1. Which of the following options is the closest in meaning to the phrase underlined in the sentence below?
It is fascinating to see life forms cope with varied environmental conditions.
A. adopt to B. adapt to
C. adept in D. accept with
Answer||| B
Solution||| The closest meaning to the phrase "cope with" is "adapt to" ie. Adapt means adjust/modify to new situation.

2. Choose the most appropriate word from the options given below to complete the following sentence.
He could not understand the judges awarding her the first prize, because he thought that her performance was quite _____.
A. superb B. medium
C. mediocre D. exhilarating
Answer||| C
Solution||| Here, "Superb" and "Exhilarating" means excellent that won't be the answer and "Medium" mostly used as noun so the most appropriate answer is "Mediocre(adjective)" which means moderate in quality.

3. In a press meet on the recent scam, the minister said, "The buck stops here". What did the minister convey by the statement?
A. He wants all the money B. He will return the money
C. He will assume final responsibility D. He will resist all enquiries
Answer||| C
Solution||| "The buck stops here" means "Responsibility will be stopped from that point". So the answer would be "he will assume final responsibility".

4. If $(z + 1/z)^2 = 98$, compute (z^2+1/z^2).
A. 96 B. 89
C. 100 D. 93
Answer||| A
Solution||| $(z + 1/z)^2 = z^2 + 1/z^2 + 2*z*1/z$ i.e $(a + b)^2=a^2+b^2+2ab$
$98 = z^2 + 1/z^2 + 2$
$98-2 = z^2+1/z^2$
$(z^2+1/z^2) = 96$.

5. The roots of $ax^2 + bx + c = 0$ are real and positive *a*, *b* and *c* are real. Then $ax^2 + b|x| + c = 0$ has
A. No roots
B. 2 real roots
C. 3 real roots
D. 4 real roots
Answer||| D
Solution||| The roots of a quadratic equation is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

The discriminant of a quadratic equation is D = b2 - 4ac
If the quadratic equation has real and equal roots then D = 0
If the quadratic equation has real and distinct roots then D > 0
In the given equation,
a, b, c are real roots. Discriminant of x i.e is b2 - 4ac > 0
Then x is also real and positive.
So $ax^2 + b|x| + c = 0$ has 4 real roots.

6. The Palghat Gap (or Palakkad Gap), a region about 30 km wide in the southern part of the Western Ghats in India, is lower than the hilly terrain to its north and south. The exact reasons for the formation of this gap are not clear. It results in the neighboring regions of Tamil Nadu getting more rainfall from the South West monsoon and the neighboring regions of Kerala having higher summer temperatures.
What can be inferred from this passage?
A. The Palghat gap is caused by high rainfall and high temperatures in southern Tamil Nadu and Kerala
B. The regions in Tamil Nadu and Kerala that are near the Palghat Gap are low-lying
C. The low terrain of the Palghat Gap has a significant impact on weather patterns in neighboring parts of Tamil Nadu and Kerala
D. Higher summer temperatures result in higher rainfall near the Palghat Gap area
Answer||| D
Solution||| From the above passage we come to know that, the climatic condition of Tamil Nadu and Kerala has been affected and the reason for the gap is not given. So the answer is "Higher summer temperatures result in higher rainfall near the Palghat Gap area"

7. Geneticists say that they are very close to confirming the genetic roots of psychiatric illnesses such as depression and schizophrenia, and consequently, that doctors will be able to eradicate these diseases through early identification and gene therapy.
On which of the following assumptions does the statement above rely?
A. Strategies are now available for eliminating psychiatric illnesses
B. Certain psychiatric illnesses have a genetic basis
C. All human diseases can be traced back to genes and how they are expressed
D. In the future, genetics will become the only relevant field for identifying psychiatric illnesses
Answer||| B
Solution||| From the above passage, it is clear that psychiatric illnesses such as depression and schizophrenia have a genetic basis but the strategy for elimination is still not available which relies on statement B.

8. Round-trip tickets to a tourist destination are eligible for a discount of 10% on the total fare. In addition, groups of 4 or more get a discount of 5% on the total fare. If the one way single person fare is Rs 100, a group of 5 tourists purchasing round-trip tickets will be charged Rs _____.
A. 1500 B. 850
C. 650 D. 950
Answer||| B
Solution||| One way fare for a single person = Rs 100
Round trip ticket fare for a single person = Rs 100+Rs 100
= Rs 200
Round trip tickets for 5 persons = 5*200
= Rs 1000
Discount applicable = (5+10) %

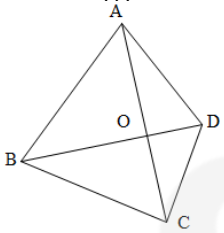
= 15%
Amount to be paid = 1000 - ((15/100)*1000)
= 1000 – 150
= Rs 850

9. In a survey, 300 respondents were asked whether they own a vehicle or not. If yes, they were further asked to mention whether they own a car or scooter or both. Their responses are tabulated below. What percent of respondents do not own a scooter?

		Men	Women
Own vehicle	Car	40	34
	Scooter	30	20
	Both	60	46
Do not own vehicle		20	50

A. 50% B. 46%
C. 48% D. 60%
Answer||| C
Solution||| No. of respondents who don't have scooter= 40(Men) + 34(Women) = 74
No. of respondents who don't have vehicle= 20(Men) + 50(Women) = 70
Total no. of respondents who don't have scooter= 74 + 70 = 144
Total no. of respondents= 40+34+30+20+60+46+20+50 = 300
Percent of respondents who don't have scooter= (144/300)*100= 48%

10. When a point inside of a tetrahedron (a solid with four triangular surfaces) is connected by straight lines to its corners, how many (new) internal planes are created with these lines? _____
A. 4 B. 3
C. 5 D. 6
Answer||| D
Solution|||



Consider a point O inside the tetrahedron as in fig below and connect it with any two of its corners (suppose A and B), we will get 1 internal plane OAB. Similarly, we can get OAC, OAD, OBC, OBD, OCD i.e. No. of internal planes is 6.

11. Consider the statement
"Not all that glitters is gold".
Predicate *glitters* (*x*) are true if *x* glitters and predicate *gold*(*x*) is true if *x* is gold. Which one of the following logical formulae represents the above statement?

A. $\forall x : glitters(x) \Rightarrow \neg\, gold(x)$

B. $\forall x : gold(x) \Rightarrow glitters(x)$

C. $\exists x : gold(x) \wedge \neg\, glitters(x)$

D. $\exists x : glitters(x) \wedge \neg gold(x)$

Answer||| D
Solution|||
Using logical connectives, it is clear that D i.e. at least one glitter object is not gold is the answer.

12. Suppose you break a stick of unit length at a point chosen uniformly at random. Then the expected length of the shorter stick is _____
A. 0.5 B. 0.25
C. 0.15 D. 0.75
Answer||| B
Solution||| Let us take in meters; the length of the stick is 1m.
Length of the smaller stick should be from 0 to 0.5m with each equal in length.
So the average length would be 0.25m i.e. the length of the shortest stick is 0.25.

13. Let G = (V, E) be a directed graph where V is the set of vertices and E the set of edges. Then which one of the following graphs has the same strongly connected components as G?

A. $G_1 = (V, E_1)\ where\ E_1 = \{(u,v) \mid (u,v) \notin E\}$

B. $G_2 = (V, E_2)\ where\ E_2 = \{(u,v) \mid (v,u) \in E\}$

C. $G_3 = (V, E_3)\ where\ E_3 = \{(u,v) \mid there\ is\ a\ path\ of\ length \leq 2\ from\ u\ to\ v\ in\ E\}$

D. $G_4 = (V_4, E)\ where\ E_4$

Answer||| B
Solution||| From the given options,
i) If a component is strongly connected in E then it will not be strongly connected in E's complement thus A cannot be the answer.
ii) B is reversing the directions of the edges in the graph so the new graph has same set of strongly connected components as the original graph. Hence B is the strongly connected graph.
iii) C is mostly the answer as according to the condition the number of edges in E3 will be those present in E and also additional edges which connect all u to all v such that uv<=2. Hence the connected component will not stay connected.
iv) V4 has only single vertices i.e those which were isolated in G and no edges will be present between them. So D is not strongly connected.

14. Consider the following system of equations:
3x + 2y = 1
4x + 7z = 1
x + y + z = 3
x – 2y + 7z = 0
The number of solutions for this system is _____
A. 1
B. 2
C. 3
D. 0
Answer||| A

Solution||| Augmented matrix is

$$\begin{bmatrix} 3 & 2 & 0 & 1 \\ 4 & 0 & 7 & 1 \\ 1 & 1 & 1 & 3 \\ 1 & -2 & 7 & 0 \end{bmatrix}$$

$R1 \leftrightarrow R3$

$$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 4 & 0 & 7 & 1 \\ 3 & 2 & 0 & 1 \\ 1 & -2 & 7 & 0 \end{bmatrix}$$

$R2 \rightarrow R2-4R1;\ R3 \rightarrow R3-3R1;\ R4 \rightarrow R4-R1$

$$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & -1 & -3 & -8 \\ 0 & -3 & 15 & -3 \end{bmatrix}$$

$R3 \rightarrow 4R3-R2$
$R4 \rightarrow 4R4-3R2$

$$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & 0 & -15 & -21 \\ 0 & 0 & 15 & 21 \end{bmatrix}$$

$R4 \rightarrow R4+R3$

$$\begin{bmatrix} 1 & 1 & 1 & 3 \\ 0 & -4 & 3 & -11 \\ 0 & 0 & -15 & -21 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Rank (A : B) = Rank(A)= 3 = no. of variables
Hence it has unique solution.

15. The value of the dot product of the eigenvectors corresponding to any pair of different Eigen values of a 4-by-4 symmetric positive definite matrix is _____.
A. -1 B. 1
C. 0 D. 2
Answer||| C
Solution||| The Eigen vectors corresponding to different Eigen values of a real symmetric matrix are orthogonal to each other. And dot product of orthogonal (perpendicular) vectors is 0.

16. Let the function

$$f(\theta) = \begin{vmatrix} \sin\theta & \cos\theta & \tan\theta \\ \sin\left(\frac{\pi}{6}\right) & \cos\left(\frac{\pi}{6}\right) & \tan\left(\frac{\pi}{6}\right) \\ \sin\left(\frac{\pi}{3}\right) & \cos\left(\frac{\pi}{3}\right) & \tan\left(\frac{\pi}{3}\right) \end{vmatrix}$$

Where $\theta \in \left[\frac{\pi}{6}, \frac{\pi}{3}\right]$ and $f'(\theta)$ denote the derivative off with respect to θ. Which of the following statements is/are TRUE?

(I) There exists $\theta \in \left(\frac{\pi}{6}, \frac{\pi}{3}\right)$ such that $f'(\theta) = 0$

(II) There exists $\theta \in \left(\frac{\pi}{6}, \frac{\pi}{3}\right)$ such that $f'(\theta) \neq 0$

A. I only
B. II only
C. Both I and II
D. Neither I nor II
Answer||| C
Solution||| By using Mean Value Theorem, which states roughly that given a planar arc between two endpoints, there is at least one point at which the tangent to the arc is parallel to the secant through its endpoints. So it is clear that both the statements I and II are true.

17. Consider the following Boolean expression for F:
F (P, Q, R, S) = PQ + P'QR + P'QR'S
The minimal sum-of-products form of F is:
A. PQ + QR + QS
B. P + Q + R + S
C. P' +Q' + R' + S'
D. P'R + P'R'S + P
Answer||| A
Solution||| Let us assume
PQ+P'QR + P'QR'S = PQ+P'Q(R +R'S)
= PQ+P'Q((R+R')(R+S)) [i.e.(A+BC)=(A+B)(A+C)]
= PQ+P'Q(R +S) [i.e. R+R' = 1]
= Q(P+P'(R+S))
= Q((P+P')(P+R+S)) [i.e. A+BC=(A+B)(A+C)]
= Q(P+R+S) [i.e. P+P'=1]
= PQ+QR+QS

18. The base (or radix) of the number system such that the following equation holds is_____

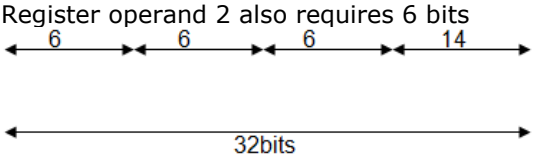
$$\frac{312}{20} = 13.1$$

A. 3 B. 5
C. 4 D. 6
Answer||| B
Solution||| $(2x^0+1x^1+3x^2)/(0+2x^1) = (3x^0+1x^1+1x^{-1})$
$(2+x+3x^2)/2x=(3+x+(1/x))$
$3x^2+x+2=2x(x^2+3x+1)/x$
$3x^2+x+2-2x^2-6x-2=0$
$x^2-5x=0$
x=0 or 5

19. A machine has a 32-bit architecture, with 1-word long instructions. It has 64 registers, each of which is 32 bits long. It needs to support 45 instructions, which have an immediate operand in addition to two register operands. Assuming that the immediate operand is an unsigned integer, the maximum value of the immediate operand is _____

opcode	reg opd 1	reg opd 2	Immediate opd

A. 16383
B. 16391
C. 16387
D. 16385
Answer||| A
Solution||| 1Word= 32 bits each instruction has 32bits
To support 45 instructions, opcode must contain 6-bits
Register operandi requires 6 bits, since the total registers are 64.
Register operand 2 also requires 6 bits



14-bits are left over for immediate Operand Using 14-bits, we can give maximum 16383. Since 2^{14} = 16384(from 0 to 16383)

20. Consider the following program in C language:

```
#include <stdio.h>
main ( )
{ int i;
int *pi = &i;
scanf("%d",pi);
printf("%d\n", i+5);
}
```

Which one of the following statements is TRUE?
A. Compilation fails.
B. Execution results in a run-time error.
C. On execution, the value printed is 5 more than the address of variable i.
D. On execution, the value printed is 5 more than the integer value entered.
Answer||| D
Solution||| Value of i will be stored in the address of pi. scanf() places the entered value into the variable. Then printf(), prints 5 more than the value entered in console.

