning trees for the following graph : $\qquad$

A. 15
B. 12
C. 8
D. 21

Ans. A
Sol. We have a total of 7 edges in the graph, among them 5 are required in spanning tree. Hence, number of ways to select 5 out of 7 edges $=$
${ }^{7} C_{3}=\frac{7!}{5!\times 2!}=21$
But it contains all those cases also, where cycles are present, hence we have to subtract those cases
Cycle with 3 edges $=0$
Cycle with 4 edges $=2 \times 3=6$

Two cycles are possible selecting one more edge
with 5 edges
from remaining 3 edges.
Hence, total cases need to be subtracted $=0+6+0=6$
Hence, total number of spanning trees $=21-6=15$
43. What is the minimum of the multiplications required to multiply the following three matrices. $\mathrm{A}_{3 \times 7}, \mathrm{~B}_{7 \times 2}$ and $\mathrm{C}_{2 \times 9}$
A. 96
B. 97
C. 98
D. 378

Ans. A
Sol. To multiply $A B$, we need $3 \times 7 \times 2=42$ multiplications.
(AB) ${ }_{3 \times 2} \cdot C_{2 \times 9}$
Further multiplication with $C$ requires $3 \times 2 \times 9=54$ Multiplications
$\therefore$ Total $54+42=96$ multiplications for $(A B) C$.
To multiply $B C$, we need $7 \times 2 \times 9=126$ multiplications.
$\mathrm{A}_{3 \times 7}(\mathrm{BC}) 7 \times 9$

Further multiplications with A require $3 \times 7 \times 9=189$ Multiplications
$\therefore$ Total $126+189=315$ multiplications for $A(B C)$
$\therefore$ Minimum multiplications required are 96 .
44. Which of the following sorting algorithm is of divide and conquer type?
A. Bubble sort
B. Insertion sort
C. Merge sort
D. Selection sort

## Ans. C

Sol. Merger sort is of divide and conquer. Bubble, Insertion, and Selection sort are of greedy paradigm.
45. Which of the following variables is used to hold the address of another object?
A. Integer
B. Pointer
C. Constant
D. Memory Variable

## Ans. B

Sol. A pointer is a variable which contains the address in memory of another variable.
46.

```
extern int a = 6;
main( )
{
void fun();
printf("%d,",a);
fun( );
}
void fun( )
{
printf("%d", a);
}
return()
What is the output of above program?
```

A. Compile Time Error
B. Run Time Error
C. 6,6
D. 6,0

Ans. C
Sol. When we initialize global variable at the time of its prototype of declaration (i.e extern int $a=$ 6 ) then there exist physical memory to the variable ' $a$ ' hence value ' 6 ' will be stored in that location.

In the given two functions, the variable 'a' refers to the same memory location so the output is 6,6.
47. Let $A$ be a square matrix of size $n \times n$. Consider the following code, what is the output? void main()
\{
for(int $\mathrm{i}=0 ; \mathrm{i}<\mathrm{n} ; \mathrm{i}++$ )
\{
for(int $j=0 ; j<n ; j++)$
\{
if( $\mathrm{i}==\mathrm{j}$ )
$A[i][j]=1$;
else
$A[i][j]=0$;
\}
\}
\}
A. Null matrix
B. Transpose of matrix
C. Identity matrix
D. Inverse matrix

## Ans. C

Sol. Identity matrix, we can clearly see each diagonal element will become 1 and all other elements will become zero after execution of this code.
48. The number of possible binary trees with 4 nodes is
A. 12
B. 13
C. 14
D. 15

Ans. C
Sol. Total number of possible binary trees(unlabelled) with $n$ nodes $=[C(2 n, n) / n+1]$
So, total number of possible binary trees(unlabelled) with 4 nodes $=[C(2 * 4,4) / 4+1]=14$
49. A binary search tree contains the numbers $5,6,7,14,18,19,20,24,25,36,38,39$. When the tree is traversed in pre-order and the values in each node printed out, the sequence of values obtained is $18,14,7,5,6,36,20,19,25,24,38,39$. If the tree is traversed in post-order, the sequence obtained would be :
A. $7,5,6,14,39,38,36,24,25,19,20,18$
B. $6,5,7,14,19,24,25,20,39,38,36,18$
C. $5,6,7,14,19,20,24,25,38,39,36,18$
D. None of these

