EXCLUSIVE GUIDE FOR CS GATE ASPIRANTS

GATEGENIE

PRACTICING TO TAKE THE GATE EXAMINATION

TEST SERIES FOR COMPUTER SCIENCE GATE

SECOND EDITION

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Preface

Graduate Aptitude Test in Engineering(GATE) is an entrance examination for Masters in Technology (M. Tech) in various disciplines at prestigious Indian Institute of Technologies(IITs), National Institute of Technologies (NITs) and a few other engineering colleges across India. GATE has become a yard stick to normalize performance of students across the engineering colleges in India. GATE is in that sense becomes a qualification, which is also useful in getting positions like project staff or research assistant in IITs. The number of candidates appearing for GATE has increased substantially over the years and more and more students are opting for M. Tech. in IITs or other institutes in India. This also has increased the competition where you need to break in top 100 to get admitted in IIT of your choice. This competition makes it very important to plan your GATE preparation and get through with flying colors.

GATE preparation should first begin with basics of various subjects and then sharpening them. The subjects should be studied thoroughly with proper revision schedule. The good thing is that these subjects are most of the time part of our bachelor curriculum and their study could well be done with the help of reference books. We have compiled a list of necessary reference books and also prepared a mapping between GATE syllabus and reference books to aid self learner greatly. The list and mapping is available on our website. This becomes a starting point for GATE preparation. There is no need to go for expensive study material available in the market as their contents are verbatim copied from the reference books and is sold at a cost, which is higher than the sum cost of all the reference books. Hence, we recommend you to go for more reliable reference books or other books which you have used during your study in engineering. Once you are ready with your basics, its time to test your preparation and this is where GateGenie has a role to play. We not only test your preparation but also identify the gray areas. The next important step is to again go back to basics for these areas, patch them up and appear for a test again. Additionally, GateGenie test series has solutions with explanations which guides students to attack a problem. This is the Unique Selling Point(USP) for GateGenie which will be very useful for students. The line of attack for a problem plays a key role in time bound competitive exams. GateGenie provides detailed explanation of the way a problem should be attacked and how similar problems can be solved using the same approach. The explanation given clears the concept. Each questions in the test series is "concept" oriented and clears a concept which you should learn and master to solve any related question.

During mock tests, you need to identify subjects/topics which are your gray areas and then put more efforts in those areas. This way, you should patch up all your weak points be ready for the final GATE exam. The self evaluation sheet is a vital assistance to identify your gray areas and work on it.

Supplements: We will be putting up few articles for students to help GATE preparation.We also have a scheduler which can be helpful to plan your studies. Our website www.gategenie.com has all the information specified above. We will also post admission related stuff after the GATE results are out.

Errata: We have endeavored to eliminate typos, bugs, and the like from the text. We would appreciate it if you could notify us of any errors or omissions in the book. An updated errata page will be accessible from out home page. Also, if you would like to suggest improvements or to contribute, we would be glad to hear from you. Any correspondence or thoughts related to www.gategenie.com can be emailed on support@gategenie.com.

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Contents

GateGenie Practice Test No. 1

All questions carry 1 marks each.

Q. 1. Given: $Pr(C|D) = 0.2$ and $Pr(D|C) = 0.06$. What is $Pr(C)$ and $Pr(D)$?
(1) 0.2, 0.06 (2) 0.30, 0.70 (3) 0.06, 0.2 (4) None of above

Q. 2. Which of the following is tautology?
(1) $x \cup y \rightarrow y \cap z$ (2) $x \cap y \rightarrow y \cup z$
(3) $x \cup y \rightarrow (y \rightarrow z)$ (4) $x \rightarrow y \rightarrow (y \rightarrow z)$

Q. 3. Suppose $A = \{\}, B = \{1, 2, 3\}$. What does the set $B \times A$ contain?
(1) { } (2) $\{1, 2, 3\}$
(3) $\{(1), (2), (3)\}$ (4) None of the above

Q. 4. Which of the following statement is not correct?
(1) Continuity is a necessary and sufficient condition for differentiability
(2) Differentiability is sufficient condition for continuity
(3) Continuity is a necessary condition for differentiability
(4) Existent of $\lim_{\delta x \rightarrow 0} \frac{f(x+\delta x)-f(x)}{\delta x}$ is a necessary and sufficient condition for differentiability

Q. 5. The number -45 in 2's complement representation is:
(1) 0010 1101 (2) 1101 0011
(3) 0001 0010 (4) 0010 1110

Q. 6. A Latch remembered previous output as 1. With S=1 and R=0, what is value of Q?
(1) 1 (2) 0 (3) 1 or 0 (4) None of the above

Q. 7. How many select lines does 1:16 multiplexer have?
(1) 1 (2) 4 (3) 5 (4) 16

Q. 8. Software interrupts are useful to processor to
(1) test processor interrupts system
(2) implement co-routines
(3) obtain system service which need execution of privilege instructions
(4) return from subroutine

Q. 9. Which of the following identities are correct?
(1) $rs^* = rss^*$ (2) $(r^*s^*) = (r + s)^*$
(3) $(r + s)^* = r^* + s^*$ (4) $(r^*s^*)^* = (r + s)^*$

Q. 10. Let L_1 and L_2 are regular sets defined over alphabet Σ^*. Mark the false statement.
(1) $L_1 \cup L_2$ is regular (2) $L_1 \cap L_2$ is not regular
(3) $\Sigma^* - L_1$ is regular (4) L_1^* is regular

Q. 11. Suppose A and B are two sets of strings from Σ^*. Further suppose that B is a subset of A. Which of the following statement must always be true for A and B.
I. If A is finite then B is finite
II. If A is regular then B is regular
III. If A is context free then B is context free
(1) I only (2) II only (3) III only (4) All three

Q. 12. Minimum number of edges in a connected cyclic graph on n-nodes is
(1) $log_2\ n$ (2) $n - 1$ (3) n (4) $n + 1$

Q. 13. Tree Sort is:
(1) Insertion of n values in a tree and then pre-order
(2) Insertion of n values in a binary search tree and then in-order
(3) Insertion of n values in a binary search tree and then pre-order
(4) None of the above

Q. 14. Prim's Algorithm can be improved by
(1) Heap (2) Binomial Heap
(3) Fibonacci Heap (4) Priority Queues

Q. 15. What is the worse case and best case complexity of bubble sort?
(1) $O(n^2)$ and $O(log\ n)$ (2) $O(n^2)$ and $O(n\ log\ n)$
(3) $O(n^2)$ and $O(n)$ (4) $O(n\ log\ n)$ and $O(log\ n)$

Q. 16. Number of edges of a complete binary tree with 16 leaf nodes is
(1) 14 (2) 30 (3) 32 (4) 28

Q. 17. Which data structure can be used for checking palindrome
(1) Queue (2) Singly Linked List
(3) Stack (4) Doubly Linked List

Q. 18. In compilers, the type checking is done in:
(1) Lexical Analysis (2) Semantic Analysis
(3) Code Generation phase (4) None of the above

Q. 19. What is time and space complexity for determining $x \in L(r)$ with DFA?
(1) Space complexity $O(x)$ and time complexity $O(\mid r \mid)$
(2) Space complexity $O(r)$ and time complexity $O(\mid r \mid * \mid x \mid)$
(3) Space complexity $O(2^{|r|})$ and time complexity $O(\mid x \mid)$
(4) Space and time complexity both $O(\mid r \mid)$

Q. 20. Which grammar causes recursive-descent parser to go into infinite loop?
(1) LL(1) (2) Left recursive grammar
(3) Right recursive grammar (4) Grammar with left factors

Optional for practice.

Q. 21. Consider a situation, in which several people are executing copies of the mail program, which of the following statements are not correct:
I. All the users share one program counter and stack for mail program.
II. All the users share the same execution sequence.
III. All the users share same text section, but data section varies necessarily.
(1) I and II (2) only I (3) only II (4) only III

Q. 22. A computer system has 6 tape drives with n process competing for them. Each process may need up-to 2 tape drives. The maximum value of n from which the system is guaranteed to be deadlock free is:
(1) 2 (2) 3 (3) 4 (4) 1

Q. 23. Consider a logical address space of eight pages of 1024 words each mapped onto a physical memory of 32 frames. How many bits are there in the logical address?
(1) 13 (2) 15 (3) 23 (4) 14

Q. 24. Which of the following languages will be equivalent:

$$\begin{aligned} L_1 &= \{0^n 1^n; n \geq 1\} \\ L_2 &= S \rightarrow 0S1 \mid 01 \\ L_3 &= 01 \mid 0^+011^+ \end{aligned}$$

(1) L_1 and L_2 (2) L_1 and L_2
(3) L_2 and L_3 (4) L_1, L_2 and L_3

Q. 25. A graph has n nodes and k components. A node with two edges, connecting two separate components is added. Number of components in the new graph will be:

(1) $k+1$ (2) k (3) $k-1$ (4) $k-2$

All questions carry 2 marks each.

Q. 26. Locality of reference implies that the page reference made by a process
(1) will always be the page used in previous page
(2) is likely to be one of the pages used in the last
(3) will always be one of the pages in memory
(4) will always save you from page fault

Q. 27. Is the natural left outer join operation associative?
(1) Yes (2) No
(3) Depends on the relations (4) None of the above.

Q. 28. When doing merge-join, the preferred buffer management algorithm is
(1) LRU (2) FCFS (3) MRU (4) None of the above

Q. 29. Quality of Service (QoS) is related with
(1) Transport Layer (2) Application Layer
(3) Network Layer (4) Physical Layer

Q. 30. In CRC, what is CRC?
(1) divisor (2) quotient (3) dividend (4) remainder

Q. 31.
I. An SQL query automatically eliminates duplicates
II. An SQL query will not work if there are no indexes on the relations
III. SQL permits attribute names to be repeated in the same relation
Which of the above are true?
(1) I only (2) II only
(3) III only (4) I and II only

Q. 32. Cost of joining 3 relations is —— than joining 4 relations
(1) greater (2) always smaller
(3) sometimes smaller (4) never smaller

Q. 33. There are pencils in the box: 10 red ones, 8 blue, 8 green, 4 yellow. Let us take, with eyes closed, some number of pencils from the box. What is the least number of pencils we have to take in order to ensure that we get at least 4 pencils of the same color?
(1) 4 (2) 16 (3) 12 (4) 13

Q. 34. Consider a binary relation R shown in the following matrix on set $S = \{1, 2, 3, 4\}$.

$$R = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

The relation R is:
(1) Equivalence relation
(2) irreflexive and antisymmetric
(3) irreflexive, symmetric and transitive
(4) transitive but neither reflexive nor irreflexive

Q. 35. What could we say about the following system of linear equations?

$$\begin{aligned} x_2 - 4x_3 &= 8 \\ 2x_1 - 3x_2 + 2x_3 &= 1 \\ 5x_1 - 8x_2 + 7x_3 &= 1 \end{aligned}$$

(1) The system is consistent with a unique solution
(2) The system is consistent
(3) The system is inconsistent
(4) None of the above

Q. 36. How many iterations are required to find the smallest positive roots of the following equation by secant method

$$f(x) = x^3 - 3x^2 + x + 1$$

with initial guesses of 0 and 1.5.
(1) 3 (2) 2 (3) 5 (4) 7

Q. 37. A cylindrical container with a circular base and an open top is hold to 64 cm^3. Find its dimensions so that the surface area is minimized.
(1) Radius=4 and Height= $4/\pi^{(1/2)}$
(2) Radius and Height = 4
(3) Radius and Height = 8
(4) Radius and Height = $4/\pi^{(1/3)}$

Q. 38. Fig. (1.1) shows relation on set $S = \{2, 3, 6, 8\}$. The relation is
(1) Equivalence Relation (2) Poset
(3) Symmetric and Reflexive relation (4) None of the above

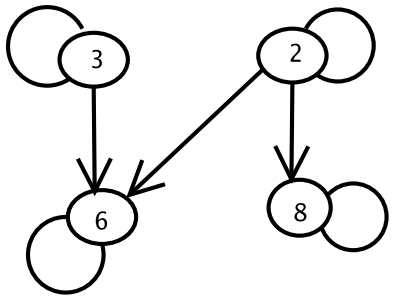


Figure 1: Fig. for Q. 38

Q. 39. While transmitting binary digits through a communication channel, the number of digits received correctly, Cn out of n transmitted digits has a binomial distribution $b(k; n, p)$. Find out the probability of error free transmission.
(1) $p^{(n-1)}$ (2) p^n (3) p^0 (4) None of the above

Q. 40. What is the baud rate for standard 10 Mbps Ethernet link?
(1) 100 MBaud (2) 200 MBaud (3) 10 MBaud (4) 20 MBaud

Q. 41. Q: Which of the following is part of congestion prevention policies at network layer
(1) Out-of-order caching policy
(2) Retransmission policy
(3) Acknowledgment policy
(4) Routing Algorithm

Q. 42. Q: What is the subnetwork address for IP:213.23.47.37 and Mask: 255.255.255.240

(1) 213.23.47.16 (2) 213.23.47.32
(3) 213.23.48.32 (4) 213.23.47.48

Q. 43. According to IEEE standard, a 32 bit single precision floating point number N is defined as

$$N = (-1)^s \times 1.F \times 2^{(E-127)}$$

S is sign bit, F is fractional mantissa, and E is biased exponent. S uses 1 bit, F uses 8 bits, and E uses 23 bits. What will be decimal value of the floating point number defined in above format as $C1E00000$.
(1) 26 (2) -15 (3) -26 (4) -28

Q. 44. Match the pairs about implementation and addressing modes:

Group A	**Group B**
A. Array	I. Indirect Addressing
B. Relocatable code	II. Indexed Addressing
C. Array as parameter	III. Base Register Addressing

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

Q. 45. Consider the following K-Map

	BC			
A	1	0	1	0
	0	1	0	1

Which of the following is not equation of the system?
(1) $A \odot B \oplus C$
(2) $A \oplus B \oplus C$
(3) $A'B'C' + AB'C + A'BC + ABC$
(4) $A \oplus B \odot C$

Q. 46. A complete binary tree can be stored in array. Then to access child of ith node, – th and – th index of array needs to be used.(index starts at 1)
(1) $2i-1,\ 2i$ (2) $2i,\ 2i+1$
(3) $2i+1,\ 2i+2$ (4) $2i-1,\ 2i+1$

Q. 47. Consider the grammar,

$$\begin{aligned} S &\rightarrow PQ \mid SQ \mid PS \\ P &\rightarrow x \\ Q &\rightarrow y \end{aligned}$$

To get a set of n terminals, the number of productions to be used are
(1) n^2 (2) $n+1$ (3) $2n$ (4) $2n-1$

Q. 48. Consider a DFA accepting all strings over $\{a, b\}$ such that number of a's and b's are even. What is the minimum number of states such DFA will have?
(1) 4 (2) 2 (3) 6 (4) 8

Q. 49. Which of the following languages are context free:

$$\begin{aligned} L_1 &= a^i b^i c^j \mid i \geq 1 \; and \; j \geq 1 \\ L_2 &= a^i b^i c^j \mid j \geq i \\ L_3 &= a^i b^i c^i \mid i \geq 1 \end{aligned}$$

(1) Only L_1 (2) L_2 and L_3
(3) Only L_2 (4) Only L_3

Q. 50. Which of the following functions are computable with Turing machine?
(1) $n * (n-1) * (n-2) \ldots * 2 * 1$
(2) $\lceil log_2\ n \rceil$
(3) 2^{2^n}
(4) None of the above

Q. 51. Consider the grammar

$$\begin{aligned} S &\rightarrow A \\ A &\rightarrow BA \mid \epsilon \\ B &\rightarrow aB \mid b \end{aligned}$$

The grammar is
(1) LALR (2) LR(0) (3) LR(1) (4) None of the above

Q. 52. Consider

$$\begin{aligned} L_1 &= O^n 1^n \\ L_2 &= 0^n c 1^n \end{aligned}$$

Which of the following statements are correct:
I. L_1 and L_2 are accepted by non-deterministic PDA.
II. L_1 and L_2 are accepted by deterministic PDA.
III. Only L_2 is accepted by deterministic PDA
(1) Only I (2) I and II
(3) I and III (4) All three

Q. 53. How many height balanced trees with 5 nodes are possible?
(1) 3 (2) 4 (3) 5 (4) 6

Q. 54. Consider a knapsack problem with

$$\begin{aligned} n &= 3, m = 20, \\ (p1, p2, p3) &= (25, 24, 15), \text{and} \\ (w1, w2, w3) &= (18, 15, 10) \end{aligned}$$

Which is the optimal solution for $(x1, x2, x3)$:
(1) 1/2, 1/3, 1/4
(2) 1, 2/15, 0
(3) 0, 2/3, 1
(4) 0, 1, 1/2

Q. 55. Given array representation of a heap, does that represent a min-heap

I:	0	2	4	7	5	5	6
II:	5	7	8	6	9	9	10

(1) I only (2) II only
(3) I and II both (4) None

Q. 56. If the following function is to find GCD recursively, fill in the blank:

```
int GCD(int a, int b) {
    if( b == 0 )   return a;
    else   return GCD(b, ...);
}
```

(1) a/b (2) b/a (3) $b\%a$ (4) $a\%b$

Q. 57. Consider

$$\begin{aligned} T_1(n) &= T_1(n/3) + T_1(2n/3) + n. \\ T_2(n) &= 3T_2(n/4) + n \end{aligned}$$

Which of the following statement is not incorrect?
(1) T_1 has faster order growth than T_2
(2) T_2 has faster order growth than T_1
(3) T_1 and T_2 has same order growth
(4) None of the above

Q. 58. The recurrence relation below is

$$\begin{aligned} T(n) &= 2T(n/2) + n^2 \\ T(1) &= 1 \end{aligned}$$

(1) $O(n^3)$ (2) $O(n^2)$ (3) $O(n)$ (4) $O(n\ log\ n)$

Q. 59. Find the weight of the following spanning tree:
(1) 35 (2) 37 (3) 32 (4) 39

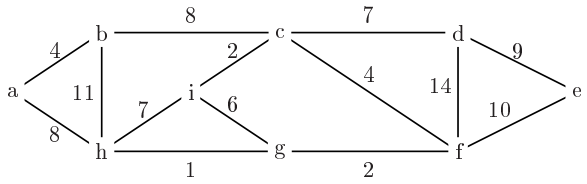


Figure 2: Fig. for Q. 59

Q. 60. What is the post-order traversal of a tree whose pre-order and in-order are:

PRE: ABDEHICFGJK
IN : DBHEIAFCJGK

(1) DIHBEFKJCGA (2) DHIBEFKJCGA
(3) DHIEBFJKGCA (4) DHBIEFJKCGA

Q. 61. Given pointer to a node which is to be deleted, what is the time complexity of deletion of that node in a circular linked list? (n is no. of nodes in the list).
(1) $O(n)$ (2) $O(log\ n)$ (3) $O(1)$ (4) $O(n^2)$

Q. 62. What is the number of edges in a graph if degree of each node is ≥ 4 and ≤ 6. Thus the number of nodes will be
(1) $> 4n$ and $< 6n$ (2) $> 2n$ and $< 3n$
(3) $\geq 2n$ and $\leq 3n$ (4) $> 2(n-1)$ and $< 3(n-1)$

Q. 63. In a box there are random number of white and black marbles. At a time two marbles are taken out at random and if
A. Both Black: Discard both and insert a white
B. Both White: Discard one and retain one
C. One Black and One White: Discard White and retain Black.
If initially there are n_b black and n_w white marbles then determine the color of the only marble remaining at the end.
(1) white if n_b is even (2) white if n_w is odd
(3) black if n_b is even (4) black if n_w is odd

Q. 64. A 8-queens problem is example of

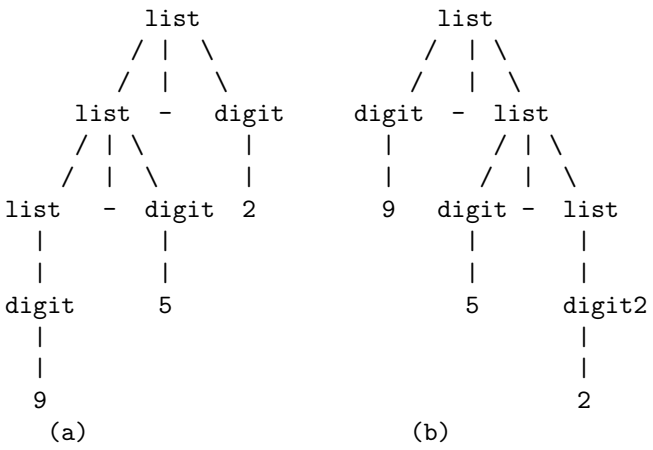
(1) Dynamic Programming (2) Backtracking
(3) Greedy (4) None of the above

Q. 65. How many tokens will be generated from the following C statement:

```
if(x > 10)   y ++;
else   y --;
```

(1) 13 (2) 8 (3) 11 (4) 9

Q. 66. Consider the following two parse trees for the expression: 9 - 5 - 2.



Consider the following statements:

1. The parse tree (a) represents right associative operator evaluation and that of (b) represents left associative evaluation.

2. The grammar generating the sentence is not ambiguous.

Which of the above statements are false?
(1) Only 2 (2) 1 and 2
(3) Only 1 (4) Both the statements are correct.

Q. 67. Consider the following production rules and their syntax directed definition:

Production	Semantic Rule
$expr \rightarrow expr1 + term$	$expr.t := expr1.t \|\| term.t \|\| '+'$
$expr \rightarrow expr1 - term$	$expr.t := expr1.t \|\| term.t \|\| "-"$
$expr \rightarrow term$	$expr.t := term.t$
$term \rightarrow 0$	$term.t :=' 0'$
$term \rightarrow 1$	$term.t :=' 1'$
...	...
$term \rightarrow 9$	$term.t :=' 9'$

What will be the translation of expression: $8 - 5 + 2$?
(1) 8-5+2 (2) 852-+
(3) -+852 (4) 85-2+

Q. 68. Consider the following activation tree in Fig.(1.3). How many elements will be present on the stack after completion of execution of p(1,0)?
(1) 3 (2) 6 (3) 5 (4) 4

Q. 69. Let A be a 10×20 array. What will be the height of annotated parse tree for the assign-

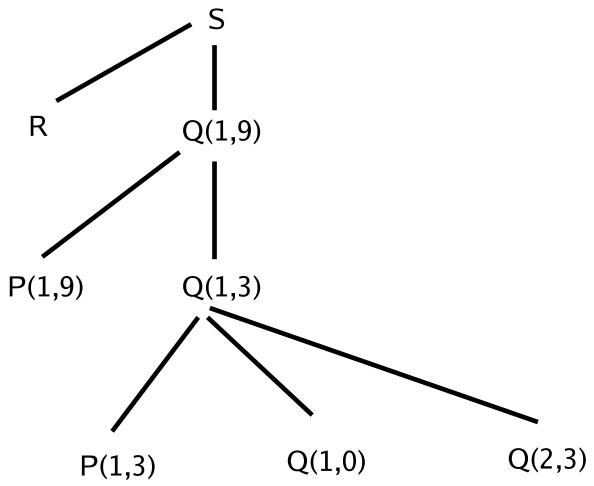


Figure 3: Fig. for Q. 68

ment: $x := A[y, z]$. The grammar is as follows:

$$\begin{aligned} S &\rightarrow L := E \\ E &\rightarrow L \\ L &\rightarrow id \\ L &\rightarrow E_{list}] \\ E_{list} &\rightarrow E_{list}, E \\ E_{list} &\rightarrow id[E \end{aligned}$$

(1) 7 (2) 6 (3) 9 (4) 11

Q. 70. Consider the following grammar

$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow (E) \mid id \end{aligned}$$

Write the productions for E, T and F after converting this grammar to LL(1) grammar.
(1) $E \rightarrow +TE',\ T \rightarrow *FT',\ F \rightarrow (E)|id$
(2) $E \rightarrow +TE'|\in,\ T \rightarrow *FT'|\in$
(3) $E \rightarrow T,\ T \rightarrow F,\ F \rightarrow (E)|id$
(4) $E \rightarrow TE',\ T \rightarrow FT',\ F \rightarrow (E)|id$

Q. 71. Arrange the following systems in ascending order in terms of CPU utilization:
1. Hands-on computer system
2. Batch System
3. Batch System with Spooling
4. Batch System with similar jobs executed together
(1) 1,3,4,2 (2) 3,2,4,1 (3) 2,4,3,1 (4) 4,2,3,1

Q. 72. Consider the following set of processes that arrive at time 0 in the order P_1, P_2, P_3, and P_4 and the length of their CPU burst is given below:

Process	Burst Time
P_1	5
P_2	4
P_3	6
P_4	3

Further suppose that we're interested in running the processes in FCFS or Round Robin scheduling with time quantum of 6. Which of the following holds true in the situation:
(1) FCFS out performs Round robin scheduling
(2) Round robin performs better than FCFS
(3) Both yield exactly the same performance
(4) None of the above.

Q. 73. Consider a system with five processes P_0 to P_4 and three resources R_1, R_2 and R_3, each having 10, 5, 7 instances respectively. The system snapshot at time T_0 is shown below:

	Allocation			Max			Available		
	R_1	R_2	R_3	R_1	R_2	R_3	R_1	R_2	R_3
P_0	0	1	0	7	5	3	3	3	2
P_1	2	0	0	3	2	2			
P_2	3	0	2	9	0	2			
P_3	2	1	1	2	2	2			
P_4	0	0	2	4	3	3			

Which of the following execution sequence ensures safety in the system?
(1) $P_1,\ P_3,\ P_4,\ P_2,\ P_0$
(2) $P_1,\ P_4,\ P_2,\ P_3,\ P_0$
(3) $P_3,\ P_1,\ P_2,\ P_4,\ P_0$
(4) $P_4,\ P_2,\ P_3,\ P_0$

Q. 74. Consider a paging system with the page table in memory. Each memory reference takes 200 ns. The TLB has hit ratio of 75% and the time to look for pages in TLB is almost negligible. What is the effective paged memory reference take?
(1) 400 (2) 250 (3) 150 (4) 200

Q. 75. In a system with 62 frames there are two processes running, P_1 of size 10k and P_2 of size 127k. How many frames will be allocated to each of the processes by proportional allocation scheme?
(1) 31 frames each to P_1 and P_2
(2) 4 frames to P_1 and 57 frames to P_2
(3) 2 frames to P_1 and 60 frames to P_2
(4) None of the above

Q. 76.

```
void abc(char *s) {
    if( s[0] == '\0')   return;
    abc(s+1);
    abc(s+1);
    printf("%c",s[0]);
}
main() {
    abc("123");
}
```

What is the output of the program:
(1) 3 3 2 1 3 2 1
(2) 3 2 3 1 3 2 1
(3) 3 3 2 3 3 2 1
(4) 3 3 3 1 3 3 2

Q. 77.

```
int f(int num) {
    int bits=0;
    while( num ) {
        num &= (num -1);
        ++bits ;
    }
    return bits;
}

int main(void) {
    printf("%d",f(11));
}
```

(1) 2 (2) 3 (3) 4 (4) 5

Q. 78. Consider a program in a language with C like syntax but do not assume the C language semantics: What will be the value of x, y, and k after execution:

```
x=5, y = 6;
k = 0;
while( x != 0 ) {
    if( --x && y-- )  k++;
}
```

(1) 024 (2) 013
(3) 014 (4) 023

Q. 79. Union is not recommended in C because
(1) It saves memory but memory is very cheap now a days
(2) It unnecessarily complicates the program
(3) One type of data can be accessed as other type which
(4) None of the above

Q. 80. How many times `fib(3)` is called during invocation of `fib(6)` ?

```
fib(x) = fib(x-1) + fib(x-2)
fib(0) = 1
fib(1) = 1
```

(1) 3 (2) 4 (3) 5 (4) 6

Q.81-90 are in the set of two each. We have not implemented dependency of 81b on 81a so that you can get correct answers for both. But in exam, you will be evaluated on dependency basis

Information pertains to Q. 81 - 82

Analysis of the daily registrations at GateGenie on a certain day indicated that the source of registrations from North India are 15%, South India are 35% and that from Western part of India are 50%. Further suppose that the probabilities that a registration being a free registration from these parts are 0.01, 0.05 and 0.02, respectively.

Q. 81. Find the probability that a registration chosen at random is a free-registration.
(1) 0.603 (2) 0.029 (3) 0.009 (4) None of the above

Q. 82. Find the probability that a randomly chosen registration comes from South India, given that its a free registration.
(1) 60% (2) 3% (3) 17% (4) None of the above

Information pertains to Q. 83 - 84

Array $S1$ contains 256 elements 4 bytes each. Its first element is stored at physical address 4096. Array $S2$ contains 512 elements 4 bytes each stored from physical address location 8192. Assume that only arrays $S1$ and $S2$ can be cached in an initially empty, physically addressed, physically tagged, direct mapped 2kb cache with 8 byte block size.

Q. 83. The following loop is then executed:

```
for( i=0; i<256; i++) {
     A[i] = A[i] + B[2*i]
}
```

During the execution of loop, how many bytes will be written to memory if the cache has write through policy?
(1) 0 (2) 256 (3) 1024 (4) 2048

Q. 84. If the cache has write back policy, how many bytes will be written to memory during execution of loop?
(1) 0 (2) 256 (3) 1024 (4) 2048

Information pertains to Q. 85 - 86

Let $X = \{1, 2, 3, 4\}$. If
$R = \{< x, y > \mid x \in X \; ; y \in X \; ; (x - y) > 0 \; ; (x - y)\%2 = 0\}$
$S = \{< x, y > \mid x \in X \; ; y \in X \; ; (x - y) > 0 \; ; (x - y)\%3 = 0\}$
Q. 85. Find $|R \cup S|$ and $|R \cap S|$.
(1) $|R \cup S| = 6$, $|R \cap S| = 0$
(2) $|R \cup S| = 3$, $|R \cap S| = 6$
(3) $|R \cup S| = 2$, $|R \cap S| = 2$
(4) $|R \cup S| = 5$, $|R \cap S| = 3$

Q. 86. If $X = \{1, 2, 3, \ldots\}$, what is $R \cap S$?
(1) $R = \{< x, y > \mid x \in X \; ; y \in X \; ; (x - y) > 0 \; ;$
$(x - y)\%2 = 0$ *or* $(x - y)\%3 = 0 \; \}$
(2) $R = \{< x, y > \mid x \in X \; ; y \in X \; ; (x - y) > 0 \; ; (x - y)\%6 = 0\}$
(3) $R = \{< x, y > \mid x \in X \; ; y \in X \; ; (x - y) > 0 \; ; (x - y)\%5 = 0\}$
(4) None of the above

Information pertains to Q. 87 - 88

Q. 87. What will be the array representation of a max-heap with insertions:

$$40, 80, 35, 90, 45, 50, 70$$

(1) 90 80 70 40 45 35 50
(2) 90 80 70 45 40 50 35
(3) 90 70 80 40 45 35 50
(4) 90 70 80 45 40 50 35

Q. 88. If 100 is added to the heap above,what will be the new array representation
(1) 90 80 70 40 45 35 50 100
(2) 100 90 70 80 45 35 50 40
(3) 100 90 80 70 40 45 35 50
(4) 100 80 90 70 40 45 35 50

Information pertains to Q. 89 - 90

Consider the following relational database
`Student(ID, name, dept-no, hostel-no, ...) PK:ID`
`Department(dept-no, name, ... ) PK:dept-no`
`Hostel(hostel-no, warden-name, ... ) PK:hostel-no`

Q. 89. What does following query gives:

```
select h.hostel-no, d.dept-no, count(*)
from Hostel h, Department d, Student s
where s.dept-no = d.dept-no
and s.hostel-no = h.hostel-no
order by h.hostel-no
group by h.hostel-no, d.dept-no;
```

(1) Number of students per dept. for each hostel
(2) Number of students in all hostels for each dept.
(3) Number of students per hostel in each dept.
(4) None of the above

Q. 90. Write a query to print `hostel-no` in which there is no `student` from `department` name **CSE**.

(1)
```
select h.hostel-no from Hostel h
where h.hostel-no
IN (select distinct h.hostel-no
from Hostel h, Department d, Student s
where h.hostel-no = s.hostel-no
and s.dept-no = d.dept-no
and d.name = 'CSE' );
```

(2)
```
select h.hostel-no from Hostel h
where h.hostel-no
NOT IN ( select distinct h.hostel-no
from Hostel h, Department d, Student s
where h.hostel-no=s.hostel-no
and s.dept-no=d.dept-no
and d.name='CSE' );
```

(3)
```
select h.hostel-no from Hostel h
where h.hostel-no
NOT IN ( select distinct h.hostel-no
from Hostel h, Department d, Student s
where h.hostel-no=s.hostel-no
and s.dept-no=d.dept-no
and d.name <> 'CSE');
```

(4)
```
select h.hostel-no from Hostel h
where h.hostel-no IN
(select distinct h.hostel-no
from Hostel h, Department d, Student s
where h.hostel-no=s.hostel-no
and s.dept-no=d.dept-no
and d.name <> 'CSE' );
```

GateGenie Practice Test No. 2

GateGenie Practice Test No. 2

All questions carry 1 marks each.

Q. 01. In how many ways 10 red balls can be kept in 5 different bins?
(1) 1001 (2) 252 (3) 10^5 (4) 10!

Q. 02. A and B are square matrices. A has eigen values $3, 0, 2$. B has eigen values 4 and 1. Which of the following statement is correct?
(1) A and B both are invertible
(2) B is invertible but not A
(3) A is invertible but not B
(4) none of the above

Q. 03. An empty relation ϕ is
(1) Symmetric but reflexive (2) Equivalence relation
(3) Partial order (4) None of the above

Q. 04. A countable union of countable sets is not
(1) countable (2) uncountable
(3) countably infinite (4) denumerable

Q. 05. All digital circuits can be realized using only
(1) Ex-OR gates (2) Multiplexer (3) Half-Adders (4) OR gates

Q. 06. A multiplexer with a 4-bit data select input is a
(1) 4:1 multiplexer (2) 2:1 multiplexer
(3) 16:1 multiplexer (4) 8:1 multiplexer

Q. 07. Relative mode addressing is most relevant to writing a
(1) Co-routines
(2) Position independent code
(3) Shareable code
(4) Interrupt handler

Q. 08. Which of the following is not a form of memory
(1) instruction cache
(2) instruction opcode
(3) instruction register
(4) translation look-aside buffer

Q. 09. Which of the following statement is not true?
(1) DFA makes precisely one transition for an input
(2) NFA makes more than one transition for an input
(3) To check if the input is accepted by a NFA,
(4) On a given string w, DFA terminates exactly in

Q. 10. Suppose $r_1 = \epsilon$, $r_2 = 0^*1^*$, which of the following statement is true about r_1 and r_2?
(1) r_1 is not regular expression, while r_2 is a regular
(2) r_1 and r_2 both are regular expression.
(3) r_1 is regular expression but r_2 is not.
(4) Neither r_1 nor r_2 are regular expressions.

Q. 11. Consider the following set of languages:

$$\begin{aligned} L_1 &= a^i b^i | j = i^2 \\ L_2 &= a^i b^j c^i d^j | i, j < 0 \\ L_3 &= a^i b^i c^j d^j | i, j < 0 \end{aligned}$$

Which of above language is not context free?
(1) L_2 and L_3 (2) L_1 and L_3
(3) L_1 and L_2 (4) All L_1, L_2 and L_3

Q. 12. Number of comparisons required by selection sort can be reduced by considering elements in pair and finding the minimum and maximum at the same time. What will be the complexity of the new algorithm
(1) $O(n)/2$ (2) $O(n)/4$ (3) $O(n)$ (4) $O(log\ n)$

Q. 13. Partitioning and Merging are the two main parts of Quick sort. Which of the following is true?
(1) Partitioning is key step and merging is trivial
(2) Partitioning is trivial and merging is key step.
(3) Both Partitioning and merging are trivial
(4) Both Partitioning and merging are key steps.