21. Let *G* be a graph with *n* vertices and *m* edges. What is the tightest upper bound on the running time of Depth First Search on G, when G is represented as an adjacency matrix?

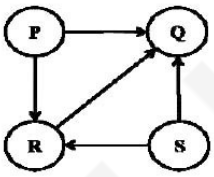
A. $\Theta(n)$ B. $\Theta(n+m)$ C. $\Theta(n^2)$ D. $\Theta(m^2)$
Answer||| C
Solution||| Let us take the vertices as n and the edges as m of a graph G. DFS algorithm takes O (m + n) time using adjacency matrix. So the graph is represented as n × n matrix. To do DFS, for every vertex, we do transverse the corresponding row to the vertex to find all adjacent vertices. Thus the time complexity is O (n^2).

22. Consider a rooted *n* node binary tree represented using pointers. The best upper bound on the time required to determine the number of sub trees having exactly 4 nodes is $0(n^a \log^b n).$ Then the value of *a* + 10*b* is ____.
A. 1 B. 11
C. 12 D. 21
Answer||| A
Solution||| int print_subtrees_size_4(node*n)

```
{
int size=0;
if(node==null)
return 0;
size=print_subtrees_size_4(node->left) +
print_subtrees_size_4(node->right)+1;
if(size==4)
printf("Size of the subtree is 4");
return size;
}
```

The above function on taking input the root of a binary tree prints all the sub trees of size 4 in O(n) time. Thus a = 1, b = 0, a + 10b = 1

23. Consider the directed graph given below:



Which one of the following is TRUE?
A. The graph does not have any topological ordering.
B. Both PQRS and SRQP are topological orderings.
C. Both PSRQ and SPRQ are topological orderings.
D. PSRQ is the only topological ordering.
Answer||| C
Solution||| Topological ordering is nothing but linear ordering of vertices of a directed graph such that for every directed edge uv from vertex u to v, u comes before v in ordering. Here topological ordering exists because the graph has no directed cycles. PSRQ and SPRQ both satisfy this condition so both are topological ordering.

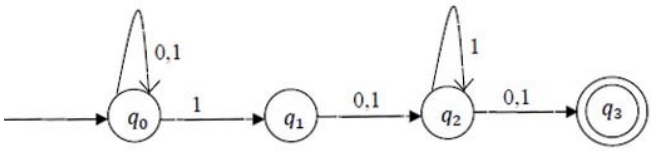
24. Let P is a quick sort program to sort numbers in ascending order using the first element as the pivot. Let t_1 and t_2 be the number of comparisons made by P for the inputs [1 2 3 4 5] and [4 1 5 3 2] respectively. Which one of the following holds?
A. $t_1 = 5$
B. $t_1 < t_2$
C. $t_1 > t_2$
D. $t_1 = t_2$
Answer||| C
Solution||| [1 2 3 4 5] is already sorted hence it takes more time than [4 1 5 3 2]. Quick sort program takes more time when given inputs are in sorted order. Hence $t_1 > t_2$

25. Which one of the following is TRUE?
A. The language $L = \{a^n b^n \mid n \geq 0\}$ is regular.
B. The language $L = \{a^n b^n \mid n \; is \; prime\}$ is regular.
C. The language $L = \{w \mid w \; has \; 3k+1 b's \; for \; some \; k \in$ n with $\sum = \{a,b\}\}$ is regular.

D. The language
$L = \{ww \mid w \in \sum^* \ with \sum = \{0,1\}\}$ is regular.

Answer||| C
Solution||| The statement C is true because the language $L = \{w \mid w \ has \ 3k+1b's \ for \ some \ k \in$ n with $\sum = \{a,b\}\}$ is regular since the total count of b are multiple of 3 +1. The regular expression is a*ba*(a*ba*ba*ba)*+(a*ba*ba*ba)*a*ba*.

26. Consider the finite automaton in the following figure.



What is the set of reachable states for the input string 0011?
A. {q_0, q_1, q_2}
B. {q_0, q_1}
C. {q_0, q_1, q_2, q_3}
D. {q_3}
Answer||| A
Solution||| $\delta(q_0,0011) = \delta(q_0,011)$
$= \delta(q_0,11)$
$= \delta(\{q_0, q_1\}1)$
$= \delta(q_0,1) \cup \delta(q_1,1)$
$= \{ q_0, q_1\} \cup \{ q_2\}$
$= \{ q_0, q_1, q_2\}$

27. Which one of the following is FALSE?
A. A basic block is a sequence of instructions where control enters the sequence at the beginning and exits at the end.
B. Available expression analysis can be used for common sub expression elimination.
C. Live variable analysis can be used for dead code elimination.
D. x = 4 ∗ 5 ⇒ *x* = 20 is an example of common sub expression elimination.
Answer||| D
Solution||| The statement D is False because, x = 4 * 5; x = 20 is not an example of common sub-expression but it is constant folding expression.

29. Suppose a disk has 201 cylinders, numbered from 0 to 200. At some time the disk arm is at cylinder 100, and there is a queue of disk access requests for cylinders 30, 85, 90, 100, 105, 110, 135 and 145. If Shortest-Seek Time First (SSTF) is being used for scheduling the disk access, the request for cylinder 90 is serviced after servicing _____ number of requests.
A. 1
B. 3
C. 2
D. 4
Answer||| B
Solution||| In SSTF algorithm, request closest to the current position of the disk arm and head is handled first. Here, the arm is currently at cylinder number 100. Now the requests come in the queue order for cylinder numbers 30, 85, 90, 100, 105, 110, 135 and 145. The disk will service first the cylinder no 100 (as the arm is at cylinder 100 right now), then 105, then 110, and then the arm comes to service request for cylinder 90. Hence before servicing request for cylinder 90, the disk would have serviced 3 requests. So option B is the answer.

30. Which one of the following is FALSE?
A. User level threads are not scheduled by the kernel.
B. When a user level thread is blocked, all other threads of its process are blocked.
C. Context switching between user level threads is faster than context switching between kernel level threads.
D. Kernel level threads cannot share the code segment.
Answer||| B
Solution||| From the given options, it is clear that, statement D is False because Kernel level threads within the same process share code section, data section and other operating system resources such as open files and signals.

31. Consider the relation scheme R = (E, F, G, H, I, J, K, L, M, N) and the set of functional dependencies {{E, F} → {G}, {F} → {I, J}, {E, H} → {K, L}, {K} → {M}, {L} → {N}} on R. What is the key for R?
A. {E, F} B. {E, F, H}
C. {E, F, H, K, L} D. {E}
Answer||| B
Solution||| Here, R = (E, F, G, H, I, J, K, L, M, N)
{E, F} → {G}
{F} → {I, J}
{E, H} → {K, L}
{K} → {M}
{L} → {N}
E, F, H together functionally derive all the attributes of R. Thus {E, F, H} is the key for R.

32. Given the following statements:
S1: A foreign key declaration can always be replaced by an equivalent check assertion in SQL.
S2: Given the table R (a, b, c) where a and b together form the primary key, the following is a valid table definition.
CREATE TABLE S (
a INTEGER,
d INTEGER,
e INTEGER,
PRIMARY KEY (d),
FOREIGN KEY (a) references R)
Which one of the following statements is **CORRECT**?
A. S1 is TRUE and S2 is FALSE.
B. Both S1 and S2 are TRUE.
C. S1 is FALSE and S2 is TRUE.
D. Both S1 and S2 are FALSE.
Answer||| D
Solution||| Both statements S1 and S2 are False. Check assertions are not sufficient to replace foreign key. Foreign key declaration may have cascade delete which is not possible by just check insertion. Also foreign key of one table should uniquely identify a row of other table. In the statement S2, table S has a foreign key that refers to field 'a' of R. The field 'a' in table R doesn't uniquely identify a row in table R.

33. Consider the following three statements about link state and distance vector routing protocols, for a large network with 500 network nodes and 4000 links.
[S1] The computational overhead in link state protocols is higher than in distance vector protocols.
[S2] A distance vector protocol (with split horizon) avoids persistent routing loops, but not a link state protocol.
[S3] After a topology change, a link state protocol will converge faster than a distance vector protocol.
Which one of the following is correct about S1, S2, and S3?
A. S1, S2, and S3 are all true.
B. S1, S2, and S3 are all false.
C. S1 and S2 are true, but S3 is false.
D. S1 and S3 are true, but S2 is false.
Answer||| D
Solution||| S1 is true because, In Link State all nodes compute shortest path for whole network graph. S2 is false as the distance vector protocol split horizon with poison reverse reduces the chance of forming loops and uses a maximum number of hops to counter the 'count-to-infinity' problem. These measures avoid the formation of routing loops in some but not all cases. S3 is true as the distance vector protocol has count to infinity problem and converges slower.

34. Which of the following are used to generate a message digest by the network security protocols?
(P) RSA (Q) SHA-1 (R) DES (S) MD5
A. P and R only
B. Q and R only
C. Q and S only
D. R and S only
Answer||| C
Solution||| SHA1 and MD5 algorithms are used to generate a message digest by the network security protocols. So, C is the correct answer.

36. Consider a token ring network with a length of 2 km having 10 stations including a monitoring station. The propagation speed of the signal is 2 × 102 m/s and the token transmission time is ignored. If each station is allowed to hold the token for 2 μsec, the minimum time for which the monitoring station should wait (in μsec) before assuming that the token is lost is _____.
A. 28 to 30 B. 20 to 22
C. 30 to 32 D. 38 to 40
Answer||| A
Solution||| Length d is 2km, Speed v is 2*10^8m/s, No of stations m is 10 and Ticket Holding time t is 2 μs. Thus the Waiting Time is Min t to Max t.
Max t = Tp in the Ring + No. of active stations * t
= $(10*10^{-6}) + (10*2*10^{-6})$
= 30μs
Then the waiting time is (30 - 2) to 30 μs or 28 to 30 μs.

37. Let the size of congestion window of a TCP connection be 32 KB when a timeout occurs. The round trip time of the connection is 100 m sec and the maximum segment size used is 2 KB. The time taken (**in m sec**) by the TCP connection to get back to 32 KB congestion window is _____.
A. 1100 to 1300
B. 800 to 1000
C. 1400 to 1600
D. 1500 to 1700
Answer||| A
Solution||| Here, Congestion Window Size (CWS) is 32KB and Round Trip Time (RTT) = l00ms. When Time Out occurs, for the next round of Slow Start,
Threshold = (size of CWS) /2 i.e. Threshold = 16KB
Slow Start
2KB
I RTT
4KB
2 RTT
8KB
3RTT
16KB ---------->Threshold reaches. So Additive Increase Starts
4 RTT
18KB
5RTT
20K B
6RTT
22KB
7RTT
24KB
8RTT
26KB
9RTT
28KB
I0RTT
30KB
11RTT
32KB
So, Total no. of RTT's = 11 → 11 * 100 = 1100

38. Consider a selective repeat sliding window protocol that uses a frame size of 1 KB to send data on a 1.5 Mbps link with a one-way latency of 50 msec. To achieve a link utilization of 60%, the minimum number of bits required to represent the sequence number field is _____.
A. 3 B. 5
C. 4 D. 6
Answer||| B
Solution||| Transmission delay, Tp = Frame Size/bandwidth
= (1*8*10^3)/(1.5 * 10^6)=5.33ms
Propagation delay, Tx = 50ms
Efficiency= 60/100=0.6
We know that, Efficiency = Window Size/(1+2a) where a = Tp/Tx
Therefore, Window size = 11.856
Min sequence number = 2*window size = 23.712
Bits required in Min sequence number = log2(23.712)
Answer is 4.56= 5

39. Consider the following four schedules due to three transactions (indicated by the subscript) using read and write on a data item x, denoted by r(x) and w(x) respectively. Which one of them is conflict serializable?
A. r1(x); r2(x); w1(x); r3(x); w2(x)
B. r2(x); r1(x); w2(x); r3(x); w1(x)
C. r3(x); r2(x); r1(x); w2(x); w1(x)
D. r2(x); w2(x); r3(x); r1(x); w1(x)

Answer||| D
Solution||| If there is a cycle in precedence graph then the schedule is not conflict serializable. But in option D, there is no interleaving of operations. The option D has first all operations of transaction T2, then T3 and T1.It is a conflict equivalent to T2→T3→T1 & T3→T2→T1

40. Given the following two statements:
S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF.
S2: AB → C, D → E, E → C is a minimal cover for the set of functional dependencies
AB → C, D → E, AB → E, E → C.
Which one of the following is CORRECT?
A. S1 is TRUE and S2 is FALSE.
B. Both S1 and S2 are TRUE.
C. S1 is FALSE and S2 is TRUE.
D. Both S1 and S2 are FALSE.
Answer||| A
Solution|||
If a table is in BCNF it is also in I NP, 2NF and 3NF thus the statement S1 is True. In the statement S2, the first FD set cannot cover second FD set because in second FD set, AB can functionally derive E but that is not happening in first FD set, thus the statement s2 is False.