Ans. B
Sol. Inorder : 5, 6, 7, 14, 18, 19, 20, 24, 25, 36, 38, 39
Preorder : 18, 14, 7, 5, 6, 36, 20, 19, 25, 24, 38, 39

Tree will be,


Postorder : 6, 5, 7, 14, 19, 24, 25, 20, 39, 38, 36, 18
50.

```
void fun2(int);
Void fun1(int n);
{
        if ( }\textrm{n}==0=0
        return;
        printf("%d", n);
        fun2(n-2);
        printf("%d", n);
}
void fun2(int P)
    {
        if (P= = 0)
        return;
        printf("%d", P);
        fun1(+ + P);
        printf("%d", P);
        getch( );
}
void main ()
{
        fun1 (4);
}
```

What is the output of above program?
A. 4231221324
B. 2231223334
C. 4321223234
D. 4232212334

## Ans. A

Sol. Output after executing above function calls will be: 4231221324 .
So, option A is the correct answer.
51. The data structure queue is used in which of the following?
A. Depth first search
B. Breadth first search
C. Both A and B
D. None of the above

## Ans. B

Sol. Breadth first search, Queue is used in BFS and stack is used DFS.
52. Which of the following services use TCP?

1) DHCP
2) $S M T P$
3) $H T T P$
4) $T F T P$
5) FTP
A. 1 and 2
B. 2, 3 and 5
C. 1, 2 and 4
D. 1, 3 and 4

Ans. B
Sol. SMTP, HTTP and FTP use TCP.
53. A packet addressed to 128.48 .64 .0 came to a router having routing table as follows.

| Distination | Subnet Mask | Interface |
| :--- | :--- | :--- |
| 192.18 .1 .0 | 255.255 .255 .0 | A |
| 128.48 .0 .0 | 255.255 .128 .0 | B |
| 128.48 .0 .0 | 255.255 .0 .0 | C |
| Default |  | D |

Which interface will it be forwarded to ?
A. A
B. B
C. C
D. D

Ans. B
Sol. Logical AND operation between subnet mask and IP address gives the subnet ID.
a) $128.48 .64 .0 \& 255.255 .255 .0=128.48 .64 .0$ which is not equal to the destination so the packet will not be forwarded to the interface $A$.
b) $128.48 .64 .0 \& 255.255 .128 .0=128.48 .0 .0$ so packet can be forwarded to $B$.
c) $128.48 .64 .0 \& 255.255 .0 .0=128.48 .0 .0$ so packet can be forwarded to $C$.

If two IP addresses match then the packet should be forwarded to the subnet with more number of 1 's in the subnet mask.
Hence, router will forward the packet to interface $B$.
54. Which of the following is not a stateless protocol of application layer?
A. SMTP
B. DNS
C. POP
D. HTTP

Ans. C
Sol. Stateful->POP, FTP
Stateless-->DNS, HTTP, SMTP
55. Which of the following protocols is used by email server to maintain a central repository that can be accessed from any machine ?
A. POP3
B. FTP
C. SMTP
D. DMSP

Ans. A
Sol. *POP3 and IMAP are known as pull protocol because they are used for retrieving the mail from server.

* SMTP is simple mail transfer protocol.
* DMSP is distributed mail service protocol.

56. A computer system supports one address and two address instructions and the word size is 20 bits. Main memory is 128 words. If there are 32 two address instructions than how many one address instructions are used?
A. 4096
B. 2048
C. 512
D. 8192

Ans. A
Sol.
20 bits

| opcode | address | address |
| :--- | :--- | :--- |
| 6 bits | 7 bits | 7 bits |

No. Of opcode possible $=2^{6}=64$
No. Of free opcodes $=64-32=32$
No. Of one address instruction $=32 *\left(2^{7}\right)=4096$
57. In time division switches if each memory access takes 100 ns and one frame period is $125 \mu \mathrm{~s}$, then maximum number of lines that can be supported is
A. 625 lines
B. 1250 lines
C. 2300 lines
D. 318 lines

Ans. A
Sol. $2^{*} \mid \max$ no. of lines|*|memory access time|=|one frame period|

$$
\begin{aligned}
& =>\mid \mathrm{max} \text { no. of lines } \left\lvert\,=\frac{\mid \text { one frame period } \mid}{2 * \mid \text { memory access time } \mid}\right. \\
& =\frac{125 \mu \mathrm{~s}}{2 * 100 \mathrm{~ns}}=625 \text { lines }
\end{aligned}
$$