Q. 14. Dynamic programming paradigm can be used in

1. Matrix Chain Multiplication
2. Intelligent Fibonacci Number Calculation
3. Tower of Hanoi
4. Edit Distance

(1) 1, 2, and 4 (2) 1, 3, and 4
(3) 2 and 4 (4) All four.

Q. 15. A tree edge is
(1) An edge (u, v) in the depth first traversal if v was first discovered by exploring edge (u, v)
(2) An edge (u, v) in the depth first traversal if u was first discovered by exploring edge (u, v)
(3) Edge (u, v) connecting a vertex u to an ancestor v in a depth-first tree.
(4) An edge which creates a cycle during depth-first traversal.

Q. 16. A bridge is
(1) A node whose removal disconnects a graph.
(2) A node whose addition connects two components of a graph.
(3) An edge whose addition connects two components of a graph.
(4) An edge whose removal disconnects a graph.

Q. 17. Time complexity of Dijkstra's algorithm is
(1) $O(V)$ (2) $O(V + E)$
(3) $O(V^2 + E^2)$ (4) $O(V^2)$

Q. 18. Height of a complete tree with $2^n - 1$ nodes is
(1) $n - 2$ (2) $n - 1$ (3) n (4) $n + 1$

Q. 19. Which of the following is the regular expression for real number with one decimal point.
(1) $[0-9]* \ . \ [0-9]*$
(2) $[0-9]+ \ . \ [0-9]* \ | \ . \ [0-9]+$
(3) $[0-9]* \ . \ [0-9]+$
(4) $[0-9]+ \ . \ [0-9]* \ | \ . \ [0-9]*$

Q. 20. A link-editor is a program that
(1) acts as link between compiler and user program
(2) matches parameter of subroutine definition with the location of parameters of subroutine call
(3) matches external names of one program with their locations in other program
(4) matches the parameter of macro definition with locations of the parameters of macro call

Optional for practice.

Q. 21. A operator precedence parser is:
(1) Bottom up parser (2) Top down parser
(3) Back tracking parser (4) Recursive descent parser

Q. 22. Which of the following is the most powerful parsing method?
(1) LL(1) (2) Canonical LR
(3) SLR (4) LALR

Q. 23. In which of the following situation, spooling is not essential -

1. Swapping pages to disk from main memory
2. Terminal used to enter data for a program being executed
3. CPU sends data to remote printer using communication path

(1) Only 2 (2) 2 and 3
(3) Only 3 (4) All are correct

Q. 24. Convoy effect is a result of -
(1) One CPU-bound process and many I/O bound processes
(2) Many CPU Bound processes and less I/O bound processes
(3) Many CPU and I/O bound processes
(4) Proper mix of CPU and I/O bound processes

Q. 25. A counting semaphore is initialized to 10. The 6 P(wait) operations and 4 V(signal) operations were completed in this semaphore. The resulting value of semaphore is:
(1) 0 (2) 8 (3) 10 (4) 12

All questions carry 2 marks each.

Q. 26. Which of the following statements is correct about paging?
(1) Paging suffers problem of external fragmentation.
(2) Paging suffers from internal fragmentation.
(3) Paging suffers from problem of internal and external fragmentation
(4) Paging completely avoids all sort of fragmentations.

Q. 27. What is the candidate key for following relations

$$\begin{aligned} R &= ABCDE \\ A &\rightarrow B,\ C \\ B &\rightarrow E \\ D &\rightarrow E \end{aligned}$$

(1) AB (2) AC (3) BD (4) AD

Q. 28. B+ trees has significant advantage over extensible hashing for an attribute A of a relation because
(1) B+ trees are good for multi-point queries
(2) B+ trees are good for point queries
(3) B+ trees are good for range queries
(4) None of the above

Q. 29. Where does MAC layer lie in the protocol stack?

(1) Between physical layer and data link
(2) Between data link and network layer
(3) Between Network layer and Transport layer
(4) Above the transport layer

Q. 30. Which of the following IPs can two different hosts connected to the internet have?
(1) 10.12.14.10 (2) 172.16.5.12
(3) 192.168.32.51 (4) 202.144.131.5

All questions carry 2 marks each.

Q. 31. If relations R and S are given below, what will be $N \bowtie S$.

R			S		
A	B	C	B	C	D
a	b	c	b	c	d
d	b	c	b	c	e
b	b	f	a	d	b
c	a	d			

(1)

A	B	C	D
a	b	c	d
a	b	c	e
c	a	d	b

(2)

A	B	C	D
d	b	c	d
d	b	c	e
c	a	d	b

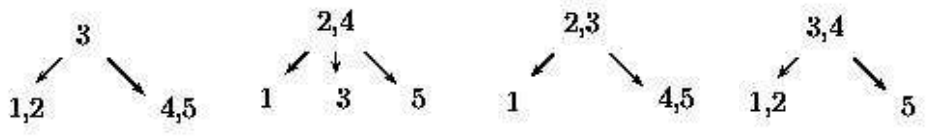
(3)

A	B	C	D
a	b	c	d
d	b	c	d
c	a	d	b

(4)

A	B	C	D
a	b	c	d
a	b	c	e
d	b	c	d
d	b	c	e
c	a	d	b

Q. 32. If series of inserts are performed on a empty B+-tree, then how will be the final tree after insert of 1, 2, 3, 4, and 5. Consider that each node can contain max 2 values and 3 pointers.



(a) (b) (c) (d)

Q. 33. How many integers in $S = \{1, 2, 3, \ldots, 1000\}$ are divisible by 3 or 5?
(1) 599 (2) 467 (3) 333 (4) 66

Q. 34. Let A be the set of non-zero integers and let # be the relation on $A \times A$ defined as

$$(a, b)\#(c, d) \text{ if } ad = bc$$

The relation A is
(1) Equivalence relation
(2) Poset
(3) Antisymmetric
(4) Reflexive and symmetric but not transitive

Q. 35. Find the length of minimal spanning tree for graph represented in the following figure:
(1) 28 (2) 55 (3) 24 (4) none of the above

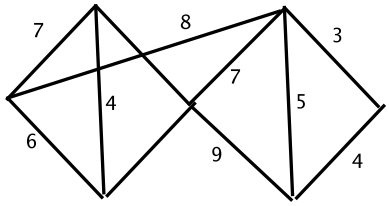


Figure 4: Fig. for Q. 35

Q. 36. How many numbers from a set $\{1, 2, 3, ..., 20\}$ should be chosen in order to have one number multiple of another?
(1) 10 (2) 11 (3) 3 (4) 9

Q. 37. Which of the functions are invertible?

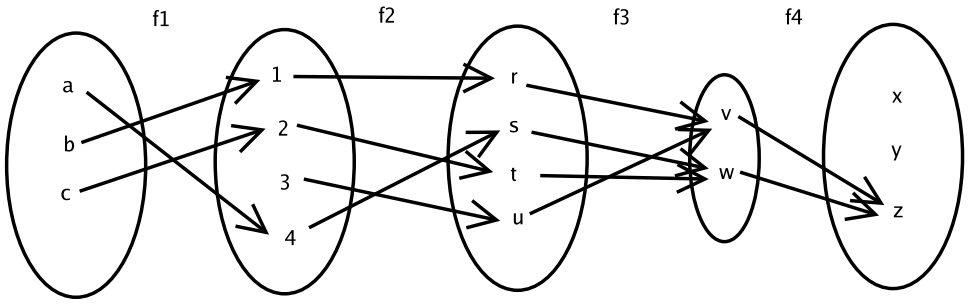


Figure 5: Fig. for Q. 37

(1) f_1 and f_4 (2) f_2 and f_3 (3) only f_2 (4) only f_3

Q. 38. Suppose,
$P(x) : x$ is a person
$F(x, y) : x$ is the father of y
$M(x, y) : x$ is mother of y
What does the following indicates

$$(\exists z)(P(z) \cap F(x, z) \cap M(z, y))$$

(1) x is father of mother of y (2) y is father of mother of x
(3) x is father of y (4) none of the above

Q. 39. A set of odd integers under the operation of multiplication
(1) will not for a group (2) will form a group
(3) will form a abelian group (4) has no identity element.

Q. 40. Consider an error-free 64-kbps satellite channel used to send 512-byte data frames in one direction, with very short acknowledgments coming back the other way. What is the maximum throughput for a window size of 7. Assume that the satellite is geostationary satellite at a distance of 32000 km from the earth.
(1) approximately 12.5 kbps (2) approx. 25 kbps
(3) approx. 50 kbps (4) approx. 100 kbps

Q. 41. Two CSMA/CD stations are each trying to transmit large files of multiple frames. After each frame is sent, they contend for the channel using the binary exponential back-off algorithm. What is the probability that the contention ends in round 3?
(1) 1/8 (2) 1/4 (3) 3/8 (4) 1/2

Q. 42. Consider a CSMA/CD network running at 1 Gbps over a 1-km cable with no repeaters. The

signal speed in the cable is 200,000 km/sec. What is the minimum frame size. Assume that the propagation speed in the cable is $2 * 10^8$ m/sec?
(1) 64 bytes. (2) 625 bytes (3) 1343 bytes. (4) 1250 bytes.

Q. 43. Given the following two numbers:

$$\begin{aligned} a &= 0001101000110011 \\ b &= 1110010111101011 \end{aligned}$$

What will be values of P_3, P_2, P_1 and P_0 in case of Look ahead carry adder?
(1) 1, 1, 1, 0 (2) 0, 0, 0, 0
(3) 1, 1, 1, 1 (4) 0, 0, 0, 1

Q. 44. What is total delay in addition of two 16 bit numbers using Look ahead carry adder?
(1) 32 (2) 5 (3) 4 (4) 2

Q. 45. Perform the following product: $2 * -3$ using Booth's algorithm. What will be the output after the final step of Booth's algorithm.
(1) 1111 10101 (2) 1100 10101
(3) 0011 10110 (4) 1111 11001

Q. 46. What are the first 3 numbers printed for which true is returned by the function if function perfect is invoked with $i > 1$ to $i < 1000$

```
boolean perfect(int i){
    if( !  i%j ) sum += j;
    }
    if( sum == i ) return true;
    else return true;
}
```

(1) 0 1 1 2 (2) 1 2 3 7
(3) 6 14 28 (4) 1 2 3 6

Q. 47. Deterministic Finite Automata of a language over alphabets $\{0, 1\}$, which does not contain 3 consecutive 0s. How many states, S, in all the DFA will have and how many of them will be final states, F?
(1) $|S| = 5$ and $|F| = 2$
(2) $|S| = 5$ and $|F| = 3$
(3) $|S| = 4$ and $|F| = 3$
(4) $|S| = 3$ and $|F| = 1$

Q. 48. L1 has the following grammar

$$\begin{aligned} S &\rightarrow aB \mid BA \\ A &\rightarrow bAA \mid aS \mid a \\ B &\rightarrow b \mid bS \mid aBB \end{aligned}$$

L2 has the following grammar

$$S \rightarrow Sba \mid a$$

Which of the following statement is true about $L_3 = L_1 \cap L_2$ and $L_4 = L_1.L_1^*$?
(1) Both L_3 and L_4 are not context free.
(2) L_3 is context free, but L_4 is not
(3) Both L_3 and L_4 are context free.
(4) L_4 is context free, but not L_3

Q. 49.

1. L_1 is accepted by PDA M_1 by empty stack.

2. L_2 is accepted by PDA M_2 by final state.

Which of the following statement is correct?
(1) L_1 is context free language, but L_2 is not.
(2) L_1 is subset of L_2.
(3) Both L_1 and L_2 are CFL and equivalent.
(4) Both L_1 and L_2 are CFL.

Q. 50. Consider the following grammar

$$\begin{aligned} S &\rightarrow AB \\ A &\rightarrow BC \mid a \\ B &\rightarrow CC \mid b \\ C &\rightarrow a \end{aligned}$$

What is rank of S, denoted by S_r and A, denoted by A_r in this grammar?
(1) $S_r = 2, A_r = 1$
(2) $S_r = 3, A_r = 2$
(3) $S_r = 5, A_r = 4$
(4) $S_r = 2, A_r = 2$

Q. 51. Let M be a Turing machine has $Q = \{q_0, q_1, q_2, q_3, q_4\}$ a set of states, input alphabets $\{0, 1\}$. The tape alphabets are $\{0, 1, B, X, Y\}$. The symbol B is used to represent end of input string. The final state is q_4. The transitions are as follows:

1. $(q_0, 0) = (q_1, X, R)$
2. $(q_0, Y) = (q_3, Y, R)$
3. $(q_1, 0) = (q_1, 0, R)$
4. $(q_1, 1) = (q_2, Y, L)$
5. $(q_1, Y) = (q_1, Y, R)$
6. $(q_2, O) = (q_2, 0, L)$
7. $(q_2, X) = (q_0, X, R)$
8. $(q_2, Y) = (q_2, Y, L)$
9. $(q_3, Y) = (q_3, Y, R)$
10. $(q_3, B) = (q_4, B, R)$

Which of the following is true about M?
(1) M halts on L having 100 as substring
(2) M halts on L having 101 as substring
(3) M halts on L not having 0011 substring
(4) M halts on L not having 1100 substring

Q. 52. If L_1 and L_2 is a pair of complementary language. Which of the following statement is not appropriate?
(1) both L_1 and L_2 are recursive
(2) neither L_1 and L_2 is recursive
(3) neither L_1 and L_2 is recursively enumerable
(4) one is recursively enumerable but not recursive, the other is not recursively enumerable

Q. 53. Consider a series of operations on binary search tree:

```
insert(30)
insert(34)
insert(86)
insert(84)
insert(44)
insert(40)
insert(39)
```

What is the height of the tree?
(1) 3 (2) 5 (3) 7 (4) 9

Q. 54. What will be the height of the tree if the tree is converted to a complete binary search tree?
(1) 2 (2) 3 (3) 4 (4) 5

Q. 55. if the insertions in **Q**. 53 were to be done in a height balanced AVL tree, what would have been the tree height?
(1) 2 (2) 3 (3) 4 (4) 5

Q. 56. What is the depth of recursion for Tower of Hanoi problem with n disks
(1) $n-1$ (2) n (3) $n+1$ (4) $log_2\ n$

Q. 57. Convert the following postfix expression to prefix expression

$$a\ b\ +\ c\ d\ *\ +$$

(1) + a b + * c d (2) + + a b * c d
(3) * + a b + c d (4) + * a b + c d

Q. 58. The Recurrence Relation below is:

$$T(n) = 4T(n/2) + n$$

(1) $O(n^3)$ (2) $O(n^2)$ (3) $\theta(n^2)$ (4) $\theta(n^3)$

Q. 59. consider the function below:

```
int fun(int i){
    switch i:
        case 1:  print(1);
        case 5:  print(5);
        case 3:  print(3);
        default :  print(0);
    }
}
```

If `random()` returns a natural number, what can be output of
`fun(random() % 10 )`
(1) 1 (2) 5 (3) 3 (4) 0

Q. 60. Give below a partial program to calculate number nodes in a tree. Fill in the blanks below:

```
int count ( node *root){
    if( root == NULL )   return 0;
    return 1 ___ count( root → left ) __ count( root → right)
}
```

(1) + + (2) * * (3) + * (4) * +

Q. 61. Given a partial program for reversal of a linked list. Complete the program:

```
void reverse(node *hdr){
    node *r = hdr;
    node *l = NULL;
    node *t;
    while( r != NULL){
        __ = r-> next;
        r-> next = l;
        l = __;
        r = t;
    }
}
```

(1) r t (2) l t (3) t r (4) l r

Q. 62. Which is the shortest path from s to v in the following graph.
(1) A C E D (2) A B C D
(3) A C D (4) A E D

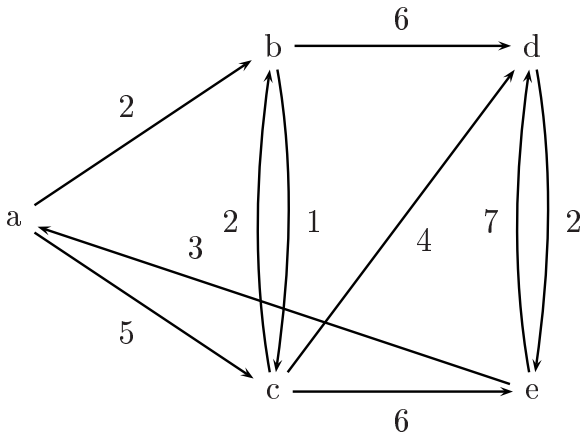


Figure 6: Fig. for Q. 62

Q. 63. An array of N elements is given. Elements are required to be shifted right by x places(right shift by x places). Which one of the following method can be efficiently used?
(1) Right shift the array by one element in one pass. Make x such passes.
(2) Allocate extra space of x. Copy last x places there. Now shift remaining array toward right, and then copy x places from temp. location to the start of array.
(3) Reverse 1 to x and $x+1$ to N sub-arrays and then reverse 1 to N.
(4) Store all elements in a list. Cut first x elements and append at the end. Now restore the array from list.

Q. 64. In a touring knight problem (a knight starts from some position on a chess board and visits all positions exactly once), the touring knight will not backtrack if in the lookahead
(1) Maximum number of possible locations at the next step are considered.
(2) Minimum number of possible locations at the next step are considered.
(3) Next move is chosen randomly from possible moves.
(4) Has to backtrack in any case.

Q. 65. What is the number of lexemes generated from the following program?

```
int max (i,j) int i, j;
/* return maximum of integers i and j */
{
    return i>j?i:j;
}
```

(1) 32 (2) 30 (3) 25 (4) 16

Q. 66. In a string of length n, how many substrings can be generated?
(1) 2^n (2) n^2 (3) $n(n+1)/2$ (4) $n(n-1)/2$

Q. 67. Consider the following regular grammar,

$$\begin{aligned} R_1 &= (a \mid b)^* \\ R_2 &= (a^* \mid b^*)^* \\ R_3 &= ((\epsilon \mid a)b^*)^* \end{aligned}$$

Minimized deterministic finite automata of which R_1, R_2 and R_3 are exactly same except state names?
(1) DFA for R_1 and R_2 are similar
(2) DFA for R_2 and R_3 are similar
(3) DFAs of R_1, R_2 and R_3 are different
(4) DFAs of R_1, R_2 and R_3 are similar

Q. 68. Consider the following grammar

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow \mid \epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow *FT' \mid \epsilon \\ F &\rightarrow (E) \mid id \end{aligned}$$

Which of the following is `Follow(F)`.
(1) $\{), id\}$
(2) $\{), id, \$, *, +\}$
(3) $\{+, *,), \$\}$
(4) $\{+,), \$\}$

Q. 69. Consider the following syntax directed definition of a simple desk calculator:

$$\begin{aligned} &1.\ L \rightarrow E_n\{\ print(E.val)\ \} \\ &2.\ E \rightarrow E_1 + 1\{\ E.val\ =\ E_1.val\ +\ T.val\ \} \\ &3.\ E \rightarrow T\ \ E.val\ =\ T.val \\ &4.\ T \rightarrow T_1 * F\{\ T.val\ =\ T_1.val * F.val\} \\ &5.\ T \rightarrow F\{\ T.val\ =\ F.val\} \\ &6.\ F \rightarrow (\ E\ )\{\ F.val\ =\ E.val\} \\ &7.\ F \rightarrow digit\{\ F.val\ =\ digit.lexval\} \end{aligned}$$

How many internal nodes are there in annotated parse tree for input $3 * 5 + 4n$
(1) 9 (2) 6 (3) 15 (4) 16

Q. 70. Consider the following grammar

$$\begin{aligned} S &\rightarrow iEtSS' \mid a \\ S &\rightarrow eS \mid \epsilon \\ E &\rightarrow b \end{aligned}$$

The grammar is
(1) LL(1)
(2) SLR but not LL(1)
(3) LALR but not SLR
(4) Not LL(1)

Q. 71. Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is

86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130

Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests, for each of the following disk- scheduling algorithms?

- FCFS
- SSTF
- SCAN

(1) 7081, 1745, 9769
(2) 7081, 1745, 7081
(3) 1745, 1004, 9600
(4) 9769, 1745, 7081

Q. 72. Which of the disk scheduling algorithm performs better?
(1) FCFS
(2) SSTF
(3) SCAN
(4) None of the above

Q. 73. Consider a program to be run on a computer system in round-robin CPU scheduling. The size of the program is 100K. It is given that the hard disk has a transfer rate of 1 megabyte per second. Assume that there are no head seeks and average latency is 8 milliseconds. What could be the acceptable time quantum for effective CPU utilization?
(1) 2.048 sec (2) 0.216 sec (3) 0.108 sec (4) 0.100 sec

Q. 74. An assembler is partitioned in Pass 1 and Pass 2. The symbol table, and common support routines are used by Pass 1 and 2. The memory requirement for each of the components are as follows:

- Pass 1 - 100K
- Pass 2 - 120K
- Symbol table - 50K
- Common Routines - 20K

Given that the overlay driver takes 10 K, what is the amount of memory required to load the program using overlays?
(1) 290 (2) 190 (3) 200 (4) 180

Q. 75. Consider the following programming structures/techniques.

1. Stack
2. Indirection
3. Hashed Symbol Table
4. Sequential search

Which of the above are better for paged environment?
(1) 1 and 2 (2) 1 and 4
(3) 2 and 3 (4) All are equally better

Q. 76. What is the output of following program?

```
main(){
    f(1234);
}
int f(int i){
    if( i && i < 10 ) {
        printf("%d ",i);
        return;
    }
    f(i % 10 );
    f(i / 10 );
}
```

(1) 1 2 3 4 3 2 1 (2) 4 3 2 1 1 2 3
(3) 4 3 2 1 (4) 1 2 3 4

Q. 77.

```
1   int k ;
2   fun( int i ){
3      k = i + 3;
4      print(k);
5   }
6
7
8   gun ( int i ) {
9       int k = 4;
10      k = i + 4 ;
11      fun( k) ;
12     print(k);
13  }
14  main() {
15     k = 2;
16     gun(k ) ;
17     print (k);
18  }
```

What will be the output if static scoping is used?
(1) 2 6 9 (2) 6 4 5 (3) 6 9 9 (4) 2 5 9

Q. 78. In the program above, if dynamic scoping used, what will be the output?
(1) 12 9 6 (2) 12 12 2
(3) 12 9 12 (4) 2 6 9

Q. 79. In a C program, following definitions are used:

```
char *s1 = "Gate";
char s2[] = "Genie";
```

1. `s1` is a variable where as `s2` is not.
2. Each location at `s1` is not a variable where as each location at `s2` is.
3. `strcpy(s1,"Str")` can not be used.
4. `strcpy(s2,"Str")` can be used.

Which of the above statements are true?
(1) Only 1, 2 are correct. (2) Only 3 and 4 are correct
(3) 1, 3 and 4 are correct. (4) All are correct.

Q. 80.

```
1 #define swap(a,b) a=a+b, b=a-b, a=a-b
2
3 int main(){
4     int t1 = 2, t2=5, c;
5     c = swap(t1,t2);
6     printf("%d %d %d", t1, t2, c);
7 }
```

what is the output of the program?
(1) 5 2 7 (2) 5 2 5 (3) 5 2 2 (4) 2 5 7

Q.81-90 are in the set of two each. We have not implemented dependency of 81b on 81a so that you can get correct answers for both. But in exam, you will be evaluated on dependency basis

For Q.81-82.

A given lot of ICs contains 2% defective chips. Each chip is tested before delivery. The tester itself is not fully reliable about the test.

$$\text{P(Tester certifies good} \mid \text{actually good)} = 0.95$$
$$\text{P(Tester certifies defective} \mid \text{actually defective)} = 0.94$$

If the chip is found to be defective, what is the probability that it is actually defective?
(1) 27% (2) 94% (3) 73% (4) 6%

Q. 82. An analog signal received at a detector may be modeled as a normal distribution random variable $N(200, 256)$. What is the probability that the signal will exceed 240 units?
(1) 0.996 (2) 0.00621 (3) 0.023 (4) none of the above

For Q.83-84.

Q. 83. Represent -5.0 in IEEE 754 floating point format.
(1) C0A0 0000 (2) 81A0 0000 (3) C0C0 0000 (4) 8020 0000

Q. 84. In an unpipelined machine, assume that the times required for the five functional units, which operate in each of the five cycles, are as follows:

10 ns, 8ns, 10ns, 10 ns and 7ns.

Addition of pipelining adds 1ns of overhead. Find the speedup versus the unpipelined execution. (1) 5.3 (2) 2.2

For Q.85-86.

Q. 85. What is the probability that the signal is larger than 240 units given that it is larger than 210 units?
(1) 0.023 (2) 0.006 (3) 0.98 (4) none of above

Q. 86. Find eigen values of

$$A = \begin{bmatrix} 2 & 3 \\ 3 & -6 \end{bmatrix}$$

(1) 2 and -6 (2) 3 and 2 (3) 4 and -6 (4) 3 and -7

For Q.87-88.

Q. 87. What is the minimum and maximum number of elements in a heap of size h.

(1) $2^{(h-1)}, (2^h + 1) - 1$ (2) $2^h, (2^h + 1) - 1$
(3) $2^{(h-1)}, (2^h) - 1$ (4) $(2^h) - 1, (2^h + 1) - 1$

Q. 88. What will be returned for `conv(50)`

```
int conv(int t){
    int u = 0
    u = 5 / 9 * (t - 32);
    return u;
}
```

(1) 10 (2) 0 (3) -10 (4) 5

For Q.89-90.

Consider a schema given below:

```
branch(branchid, name, manager,...)
customer(cid, name, address,...)
account(accountid, cid, branchid,type)
```

The `account type` can be savings or current.

Q. 89. What does the following query does?

```
select c.name
from customer c, branch b, account a1, account a2
where a1.cid = c.cid and a2.cid = c.cid
and a1.type = 'current' and a2.type = 'savings'
and a1.branchid <> a2.branchid ;
```

(1) Select name of customers with two accounts of different types in same branch
(2) Select name of customers with two accounts of same types in different branches
(3) Select name of customers with two accounts of different type in different branches
(4) Select name of customers with same account number with different types in different branches.

Q. 90. Which of the following queries will then print list of branches with customers having current accounts more than savings accounts.

(1)

```
select b1.name from branch b1, branch b2
where ( select count(*) from branch b, account a
where b.branchid = a.branchid
and a.type = 'current') >
( select count(*) from branch b, account a
where b.branchid = a.branchid and a.type = 'savings' )
```

(2)

```
select b1.name from branch b1
where ( select count(*) from branch b, account a
where b.branchid = a.branchid
and a.type = 'current' ) >
( select count(*) from branch b, account a
where b.branchid = a.branchid and a.type = 'savings' )
```

(3)

```
select b1.name from branch b1
where ( select count(*) from branch b, account a
where b.branchid = a.branchid
and a.type = 'current') >
( select count(*) from branch b, account a
where b.branchid = a.branchid and a.type = 'savings' )
```

(4)

```
select b1.name from branch b1, branch b2
where ( select count(*) from branch b, account a
where b.branchid = a.branchid
and b.branchid = b1.branchid
and a.type = 'current' ) >
( select count(*) from branch b, account a
where b.branchid = a.branchid
and b.branchid = b1.branchid
and a.type = 'savings' )
```

GateGenie Practice Test No. 3

GateGenie Practice Test No. 3

All questions carry 1 marks each.

Q. 01. Give the converse of "If it is raining then I get wet".
(1) If it is not raining then I get wet
(2) If it is not raining then I do not get wet
(3) If it get wet then it is raining
(4) If I do not get wet then it is not raining

Q. 02.

$$A = \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 8 & 9 \\ 0 & 0 & 7 & 4 \\ 0 & 0 & 0 & 3 \end{bmatrix}$$

$|A| =?$
(1) 0 (2) 120 (3) 252 (4) 40

Q. 03. How many spanning trees are there in graph having n edges?
(1) $n!$ (2) 2^n (3) n (4) n^2

Q. 04. Which of the following statement is true about $B = \{D, \{A\}\}$
(1) $A \epsilon B$ (2) $\{A\} \epsilon B$
(3) $\{A\} \subseteq B$ (4) $\{D, A\} \epsilon Pow(B)$

Q. 05. How many arithmetic 0s are there in 1's complement?
(1) 0 (2) 1 (3) 2 (4) none of above

Q. 06. In boolean algebra $x + xy =?$
(1) x (2) y (3) xy (4) none of above

Q. 07. Given function $F = \sum(1, 3, 6, 7)$ on 3 variables. Express F in product of sum (POS) form.
(1) $F' = \Pi(1, 3, 6, 7)$ (2) $F' = \Pi(1, 2, 3, 6)$
(3) $F' = \Pi(0, 2, 4, 5)$ (4) none of above

Q. 08. What is average rotation time for disk having speed 7200 RPM?
(1) 8.3 ms (2) 4.15 ms (3) 6.9 ms (4) 0.20 ms

Q. 09. The transition function of DFA from one state to another on a given input symbol w is a function $Q \times \Sigma^*$ to
(1) 2^Q (2) Q (3) Q' (4) Q^2

Q. 10. If L_1 and L_2 are regular languages over Σ^* Which of the following statements are incorrect?
(1) $L_1 \cup L_2$ is regular (2) $L_1 \cap L_2$ is regular
(3) L_1^* is regular (4) None of the above

Q. 11. Context free languages are closed under
(1) union (2) intersection (3) complementation (4) kleene closure

Q. 12. Time complexity of randomized quick sort is
(1) $O(log\ n)$ (2) $O(n\ log\ n)$ (3) $O(n^2)$ (4) $O(n)$

Q. 13. Time complexity of Bellman-Ford algorithm for finding single source shortest path for negative weight edges is
(1) $O(V)$ (2) $O(E)$ (3) $O(VE)$ (4) $O(V+E)$

Q. 14.

```
dec2bin(int i ){
  if( i ){
    dec2bin(i _ 2 );
    printf("%d",i _ 2 ) ;
  }
}
```

Fill in the blanks if the program above prints binary representation of a decimal number.
(1) % % (2) % / (3) / % (4) / /

Q. 15.

```
count = 0;
for(i=1;i<100;i+=i){
   ++count;
}
```

What will be the value of count at the end of the loop execution?
(1) 10 (2) 7 (3) 99 (4) 100

Q. 16. What feature of heaps allows them to be efficiently implemented using a partially filled array?
(1) Heaps are binary search trees.
(2) Heaps are complete binary trees.
(3) Heaps are full binary trees.
(4) Heaps contain only integer data.

Q. 17. What is postfix notion for following infix notation?

\+ A * + B C D

(1) B + C * D + A
(2) A + * B C + D
(3) A + * B + C D
(4) A + B + C * D

Q. 18. Which of the following has the least processing delay
(1) repeater (2) bridge (3) router (4) gateway

Q. 19. Σ^* over $\{0,1\}$ is
(1) uncountably infinite (2) countably infinite
(3) finite (4) none of the above

Q. 20. Which of the following is not context free language?
(1) $\{a^n b^n c^m d^m \mid n \geq 1, m \geq 1\}$
(2) $\{a^n b^m c^m d^n \mid n \geq 1, m \geq 1\}$
(3) $\{a^n b^m c^n b^m \mid n = m\}$
(4) $\{a^n b^m c^n d^m \mid n \geq 1, m \geq 1\}$

Optional for practice.

Q. 21. Which of the following can be handled by predictive parsers?
(1) Left recursion (2) Left factors
(3) Ambiguity (4) Nondeterminism

Q. 22. The grammar having no ϵ transition or two adjacent nonterminals in the right side of any production is?
(1) LL(1) grammar (2) Unambiguous grammar
(3) Operator grammar (4) Context Sensitive grammar

Q. 23. Which of the following device, spooling uses for reading and writing the data?
(1) Cache (2) RAM (3) Disk (4) I/O devices

Q. 24. Which of the following information is not part of process control block:

1. Process State
2. List of open files
3. Process Page Table
4. Stack pointer

(1) Only 3 (2) 3 and 4 (3) 2 and 4 (4) none of the above

Q. 25. Consider a logical address space of eight pages of 1024 words each mapped onto a physical memory of 32 frames. How many bits are there in physical address?
(1) 13 (2) 15 (3) 10 (4) 14

All questions carry 2 marks each.

Q. 26. In which of the following situations deadlock will occur?
(1) Process requests all the required resources in the beginning
(2) Process requests resource only if it has none
(3) Resources are immediately allocated to process holding some resources
(4) Process orders resources in increasing order of enumeration

Q. 27. Redundancy is dangerous as it is a potential threat to data

1. Integrity
2. Consistency
3. Atomicity

(1) 1 and 2 only (2) 1 and 3 only
(3) 2 and 3 only (4) All of the above

Q. 28. An attribute of one table matching the primary key of another table, is called as
(1) Candidate Key (2) Primary Key
(3) Foreign Key (4) Composite Key

Q. 29. A network on the internet has a subnet mask of 255.255.240.0. How many hosts can each subnet handle?
(1) 256 (2) 2048 (3) 2046 (4) 4096

Q. 30. Which of the following is NOT a consequence of subnetting a network?
(1) Isolation of network traffic. (2) Routing table explosion.
(3) Improved security. (4) None of the above.

Q. 31. Which of the following statements are correct?

1. Every view serializable schedule is conflict serializable
2. Every conflict serializable schedule is view serializable.

3. Some view serializable schedules are conflict serializable.

4. No view serializable schedule is conflict serializable.

(1) 1 only
(2) 2 and 3 only
(3) 1 and 4 only
(4) 2 and 4 only

Q. 32. Consider three tables with following number of tuples in each

S(a,b,c) = 100 , R(a,d,e) = 80 , T(x,d,f) = 90
Tuples in S and R with same value of attribute 'a' = 60
Tuples in R and T with same value of attribute 'd' = 70

What is the maximum and minimum number of tuples in

(S left outer join R) full outer join T ?

(1) 130 120 (2) 150 140 (3) 140 130 (4) 140 120

Q. 33. Given two numbers:

$$a = p_1^{a_1}.p_2^{a_2}\dots p_k^{a_k}$$
$$b = p_1^{b_1}.p_2^{b_2}\dots p_k^{b_k}$$

p_i is i^{th} prime number i.e. $p_0 = 2$, $p_1 = 3$ and so on. What is $GCD(a, b)$?

(1) $\Pi p_i^{max(ai,bi)}$ (2) $\Pi p_i^{min(ai,bi)}$
(3) $\Pi p_i^{|ai-bi|}$ (4) $\Pi p_i^{ai/bi}$

Q. 34. $R : A \to B$. A_1 is subset of A and A_2 is subset of B. Which of the following statements is not correct?

(1) $R(A1 \cup A2) \subseteq R(A1) \cup R(A2)$
(2) $R(A1 \cap A2) \subseteq R(A1) \cap R(A2)$
(3) $R(A1 \cup A2) \supseteq R(A1) \cup R(A2)$
(4) $R(A1 \cup A2) \supseteq R(A1) \cap R(A2)$

Q. 35. Compute

$$A = \begin{bmatrix} 5 & -7 & 2 & 2 \\ 0 & 3 & 0 & -4 \\ -5 & -8 & 0 & 3 \\ 0 & 5 & 0 & -6 \end{bmatrix}$$

Compute $|A|$.