41. An operating system uses the Banker's algorithm for deadlock avoidance when managing the allocation of three resource types X, Y, and Z to three processes P0, P1, and P2. The table given below presents the current system state. Here, the Allocation matrix shows the current number of resources of each type allocated to each process and the Max matrix shows the maximum number of resources of each type required by each process during its execution.

	Allocation			Max		
	X	Y	Z	X	Y	Z
P0	0	0	1	8	4	3
P1	3	2	0	6	2	0
P2	2	1	1	3	3	3

There are 3 units of type X, 2 units of type Y and 2 units of type Z still available. The system is currently in a safe state. Consider the following independent requests for additional resources in the current state:
REQ1: P0 requests 0 units of X, 0 units of Y and 2 units of Z
REQ2: P1 requests 2 units of X, 0 units of Y and 0 units of Z
Which one of the following is TRUE?
A. Only REQ1 can be permitted.
B. Only REQ2 can be permitted.
C. Both REQ1 and REQ2 can be permitted.
D. Neither REQ1 nor REQ2 can be permitted.
Answer||| B
Solution||| REQ1
Once P0 is allocated with (0,0,2), the status of the system will be as follows

Allocation	Max	Need	Available
X Y Z	X Y Z	X Y Z	X Y Z
0 0 3	8 4 3	8 4 0	3 2 0
3 2 0	6 2 0	3 0 0	
2 1 1	3 3 3	1 2 2	

With available (3, 2, 0) only P1 can be served. Once P1 is executed, available will be (6, 4, 0) with (6, 4, 0) we can't serve either P0 or P2. Hence there is no safe sequence. Hence REQ1 can't be permitted.
REQ2
Once P1 is allocated with (2, 0, 0), the status of the system will be as follows

	Allocation	Max	Need	Available
	X Y Z	X Y Z	X Y Z	X Y Z
P0	0 0 1	8 4 3	8 4 2	1 2 2
P1	5 2 0	6 2 0	1 0 0	
P2	2 1 1	3 3 3	1 2 2	

With available (1, 2, 2), we can serve either P1 or P2. If we serve P1 then the safe sequence is (P1, P2, P0). If we serve P2 then the safe sequence is (P2, P1, P0). As true is at least one safe sequence we can permit REQ2.

42. Consider the following set of processes that need to be scheduled on a single CPU. All the times are given in milliseconds.

Process Name	Arrival Time	Execution Time
A	0	6
B	3	2
C	5	4
D	7	6
E	10	3

Using the shortest remaining time first scheduling algorithm, the average process turnaround time (in m sec) is _____.
A. 7.2
B. 8.2
C. 6
D. 9
Answer||| A
Solution||| By using Gantt chart, the completion time for processes A, B, C, D and E are 8, 5, 12, 21 and 15 respectively.
Turnaround Time (TAT) = Completion Time - Arrival Time
Average TAT = ((8-0) + (5-3) + (12-5) + (21-7) + (15-10)) / 5
=36/5 = 7.2ms

43. Assume that there are 3 page frames which are initially empty. If the page reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is_____.
A. 7 B. 6
C. 5 D. 4
Answer||| A
Solution||| Using optimal page replacement policy, we can replace the place which is not used for longest duration in future. For a three page frames, if the reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6
Initially, there are three page faults and entries are 1 2 3
Page 4 cause a page fault and replaces 3 (3 is the longest distant in future), entries become 1 2 4
Total page faults = 3+1 = 4
Pages 2 and 1 don't cause any fault.
5 cause a page fault and replaces 1, entries become 5 2 4
Total page faults = 4 + 1 = 5

3 cause a page fault and replaces 1, entries become 3 2 4
Total page faults = 5 + 1 = 6
3, 2 and 4 don't cause any page fault.
6 cause a page fault.
Total page faults = 6 + 1 = 7

44. A canonical set of items is given below

$$S \rightarrow L > R$$

$$Q \rightarrow R$$

On input symbol < the set has
A. A shift-reduce conflict and a reduce-reduce conflict.
B. A shift-reduce conflict but not a reduce-reduce conflict.
C. A reduce-reduce conflict but not a shift-reduce conflict.
D. Neither a shift-reduce nor a reduce-reduce conflict.
Answer||| D
Solution||| On input symbol ' < ' which is not present in the given canonical set of items. Hence it is neither a shift-reduce nor a reduce-reduce conflict on symbol '<'. Thus D is the correct option.

45. Let L be a language and $\overline{L}$ be its complement. Which one of the following is NOT a viable possibility?

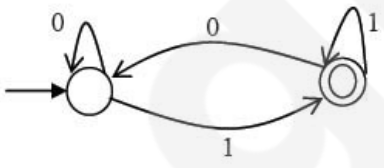
A. Neither L nor $\overline{L}$ is recursively enumerable (r.e.).

B. One of L and $\overline{L}$ is r.e. but not recursive; the other is not r.e.

C. Both L and $\overline{L}$ are r.e. but not recursive.

D. Both L and $\overline{L}$ are recursive.
Answer||| C
Solution||| Recursive languages are closed under complement. If a language L is recursive enumerable but not recursive then its complement is not a recursive enumerable, so both L and t are recursive enumerable but not recursive is not viable possibility.

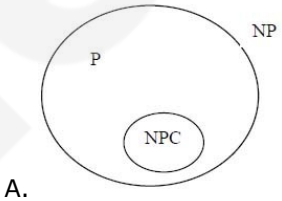
46. Which of the regular expressions given below represent the following DFA?



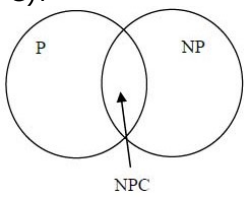
I) 0*1(1+00*1)*
II) 0*1*1+11*0*1
III) (0+1)*1
A. I and II only
B. I and III only
C. II and III only
D. I, II, and III
Answer||| B
Solution||| The Regular Expressions I and II represents the above given DFA because, the given DFA will accept all the strings over ε = {0, 1} which are ending with 1. 0*1(1 + 00*1)* and (0+1)*1 are the regular expressions which are ending with 1.

47. There are 5 bags labeled 1 to 5. All the coins in a given bag have the same weight. Some bags have coins of weight 10 gm, others have coins of weight 11 gm. I pick 1, 2, 4, 8, 16 coins respectively from bags 1 to 5. Their total weight comes out to 323 gm. Then the product of the labels of the bags having 11 gm coins is ___.
A. 13
B. 15
C. 12
D. 8
Answer||| C
Solution||| Let us assume X be the no of coins of 11gm and Y be the no of 10 gm coins. Then, 11X+10Y= 323 ...(1)
Sum of the coins taken from each bags is 31. Then, X+Y=31.....(2)
Solving (1) & (2) we get X=13 and Y=18
Thus coins of 11gm are 13 and possible combination for 13 is (1coin from bag1) + (4coins from bag3) + (8coins from bag4)
Product of labels of bags will be 1*3*4=12.

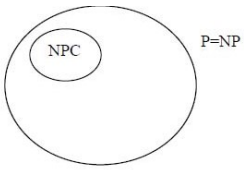
48. Suppose a polynomial time algorithm is discovered that correctly computes the largest clique in a given graph. In this scenario, which one of the following represents the correct Venn diagram of the complexity classes P, NP and NP Complete (NPC)?



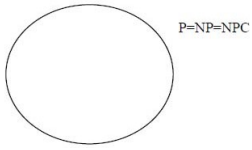
A.



B.



C.

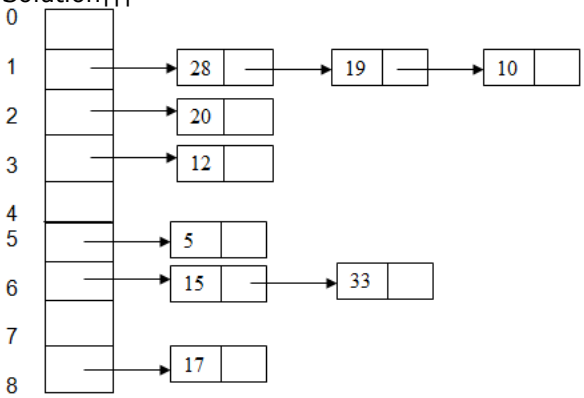


D.

Answer||| D
Solution||| Here it is given that some polynomial time algorithm exists which computes the largest clique problem in the given graph which is known as NP a complete problem. If one NP complete problem can be solved in polynomial time, then all of them can be. So NPC set becomes equals to P i.e. P=NP=NPC.

49. The minimum number of comparisons required finding the minimum and the maximum of 100 numbers is _____.
A. 147
B. 145
C. 146
D. 148
Answer||| D
Solution||| To find minimum and maximum comparisons for n numbers = (3n/2-2)
= (3(100)/2)-2
= 150-2
= 148

50. Consider a hash table with 9 slots. The hash function is $h(k) = k \bmod 9$. The collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17 and 10. The maximum, minimum, and average chain lengths in the hash table, respectively, are
A. 3, 0, and 1
B. 3, 3, and 3
C. 4, 0, and 1
D. 3, 0, and 2
Answer||| A
Solution|||



Therefore, the maximum and minimum chain length is 3 & 0 respectively.
Average chain length = (0 + 3 + 1 + 1 + 0 + 1 + 2 + 0 + 1)/9 = 1.

51. Consider the following C function in which size is the number of elements in the array E:

```
int MyX(int *E, unsigned int size)
{
int Y = 0;
int Z;
int i, j, k;
for(i = 0; i < size; i++)
Y = Y + E[i];
for(i = 0; i < size; i++)
for(j = i; j < size; j++)
{
Z = 0;
for(k = i; k <= j; k++)
Z = Z + E[k];
if (Z > Y)
Y = Z;
}
return Y;
}
```

The value returned by the function MyX is the
A. Maximum possible sum of elements in any sub-array of array E.
B. Maximum element in any sub-array of array E.
C. Sum of the maximum elements in all possible sub-arrays of array E.
D. The sum of all the elements in the array E.
Answer||| A
Solution|||

```
int MyX(int *E, unsigned int size)
{
int Y = 0;
int Z;
int i, j, k;
for(i = 0; i < size; i++)          } Calculates sum of elements of array and stores it in Y
Y = Y + E[i];
for(i = 0; i < size; i++)
for(j = i; j < size; j++)          }
{                                  }
Z = 0;                             } Calculates sum of elements of all possible sub arrays of E
for(k = i; k <= j; k++)            }
Z = Z + E[k];
if (Z > Y)                         --> Checks whether sum of elements of each sub array is greater than the sum of elements of array if so, that sum is assigned to Y, if not Y will be the sum of elements of complete array
Y = Z;
}
return Y;                          --> Returns the maximum possible sum of elements in any sub array of the given array E
}
```

Thus the answer is A.

52. Consider the following pseudo code. What is the total number of multiplications to be performed?

```
D = 2
for i = 1 to n do
for j = i to n do
for k = j + 1 to n do
D = D * 3
```

A. Half of the product of the 3 consecutive integers.
B. One-third of the product of the 3 consecutive integers.
C. One-sixth of the product of the 3 consecutive integers.
D. None of the above.
Answer||| C
Solution||| Here,
For i = 1, the multiplication statement is executed (n-1) + (n-2) + .. 2 + 1 times
For i = 2, the multiplication statement is executed (n-2) + (n-3) + .. 2 + 1 times
……
……
For i = n-1, the statement is executed once.
For i = n, the statement is not executed at all
So overall the statement is executed {[(n-1) + (n-2) + 2 + 1] + [(n-2) + (n-3) + 2 + 1] + … + 1 + 0} times.
The above series can be written as S = [n*(n-1)/2 + (n-1)*(n-2)/2 + ….. + 1]
The sum of above series can be obtained by trick of subtraction the series from standard Series $S1 = n^2 + (n-1)^2 + .. 1^2$. The sum of this standard series is n*(n+1)*(2n+1)/6
S1 – 2S = n + (n-1) + … 1 = n*(n+1)/2
2S = n*(n+1)*(2n+1)/6 – n*(n+1)/2
S = n*(n+1)*(n-1)/6
Thus the statement "D = D * 3" is executed n*(n+1)*(n-1)/6 times.