58. Choose the correct answer.
I. Direct addressing is the operand is inside the instruction
II. Indirect address in which the location of the operand is implicit.
III. Relative addressing is not good for program relocation
A. 2 and 3 are true
B. 1 and 2 are true
C. All True
D. All False

## Ans. D

Sol. All above are false statements.
In Direct addressing, the operand is present in the address of the pointed address value.
Indirect addressing address is not implicit it needs two address references to reach value.
Relative addressing is good for program relocation.
59. In terms of speed of control design, choose the correct order of control unit.
A. Vertical control unit < horizontal control unit < hardwired control unit
B. horizontal control unit >Vertical control unit >hardwired control unit
C. hardwired control unit = horizontal control unit < Vertical control unit
D. hardwired control unit= Vertical control unit= horizontal control unit

## Ans. A

Sol. Hardwired control unit is fastest and microprogram control unit is slower compared to hardwired. And between Vertical and horizontal control unit, horizontal is fast because its decoded and does not need decoder to understand.
60. Which of the following can be shown by using ER diagram?
A. Attributes of the Entities
B. Entities of the database
C. Relationship between the entities
D. All of the above

Ans. D
Sol. The entity-relationship model (or ER model) is a way of graphically representing the logical relationships of entities (or objects) in order to create a database. ER diagram contain entity, attributes and relationship between the entities.
61. Given relation $R(P, Q, R, S, T)$ and set of functional dependencies
$F=\{P Q \rightarrow R, P Q \rightarrow S, Q R \rightarrow S, Q R \rightarrow T\}$
The highest normal form satisfied by $R$ is $\qquad$
A. 1 NF
B. 2 NF
C. 3 NF
D. BCNF

Ans. C

Sol. Candidate keys for the relation are PQ.
Hence, the highest normal form will be 3NF.
62. Consider the following statements for $B+$ Tree:

S1: All leaf nodes are at the same level.
S2: Every leaf node contains a pointer to its next node if it is present.
Which of the following is true?
A. Only S1
B. Only S2
C. Both S1 and S2
D. Neither S1 nor S2

## Ans. C

Sol. Both the statements are true for B+ tree:
-All leaf nodes are at the same level.
-Every leaf node contains a pointer to its next node if it is present.
63. Read the following statement and find the correct option.

P: A query in Structural Query Language can contain HAVING clause without having GROUP BY clause

Q : A query in Structural Query Language can contain a HAVING clause only when GROUP BY clause is also there in query.
R : All attributes used in the GROUP BY clause must appear in the SELECT clause
S: No It is not necessary that all attributes used in the GROUP BY clause need to appear in the SELECT clause
A. P and R
B. P and S
C. Q and R
D. Q and $S$

Ans. C
Sol. As per the SQL concepts option c is right but suppose if tak about execution of these sql query on different database. Let us take MYSQL then option B will also be right. What happend if If we use a HAVING clause without a GROUP BY clause in this situation the HAVING condition applies to all rows that satisfy the search condition and in the result all rows that satisfy the search condition make up a single group.
64. Consider the following transaction involving two bank accounts $x$ and $y$ :

Read (x);
$X=x-50$
Write (x);
Read (y);
$y=y+50 ;$
write (y);
Which of the following constraints fail if transaction is fail just after write (x); operation?
A. Atomicity
B. Durability
C. Isolation
D. None of these

Ans. A
Sol. According to Atomicity either all operations of transaction are reflected properly in database, or none are. So, here transaction fails in middle so, Atomicity is fail.
65. If the value of $X+Y=1$, then the value of $X \oplus Y$ is equal to
A. $X$
B. $\bar{X}+\bar{Y}$
C. 1
D. 0

Ans. B

## Sol.

$$
\begin{aligned}
X \oplus Y & =\overline{X \odot Y}=\overline{\bar{X} \bar{Y}+X Y} \\
& =\overline{(\overline{X Y})} \overline{(X Y)} \\
& =(X+Y)(\bar{X}+\bar{Y}) \\
& =\bar{X}+\bar{Y} \\
(\because X & +Y=1 \text { which is given })
\end{aligned}
$$

66. An $n$-variable $K$-map usually have
A. $n^{2}$ cells or squares
B. $2^{n}$ cells or squares
C. $2^{n+1}$ cells or squares
D. none of the above