(1) 90 (2) 20 (3) 0 (4) 4

Q. 36.

$$A = \begin{bmatrix} 3 & 4 \\ 5 & 6 \end{bmatrix}$$

Find A^{-1}.

(1) $A = \begin{bmatrix} 3/2 & -2 \\ 5/2 & 6 \end{bmatrix}$ (2) $A = \begin{bmatrix} -3 & -4 \\ -5 & -6 \end{bmatrix}$
(3) $A = \begin{bmatrix} -3 & 2 \\ 5/2 & -3/2 \end{bmatrix}$ (4) A is not invertible

Q. 37. A fair six-sided die is tossed three times and the resulting sequence of numbers is recorded. What is the probability of the event E that either all three numbers are equal or none of them is a 4?

(1) 7/12 (2) 131/126 (3) 125/131 (4) none of the above

Q. 38. Which of the following are not logically equivalent?
(1) $p \Rightarrow q \equiv ((\neg p) \cup q)$
(2) $\neg(p \leftrightarrow q) \equiv ((p \cap q) \cup (q \cap \neg p))$
(3) $\exists x(p(x) \Rightarrow q(x)) \equiv \forall x p(x) \Rightarrow q(x)$
(4) $\exists x p(x) \Rightarrow \forall x q(x)$

Q. 39. Consider the following fig. Which of the following is true?

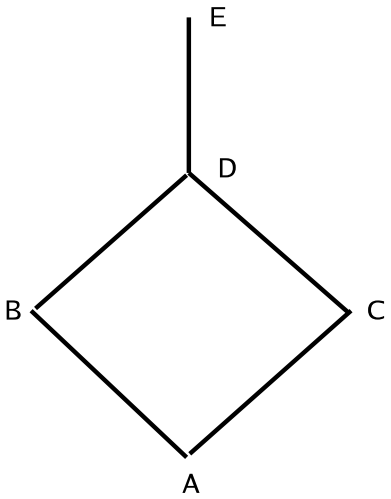


Figure 7: Fig. for Q. 39

(1) There exists a Euler path but not Euler circuit
(2) There exists a Euler circuit
(3) Euler path is not possible.
(4) none of the above

Q. 40. A data stream of size 512 bytes has to be sent over a TCP/IP network running at 10Mbps. The transport layer adds a header of size 10 bytes. The network layer adds a header of size 20 bytes and the data link layer adds a header of size 30 bytes. What is the effective data transmission rate for this data stream. Assume the payload field of each layer can accommodate the data into one packet.
(1) 10 Mbps (2) 9.1 Mbps (3) 8.9 Mbps (4) 11.1 Mbps

Q. 41. Match the following

```
1. Connectionless unreliable A. Registered post
2. Connectionless reliable   B. Digitized voice
3. Connection oriented       C. File transfer
reliable
4. Connection oriented       D. Electronic junk mail
unreliable
```

(1) 1-C, 2-A, 3-D, 4-B
(2) 1-D, 2-C, 3-A, 4-B
(3) 1-B, 2-A, 3-C, 4-D
(4) 1-D, 2-A, 3-C, 4-B

Q. 42. Consider a CSMA/CD network running at 100Mbps over 5km shared-medium cable with no repeater. The signal speed in the cable is 200,000km/sec.
(1) 500 (2) 625 (3) 701 (4) 902

Q. 43. Which of the following is not true?
(1) $(X \odot Y) \odot Z = X \odot (Y \odot Z)$ (2) $(X \odot Y) \odot Z = (X + Y + Z)'$
(3) $(X \oplus Y) \oplus Z = (X \oplus Y) \oplus Z$ (4) $(x + y) + z = x + (y + z)$

Q. 44. Simplify a function F on 4 variables using K-Map:

$$F = \sum(1, 2, 4, 7, 8, 11, 13, 14)$$

(1) $x'y' + xy$ (2) $xy + x'y$
(3) $x'y + y'x$ (4) $x + xy'$

Q. 45. Implement $F(A, B, C) = \sum(1, 3, 5, 6)$ using 4:1 multiplexer. What input will be there on select line S_0 and S_1. S_1 being the most significant bit. Answer in order S_1, S_0.
(1) 0, 1 (2) B, C (3) A, B (4) A, C

Q. 46. The value of j at the end of the execution of the following C program

```
int reduce(int i){
        int count;
        count-= i;
        return count;
    }

    main(){
        int i,j;
        for(i=0;i<5;i++){
            j = reduce(i);
        }
    }
```

(1) -5 (2) -10 (3) 10 (4) Garbage

Q. 47. Consider the following statements about L

1. L is accepted by multi-tape Turing machine M_1.
2. L is also accepted by a single tape Turing machine M_2.

Which of the following statement is correct?
(1) Acceptance by M_2 is slower by $O(n^2)$
(2) Acceptance by M_2 is slower by $O(n)$
(3) Acceptance by M_2 is faster by $O(n^2)$
(4) Acceptance by M_2 is faster by $O(n)$

Q. 48. Define language L_0 and L_1 on $\Sigma = a, b$ as follows:

$$L = \{ < M, w, abb > \mid M \textit{ halts on } w\}$$

$< M, w, x >$ is a triplet, where M is encoding in TM on string w and x is a grammar. Which of the following is true?
(1) Both are recursive
(2) L and L' is recursively enumerable
(3) L is recursively enumerable but L' is not
(4) neither L nor L' is recursively enumerable

Q. 49. Let $M = (\{q_0, q_1\}, \{0, 1\}, \{X, Z_0\}, \delta; Z_0, \phi)$ be a PDA with the transition functions:

$$\begin{aligned}
(q_0, 0, Z_0) &= q_0, XZ_0 \\
(q_0, 0, X) &= q_0, XX \\
(q_0, 1, X) &= q_1, \epsilon \\
(q_1, 1, X) &= q_1, \epsilon \\
(q_1, \epsilon, X) &= q_1, \epsilon \\
(q_1, \epsilon, Z_0) &= q_1, \epsilon
\end{aligned}$$

Construct a CFG $G = (V, T, P, S)$ generating $N(M)$. What is cardinality of V?
(1) 5 (2) 9 (3) 8 (4) 4

Q. 50. With respect to the **Q 49**, How many productions are non-unit productions?
(1) 6 (2) 1 (3) 7 (4) 2

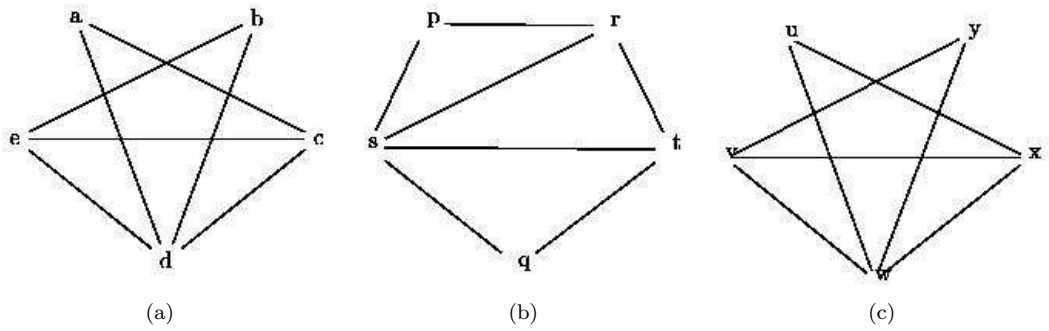
Q. 51. Let $L = w : w \ni 3k + 1\ b's\ \forall k > 0$. Construct a minimized finite automata D accepting L. How many states are there in D?
(1) 4 (2) 3 (3) 2 (4) The language is not regular

Q. 52. Consider L with the following productions

$$\begin{aligned} S &\rightarrow aAS \mid a \\ A &\rightarrow SbA \mid SS \mid ba \end{aligned}$$

Which of the following statements is correct?
(1) L is recursive (2) L is inherently ambiguous
(3) L is unambiguous CFL (4) L is ambiguous CFL

Q. 53. Which of the following graphs are isomorphic?



(a) (b) (c)

Figure 8: Figs for Q. 53

(1) A and B (2) A and C (3) B and C (4) All three

Q. 54. What is the order of addition and multiplication of matrices of order $n \times n$?
(1) $O(n)$ and $O(n^2)$ (2) $O(n^2)$ and $O(n^3)$
(3) $O(1)$ and $O(n)$ (4) $O(n^3)$ and $O(n^2)$

Q. 55. Which of the following is not a valid subnet mask?
(1) 255.255.224.0 (2) 255.240.0.0
(3) 255.255.252.0 (4) 255.255.228.0

Q. 56. Number of binary trees with 4-nodes is
(1) 336 (2) 14 (3) 24 (4) 16

Q. 57. Which of the following statement(s) is/are true?

1. Q belongs to NP implies Q belongs to P
2. Q belongs to P implies Q belongs to NP
3. Q belongs to NP-Complete implies Q belongs to NP-Hard
4. Q belongs to NP-Hard implies Q belongs to NP-Complete

(1) 1 and 3 (2) 2 and 4
(3) 1 and 4 (4) 2 and 3

Q. 58.

$$\begin{aligned} T(n) &= T(n-1) + lg\ n \\ T(1) &= 1 \end{aligned}$$

(1) $T(n) = O(n^2)$ (2) $T(n) = O(n\ lg\ n)$
(3) $T(n) = O(n)$ (4) $T(n) = O(lg\ n)$

Q. 59. Consider a binary search tree as shown in Fig. 9: The tree after addition of 33 will be

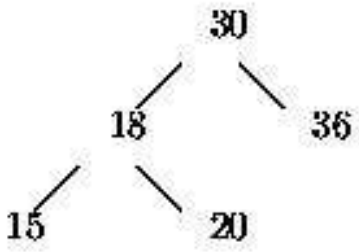
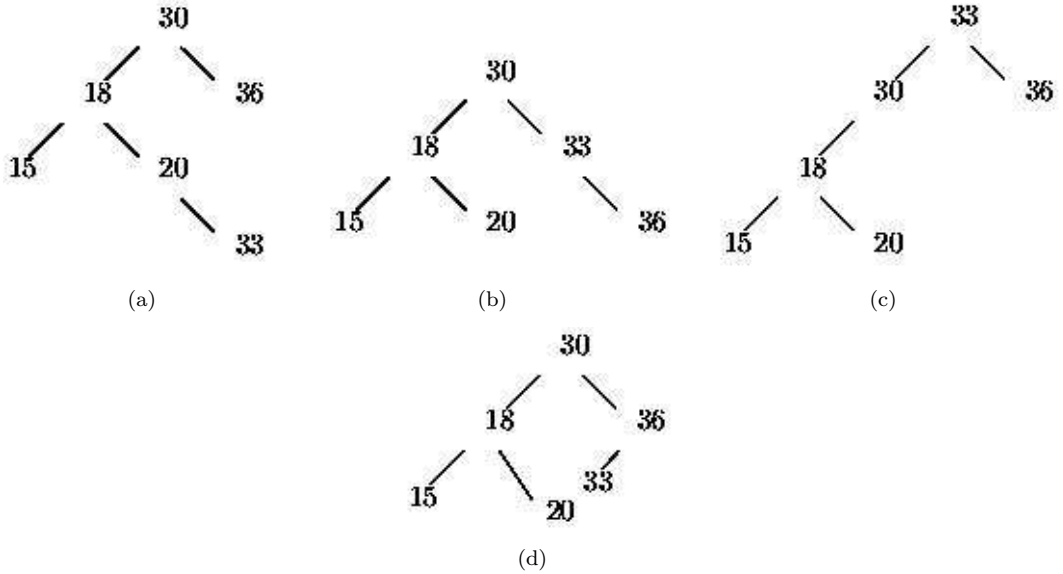


Figure 9: Fig. for Q. 59



Q. 60. Number of binary trees with 3 nodes which when traversed in pre-order will be PQR
(1) 2 (2) 3 (3) 4 (4) 5

Q. 61. The expression which access the i, j th entry of a $m \times n$ matrix stored in column major form is: Note that m is number of columns and n is number of rows
(1) $n \times (i-1) + j$ (2) $m \times (j-1) + i$
(3) $m \times (n-j) + j$ (4) $n \times (m-i) + j$

Q. 62. Suppose you have a directed graph representing all the flights that an airline flies. What algorithm might be used to find the best sequence of connections from one city to another?
(1) Breadth first search. (2) Depth first search.
(3) A cycle-finding algorithm. (4) A shortest-path algorithm.

Q. 63. Consider the usual algorithm for determining whether a sequence of parentheses is balanced. Suppose that you run the algorithm on a sequence that contains 2 left parentheses and 3 right parentheses (in some order). What is the maximum number of parentheses that will ever appear on the stack AT ONE TIME during the computation?
(1) 1 (2) 2 (3) 3 (4) 4

Q. 64. Minimum number of colors needed to color a graph of n nodes ($n > 3$) and 2 edges is:
(1) 1 (2) 2 (3) 3 (4) 4

Q. 65. Consider the following statements:
S1: Viable prefixes of right sentential form appears on the stack of a shift reduce parser.
S2: Viable prefix extends past the right end of the rightmost handle of sentential form.
S3: It is always possible to add terminal symbol at end of viable prefix to obtain right sentential form
(1) S1 and S2 are true (2) S1 and S3 are true
(3) Only S1 is true (4) S2 and S3 is correct

Q. 66. Consider the following grammar

$$\begin{aligned} expr &\rightarrow expr * term \mid expr/term \mid term \\ term &\rightarrow term + factor \mid term - factor \mid factor \\ factor &\rightarrow digit \mid (expr) \end{aligned}$$

Which of the following statements is not correct?
(1) + and - are left associative
(2) * and / are left associative
(3) * and / have the highest precedence
(4) +/- have the highest precedence

Q. 67. Consider the following regular grammar,

$$\begin{aligned} R_1 &= (a|b)^* \\ R_2 &= (a^*|b^*)^* \\ R_3 &= ((\epsilon|a)b^*)^* \end{aligned}$$

Which of the following statements are not correct?
(1) $R_1 = R_2$ (2) $R_1 \subset R_2$
(3) $R_3 \subseteq R_1 \cap R_3 \subseteq R_2$ (4) $R_2 \subseteq R_1$.

Q. 68. Consider the following grammar

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow *TE' \mid \epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow *FT' \mid \epsilon \\ F &\rightarrow (E) \mid id \end{aligned}$$

Which of the following is $First(E)$.
(1) $\{T,)\}$
(2) $\{(, id\}$
(3) $\{), \$\}$
(4) none of above

Q. 69. Consider the following syntax directed definition of a simple desk calculator:

1. $L \rightarrow En\{print(E.val)\}$
2. $E \rightarrow E1 + 1\{E.val = E1.val + T.val\}$
3. $E \rightarrow T\{E.val = T.val\}$

4. $T \rightarrow T1 * F\{T.val = T1.val * F.val\}$
5. $T \rightarrow F\{T.val = F.val\}$
6. $F \rightarrow (E)\{F.val = E.val\}$
7. $F \rightarrow digit\ \{F.val = digit.lexval\}$

How many moves a translator makes to get the final value of $3 * 5 + 4n$.
(1) 9 (2) 6 (3) 15 (4) 16

Q. 70. Consider the following grammar

$$\begin{aligned} S &\rightarrow Aa|bAc|dc|bda \\ A &\rightarrow d \end{aligned}$$

The grammar is not
(1) LALR(1) (2) LR(1) (3) SLR(1) (4) none of the above

Q. 71. The selection of time quantum of Round Robin Scheduling policy does not affect:
(1) Turn-around time (2) Context-switch frequency
(3) Performance of Round Robin policy (4) none of the above

Q. 72. Assuming pages of size 128 words each, how many page faults will be generated by the following C snippet:

```
int A[128][128];
for( int j=0; j<128; j++)
  for( int i=0; i<128; i++)
    A[i][j] = 0;
```

(1) 128 (2) 16384 (3) 0 (4) none of the above

Q. 73. A certain computer provides its users with a virtual-memory space of 2^{32} bytes. The computer has 2^{18} bytes of physical memory. The virtual memory is implemented by paging, and the page size is 4096 bytes. A user process generates the virtual address 11123456. What is displacement in the page?
(1) 0001 0001 0001
(2) 0001 0001 0001 0010 0011
(3) 0010 0011 0100 0101 0110
(4) 0100 0101 0110

Q. 74. Assume we have a demand-paged memory. The page table is held in registers. It takes 8 milliseconds to service a page fault if an empty page is available or the replaced page is not modified, and 20 milliseconds if the replaced page is modified. Memory access time is 100 ns. Assume that the page to be replaced is modified 70 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 200 ns?
(1) $6.1 * 10^{-6}$ (2) $7.3 * 10^{-6}$
(3) $3.4 * 10^{-4}$ (4) none of the above

Q. 75. Consider the following page reference string:

102, 203, 306, 424, 227, 156, 527,
656, 253, 183, 207, 308, 745, 623,
345, 242, 112, 223, 321, 622.

A page size is 100 bytes. How many page faults will occur with LRU Replacement algorithm with 5 frames?
(1) 10 (2) 8 (3) 7 (4) 11

Q. 76. Suppose you are given array $p[1 \ldots N]$ and $q[1 \ldots N]$ both uninitialized (that is, each location may contain an arbitrary value), and a variable count, initialized to 0. Consider the following procedures set and *is_set*:

```
set(i){
  count = count + 1;
  q[count] = i ;
  p[i] = count;
}
boolean is_set(i){
  if(p[i] <= 0 || p[i] > count) {
    return false;
  if( q[p[i]] != i)
    return false;
  return true;
  }
}
```

Suppose we make following sequence of calls:

`set(3); set(4); set(2); set(1)`

What will be the value of `q[2],q[3], q[4]`, and `p[2],p[3],p[4]`

(1) 4 2 1 4 3 1 (2) 3 4 2 4 3 1
(3) 3 4 2 3 1 2 (4) 4 2 1 3 1 2

Q. 77.

```
 1 int x;
 2  Q(int z){
 3    z += x;
 4  }
 5
 6  P(int y){
 7    int x;
 8    x = y + 3;
 9    Q(x);
10    print(x);
11  }
12
13 main(){
14   x = 3;
15   P(x);
16   Q(x);
17   print(x);
18 }
```

What will be the output of the program if static scoping is used?

(1) 9, 6 (2) 3, 18 (3) 3, 6 (4) 9, 18

Q. 78. What will be the output of following C program:

```
main(){
  int i, j, k;
  i = 2, j= 8;
  for( k = i; k <= j; k++, j--){
     printf("%d  ", j % k);
  }
}
```

(1) 0 1 2 0 (2) 0 1 2 3
(3) 0 1 2 1 (4) 0 1 3 0

Q. 79.

```
P(int a,int b,int c){
  a = 2;
  c = a + b;
}

main(){
  x = 1;
  y = 5;
  z = 10;
  P(x, x*y, z);
  print(x,y,z);
}
```

What will be output if pass by name is used?
(1) 6 (2) 12 (3) 10 (4) 8

Q. 80. **a.** What is the expression evaluated to?
b. What is the maximum number of elements in the stack during evaluation of the expression: 3 5 + 3 2 2 * + +
(1) 15 3 (2) 12 3 (3) 15 4 (4) 12 4

Q.81-90 are in the set of two each. We have not implemented dependency of 81b on 81a so that you can get correct answers for both. But in exam, you will be evaluated on dependency basis

For Q.81-82.

Consider the poset $A = \{a, b, c, d, e, f, g, h\}$. The Hasse diagram is given below.

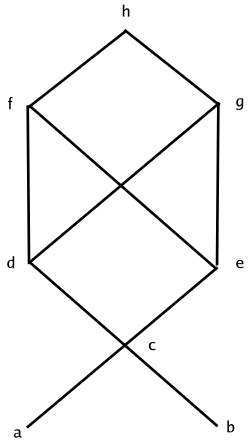


Figure 10: Fig. for Q. 81

Q. 81. Find the lower and upper bound for $B_1 = \{a, b\}$ respectively.
(1) $\{a, b\}$ and $\{c\}$ (2) $\{a, b\}$ and $\{f\}$
(3) $\{\}$ and $\{c, d, e, f, g, h\}$ (4) $\{\}$ and $\{c\}$

Q. 82. With respect to **Q81**, the lower and upper bound for $B_1 = \{c, d, e\}$ respectively are
(1) $\{a, b\}$ and $\{h\}$ (2) $\{c\}$ and $\{h\}$
(3) $\{c, a, b\}$ and $\{h\}$ (4) $\{c, a, b\}$ and $\{f, g, h\}$

For Q.83-84.

Q. 83. If machine A runs a certain program in 10ms and machine B runs the same program in 15 ms. Which of the following statement is true?
(1) A is 66% faster than B
(2) A is 66% slower than B
(3) A is 50% slower than B
(4) A is 50% faster than B

Q. 84. What is average time to read or write a 512-byte sector for a typical disk with average seek time 9ms, transfer rate 4 MB/sec, and the disk rotates at 7200 RPM, and the controller overhead is 1ms. Assume that the disk is idle so that there are no queuing delay.
(1) 14.3 ms (2) 13.3 ms (3) 4.275 ms (4) 0.125 ms

For Q.85-86.

Q. 85. A semi-groups is

1. Closed
2. Commutative
3. Associative

(1) 1 and 2 only (2) 1 and 3 only
(3) 2 and 3 only (4) All are correct.

Q. 86. Let $(A, *)$ be a semi-group. Furthermore, $\forall a, b \in A$, if $a \neq b$ then $a * b \neq b * a$ Which of the following are correct?

1. $\forall a \in A, a * a = a$
2. $\forall a, b \in A, a * b * a = a$
3. $\forall a, b, c \in A, a * b * c = a * c$

(1) 1 and 2 only (2) 1 and 3 only
(3) 2 and 3 only (4) All are correct.

For Q.87-88.

Q. 87. What will be the number of elements in left-subtree and right-subtree of the heap if following elements are inserted in order: `45,26, 84, 63, 27, 94, 47`
(1) (3,3) (2) (2,4) (3) (4,3) (4) (4,2)

Q. 88. What will the ratio of number of nodes if root is deleted?
(1) (2,4) (2) (2,3) (3) (3,3) (4) None of the above

For Q.89-90.

Q. 89. Consider a simple schema where records of share transactions are stored.

```
share(name, lastclosing, currentclosing,transdate)
```

Which of the following queries will print shares with 10% and more volatility today?

(1)
```
select s.name from share s
where s.currentclosing = s.lastclosing * 1.10
and s.currentclosing = s.lastclosing * 0.90
and s.transdate = today();
```

(2)
```
select s.name from share s
where s.currentclosing ≥ s.lastclosing * 1.10
or s.currentclosing ≤ s.lastclosing * 0.90
```

(3)
```
select s.name from share s
where s.currentclosing > s.lastclosing * 0.10
and s.currentclosing ≤ s.lastclosing * 0.10
and s.transdate = today();
```

(4)
```
select s.name from share s
where (s.currentclosing ≥ s.lastclosing * 1.10
or s.currentclosing ≤ s.lastclosing * 0.90 )
and s.transdate = today();
```

Q. 90. With respect to schema of **Q. 89**, what does the following query output?

```
select s1.name, max(transdate) as lastdate
from share s1, share s2
where s1.currentclosing = s2.currentclosing
and s1.transdate <> s2.transdate
and s1.name = s2.name
and s1.transdate = today();
```

(1) Prints list of shares with first day on which the closing amount was same as today

(2) Prints list of shares with last date for which the closing amount was same as today"s closing amount.

(3) Prints Last date on which the closing amount was not same as today' closing value.

(4) Prints list of shares with date on which the share value was equal to yesterday"s share value.

GateGenie Practice Test No. 4

GateGenie Practice Test No. 4

All questions carry 1 marks each.

Q. 01. What is cardinality of a multi-set having letters "MISSISSIPPI"?
(1) 4 (2) 11 (3) 3 (4) 6

Q. 02. How many distinguishable permutations can be generated from word "BANANA"?
(1) 720 (2) 60 (3) 240 (4) 120

Q. 03. How many edges are there in a complete graph having 12 nodes?
(1) 12 (2) 144 (3) 66 (4) none of above

Q. 04. What is the maximum length of cycles in a digraph of partial order on A having n elements?
(1) 2 (2) 3 (3) 1 (4) n

Q. 05. How many min-term does decoder provides for n input variables?
(1) $(2)^n$ (2) n (3) $log\ n$ (4) $((2)^2)^n$

Q. 06. $F(A, B, C) = \sum(1, 3, 5, 6)$ can be implemented with:
(1) 2:1 (2) 4:1 (3) 8:1 (4) None of the above

Q. 07. Which of the following operations are commutative and associative?
(1) OR (2) NAND (3) NOR (4) None of the above

Q. 08. Fig. 8 represents,

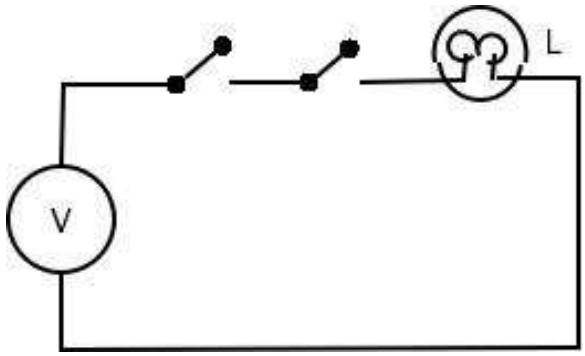


Figure 11: Fig. for Q. 8

(1) AND (2) OR (3) NOR (4) NAND

Q. 09. Which of the following is undecidable?
(1) Equivalence of regular languages
(2) Equivalence of context free languages
(3) Finiteness check on context free languages
(4) Emptiness of regular languages

Q. 10. Which of the following statement is not correct?

(1) If L is accepted by NFA, then there exists a DFA that accepts L
(2) If L is accepted by an NFA with ϵ transition, then L can be accepted by NFA without ϵ transition.
(3) If L is accepted by a non-deterministic PDA, then it is not always true that L is also accepted by deterministic PDA.
(4) If L is acceptable by multi-tape Turing Machine, then L' is recursively enumerable.

Q. 11. Which of the following regular expression does not contain 00 as a substring?
(1) $(0+\epsilon)(1+10)^*$ (2) $(1^*0^*)^*$ (3) 10^*+1^* (4) $(1+0)^*$

Q. 12. Programming language like C inherently supports recursion because
(1) It has static allocation of variables
(2) Has stack based implementation
(3) News machine architecture supports recursion.
(4) Has dynamic allocation of variables.

Q. 13. Symmetric matrices can be stored efficiently by stored only the lower half or the upper half in a one dimensional array. Let us consider a situation where only lower half of the matrix is stored. In this case, an (i,j) element is accessed as:
(1) i(i-1)/2 + j (2) i(i-1)/2 - j
(3) j(j-1)/2 + i (4) j(j-1)/2 - i

Q. 14. A ternary tree is a tree in which every internal node has exactly three children. Number of leaves in a ternary tree with n internal nodes:
(1) 2(n+1) + 3 (2) 2n (3) 3n (4) 2(n-1) + 3

Q. 15.

```
struct A{
  int num;
  union B{
    int val1;
    float val2;
  }
}
```

If int take 2 bytes and float takes 4 bytes then memory required for an array of 30 elements of A is
(1) 240 (2) 120 (3) 180 (4) 300

Q. 16. Which statement is true for a B-tree?
(1) All entries of a node are greater than or equal to the entries in the node's children.
(2) All leaves are at the exact same depth.
(3) All nodes contain the exact same number of entries.
(4) All non-leaf nodes have the exact same number of children.

Q. 17. Why is writing easily modifiable code important?
(1) Easily modifiable code generally has a quicker run time.
(2) Most real world programs require change at some time.
(3) Most text editors make it easy to modify code.
(4) Several people may be writing the same function at the same time.

Q. 18. In a real computer, what will happen if you make a recursive call without making the problem smaller?
(1) The operating system detects the infinite recursion because of the "repeated state"
(2) The program keeps running until you press Ctrl-C
(3) The results are nondeterministic
(4) The run-time stack overflows, halting the program

Q. 19. goto function of LR class of grammar is represented as
(1) Deterministic Finite Automata transitions
(2) Non-deterministic Finite Automata transitions
(3) PDA transitions
(4) Parsing table

Q. 20. A linker reads four modules whose lengths are 100, 500, 400, 200 words respectively. If they are loaded in that order, what are the relocation constants?
(1) 0, 100, 200, 400
(2) 0, 100, 600, 1000
(3) 100, 200, 400, 500
(4) 100, 300, 700, 1200

Optional for practice.

Q. 21. A rightmost derivation in reserve can be obtained by
(1) Handle pruning (2) Reduction (3) Shifting (4) prefixing

Q. 22. Which of the following statements is true?
(1) SLR parser is more powerful than LALR
(2) LALR parser is more powerful than Canonical LR
(3) Canonical LR is more powerful than LALR parser
(4) SLR, Canonical LR and LALR parsers have the same power

Q. 23. One possible way of avoiding deadlock is by ensuring that a process is allocated all the required resources in the beginning of its execution. Which of the following statement is true?

s1: It results in lesser resource utilization
s2: It suffers from starvation

(1) Only s1 (2) Only s2
(3) Both s1 and s2 (4) none of the above

Q. 24. A page fault rate for a certain algorithm on a reference string is n with a certain number of frames. After increasing number of frames it was observed that the set of pages in memory for earlier case is always subset of the later case (after increasing frames). The algorithm is not necessarily:
(1) Stack algorithm (2) LRU (3) Optimal (4) FIFO

Q. 25. In a system using pre paging requires to store the following along with process control block
(1) Process page table (2) Working set
(3) Future page references (4) none of the above

All questions carry 2 marks each.

Q. 26. Which of the following statement is true for a system with 13% CPU utilization and 97% disk utilization?
(1) Increase degree of multiprogramming to improve CPU utilization
(2) The system is thrashing
(3) Add faster disk to improve CPU utilization
(4) none of above

Q. 27. If R and S are two relations then R intersection S can be represented as

1. $R \cup (R - S)$
2. $S - (S - R)$
3. $R - (R - S)$
4. $(R \cup S) - [(R - S) \cup (S - R)]$

(1) 2 and 3 only
(2) 1, 2 and 3 only
(3) 3 and 4 only
(4) 2, 3 and 4 only

Q. 28. Consider the following set of functional dependencies on the schema (A, B, C).

$$\begin{aligned} A &\rightarrow BC \\ B &\rightarrow C \\ A &\rightarrow B \\ AB &\rightarrow C \end{aligned}$$

The canonical cover for this set is
(1) $A \rightarrow BC$ and $B \rightarrow C$
(2) $A \rightarrow BC$ and $AB \rightarrow C$
(3) $A \rightarrow BC$ and $A \rightarrow B$
(4) $A \rightarrow B$ and $B \rightarrow C$

Q. 29. Match the following

1. Data Link Layer	A. Routing packets
2. Transport Layer	B. Concerned with piggybacking
3. Network Layer	C. Connection Management
4. Physical Layer	D. Deals with mechanical, electrical and procedural interfaces

(1) 1-B, 2-C, 3-A, 4-D
(2) 1-C, 2-B, 3-A, 4-D
(3) 1-D, 2-C, 3-A, 4-B
(4) 1-D, 2-B, 3-A, 4-C

Q. 30. Which of the following has the highest processing delay?
(1) repeater (2) bridge (3) router (4) gateway

Q. 31. For the given schedule, which of the following is true?

T_1	T_2	T_3	T_4
			read(A)
	read(A)		
		read(A)	
write(B)			
	write(A)		
		read(B)	
	write(B)		

(1) This schedule can not be serialized.
(2) This schedule is equivalent to T_3, T_4, T_1, T_2.
(3) This schedule is equivalent to T_1, T_4, T_3, T_2.
(4) This schedule is equivalent to T_2, T_3, T_1, T_4.

Q. 32. A student can register for at most n courses and each course can have at most m students. Each student is enrolled to at least one course and each course has at least one student. The schema is normalized into three tables:

`Student, Registers, Courses`

The number of tuples in `student` and `course` table are X and Y resp. Which of the following can be incorrect?
(1) $Y = 1$ (2) $Y \leq n \times X$ (3) $X \geq m \times Y$ (4) $X \leq 10$

Q. 33. Compute determinant:

$$A = \begin{bmatrix} 2 & -8 & 6 & 8 \\ 3 & -9 & 5 & 10 \\ -3 & 0 & 1 & -2 \\ 1 & -4 & 0 & 6 \end{bmatrix}$$

(1) 20 (2) -36 (3) -108 (4) none of above

Q. 34. Solve the following equation with Newton-Raphson method upto 2 iterations with starting value of 7.

$$f(x) = x^2 - 25 = 0$$

(1) 5.285 (2) 5.000 (3) 5.007 (4) none of above

Q. 35. Find the eigen values of the following matrix.

$$A = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & -3 \end{bmatrix}$$

(1) 4, -3 (2) 4, 1 (3) 1, -3 (4) 2, -1.5

Q. 36. How many numbers between $1, 2, 3, \ldots, 100000$ have the property that the sum of their digits is 7?

(1) 700 (2) 330 (3) 150 (4) 275

Q. 37. If $X_1, X_2, \ldots, X_n$ are mutually independent and identically distributed with common mean of μ and variance σ^2. X' is the sample mean. Which of the following is true?

(1) $Z_n = \sum(X - \mu)/\sigma^2$ (2) $Z_n = (X' - \mu)/\sigma * n$
(3) $Z_n = (X' - \mu)/\sigma * n^{0.5}$ (4) $Z_n = (X' - \mu) * n^{0.5}/\sigma$

Q. 38. Let $A = 1, 2, 3, 4, 5, 6$. R be the equivalence relation defined on set A

$$R = \{(1,1), (1,5), (2,2), (2,3), (2,6), (3,2), (3,3), (3,6), (4,4), (5,1), (5,5), (6,2), (6,3), (6,6)\}$$

Which of the following is partition of A induced by R.