53. Consider a 6-stage instruction pipeline, where all stages are perfectly balanced. Assume that there is no cycle-time overhead of pipelining. When an application is executing on this 6-stage pipeline, the speedup achieved with respect to non-pipelined execution if 25% of the instructions incur 2 pipeline stall cycles is _____.
A. 4 B. 8
C. 6 D. 7

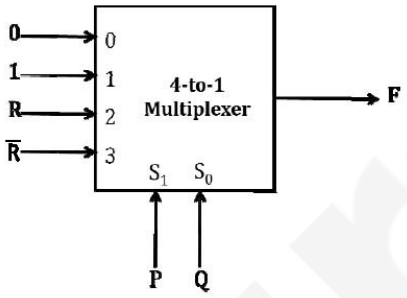
Answer||| A
Solution||| For 6 stages, non- pipelining takes 6 cycles. There were 2 stall cycles for pipelining for 25% of the instructions
So pipe line time = (1 + (2(25/100))) = 3/2 = 1.5

Speed up $= \frac{Non\ pipe\ line\ time}{Pipe\ line\ time}$

= 6/1.5
= 4

54. An access sequence of cache block addresses is of length N and contains n unique block addresses. The number of unique block addresses between two consecutive accesses to the same block address is bounded above by k. What is the miss ratio if the access sequence is passed through a cache of associatively A ≥ k exercising least-recently-used replacement policy?
A. n/N B. 1/N C. 1/A D. k/n
Answer||| A
Solution||| There are N access request for the cache blocks out this n blocks are unique.
In between two access of the same block there are request of (k-1) other block.
And if their associatively >=k and use LRU, then there will be only one cache miss for every unique block i.e. n and it will be the time when the enter the cache for the first time. Therefore,
Miss ratio = (Cache miss)/(No. of request) = n/N

55. Consider the 4-to-1 multiplexer with two select lines S_1 and S_0 given below.



The minimal sum-of-products form of the Boolean expression for the output F of the multiplexer is

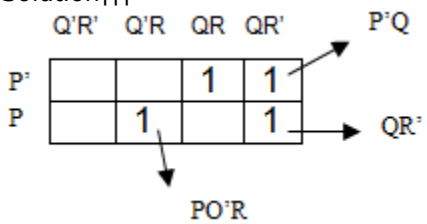
A. $\bar{P}Q + Q\bar{R} + P\bar{Q}R$

B. $\bar{P}Q + \bar{P}Q\bar{R} + PQ\bar{R} + P\bar{Q}R$

C. $\bar{P}QR + \bar{P}Q\bar{R} + Q\bar{R} + P\bar{Q}R$

D. $PQ\bar{R}$

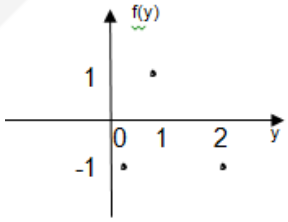
Answer||| A
Solution|||



For 4 to 1 mux = P'Q'(0)+P'Q(1)+PQ'R+PQR'
=P'Q+PQ'R+PQR'
=Q(P'+PR')+PQ'R
= Q(P'+R')+PQ'R
=P'Q+QR'+PQ'R

56. The function f(x) = x sin x satisfies the following equation: f"(x) + t cos x = 0. The value of t is _____
A. 2 B. -2 C. 1 D. -1
Answer||| B
Solution||| Given f(x) = x sin x then,
f'(x) = x cos x + sin x
f"(x) = x (-sin x) + cos x + cos x = 2cosx - x sinx
= 2cosx— f(x)
Given that, f"(x) + t cos x = 0
2 cos x - f(x) + f(x) + t cos x = 0
2 cos x + t cos x = 0
cos x(t + 2) = 0
t + 2 = 0
t = -2

57. A function f(x) is continuous in the interval [0,2]. It is known that f(0) = f(2) = -1 and f(1) = 1. Which one of the following statements must be true?
A. There exists a y in the interval (0,1) such that f(y) = f(y+1)
B. For every y in the interval (0,1), f(y) = f(2-y)
C. The maximum value of the function in the interval (0,2) is 1
D. There exists a y in the interval (0,1) such that f(y) = -f(2-y)
Answer||| A
Solution|||



Define g(x) =f(x)-f(x+1) in [0.11. g(0) is negative and g(1) is positive. By intermediate value theorem there is y€(0,l) such that g(y)=0
That is f(y) =f(y+l).

58. Four fair six-sided dice are rolled. The probability that the sum of the results being 22 is x/1296. The value of X is _____.
A. 10 B. 9 C. 8 D. 7
Answer||| A
Solution||| 22 occurred in following ways
6 6 6 4 → 4ways
6 6 5 5 → 6ways
Required probability = (6+4)/2296
= 10/2296
From the given data, x = 10

59. A pennant is a sequence of numbers, each number being 1 or 2. An n-pennant is a sequence of numbers with sum equal to n. For example, (1,1,2) is a 4-pennant. The set of all possible 1-pennants is {(1)}, the set of all possible 2-pennants is {(2), (1,1)} and the set of all 3-pennants is {(2,1), (1,1,1), (1,2)}. Note that the

pennant (1,2) is not the same as the pennant (2,1). The number of 10-pennants is _____.
A. 87 B. 88
C. 89 D. 90
Answer||| C
Solution|||
No twos = 1111111111 = 1 pennant
Single twos = 211111111 = (9!/(8!1!)) =9 pennants
Two twos: 22111111 = (8!/(6!2!)) = 28 pennants
Three twos: 2221111 = (7!/(3!4!)) = 35 pennants
Four twos: 222211= (6!/(4!2!)) = 15 pennants
Five twos: 22222=1 pennant i.e. Total =89 pennants.

60. Let S denote the set of all functions f : {0,1}4 → {0,1}. Denote by N the number of functions from S to the set {0, 1}. The value of log2 log2 N is is _____.
A. 12 B. 13
C. 15 D. 16
Answer||| D
Solution||| The number of functions from A to B where size of A = |A| and size of B = |B| is $|B|^{|A|}$ $\{0,1\}^4$ = {0, 1 }X{0,1}X{0,1}X{0,I} = 16
$|S| = 2^{16}$
$N = 2^{|8|}$
loglog N = loglog $2^{|8|}$ = log |S| = log 2^{16} = 16

61. Consider an undirected graph G where self-loops are not allowed. The vertex set of G is {(i, j): 1 ≤ i ≤ 12, 1 ≤ j ≤ 12}. There is an edge between (a, b) and (c, d) if |a - c| ≤ 1 and |b - d| ≤ 1.The number of edges in this graph is _____.
A. 500 B. 502
C. 506 D. 510
Answer||| C
Solution||| From the given data, there can be total 12*12 possible vertices. The vertices are (1, 1), (1, 2).... (1, 12) (2, 1), (2, 2),....
Number of edges is equal to number of pairs of vertices that satisfy above conditions. For example, vertex pair {(1, 1), (1, 2)} satisfy above condition.
For (1, 1), there can be an edge to (1, 2), (2, 1), (2, 2). Note that there can be self-loop as mentioned in the question. Same is count for (12, 12), (1, 12) and (12, 1)
For (1, 2), there can be an edge to (1, 1), (2, 1), (2, 2), (2, 3), (1, 3)
Same is count for (1, 3), (1, 4).... (1, 11), (12, 2), ... (12, 11)
For (2, 2), there can be an edge to (1, 1), (1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2), (3, 3)
Same is count for remaining vertices.
For all pairs (i, j) there can total 8 vertices connected to them if i and j are not in {1, 12}. There are total 100 vertices without a 1 or 12. So total 800 edges.
For vertices with 1, total edges = (Edges where 1 is first part) + (Edges where 1 is second part and not first part)
= (3 + 5*10 + 3) + (5*10) edges
Same is count for vertices with 12
Total number of edges:
= 800 + [(3 + 5*10 + 3) + 5*10] + [(3 + 5*10 + 3) + 5*10]
= 800 + 106 + 106
= 1012
Since graph is undirected, two edges from v1 to v2 and v2 to v1 should be counted as one. So total number of undirected edges = 1012/2 = 506.

62. An ordered n-tuple (d_1, d_2, …,d_n) with $d_1 \geq d_2 \geq \cdots \geq d_n$ is called graphic if there exists a simple undirected graph with *n* vertices having degrees d_1, d_2, … , d_n respectively. Which of the following 6-tuples is NOT graphic?
A. (1, 1, 1, 1, 1, 1)
B. (2, 2, 2, 2, 2, 2)
C. (3, 3, 3, 1, 0, 0)
D. (3, 2, 1, 1, 1, 0)
Answer||| C
Solution||| According to havel-hakimi theorem,
(1, 1, 1 ,1, 1, 1) is graphic if <1,1,1,1,0> is graphic
(0,1,1,1,1) is graphic if(0,1,1,0) is graphic
(0,0,1,1) is graphic 111(0,0,0) is graphic
Since (0,0,0) is graphic (1,1,1,1,1,1) is also graphic.
(The process is always finding maximum degree and removing it from degree sequence, subtracts 1 from each degree for d times from right to left where d is maximum degree)
(2,2,22,2,2) is graphic if (2,2,2,2-1,2-1) = (2,2,2,1,1) is graphic.
(1,1,2,2,2) is graphic if(1,1,1,1)is graphic.
(1,1,1,1) is graphic 1ff (0,1,1)
(0,1,1) is graphic if (0,0) is graphic.
Since (0,0) is graphic (2,2,2,2,2,2) is also graphic.
Consider option C now.
(3,3,3,1,0,0) → (0,0,1.3,3,3) is graphic if (0.0,0,2,2) is graphic.
Note that before applying the havel-hakimi step degree sequence should be in non-increasing order.
(0,0,0,2,2) is graphic if (0,0,-1,1) is graphic.
Since (0,0,-1,1) is not graphic (3,3,3,1,0,0) is also not graphic.

63. Which one of the following propositional logic formulas is TRUE when exactly two of p, q, and r are TRUE?
A. ((p ↔ q) ∧ r) ∨ (p ∧ q ∧ ~ r)
B. (~ (p ↔ q) ∧ r) ∨ (p ∧ q ∧ ~ r)
C. ((p → q) ∧ r) ∨ (p ∧ q ∧ ~ r)
D. (~ (p ↔ q) ∧ r) ∧ (p ∧ q ∧ ~ r)
Answer||| B
Solution||| Let us assume 'p' and 'q' as TRUE and 'r' as false because exactly two of 'p', 'q', and 'r' can be TRUE.
p <--> q means if both 'p' and 'q' have same values then p <--> q is TRUE. So, ((p <--> r) and r) evaluates to be FALSE. Therefore, ~((p <--> r) and r) is TRUE.
Here, two sub- expressions are connected via OR operator and one of the sub-expression is TRUE. So, the complete expression becomes TRUE. Therefore, option B. is TRUE.

64. Given the following schema:
employees (emp-id, first-name, last-name, hire-date, dept-id, salary)
departments(dept-id, dept-name, manager-id, location-id)
You want to display the last names and hire dates of all latest hires in their respective departments in the location ID 1700. You issue the following query:

SQL>SELECT last-name, hire-date
FROM employees
WHERE (dept-id, hire-date) IN
(SELECT dept-id, MAX(hire-date)
FROM employees JOIN departments USING(dept-id)
WHERE location-id = 1700
GROUP BY dept-id);
What is the outcome?
A. It executes but does not give the correct result.
B. It executes and gives the correct result.
C. It generates an error because of pair wise comparison.
D. It generates an error because the GROUP BY clause cannot be used with table joins in a sub query.
Answer||| B
Solution||| The given query uses below inner query,
SELECT dept-id, MAX (hire-date)
FROM employees JOIN departments USING (dept-id)
WHERE location-id = 1700
GROUP BY dept-id
The inner query produces last max hire-date in every department located at location id 1700. The outer query simply picks all pairs of inner query. Therefore, the query produces correct result.
SELECT last-name, hire-date
FROM employees
WHERE (dept-id, hire-date) IN
(Inner-Query);
Thus it executes and gives the correct result.

65. Consider two processors P_1 and P_2 executing the same instruction set. Assume that under identical conditions, for the same input, a program running on P_2 takes 25% less time but incurs 20% more CPI (clock cycles per instruction) as compared to the program running on P_1. If the clock frequency of P_1 is 1GHz, then the clock frequency of P_2 (in GHz) is _____.
A. 1.2
B. 1.3
C. 1.5
D. 1.6
Answer||| D
Solution||| 1 cycle time for p1 = 10^9/1GH
= 1 n.s
Assume p1 takes 5 cycles for a program then p2 lakes 20% more means, 6 cycles. p2 Takes 25% less time means, if p1 takes 5 n.s, then p2 takes 3.75 n.s.
Assume p2 clock frequency is x GHz.
p2 taken 6 cycles, so $(6*10^9)/(xGH) = 3.75$. i.e. x = 1.6

66. Choose the most appropriate phrase from the options given below to complete the following sentence.
India is a post-colonial country because
A. It was a former British colony
B. Indian Information Technology professionals have colonized the world
C. India does not follow any colonial practices
D. India has helped other countries gain freedom
Answer||| A
Solution||| A country is called postcolonial if it came into existence after the colonies of the British and the Europeans were abolished and the countries then under their rule were declared independent. India was under the British colonial rule till 1947, i.e. it was a former British colony and thus is called a postcolonial country. So, A is the correct option.

67. Who _____ was coming to see us this evening?
A. you said
B. did you say
C. did you say that
D. had you said
Answer||| B
Solution||| Only B. makes sense, others don't fit.

68. Match the columns.
Column I
1) eradicate
2) distort
3) saturate
4) utilize
Column II
P) misrepresent
Q) soak completely
R) use
S) destroy utterly
A. 1:S, 2:P, 3:Q, 4:R
B. 1:P, 2:Q, 3:R, 4:S
C. 1:Q, 2:R, 3:S, 4:P
D. 1:S, 2:P, 3:R, 4:Q
Answer||| A
Solution|||"eradicate" means "destroy utterly"
"disort" matches with "misrepresent"
"saturate" matches with "soak completely"
"utilize" matches with "use"

69. What is the average of all multiples of 10 from 2 to 198?
A. 90 B. 100
C. 110 D. 120
Answer||| B
Solution||| From 2 to 198 there are 19 multiples of 10. These are 10, 20, 30.....180, 190.
This is an A.P series, whose sum is (n/2{a1 + aN}), where a1 and aN are the 1st and last terms respectively and total number of multiples are,
Total number ⇒ aN = a + (n-1)d
190 = 10 + (n-1)*10
180 = (n-1)*10
18 = n-1
n = 19
Now, a1 = 10, aN = 190
Sum ⇒ Sn = (19/2{10 + 190 }) = 1900
Average = Sum / Total number = 1900 / 19 = 100.