## Ans. B

Sol. K-map is a graphical method, which consists of $2^{n}$ cells for ' $n$ ' variables. The adjacent cells are differed only in single bit position.
67. The characteristic equation of $S-R$ latch is $\qquad$
A. $Q^{+}=S+R^{\prime} Q$
B. $Q^{+}=S+R^{\prime} Q^{\prime}$
C. $Q^{+}=S^{\prime}+R^{\prime} Q$
D. $Q^{+}=S+R Q^{\prime}$

## Ans. A

Sol. A characteristic equation is needed when a specific gate requires a specific output in order to satisfy the truth table. The characteristic equation of $S-R$ latch is $Q^{+}=S+R^{\prime} Q$
68. Which of the following flip-flops is used to avoid race around problem?
A. T flip-flop
B. SR flip-flop
C. Master-Slave Flip-flop
D. D flip-flop

Ans. C
Sol. Master-Slave flip flop is used to avoid the race around condition.
69. $L 1=\left\{a^{n} b^{2 n} / n>0\right\}, L 2=\left\{a^{n} b^{n} / n>0\right\} L 1 \cup L 2$ is $a$ ?
A. RL
B. D-CFL
C. CFL
D. None

Ans. C
Sol. L1 is D-CFL and L2 is D-CFL but there union is not D-CFL as we need two transition from start state. One will guess a path to L1 and another to L2. Thus we cannot make D-PDA for it but we can make PDA and so it is CFL.
70. Recursive enumerable languages are not closed under $\qquad$ .
A. Set difference
B. Complement
C. Both (A) and (B)
D. None of the options

Ans. C
Sol. Recursive enumerable language is not closed under complement operation hence also not closed under set difference operation.
71. Consider the following statements:

S1: Infinite union of regular languages can be context-free.
S2 : Language obtained after applying Kleen closure on a regular language will always be regular and infinite.
Which of the above statement is true?
A. $S_{1}$ only
B. $S_{2}$ only
C. Both $\mathrm{S}_{1}$ and $\mathrm{S}_{2}$
D. Neither $S_{1}$ nor $S_{2}$

Ans. A
Sol. For $S_{1}: L_{1}=\varepsilon, L_{2}=\{a b\}, L_{3}=\left\{a^{2} b^{2}\right\}, L_{4}=\left\{a^{3} b^{3}\right\} \ldots$...and so on.
$L=L_{1} \cup L_{2} \cup L_{3} \cup L_{4} \ldots$
$L=a^{n} b^{n}$
Hence $S_{1}$ is correct. Infinite union of regular language can be context free.
For $\mathbf{S}_{\mathbf{2}}$ : Let L be $\Phi$ which is regular language. $L^{*}=\Phi^{*}=\varepsilon$, this language is regular but finite. So S2 is false.
Hence, option A is the correct answer.
72. The collection of Turing recognizable languages are closed under :
(i) Union
(ii) Intersection
(iii) Complement
(iv) Concatenation
(v) Star closure
A. (i) Only
B. Both (i), (iv)
C. (i), (ii), (iv) and (v)
D. All of the options

Ans. C

Sol. Turing recognizable language (REL) are closed under union, intersection, concatenation and star closure operations but not closed under complement operation.
73. Which one of the following is a top-down parser?
A. Recursive descent parser
B. Operator precedence parser
C. An $L R(k)$ parser
D. An LALR(k) parser

Ans. A
Sol. Recursive Descent also known as top down parsing also known to be LL(1).
74. Assuming that the input is scanned in left to right order, while parsing an input string the topdown parser use
A. Rightmost derivation
B. Leftmost derivation
C. Rightmost derivation that is traced out in reverse
D. Leftmost derivation that is traced out in reverse

## Ans. B

Sol. Parsing is classified into two categories, i.e. Top Down Parsing and Bottom-Up Parsing.
Top-Down Parsing is based on Left Most Derivation
Bottom Up Parsing is dependent on Reverse Right Most Derivation.
75. Consider the grammar $G$ whose SLR parser has $n 1$ states and LALR parser has $n 2$ states. What is the relation between $n 1$ and $n 2$ ?
A. $\mathrm{n} 1=\mathrm{n} 2$
B. $\mathrm{n} 1<\mathrm{n} 2$
C. $\mathrm{n} 1>\mathrm{n} 2$
D. Cannot predict