(1) $\{\{1, 2, 3, 6\}, \{5\}, \{4\}\}$
(2) $\{\{1, 2\}, \{1, 4\}, \{2, 3\}, \{5\}\}$
(3) $\{\{1, 5\}, \{2, 3, 6\}, \{4\}\}$
(4) $\{\{1\}, \{5\}, \{2, 3, 6\}, \{4\}\}$

Q. 39. How many partitions can be formed on a set A having cardinality 6.

(1) 6 (2) 64 (3) 90 (4) 203

Q. 40. Match the following:

```
A) Cyclic redundancy code   i) Error correction
B) Serial communication     ii) Wired-OR
C) Open collector           iii) Error detection
D) Hamming code             iv) RS-232-C
```

(1) A-i, B-iv, C-ii, D-iii
(2) A-i, B-ii, C-iv, D-iii
(3) A-iii, B-iv, C-ii, D-i
(4) A-iii, B-iv, C-iv, D-i

Q. 41. Calculate the total time required to transfer a 1000-KB file on a network with 1.5Mbps bandwidth , assuming an RTT of 100 ms, a packet size of 1 KB and an initial $2 \times RTT$ of handshaking before

data is sent. The data packets can be sent continuously.
(1) 5.15 seconds (2) 105.61 seconds
(3) 5.71 seconds (4) 1.15 seconds

Q. 42. Calculate the total time required to transfer a 1000-KB file on a network assuming an RTT of 100 ms, a packet size of 1 KB and an initial $2 \times RTT$ of handshaking before data is sent. The network has infinite bandwidth and upto 20 packets can be sent per RTT.
(1) 5.15 seconds (2) 105.61 seconds
(3) 5.71 seconds (4) 1.15 seconds

Q. 43. In a certain machine data references constitute 40% of the mix, and that the ideal CPI of the pipelined machine is 1. Assume that the machine with structural hazards has a clock rate that is 1.05 times higher than the clock rate of machine without hazard. What is effective speedup with pipelining without structural hazard?
(1) 1.05 (2) 1.3 (3) 1 (4) none of above

Q. 44. Which of the following programming technique is good in demand paging environment?
(1) Pure code (2) Hashed Symbol Table
(3) Binary search (4) none of above

Q. 45. Implement $F(A, B, C) = \sum(1, 3, 5, 6)$ using 4:1 multiplexer. What input will be there on I_0, I_1, I_2 and I_3.
(1) $0, 1, A, A'$ (2) $0, A, 1, A'$
(3) $A', A, 0, 1$ (4) $A', 0, A, 1$

Q. 46.

```
1 int fun(int a, int b){
2  static int count=0;
3   if( a == 0 || b==0 ){ return 1 ;}
4   if ( a > b  ) return 1 + fun(a-1,b) + fun(a, b-1);
5   return 1 + fun(a,b-1);
6 }
7
8 main() {
9  printf("%d\\n",fun(2,2));
10 }
```

What will be the output of the program?
(1) 3 (2) 4 (3) 5 (4) 7

Q. 47. A TM $M = (\{q_0, q_1, \ldots, q_6\}, \{0, 1\}, \{0, 1, B\}, \delta; q_0, B, \phi\}$. The transitions are:
$(q_0, 0) = q_1, B, R$ $(q_4, 1) = q_4, B, L$
$(q_1, 0) = q_1, 0, R$ $(q_4, 0) = q_4, 0, L$
$(q_0, 1) = q_2, 1, R$ $(q_4, B) = q_6, 0, R$
$(q_2, 0) = q_2, 1, R$
$(q_2, 1) = q_3, 1, L$
$(q_3, 0) = q_3, 0, l$ $(q_0, 1) = q_5, B, R$
$(q_3, 1) = q_3, 1, L$ $(q_5, 1) = q_5, B, R$
$(q_3, B) = q_0, B, R$ $(q_5, B) = q_6, B, R$
$(q_2, B) = q_4, B, L$
What is the language accepted by TM?
(1) 0^*10^*
(2) $0^{(m-n)} \mid m < n$
(3) $(0 + 1)^*$
(4) $0^n10^m \mid m \leq n$

Q. 48. Referring to Turing Machine in **47**, What will be the output when the input is $I_1 = 0100$ and $I_2 = 0010$?

(1) $I_1 = 0$ and $I_2 =$ Blank
(2) $I_1 =$ Blank and $I_2 = 0$
(3) $I_1 = 1$ and $I_2 = 1$
(4) none of above

Q. 49. Consider the CFG $G(V, T, P, S)$ with the following productions:

$$\begin{aligned} S &\rightarrow AB \mid a \\ A &\rightarrow a \end{aligned}$$

Let CFG G' is equivalent CFG with no useless symbols. How many productions will be there in G'?
(1) 1 (2) 2 (3) 3 (4) 5

Q. 50. Suppose L_1 and L_2 are two languages over Σ^*.

$$L = \Sigma^* - ((\Sigma^* - L_1) \cup (\Sigma^* - L_2))$$

L is of similar type as L_1 or L_2 or both. Which of the following statements is true?

1. L, L_1 and L_2 are context free languages
2. L, L_1 are context free and L_2 is regular set
3. L, L_1 and L_2 are accepted by a finite automata

(1) only 2 (2) 1 and 3
(3) 2 and 3 (4) All are correct

Q. 51. Let $L = (\{S, A, B\}, \{a, b\}, P, s)$. It has the following productions:

$$\begin{aligned} S &\rightarrow bA \mid aB \\ A &\rightarrow bAA \mid aS \mid a \\ B &\rightarrow aBB \mid bS \mid b \end{aligned}$$

Construct an equivalent grammar L' in CNF. How many nodes with out-degree=0 are present in the graph of L'?
(1) 2 (2) 4 (3) 8 (4) 3

Q. 52. If $\Sigma = 0, 1$ and a certain Turing Machine M generates $\epsilon, 0, 1, 01, 10, 11, \ldots$. Which of the following statement is correct?
(1) L is recursive but not L'
(2) L and L' both are recursive
(3) L and L' both are recursively enumerable
(4) L is recursively enumerable but not recursive and

Q. 53. What is postfix notion for following prefix notation?

% B * A + * + % A B % + A C B A B

(1) B % A * A % B + A + C % B * A + B
(2) B A A B % % + A C % B + * A + B %
(3) B A A B % A C % B + * % + A + B %
(4) B A A B % A C + B % + A * B + * %

Q. 54. What will be the output of the program is call-by-reference is used

```
int a, b;
P(int x,int y,int z){
  y++;
  z+=x;
}
main(){
```

```
  a=2,b=3;
  P(a+b,a,a)
  print(a);
}
```

(1) 5 (2) 7 (3) 8 (4) 9

Q. 55. Consider recursive function to calculate Fibonacci numbers:

```
int fun fib(int i){
  if( i == 0 or i == 1 ) {
    return 1;
  }
  return fib(i-1) + fib(i-2);
}
```

If a stack of 16 bytes is used during execution of the program above and only return address and parameters are stored on the stack each take 2 bytes, what will be the maximum value of n for which stack will not overflow?
(1) 2 (2) 4 (3) 6 (4) 8

Q. 56. Which of the following is true?
(1) $f \in O(n^2) \Rightarrow f \in O(n)$
(2) $f \in O(n) \Rightarrow f \in O(n^2)$
(3) $f \in \Omega(n) \Rightarrow f \in O(n^2)$
(4) All of the above.

Q. 57. If time take to sort 100 entries by quick sort is 10 sec. What will be the approximate time taken to sort 1000 entries.
(1) 100 (2) 150 (3) 1000 (4) 4000

Q. 58. Match the device on the LHS with the layer at which they work on the RHS.

```
i. repeater          A. Data Link Layer
ii. bridge           B. Physical Layer
iii. router          C. Transport layer
iv. gateway          D. Network layer
```

(1) i-B,ii-A,iii-D,iv-C
(2) i-A,ii-B,iii-D,iv-C
(3) i-A,ii-B,iii-C,iv-D
(4) i-A,ii-C,iii-B,iv-D

Q. 59. Which of the following is/are true?

1. Spanning tree is unique for a graph
2. Prim's and Kruskal's algorithms can give same spanning tree

(1) 1 only (2) 2 only
(3) Both 1 and 2 (4) None of the above

Q. 60. Given a pre-order of a binary search tree as

`5 2 1 3 4 9 7 6 8 12 11 10` (range 1-12)

What will be the post-order?
(1) 1 4 3 2 5 8 7 9 10 11 12
(2) 1 4 3 2 5 7 8 10 11 12 9
(3) 1 4 3 2 5 7 8 12 9 10 11
(4) 1 4 3 2 6 8 7 10 11 12 5

Q. 61. Suppose we have a circular array implementation of the queue class, with ten items in the queue stored at *data*[2] through *data*[11]. The current capacity is 12. Where does the insert method place the new entry in the array? (index starts at 0, tail is 2, head is 11)
(1) *data*[12] (2) *data*[11] (3) *data*[0] (4) *data*[1]

Q. 62. Suppose you have a game with 5 coins in a row and each coin can be heads or tails. What number of vertices might you expect to find in the state graph?
(1) 7 (2) 10 (3) 25 (4) 32

Q. 63. Suppose that a digitized TV picture is to be transmitted from a source that uses a matrix of 640×480 picture elements (pixels), where each pixel can take on one of 16 intensity values. Assume that 30 frames are sent per second. The source rate in Mbps is
(1) 147.456 (2) 36.864 (3) 9.216 (4) 0.3

Q. 64. Which is faster:
A. Transmitting the contents of a full CDROM with 33.6 Kbps modem from Los Angeles to Hong Kong.
B. Mailing the CD-ROM from Los Angeles to Hong Kong. This takes 8 days.
(1) A is faster than B
(2) B is faster than A
(3) A and B take equal amount of time
(4) Insufficient data available

Q. 65. Consider the following grammar:

$$\begin{aligned} E' &\rightarrow E \\ E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow id \mid (E) \end{aligned}$$

Construct transition diagram of NFA recognizing viable prefixes. How many states are there in the DFA?
(1) 10 (2) 11 (3) 12 (4) 7

Q. 66. In a string of length n, how many proper prefixes can be generated?
(1) 2^n (2) n (3) $n(n+1)/2$ (4) $n-1$

Q. 67. Consider the following grammar,

$$\begin{aligned} S &\rightarrow L = R \mid R \\ L &\rightarrow *R \mid id \\ R &\rightarrow L \end{aligned}$$

The grammar is
(1) Ambiguous (2) SLR(1)
(3) LALR(1) (4) none of the above

Q. 68. Consider a program written in a functional programming language with lazy evaluation of expression.

```
fun( x, y, z){
  z = 2 * x
}
main() {
  a=2,b=3
  fun( a+ (++b), ++b, c)
}
```

What will be the values of a, b, and c after the execution.
(1) 2 3 10 (2) 2 4 12
(3) 2 5 12 (4) 2 5 14

Q. 69. Consider a shape hierarchy of objects:

```
          Shape
          /  \
   Rectangle   Circle
```

If area() is a pure virtual function, which of the following statements is true?
(1) area() is defined in Shape can be defined in Rectangle/Circle
(2) area() is not defined in Shape but must be defined in Rectangle/Circle
(3) area() may or may not be defined in Shape
(4) area() may or may not be defined in Rectangle/Circle

Q. 70. Consider following C code with multiple files.

```
File A.c        File B.c     Main.c
int a=10;       int a=20;    main(){
funA(){         funB(){        funA();
  a *= 2;         a *= 2;      funB();
}               }            }
```

All these files are part of same program. Which of the following statements is/are true?

1. Each file will compile successfully(separately)
2. The compiler will give duplicate variable error
3. The linker will give error
4. The value of at start of program will be either 10 or 20

which is compiler dependent.
(1) 1 and 3 (2) 1 and 4 (3) 2 only (4) 4 only

Q. 71. Given memory partitions in the order below: `P1: 100K, P2: 500K, P3: 200K, P4: 300K, P5: 600K`. How would BEST FIT algorithms place processes: `212K, 417K, 112K, and 426K` (in order)
(1) P4, P5, P3, P2
(2) P2, P5, P3, 426K waits
(3) P4, P2, P3, P5
(4) None of the above

Q. 72. Calculate the average waiting time for round robin scheduling with time quantum of 4 milisecond.

Process	Burst Time
P_1	24
P_2	3
P_3	3

(1) 10 (2) 2 (3) 3 (4) 5.66

Q. 73. One problem with contiguous allocation is that the user must preallocate enough space for each file. If the file grows to be larger than the space allocated for it, special actions must be taken. One solution to this problem is to define a file structure consisting of an initial contiguous area (of a specified size). If this area is filled, the operating system automatically defines an overflow area that is linked to the initial contiguous area. If the overflow area is filled, another overflow area is allocated. The protocol results in
(1) More overhead than standard contiguous allocation and linked allocation
(2) Less overhead than standard contiguous allocation and linked allocation
(3) More overhead than contiguous allocation and lesser overhead
than standard linked allocation
(4) none of the above

Q. 74. Suppose the disk drive has 200 cylinders. The drive is currently serving the request at cylinder 53. The previous request was at cylinder 25. A queue of pending requests in FIFO order is

```
98, 183, 37, 122, 14, 124, 65, 67
```

Starting from the current head position. What is the total distance traveled by the disk arm in SCAN scheme?
(1) 640 (2) 208 (3) 384 (4) 236

Q. 75. Requests are not usually uniformly distributed. For example, a cylinder containing the file system FAT or inodes can be expected to be accessed more frequently than a cylinder that only contains files. Suppose you know that 50 percent of the requests are for a small, fixed number of cylinders. Which of the following scheme results in the lowest arm movement?
(1) SSTF (2) LOOK (3) C-SCAN (4) FCFS

Q. 76.

```
int me;
printme(){
  print(me);
}
fun(){
  int me;
  me = 5;
  printme();
}
main(){
  me = 2;
  printme();
  fun();
  printme();
}
```

What will be the output if static scoping is used?
(1) 2 5 2
(2) 2 2 2
(3) 2 5 5
(4) 5 5 2

Q. 77. In the program for **Q. 76**, what will be the output if dynamic scoping is used?
(1) 2 5 2 (2) 2 2 2
(3) 2 5 5 (4) 5 5 2

Q. 78.

```
fun(int i, int j,int k) {
  i--;
  i =  j * 3;
  k =  i + 2;
}
main(){
  int p , q,r;
  p = 8,q=2;
  fun(p,++q,r);
  print(p,q,r);
}
```

What will be the values of p,q, r if pass by name is used?
(1) 9 3 11 (2) 8 3 11
(3) 9 2 9 (4) 8 2 9

Q. 79. What will the values of p, q, r if pass by value is used?
(1) 8 3 0 (2) 8 2 0
(3) 8 3 garbage (4) 8 3 11

Q. 80. What will be the values of a, b, and c after the execution of the following two statements:

```
a=3,b=5;
c = a+++b;
```

(1) 3 6 9 (2) 4 5 8
(3) 4 5 9 (4) 3 5 8

Q.81-90 are in the set of two each. We have not implemented dependency of 81b on 81a so that you can get correct answers for both. But in exam, you will be evaluated on dependency basis

For Q.81-82.

Consider the following Posets

$$\begin{aligned} S_1 &= \{1,2,3,4,12\}, R: S_1 \times S_1, aRb \; if \; a|b \\ S_2 &= \{2^{\{a,b,c\}}\}, R: S_2 \times S_2, aRb \; if \; a \subseteq b \\ S_3 &= \{n\%k = 0, \forall k \in \{1,2,4,5,10,20\}\} \end{aligned}$$

Q. 81. Which are the distributed lattices?
(1) S_1 and S_3 (2) S_1 and S_2
(3) S_2 and S_3 (4) All S_1, S_2 and S_3

Q. 82. Which are the complemented lattices?
(1) only S_2
(2) S_1 and S_3
(3) only S_1
(4) All S_1, S_2 and S_3

For Q.83-84.

We want to study the impact of different cache mechanism on performance of CPU. The mechanism used are direct mapping and two-way set associative mapping. CPU has clock cycle time 2 ns, CPI is 2 and average memory references in an instruction is 1.3. The cache size is 64 KB and both have the block of 32 bytes. The cache miss penalty is 70ns for either organization. Set-associative cache takes 1.10 times more CPU cycles. Assume that the hit time is 1 clock cycle. Miss rate for direct mapped cache is 1.4%, while for the other is 1%.

Q. 83. Which of the two results in faster memory access?
(1) 2 way set associative cache has faster memory access
(2) Direct cache mapping has faster memory access
(3) The memory access time is same for both
(4) none of the above

Q. 84. Which of the above cache scheme leads to better CPU utilization?
(1) 2-way associative cache does better than direct map cache
(2) The direct map cache does better than 2-way associative cache
(3) Both results in same CPU utilization
(4) none of the above

For Q.85-86.

Q. 85. Consider:
S_1: Let A be a collection of subset of a set B. The relation subset of set inclusion. For example, aRb if $A \subseteq B$.
S_2: Let Z be the set of positive integers. The relation $\geq$
S_3: D is a divisible relation. aRb if $a\%b = 0$.
Which of the following is true?
(1) S_1 and S_2 are linearly ordered set
(2) Only S_2 is linearly ordered set
(3) Only S_3 is linearly ordered set
(4) All sets are linearly ordered set

Q. 86. What is length of minimal spanning tree of the following graph:

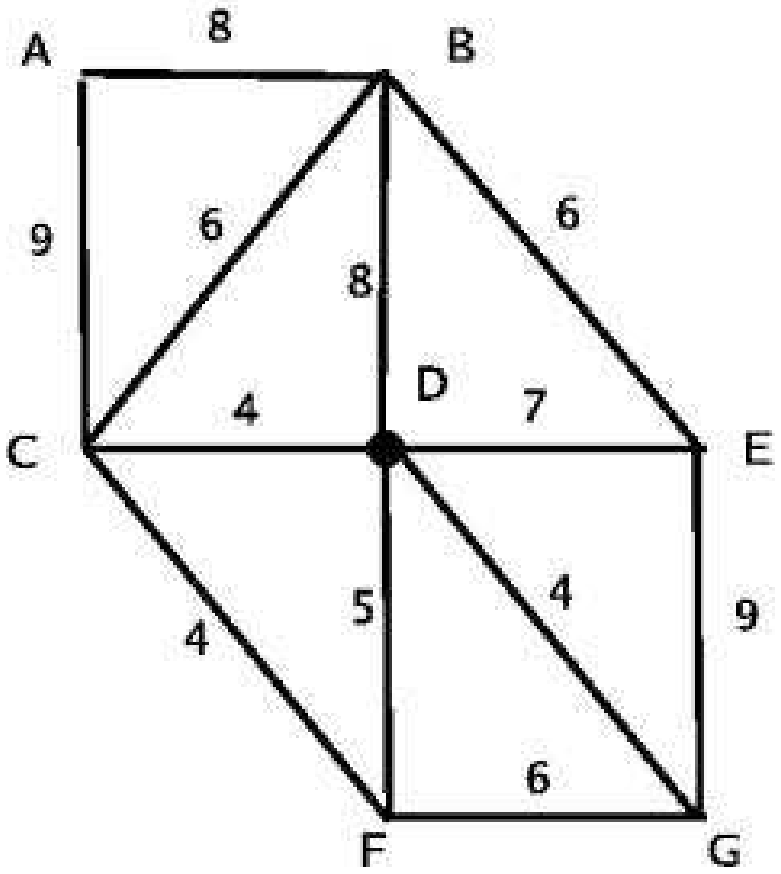


Figure 12: Fig. for Q. 86

(1) 47 (2) 24 (3) 32 (4) 43

For Q.87-88.

Q. 87. A hash table implementation uses function of (% 7) and linear probing to resolve collision. What is the ratio of numbers in the following series with out collision and with collision if 7 buckets are used?
`32, 56, 87,23, 65, 26, 93`
(1) 2,5 (2) 3,4 (3) 4,3 (4) 5,2

Q. 88. Which element will fall in bucket 5, if bucket numbering starts with 0?
(1) 26 (2) 65 (3) 93 (4) None of the above.

For Q.89-90:

Consider the schema:

```
book(bookid, name, publisherid)
author(authorid, name)
publisher(publisherid, name)
details(publisherid,bookid,authorid)
```

Q. 89. What does the following query output?

```
select distinct a.name
from author a, publisher p, book b, details d
where b.bookid = d.bookid
and a.authorid = d.authorid
and d.publisherid = 'NewPub';
```

(1) Author names whose books are published by NewPub
(2) Unique author names whose books are published by NewPub
(3) Unique author names with books not published by NewPub
(4) Author names with books not published by NewPub

Q. 90. In the schema in Q89, which query will print authorid, publishedid and the number of books of this combination sorted by author name?

(1)
```
select a.name, p.publisherid, count(*)
from author a, publisher p, details d
where d.publisherid = p.publisherid
and a.authorid = d.authorid
group by a.name, p.publisherid
order by a.name;
```
(2)
```
select d.authorid, d.publisherid count(*)
from author a, details d
where a.authorid = d.authorid
group by d.authorid, d.publisherid
order a.name;
```
(3)
```
select d.authorid, d.publisherid,sum(*)
rom author a, details d
where a.authorid = d.authorid
group by d.authorid, d.publisherid
order a.authorid;
```
(4)
```
select a.name, d.publisherid,sum(*)
from author a, details d
where a.authorid = d.authorid
group by d.authorid, d.publisherid
order a.authorid;
```

GateGenie Practice Test No. 5

GateGenie Practice Test No. 5

All questions carry 1 marks each.

Q. 01. What is cardinality of power set of a set having letters "MISSISSIPPI"?
(1) 2O48 (2) 16 (3) 32 (4) 64

Q. 02. Give the contrapositive of "If it is raining then I get wet".
(1) If it is not raining then I get wet
(2) If it is not raining then I do not get wet
(3) If it get wet then it is raining
(4) If I do not get wet then it is not raining

Q. 03. Find out connected components of G where $V(G) = \{A, B, C, P, Q\}$, $E(G) = \phi$
(1) $\{\{A\}, \{B\}, \{C\}, \{D\}, \{E\}, \{F\}\}$ (2) $\{A, B, C, P, Q\}$
(3) $\{\{A, C\}, \{P, Q\}, \{B\}\}$ (4) None of the above

Q. 04.

$$S = \{1, 2, 3, 4, 5, 6\}.$$
$$R = \{S \times S | \ m \ divides \ n\}$$

R is
(1) Equivalence Relation (2) Lattice
(3) Symmetric relation (4) Poset

Q. 05. what will be $X + Y$

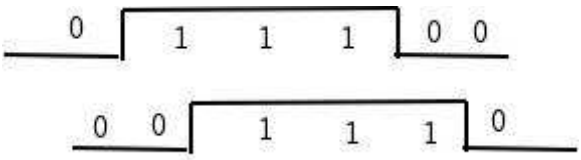


Figure 13: Fig. for Q. 5

(1) 001100 (2) 011110 (3) 000100 (4) 010010

Q. 06. Which of the following instructions should not be privileged?
(1) Set value of timer (2) Read the clock
(3) Clear memory (4) Turn off interrupts

Q. 07. Assume a set associative cache has 4 sets with two blocks per set. The memory has 32 blocks. Where will be block 12 placed in cache?
(1) either in block number 0 or 1
(2) anywhere from block number 0 to 7
(3) in block number 4
(4) none of the above

Q. 08. In which of the following situation, $X \oplus X \oplus X \oplus \ldots = 1$?
(1) Always
(2) Never
(3) When number X are even and X = 1
(4) When number X are odd and X = 1

Q. 09. The transition function of DFA from one state to another on a given input symbol w is a

function $Q \times \Sigma^* \rightarrow$
(1) 2^Q (2) Q (3) Q' (4) Q^2

Q. 10. Suppose $L_1 = \{0, 1\}$ and $L_2 = \{011, 11\}$. How many distinct elements are there in $L = L_1.L_2$.
(1) 4 (2) 3 (3) 2 (4) none of the above

Q. 11. Which of the following regular expression represent strings not beginning with at least one zero and ends in at least one 1.
(1) 0^*1^* (2) $00^*(0+1)^*1$
(3) $0(0+1)^*1$ (4) None of above

Q. 12. Which of the following statements are true?

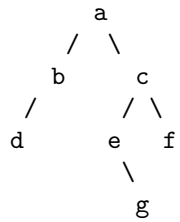
1. Collision increases with number of entries in a hash table.
2. Recursive programs are efficient because of compact code.
3. Binary search tree using doubly linked list is efficient.

(1) 1 and 2 only (2) 1 and 3 only
(3) 2 and 3 only (4) None of the above

Q. 13. Bubble sort is used to sort following sequence of numbers. What will be the sequence after 2nd iteration. `7 5 3 1 2 9`
(1) 1 2 3 5 7 9 (2) 3 1 2 5 7 9 (3) 5 3 1 2 7 9 (4) 3 5 7 1 2 9

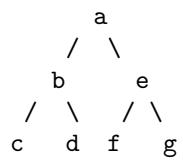
Q. 14. Suppose that X is a B-tree leaf containing 41 entries and having at least one sibling. Which statement is true?
(1) Any sibling of X is also a leaf.
(2) Any sibling of X contains at least 41 entries.
(3) The parent of X has exactly 42 entries.
(4) X has at least 41 siblings.

Q. 15.



What will be the post-order of the above tree?
(1) d b g e f c a (2) d b a g e c f
(3) d b a c g e f (4) d b g e f c a

Q. 16. Given a heap below, what will be its array representation?



(1) a b e c d f g (2) a b e c f d g
(3) a b e d f c g (4) a b e c d f g

Q. 17. Tree algorithms typically run in time $O(d)$. What is d?
(1) Avg. number of children for internal nodes.
(2) The number of leaf nodes in the tree.
(3) The number of internal nodes in the tree.
(4) The depth of the tree.

Q. 18. A linked list stores the numbers in sorted order. What will be the list contents after the following insert/delete operations:

```
insert(43)
insert(26)
insert(93)
delete(26)
insert(72)
insert(52)
delete(72)
insert(73)
```

(1) 43 52 72 73 (2) 43 52 73 93
(3) 26 43 52 73 (4) 43 52 73 93

Q. 19. $(1 + 01)^*$ does not contain the substring
(1) 10 (2) 11 (3) 01 (4) none of the above

Q. 20. goto function of LR class of parser recognizes
(1) Valid Item (2) Viable prefix (3) Handle (4) Production

Optional for practice.

Q. 21. The set of prefixes of right sentential forms that can appear on the stack of a shift reduce parser is called:
(1) Handle (2) Viable prefix (3) Production (4) Valid Item

Q. 22. Which of the following statements is true?
(1) SLR parser has more states than LALR parser
(2) LALR parser has more states than Canonical LR
(3) Canonical LR has less states than SLR parser
(4) SLR and LALR parsers have same number of states

Q. 23. After the context switch during Round robin scheduling, the process is not moved from CPU to:
(1) The tail of ready queue (2) Waiting queue
(3) Terminated state (4) None of the above

Q. 24. A page size of 1 byte suffers from
(1) more I/O with disk
(2) thrashing
(3) inaccurate matching of program locality
(4) internal fragmentation

Q. 25. Which of the following programming language provides better locality of reference?
(1) LISP (2) C (3) PASCAL (4) C++

All questions carry 2 marks each.

Q. 26. Consider a system with three resources, tape drive, printer and disk drive. Each one of them are assigned a unique number.

R1 = F(Printer) = 12
R2 = F(Tape Drive) = 1
R3 = F(Disk Drive) = 4

Which of the following access patterns necessarily avoids deadlock?
(1) R1, R3, R2 (2) R2, R3, R1
(3) R1, R2, R3 (4) R3, R2, R1

Q. 27. A system which has lot of crashes, data should be written to the disk using:
(1) write-through (2) write-back
(3) Both of the above. (4) None of the above.

Q. 28. In SQL, relations can contain null values and comparisons with null values are treated as unknown. Suppose all comparisons with a null values are treated as false which of the following pairs is not equivalent?
(1) $[x = 5]$, $[\neg(\neg(x = 5))]$
(2) $[x = 5]$, $[x > 4 \cap x < 6]$, where x is an integer
(3) $[x * 5]$, $[\neg(x = 5)]$
(4) none of these

Q. 29. Match the following

```
1. Data Link Layer          A. Controls addressing
2. Transport Layer          B. Manages Dialog control
3. Network Layer            C. Pure end-to-end layer
4. Session Layer            D. Framing, error-control
```

(1) 1-A, 2-C, 3-B, 4-D
(2) 1-D, 2-C, 3-B, 4-A
(3) 1-C, 2-D, 3-A, 4-B
(4) 1-D, 2-C, 3-A, 4-B

Q. 30. Machine A wants to transmit n packets to machine B using packet switching network on a link with l intermediate hops. The transmission time for each packet is t seconds. The time it takes to transmit the data from A to B is : (Assume that the propagation delay is negligible).
(1) $(n + l) * t$ (2) $(n + l - 1) * t$ (3) $(n + l + 1) * t$ (4) $n * t + l$

Q. 31. Which of the following combination of T_i and T_j can not be serializable?
(1) T_i executes read(Q) before T_j executes read(Q)
(2) T_i executes read(Q) before T_j executes write(Q)
(3) T_i executes write(Q) before T_j executes read(Q)
(4) T_i executes write(Q) before T_j executes write(Q)

Q. 32. _(underscore) - matches any single character \\- escape character In the following instance of students table:

Name	Subject	Marks	Password
Anu	DB	30	%%\\
Ann	Algo	40	\\%%
Anju	Networks	30	%\\%
An	DB	50	\\%%
Ant	Algo	25	\\%\\%

How many rows will be selected by following query:

```
select *  from students
where Name like 'A_%_'
and Password like '%\\\\\\\%%'
```

(1) 1 (2) 2 (3) 3 (4) 4

Q. 33. Consider

$$A = \begin{bmatrix} 0 & 1 & 2 & -1 \\ 2 & 5 & -7 & 3 \\ 0 & 3 & 6 & 2 \\ -2 & -3 & 4 & -2 \end{bmatrix}$$

Which of the following statements is not true?
(1) A is invertible (2) A is non-invertible
(3) $|A| \neq 0$ (4) none of above

Q. 34. Apply Jacobi's method to the following system

$$\begin{aligned} 10x_1 + x_2 - x_3 &= 18 \\ x_1 + 15x_2 + x_3 &= -12 \\ -x_1 + x_2 + 20x_3 &= 17 \end{aligned}$$

Starting with $(0, 0, 0)$ as an initial solution, use two iterations to find the solution. The solution is:
(1) 1.965, -0.9767, 0.98 (2) 1.8, -0.8, 0.85
(3) 1.99, -0.99, -0.99 (4) 2.0, -1.0, 1

Q. 35. Solve the following equation with successive bisection method up-to 4 iterations with starting value of 2 and 7.

$$f(x) = x^2 - 25 = 0$$

What will be the range of search after 4th iteration.
(1) 4.5 to 7 (2) 4.99 to 5.00
(3) 4.81 to 5.12 (4) 4.5 to 5.75

Q. 36. Consider a set of 9 non-negative real numbers, $a_0, a_1, \ldots, a_8$ whose sum is 90. The sum of at least three numbers is at least
(1) 20 (2) 30 (3) 45 (4) none of above

Q. 37. How many ways a set of $2n$ elements can be partitioned into n sets with 2 elements each?
(1) $2n!/2$ (2) $2n!/2^n$
(3) $2n!.2^n$ (4) $2n!$

Q. 38. How many number of spanning trees are possible in the following figure 14.
(1) 64 (2) 8 (3) 16 (4) 96

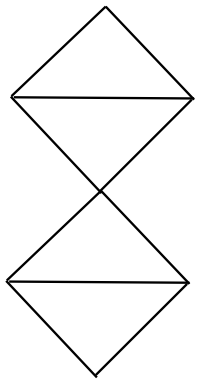


Figure 14: Fig. for Q. 38

Q. 39. $R = \{(1,1),(1,2),(2,1),(3,3)\}$ on set $A = \{1,2,3\}$. Which of the following is A/R?
(1) $\{[1],[2],[3]\}$ (2) $\{[1],[3]\}$
(3) $\{[1],[2]\}$ (4) none of above

Q. 40. Consider a 10Mbps circuit switched network. The connection establishment between two nodes A and B is 30msec. The propagation delay between A and B is 10 msec. The size of the acknowledgments is negligible. The time it takes to transmit 2200 bytes from A to B is (including the acknowledgment)
(1) 45.76 msec (2) 51.76 msec
(3) 55.76 msec (4) 41.76 msec

Q. 41. Calculate the total time required to transfer a 1000-KB file on a network with 1.5Mbps bandwidth , assuming an RTT of 100 ms, a packet size of 1 KB and an initial 2 x RTT of handshaking before data is sent. The data packets are sent such that after a packet is sent, we must wait for one RTT before

sending the next packet.
(1) 5.15 seconds (2) 105.61 seconds
(3) 5.71 seconds (4) 1.15 seconds

Q. 42. Calculate the total time required to transfer a 1000-KB file on a network assuming an RTT of 100 ms, a packet size of 1 KB and an initial 2 x RTT of handshaking before data is sent. The bandwidth of the network is infinite, and during the first RTT we can send one packet $(2^1 - 1)$, during the second RTT we can send two packets $(2^2 - 1)$, during the third we can send four $(2^3 - 1)$, and so on.
(1) 5.15 seconds (2) 105.61 seconds
(3) 5.71 seconds (4) 1.15 seconds

Q. 43-46

Consider a file currently consisting of 100 blocks. Assume that the file control block (and the index block, in the case of indexed allocation) is already in memory. In the contiguous- allocation case, assume that there is no room to grow in the beginning, but there is room to grow in the end. Assume that the block information to be added is stored in memory.

Q. 43. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies respectively, if, for one block, the block is added in the beginning.
(1) 201,1,1, (2) 1,1,1 (3) 1,1,2 (4) 201, 2, 2

Q. 44. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies respectively, if, for one block, the block is added in the middle.
(1) 101, 52, 1 (2) 101, 2, 1 (3) 101, 51, 1 (4) 52, 1, 1

Q. 45. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies respectively, if, for one block, the block is added in the end.
(1) 201, 101, 1 (2) 201, 102, 1 (3) 1, 103, 1 (4) 1,3,1

Q. 46. Calculate how many disk I/O operations are required for contiguous, linked, and indexed (single-level) allocation strategies respectively, if, for one block, the block is removed from the middle.
(1) 99, 3, 1 (2) 98, 50, 0 (3) 98, 52, 0 (4) 98, 51, 1

Q. 47. Given an arbitrary DFA of size 2^N what will be the size of corresponding NFA?
(1) $N * N$ (2) 2^N (3) $2N$ (4) $N!$

Q. 48. Which of the following graphs are traversable where $V(G) = A, B, C, D$ and

1. $E(G) = [\{A, B\}, \{B, C\}, \{C, D\}, \{D, A\}]$
2. $E(G) = [\{A, B\}, \{A, C\}, \{B, C\}, \{B, D\}, \{C, D\}, \{D, A\}]$
3. $E(G) = [\{A, B\}, \{B, A\}, \{C, D\}, \{C, C\}, \{D, C\}]$

(1) 1 (2) 2 (3) 3 (4) none of the above

Q. 49. A manufacturer produces IC chips, 1% of which are defective. Find the probability that in a box containing 100 chips, no defectives are found. Use poison approximation to binomial distribution.
(1) 0.366 (2) 0.368 (3) 0.1 (4) none of the above

Q. 50. How many ways of selecting 5 cards from a pack of 52 cards with replacement and without replacement respectively?
(1) 52^5 and 52.51.....48
(2) 52.51.....48 and 52^5
(3) 26.51.....48 and 52.51
(4) 52^5 and 26.51.....48

Q. 51. The following CFG

$$S \to aS \mid bS \mid a \mid b$$

is equivalent to the regular expression:

1. $(a^* + b)^*$
2. $(a + b)^+$
3. $(a + b)(a + b)^*$
4. $(a + b)^*(a + b)$

(1) 2 and 3 only (2) 2, 3, 4
(3) all of the above (4) only 3 and 4

Q. 52. The following CFG

$$\begin{aligned} S &\to aB \mid bA \\ A &\to ba \mid aS \mid bAA \\ B &\to b \mid bS \mid aBB \end{aligned}$$

generates strings of terminals that have
(1) equal number of a's and b's
(2) odd number of a's and even number of b's
(3) even number of a's and even number of b's
(4) odd number a's and even number of a's

Q. 53. A normal bubble sort implementation requires 100 sec. to sort 10000 entries. What should be the input size if the sort is to complete in 50 secs.
(1) 100 (2) 1000 (3) 2500 (4) 5000

Q. 54. Consider this function declaration:

```
void quiz(int i)
{
    if (i > 0)
    {
        quiz(i / 2);
        quiz(i / 2);
    }
    cout << "*";
}
```

How many asterisks are printed by the function call `quiz(5)`?
(1) 3 (2) 7 (3) 8 (4) None of the above

Q. 55. If G is an directed graph with 20 vertices, how many boolean values will be needed to represent G using an adjacency matrix?
(1) 20 (2) 40 (3) 200 (4) 400

Q. 56. Consider pseudo code for a program:

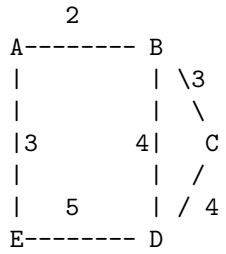
```
while(true){
  if(random num < 0.5 )
    pop the stack (if not empty) and output it.
  else
    take the input from standard input and push it on stack
}
```

If input to the program is `1 2 3 4 5`, what can NOT be the output of the program:
(1) 3 2 4 5 1 (2) 1 3 2 4 5
(3) 1 3 5 2 4 (4) 3 4 2 5 1

Q. 57. How many substrings of different lengths that can be formed using a character string of length n?
(1) $n!$ (2) $n(n-1)/2$ (3) $n+1$ (4) n

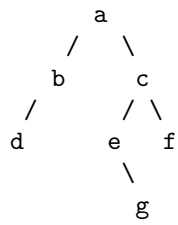
Q. 58. $T(n) = 2T(n/2) + n$
(1) $O(n\ log\ n)$ (2) $O(n^2)$ (3) $O(log\ n)$ (4) None of the above.