70. The value of $\sqrt{12+\sqrt{12+\sqrt{12+\ldots}}}$
A. 3.464 B. 3.932 C. 4.000 D. 4.444
Answer||| C
Solution|||
Let us take x = $\sqrt{12+\sqrt{12+\sqrt{12+\ldots}}}$. Now squaring both sides,
$x^2 = 12 + x$
$x^2 - x - 12 = 0$

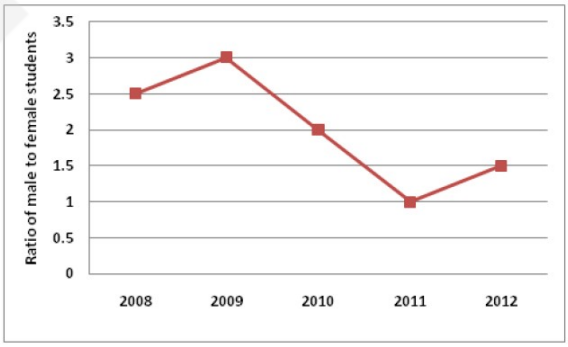
Now solve this quadratic equation for finding the roots(value of x, or this expression).
(x-4) (x+3) = 0
i.e. x = 4

71. The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?
A. Kaliningrad was historically Russian in its ethnic make up
B. Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia
C. Koenigsberg was renamed Kaliningrad, as that was its original Russian name
D. Poland and Lithuania are on the route from Kaliningrad to the rest of Russia
Answer||| B
Solution||| Option A is incorrect because First line says that Kaliningrad (Koenigsberg before war) had a majority of the German population before the war. So, it was historically German and not Russian.
According to the passage, Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia. Thus option B is the correct answer.
C cannot be inferred from the passage as it is nowhere in the passage what the original Russian name of Koenigsberg was.
D is also not true because no data about the route is mentioned in the passage.

72. The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.
Which one of the following statements, if true, does not contradict this conclusion?
A. A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent
B. More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency
C. Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test
D. The number of people with malarial fever (also contracted from mosquito bites) has increased this year
Answer||| D
Solution|||Option A contradicts the conclusion of the municipal authorities. So, A is not the correct choice.
B is an incorrect choice because there is no data in the passage relating the reporting of cases and the efficiency of the administrative capabilities of the municipal authorities.
C is also not correct as it contradicts the conclusion of the municipal authorities.
D is the correct choice as both malarial fever and dengue fever are caused by mosquito bite. If dengue fever had increased because of some other reason other than that concluded by the municipal authorities, then there would not have been increase in the people with malarial fever. This statement supports the conclusion of the municipal authorities.

73. If x is real and $|x^2 - 2x + 3| = 11$, then possible values of $|- x^3 + x^2 - x|$ include
A. 2, 4 B. 2, 14 C. 4, 52 D. 14, 52
Answer||| D
Solution|||
By using modulus property,
$|x| = x$ when $x >= 0$
$|x| = -x$ when $x < 0$
i.e. range of a modulus function is always positive.
Now, given that $|x^2 - 2x + 3| = 11$, we can say that
$x^2 - 2x + 3 = +11$ ----------(1) and
$x^2 - 2x + 3 = -11$----------(2)
Solving 1st equation, we get real roots as 4 and -2.
Solving 2nd equation, we get imaginary roots, hence we ignore them.
Now, for equation $|- x^3 + x^2 - x|$, we put 4 and -2 in place of x.
Putting x = 4, we get $|-4^3 + 4^2-4| = |-64+16-4| = 52$
Putting x = -2 we get $|-(-2)^3 + (-2)^2 - (-2)| = 14$
So $|- x^3 + x^2 - x|$ has possible values as 52 and 14

74. The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students doubled in 2009, by what percent did the number of male students increase in 2009?



A. 120 B. 140 C. 160 D. 180
Answer||| B
Solution||| Let us assume, x represents the males and y represents the females.
In the year 2008,
x / y = 2.5 ---------- (1)
In the year 2009,
M / 2y = 3 ---------- (2)
where M is the total number of males in 2009.
Now x = 2.5y (from (1)) and M = 6y (from (2)). Hence increased number of males in 2009 is,
M - x = 6y - 2.5y = 3.5y
Now the increase in % of males = (change in no of males / initial number)*100
= (3.5y / x)*100 = (3.5 / 2.5)*100 = 140

75. At what time between 6 a.m and 7 a.m Will the minute hand and hour hand of a clock make an angle closest to 60°?
A. 6: 22 a. m

B. 6: 27 a. m
C. 6: 38 a. m
D. 6: 45 a. m
Answer||| A
Solution||| Angle by minute hand is 60 min → 360°
1 min → 360/60 = 6°
8 min → 48°
Angle → 48° with number '6' i.e Angle by hour hand is,
60 min = 30°
22 min → ((30/60)*22) = 11
Total Angle = 48 + 11 = 59°
So at 6: 22 a. m, the minute hand and hour hand of a clock make an angle closest to 60°.

76. Consider the following statements:
P : Good mobile phones are not cheap
Q : Cheap mobile phones are not good
L : P implies Q
M : Q implies P
N : P is equivalent to Q
Which one of the following about L, M, and N is CORRECT?
A. Only L is TRUE.
B. Only M is TRUE.
C. Only N is TRUE.
D. L, M and N are TRUE.
Answer||| D
Solution|||
Let a and b be two proposition, a: Good Mobile phones and b: Cheap Mobile Phones. P and Q can be written as,
P: a-->~b
Q: b-->~a
Truth Table
a b ~a ~b P Q
T T F F F F
T F F T T T
F T T F T T
F F T T T T
From the above table, it clear that P and Q are equivalent. So option D is correct option.

77. Let X and Y be finite sets and f : X → Y be a function. Which one of the following statements is TRUE?
A. For any subsets A and B of X, |f (A ∪ B)| = |f (A)| + |f (B)|
B. For any subsets A and B of X, f (A ∩ B) = f (A) ∩ f (B)
C. For any subsets A and B of X, |f (A ∩ B)| = min {|f (A)|, |f (B)|}
D. For any subsets S and T of Y, $f^{-1}(S \cap T) = f^{-1}(S) \cap f^{-1}(T)$
Answer||| D
Solution|||
Let x = {a, b, c} and y = {1, 2}. A Function f maps each element of x to 1 in y. then, f(a)=1 , f(b) =1 , f(c) =1
A = {a, b} B = {b, c}
In Option A,
| f(A u B) | = |f({a, b, c})| = 3
| f(A)|+|f(B) | = 2 + 2 = 4
LHS! = RHS.
In Option B,
f(A ∩ B) = f({b}) = { 1 }
f(A) ∩ f(B) = {1, 1} ∩ {1, 1} = {1, 1}
LHS! = RHS
In Option C,
|f(A ∩ B)| = |f({b})| = |{ 1 }| = 1
min{|f(A)|,|f(B) |} = min(2,2) = 2
LHS! = RHS
In Option D,
In a function a value can be mapped only to one value

78. Let G be a group with 15 elements. Let L be a subgroup of G. It is known that L ≠ G and that the size of L is at least 4. The size of L is _____.
A. 3 B. 5
C. 7 D. 9
Answer||| B
Solution|||
By Lagrange's theorem, the order of sub group divides the order of group.
Subgroups of G can be of order 1, 3, 5 or 15 and according to the conditions and choices, B is the right answer.

79. Which one of the following statements is TRUE about every n × n matrix with only real eigenvalues?
A. If the trace of the matrix is positive and the determinant of the matrix is negative, at least one of its eigenvalues is negative.
B. If the trace of the matrix is positive, all its eigenvalues are positive.
C. If the determinant of the matrix is positive, all its eigenvalues are positive.
D. If the product of the trace and determinant of the matrix is positive, all its eigenvalues are positive
Answer||| A
Solution||| If the trace of the matrix is positive arid the determinant of the matrix is negative then at least one of its eigen values is negative. Since determinant = product of eigen values.

80. If V_1 and V_2 are 4-dimensional subspaces of a 6-dimensional vector space V, then the smallest possible dimension of $V_1 \cap V_2$ is _____.
A. 1 B. 2
C. 3 D. 4
Answer||| B
Solution|||
Let the basis of 6-dimensional vector space be {e1, e2, e3, e4, e5, e6}. In order for V1 ∩ V2 to have smallest possible dimension V1 and V2 could be say, {e1, e2, e3, e4} and {e3, e4, e5, e6} respectively. The basis of V1 ∩ V2 would then be {e3, e4} => Smallest possible dimension = 2.

81. If $\int_0^{2\pi} |x \sin x| dx = k\pi$, then the value of k is equal to _____ .
A. 1
B. 2
C. 3
D. 4
Answer||| D
Solution|||
$$\int_0^{2\pi} |x \sin x| dx = K\pi$$

$$\Rightarrow \int_0^{\pi} x\sin x\,dx + \int_0^{2\pi} -(x\sin x)\,dx$$

$$= K\prod \left\{\frac{i.e\ |\sin x| = -\sin x\}}{\prod < x < 2\prod}\right\}$$

⇒ x(-cos x)-1(-sin x)|lim Π to 0[-(-xcos x + sin x)]|lim2Π to Π = KΠ
⇒ (-Πcos Π + sin Π)-0-[(-2Πcos 2Π + sin 2Π)−(-Πcos Π +sin Π)] = KΠ
⇒ Π + 0 − [-2Π + 0 − (Π +0)] = KΠ
⇒ 4Π = KΠ i.e K = 4

82. Consider the following min term expression for F:

$$F(P,Q,R,S) = \sum\ 0,2,5,7,8,10,13,15$$

The min terms 2, 7, 8 and 13 are 'do not care' terms. The minimal sum-of-products form for F is

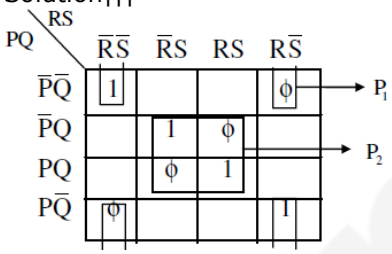
A. $Q\bar{S} + \bar{Q}S$

B. $\bar{Q}\bar{S} + QS$

C. $\bar{Q}\bar{R}\bar{S} + \bar{Q}R\bar{S} + Q\bar{R}S + QRS$

D. $\bar{P}\bar{Q}\bar{S} + \bar{P}QS + PQS + P\bar{Q}\bar{S}$

Answer||| B
Solution|||



The Karnaugh map for the function F is as follows:

P1 = Q'S' and P2 = QS

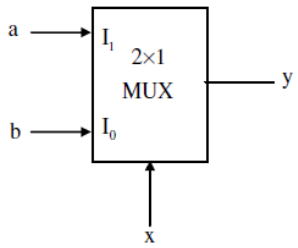
Then, F(P,Q,R,S) = P1+P2 $\left\{\begin{matrix}\bar{Q}\bar{S} + QS \\ Q'S' + QS\end{matrix}\right\}$ =

= Q'S' + QS

83. Consider the following combinational function block involving four Boolean variables x, y, a, b where x, a, b are inputs and y is the output.

```
f (x, y, a, b)
{
if (x is 1) y = a;
else y = b;
}
```

Which one of the following Digital Logicblocks is the most suitable for implementing this function?
A. Full adder
B. Priority encoder
C. Multiplexor
D. Flip-flop
Answer||| C
Solution|||



This function can be interpreted as having two inputs a, b and select signal x. Output y will depend on the select signal x. Function will be like (ax+bx') its implementation will be like as shown in fig.

84. Consider the following processors (ns stands for nanoseconds). Assume that the pipeline registers have zero latency.
P1 : Four-stage pipeline with stage latencies 1 ns, 2 ns, 2 ns, 1 ns.
P2 : Four-stage pipeline with stage latencies 1 ns, 1.5 ns, 1.5 ns, 1.5 ns.
P3 : Five-stage pipeline with stage latencies 0.5 ns, 1 ns, 1 ns, 0.6 ns, 1 ns.
P4 : Five-stage pipeline with stage latencies 0.5 ns, 0.5 ns, 1 ns, 1 ns, 1.1 ns.
Which processor has the highest peak clock frequency?
A. P1 B. P2 C. P3 D. P4
Answer||| C
Solution||| Clock period (CP) = max stage delay + overhead
So CP_{P1} = Max(1,2,2,1) = 2ns
CP_{P2} = Max(1, 1.5, 1.5, 1.5)=1.5ns
CP_{P3} = Max(0.5, 1, 1, 0.6, 1)=1ns
CP_{P4} = Max(0.5, 0.5, 1, 1, 1.1)=1.1ns
As frequency α(1/C.P) , so least clock period will give the highest peak clock frequency,
So,f_{p3} = 1/1ns = 1GHz

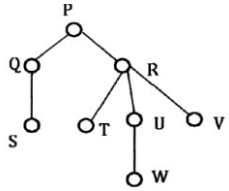
85. Let A be a square matrix of size n × n. Consider the following pseudo code. What is the expected output?

```
C = 100
for i = 1 to n do
for j = 1 to n do
{
Temp = A [i] [j] + C;
A [i] [j] = A [j] [i];
A [j] [i] = Temp – C;
}
for i = 1 to n do
for j = 1 to n do
output (A [i] [j])}
```

A. The matrix A itself
B. Transpose of the matrix A
C. Adding 100 to the upper diagonal elements and subtracting 100 from lower diagonal elements of A.
D. None of the above
Answer||| A
Solution|||If we take look at the inner statements of first loops, we can see that the statements swap A[i][j] and A[j][i] for all i and j. Since the loop runs for all elements, every element A[l][m] would be swapped twice, once for i = l and j = m and then for i = m and j = l. Swapping twice means the matrix doesn't change

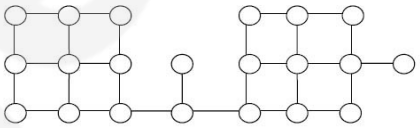
86. The minimum number of arithmetic operations required to evaluate the polynomial $P(X) = X^5 + 4X^3 + 6X + 5$ for a given value of X, using only one temporary variable is _____.
A. 6 B. 7
C. 8 D. 9
Answer||| B
Solution||| $P(X) = x^5 + 4x^3 + 6x + 5$
$= x(x^4 + 4x^2 + 6) + 5$
$= x(x(x^3 + 4x) + 6) + 5$
$= x(x(x(x^2 + 4)) + 6) + 5$
$= x(x(x(x) + 4)) + 6) + 5$
Let T be a temporary variable to store intermediate results.
1) T = (x) * (x)
2) T = T + 4
3) T = (x) * (T)
4) T = (x) * (T)
5) T = T + 6
6) T = (x) * T
7) T = T + 5
Thus, we need 7 operations if we are to use only one temporary variable.