Ans. A
Sol. Number of states $(S L R)=$ Number of States (LALR) $\leq$ number of states (CLR)
76. If in a parse tree, node value is determined by the attribute value at child nodes then it is called as:
A. Synthesized attribute
B. Inherited attribute
C. Both $A$ and $B$
D. None

Ans. A
Sol. An attribute is said to be Synthesized attribute if its parse tree node value is determined by the attribute value at child nodes.
77. The number of bit strings of length 8 that will either start with 1 or end with 00 is?
A. 32
B. 128
C. 160
D. 192

Ans. C

Sol. (I) Number of 8 bit strings starting with $1: 1$ $=2^{7}=128$
(II) Number of 8 bit strings ending with 00 : $\qquad$ 00

It has 2 possibilities:
if the string starts with 0 then total strings $=2^{5}=32$
and if the string starts with 1 then total strings $=32$ but they are already covered in all the strings starting with 1
So, total number of strings $=128+32=160$
78. Which one is the correct translation of the following statement into mathematical logic? "None of my friends are perfect."
A. $\neg \exists \mathrm{x}(\mathrm{p}(\mathrm{x}) \wedge \mathrm{q}(\mathrm{x}))$
B. $\exists x(\neg p(x) \wedge q(x))$
C. $\exists x(\neg p(x) \wedge \neg q(x))$
D. $\exists x(p(x) \wedge \neg q(x))$

Ans. A
Sol. $\exists x(p(x) \wedge q(x))$ means there exists a friend who is perfect. By negating whole expression it will be translated as "none of my friends are perfect".
79. In how many ways can 10 books be arranged on a shelf such that a particular pair of books will never be together?
A. $9!\times 2!$
B. $10!\times 2!$
C. 9 !
D. $9!\times 8$

Ans. D
Sol. Total number of ways in which we can arrange 10 books on a shelf

$$
\begin{equation*}
={ }^{10} \mathrm{P}_{10}=10! \tag{A}
\end{equation*}
$$

Now we will find out total number of ways in which 10 books can be arranged on a shelf such that a particular pair of books will always be together.
We have a total of 10 books. If a particular pair of books must always be together, just tie these two books together and consider as a single book. Hence we can take total number of books as 9. These 9 books can be arranged in ${ }^{9} \mathrm{P}_{9}=9$ ! ways.

We had tied two books together. These books can be arranged among themselves in ${ }^{2} P_{2}=2$ ! ways.
Hence, total number of ways in which 10 books can be arranged on a shelf such that a particular pair of books will always be together

$$
\begin{equation*}
=9!\times 2! \tag{B}
\end{equation*}
$$

From (A) and (B),
Total number of ways in which 10 books can be arranged on a shelf such that a particular pair of books will never be together

$$
=10!-(9!\times 2!)=(9!\times 10)-(9!\times 2)=9!(10-2)=9!\times 8
$$

80. There are 8 pairs of eye lenses of different colors. In how many ways can one choose lenses of two different colors for both the eyes?
A. 56
B. 64
C. 124
D. 376

## Ans. A

Sol. We will first select the right eye lens. This can be done in 8 ways.
The left eye lens can be any except that corresponding to the right eye lens already selected. So, it can be selected in 7 ways.
$\therefore$ Required number $=8 \times 7=56$
81. Which is not a software life cycle model?
A. Waterfall model
B. Spiral model
C. Prototyping model
D. Capability Maturity Model

Ans. D
Sol. Capability Maturity Model because CMM is not a software life cycle model. Instead, it is a strategy for improving the software process.
82. Which of the following characteristics include in the spiral model of software development?
A. Ends with the delivery of the software product
B. Is more chaotic than the incremental model
C. Includes project risks evaluation during each iteration
D. work well for smaller project

## Ans. C

Sol. The main objective of the spiral model is to emphasize management to evaluate and resolve risks in the software project.
83. RAD Software process model stands for:
A. Rapid Application Development
B. Relative Application Development
C. Rapid Application Design
D. Recent Application Development

## Ans. A

Sol. RAD model is Rapid Application Development model. It is a type of incremental model. In RAD model the components or functions are developed in parallel as if they were mini projects. The developments are time boxed, delivered and then assembled into a working prototype. This can quickly give the customer something to see and use and to provide feedback regarding the delivery and their requirement.
84. Alpha testing is done on which side of software development?
A. Customer side
B. Developer side
C. Both Customer side and developer side
D. Server side

Ans. B
Sol. Alpha testing takes place at the developer's site by the internal teams, before release to external customers. Alpha testing performed to identify all possible issues/bugs before releasing the product to everyday users or public.
85. The major shortcoming of waterfall model is
A. the difficulty in accommodating changes after requirement analysis.
B. the difficult in accommodating changes after feasibility analysis.
C. the system testing.
D. the maintenance of system.