Q. 59. How many spanning trees does the following graph have?



(1) 1 (2) 2 (3) 3 (4) 4

Q. 60-61



Q. 60. In the height balanced tree below, how many nodes will become unbalanced when a node is inserted as a child of the node g?
(1) 1 (2) 2 (3) 3 (4) 4

Q. 61. On addition of a node below g in the height balanced tree , which of the following will make the tree height balanced again with minimum movement?
(1) Making c as root.
(2) Connecting left subtree below c as right subtree of b
(3) Readjusting e,g, h with g/h as root.
(4) g as left subtree of f

Q. 62. Let G be a graph with 100 vertices numbered 1 to 100. Two vertices i and j are adjacent if $|i-j| = 8$ or $|i-j| = 12$. The number of connected components in G is
(1) 4 (2) 8 (3) 12 (4) 25

Q. 63. Which of the following statements is true?
(1) The complete graph of 5 vertices is planar
(2) Sum of degrees of all nodes is always odd
(3) A graph with n-vertices must be connected if it has more than $\binom{n-1}{2}$ edges.
(4) None of the above.

Q. 64. Number of diagonals of a polygon with n-vertices is:

(1) $n(n-1)/2 - n$ (2) $n(n-3)/2$ (3) $n(n-1)/2$ (4) n

Q. 65. How many entries will be there in symbol table for the following C code snippet?

```
int max (int i, int j)
/* return maximum of integers i and j */
{
     return i>j?i:j;
}
```

(1) 3 (2) 5 (3) 10 (4) 16

Q. 66. Consider the following grammar:

$$\begin{aligned} E' &\rightarrow E \\ E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow id \mid (E) \end{aligned}$$

How many $LR(0)$ items are there in `closure(`$\{E' \rightarrow .E\}$`)` ?
(1) 1 (2) 6 (3) 7 (4) 5

Q. 67. If $I = \{[E' \rightarrow E], [E \rightarrow E. + T]\}$, then how many $LR(0)$ items are there in `goto(I, +)`?
(1) 5 (2) 4 (3) 2 (4) 1

Q. 68. Consider the following grammar

$$\begin{aligned} S &\rightarrow aAd \mid bBd \mid aBe \mid bAe \\ A &\rightarrow c \\ B &\rightarrow c \end{aligned}$$

The grammar is
(1) $LR(1)$ but not $LALR(1)$
(2) $LALR(1)$ but not $SLR(1)$
(3) $SLR(1)$ but not $LR(1)$
(4) $LALR(1)$

Q. 69. How many equivalence classes are the DFA Fig. (15)?
(1) 5 (2) 2 (3) 6 (4) 1

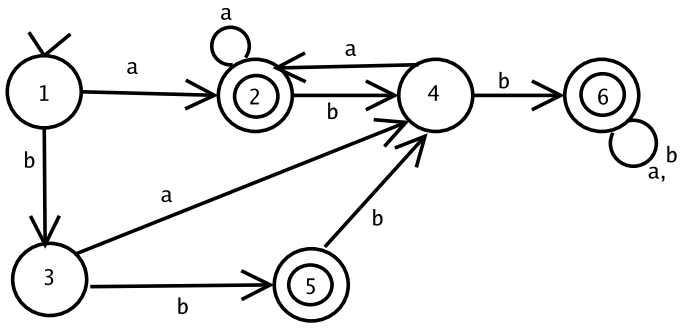


Figure 15: Fig. for Q. 69

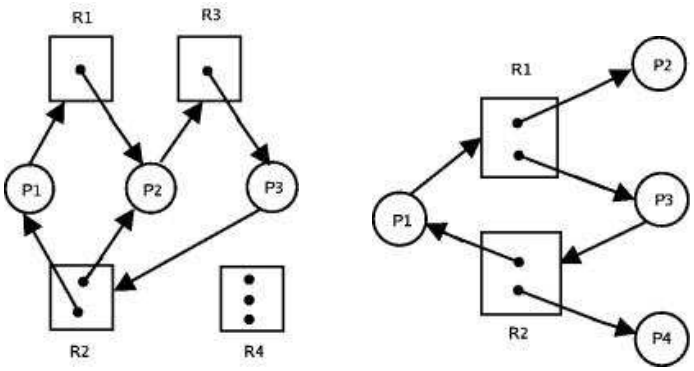
Q. 70.

```
int fun(int i){
```

```
  if(i ) {
    fun(i / 10)
    print(i % 10);
  }
}
```

What is the program doing?
(1) Printing the digits in reverse order
(2) Printing the digits in straight order
(3) Prints the number i successively
(4) Prints $i, i/10, \ldots, 0$

Q. 71. Which of the following is true?



(a) (b)

Figure 16: Fig. for Q. 71

(1) Deadlock occurs in both the cases
(2) Deadlock occurs in fig. 16(a), but not in 16(b)
(3) Deadlock occurs in fig. 16(b), but not in 16(a)
(4) none of above

Q. 72. Consider a demand-paging system with the following time-measured utilization:

CPU utilization	20%
Paging disk	97.7%
Other I/O devices	5%

Which of the following will probably improve CPU utilization?
(1) Increase the degree of multiprogramming
(2) Add pre paging to the page fetch algorithms
(3) Increase the page size
(4) none of the above

Q. 73. Consider the following code:

```
repeat
while flag[j] do no op;
     flag[i] = true;

     critical section

     flag[i] = false;

     remainder section
until false;
```

Which of the following statement is true?
(1) Mutual exclusion and Bounded waiting are satisfied
(2) Only mutual exclusion is satisfied
(3) Mutual exclusion is violated
(4) Mutual exclusion and progress requirements are met

Q. 74. Consider the following page reference string:

```
102, 203, 306, 424, 227, 156, 527,
656, 253, 183, 207, 308, 745, 623,
345, 242, 112, 223, 321, 622.
```

A page size is 100 bytes. How many page faults will occur with Optimal replacement algorithm with 5 frames?
(1) 10 (2) 8 (3) 7 (4) 5

Q. 75. Assuming pages of size 128 words each, how many page faults will be generated by the following C snippet:

```
int A[128][128];
for( int i=0; i<128; i++)
  for( int j=0; j<128; j++)
    A[i][j] = 0;
```

(1) 128 (2) 16384 (3) 0 (4) none of the above

Q. 76. Consider the program to compute sum of factorials of first n natural numbers.

```
int sum(int n){
  int sum,fact;
  __ = 0;          ... (1)
  __ = 1;          ... (2)

  for(i=1;i<=n;i++){
    fact *= __;    ... (3)
    sum += __;     ... (4)
  }
  return sum;
}
```

(1) sum fact fact sum (2) fact sum i fact
(3) fact sum sum fact (4) sum fact i fact

Q. 77-78

Consider the program given below:

```
int k;
int g(int x){
  print(k);
  return x + k;
}
int f(int x){
  int k;
  k = 2;
  print(k);
  return k + g(x);
}
```

```
main(){
  k = 4;
  k = g(k);
  print(k);
  k = f(k);
  print(k);
}
```

Q. 77. What will be the output if static scoping is used?
(1) 4 8 8 2 18 (2) 4 8 2 2 12
(3) 4 8 8 2 12 (4) 4 8 2 2 18

Q. 78. If dynamic scoping is used in the program then what will output?
(1) 4 8 8 2 18 (2) 4 8 2 2 12
(3) 4 8 8 2 12 (4) 4 8 2 2 18

Q. 79. A language with string manipulation facility uses the following operations:

```
head(s): first character of string s
tail(s): all but first character of string s
concat(s1,s2): s1s2
```

For string `s = abcd`, What will be the output for:

```
concat(head(tail(s), head(concat(head(tail(s)), tail(s))))
```

(1) bb (2) bc (3) ac (4) ab

Q. 80. What will be the value of P after execution of the program?

```
P = -10; Q=-20;
if( P > Q ) {
  if ( P < 0 ) {
    P = abs(P)
  }else{
    P = 2 * P ;
  }
}
```

(1) 10 (2) -10 (3) 20 (4) -20

Q. 81. Let $S = \{1, 2, 3, 4, 5, 6\}$. Which of the following is not partition of S.

$$\begin{aligned} P_1 &= [\{1,2,3\},\{1,4,5,6\}] \\ P_2 &= [\{1,2\},\{3,5,6\}] \\ P_3 &= [\{1,3,5\},\{2,4\},\{6\}] \\ P_4 &= [\{1,3,5\},\{2,4,6,7\}] \end{aligned}$$

(1) Only P_3 (2) P_2 and P_3
(3) P_2, P_3 and P_4 (4) P_3 and P_4

Q. 82. Let A be the set of students in a school. Determine which of the following assignments defines a function on A.

1. f_1 = To each student assign his or her age
2. f_2 = To each student assign his or her teacher
3. f_3 = To each student assign his or her sex
4. f_4 = To each student assign his or her spouse

Which of the above are function?
(1) only f_1 (2) only f_1 and f_4
(3) f_1, f_2, f_3 (4) All f_1,f_2,f_3,f_4

Q. 83-84

Consider the following I/O scenarios on a single-user PC.
a. A mouse used with a graphical user interface
b. A tape drive on a multitasking operating system (assume no device preallocation is available)
c. A disk drive containing user files
d. A graphics card with direct bus connection, accessible through memory-mapped I/O

Q. 83. Match each of the following to `(i) interrupt I/O, (ii) polling`.
(1) `a,d-ii, b,c-i`
(2) `a,b-i, c,d-ii`
(3) `a,c-i, b-ii, d-none`
(4) `a,b,c-i, d-none`

Q. 84. Which is more appropriate for the above scenarios: `(i) buffering (ii) caching (iii) spooling or combination` ?
(1) `a-i, b-i,iii, c-i,ii,iii, d-i,ii`
(2) `a-i, b-i,ii,iii, c-i,ii, d-i`
(3) `a-iii, b-i,iii, c-ii, d-i,ii`
(4) `a-i, b-iii, c-i,iii, d-i`

Q. 85. At least how many different colors are needed to paint the graph represented in the following adjacency list:

```
v1: v2, v3, v5
v2: v1, v4, v6
v3: v1, v4, v6
v4: v2, v5
v5: v1, v4, v6
v6: v2, v3, v5
```

(1) 3 (2) 2 (3) 5 (4) 1

Q. 86. Let A be the collection of subsets of a set S. The relation subset of set inclusion is not
(1) Poset (2) Distributive Lattice
(3) Complemented Lattice (4) Equivalence relation

Q. 87. How many Hasse diagrams are possible for all the lattice with up-to 4 elements?
(1) 1 (2) 2 (3) 3 (4) 4

Q. 88. Which of the following algorithm is best suited to sort integers in the range $[1 \dots N^3]$ in $O(n)$ time.
(1) Heap (2) Quick (3) Merger (4) Radix

Q. 89-90

Consider the following schema

```
Employee(id,name, basic)
Salary(empid, bonus);
```

Q. 89. What will the following query do?

```
select name, basic * bonus as monthlySal
from Employee e, salary s
where bonus > 1.20
and bonus < 1.50
and basic > 5000
and basic < 9999
```

(1) Name of employee along with his monthly salary for employees with bonus of 120 to 150 % and basic of 5000 to 9999.
(2) Monthly salary for employees with bonus of 120 to 150 % and basic of 5000 to 9999.
(3) Monthly salary for employees with bonus of 20 to 50 % and basic of 5000 to 9999.
(4) None of the above.

Q. 90. Print name and salary of a person getting minimum salary.

(1)
```
select name, (basic*bonus) as sal
from Employee e, salary s
where s.empid = e.id and basic * bonus = (
select min(basic * bonus) from Employee e, salary s
where e.id = s.id );
```
(2)
```
select name, min(basic*bonus)
from Employee e, salary s;
```
(3)
```
select name, min(basic*bonus)
from Employee e, salary s
where s.empid = e.id group by name;
```
(4)
```
select name, min(basic*bonus) as sal
from Employee e,
salary s where s.empid = e.id group by sal;
```

CS GATE 2003 with GateGenie Solutions

CSE GATE 2003

All questions carry 1 marks each.

Q. 1: Consider the following C function.

```
float f,(float x, int y) {
    float p, s; int i;
    for (s=1, p=1, i=1; i < y; i ++) {
       p*= x/i;
       s+=p;
    }
    return s;
}
```

For large values of y, the return value of the function f best approximates
(1) X^Y (2) e^x (3) $ln(1+x)$ (4) X^X

Explanation: Use a simple table to calculate the values, initiate with the starting conditions

i	p	s
1	1	1
1	x	$1+x$
2	$x^2/2$	$1+x+x^2/2$
3	$x^3/6$	$1+x+x^2/2+x^3/6$

Thus,

$$s = 1 + x + x^2/2! + x^3/3! + \ldots = e^x$$

Q. 2: Assume the following C variable declaration

```
int *A [10], B [10][10];
```

Of the following expressions
I. A[2]
II. A[2][3]
III. B[1]
IV. B[2][3]
which will not give compile-time errors if used as left hand sides of assignment statements in a C program ?
(1) I, II, and IV only (2) II, III, and IV only
(3) II and IV only (4) IV only

Explanation:

- I. A [2]- valid : a pointer to an integer array can be stored in it.
- II A [2] [3]- valid : location of an integer
- III B [1]- invalid: will give incompatible type assignment
- IV B [2] [3]- valid: integer can be assigned

Q. 3: Let $P(E)$ denote the probability of the event E. Given $P(A) = 1, P(B) = 1/2$, the values of $P(A \mid B)$ and $P(B \mid A)$ respectively are
(1) 1/4, 1/2 (2) 1/2, 1/4 (3) 1/2, 1 (4) 1, 1/2

Explanation: P(A) = 1, which is independent of event B. Hence option 4.

Q. 4: Let A be a sequence of 8 distinct integers sorted in ascending order. How many distinct pairs of sequences, B and C are there such that
(i) each is sorted in ascending order,
(ii) B has 5 and C has 8 elements, and
(iii) the result of merging B and C gives A ?
(1) 2 (2) 30 (3) 56 (4) 256

Explanation: The problem is finally reduced to selecting 5 elements out of 8. Hence option 3.

Q. 5: n couples are invited to a party with the condition that every husband should be accompanied by his wife. However, a wife need not be accompanied by her husband. The number of different gatherings possible at the party is
(1) $\binom{2n}{n} \times 2^n$ (2) 3^n (3) $(2n!)/2^n$ (4) $\binom{2n}{n}$

Explanation: Either husband and wife will come or only wife will come. Thus there are three choices per couple, so 3^n possible gatherings.

Q. 6: Let $T(n)$ be the number of different binary search trees on n distinct elements. Then

$$T(n) = \sum_{k=1} nT(k-1)T(x)$$

where x is
(1) $n-k+1$ (2) $n-k$ (3) $n-k-1$ (4) $n-k-2$

Explanation: It can be viewed as sum of all possible ways of forming a tree using the left and right subtree. There are n nodes out of which, one is root. Hence remaining are $(n-1)$. Now if $(k-1)$ is the number of nodes in left subtree, the number of nodes in right subtree will be: $(k-1)+(x) = n-1$ Hence $x = n-k$. Hence option 2.

Q. 7: Consider the set Σ^* of all strings over the alphabet $\Sigma = (0, 1)$. Σ^* with the concatenation operator for strings
(1) does not form a group
(2) forms a non-commutative group
(3) does not have a right identity element
(4) forms a group if the empty string is removed from Σ^*

Explanation: A group needs to satisfy three properties:

1. Association
$$a * (b * c) = (a * b) * c$$
2. Identify:
$$a * \epsilon = \epsilon * a = a$$
3. Inverse:
$$a * a^{-1} = a^{-1} * a = e$$
No such inverse exists.

Hence, option 1.

Q. 8: Let G be an arbitrary graph with n nodes and k components. If a vertex is removed from

G, the number of components in the resultant graph must necessarily lie between
(1) k and n (2) $k-1$ and $k+1$
(3) $k-1$ and $n-1$ (4) $k+1$ and $n-k$

Explanation:

- **Lower Limit:** If removal of a node does not add to formation of new component then its $(k-1)$, as the node removed might itself be a component.
- **Upper Limit:** If the node removed makes the resultant graph separate out into $(n-1)$ nodes or components, then $(n-1)$.

hence option 3

Q. 9: Assuming all numbers are in 2's complement representation, which of the following numbers is divisible by 11111011 ?
(1) 11100111 (2) 11100100 (3) 11010111 (4) 11011011

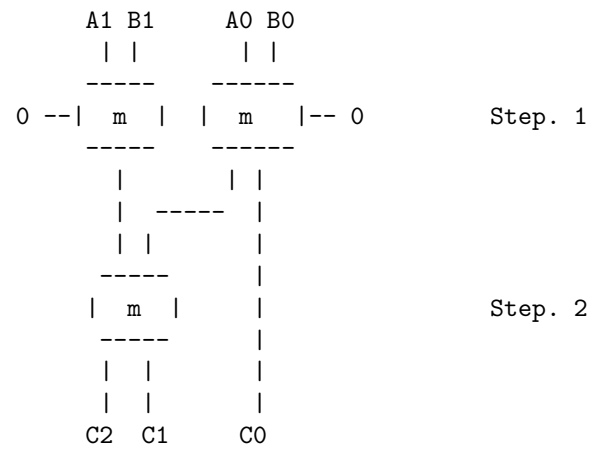
Q. 10: For a pipelined CPU with a single ALU, consider the following situations

1. The $j+1$-st instruction uses the result of the j-th instruction as an operand
2. The execution of a conditional jump instruction
3. The j-th and $j+1$-st instructions require the ALU at the same time

Which of the above can cause a hazard?
(1) 1 and 2 only (2) 2 and 3 only (3) 3 only (4) All the three

Q. 11: Consider an array multiplier for multiplying two n bit numbers. If each gate in the circuit has a unit delay, the total delay of the multiplier is
(1) $\theta(1)$ (2) $\theta(log\ n)$ (3) $\theta(n)$ (4) $\theta(n^2)$

Explanation:



The array multiplier for multiplication of 2-bit numbers is as shown above.

$$\begin{aligned} Total\ delay &= Delay\ in\ step.\ 1 + Delay\ in\ step.\ 2 \\ &= 1+1=2 \end{aligned}$$

Since the operation happens in parallel in step. 1, the total delay in step 1 is 1.

The total delay is 2 which is $\theta(n)$.

Q. 12: Ram and Shyam have been asked to show that a certain problem θ is NP-complete. Ram shows a polynomial time reduction from the 3-SAT problem to θ, and Shyam shows a polynomial time reduction from θ to 3-SAT. Which of the following can be inferred from these reductions?
(1) θ is NP-hard but not NP-complete
(2) θ is in NP, but is not NP-complete
(3) θ is NP-complete
(4) θ is neither NP-hard, nor in NP

Explanation: 3-SAT is a standard NP-complete problem so both the problems are NP-complete.

Q. 13: Nobody knows yet if $P = NP$. Consider the language L defined as follows:

$$\begin{aligned} L = & \{ \quad (0+1)^* \; if \; P \; = \; NP \\ & \{ \quad \phi \; otherwise \end{aligned}$$

Which of the following statements is true?
(1) L is recursive
(2) L is recursively enumerable but not recursive
(3) L is not recursively enumerable
(4) Whether L is recursive or not will be known after we find out if $P = NP$

Explanation: $(0+1)^*$ is a regular set and hence it is recursive, the null set is recursive. Hence whether $P = NP$ or not both choices yield recursive as the answer.
Ans: L is recursive i.e. A

Q. 14: The regular expression $0^*(10^*)^*$ denotes the same set as
(1) $(1^*0)^*1^*$ (2) $0 + (0+10)^*$
(3) $(0+1)^*10(0+1)^*$ (4) none of the above

Explanation: The rule is as follows:

$$a^*(ba^*)^* = (a+b)^*$$

This rule implies that

$$\begin{aligned} 0^*(10^*)^* &= (0+1)^* \\ 1^*(1^*0)^* &= (1+0)^* = (0+1)^* \end{aligned}$$

Ans: $0^*(10^*)^* = (0+1)^* = (1^*0)1^*$ i.e. A

Q. 15: If the strings of a language L can be effectively enumerated in lexicographic (i.e., alphabetic) order, which of the following statements is true?
(1) L is necessarily finite
(2) L is regular but not necessarily finite
(3) L is context free but not necessarily regular
(4) L is recursive but not necessarily context free

Explanation: The following theorem says it all:

L is recursive iff L is enumerable in lexicographic order

It is also known that- Context free language. is subset of Recursive languages.
Ans: L is recursive but not necessarily context free i.e. D

Q. 16: Which of the following suffices to convert an arbitrary CFG to an $LL(1)$ grammar ?
(1) Removing left recursion alone
(2) Factoring the grammar alone
(3) Removing left recursion and factoring the grammar
(4) None of the above

Explanation: Reference: Compilers: Principle, Techniques and Tools
Aho, Sethi and Ullman
Topic: Syntax Analysis, Section: 4.4
Ans: Removing left recursion and factoring the grammar i.e. C

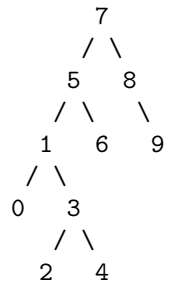
Q. 17: Assume that the SLR parser for a grammar G has n_1 states and the LALR parser for G has n_2 states. The relationship between n_1 and n_2 is
(1) n_1 is necessarily less than n_2
(2) n_1 is necessarily equal to n_2
(3) n_1 is necessarily greater than n_2
(4) none of the above

Explanation: Reference: Compilers: Principle, Techniques and Tools
Aho, Sethi and Ullman
Topic: Syntax Analysis, Section: 4.7 Constructing LALR Parsing Tables
Ans: n_1 is necessarily equal to n_2 i.e. B

Q. 18: In a bottom-up evaluation of a syntax directed definition, inherited attributes can
(1) always be evaluated
(2) be evaluated only if the definition is L-attributed
(3) be evaluated only if the definition has synthesized attributes
(4) never be evaluated

Q. 19: Suppose the numbers 7, 5, 1, 8, 3, 6, 0, 9, 4, 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the usual ordering on natural numbers. What is the in-order traversal sequence of the resultant tree?
(1) 7 5 1 0 3 2 4 6 8 9 (2) 0 2 4 3 1 6 5 9 8 7
(3) 0 1 2 3 4 5 6 7 8 9 (4) 9 8 6 4 2 3 0 1 5 7

Explanation: The tree has to start with root as 7. Here is the tree:



In-order :

0 1 2 3 4 5 6 7 7 9

Obvious sol. to the problem is that in-order traversal of a binary search tree always gives the sorted sequence. Hence no need to even generate the tree.

Q. 20: Consider the following three claims

1. $(n+k)^m = \theta(n^m)$, where k and m are constants
2. $2^{n+1} = 0(2^n)$
3. $2^{2n} = 0(2^n)$

Which of these claims are correct?
(1) 1 and 2 (2) 1 and 3 (3) 2 and 3 (4) 1, 2 and 3

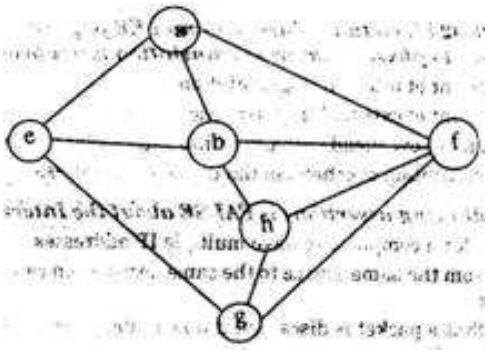


Figure 17: Fig. for Q. 21

Q. 21: Consider the following graph Among the following sequences

1. a b e g h f
2. a b f e h g
3. a b f h g e
4. a f g h b e

Which are depth first traversals of the above graph?
(1) 1, 2 and 4 only (2) 1 and 4 only
(3) 2, 3 and 4 only (4) 1, 3 and 4 only

Explanation: II. Here e is not connected with f and hence can not be part of depth first traversal. So, D not containing II is the solution.

Q. 22 : The usual $\theta(n^2)$ implementation of Insertion Sort to sort an array uses linear search to identify the position where an element is to be inserted into the already sorted part of the array. If, instead, we use binary search to identify the position, the worst case running time will
(1) remain $\theta(n^2)$ (2) become $\theta(n\ (log\ n)^2)$
(3) become $\theta(n\ log\ n)$ (4) become $\theta(n)$

Q. 23 : In a heap with n elements with the smallest element at the root, the 7 th smallest element can be found in time
(1) $\theta(n\ log\ n)$ (2) $\theta(n)$ (3) $\theta(log\ n)$ (4) $\theta(1)$

Explanation: With large n, the number of comparisons required for finding 7th smallest element becomes irrelevant of the height ($logn$) of the heap. It can be found out in constant time. Hence option 4.

Q. 24: Which of the following statements is FALSE?
(1) In statically typed language, each variable in a program has a fixed type
(2) In un-typed languages, values do not have any types
(3) In dynamically typed languages, variables have no types
(4) In all statically typed languages, each variable in a program is associated with values of only a single type during the execution of the program

Q. 25: Using a larger block size in a fixed block size file system leads to
(1) better disk throughput but poorer disk space utilization
(2) better disk throughput and better disk space utilization
(3) poorer disk throughput but better disk space utilization
(4) poorer disk throughput and poorer disk space utilization

Q. 26: In a system with 32 bit virtual addresses and 1 KB page size, use of one-level page tables for virtual to physical address translation is not practical because of
(1) the large amount of internal fragmentation
(2) the large amount of external fragmentation
(3) the large memory overhead in maintaining page tables
(4) the large computation overhead in the translation process

Q. 27: Which of the following assertions is FALSE about the Internet Protocol (IP)?
(1) It is possible for a computer to have multiple IP addresses
(2) IP packets from the same source to the same destination can take different routes in the network
(3) IP ensures that a packet is discarded if it is unable to reach its destination within a given number of hops
(4) The packet source cannot set the route of an outgoing packets; the route is determined only by the routing tables in the routers on the way

Q. 28: Which of the following functionalities must be implemented by a transport protocol over and above the network protocol?
(1) Recovery from packet losses
(2) Detection of duplicate packets
(3) Packet delivery in the correct order
(4) End to end connectivity

Q. 29: Which of the following scenarios may lead to an irrecoverable error in a database system?
(1) A transaction writes a data item after it is read by an uncommitted transaction
(2) A transaction reads a data item after it is read by an uncommitted transaction
(3) A transaction reads a data item after it is written by a committed transaction
(4) A transaction reads a data item after it is written by an uncommitted transaction

Q. 30 : Consider the following SQL query: *select distinct a1, a2, ... , an from r1, r2, ..., rm where* P . For an arbitrary predicate P, this query is equivalent to which of the following relational algebra expressions?
(1) $\Pi_{a_1,a_2,\ldots,a_n}\sigma_p(r_1 \times r_2 \times \ldots \times r_m)$
(2) $\Pi_{a_1,a_2,\ldots,a_n}\sigma_p(r_1 \bowtie r_2 \bowtie \ldots \bowtie r_m)$
(3) $\Pi_{a_1,a_2,\ldots,a_n}\sigma_p(r_1 \cup r_2 \cup \ldots \cup r_m)$
(4) $\Pi_{a_1,a_2,\ldots,a_n}\sigma_p(r_1 \cap r_2 \cap \ldots \cap r_m)$

Q. 31-90 carry two marks each

Q. 31 : Let $(S, \leq)$ be a partial order with two *m*inimal elements a and b, and a maximum element c. Let $P : S \rightarrow \{\text{TRUE, FALSE }\}$ be a predicate defined on S. Suppose that $P(a) =$**TRUE**, $P(b) =$**FALSE** and $P(x) \Rightarrow P(y)$ for all $x, y \in S$ satisfying $x \leq y$, where $\Rightarrow$ stands for logical implication. Which of the following statements CANNOT be true?
(1) $P(x) =$ **True** for all $x \in S$ such that $x \neq b$
(2) $P(x) =$ **False** for all $x \in S$ such that $x \neq a$ and $x \neq c$
(3) $P(x) =$ **False** for all $x \in S$ such that $b \leq x$ and $x \neq c$
(4) $P(x) =$ **False** for all $x \in S$ such that $a \leq x$ and $b \leq x$

Q. 32 : Which of the following is a valid first order formula? (Here a and b are first order formu-

lae with x as their only free variable)
(1) $((\forall\alpha)[\alpha] \Rightarrow (\forall x)[\beta]) \Rightarrow (\forall x)[\alpha \Rightarrow \beta]$
(2) $(\forall\alpha)[\alpha] \Rightarrow (\exists x)[\beta \wedge \alpha]$
(3) $((\forall\alpha)[\alpha \vee \beta] \Rightarrow (\exists x)[\alpha]) \Rightarrow (\forall x)[\alpha]$
(4) $(\forall\alpha)[\alpha \rightarrow \beta] \Rightarrow ((\forall x)[\alpha] \Rightarrow (\forall x)[\alpha \Rightarrow \beta])$

Q. 33 : Consider the following formula α and its two interpretations I_1 and I_2
$\alpha : (\forall x)[Px \Longleftrightarrow (\forall y)[Qxy \Longleftrightarrow \neq Qyy]] \Rightarrow (\forall x)[\neq Px]$
I_1 : Domain: the set of natural numbers
$Px \equiv$ 'x is a prime number'

$Qxy \equiv$ 'y divides x'
I_2 : same as I_1 except that $Px \equiv$ 'x is a composite number'
(1) I_1 satisfies α, I_2 does not
(2) I_2 satisfies α, I_1 does not
(3) Neither I_1 nor I_2 satisfies α
(4) Both I_1 and I_2 satisfy α

Q. 34 : m identical balls are to be placed in n distinct bags. You are given that $m \geq kn$, where k is a natural number ≥ 1. In how many ways can the balls be placed in the bags if each bag must contain at least k balls?
(1) $\binom{m-k}{n-1}$ (2) $\binom{m-kn+n-1}{n-1}$
(3) $\binom{m-1}{n-k}$ (4) $\binom{m-kn+n+k-2}{n-k}$

Q. 35 : Consider the following recurrence relation

$$\begin{aligned} T(1) &= 1 \\ T(n+1) &= T(n) + \lfloor\sqrt{(n+1)}\rfloor, \forall n \geq 1 \end{aligned}$$

The value of $T(m^2)$ for $m \geq 1$ is
(1) $\frac{m}{6}(21m - 39) + 4$
(2) $\frac{m}{6}(4m^2 - 3m + 5)$
(3) $\frac{m}{2}(3m^{2.5} - 11m + 20) - 5$
(4) $\frac{m}{6}(5m^3 - 34m^2 + 137m - 104) + \frac{5}{6}$

Explanation: Put $m = m^2 = 1$ in all options. Only option 2 satisfies $T(1) = 1$.

Q. 36 : How many perfect matchings are there in a complete graph of 6 vertices?
(1) 15 (2) 24 (3) 30 (4) 60

Explanation: Select two pairs of 3 nodes each. say A B C and E F G. There are 6 possible way of perfect matchings in this set and 5 such distinct sets can be selected from 6 vertices. Hence 30.
Q. 37 : Let $f : A \rightarrow B$ be an injective(one to one) function. Define $g : 2^A \rightarrow 2^B$ as:

$$g(C) = \{f(x) \mid x \in C\}, \text{for all subsets } C \text{ of } A.$$

Define $h : 2^B \rightarrow 2^A$ as: $h(D) = \{x \mid x \in a, f(x) \in D\}$, for all subsets D of B. Which of the following statements is always true?
(1) $g(h(D)) \subseteq D$ (2) $g(h(D)) \supseteq D$
(3) $g(h(D)) \cap D = \phi$ (4) $g(h(D)) \cap (B - D) \neq \phi$

Q. 38 :

$+$	a	b	c
a	b	a	c
b	a	b	c
c	a	c	b

$\times$	a	b	c
a	a	b	c
b	b	c	a
c	c	c	b

For example, $a + c = c, c + a = a, c \times b = c$ and $b \times c = a$. Given the following set of equations:

$$(a \times x) + (a \times y) = c$$
$$(b \times x) + (c \times y) = c$$

the number of solution(s) (i.e., pair(s)(x,y) that satisfy the equations) is
(1) 0 (2) 1 (3) 2 (4) 3

Q. 39 : Let $\Sigma = \{a, b, c, d, e\}$ be an alphabet. We define an encoding scheme as follows:

$$g(a) = 3, g(b) = 5, g(c) = 7, g(d) = 9, g(e) = 11$$
Let p_i denote the i-th prime number ($p_1 = 2$)

For a non-empty string $s = a_1, \ldots, a_n$ where each $a_i \in \Sigma$, define $f(s) = \Pi_{i=1}^{n} P_i^{g(a_i)}$. For a non-empty sequence $< s_1, \ldots, s_n >$ of string from Σ^+, define

$$h(< s_1, \ldots, s_n >) = \Pi_{i=1}^{n} P_i^{f(s_i)}$$

Which of the following numbers is the encoding , h, of a non-empty sequence of strings?
(1) 2 73 75 7 (2) 2 83 85 8
(3) 2 93 95 9 (4) 2 105 107 10

Q. 40 : A graph $G = (V, E)$ satisfies $\mid E \mid \leq 3 \mid V \mid -6$. The min-degree of G is defined as $min_{v \in V}\{degree(v)\}$. Therefore, min-degree of G can not be
(1) 3 (2) 4 (3) 5 (4) 6

Q. 41 : Consider the following system of linear equations

$$\begin{bmatrix} 2 & 1 & -4 \\ 4 & 3 & -12 \\ 1 & 2 & -8 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \alpha \\ 5 \\ 7 \end{bmatrix}$$

Notice that the second and the third columns of the coefficient matrix are linearly dependent. For how many values of α, does this system of equations have infinitely many solutions?
(1) 0 (2) 1 (3) 2 (4) infinitely many

Q. 42 : A piecewise linear function $f(x)$ is plotted using thick solid lines in the figure below (the plot is drawn to scale). If we use the Newton-Raphson method to find the roots of $f(x) = 0$ using $x0$, $x1$

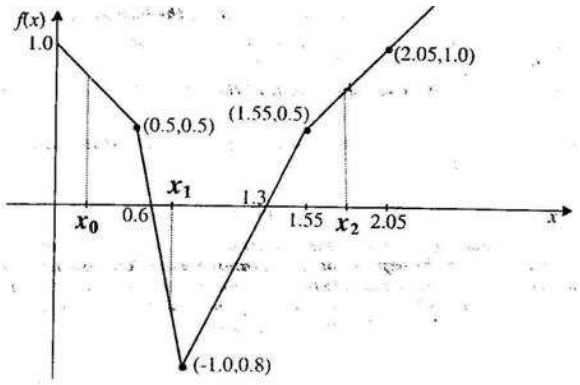


Figure 18: Fig. for Q. 42

and $x2$ respectively as initial guesses, the roots obtained would be

(1) 1.3, 0.6, and 0.6 respectively
(2) 0.6, 0.6, and 1.3 respectively
(3) 1.3, 1.3, and 0.6 respectively
(4) 1.3, 0.6, and 1.3 respectively

Q. 43 : The following is a scheme for floating point number representation using 16 bits.

Bit Position	15	14 9	8 0
	s	e	m
	Sign	Exponent	Mantissa

Let s, e, and m be the numbers represented in binary in the sign, exponent, and mantissa fields respectively. Then the floating point number represented is:

$$\left\{ \begin{array}{ll} (-1)^s(1 + m \times 2^{-9}) & \text{, if the exponent } \neq 111111 \\ 0 & \text{, otherwise} \end{array} \right\}$$

What is the maximum difference between two successive real numbers representable in this system?
(1) 2^{-40} (2) 2^{-9} (3) 2^{22} (4) 2^{31}

Q. 44 : A 1-input, 2-output synchronous sequential circuit behaves as follows.

Let z_k, n_k denote the number of 0's and 1's respectively in initial k bits of the input ($z_k + n_k = k$). The circuit outputs 00 until one of the following conditions holds.