87. Consider the following rooted tree with the vertex labeled P as the root:

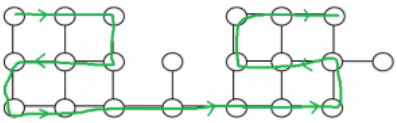


The order in which the nodes are visited during an in-order traversal of the tree is
A. SQPTRWUV
B. SQPTUWRV
C. SQPTWUVR
D. SQPTRUWV
Answer||| A
Solution||| Algorithm In order (tree) - Use of Recursion.
Steps:
1) Traverse the left sub tree, i.e., call In order (left-sub tree)
2) Visit the root.
3) Traverse the right sub tree, i.e., call In order(right-sub tree)
We begin in the above tree with root as the starting point, which is P.
Step 1(for node P):
Traverse the left sub tree of node or root P. So we have node Q on left of P.
-> Step 1(for node Q)
Traverse the left subtree of node Q. So we have node S on left of Q.
* Step 1 (for node S)
Now again traverse the left sub tree of node S which is NULL here.
* Step 2(for node S)
Visit the node S, i.e print node S as the 1st element of in order traversal.
* Step 3(for node S)
Traverse the right sub tree of node S which is NULL here.
Now move up in the tree to Q which is parent of S.(Recursion, function of Q called for function of S). Hence we go back to Q.
-> Step 2(for node Q):
Visit the node Q, i.e print node Q as the 2nd element of in order traversal.
-> Step 3 (for node Q)
Traverse the right sub tree of node Q which is NULL here.
Now move up in the tree to P which is parent of Q. (Recursion, function of P called for function of Q). Hence we go back to P.
Step 2(for node P)
Visit the node P, i.e print node S as the 3r element of in order traversal.
Step 3 (for node P)
Traverse the right sub tree of node P. Node R is at the right of P.
Till now we have printed SQP as the in order of the tree. Similarly other elements can be obtained by traversing the right sub tree of P. The final correct order of In order traversal would be SQPTRWUV.

88. Suppose depth first search is executed on the graph below starting at some unknown vertex. Assume that a recursive call to visit a vertex is made only after first checking that the vertex has not been visited earlier. Then the maximum possible recursion depth (including the initial call) is _____.



A. 17
B. 18
C. 19
D. 20
Answer||| C
Solution||| The following diagram shows the worst case situation where the recursion tree



has maximum depth. So the recursion depth is 19 (including the first node).

89. You have an array of *n* elements. Suppose you implement quicksort by always choosing the central element of the array as the pivot. Then the tightest upper bound for the worst case performance is
A. $O(n^2)$ B. $O(n \log n)$
C. $\Theta(n \log n)$ D. $O(n^3)$
Answer||| A
Solution||| The Worst case time complexity of quick sort is $O(n^2)$. This will happen when the elements of the input array are already in order (ascending or descending), irrespective of position of pivot element in array.
90. The length of the shortest string NOT in the language (over $\Sigma = \{a, b\}$) of the following regular expression is _____.
$a*b*(ba)*a*$
A. 2 B. 3
C. 4 D. 5
Answer||| B

Solution||| R.E=a* b*(ba)*a*
Length 0 is present as it accepts € all length 1, strings are present (a, b) also aa, ab, ba, bb are present, But 'bab' is not present. So it is 3.

91. Let Σ be a finite non-empty alphabet and let 2^{Σ^*} be the power set of Σ*. Which one of the following is TRUE?
A. Both 2^{Σ^*} and Σ* are countable
B. 2^{Σ^*} is countable and Σ* is uncountable
C. 2^{Σ^*} is uncountable and Σ* is countable
D. Both 2^{Σ^*} and Σ* are uncountable
Answer||| C
Solution||| 2^{Σ^*} is the power set of Σ*
Σ* is count ably infinite.
The power set of count ably infinite set is uncountable.
So 2^{Σ^*} is uncountable, and Σ* is countable.

92. One of the purposes of using intermediate code in compilers is to
A. Make parsing and semantic analysis simpler.
B. Improve error recovery and error reporting.
C. Increase the chances of reusing the machine-independent code optimizer in other compilers.
D. Improve the register allocation.
Answer||| C
Solution||| After semantic Analysis, the code is converted into intermediate code which is language independent; the advantage of converting into intermediate code is to improve the performance of code generation and to increase the chances of reusing the machine-independent code optimizer in other compilers.

93. Which of the following statements are CORRECT?
1) Static allocation of all data areas by a compiler makes it impossible to implement recursion.
2) Automatic garbage collection is essential to implement recursion.
3) Dynamic allocation of activation records is essential to implement recursion.
4) Both heap and stack are essential to implement recursion.
A. 1 and 2 only B. 2 and 3 only
C. 3 and 4 only D. 1 and 3 only
Answer||| D
Solution||| 1) Static allocation of all data areas by a compiler makes it impossible to implement recursion. True, dynamic allocate of memory is required for function call stack as number of calls is not known advance for recursive functions.
2) Automatic garbage collection is essential to implement recursion. False, Automatic garbage collection is not essential.
3) Dynamic allocation of activation records is essential to implement recursion. True, as number of calls or number of activation records is not known advance for recursive functions.
4) Both heap and stack are essential to implement recursion. Heap is not needed for function calls. It is generally used for dynamic memory allocation by user (or programmer).

95. A system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (LRU) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?
4, 7, 6, 1, 7, 6, 1, 2, 7, 2
A. 4 B. 5
C. 6 D. 7
Answer||| C
Solution|||
What is a Page fault? An interrupt that occurs when a program requests data that is not currently in real memory. The interrupt triggers the operating system to fetch the data from a virtual memory and load it into RAM. Now, 4, 7, 6, 1, 7, 6, 1, 2, 7, 2 is the reference string, you can think of it as data requests made by a program. Now the system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (LRU) page replacement policy.
[ ] - Initially page frames are empty. i.e. no process pages in main memory.
[4] - Now 4 is brought into 1st frame (1st page fault)
Explanation: Process page 4 was requested by the program, but it was not in the main memory (in form of page frames), which resulted in a page fault, after that process page 4 was brought in the main memory by the operating system.
[4 7] - Now 7 is brought into 2nd frame (2nd page fault) - Same explanation.
[4 7 6] - Now 6 is brought into 3rd frame (3rd page fault)
[1 7 6] - Now 1 is brought into 1st frame, as 1st frame was least recently used (4th page fault). After this 7, 6 and 1 are were already present in the frames hence no replacements in pages.
[1 2 6] - Now 2 is brought into 2nd frame, as 2nd frame was least recently used (5th page fault).
[1 2 7] -Now 7 is brought into 3rd frame, as 3rd frame was least recently used (6th page fault).
Hence, total number of page faults(also called pf) are 6.
Therefore, C is the answer.

96. What is the optimized version of the relation algebra expression $\pi_{A1}(\pi_{A2}(\sigma_{F1}(\sigma_{F2}(r))))$, where A1, A2 are sets of attributes in r with A1 ⊂ A2 and F1, F2 are Boolean expressions based on the attributes in r?
A. $\pi_{A1}(\sigma_{(F1 \wedge F2)}(r))$
B. $\pi_{A1}(\sigma_{(F1 \vee F2)}(r))$
C. $\pi_{A2}(\sigma_{(F1 \wedge F2)}(r))$
D. $\pi_{A2}(\sigma_{(F1 \vee F2)}(r))$
Answer||| A
Solution||| The Relational Algebra expression in the question above does 4 operations step by step (innermost braces first),
1) Select those tuples from relation r which satisfies expression/condition F1, say the result of this operation is set A.
2) Select those tuples from set A which satisfies expression/condition F2, say the result of this operation is set B.

3) Select attributes set A2 from set B, say the result of this operation is set C.
4) Select attributes set A1 from set C, say the result is set D which is the final result.
Now to optimize this expression, we can combine steps 1 and 2 by AND operator between F1 and F2 condition, like F1 ^ F2, and instead of selecting first attribute set A2, we can directly select attribute set A1 from the result of the combined operation, which is represented by expression in Option (A)

97. A prime attribute of a relation scheme R is an attribute that appears
A. In all candidate keys of R.
B. In some candidate key of R.
C. In a foreign key of R.
D. Only in the primary key of R.
Answer||| B
Solution|||The constituent attributes of a Candidate key or simply the attributes of a candidate key are called the prime attributes. Suppose ABC is one candidate key of a Relation R (ABCDEFGH). Then the attributes A, B and C all are prime attributes. Similarly if ABD is also another candidate key in the same relation R, then D is also the prime attribute. And conversely, an attribute that does not occur in ANY candidate key is called a non-prime attribute

98. In the following pairs of OSI protocol layer/sub-layer and its functionality, the INCORRECT pair is
A. Network layer and Routing
B. Data Link Layer and Bit synchronization
C. Transport layer and End-to-end process communication
D. Medium Access Control sub-layer and Channel sharing
Answer||| B
Solution||| Option A) Yes, Network layer does Routing.
Option B) No, Bit synchronization is provided by Physical Layer.
Option C) Yes, Transport layer provides End-to-end process communication.
Option D) Yes, Medium Access Control sub-layer of Data Link Layer provides channel sharing.

99. A bit-stuffing based framing protocol uses an 8-bit delimiter pattern of 01111110. If the output bit-string after stuffing is 01111100101, then the input bit-string is
A. 0111110100 B. 0111110101
C. 0111111101 D. 0111111111
Answer||| B
Solution|||
Here the 8-bit delimiter pattern is 01111110.
The output bit-string after stuffing is 01111100101.
The above highlighted bit is stuffed bit.
So input bit string must be 0111110101.
100. Host A (on TCP/IP v4 network A) sends an IP datagram D to host B (also on TCP/IP v4 network B). Assume that no error occurred during the transmission of D. When D reaches B, which of the following IP header field(s) may be different from that of the original datagram D?
(i) TTL (ii) Checksum (iii) Fragment Offset
A. (i) only
B. (i) and (ii) only
C. (ii) and (iii) only
D. (i), (ii) and (iii)
Answer ||| D
Solution||| All (i), (ii) and (iii) are changed.
TTL is decremented at every hop. So TTL is different from original value.
Since TTL changes, the Checksum of the packet also changes.
A packet is fragmented if it has a size greater than the maximum transmission Unit (MTU) of the network. There may be intermediate networks that may change fragment offset by fragmenting the packet.

101. An IP router implementing Classless Inter-domain Routing (CIDR) receives a packet with address 131.23.151.76. The router's routing table has the following entries:

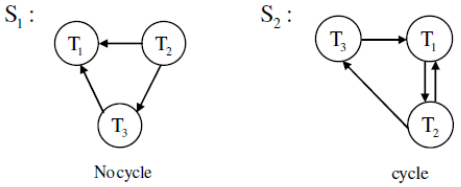
Prefix	Output Interface I Identifier
131.16.0.0/12	3
131.28.0.0/14	5
131.19.0.0/16	2
131.22.0.0/15	1

The identifier of the output interface on which this packet will be forwarded is `_____.
A. 1 B. 2
C. 3 D. 5
Answer||| A
Solution|||
Given address 131.23.151.76 coming to the first field of given routing table,
→ 131.16.0.0/12
131.0001 0111.151.76
131.0001 0000.0.0 (given mask bits = 12)
131.16.0.0 Matched
Coming to the 2nd field of given Routing table
→ 131.28.0.0/14
131.0001 0111.151.76
131.0001 0100.0.0 (given mask bits = 14)
131.20.0.0 Not matched.
Coming to the 3rd field of given Routing table
→ Error! Not a valid link. 131.19.0.0/16
131.0001 0111.151.76
131.0001 0111.0.0 (given mask bits = 16)
131.23.0.0 Not matched
Coming to the 4th field of given Routing table
→ 131.22.0.0/15
131.0001 0111.151.76
131.0001 0110.0.0 (given mask bits = 15)
131.22.0.0 Matched
We are getting 1st and 4th entries are matched so among them we have to picked up the longest mask bit, so output interface identifier is 1.
102. Every host in an IPv4 network has a 1-second resolution real-time clock with battery backup. Each host needs to generate up to 1000 unique identifiers per second. Assume that each host has a globally unique IPv4 address. Design a 50-bit globally unique ID for this purpose. After what period (in seconds) will the identifiers generated by a host wrap around?
A. 128 B. 64
C. 256 D. 512

Answer||| C
Solution|||
Given that each host has a globally unique IPv4 address and we have to design 50 - bit unique Id. So, 50 - bit in the sense (32 + 18). It is clearly showing that IP address (32 - bit) followed by 18 bits.
1000 unique Ids => 1 second
2^{18} unique Ids => $2^{18}/1000 = 2^8 = 256$

103. An IP router with a Maximum Transmission Unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet are
A. MF bit: 0, Datagram Length: 1444; Offset: 370
B. MF bit: 1, Datagram Length: 1424; Offset: 185
C. MF bit: 1, Datagram Length: 1500; Offset: 370
D. MF bit: 0, Datagram Length: 1424; Offset: 2960
Answer||| A
Solution|||Number of packet fragments = ⌈ (total size of packet)/(MTU) ⌉
= ⌈ 4404/1500 ⌉
= ⌈ 2.936 ⌉
= 3
So Datagram with data 4404 byte fragmented into 3 fragments. The first frame carries bytes 0 to 1479 (because MTU is 1500 bytes and HLEN is 20 byte so the total bytes in fragments is maximum 1500-20=1478). The offset for this datagram is 0/8 = 0. The second fragment carries byte 1480 to 2959. The offset for this datagram is 1480/8 = 185. Finally the third fragment carries byte 2960 to 4404. The offset is 370 and for all fragments except last one the M bit is 1. So in the third bit M is 0.