## Ans. A

Sol. The major shortcoming of waterfall model is the difficulty in accommodating changes after requirement analysis.
System testing, maintenance of system and accommodating changes after feasibility analysisare minor shortcoming.
86. If $P(A \cap B)=1 / 2, P\left(A^{\prime} \cap B^{\prime}\right)=1 / 2$ and $2 P(A)=P(B)=p$, then the value of $p$ is given by
A. $1 / 4$
B. $1 / 2$
C. $1 / 3$
D. $2 / 3$

Ans. D

$$
\mathrm{P}(\overline{\mathrm{~A}} \cap \overline{\mathrm{~B}})=\frac{1}{2}
$$

Sol. Given $P(A \cap B)=\frac{1}{2} \quad 1-P(A \cup B)=\frac{1}{2} \Rightarrow P(A \cup B)=\frac{1}{2}$
$2 P(A)=P(B)=P$
$\Rightarrow \frac{1}{2}=\frac{P}{2}+P-\frac{1}{2} \Rightarrow \frac{3}{2} P=1$
$\Rightarrow \mathrm{P}=\frac{2}{3}$
87. Three unbiased coins are tossed. What is the probability of getting at least 2 tails?
A. 0.75
B. 0.5
C. 0.25
D. 0.2

Ans. B
Sol. $\mathrm{S}=\{\mathrm{HHH}, \mathrm{HHT}, \mathrm{HTH}, \mathrm{HTT}, \mathrm{THH}, \mathrm{THT}, \mathrm{TTH}, \mathrm{TTT}\}$
$\mathrm{E}=\{\mathrm{HTT}, \mathrm{THT}, \mathrm{TTH}, \mathrm{TTT}\}$
$n(S)=8$
$n(E)=4$
$P(E)=n(E) / n(S)=4 / 8=0.5$
88. A $3 \times 5$ matrix has all its entries equal to 1 . The rank of the matrix is
A. 3
B. 5
C. 1
D. 0

Ans. C
Sol. Rank $\leq 3$ since all entries are 1 ,
$\therefore \mid 3 \times 3$ submatrices $|=| 2 \times 2$ submatrices $\mid=0$
only $1 \times 1$ or single entries are $\neq 0$
$\therefore$ rank $=1$
89. Consider two matrices $M_{1}$ and $M_{2}$ with $M_{1} * M_{2}=0$ and $M_{1}$ is non-singular. Then which of the following is true?
A. $M_{2}$ is non-singular
B. $M_{2}$ is null matrix
C. $M_{2}$ is the identity matrix
D. $M_{2}$ is transpose of $M_{1}$

## Ans. B

Sol. Non-singular matrix multiplied by null matrix results null matrix. Thus, $\mathrm{M}_{2}$ is null matrix.
90. The value of $p$ such that the vector $\left[\begin{array}{l}1 \\ 2 \\ 3\end{array}\right]$ is an eigen vector of the matrix $\left[\begin{array}{ccc}4 & 1 & 2 \\ p & 2 & 1 \\ 14 & -4 & 10\end{array}\right]$ is:
A. 15
B. 16
C. 17
D. 18

Ans. C
Sol. Given $A=\left[\begin{array}{ccc}4 & 1 & 2 \\ P & 2 & 1 \\ 14 & -4 & 10\end{array}\right] \quad X=\left[\begin{array}{l}1 \\ 2 \\ 3\end{array}\right]$
$\because A X=\lambda_{X} A X=\left[\begin{array}{ccc}4 & 1 & 2 \\ P & 2 & 1 \\ 14 & -4 & 10\end{array}\right]\left[\begin{array}{l}1 \\ 2 \\ 3\end{array}\right]=\left[\begin{array}{c}12 \\ P+7 \\ 36\end{array}\right]=12\left[\begin{array}{c}1 \\ \frac{P+7}{12} \\ 3\end{array}\right]$
$\Rightarrow 12 \cdot\left[\begin{array}{c}1 \\ \frac{P+7}{12} \\ 3\end{array}\right]=\lambda\left[\begin{array}{l}1 \\ 2 \\ 3\end{array}\right]$
So $\frac{p+7}{12}=2 \Rightarrow p+7=24 \Rightarrow p=17$
91. Which of the following data structure used by recursion?
A. Queue
B. Tree
C. Array
D. Stack