- $z_k - n_k = 2$. In this case, the output at the k-th and all subsequent clock ticks is 10.
- $n_k - z_k = 2$. In this case, the output at the k-th and all subsequent clock ticks is 01.

What is the minimum number of the states required in the state transition graph of the above circuit?
(1) 5 (2) 6 (3) 7 (4) 8

Q. 45 : The literal count of a boolean expression is the sum of the number of times each literal appears in the expression. For example, the literal count of $(xy + xz')$ is 4. What are the minimum possible literal counts of the product-or-sum and sum-of product representations respectively of the function given by the following K- map? Here, X denotes "don't care"

xy / zw	00	01	11	10
00	X	1	0	1
01	0	1	X	0
11	1	X	X	0
10	X	0	0	X

(1) (11, 9) (2) (9, 13) (3) (9, 10) (4) (11, 11)

Q. 46 : Consider the ALU shown below. If the operands are in 2's complement representation, which of the following operations can be performed by suitably setting the control lines K and C_o only (+ and - denote addition and subtraction respectively)?
(1) $A + B$, and $A - B$, but not $A + 1$
(2) $A + B$, and $A + 1$, but not $A - B$
(3) $A + B$, but not $A - B$, or $A + 1$
(4) $A + B$, and $A - B$, and $A + 1$

Q. 47 : Consider the following circuit composed of XOR gates and non-inverting buffers. The non-inverting buffers have delays $\delta_1 = 2$ ns and $\delta_2 = 4$ ns as shown in the figure. Both XOR gates and all

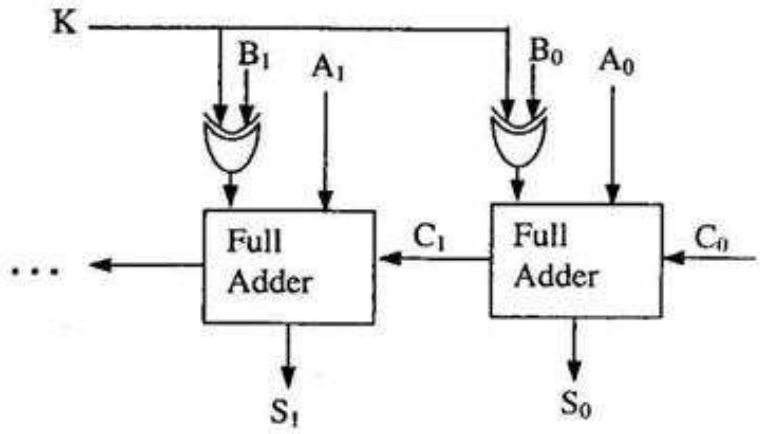


Figure 19: Fig. for Q. 46

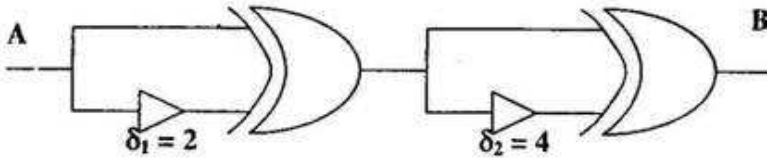


Figure 20: Fig. for Q. 47

wires have zero delay. Assume that all gate inputs, outputs and wires are stable at logic level 0 at time 0. If the following waveform is applied at input A, how many transition(s) (change of logic levels) occur(s) at B during the interval from 0 to 10 ns ?

(1) 1 (2) 2 (3) 3 (4) 4

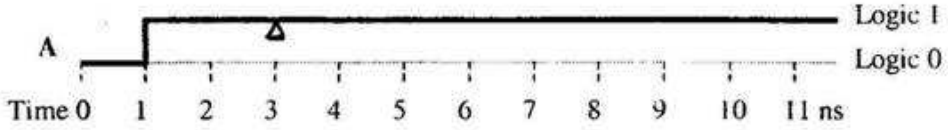


Figure 21: Fig. for Q. 47

The following information pertains to Q. 48-49

Consider the following assembly language program for a hypothetical processor. A, B, and C are 8 bit registers. The meanings of various instructions are shown as comments.

```
     MOV B, #0    ; B ← 0
     MOV C, #8    ; C ← 8
Z:   CMP C, #0    ; compare C with 0
     JZ X         ; jump X if zero flag is set
     SUB C, #1    ; C ← C - 1
     RRC A, #1    ; right rotate A through carry by one bit. Thus:
                  ; if the initial values of A and the carry flag are a7 ... a0 and
                  ; c0 respectively, their values after the execution of this
                  ; instruction will be c0 a7 ... a1 and a0 respectively.
     JC Y         ; jump to Y if carry flag is set
     JMP Z        ; jump to Z
Y:   ADD B, #1    ; B ← B + 1
     JMP Z        ; jump to Z
X:
```

Q. 48 : If the initial value of register A is A_0, the value of register B after the program execution will be

(1) the number of 0 bits in A_0 (2) the number of 1 bits in A_0
(3) A_0 (4) 8

Explanation: For example, consider A_0 = 1 0 1 0 1 0 1 0 and carry = 0, the following is as per program execution.

```
1 0 1 0 1 0 1 0   Carry = 0 C=8 B=0
0 1 0 1 0 1 0 1   Carry = 0 C=7
0 0 1 0 1 0 1 0   Carry = 1 C=6 B=1
1 0 0 1 0 1 0 1   Carry = 0 C=5
0 1 0 0 1 0 1 0   Carry = 1 C=4 B=2
1 0 1 0 0 1 0 1   Carry = 0 C=3
0 1 0 1 0 0 1 0   Carry = 1 C=2 B=3
1 0 1 0 1 0 0 1   Carry = 0 C=1
0 1 0 1 0 1 0 0   Carry = 1 C=0 B=4
```

Example 2. A_0 = 1 1 1 1 1 1 1 1 and carry = 0

```
1 1 1 1 1 1 1 1  8 carry=0
0 1 1 1 1 1 1 1  7 carry=1 b=1
1 0 1 1 1 1 1 1  6 carry=1 b=2
1 1 0 1 1 1 1 1  5 carry=1 b=3
1 1 1 0 1 1 1 1  4 carry=1 b=4
1 1 1 1 0 1 1 1  3 carry=1 b=5
1 1 1 1 1 0 1 1  2 carry=1 b=6
1 1 1 1 1 1 0 1  1 carry=1 b=7
1 1 1 1 1 1 1 0  0 carry=1 b=8
```

The above two example, shows that the value of B after the program execution is equal to the number of 1 bits in A_0.

Logical argument based on program says that the value of B is incremented each time the carry flag is set (=1), which in turns mean that the value of B is same as the number of times carry flag is set, which is same as number of 1 bits in A_0.

Ans: The number of 1 bits in A_0 i.e. B

Q. 49 : Which of the following instructions when inserted at location X will ensure that the value of register A after program execution is the same as its initial value?

(1) RRCA, #
(2) NOP; no operation
(3) LRC A, #1; left rotate A through carry flag by one bit
(4) ADD A, #1

Explanation: For example, consider A_0 = 1 0 1 0 1 0 1 0 and carry = 0, the following is as per program execution.

```
1 0 1 0 1 0 1 0   Carry = 0 C=8 B=0
0 1 0 1 0 1 0 1   Carry = 0 C=7
0 0 1 0 1 0 1 0   Carry = 1 C=6 B=1
1 0 0 1 0 1 0 1   Carry = 0 C=5
0 1 0 0 1 0 1 0   Carry = 1 C=4 B=2
1 0 1 0 0 1 0 1   Carry = 0 C=3
0 1 0 1 0 0 1 0   Carry = 1 C=2 B=3
1 0 1 0 1 0 0 1   Carry = 0 C=1
0 1 0 1 0 1 0 0   Carry = 1 C=0 B=4
```

One more right rotation through carry will restore the original number.

Ans: RRC A, #1 i.e. A

Q. 50: Consider the following deterministic finite state automaton M. Let S denote the set of seven bit

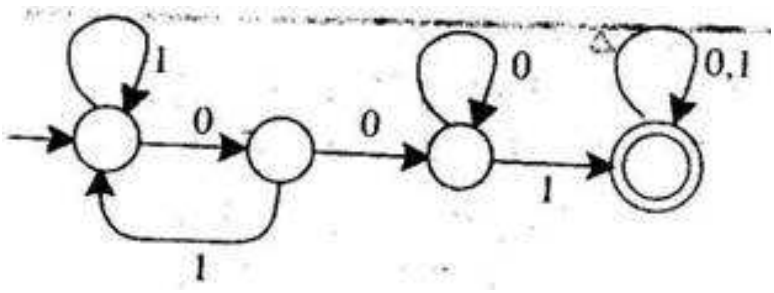


Figure 22: Fig. for Q. 50

binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

(1) 1 (2) 5 (3) 7 (4) 8

Explanation: Name the states of the finite automata left to right as A,B,C and D. The strings with the 1st, 4th and 7th bits as 1's will be

```
1001D001
1001D011
1001D101
1001D111

1011A001
1011A011
1011A101
1011A111

1101A001
1101A011
1101A101
1101A111

1111A001
1111A010
1111A101
1111A111
```

The first four are accepted. In the remaining three block of fours only the first string is accepted.

Ans: The total number of strings accepted are 7 i.e. (C)

Q. 51: Let $G = (\{S\}, \{a, b\}R, S)$ be a context free grammar where the rule set R is

$$S \rightarrow aSb \mid SS \mid \epsilon$$

Which of the following statements is true?
(1) G is not ambiguous
(2) There exist $x, y \in L(G)$ such that $xy \in L(G)$
(3) There is a deterministic pushdown automaton that accepts $L(G)$
(4) We can find a deterministic finite state automaton that accepts $L(G)$

Explanation: As one could see, the grammar generates set of strings which have equal number of a's and b's. The strings are similar to balanced parenthesis. Lets explore the options:

- e (the empty string) has an infinite number of derivation trees, so exclude (A).
- The concatenation of any two strings of balanced parenthesis is a balanced parenthesis string, so exclude (B).
- DFA can't recognize language which involves some kind of counting as referred by "equal number of a's and b's" , so exclude (D).
- The grammar can be accepted by Deterministic PDA and hence (C) is the answer.

Ans: We can find deterministic PDA that accepts L(G).

Q. 52: Consider two languages L_1 and L_2, each on the alphabet Σ. Let $f : \Sigma^* \rightarrow \Sigma^*$ be a polynomial time computable bijection such that

$$(\forall x)\,[x \in L_1 \text{iff} f(x_1) \in L_2]$$

Further let f^{-1} be also polynomial time computable.

Which of the following CANNOT be true?
(1) $L_1 \in P$ and L_2 is finite
(2) $L_1 \in NP$ and $L_2 \in P$
(3) L_1 is undecidable and L_2 is decidable
(4) L_1 is recursively enumerable and L_2 is recursive

Explanation: To see a simple solution, let us take the special case of $L_1 = L_2 = L$.

- (A) It is possible now that L_2 is finite and L_1 is trivially in P, as every finite set is in P.
- (B) L_2 in P means L_1 can be in NP as every language in P is trivially in NP.
- (D) L_2 is recursive and L_1 in r.e. sets is possible as every recursive set is trivially recursively enumerable.

So by elimination we have (C) as the answer. Evidently if L_1 is undecidable then then it cannot be recursive like L_2.

Q. 53: A single tape Turing Machine M has two states q_0 and q_1, of which q_0 is the starting state. The tape alphabet of M is $\{0, 1, B\}$ and its input alphabet is $\{0, 1\}$. The symbol B is the blank symbol used to indicate end of an input string. The transition function of M is described in the following table

	0	1	B
q_0	$(q_1, 1, R)$	$(q_1, 1, R)$	Halt
q_1	$(q_1, 1, R)$	$(q_0, 1, L)$	(q_0, B, L)

The table is interpreted as illustrated below: The entry $(q_1, 1, R)$ in row q_0 and column 1 signifies that if M is in state q_0 and reads 1 on the current tape square, then it writes 1 on the same tape square, moves its tape head one position to the right and transitions to state q_1. Which of the following statements is true about M ?

(1) M does not halt on any string in $(0+1)^+$
(2) M does not halt on any string in $(00+1)^*$
(3) M halts on all string ending in a 0
(4) M halts on all string ending in a 1

Explanation: Let us eliminate the cases.

- (A) It is possible now that L_2 is finite and L_1 is trivially in P,
- Consider the machine on blank tape then e is the input. On B the machine halts. This excludes (B). It is easy to check that the machine loops on inputs 0 and 1.

Thus (A) is the answer.

Q. 54: Define languages L_0 and L_1 as follows:

$$\begin{aligned} L_0 &= \{< M, w, 0 >| \ M \text{ halts on } w\} \\ L_1 &= \{< M, w, 1 >| \ M \text{ does not halts on } w\} \end{aligned}$$

Here $< M, w, i >$ is a triplet, whose first component. M is an encoding of a Turing Machine, second component, w, is a string, and third component, i, is a bit.

Let $L = L_0 \cup L_1$. Which of the following is true?
(1) L is recursively enumerable, but $L'$is not
(2) L' is recursively enumerable, but L is not
(3) Both L and L are recursive
(4) Neither L nor L' is recursively enumerable

Explanation: If L is r.e. then we have a Turing machine M accepting it. Let M be an enumerator(any Turing machine can be considered to be an enumerator). Then for any Turing Machine M' and input w' in a finite amount of time M will enumerate the string $< M', w', 0 >$ or $< M', w', 1 >$, thus deciding if M' on input w' halts or not. Such a machine cannot exist.

Consider the complement of $L = L'$, accepted by a turning machine M_1. If a machine M_1 exists then it will enumerate either $< M', w', 0 >$ or $< M', w', 1 >$ in a finite amount of time resolving the halting problem. So L' cannot be r.e.

Ans: Neither L nor L' is recursively enumerable.

Q. 55: Consider the NFA M shown below. Let the language accepted by M be L. Let L_1 be the

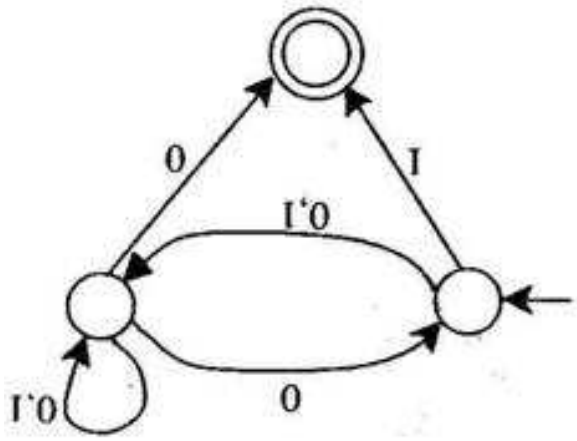


Figure 23: Fig. for Q. 55

language accepted by the NFA M_1, obtained by changing the accepting state of M to a non-accepting state and by changing the non-accepting state of M to accepting states. Which of the following statements is true?

(1) $L_1 = \{O, 1\}^* - L$ (2) $L_1 = \{O, 1\}^*$
(3) $L_1 \subseteq L$ (4) $L_1 = L$

Explanation: By interchanging the final and non-final states of M we see that the new machine gives e as an element of L_1 as the start state becomes a final state in the machine for L_1.

- This excludes (C) and (D) from the answers.
- 1 is in L and L_1 and this excludes (A) from the answer.
- The only choice left is (B). In the machine for L_1 we have a complete finite automata where all the states i.e entries in the transition table are final states. Thus L_1 is $(0 + 1)^*$.

Ans: $L_1 = \{0, 1\}^*$ i.e. B

Q. 56: Consider the grammar shown below

$$\begin{aligned} S &\rightarrow iEtSS' \mid a \\ S' &\rightarrow eS \mid \epsilon \\ E &\rightarrow b \end{aligned}$$

In the predictive parse table. M, of this grammar, the entries $M[S', e]$ and $M[S, \$]$ respectively are
(1) $\{S' \rightarrow eS\}$ and $\{S' \rightarrow \epsilon\}$ (2) $\{S' \rightarrow eS\}$ and $\{\}$
(3) $\{S' \rightarrow \epsilon\}$ and $\{S' \rightarrow \epsilon\}$ (4) $\{S' \rightarrow eS, S' \rightarrow \epsilon\}$ and $\{S' \rightarrow \epsilon\}$

Explanation:
Reference: Compilers: Principle, Techniques and Tools
Aho, Sethi and Ullman
AWL, International Student Edition
Topic: Syntax Analysis, Section: 4.4 Example 4.19

Follow the example along with algorithm for constructing predictive parsing table. The solution to example includes parsing table for the same.

Ans: $\{S' \rightarrow eS, S' \rightarrow \epsilon\}$ and $\{S' \rightarrow \epsilon\}$ i.e. D

Q. 57: Consider the grammar shown below.

$$\begin{aligned} S &\rightarrow CC \\ C &\rightarrow cC \mid d \end{aligned}$$

The grammar is
(1) LL (1) (2) SLR (1) but not LL (1)
(3) LALR (1) but not SLR (1) (4) LR (1) but not LALR (1)

Q. 58: Consider the translation scheme shown below

$$\begin{aligned} S &\rightarrow TR \\ R &\rightarrow +T\{print\ ('+');\}\ R \mid \epsilon \\ T &\rightarrow num\ \{print\ (num.val);\} \end{aligned}$$

Here *num* is a token that represents an integer and *num.val* represents the corresponding integer value. For an input string '9 + 5 + 2, this translation scheme will print
(1) 9 + 5 + 2 (2) 9 5 + 2 +
(3) 9 5 2 + + (4) + + 9 5 2

Explanation:
Reference: Compilers: Principle, Techniques and Tools
Aho, Sethi and Ullman
AWL, International Student Edition
Topic: Syntax Directed Translation, Section: 5.4 Example 5.12

Ans: `9 5 + 2 +` i.e. B

Q. 59: Consider the syntax directed definition shown below.

$$\begin{aligned} S &\rightarrow id := E\{gen(id.place = E.place;);\} \\ E &\rightarrow E_1 + E_2\{t = newtemp(); \\ &\quad gen(t = E_1.place + E_2.place;); \\ &\quad E.place = t\} \\ E &\rightarrow id\{E.place = id.place;\} \end{aligned}$$

Here, *gen* is a function that generates the output code, and *newtemp* is a function that returns the name of a new temporary variable on every call. Assume that t_i's are the temporary variable names generated by newtemp. For the statement 'X := Y + Z', the 3-address code sequence generated by this definition is

(1) $X = Y + Z$
(2) $t_1 = Y + Z; X = t_1$
(3) $t_1 = Y; t_2 = t_1 + Z; X = t_2$
(4) $t_1 = Y; t_2 = Z; t_3 = t_1 + t_2; X = t_3$

Explanation:
Reference: Compilers: Principle, Techniques and Tools
Aho, Sethi and Ullman
AWL, International Student Edition
Topic: Intermediate Code Generation, Section: 8.1

Rule: When the three-address code is generated, temporary names are made up for the interior nodes of a syntax tree.

Ans: $t_1 = Y; t_2 = Z; t_3 = t_1 + t_2; X = t_3$ i.e. D

Q. 60: A program consists of two modules executed sequentially. Let $f_1(t)$ and $f_2(t)$ respectively denote the probability density functions of time taken to execute the two modules. The probability density function of the overall time taken to execute the program is given by

(1) $f_1(t) + f_2(t)$ (2) $\int_0^t f_1(x)f_2(x)dx$
(3) $\int_0^t f_1(x)f_2(t-x)dx$ (4) $max(f_1(t), f_2(t))$

The following information pertains to Q. 61 - 62

In a permutation $a_1 \ldots a_n$ of n distinct integers, an inversion is a pair (a_i, a_j) such that $i < j$ and $a_i > a_j$

Q. 61: If all permutations are equally likely, what is the expected number of inversions in a randomly chosen permutation of $1 \ldots n$?

(1) $n(n-1)/2$ (2) $n(n-1)/4$ (3) $n(n+1)/4$ (4) $2n\lfloor log_2 n \rfloor$

Explanation:
Rule: The expected number of inversions in a permutation of n elements (averaged over all $n!$ permutations) is $n(n-1)/4$.
Proof:
For any permutation $P = j_0, j_1, \ldots, j_{n-1}$, define its transpose $P_t = j_{n-1}, \ldots, j_1, j_0$. (For example, the transpose of `3 4 2 1 5` is `5 1 2 4 3`). Now for any pair j, k, with $j < k$, the inversion (k, j) appears either in P or in P_t, but not both, for every permutation P. There are

$$\begin{aligned} \sum_{0 \le j \le n-1} n - 1 - j &= \sum_{0 \le j' \le n-1} j' \\ &= n(n-1)/2 \; inversions \end{aligned}$$

So every pair of permutations P, P_t contains a total of $n(n-1)/2$ inversions, and so on the average a permutation contains $(n(n-1)/2) \times (1/2) = n(n-1)/4$ inversions.

Ans: $n(n-1)/4$ i.e. B

Q. 62: What would be the worst case time complexity of the Insertion Sort algorithm, if the inputs are restricted to permutations of $1 \ldots n$ with at most n inversions?
(1) $\theta(n^2)$ (2) $\theta(n\ log\ n)$ (3) $\theta(n^{1.5})$ (4) $\theta(n)$

Explanation:
Rule: The number of comparisons insertion sort does is same as number of inversions. This implies that the worst case complexity of insertion sort on data having at most n inversions is $\theta(n)$.
Ans: $\theta(n)$ i.e. D

Q. 63: A data structure is required for storing a set of integers such that each of the following operations can be done in (log n) time, where n is the number of elements in the set.

- Deletion of the smallest element
- Insertion of an element if it is not already present in the set

Which of the following data structures can be used for this purpose?
(1) A heap can be used but not a balanced binary search tree
(2) A balanced binary search tree can be used but not a heap
(3) Both balanced binary search tree and heap can be used
(4) Neither balanced binary search tree nor heap can be used

Q. 64: Let S be a stack of size $n \geq 1$. Starting with the empty stack, suppose we push the first n natural numbers in sequence, and then perform n pop operations. Assume that Push and Pop operation take X seconds each, and Y seconds elapse between the end of one such stack operation and the Blurt of the next operation. For $m \geq 1$, define the stack-life of m as the time elapsed from the end of Push(m) to the start of the pop operation that removes m from S. The average stack-life of an element of this stack is
(1) $n(X+Y)$ (2) $3Y+2X$ (3) $n(X+Y)-X$ (4) $Y+2X$

Explanation

1. Stack-life depends on n. Large value of m will have higher avg. stack life. Hence options 2 and 3 are not possible.
2. Now consider when $n=1$, avg. stack life is Y.
   1 – $X+Y$
   3 – $n(X+Y)-X$ which is Y
   Hence option 3 is correct.

Can be tested for more numbers.

Q. 65: Consider the following 2-3-4 tree (i.e., B-tree with a minimum degree of two) in which each data item is a letter. The usual alphabetical ordering of letters is used in constructing the tree What is

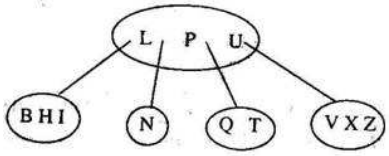


Figure 24: Fig. for Q. 65

the result of inserting G in the above tree ?
(d) none of the above
Q. 66: The cube root of a natural number n is defined as the largest natural number m such that $m^3 \leq n$.

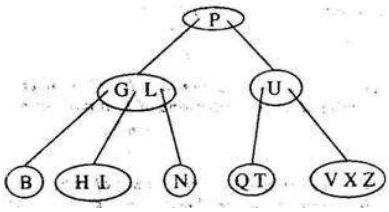


Figure 25: 65. (a)

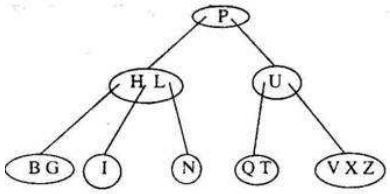


Figure 26: 65. (b)

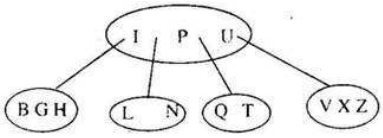


Figure 27: 65. (c)

The complexity of computing the cube root of n (n is represented in binary notation) is
(1) $O(n)$ but not $O(n^{0.5})$
(2) $O(n^{0.5})$ but not $O((log\ n)^k)$ for any constant $k > 0$
(3) $O((log\ n)^k)$ for some constant $k > 0$, but not $O((log\ log\ n)^m)$
for any constant $m > 0$
(4) $O((log\ log\ n)^k)$ for some constant $k > 0.5$, but
not $O((log\ log\ n)^{0.5})$

Q. 67: Let $G = (V, E)$ be an undirected graph with a sub graph $G_1 = (V_1, E_1)$. Weights are assigned to edges of G as follows:

$$w(e) = \begin{cases} 0\ if\ e \in E_1 \\ 1\ otherwise \end{cases}$$

A single-source shortest path algorithm is executed on the weighted graph (V, E, w) with an arbitrary vertex v_1 of V_1 as the source. Which of the following can always be inferred from the path costs computed?
(1) The number of edges in the shortest paths from V_1 to all vertices of G
(2) G_1 is connected
(3) V_1 forms a clique in G
(4) G_1 is a tree

Q. 68: What is the weight of a minimum spanning tree of the following graph?
(1) 29 (2) 31 (3) 38 (4) 41

Explanation: Edges for solution are:

- a-c: 1
- a-e: 2

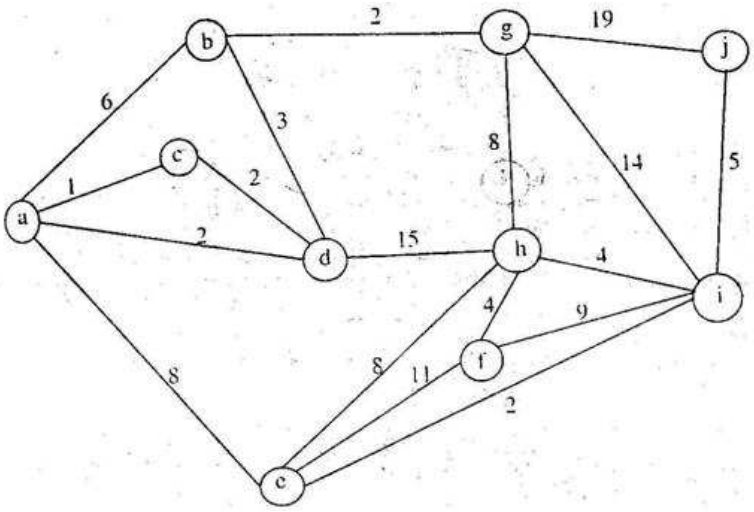


Figure 28: Fig. for Q. 68

- e-i: 2
- b-g: 2
- b-d: 3
- i-h: 4
- h-g: 4
- i-j: 5
- a-e: 8

Total: 31

Q. 69: The following are the starting and ending times of activities A, B, C, D, E, F, G and H respectively in chronological order:

a s b s a s a e d s a e e s f s b e d e g s e e f e h s g e h e

Here, x_s denotes the starting time and X_e denotes the ending time of activity X. W need to schedule the activities in a set of rooms available to us. An activity can be scheduled in a room only if the room is reserved for the activity for its entire duration. What is the minimum number of rooms required?
(1) 3 (2) 4 (3) 5 (4) 6

Explanation:
Consider following diagram:

```
Process  a  b  c     d    e  f        g        h
Start   -|--|--|-----|----|--|--------|--------|--------
Count    1  2  3     3    3  4        3        2
                            ***
Count              2    2        3  2     2  1     1  0
End     ----------|----|--------|--|-----|--|-----|--|--
Process            a    c        b  d     e  f     g  h
```

Ans: The max. in the count row, i.e. 4

Q. 70: Let $G = (V, E)$ be a directed graph with n vertices. A path from v_i to v_j in G is sequence

of vertices $(v_i, v_{i+1}, \ldots, v_j)$ such that $(v_k, v_{k+1}) \in E$ for all k in i through $j-1$. A simple path is a path in which no vertex appears more than once.

Let A be an $n \times n$ array initialized as follow

$$A[j,k] = \left\{ \begin{array}{ll} 1 & \text{if } (j,k) \in E \\ 0 & \text{otherwise} \end{array} \right\}$$

Consider the following algorithm

```
for i = 1 to n
  for j = 1 to n
    for k = 1 to n
      A [j, k] = max (A[j, k] (A[j,i] + A [i, k]);
```

Which of the following statements is necessarily true for all j and k after terminal of the above algorithm?
(1) $A[j,k] \leq n$
(2) If $A[j,j] \geq n-1$ then G has a Hamiltonian cycle
(3) If there exists a path from j to k, $A[j,j]$ contains the longest path length from j to k
(4) If there exists a path from j to k, every simple path from j to k contains at $A[j,j]$ edges

Explanation:
The last line of the algorithm tries to find

$$\max(\text{A[j,k]}, \text{ A[j,i]+A[i,k]})$$

A[j,k] is the existing know distance and A[j,i]+A[i,k] is some other possible way through i an intermediate node. As, max is taken, the longer route is retained and hence option C.

Q. 71: Consider the following logic program P

$$\begin{array}{rcl} A(x) & \leftarrow & B(x,y), C(y) \\ & \leftarrow & B(x,x) \end{array}$$

Which of the following first order sentences is equivalent to P ?
(1) $(\forall x)\,[(\exists y)\,[B(x,y) \wedge C(y)] \Rightarrow A(x)] \wedge \neg(\exists x)\,[B(x,x)]$
(2) $(\forall x)\,[(\forall y)\,[B(x,y) \wedge C(y)] \Rightarrow A(x)] \wedge \neg(\exists x)\,[B(x,x)]$
(3) $(\forall x)\,[(\exists y)\,[B(x,y) \vee C(y)] \Rightarrow A(x)] \wedge \neg(\exists x)\,[B(x,x)]$
(4) $(\forall x)\,[(\forall y)\,[B(x,y) \wedge C(y) \Rightarrow A(x)]] \wedge (\exists x)\,[B(x,x)]$

Q. 72: The following resolution rule is used in logic programming

$$\text{Derive clause } (P \vee Q) \text{ from clauses } (P \vee Q), (Q \vee \neg R)$$

Which of the following statements related to this rule is FALSE?
(1) $((P \vee R) \wedge (Q \vee \neg R)) \Rightarrow (P \vee Q)$ is logically valid
(2) $(P \vee Q) \Rightarrow ((P \vee R) \wedge (Q \vee \neg R))$ is logically valid
(3) $(P \vee Q)$ is satisfiable if and only if $(P \vee R) \wedge (Q \vee \neg R)$ is satisfiable
(4) $(P \vee Q) \Rightarrow$ FALSE if and only if both P and Q are unsatisfiable

The following information pertains to Q. 73 - 74

The following program fragment is written in a programming language that allows variables and does not allow nested declarations of functions.

```
global int i = 100, j =5; ,
void P(x) {
```

```
   int i = 10;
   print (x + 10);
   i = 200;
   j = 20;
   print (x);
}
main() {
   P(i + j);
}
```

Q. 73: If the programming language uses static scoping and call by need parameter passing mechanism, the values printed by the above program are
(1) 115, 220 (2) 25, 220 (3) 25, 15 (4) 115,105

Explanation:

Q. 74: If the programming language uses dynamic scoping and call by name parameter passing mechanism, the values printed by the above program are
(1) 115, 220 (2) 25, 220 (3) 25, 15 (4) 115,105

Q. 75: Consider the following class definitions in a hypothetical Object Oriented language that supports inheritance and uses dynamic binding. The language should not be assumed to be either Java or C++, though the syntax is similar.

```
Class P {                Class Q subclass of P {
   void f(int i) {         void f(int i) {
   print(i);                  print(2*i);
   }                         }
}                        }
```

Now consider the following program fragment:

```
P x = new Q ();
Q y = new Q ();
P z = new Q ();
x.f(1); ((P)y).f(1); z.f(1);
```

Here `((P) y)` denotes a typecast of `y` to `P`. The output produced by executing the above program fragment will be
(1) 1 2 1 (2) 2 1 1 (3) 2 1 2 (4) 2 2 2

Explanation:
`x.f(1) = 1` and `z.f(1) = 1` are obvious.
For `((P)y).f(1)` , the type cast, make call of `P` of `f`, and hence output is 1. and sol. is 2 1 2.

Q. 76: Which of the following is NOT an advantage of using shared, dynamically linked libraries as opposed to using statically linked libraries?
(1) Smaller sizes of executable files
(2) Lesser overall page fault rate in the system
(3) Faster program startup
(4) Existing programs need not be re-linked to take advantage of newer versions of libraries

Q. 77: A uni-processor computer system only has two processes, both of which alternate 10ms CPU bursts with 90ms I/O bursts. Both the processes were created at nearly the same time. The I/O of both processes can proceed in parallel. Which of the following scheduling strategies will result in the *l*east CPU utilization (over a long period of time) for this system?

(1) First come first served scheduling
(2) Shortest remaining time first scheduling
(3) Static priority scheduling with different priorities for the two processes
(4) Round robin scheduling with a time quantum of 5 ms.

Explanation:
Given scenario: P_1 and P_2 processes with 10 ms CPU burst and 90 ms IO burst I/O can process in parallel.

- Consider the FCFS:

Start Time	End Time	Process
0	10	P_1
10	20	P_2
20	100	CPU Idle due to I/O
100	110	P_1
110	120	P_2
120	200	CPU Idle due to I/O

- The situation is similar in options B and C
- D. Consider the following diagram with Round Robin Scheduling with a time quantum of 5 ms.

Start Time	End Time	Process
0	5	P_1
5	10	P_2
10	15	P_1
15	20	P_2
20	105	CPU Idle due to I/O
105	110	P_1
110	115	P_2
115	120	P_1
120	125	P_2
125	210	CPU Idle due to I/O

As can be seen from two tables, the option D will result in the least CPU utilization.