104. Consider the transactions T1, T2, and T3 and the schedules S1 and S2 given below:
T1: r1(X); r1(Z); w1(X); w1(Z)
T2: r2(Y); r2(Z); w2(Z)
T3: r3(Y); r3(X); w3(Y)
S1:r1(X);r3(Y);r3(X);r2(Y);r2(Z);w3(Y);w2(Z);r1(Z);w1(X);w1(Z)
S2:r1(X);r3(Y);r2(Y);r3(X);r1(Z);r2(Z);w3(Y);w1(X);w2(Z);w1(Z)
Which one of the following statements about the schedules is TRUE?
A. Only S1 is conflict-serializable.
B. Only S2 is conflict-serializable.
C. Both S1 and S2 are conflict-serializable.
D. Neither S1 nor S2 is conflict-serializable.
Answer||| A
Solution|||
For conflict serializability of a schedule(which gives same effect as a serial schedule) we should check for conflict operations, which are Read-Write, Write-Read and Write-Write between each pair of transactions, and based on those conflicts we make a precedence graph, if the graph contains a cycle, it's not a conflict serializable schedule.
Precedence graph for S1 and S2 are as follows:



No cycle cycle

From these graphs, it is clear that S1 is conflict-serializable.

105. Consider the relational schema given below, where eId of the relation dependent is a foreign key referring to empId of the relation employee. Assume that every employee has at least one associated dependent in the dependent relation.
employee (empId, empName, empAge)
dependent(depId, eId, depName, depAge)
Consider the following relational algebra query:
$\Pi_{empId}(employee) - \Pi_{empId}(employee \bowtie_{(empId = eID) \wedge (empAge \leq depAge)} dependent)$
The above query evaluates to the set of empIds of employees whose age is greater than that of
A. Some dependent.
B. All dependents.
C. Some of his/her dependents.
D. All of his/her dependents.
Answer||| D
Solution|||The below sub query after the subtraction sign produces id's of those employees who have at least one dependent with age greater than or equal the employee's age.

$$\Pi_{empId}(employee \bowtie_{(empId = eID) \wedge (empAge \leq depAge)} dependent)$$

When the result of above sub query is subtracted from all employees, we get the employees whose age is greater than all dependents.

106. A system contains three programs and each requires three tape units for its operation. The minimum number of tape units which the system must have such that deadlocks never arise is _____.
A. 6 B. 7
C. 8 D. 9
Answer||| B
Solution|||

	Maximum	Allocate	Need	Available
P_1	3	2	1	1
P_2	3	2	1	
P_3	3	2	1	

With the above given data, after allocating 2 units of tape to each process, with 1 available unit any of the 3 process can be satisfied in such a way that no dead lock will be there. So answer is 7 tape units.

107. An operating system uses shortest remaining time first scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

Process	Arrival Time	Burst Time
P1	0	12
P2	2	4
P3	3	6
P4	8	5

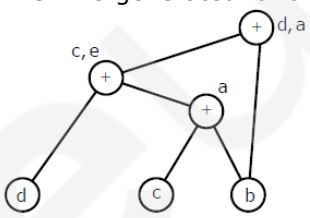
The average waiting time (in milliseconds) of the processes is _____.
A. 4.5
B. 5.0
C. 5.5
D. 6.5
Answer||| C
Solution||| The Burst Time is the total time needed by a process from the CPU for its complete execution. And Waiting Time is how much time processes spend in the ready queue waiting their turn to get on the CPU Now,
The Gantt chart for the above processes is :

P_1	P_2	P_3	P_4	P_5
0	2	6	12	17	27

Process p1 arrived at time 0, hence cpu started executing it. After 2 units of time P2 arrives and burst time of P2 was 4 units, and the remaining time of the process p1 was 10 units,hence cpu started executing P2, putting P1 in waiting state(Pre-emptive and Shortest remaining time first scheduling). Due to P1's highest remaining time it was executed by the cpu in the end.
Now calculating the waiting time of each process:
P1 -> 17 -2 = 15
P2 -> 0
P3 -> 6 - 3 = 3
P4 -> 12 - 8 = 4
Hence total waiting time of all the processes is
= 15 + 0 + 3 + 4=22
Total no of processes = 4
Average waiting time = 22 / 4 = 5.5
Thus C is the answer.

108. Consider a paging hardware with a TLB. Assume that the entire page table and all the pages are in the physical memory. It takes 10 milliseconds to search the TLB and 80 milliseconds to access the physical memory. If the TLB hit ratio is 0.6, the effective memory access time (in milliseconds) is _____.
A. 118 B. 120
C. 122 D. 124
Answer||| C
Solution||| $T_{ave} = H_1 \times (T_{TLB} + T_M) + (1-H_1) \times (T_{TLB} + 2 \times T_M)$
T_{TLB} = time to search in TLB = l0 ms
T_M = time to access physical memory = 30 ms
H_1 = TLB hit ratio = 0.6
T_{ave} = 0.6 x (I0+80) + (1 - 0.6) (10 + 2 x 80)
T_{ave} = 0.6 x90ms + 0.4(170)ms
T_{ave} = 54ms + 68ms = 122ms

109. Consider the basic block given below.
a = b + c
c = a + d
d = b + c
e = d – b
a = e + b
The minimum number of nodes and edges present in the DAG representation of the above basic block respectively are
A. 6 and 6 B. 8 and 10 C. 9 and 12 D. 4 and 4
Answer||| A
Solution||| The given basic block can be rewritten as
a=b+c a=b+c
c=a+d c=b+c+d
d=b+c ⇒ d=b+b+c+d = 2b+c+d
e=d-b e=b+b+c+d-b = b+c+d
a=e+b a =b+b+c+d = 2b+c+d
From above simplification it is visible that e is same as c and final value of a is same as d. So the final basic block can be written as follows:
a=b+c
c=a+d
d=2b+c+d
e=c
a=d
The DAG generated for the above basic block in as ,



Thus, the given DAG has 6 nodes and 6 edges.

110. Which one of the following problems is undecidable?
A. Deciding if a given context-free grammar is ambiguous.
B. Deciding if a given string is generated by a given context-free grammar.
C. Deciding if the language generated by a given context-free grammar is empty.
D. Deciding if the language generated by a given context-free grammar is finite.
Answer||| A
Solution||| Context free grammar is not closed under ambiguity. A set is closed under an operation means when we operate an element of that set with that operator we get an element from that set. Here, context free grammar generates a context free language and set of all context free languages is also a set. But, ambiguity is not an operation and hence we can never say that CFG is closed under ambiguity. Thus, problem mentioned in option (A) is undecidable.

111. Consider the following languages over the alphabet Σ = {0,1, c}:
$L_1 = \{0^n1^n \mid n \geq 0\}$
$L_2 = \{wcw^r \mid w \in \{0,1\}*\}$
$L_3 = \{ww^r \mid w \in \{0,1\}*\}$
Here, w^r is the reverse of the string w. Which of these languages are deterministic Context-free languages?
A. None of the languages
B. Only L_1
C. Only L_1 and L_2
D. All the three languages
Answer||| C
Solution||| For the languages L_1 and L_2, we can have deterministic push down automata, so they are DCFL's,

but for L_3 only non-deterministic PDA possible. So the language L_3 is not a deterministic CFL.

112. Suppose you want to move from 0 to 100 on the number line. In each step, you either move right by a unit distance or you take a shortcut. A shortcut is simply a pre-specified pair of integers i, j with i < j. Given a shortcut i, j if you are at position i on the number line, you may directly move to j. Suppose T(k) denotes the smallest number of steps needed to move from k to 100. Suppose further that there is at most 1 shortcut involving any number, and in particular from 9 there is a shortcut to 15. Let y and z be such that T(9) = 1 + min(T(y), T(z)). Then the value of the product yz is _____.
A. 50 B. 100
C. 150 D. 200
Answer||| C
Solution||| T(k) is the smallest number of steps needed to move from k to 100.
Now, it is given that 'y' and 'z' are two numbers such that T(9) = 1 + min (T(y), T(z))
T(9) = 1 + min (Steps from y to 100, Steps from z to 100), where 'y' and 'z' are two possible values that can be reached from 9.
One number that can be reached from 9 is 10, which is the number obtained if we simply move one position right on the number line. Another number is 15, the shortcut path from 9, as given in the question. So, we have two paths from 9, one is 10 and the other is 15. Therefore, the value of y and z is 10 and 15 (either variable may take either of the values). Thus, yz = 150.

113. Consider the decision problem 2CNFSAT defined as follows:
{| φ is a satisfiable propositional formula in CNF with at most two literals per clause}
For example,
$\varphi = (x1 \vee x2) \wedge$ [illegible] $\wedge$ [illegible] is a Boolean formula and it is in 2CNFSAT.
The decision problem 2CNFSAT is
A. NP-Complete.
B. Solvable in polynomial time by reduction to directed graph reachability.
C. Solvable in constant time since any input instance is satisfiable.
D. NP-hard, but not NP-complete.
Answer||| B
Solution||| 2 SAT is in P. This we can prove by reducing 2 SAT to directed graph reachability problem which is known to be in P.

114. Suppose we have a balanced binary search tree T holding n numbers. We are given two numbers L and H and wish to sum up all the numbers in T that lie between L and H. Suppose there are m such numbers in T. If the tightest upper bound on the time to compute the sum is O(na logb n + mc logd n), the value of a + 10b + 100c + 1000d is _____.
A. 60
B. 110
C. 160
D. 210
Answer||| B
Solution||| It takes (log n) time to determine numbers n1 and n2 in balanced binary search tree T such that,
1) n1 is the smallest number greater than or equal to L and there is no predecessor n'1 of n1 such that n'1 is equal to n1
2) n2 is the largest number less than or equal to H and there is no successor of n'2 of n2 such that is equal to n2
Since there are m elements between n1 and n2, it takes 'm' time to add all elements between n1 and n2.
So time complexity is O(logn + m)
So the given expression becomes $O(n^0 \log n + m \log^0 n)$
And a + 10b + 100c + 1000d = 0 + 10*1 + 100*1 + 1000*1 = 10 + 100 = 110
Because a = 0, b = 1, c = 1 and d = 0

115. Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?
A. (97 × 97 × 97)/1003
B. (99 × 98 × 97)/1003
C. (97 × 96 × 95)/1003
D. (97 × 96 × 95)/(3! × 1003)
Answer||| A
Solution||| Simple Uniform hashing function is a hypothetical hashing function that evenly distributes items into the slots of a hash table. Moreover, each item to be hashed has an equal probability of being placed into a slot, regardless of the other elements already placed.
Probability that the first 3 slots are unfilled after the first 3 insertions =
{(probability that first item doesn't go in any of the first 3 slots)*
(probability that second item doesn't go in any of the first 3 slots)*
(probability that third item doesn't go in any of the first 3 slots)}
= {(97C1/100C1) * (97C1/100C1) * (97C1/100C1)
= {(97/100) * (97/100) * (97/100)}
= (97 × 97 × 97)/1003

116. Consider the pseudocode given below. The function DoSomething ( ) takes as argument a pointer to the root of an arbitrary tree represented by the leftMostChild-rightSibling representation.
Each node of the tree is of type treeNode.

```
typedef struct treeNode* treeptr;
struct treeNode
{
 treeptr leftMostChild, rightSibling;
};
int DoSomething (treeptr tree)
{
 int value=0;
 if (tree != NULL) {
 if (tree->leftMostChild == NULL)
 value = 1;
 else
 value = DoSomething(tree->leftMostChild);
 value = value + DoSomething(tree->rightSibling);
 }
 return(value);
}
```

When the pointer to the root of a tree is passed as the argument to DoSomething, the value returned by the function corresponds to the
A. Number of internal nodes in the tree.
B. Height of the tree.
C. Number of nodes without a right sibling in the tree.
D. Number of leaf nodes in the tree.
Answer||| D
Solution||| The key to solving such questions is to understand or detect where/by what condition the value (or the counter) is getting incremented each time.
Here, that condition is if (tree → left Most chiid == Null)
→ Which means if there is no left most child of the tree (or the sub tree or the current node as called in recursion)
→ Which means there is no child of that particular node (since if there is no left most child, there is no child at all).
→ Which means the node under consideration is a leaf node.
→ The function recursively counts, and adds to value, whenever a leaf node is encountered.
→ The function returns the number of leaf nodes in the tree.