## Ans. D

Sol. Stack, Because stack has the last in first out property, using stack we can remember who is caller and where to return.
92. For building a Binary search tree from a given pre-order traversal with $n$ nodes, the time taken is?
A. $O\left(n^{2}\right)$
B. $\mathrm{O}(\mathrm{n})$
C. $O(n \log n)$
D. $O(\log n)$

Ans. C
Sol. As the in-order of BST is sorted, so for locating the position of an element takes logn time
For 1 element $\rightarrow$ Iogn
For n elements $\rightarrow$ nlogn
Hence C
[when you don't have complete input in advance but when you have complete input ready then you don't have to add it one by one which involves finding location of each node (logn). So for $n$ nodes it will be nlog( $n$ )]
93. The maximum number of nodes in a binary tree of level $k, k \geq 1$ is :
A. $2^{\mathrm{k}}+1$
B. $2^{k-2}$
C. $2^{\mathrm{k}}-1$
D. $2^{k+1}-1$

Ans. C
Sol. $2^{(h+1)}-1$ example: let a binary tree be of height 2 then total nodes is at level $0: 1$ node, at level 1: 2 nodes and at level 2: 4 nodes. Hence total will be : $1+2+4=7$ e.i., $2^{\wedge}(2+1)-1=8-1=7$ and here $k=h+1$
so maximum number of nodes with $k$ - level -->
$2^{k}-1$
94. What would be the solution to the given prefix notation?
*/+12/42+35
A. 12
B. 7.5
C. 9
D. 13.5

Ans. A
Sol. The infix notation of the given prefix notation is $((1+2) /(4 / 2))^{*}(3+5)$ which solves to $(3 / 2) * 8$ which by solving gives us 12 .
95. Insert $50,20,60,10,8$ into an AVL Tree. Which rotation is performed to make the tree balanced?
A. RR
B. LR
C. RL
D. LL

## Ans. D

## Sol.


96. Number of BSTs possible with 6 keys are?
A. 103
B. 122
C. 132
D. None of above

Ans. C
Sol. We know that with n distinct keys
No. of BST possible $=\frac{{ }^{2 n} C_{n}}{(n+1)}=\frac{{ }^{12} C_{6}}{7}=132$
97. Which of the following is correct statement?
A. Intermediate result of Kruskal algorithm is always forest.
B. Intermediate result of Kruskal algorithm may be forest.
C. Intermediate result of Prim's algorithm may be forest.
D. Intermediate result of Prim's algorithm is always forest.

Ans. B
Sol. Intermediate result of Prim's algorithm is always connected but Kruskal's algorithm may produce forest.
98. Which Among the following is Static Data Structure-
A. Linked List
B. Queue
C. Stack
D. Array

Ans. D

## Sol.


99. Which of the following statements is false?
A. In linked list implementation of queue, if new nodes are inserted at the beginning of linked list, then in pop operation, nodes must be removed from end.
B. In linked list implementation of queue, if new nodes are inserted at the end of linked list, then in pop operation, nodes must be removed from beginning.
C. In linked list implementation of stack, if new nodes are inserted at the beginning of linked list, then in pop operation, nodes must be removed from end.
D. In linked list implementation of stack, if new nodes are inserted at the end of linked list, then in pop operation, nodes must be removed from end.

Ans. C
Sol. In linked list implementation of stack, if new nodes are inserted at the beginning of linked list, then in pop operation, nodes must be removed from end.
Correct statement is:
In linked list implementation of stack, if new nodes are inserted at the beginning of linked list, then in pop operation, nodes must be removed from beginning.
100. S 1 : An array is a collection of similar type of data items.

S2: Linked List follows contiguous memory locations.
S3: In Non-Linear data structures, the data items are not in sequence.
S4: In Insertion Operation Underflow problem may occur.
The number of Correct Statements is/are $\qquad$
Ans. S1, S3
Sol. Only S1 and S3 are Correct.
S1: An array is a collection of similar type of data items.
S2: Linked List follows non-contiguous memory locations.

S3: In Non-Linear data structures, the data items are not in sequence.
S4: In Insertion Operation overflow problem may occur. Underflow may occur during Deletion.