Ans: Round Robin Scheduling with a time quantum of 5 ms. i.e. D

The following information pertains to Q. 78 - 79

A processor uses 2-level page tables for virtual to physical address translation. Page tables for both levels are stored in the main memory. Virtual and physical addresses are both 32 bits wide. The memory is byte addressable. For virtual to physical address translation, the 10 most significant bits of the virtual address are used as index into the first level page table while the next 10 bits are used as index into the second level page table. The 12 least significant bits of the virtual address are used as offset within the page. Assume that the page table entries in both levels of page tables are 4 bytes wide. Further, the processor has a translation look-aside buffer (TLB), with a hit rate of 96%. The TLB caches recently used virtual page numbers and the corresponding physical page numbers. The processor also has a physically addressed cache with a hit rate of 90%. Main memory access time is 10 ns, cache access time is 1 ns, and TLB access time is also 1 ns.

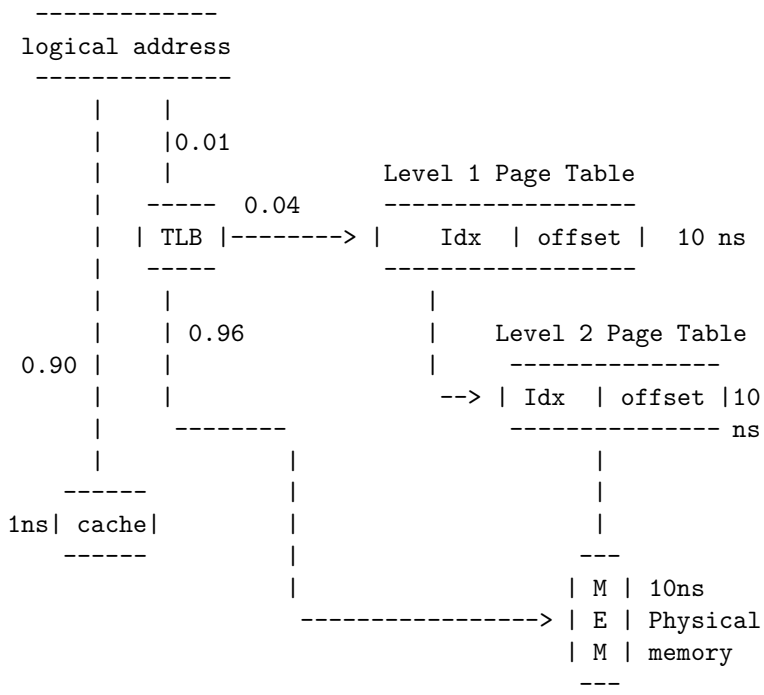
Q. 78: Assuming that no page faults occur, the average time taken to access a virtual address is approximately (to the nearest 0.5 ns)
(1) 1.5 ns (2) 2 ns (3) 3 ns (4) 4 ns

Explanation:
The values along the path are probabilities of taking that path. The values of access time are shown along with TLB, cache and level 2 page table.

We're required to find out the average time required to access virtual address. To access the address, we have the following possible options:

1. Look into cache and get the required data directly in 1 ns. This happens 90% of the time
2. If cache miss occurs, look into TLB for virtual-physical address mapping and get the required data by accessing the memory. This happens 10% of the time. We get TLB hit 96% of time. This requires:
   Total time = time for cache lookup + TLB lookup + memory access
   = 1 + 1 + 10 = 11 ns
3. In case of Cache and TLB miss, access first and second level page table and subsequently the virtual address. This requires:
   Total time = time for cache lookup + time for TLB lookup + time to access level 1 page able + time to access level 2 page table + time to access memory = 1 + 1 + 10 + 10 + 10 = 32 ns

The data given can be summarized in the following figure:



PA = probability of following option 1 = 0.90
PB = probability of following path 2 = 0.1 × 0.96 = 0.096
PC = Probability of following path 3 = 0.1 × 0.04 = 0.004
Expected access time = 0.90 × 1 + 0.096 × 11 + 0.004 × 32 = 2.08 ns
Ans: The average time taken to access virtual address is 2 ns. i.e. B

Q. 79: Suppose a process has only the following pages in its virtual address space: two contiguous code pages starting at virtual address 0x00000000, two contiguous data pages starting at virtual address OxO0400000, and a stack page starting at virtual address 0xFFFFF000. The amount of memory required for storing the page tables of this process is
(1) 8 KB (2) 12 KB (3) 16 KB (4) 20 KB

Explanation:
Since both the page tables are in memory, we need 2^{10} entries in Level 1 page table and the same number of entries in Level 2 page table.

The total memory required = Memory to hold Level 1 and 2 page tables
= 2 × (4 bytes per entry × 2^{10} entires)
= 8 KB

Ans: The amount of memory required is 8 KB i.e. A

The following information pertains to Q. 80 - 81

Suppose we want to synchronize two concurrent processes P and Q using binary semaphores S and T. The code for the processes P and Q is shown below.

```
Process P:              Process Q:
while (1) {             while (1) {
  W:                      Y:
  print '0;              print '1'
  print '0';              print '1'
  X:                      Z:
}                       }
```

Synchronization statements can be inserted only at points W, X, Y and Z

Q. 80: Which of the following will always lead to an output staring with '001100110011' ?
(1) P(S) at W, V(S) at X, P(T) at Y, V(T) at Z, S and T initially 1
(2) P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S initially I, and T initially 0
(3) p(S) at W, V(T) at X, p(T) at Y, V(S) at Z, S and T initially 1
(4) P(S) at W, V(S) at X, p(T) at Y, V(T) at Z, S initially 1, and T initially 0

Explantion
Basics:

```
P(S): while S <= 0 do no-op;
      S = S - 1;

V(S): S = S + 1;
```

Example:

```
Process P:              Process Q:
while(1) {              While(1) {
   W: P(S)                 Y: P(T)
      print '0';               print '1';
      print '0';               print '1';
   X: V(T)                    Z: V(S)
}                       }
```

The initial values of S = 1 and T = 0. The scheme ensures that the process P executes first printing 00, followed by process Q printing 11, followed by process P and so on.

This happens due to initial values of S and T. The value of S initialized to 1 and that of T to 0 ensures that P(S) at W gets executed successfully, while P(T) at Y waits till V(T) at X is executed. The scheme generates the string 001100110011.

Ans: P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S initially 1 and T initially 0 i.e. B.

Q. 81: Which of the following will ensure that the output string never contains a substring of the form 01^n0 or 10^n1 where n is odd?
(1) P(S) at W, V(S) at X, P(T) at Y, V(T) at Z, S and T initially 1
(2) P(S) at W, V(T) at X, P(T) at Y, V(S) at Z, S and T initially 1
(3) P(S) at W, V(S) at X, P(S) at Y, V(S) at Z, S initially 1
(4) V(S) at W, V(T) at X, P(S) at Y, P(T) at Z, S and T initially 1

Explanation
Basics:

```
P(S): while S <= 0 do no-op;
      S = S - 1;

V(S): S = S + 1;
```

Example:

```
Process P:                    Process Q:
while(1) {                    While(1) {
   W: P(S)                      Y: P(S)
      print ''0'';                 print ''1'';
      print ''0'';                 print ''1'';
   X: V(S)                      Z: V(S)
}                             }
```

The initial values of S = 1. The scheme ensures that the process P and Q executes in mutually exclusive manner, printing 00 or 11 and prohibiting substring 01^n0 or 10^n1, where n is odd.

Ans: P(S) at W, V(S) at X, P(S) at Y, V(S) at Z, S initially 1 i.e. C

Q. 82: The subnet mask for a particular network is 255.255.31.0. Which of the following pairs of IP addresses could belong to this network?

(1) 172.57.88.62 and 172.56.87.233
(2) 10.35.28.2 and 10.35.29.4
(3) 191.203.31.87 and 191.234.31.88
(4) 128.8.129.43 and 128.8.161.55

Explanation:
NM = 255.255.31.0

- Hence first two parts of the n/w has to be same. Last part(fourth) can be any thing. Removes possibility for A and C options.
- Now for B, consider the third part:

```
28 = 0001 1100
31 = 0001 1111
     ----------
      0001 1100

29 = 0001 1101
31 = 0001 1111
     ----------
      0001 1101
```

  Last 5 bits are different.

- Now for D, consider the third part:

```
129 = 1000 0001
31 =  0001 1111
      ----------
       1000 0001

161 = 1010 0001
31 =  0001 1111
     ----------
       1000 0001
```

  Last 5 bits are same. Hence the correct ans

Q. 83: A 2km long broadcast LAN has 10^7 bps bandwidth and uses CSMA/CD. The signal travels along the wire at 2×10^8 m/s. What is the minimum packet size that can be used on this network?
(1) 50 bytes (2) 100 bytes (3) 200 bytes (4) None of the above

Explanation: Use formula:

$$\begin{aligned} P_{min} &> 2 \times L \times C/c \\ &= 2 \times (2\ KM) \times (10^7)/(2 \times 10^8) \\ &= 200 \end{aligned}$$

Q. 84: Host A is sending data to host B over a full duplex link. A and B are using the sliding window protocol for flow control. The send and receive window sizes are 5 packets each. Data packets (sent only from A to B) are all 1000 bytes long and the transmission time for such a packet is 50 ms. Acknowledgment packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 ms. What is the maximum achievable throughput in this communication?
(1) 7.69×10^6 bps (2) 11.11×10^6 bps
(3) 12.33×10^6 bps (4) 15.00×10^6 bps

Q. 85: Consider the following functional dependencies in a database:

$$\begin{aligned} Date\_of\_Birth &\rightarrow Age \\ Age &\rightarrow Eligibility \\ Name &\rightarrow Roll\_number \\ Roll\_number &\rightarrow Name \\ Course\_number &\rightarrow Course\_name \\ Course\_number &\rightarrow Instructor \\ (Roll\_number, Course\_number) &\rightarrow Grade \end{aligned}$$

The relation `(Roll_number, Name, Date_of_birth, Age)` is
(1) in second normal form but not in third normal form
(2) in third normal form but not in BCNF
(3) in BCNF
(4) in none of the above

Q. 86: Consider the set of relations shown below and the SQL query that follows:

```
Students: (Roll_number, Name, Date_of_birth)
Courses: (Course_number, Course_name, Instructor)
Grades: (Roll_number, Course_number, Grade)

select distinct Name
from Students, Courses, Grades
where Students. Roll_number = Grades. Roll_number
and Courses. Instructor = Korth
and Courses. Course_number = Grades. Course_number
and Grades. grade = A
```

Which of the following sets is computed by the above query ?
(1) Names of students who have got an A grade in all courses taught by Korth
(2) Names of students who have got an A grade in all courses
(3) Name of students who have got an A grade in at least one of the courses taught by Korth
(4) None of the above

Explanation:

- Option B is ruled out as it does contain criteria of Instructor=Korth.
- Option A Vs. C: A has all courses by Korth and C has "at least" one of the courses by Korth.

Lets us assume that there are two courses offered by Korth and a student A has roll no 1 Then the data will look like:

```
Students:
RollNo   Name    DOB
 1      Sandeep   23/07

Courses:
CourseNo  Name          Instructor
1         DBMS           Korth
2         ADBMS          Korth

Grades:
RollNo   CourseNo   Grade
1           1         A
1           2         B
```

Consider the where condition:

- `Courses. Instructor = Korth` This selects CoursesNo as 1 and 2 for consideration
- `Courses. Course_number = Grades. Course_number` For 1 and 2 as CoursesNo, it matches rows from Grades table and gets both the entries (with Grade A and B both).
- `Grades. Grade = A` Removes the other entry with Grade =B. Hence only one entry with grade A is remaining.
- `Students. Roll_number = Grades. Roll_number` Join criteria.

So, essentially, its not for all courses by Korth but for at least one course by Korth. The distinct in select clause will eliminate the duplicate names.

Can be proved more formally also but we would like to stick to easy to understand language

Q. 87: Consider three data items D1, D2, and D3, and the following execution schedule of transactions T1, T2, and T3. In the diagram, R(D) and W(D) denote the actions reading and writing the data item D respectively.

	T1	T2	T3
↓ Time		R(D3);	
		R(D2);	
		W(D2);	
			R(D2);
			R(D3);
	R(D1);		
	W(D1);		
			W(D2);
			W(D3);
		R(D1);	
	R(D2);		
	W(D2);		
		W(D1);	

(1) The schedule is serializable as T2; T3; T1
(2) The schedule is serializable as T2; T1; T3
(3) The schedule is serializable as T3; T2; T1
(4) The schedule is not serializable

Explanation:

Draw the precedence graph and you will get a cycle. Hence its not serializable.

Graph will be:

$$\begin{aligned} &T1 \longrightarrow T2 \text{ for } D1 \\ &T2 \longrightarrow T1 \text{ for } D2 \\ &T2 \longrightarrow T3 \text{ for } D2 \\ &T3 \longrightarrow T1 \text{ for } D2 \end{aligned}$$

Hence cycle between T1 and T2.

Q. 88: In the following C program fragment `j, k, n, TwoLog_n` are integer variables, and `A` is an array of integers. The variable `n` is initialized to an integer ≥ 3, and `TwoLog_n` is initialized to the value of $2 * \lceil log_2(n) \rceil$

```
for (k = 3; k < = n; k++)
  A [k] = 0;
for (k=2; k <= TwoLog_n; k++)
  for (j=k + 1; j <= n; j++)
    A [j] = A [j] || (j%k);
for (j=3; j <= n; j++)
  if (!A[j]) printf ("%d ",j);
```

The set of numbers printed by this program fragment is

(1) $\{m \mid m \leq n, (\exists i)\,[m = i!]\}$ (2) $\{m \mid m \leq n, (\exists i)\,\left[m = i^2\right]\}$

(3) $\{m \mid m \leq n, m \text{ is prime}\}$ (4) $\{\}$

Explanation:

```
 1 #define NUM  6
 2  int main(void){
 3  int A[100];
 4  int n=5;
 5  int TwoLog_n = 6 ;
 6  int j,k;
 7  int p;
 8  for (k = 0; k &lt; n; k++)
 9    A [k] = 0;
10 for(p=0;p&lt;NUM;p++)
11    printf("%d ",A[p]);
12
13 printf("\n");
14
15  for (k=2; k &lt;= TwoLog_n; k++){
16    for (j=k + 1; j &lt;= n; j++){
17       printf("\nBefore k=%d, j=%d-\n",k, j);
18       for(p=0;p&lt;NUM;p++)
19          printf("%d ",A[p]);
20       A [j] = A [j] || (j%k);
21          printf("\n",A[p]);
22       for(p=0;p&lt;NUM;p++)
23          printf("%d ",A[p]);
24    }
25 }
26
27  for (j=3; j &lt;= n; j++)
28    if (!A[j]) printf ("%d ",j);
29
30 }
```

The trick trick is on line 20 - `(j%k);` This statement makes `A[j] = 1`, if it is not already 1 in case where `j%k != 0`. Now for every `j > k`, there will be one `j` which will have `j%k > 1` and hence will set `A[j] = 1`. Hence, all elements will be set to 1 and the output will be an empty set.

The output of above program on RH Linux 9.0 with gcc is: Observe the change from 0 to 1 noted by *.

```
0 0 0 0 0 0

Before k=2, j=3-
0 0 0 0 0 0
0 0 0 1 0 0
      *
Before k=2, j=4-
0 0 0 1 0 0
0 0 0 1 0 0
Before k=2, j=5-
0 0 0 1 0 0
0 0 0 1 0 1
          *
Before k=3, j=4-
0 0 0 1 0 1
0 0 0 1 1 1
        *
Before k=3, j=5-
0 0 0 1 1 1
0 0 0 1 1 1
Before k=4, j=5-
0 0 0 1 1 1
0 0 0 1 1 1
```

Q. 89: Consider the C program shown below.

```
# include <stdio.h>
#define print (x) print f ("%d", x)
intx;

void Q (int z) {
   z + = x; print (z);
}

void p (int *y) {
   int x = *y+2;
   Q (x); *y = x-1;
   print (x)
}

main (void) {
   x=5;
   p (&x);
   print (x);
}
```

The output of this program is
(1) 12 7 6 (2) 22 12 11 (3) 14 6 6 (4) 7 6 6

Explanation:

```
1     #include <stdio.h>
```

```
 2     #define print (x) printf ("%d", x)
 3     int x;
 4     void Q (int z) {
 5         z + = x; print (z);
 6     }
 7
 8     void p (int *y) {
 9         int x = *y+2;
10         Q (x); *y = x-1;
11         print (x);
12     }
13
14     main (void) {
15     x=5;
16     P (&x);
17     print (x);
18     }
19
```

Line	Global x	alias x	local x	z
15	5	none	–	–
9	5	*y	7	–
10	5	*y	7	–
5	5	–	–	7
5	5	–	–	**12
10	6	*y	7	–
11	6	*y	**7	–
17	** 6	–	–	–

Ans: 12 7 6

Q. 90: Consider the function f defined below.

```
struct item {
   int data;
   struct item * next;
};

int, f(struct item *p) {
   return ((p == NULL) || (p->next == NULL) ||
   (( p->data <= p->next->data) &&
   f(p->next)));
}
```

For a given linked list `p`, the function `f` returns 1 if and only if
(1) the list is empty or has exactly one element
(2) the elements in the list are sorted in non-decreasing order of data value
(3) the elements in the list are sorted in non-increasing order of data value
(4) not all elements in the list have the same data value.

Explanation:
Consider each of the statements:

- `(p == NULL) || (p → next == NULL) ||` This will return true if p is pointing to null or to the last element of the list.
- `((p→ data ≤ p → next → data) &&` data is in non-decreasing order,
- `f(p → next)));` to traverser the complete list.

So, if the elements are sorted in non-decreasing order of data values, it will return 1.

Answer keys for Q. 1-90

1.	2	2.	1	3.	4	4.	3	5.	2	6.	2	7.	1	8.	3	9.	1	10.	3
11.	3	12.	3	13.	1	14.	1	15.	1	16.	3	17.	2	18.	3	19.	3	20.	1
21.	4	22.	3	23.	4	24.	3	25.	1	26.	3	27.	2	28.	3	29.	2	30.	2
31.	1	32.	4	33.	3	34.	2	35.	2	36.	3	37.	1	38.	3	39.	2	40.	3
41.	2	42.	2	43.	4	44.	3	45.	3	46.	3	47.	1	48.	2	49.	1	50.	3
51.	3	52.	3	53.	1	54.	4	55.	2	56.	4	57.	1	58.	2	59.	4	60.	3
61.	2	62.	4	63.	1	64.	3	65.	3	66.	1	67.	1	68.	2	69.	2	70.	3
71.	4	72.	2	73.	4	74.	1	75.	1	76.	4	77.	4	78.	2	79.	1	80.	2
81.	4	82.	4	83.	3	84.	2	85.	1	86.	3	87.	4	88.	4	89.	1	90.	2

CS GATE 2004 with GateGenie Solutions

CSE GATE 2004

All questions carry 1 marks each.

1. The goal of structured programming is to
   (1) have well indented programs
   (2) be able to infer the flow of control from the compiled code
   (3) be able to infer the flow of control from the program text
   (4) avoid use of the GOTO statement

   Answer: (3)

2. Consider the following C function

```
void swap (int a, int b)
{ int temp;
temp = a;
a = b;
b = temp;
}
```

   In order to exchange the values of the two variables x and y,
   (1) call swap(x,y)
   (2) call swap(x,y)
   (3) swap(x,y) cannot be used as it does not return any value
   (4) swap(x,y) cannot be used as the parameters are passed by value

   Answer: (D)

3. A single array $A[1 \ldots MAXSIZE]$ is used to implement two stacks. The two stacks grow from opposite ends of the array. Variables top_1 and $top_2 (top_1 < top_2)$ point to the location of the topmost element in each of the stacks. If the space is to be used efficiently, the condition for stack full is
   (1) (top_1 = MAXSIZE/2) and (top_2 = MAXSIZE/2 + 1)
   (2) $top_1 + top_2$ = MAXSIZE
   (3) (top_1 = MAXSIZE/2) or (top_2 = MAXSIZE)
   (4) $top_1 = top_2 - 1$

   Answer: (4)
   Explanation: The stack becomes full when $top_1 = top_2 - 1$

4. The following numbers are inserted into an empty binary search tree in the given order:

$$10, 1, 3, 5, 15, 12, 16$$

   What is the height if the binary search tree (the height is the maximum distance of a leaf node from the root)
   (1) 2 (2) 3 (3) 4 (4) 6

   Answer: (2)
   Explanation:

```
After insertion of 10, tree:
       10
After insertion of 1:
    10
```

```
   /
  1
After insertion of 3:
        10
       /
      1
       \
        3
After insertion of 5:
        10
       /
      1
       \
        3
         \
          5
After insertion of 15:
        10
       /  \
      1   15
       \
        3
         \
          5


After insertion of 12:
           10
           |
   |-------------------|
   |                   |
   1                   15
   |                   |
|-----|             |-----|
      3            12
      |
  |------|
         5

After insertion of 16:
           10
           |
   ----------------------
   |                   |
   1                   15
   |                   |
|-----|             |-----|
      3            12     16
      |
  |------|
         5
```

The height of the tree is the distance from the root(10) to the node at the bottom of the tree (5 in this case). Thus height is 3.

5. The best data structure to check whether an arithmetic expression has balanced parentheses is a

(1) queue (2) stack (3) tree (4) list

Answer: (2)
Explanation:
Of the data structures given in the choices, only Stack is a LIFO (Last In First Out) structure. The problem of verifying balanced parentheses requires checking whether each left parenthesis has a right parenthesis.

6. Level order traversal of a rooted tree can be done by starting from the root and performing
   (1) preorder traversal (2) inorder traversal
   (3) depth first search (4) breadth first search

   Answer: (4)

7. Given the following input $4322, 1334, 1471, 9679, 1989, 6171, 6173, 4199$ and the hash function $x\%10$, which of the following statements are true?

   (i) 9679, 1989, 4199 hash to the same value
   (ii) 1471, 6171 hash to the same value
   (iii) All elements hash to the same value
   (iv) Each element hashes to a different value

   (1) (i) only (2) (ii) only
   (3) $(i) and (ii)$ only (4) $(iii) or (iv)$

   Answer: (3)
   Explanation:

$$\begin{aligned} 9679\%10 &= 9 \\ 1989\%10 &= 9 \\ 4199\%10 &= 9 \end{aligned}$$

   All hash to same value. So (i) is true.

$$\begin{aligned} 1471\%10 &= 1 \\ 6171\%10 &= 1 \end{aligned}$$

   All hash to same value. So (ii) is true. So (i) and (ii) are true.

8. Which of the following grammar rules violate the requirements of an operator grammar? P, Q, R are nonterminals, and r,s,t are terminals.

   (i) P $\rightarrow$ Q R
   (ii) P $\rightarrow$ Q s R
   (iii) P $\rightarrow \epsilon$
   (iv) P $\rightarrow$ Q t R r

   (1) (i) only (2) (i) and (ii) only
   (3) (ii) and (iii) only (4) (iii) and (iv) only

   Answer: (1)
   Explanation: An operator grammar is a grammar in which no production has two non-terminals in sequence on the right-hand side.

9. Consider a program P that consists of two source modules M_1 and M_2 contained in two different files. IF M_1 contains a reference to a function defined in M_2, the reference will be resolved at
   (1) Edit-time (2) Compile-time (3) Link-time (4) Load-time

Answer: (3)
Explanation: The linker resolves the references to external symbols using symbol table information from the object files.

10. Consider the grammar rule $E \rightarrow E_1 - E_2$ for arithmetic expressions. The code generated is targeted to a CPU having a single user register. The subtraction operation requires the first operand to be in the register. If E_1 and E_2 do not have any common subexpression, in order to get the shortest possible code
    (1) E_1 should be evaluated first
    (2) E_2 should be evaluated first
    (3) Evaluation of E_1 and E_2 should necessarily be interleaved
    (4) Order of evaluation of E_1 and E_2 is of no consequence

    Answer: (2)
    Explanation: If E_2 is evaluated first, the value of E_2 may be stored in a temporary variable in memory. E_1 can then be evaluated and the value will be available in the user-register. The restriction on the subtraction operation mentioned in the problem is that the first operand should be in the user-register, which is what we now have. The subtraction operation can then be done between an operand in the user-register and another operand in memory.

11. Consider the following statements with respect to user level threads and kernel-level threads.

    (i) Context switch is faster with kernel-supported threads.
    (ii) For user-level threads, a system call can block the entire process
    (iii) Kernel-supported threads can be scheduled independently
    (iv) User-level threads are transparent to the kernel

    Which of the following statements is true?
    (1) (ii), (iii) and (iv) in(2) (ii) and (iii) only
    (3) (i) and (iii)only in(4) (i) and (ii)only

    Answer: (1)
    Explanation:
    Refer to Operating Systems textbook by Silberschatz and Galvin.

12. Consider an operating system capable of loading and executing a single sequential user process at a time. The disk head scheduling algorithm used is *First Come First Served* (FCFS).If FCFS is replaced by *Shortest Seek Time First*(SSTF), claimed by the vendor to give 50% better benchmark results, what is the expected improvement in the I/O performance of user programs?
    (1) 50% (2) 40% (3) 25% (4) 0%

    Answer: (1)

13. Let $R_1(A, B, C)$ and $R_2(D, E)$ be two relation schema, where the primary keys are shown underlined, and let C be a foreign key in R_1 referring R_2. Suppose there is no violation of the above referential integrity constraint in the corresponding relation instances r_1 and r_2. Which one of the following relational algebra expressions would necessarily produce an empty relation?
    (1) $\Pi_D(r_2) - \Pi_C(r_1)$ (2) $\Pi_C(r_2 - \Pi_C(r_1))$
    (3) $\Pi_D(r_1 \bowtie_{C \neq D} r_2)$ (4) $\Pi_C(r_1 \bowtie_{C=D} r_2)$

    Answer: (2)
    Explanation:
    Relation instances r_1 and r_2 satisfy the foreign key constraint. This means that the primary key (D) in r_2 refers to attribute (C) in r_1. For any value of attribute C in the instance r_1, that value should also be present in the (C) column of r_2 but not necessarily vice-versa. $\Pi_C(r_1)$ refers to all values of the column C in r_1. $\Pi_D(r_2)$ refers to all values of the column D in r_2. It follows that $\Pi_C(r_1) - \Pi_D(r_2)$ is the null set. Hence the answer (B).

14. Consider the following relation schema pertaining to a students database:
    *Student (**rollno**, name, address)*

*Enroll (**rollno**, courseno, coursename)*
where the primary keys are shown underlined. The number of tuples in the *Student* and *Enroll* tables are 120 and 8 respectively. What are the maximum and minimum number of tuples that can be present in (Student * Enroll), where '*' denotes natural join?
(1) 8,8 (2) 120,8 (3) 960,8 (4) 960,120

Answer: (1)

15. Choose the best matching between Group 1 and Group 2.

Group1	**Group 2**
P. Data Link Layer	1. Ensures reliable transport of data over a physical point-to-point link
Q. Network Layer	2. Encodes/decodes data for physical transmission
R. Transport Layer	3. Allows end-to-end communication between two processes
	4. Routes data from one network node to the next

(1) P-1, Q-4, R-3
(2) P-2, Q-4, R-1
(3) P-2, Q-3, R-1
(4) P-1, Q-3, R-2

Answer: (1)

16. Which of the following is NOT true with respect to a transparent bridge and a router?
(1) Both bridge and router selectively forward packets
(2) A bridge uses IP address while a router uses MAC addresses
(3) A bridge builds up its routing table by inspecting incoming packets
(4) A router can connect between a LAN and a WAN

Answer: (2)
Explanation: Bridges work at the medium access sublayer, i.e. they use the MAC address to route the frames, routers in contrast work at the network layer and use IP addresses to perform the routing.

17. The boolean function $x'y' + xy + x'y$ is equivalent to
(1) $x' + y'$ (2) $x + y$ (3) $x + y'$ (4) $x' + y$

Answer: (4)
Explanation: Use minimization using K-map method.

18. In an SR latch made by cross coupling two NAND gates, if both S and R inputs are set to 0, then it will result in
(1) Q=0, $Q' = 1$ (2) Q=1, $Q' = 0$
(3) Q=1, $Q' = 1$ (4) Indeterminate states

Answer: (4)

19. If 73_x (in base-x number system) is equal to 54_y (in base-y number system), the possible values of x and y are
(1) 8, 16 (2) 10, 12 (3) 9, 13 (4) 8, 11

Answer: (4)
Explanation:

$$7 * x + 3 = 5 * y + 4$$
$$7 * x - 5 * y = 1$$

The only set of values from A, B, C, D that satisfies this equation is 8, 11.

20. Which of the following addressing modes is suitable for program relocation at run time?

(i) Absolute addressing
(ii) Based addressing
(iii) Relative addressing
(iv) Indirect addressing

(1) (i) and (iv) (2) (i) and (ii)
(3) (ii) and (iii) (4) (i), (ii) and (iv)

Answer: (3)

21. The minimum number of page frames that must be allocated to a running process in a virtual memory environment is determined by
(1) the instruction set architecture (2) page size
(3) physical memory size (4) number of processes in memory

Answer: (4)

22. How many 8-bit characters can be transmitted per second over a 9600 baud serial communication link using asynchronous mode of transmission with one start bit, eight data bits, two stop bits and one parity bit?
(1) 600 (2) 800 (3) 876 (4) 1200

Answer: (2)
Explanation:
Total bits transmitted for each 8-bit character = 8 + 1 + 2 + 1 = 12 bits.
9600 baud serial line , so 9600/12 = 800 characters per second can be transmitted.

23. Identify the correct translation into logical notation of the following assertion.

Some boys in the class are taller than all the girls

Note: *taller(x,y)* is true if x is taller than y.
(1) $(\exists x)(boy(x) \rightarrow (\forall y)(girl(y) \wedge taller(x,y)))$
(2) $(\exists x)(boy(x) \wedge (\forall y)(girl(y) \wedge taller(x,y)))$
(3) $(\exists x)(boy(x) \rightarrow (\forall y)(girl(y) \rightarrow taller(x,y)))$
(4) $(\exists x)(boy(x) \wedge (\forall y)(girl(y) \rightarrow taller(x,y)))$

Answer: (3)

24. Consider the binary relation:

$$S = \{(x,y) \mid y = x+1 \; and \; x,y \in \{0,1,2,\ldots\}\}$$

The reflexive closure of S is
(1) $\{(x,y) \mid y > x \; and \; x,y \in \{0,1,2,\ldots\}\}$
(2) $\{(x,y) \mid y \geq x \; and \; x,y \in \{0,1,2,\ldots\}\}$
(3) $\{(x,y) \mid y < x \; and \; x,y \in \{0,1,2,\ldots\}\}$
(4) $\{(x,y) \mid y \leq x \; and \; x,y \in \{0,1,2,\ldots\}\}$

Answer: (2)

25. If a fair coin is tossed four times, what is the probability that two heads and two tails will result?
(1) 3/8 (2) 1/2 (3) 5/8 (4) 3/4

Answer: (2)
Explanation:
The probability of a head when a fair coin is tossed a single time is 1/2. The probability of 2 heads in 4 tosses follows binomial distribution. Let the event of the result being a head be success. Thus tail means failure.
p, probability of success in a single toss = 1/2.
Probability of failure, q = 1/2.
$P(x = 2) = C(n,x)p^{n-x}q^x = C(4,2)p^2q^2 = 1/2$.

26. The number of different $n \times n$ symmetric matrices with each element either 0 or 1 is: (Note: power(2,x) is same as $2 \sup x$)
    (1) power(2,n) (2) power(2, n^2)
    (3) power(2,$(n^2+n)/2$) (4) power(2,$(n^2-n)/2$)

    Answer: (3)
    Explanation: A $n \times n$ symmetric matrix has a lower triangular matrix of size n(n+1)/2. The values in the upper triangular part of the matrix are same as that of the corresponding position in the lower triangular matrix. The lower triangular part of the matrix contains $n(n+1)/2$ elements, each of which can be 0 or 1, giving $2^{n(n+1)/2}$ possibilities.

27. Let A,B,C,D be $n \times n$ matrices, each with non-zero determinant. If ABCD = I, then B^{-1} is:
    (1) $D^{-1}C^{-1}A^{-1}$ (2) CDA
    (3) ADC (4) Does not necessarily exist

    Answer: (1)

28. What is the result of evaluating the following two expressions using three-digit floating point arithmetic with rounding?

$$(113. + -11.) + 7.51$$
$$113. + (-111. + 7.51)$$

    (1) 9.51 and 10.0 respectively
    (2) 10.0 and 9.51 respectively
    (3) 9.51 and 9.51 respectively
    (4) 10.0 and 10.0 respectively

    Answer: (2)

29. The tightest lower bound on the number of comparisons, in the worst case, for comparison-bound sorting is the order of
    (1) n (2) n^2 (3) $n \log n$ (4) $n \log^2 n$

    Answer: (3)
    Explanation:
    Refer to any Algorithms text for the chapter on Sorting.

30. The problems 3-SAT and 2-SAT are
    (1) both in P
    (2) both NP-complete
    (3) NP-complete and in P respectively
    (4) undecidable and NP-complete respectively

    Answer: (2)
    Explanation:
    There is a polynomial time algorithm to solve the 2-SAT problem. In the case of 3-SAT, given a solution it can be verified in polynomial time if it is indeed a solution. Also, it is known that it is NP-hard. Given these two facts, 3-SAT is therefore NP-complete.

Q. 31 - 90 carry two marks each

31. Consider the following C function:

```
int f(int n)
{ static int i = 1;
  if (n >=5 ) return n;
  n = n + i;
  i++;
  return f(n);
}
```

The value returned by f(1) is
(1) 5 (2) 6 (3) 7 (4) 8

Answer: (3)
Explanation: When $n = 1$, `f(1)` is called giving
$i = 1, n = 1 + 1 => n = 2; i++ => i = 2$
When $n = 2$, `f(2)` is called resulting in i retaining its values between two different invocations of the function `f`.
$n = 2, i = 2; n = 2 + 2 = 4; i++ => i = 3;$
When $f(4)$ is called;
$n = 4, i = 3; n = 4 + 3 = 7; i++ => i = 4; 7 >= 5,$
so 7 is returned. Therefore value returned is 7.

32. Consider the following program fragment for reversing the digits in a given integer to obtain a new integer. Let $n = d_1 d_2 \ldots d_m$.

```
int n, rev;
rev = 0;
while (n > 0) {
rev = rev * 10 + n % 10;
n = n / 10;
}
```

The loop invariant at the end of the $i \sup th$ iteration is:
(1) n = $d_1 d_2 \ldots d_{m-i}$ and rev = $d_m d_{m-1} \ldots d_{m-i+1}$
(2) n = $d_{m-i+1} \ldots d_{m-i} d_m$ or rev = $d_{m-i} \ldots d_2 d_1$
(3) n $\neq$ rev
(4) n = $d_1 d_2 \ldots d_m$ or rev = $d_m \ldots d_2 d_1$

Answer: (1)
Explanation:
After the ith iteration, n contains the first $m - i$ digits in the representation of $d_1 d_2 \ldots d_m$. rev contains the last i digits in reversed order. so the correct answer is (A).

33. Consider the following C program segment:

```
char p[20];
char *s = "string";
int length = strlen(s);
for (i = 0; i < length; i++)
p[i] = s[length - i];
printf("%s", p);
```

The output of the program is
(1) gnirts (2) string
(3) gnirt (4) *No output is printed*

Answer: (4)
Explanation:
The first iteration of the for loop sets the value of $p[0]$ to '\0'. The `printf` statement prints the value of a null terminated string. Thus nothing is printed.