117. Consider the C function given below. Assume that the array listA contains n (> 0) elements, sorted in ascending order.

```
int ProcessArray(int *listA, int x, int n)
{
int i, j, k;
i = 0;
j = n-1;
do {
k = (i+j)/2;
if (x <= listA[k])
j = k-1;
if (listA[k] <= x)
i = k+1;
}while (i <= j);
if (listA[k] == x)
return(k);
else
return -1;
}
```

Which one of the following statements about the function ProcessArray is CORRECT?
A. It will run into an infinite loop when x is not in listA.
B. It is an implementation of binary search.
C. It will always find the maximum element in listA.
D. It will return -1 even when x is present in listA.
Answer||| B
Solution||| By the logic of the algorithm it is clear that it is an attempted implementation of Binary Search. So we can eliminate option (C). Let us now check for options A and (D). A good way to do this is to create small dummy examples (arrays) and implement the algorithm as it is. One may make any array of choice. Running iterations of the algorithm would indicate that the loop exits when the x is not present. So option A is wrong. Also, when x is present, the correct index is indeed returned. D is also wrong. Correct answer is B. It is a correct implementation of Binary Search.

118. An instruction pipeline has five stages, namely, instruction fetch (IF), instruction decode and register fetch (ID/RF), instruction execution (EX), memory access (MEM), and register writeback (WB) with stage latencies 1 ns, 2.2 ns, 2 ns, 1 ns, and 0.75 ns, respectively (ns stands for nanoseconds). To gain in terms of frequency, the designers have decided to split the ID/RF stage into three stages (ID, RF1, RF2) each of latency 2.2/3 ns. Also, the EX stage is split into two stages (EX1, EX2) each of latency 1 ns. The new design has a total of eight pipeline stages. A program has 20% branch instructions which execute in the EX stage and produce the next instruction pointer at the end of the EX stage in the old design and at the end of the EX2 stage in the new design. The IF stage stalls after fetching a branch instruction until the next instruction pointer is computed. All instructions other than the branch instruction have an average CPI of one in both the designs. The execution times of this program on the old and the new design are P and Q nanoseconds, respectively. The value of P/Q is _____.
A. 1.5 B. 1.4
C. 1.8 D. 2.3
Answer||| A
Solution|||

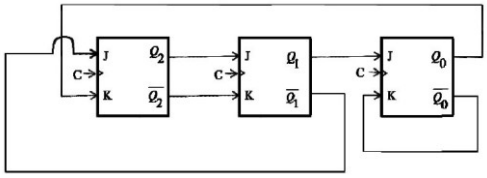
	No. of stages	Stall cycle	Stall frequency	Clock Period	Average access time
Old design	5	2	20%	2.2 ns	P
New design	8	5	20%	1 ns	Q

$P = [80\%(1 \text{ clock}) + 20\%(1_{(\text{completion})} + 2_{(\text{stall clock})})] \times T_{c\text{-}p}$
$P = (.8 + .6) \times 2.2\text{ns} = 3.08 \text{ ns}$
$Q = [80\%(1 \text{ clock}) + 20\%(1_{(\text{completion})} + 5_{(\text{stall clock})})] \times T_{c\text{-}p}$
$P = (.8 + .12) \times 1 \text{ ns} = 2 \text{ ns}$
So the value of P/Q = 3.08 ns/ 2 ns = 1.54

119. The memory access time is 1 nanosecond for a read operation with a hit in cache, 5 nanoseconds for a read operation with a miss in cache, 2 nanoseconds for a write operation with a hit in cache and 10 nanoseconds for a write operation with a miss in cache. Execution of a sequence of instructions involves 100 instruction fetch operations, 60 memory operand read operations and 40 memory operand write operations. The cache hit-ratio is 0.9. The average memory access time (in nanoseconds) in executing the sequence of instructions is _____.
A. 1.26 B. 1.68
C. 2.48 D. 4.56
Answer||| B
Solution||| The question is to find the time taken for "100 fetch operation and 60 operand red operations and 40 memory operand write operations"/"total number of instructions"
Total number of instructions= 100 + 60 + 40 = 200
Time taken for 100 fetch operations (fetch =read)
= 100*((0.9*1) + (0.1*5)) // 1 corresponds to time taken for read
// when there is cache hit
= 140 ns //0.9 is cache hit rate

Time taken for 60 read operations = 60*((0.9*1) + (0.1*5)) = 84ns
Time taken for 40 write operations = 40*((0.9*2) + (0.1*10)) = 112 ns
// Here 2 and 10 the time taken for write when there is cache
// hit and no cache hit respectively
So, the total time taken for 200 operations is = 140 + 84 + 112 = 336ns
Average time taken = time taken per operation = 336/200 = 1.68 ns

120.



The above synchronous sequential circuit built using JK flip-flops is initialized with Q2Q1Q0 = 000. The state sequence for this circuit for the next 3 clock cycles is
A. 001, 010, 011
B. 111, 110, 101
C. 100, 110, 111
D. 100, 011, 001
Answer||| C
Solution|||
JK ff truth table

j	k	Q
0	0	Q0
1	0	1
0	1	0
1	1	Q0′

Initially Q2Q1Q0=000 Present state FF input Next state

Q2	Q1	Q0	J2	K2	J1	K1	J0	K0	Q2	Q1	Q0
0	0	0	1	0	0	1	0	1	1	0	0
1	0	0	1	0	1	0	0	1	1	1	0
1	1	0	0	0	1	0	1	1	1	1	1

So answer is C

121. With respect to the numerical evaluation of the

$$K = \int_a^b x^2 dx,$$

definite integral, where a and b are given, which of the following statements is/are TRUE?
(I) The value of K obtained using the trapezoidal rule is always greater than or equal to the exact value of the definite integral.
(II) The value of K obtained using the Simpson's rule is always equal to the exact value of the definite integral.
A. I only
B. II only
C. Both I and II
D. Neither I nor II
Answer||| C
Solution||| let a=0, b=1 and n=4
h = (b-a)/n = (1-0)/4 = 0.25

x	0	0.25	0.5	0.75	1
$y=x^2$	0	0.625	0.25	0.5625	1
	y_0	y_1	y_2	y_3	y_4

I. By Trapezoidal rule,
→ = h/2[(y_0+y_4)+2(y,+y_2+y_3)]
= 0.25/2[(0+1) + 2(0.0625 + 0.25 + 0.5625)]=0.34375
II. By Simpson's rule
→ = h/3[(y_0+y_4) + 2(y_2) + 4(y_1+y_3)]
= 0.25/3[(0+1) + 2(0.25) + 4(0.0615 + 0.5625)] = 1/3

122. The value of the integral given below is

$$\int_0^{\pi} x^2 \cos x dx$$

A. -2π B. π C. $-\pi$ D. 2π
Answer||| A
Solution|||

$$\int_0^{\pi} x^2 \cos x dx$$

⇒ x^2(sin x) - 2x(-cos x) + 2(-sin x)
⇒ (Π^2 sin Π + 2Πcos Π - 2sin Π) – (0 + 0 + 0) = -2Π

123. Let S be a sample space and two mutually exclusive events A and B be such that $A \cup B$ =S. If P(.) denotes the probability of the event, the maximum value of P(A)P(B) is _____.
A. 0.25 B. 0.5 C. 0.225 D. 0.125
Answer||| A
Solution|||
Given A∪B=S,
→ P(A∪B) =P(S)=1
→ P(A) + P(B) = 1 {A & B are mutually exclusive}
→ P(B) = 1-P(A)
Maximum value of P(A) P(B) = ?
Maximum value of P A. [1 - P(A)] = ?
Let PA. = X
Let f(x) = x(1-x)=x-x2
for f(x) maximum→ f'(x) = 0 → 1-2x = 0 →x=1/2
f"(x) =-2; f''(1/2)<0
f(x) has maximum
At x = 1/2 and maximum value = f(1/2) = 1/2(1-1/2) = 1/4 = 0.25

124. Consider the set of all functions f : {0,1, … ,2014} → {0,1, … ,2014} such that f (f (i)) = i, for all 0 ≤ i ≤ 2014. Consider the following statements:
P. For each such function it must be the case that for every i, f (i) = i.
Q. For each such function it must be the case that for some i, f (i) = i.
R. Each such function must be onto.
Which one of the following is CORRECT?
A. P, Q and R are true
B. Only Q and R are true
C. Only P and Q are true
D. Only R is true
Answer||| B

Solution||| Let us consider a function (counter example) as
f(0) = 1, f(1) = 0, f(2) = 3, f(3) = 2,….,f(2012) = 2013, f(2013) = 2012 and f(2014) = 2014
Clearly f(f(i))=i for 0 ≤ i ≤ 2014
Here f(i) ≠ i for every i and f(i) = i for some i
Also f is onto
Hence, only Q and R are true

125. There are two elements x, y in a group (G,*) such that every element in the group can be written as a product of some number of x's and y's in some order. It is known that

$$x*x = y*y = x*y*x*y = y*x*y*x = e$$

where e is the identity element. The maximum number of elements in such a group is _____.
A. 2
B. 3
C. 4
D. 5
Answer||| C
Solution||| x * x = e, x is its own inverse
y * y = e, y is its own inverse
(x*y) * (x* y) = e, x*y is its own inverse
(y*x) * (y*x) = e, y*x is its own inverse
Also x*x*e = e*e can be rewritten as follows,
x*y*y*x = e*y*y*e = e, (Since y *y = e)
(x*y) * (y*x) = e shows that (x *y) and (y *x) are each other's inverse and we already know that (x*y) and (y*x) are inverse of its own. As per (G,*) to be group any element should have only one inverse element (unique). This implies x*y = y*x (is one element). So the elements of such group are 4 which are {x, y, e, x*y}.

126. If G is a forest with n vertices and k connected components, how many edges does G have?
A. [n/k] B. [k/n]
C. n – k D. n - k + 1
Answer||| C
Solution||| Each component will have n/k vertices (pigeonhole principle). Hence for each component there will be (n/k) -1 edges. Since there are k components, total number of edges= k*((n/k)-1) = n-k.

127. Let δ denote the minimum degree of a vertex in a graph. For all planar graphs on n vertices with $\delta \geq 3$, which one of the following is TRUE?
A. In any planar embedding, the number of faces is at least $\frac{n}{2}+2$
B. In any planar embedding, the number of faces is less than $\frac{n}{2}+2$
C. There is a planar embedding in which the number of faces is less than $\frac{n}{2}+2$
D. There is a planar embedding in which the number of faces is at most $\frac{n}{\delta+1}$
Answer||| A
Solution||| Euler's formula for planar graphs: v - e + f = 2.
v => Number of vertices
e => Number of edges
f => Number of faces
Since degree of every vertex is at least 3, below is true from handshaking lemma (Sum of degrees is twice the number of edges)
3v >= 2e
3v/2 >= e
Putting these values in Euler's formula,
v - 3v/2 + f >= 2
f >= v/2 + 2

128. The CORRECT formula for the sentence, "not all rainy days are cold" is
A. $\forall d\,(Rainy(d) \wedge \sim Cold(d))$
B. $\forall d\,(\sim Rainy(d) \rightarrow Cold(d))$
C. $\exists d\,(\sim Rainy(d) \rightarrow Cold(d))$
D. $\exists d\,(Rainy(d) \wedge \sim Cold(d))$
Answer||| D
Solution||| Note that (p ∧ ~q) ≡ ~(p -> q). So it means rainy day to cold implication is false for all days. This means non-rainy days are cold.
For all days, if day is not rainy, then it is cold [Non-Rainy days are cold].
There exist some days for which not rainy imply cold. [Some non-rainy days are cold].
Note that (p ∧ ~q) ≡ ~(p -> q). So it means rainy day to cold implication is false for some days. This means not all rainy days are cold.

129. Consider the following relational schema:
Employee (empId, empName, empDept)
customer (custId, custName, salesRepId, rating)
salesRepId is a foreign key referring to empId of the employee relation. Assume that each employee makes a sale to at least one customer. What does the following query return?

```
SELECT empName
FROM employee E
WHERE NOT EXISTS (SELECT custId
 FROM customer C
 WHERE C.salesRepId = E.empId
 AND C.rating <> 'GOOD');
```

A. Names of all the employees with at least one of their customers having a 'GOOD' rating.
B. Names of all the employees with at most one of their customers having a 'GOOD' rating.
C. Names of all the employees with none of their customers having a 'GOOD' rating.
D. Names of all the employees with all their customers having a 'GOOD' rating.
Answer||| D
Solution|||

If any employee has received rating other than 'good' from some customer, then there will be some rows returned by the inner query. And not exists will return false so that employee won't be printed only those employees which have got rating well from all their customers will be printed.

130. Let ⊕ denote the Exclusive OR (XOR) operation. Let '1' and '0' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q:
F(P, Q) = ((1⊕P) ⊕ (P⊕Q)) ⊕ ((P⊕Q) ⊕ (Q⊕0))
The equivalent expression for F is
A. P + Q
B. $\overline{P+Q}$
C. P ⊕ Q
D. $\overline{P \oplus Q}$
Answer||| D
Solution|||
F(P,Q) = ((1⊕P) ⊕ (P⊕Q)) ⊕ ((P⊕Q) ⊕(Q⊕0))
= (P'⊕(PQ' + P'Q)) ⊕((PQ' + P'Q) ⊕Q)
= [P'(PQ + P'Q') + P(PQ' + P'Q)] ⊕[(PQ + P'Q')Q + (PQ'+P'Q)Q']
= (P'Q' + PQ') ⊕(PQ + PQ')
= Q'⊕P = PQ + P'Q' = $\overline{P \oplus Q}$

***