34. It is desired to design an object-oriented employee record system for a company. Each employee has a name, unique id and salary. Employees belong to different categories and their salary is determined by their category. The functions getName, getId and computeSalary are required. Given the class hierarchy below, possible locations for these functions are:

(i) *getId* is implemented in the superclass

(ii) *getId* is implemented in the subclass

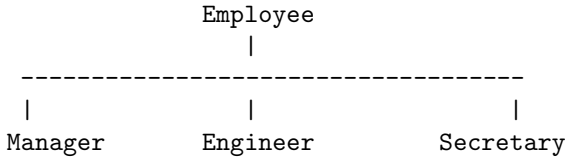
(iii) *getName* is implemented in the superclass

(iv) *getName* is implemented in the subclass

(v) *getSalary* is an abstract function in the superclass

(vi) *getSalary* is implemented in the superclass

(vii) *getSalary* is implemented in the subclass



Choose the best design

(1) (i), (iv), (vi), (viii) (2) (i), (iv), (vii)
(3) (i), (iii), (v), (vi), (viii) (4) (ii), (v), (viii)

Answer: (1)

35. Consider the label sequences obtained by the following pairs of traversals on a labeled binary tree. Which of these pairs identify a tree uniquely?

(i) preorder and postorder

(ii) inorder and postorder

(iii) preorder and inorder

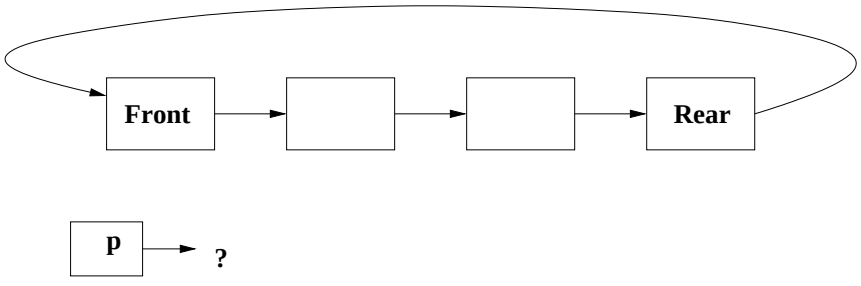
(iv) level order and postorder

(1) (i) only (2) (ii), (iii) (3) (iii) only (4) (iv) only

Answer: (2)

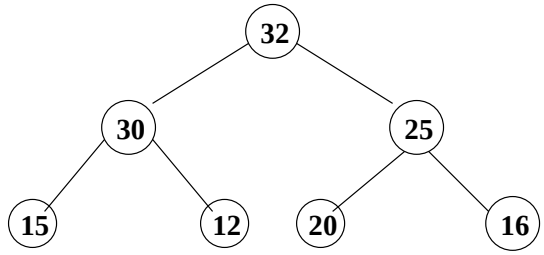
36. A circular linked list is used to represent a Queue. A single variable p is used to access the Queue. To which node should p point such that both the operations *enQueue* and *deQueue* be performed in constant time?

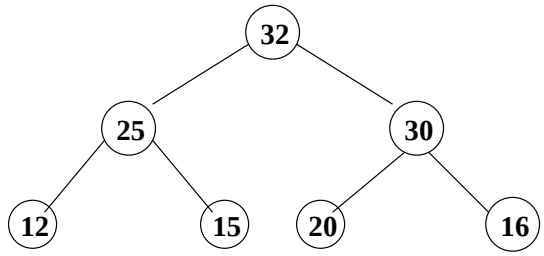
(1) rear node (2) front node
(3) not possible with a single pointer (4) node next to front

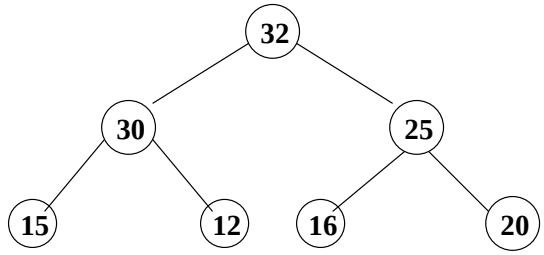


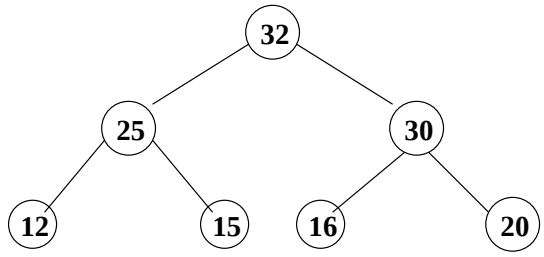
Answer: (1)
Explanation: If p points to the rear node, EnQueue can be done in constant time by adding a node after the node pointed to by p. DeQueue can also be done in constant time by removing the next node to the node pointed to by p.

37. The elements `32, 15, 20, 30, 12, 25, 16`, are inserted one by one in the given order into a $maxHeap$. The resultant $maxHeap$ is

(A)


(B)


(C)


(D)


Answer: (1)

38. Assume that the operators +,-,× are left associative and îs right associative. The order of precedence (from highest to lowest) is ˆ , ×, +,-. The postfix expression corresponding to the infix expression $a + b \times c - d \hat{} e \hat{} f$ is
    (1) $abc \times +def \hat{} \hat{}$ (2) $abc \times +de \hat{}$ f$\hat{}-$
    (3) $ab + c \times d - e \hat{}$ f$\hat{}$ (4) $-+a \times bc \hat{} \hat{} def$

    Answer: (2)
    Explanation: Since ˆ is right associative, the given expression actually means:
    $a + b \times c - (d \hat{} e) \hat{} f$. (B) in infix also means the same thing.

39. Two matrices M_1 and M_2 are to be stored in arrays A and B respectively. Each array can be stored either in row-major or column-major order in contiguous memory locations. The time complexity of an algorithm to compute $M_1 \times M_2$ will be
    (1) best if A is row-major, and B is in column-major order
    (2) best if both are in row-major order
    (3) best if both are in column-major order
    (4) independent of the storage scheme

    Answer: (4)
    Explanation: The time complexity only depends on the algorithm and not the access mechanism. The question tries to mislead by the fact that the elements can be accessed faster if the storage is row-major.

40. Suppose each set is represented as a linked list with elements in arbitrary order. Which of the operations among union, intersection, membership, cardinality will be slowest?
    (1) union only (2) intersection, membership
    (3) membership, cardinality (4) union,intersection

    Answer: (4)
    Explanation: Membership will take scanning the list once, order of n time. Union and intersection will take order of n^2 time.

41. Consider the following C program:

```
main()
{ int x, y, m, n;
scanf("%d %d", &x, &y);
/* Assume x > 0 and y > 0 */
m = x; n = y;
while ( m != n )
{ if (m > n)
m = m - n;
else
n = n - m;
}
printf("%d", n);
}
```

    The program computes
    (1) $x \div y$ using repeated subtraction
    (2) x % y using repeated subtraction
    (3) the greatest common divisor of x and y
    (4) the least common multiple of x and y

    Answer: (3)
    Explanation: The repeated subtraction in the program corresponds to the division operation in the brute force method that we use to calculate GCD.

42. What does the following algorithm approximate? (Assume m > 1, $\in$> 0).

```
x = m;
y = 1;
while ( x - y > $\in$)
{ x = (x + y) / 2;
y = m / x;
}
print (x);
```

    (1) $logm$ (2) m^2 (3) $m^{1/2}$ (4) $m^{1/3}$

    Answer: (3)

43. Consider the following C program segment.

```
struct CellNode {
struct CellNode *leftChild;
int element;
struct CellNode *rightChild;
};
int DoSomething(struct CellNode *ptr)
{
int value = 0;
```

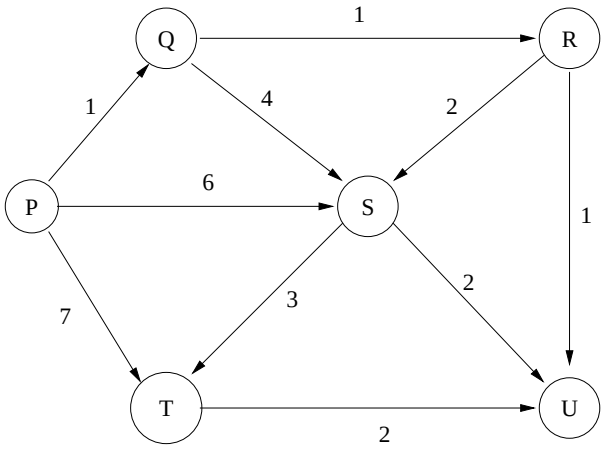
```
if (ptr != NULL)
{ if (ptr->leftChild != NULL)
value = 1 + DoSomething (ptr->leftChild);
if (ptr->rightChild != NULL)
value = max(value,
1 + DoSomething (ptr->rightChild));
}
return (value);
}
```

The value returned by the function *DoSomething* when a pointer to the root of a nonempty tree is passed as argument is

(1) The number of leaf nodes in the tree
(2) The number of nodes in the tree
(3) The number of internal nodes in the tree
(4) The height of the tree

Answer: (4)

44. Suppose we run Dijkstra's single source shortest-path algorithm on the following edge-weight directed graph with vertex P as the source. In what order do the nodes get included into the set of



vertices for which the shortest path distances are finalized?

(1) P,Q,P,S,T,U (2) P,Q,R,U,S,T
(3) P,Q,R,U,T,S (4) P,Q,T,R,U,S

Answer: (2)

45. Consider the grammar with the following translation rules and E as the start symbol.

$$\begin{aligned} E &\longrightarrow E_1 \# T\{E.value = E_1.value * T.value\} \\ &\quad\ |T\{E.value = T.value\} \\ T &\longrightarrow T_1 \& F\{T.value = T_1.value + F.value\} \\ &\quad\ |F\{T.value = F.value\} \\ F &\longrightarrow \{F.value = num.value\} \end{aligned}$$

Compute $E.value$ for the root of the parse tree for the expression: 2#3 & 5#6 & 4.

(1) 200 (2) 180 (3) 160 (4) 40

Answer: (3)
Explanation:

From the syntax rules, it can be seen that translation occurs in such a way that # has more preference than &.
So, the expression is calculated as (2#(3&5))#(6&4) = (2*(3+5))*(6+4) = 16*10 = 160

46. Consider the following set of processors, with the arrival times and the CPU-burst

P1	0	5
P2	1	3
P3	2	3
P4	4	1

What is the average turnaround time for these processes with the *preemptive shortest remaining processing time first* (SRPT) algorithm?
(1) 5.50 (2) 5.75 (3) 6.00 (4) 6.25

Answer: (1)
Explanation:
The processes will be scheduled as follows:

Time	**Process**
0	P_1
1	P_2
2	P_2
3	P_2
4	P_4
5	P_3
6	P_3
7	P_3
8	P_1
9	P_1
10	P_1
11	P_1
12	

Average turnaround time = ((12-0) + (4-1) + (8-2) + (5-4))/4 = 22/4 = 5.50

47. Consider a system with a two-level paging scheme in which a regular memory access takes 150 nanoseconds, and servicing a page fault takes 8 milliseconds. An average instruction takes 100 nanoseconds of CPU time and two memory accesses. The TLB hit ratio is 90% and the page fault rate is one in every 10,000 instructions. What is the effective average instruction execution time?
(1) 645 nanoseconds (2) 1050 nanoseconds
(3) 1215 nanoseconds (4) 1230 nanoseconds

Answer: (4)
Explanation:
Let p be the page fault probability; $p = 0.0001$
Total instruction execution time = CPU time + (p × pagefault handling time) + number of memory accesses × memory access time

Memory access time = 0.9 × 150 +
0.1 × page table access time + memory access

$$= \quad 0.9 \times 150 + 0.1 \times (150 + 150) = 165\ ns$$

$$\begin{aligned} \text{Total instruction Execution Time} &= 10^2 + 0.0001 \times 8 \times 10^6 + 2 \times 165 \\ &= 1230\ ns \end{aligned}$$

48. Consider two processes P_1 and P_2 accessing the shared variables X and Y protected by two binary semaphores S_X and S_Y respectively, both initialized to 1. P and V denote the usual semaphore operators, where P decrements the semaphore value, and V increments the semaphore value. The pseudo-code of P_1 and P_2 is as follows:

P_1 :		P_2 :	
	while true do {		while true do {
	L_1 :.....		L_3 :.....
	$X = X + 1;$		$Y = Y + 1;$
	$Y = Y - 1;$		$X = X - 1;$
	$V(S_X);$		$V(S_Y);$
	$V(S_Y);$ }		$V(S_X);$ }

In order to avoid deadlock, the correct operators at L_1, L_2, L_3 and L_4 are respectively
(1) $P(S_Y), P(S_X); P(S_X), P(S_Y)$
(2) $P(S_X), P(S_Y); P(S_Y), P(S_X)$
(3) $P(S_X), P(S_X); P(S_Y), P(S_Y)$
(4) $P(S_X), P(S_Y); P(S_X), P(S_Y)$

Answer: (4)

49. A Unix-style i-node has 10 direct pointers and one single, one double and one triple indirect pointers. Disk block size is 1Kbyte, disk block address is 32 bits, and 48-bit integers are used. What is the maximum possible file size?
(1) 2^{24} bytes (2) 2^{32} bytes (3) 2^{34} bytes (4) 2^{48} bytes

Answer: (3)
Explanation:
Number of disk block pointers that can fit in one block is 1024/4 = 256.
File size due to direct pointers = 10 * 1K = 10KBytes
File size due to single indirection pointers = 256 * 1K = 256K = 2^{18} bytes
File size due to double indirection pointer = 256 * 256 * 1K = 2^{26} bytes
File size due to triple indirection pointer = 256 * 256 * 256 * 1K = 2^{34} bytes
Total file size 2^{34} bytes (approx)

50. The relation scheme
`StudentPerformance (name, courseNo, rollNo, grade)`
has the following functional dependencies:

$$\begin{aligned} name, courseNo &\longrightarrow grade \\ rollNo, courseNo &\longrightarrow grade \\ name &\longrightarrow rollNo \\ rollNo &\longrightarrow name \end{aligned}$$

The highest normal form of this relation scheme is
(1) 2NF (2) 3NF (3) BCNF (4) 4NF

Answer: (1)

51. Consider the relation *Student (name, sex, marks)*, where the primary key is shown underlined, pertaining to the students in a class that has at least one boy and one girl. What does the following relational algebra expression produce? (Note: ρ is the rename operator).
$\Pi_{name}(\sigma_{sex=female}(Student)) -$
$\Pi_{name}(Student \bowtie_{(sex=female \wedge x=male \wedge marks \leq m)} \rho_{n,x,m}(Student))$
(1) names of girl students with the highest marks
(2) names of girl students with more marks than some boy student
(3) names of girl students with marks not less than some boy student
(4) names of girl students with more marks than all the boy students

Answer: (4)
Explanation:
$\Pi_{name}(Student \bowtie_{(sex=female \wedge x=male \wedge marks \leq m)} \rho_{n,x,m}(Student))$ gives the set of all female students who secured at least as many marks as some male student. Subtracting this set from the set of all female students gives the names of all female students with more marks than all the male students.

52. The *order* of an internal node in a B^+ tree index is the maximum number of children it can have. Suppose that a child pointer takes 6 bytes, the search field value takes 14 bytes, and the block size is 512 bytes. What is the order of the internal node?
(1) 24 (2) 25 (3) 26 (4) 27

Answer: (3)
A B^+ tree node with k children can hold $(k-1)$ search key fields.
k*6 + (k-1)*14 = 512 => k = 26.3 . The correct answer is therefore (C).

53. The employee information in a company is stored in the relation
Employee (name, sex, salary, deptName).

Consider the following SQL query

```
select deptName
from Employee
where sex='M'
group by deptName
having avg(salary) >
(select avg(salary) from Employee)
```

It returns the names of the departments in which
(1) the average salary is more than the average salary in the company
(2) the average salary of the male employees is more than the average salary of all male employees in the company
(3) the average salary of male employees is more than the average salary of employees in the same department
(4) the average salary of male employees is more than the average salary of employees in the company

Answer: (4)

54. A and B are the only two stations on an Ethernet. Each has a steady queue of frames to send. Both A and B attempt to transmit a frame, collide, and A wins the first back-off race. At the end of this successful transmission by A, both A and B attempt to transmit and collide. The probability that A wins the second back-off race is
(1) 0.5 (2) 0.625 (3) 0.75 (4) 1.0

Answer: (1)
Explanation: The fact that A won the first back-off race does not have any effect on the second back-off race. The probability for each of A or B winning a back-off race is equal to 0.5.

55. The routing table of a router is shown below:

Destination	Subnetmask	Interface
125.75.43.0	255.255.255.0	Eth0
125.75.43.0	255.255.255.128	Eth1
192.12.17.5	255.255.255.255	Eth3
default		Eth2

On which interfaces will the router forward packets addressed to destinations 128.75.43.16 and 192.12.17.10 respectively?

(1) Eth1 and Eth2 (2) Eth1 and Eth2
(3) Eth0 and Eth2 (4) Eth0 and Eth3

Answer: (2)
Explanation:Mask 255.255.255.128 will come into picture for last digit ¿ 128. Here the last digit is 16 and hence eth0 will be used. For 192.12.17.10, there is no network for this (192.12.17.5 is a host and not network) and hence will route through default.

The following information pertains to Q. 56-57

Consider three IP networks A, B and C. Host H_A in network A sends messages each containing 180 bytes of application data to a host H_C in network C. The TCP layer prefixes a 20 byte header to the message. This passes through an intermediate network B. The maximum packet size, including 20 bytes IP header, in each network is

A: 1000 bytes
B: 100 bytes
C: 1000 bytes

The networks A, B and C are connected through a 1 Mbps link, while B and C are connected by a 512 Kbps link(bps = bits per second).

56. Assuming that the packets are correctly delivered, how many bytes, including headers are delivered to the IP layer at the destination for one application message, in the best case? Consider only data packets.

(1) 200 (2) 220 (3) 240 (4) 260

Answer: (4)
Explanation: The IP layer of A hands over a packet of 220 (180 data bytes+ 20 TCP header bits + 20 IP header bits) to its data link layer. The IP layer of B receives this 220 byte packet, strips off the IP header and gets the data payload of 200 bytes. Since no packet can be of size more than 100 bytes in the network B, maximum amount of payload data(i.e. without headers) that can be held by the packet is 80 bytes. The 200 bytes thus get divided into 3 packets, two with 80 data bytes each and the third with 40 bytes. To each of this data, a header of 20 bytes is attached and IP packets of 100, 100 and 60 bytes are transferred to the IP layer at C. Thus the IP layer at C receives 100 + 100 + 60 = 260 bytes.

57. What is the rate at which application data is transferred to host H_C? Ignore errors, acknowledgments, and other overheads.

(1) 325.5 Kbps (2) 354.4 Kbps
(3) 409.6 Kbps (4) 512.0 Kbps

Answer: (2)
Explanation:
260 bytes of data is transferred to H_C on a 512 kbps link.
Time taken to transmit 260 bytes of data = 260*8/512000 sec
260 bytes of data contains 180 bytes of application data
So time taken to transmit 180 bytes of application data is 260*8/512000 seconds
Transmission rate for application data = 180*8/260*8 * 512000
= 354.46 Kbps.

58. A circuit outputs a digit in the form of 4 bits. 0 is represented by 0000, 1 by 0001, ..., 9 by 1001. A combinational circuit is to be designed which takes these 4 bits as input and outputs 1 if the digit ≥ 5, and 0 otherwise. If only AND, OR and NOT gates may be used, what is the minimum number of gates required?
(1) 2 (2) 3 (3) 4 (4) 5

Answer: (2)
Explanation: Let A,B,C,D denote the 4 bit inputs to the combinational circuit.

A	B	C	D	Output
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1

On solving the K-Map, we get Output = A + DB + CB = A +(C+D)B
This requires 2 OR and 1 AND gate. Total number of gates is thus 3.

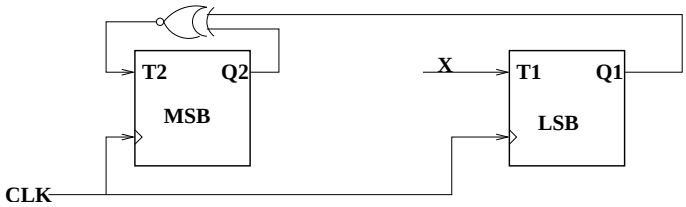
59. Which are the essential prime implicants of the following Boolean function? $f(a,b,c) = a'c + ac' + b'c$
(1) $a'c$ and ac' (2) $a'c$ and $b'c$
(3) $a'c$ only (4) ac' and bc'

Answer: (3)
Explanation: Only $a'c$ is an essential prime implicant. On drawing the K-map we observe that the only way we can group the min-term $a'bc$ is by grouping it with $a'b'c$. This means that the prime implicant obtained here is the essential prime implicant. All other min-terms can be covered by more than one prime implicants and hence are not essential.

60. Consider a multiplexer with X and Y as data inputs and Z as control input, $Z = 0$ selects input X, and $Z = 1$ selects input Y. What are the connections required to realize the 2-variable Boolean function $f = T + R$, without using any additional hardware?
(1) R to X, 1 to Y, T to Z (2) T to X, R to Y, T to Z
(3) T to X, R to Y, 0 to Z (4) R to X, 0 to Y, T to Z

Answer: (1)
Explanation: It can be verified that (A) is the only valid connection.
R is connected to X and T is connected to Z.
Thus, if $T = 0$, X is selected => X is the output, i.e. $f = X$ => $f = R$
if $T = 1$, Y is selected => $f = Y$ => $f = 1$
It can be verified that $f = T + R$ function gives values confirming to above assignment.

61. Consider the partial implementation of a 2-bit counter using T flip-flops following the sequence 0-2-3-1-0, as shown below. To complete the circuit, the input X should be



(1) Q_2' (2) $Q_2 + Q_1$ (3) $(Q_1 \oplus Q_2)'$ (4) $Q_1 \oplus Q_2$

Answer: (4)
Explanation: Set X to $Q_1 \oplus Q_2$ and it can be verified that counter steps through the given sequence.

62. A 4-bit carry lookahead adder, which adds two 4-bit numbers, is designed using AND, OR, NOT, NAND, NOR gates only. Assuming that all the inputs are available in both complemented and uncomplemented forms and the delay of each gate is one time unit, what is the overall propagation delay of the adder? Assume that the carry network has been implemented using two-level AND-OR logic.
(1) 4 time units (2) 6 time units
(3) 10 time units (4) 12 time units

Answer: (2)
Explanation: 1 gate delay for generate and propagate functions of each level.
$C_3 = G_3 + P_3G_2 + P_3P_2G_1 + P_3P_2P_1G_0 + P_3P_2P_1C_{in}$
Thus, for calculation of each of the carry outs, we need 2 gate delays after generate and propagate are calculated.
Calculation of sum using AND-OR circuit requires calculation of NOT of each of the carry bits. This takes 1 gate delay. The AND-OR circuit takes 2 more gate delays.
Total gate delays = 1 + 2 + 1 + 2 = 6 gate delays = 6 units.

Q. 63-64

Consider the following program segment for a hypothetical CPU having three user registers R1, R2 and R3.

Instruction	*Operation*	*Instruction Size(in words)*
MOV R1, 5000	;R1 ← Memory[5000]	2
MOV R2, (R1)	;R2 ← Memory[(R1)]	1
ADD R2, R3	;R2 ← R2 + R3	1
MOV 6000,R2	;R2 ← Memory[6000] ← R2	2
HALT	;Machine halts	1

63. Consider that the memory is byte addressable with word size 32 bits, and the program has been loaded starting from memory location 1000 (decimal). If an interrupt occurs while the CPU has been halted after executing the HALT instruction, the return address(in decimal) saved in the stack will be
(1) 1007 (2) 1020 (3) 1024 (4) 1028

Answer: (4)
Explanation: Each word is 32 bits, that is 4 bytes. After the interrupt is serviced, execution returns to the next location after the halt instruction. Thus, return address will point to 1000 + 7*4 = 1028

64. Let the clock cycles required for various operations be as follows:

Register to/from memory transfer: 3 clock cycles
ADD with both operands in the register: 1 clock cycle
Instruction fetch and decode: 2 clock cycles per word

The total number of clock cycles required to execute the program is
(1) 29 (2) 24 (3) 23 (4) 20

Answer: (2)
Explanation: For all the instructions, the time taken for fetch and decode = 7 words * 2 clock cycles per word. = 14 cycles

For the execution of instruction 1, cycles required = 3
For the execution of instruction 2, cycles required = 3
For the execution of instruction 3, cycles required = 1
For the execution of instruction 4, cycles required = 3

Total = 14 + 3 + 3 + 1 + 3 = 24 clock cycles.

65. Consider a small 2-way set-associative cache memory, consisting of four blocks. For choosing the block to be replaced,use the least recently (LRU) scheme. The number of cache misses for the following sequence of block addresses is

```
8, 12, 0, 12,8
```

(1) 2 (2) 3 (3) 4 (4) 5

Answer: (3)
Explanation: There are 2 sets each with 2 blocks. One of the sets can contain any of the even numbered blocks, the other can contain the odd numbered blocks. All the blocks used in the problem are even numbered, so all of them can be in the same set (not all at once though).
8 causes a cache miss.
12 causes a cache miss
0 causes a cache miss, by LRU the block containing 8 is replaced by 0.
12 does not cause a cache miss, because it is already in the cache.
8 causes a cache miss, causing 12 to be replaced with 8.
Total misses = 4

66. Let A = 1111 1010 and B = 0000 1010 be two 8-bit 2′s complement numbers. Their products in 2′s complement is
(1) 1100 0100 (2) 1001 1100 (3) 1010 0101 (4) 1101 0101

Answer: (1)
Explanation:

$$\begin{aligned} A &= -6 \\ B &= 10 \\ A \times B &= -60 \Rightarrow 11000100 \end{aligned}$$

67. The microinstructions stored in the control memory of a processor have a width of 26 bits. Each microinstruction is divided into three fields: a micro-operation field of 13 bits, a next address field(X), and a MUX select field(Y). There are 8 status bits in the inputs of the MUX. How many bits are

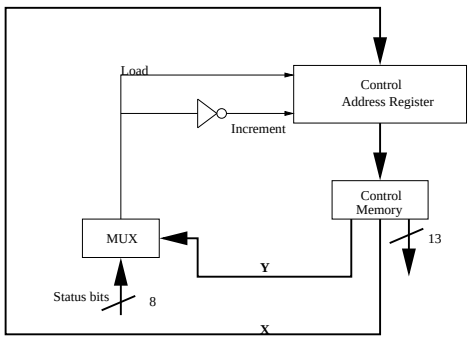


Figure 29: Fig. Q. 67 Explanation

there in the X and Y fields, and what is the size of the control memory in number of words?
(1) 10, 3, 1024 (2) 8, 5, 256
(3) 5, 8, 2048 (4) 10, 3, 512

Answer: (1)
Explanation:
13 + X + Y = 26 ⇒ X + Y = 13
If we look at MUX, it has 8 status bits, so Y needs to be 3 bits wide. Thus, X = 10.
Next address points to a memory location in the microinstruction memory. Therefore the size of the microinstruction memory, control memory is 1024 words.

68. A hard disk with a transfer rate of 10 Mbytes/second is constantly transferring data to memory using DMA. The processor runs at 600 MHz, and takes 3000 and 900 clock cycles to initiate and complete DMA transfer respectively. If the size of the transfer is 20 Kbytes, what is the percentage of processor time consumed for the transfer operation?
(1) 5.0 % (2) 1.0 % (3) 0.5 % (4) 0.1 %

Answer: (4)
Explanation:
For transferring, the DMA requires $20 \times 10^3/10^7$ seconds = 2000 microseconds.
The processor participates in the transfer for 1200 clock cycles = $1200 * 1/(600 * 10^6)$ seconds = 2 microseconds
Therefore the percentage of the processor time consumed for the transfer = 2/(2000+2) * 100 0.1 %

69. A 4-stage pipeline has the stage delays as 150, 120, 160 and 140 nanoseconds respectively. Registers that are used between the stages have a delay of 5 nanoseconds each. Assuming constant clocking rate, the total time taken to process 1000 data items on this pipeline will be
(1) 120.4 microseconds (2) 160.5 microseconds
(3) 165.5 microseconds (4) 590.0 microseconds

Answer: (3)
Explanation:
The total processing time for 1000 items is :
For one data item 150 + 5 + 120 + 5 + 160 + 5 + 140 = 585
For two data items = 585 + (2-1)*165
For 1000 data items = 585 + (1000-1)*165 = 165.420

70. The following propositional statement is $(P \rightarrow (Q \vee R)) \rightarrow ((P \wedge Q) \rightarrow R)$ (1) satisfiable but not valid (2) valid
(3) a contradiction (4) none

Answer: (1)
Explanation: There is an assignment for P, Q, R that causes the proposition to be satisfied ⇒ satisfiable
But the proposition to be valid, it should be true for every assignment for P,Q,R. This is not the case ⇒ not valid.

71. How many solutions does the following system of linear equations have?

$$\begin{aligned} -x + 5y &= -1 \\ x - y &= 2 \\ x + 3y &= 3 \end{aligned}$$

(1) infinitely many (2) two distinct solutions
(3) unique (4) none

Answer: (3) Solving equations 2 and 3, we get a unique solution point: (9/4, 1/4). This equation also satisfies equation (1). So the system of three equations has a unique solution.

72. The following is incomplete operation table of a 4-element group.

*	e	a	b	c
e	e	a	b	c
a	a	b	c	e
b	a	b	c	e
b				
c				

The last row of table is
(1) c a e b (2) c b a e
(3) c b e a (4) c e a b

Answer: (3)
Explanation: e is the identity element. so the second column of the table contains b and c. The column corresponding to $b * a$
$b * a = (a * a) * a$; rewriting b as a*a
$= a * (a * a) = a * b$; from the table
= c => b*a = c In similar fashion we can complete the entire table.

73. The inclusion of which of the following sets into

```
S = {{1,2}, {1,2,3}, {1,3,5}, {1,2,4}, {1,2,3,4,5}}
```

is necessary and sufficient to make S a complete lattice under the partial order defined by set containment?
(1) $\{1\}$
(2) $\{1\}, \{2, 3\}$
(3) $\{1\}, \{1, 3\}$
(4) $\{1\}, \{1, 3\}, \{1, 2, 3, 4\}, \{1, 2, 3, 5\}$

Answer: (3)
Explanation: Drawing the Hasse diagram shows us that for the two elements, {1,2,3} and {1,3,5}, the greatest lower bound is not present in the already given set, adding set {1,3}, we get the GLB for these two sets. In a similar fashion for {1,2,4} and {1,3,5} the GLB that needs to be added to the set is {1}. If these two sets are added then every subset of elements will have a GLB and an LUB.

74. An examination paper has 150 multiple-choice questions of one mark each, with each question having four choices. Each incorrect answer fetches -0.25 mark. Suppose 1000 students choose all their answers randomly with uniform probability. The sum total of the expected marks obtained marks by all these students is
(1) 0 (2) 2550 (3) 7525 (4) 9375

Answer: (4)
Explanation: There are 150 questions and 1000 students. The probability of choosing a correct answer is 1/4. The probability of choosing the wrong answer is 3/4.
Thus weight for each answer: 1/4*1 - 3/4*0.25 = 1/16 (0.25 is penalty for incorrect answer)
So sum of expected marks = 1000*150*1/16 =9375

75. Mala has a coloring book in which each English letter is drawn two times. She wants to paint each of these 52 prints with one of k colors, such that the color-pairs used to color any two letters are different. Both prints of a letter can also be colored with the same color. What is the minimum value of k that satisfies this requirement?
(1) 9 (2) 8 (3) 7 (4) 6

Answer: (4)
Explanation: There are k distinct colors. So there are k^2 color pairs. In order to be able to color such that color-pairs used for any two letters are different, k^2 ¿ number of letter pairs.

$$k^2 > 26 \Rightarrow k > 5.09$$

Therefore minimum value of k is 6.

76. In an $M \times N$ matrix such that all non-zero entries are covered in a rows and b columns. Then the maximum number of non-zero entries, such that no two are on the same row or column, is
(1) $\leq a + b$ (2) $\leq max\{a, b\}$
(3) $\leq min\{M - a, N - b\}$ (4) $\leq min\{a, b\}$

Answer: (4)

77. The minimum number of colors required to color the following graph, such that no two adjacent vertices are assigned the same color, is
(1) 2 (2) 3 (3) 4 (4) 5

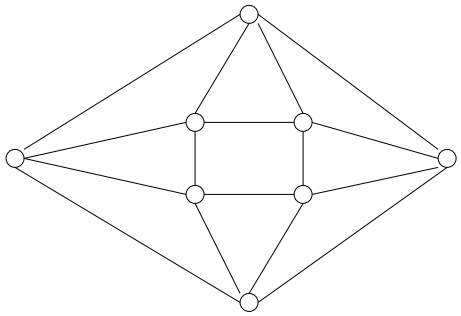


Figure 30: Fig: Q. 77

Answer: (3)
Explanation:
It is known that any planar graph can be colored using not more than 4 colors. As the given graph is a planar graph it can be colored using 4 colors. But we also have to check the graph to see whether it can be colored using only 3 colors. By simple checking it is clear that coloring with 3 colors is not possible. The coloring is as follows, a,b,c,d are distinct colors:

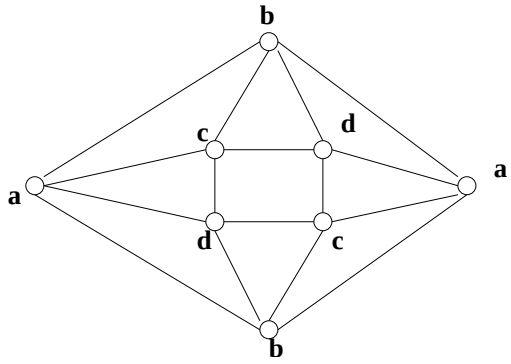


Figure 31: Explanation Q. 77

78. Two n bit binary strings, S_1 and S_2 are chosen randomly with the uniform probability. The probability that the Hamming distance between these strings (the number of bit positions where the two strings differ) is equal to d is
(1) $C(n, d)/2^n$ (2) $C(n, d)/2^d$ (3) $d/2^n$ (4) $1/2^d$

Answer: (1)
Explanation:
Probability that i_{th} bit in S_1 and S_2 matches is $p = 1/2$ Therefore, using binomial distribution, the probability that it matches in d positions is,
$P(X = d) = C(n, d)((1/2)^d)((1/2)^{(n-d)}) \Rightarrow C(n, d)/2^n$

79. How many graphs on n labeled vertices exist which have at least $(n_2 - 3n)/2$ edges?
(1) $C((n^2-n)/2, (n^2-3n)^2)$ (2) $\sum_{k=0}^{(n^2-3n)/2} C((n^2-n), k)$
(3) $C((n^2-n)/2, n)$ (4) $\sum_{k=0}^{n} C((n^2-n)/2, k)$

Answer: (4)
Explanation:
Total number of edges in a graph with n labeled vertices is $n(n-1)/2 = (n^2-n)/2$
The number of ways of choosing k edges from $(n^2-n)/2$ edges $= C((n^2-n)/2, k)$. This is also the number of graphs having k edges.
Number of graphs with at least k edges = Number of graphs with k edges + number of graphs with (k+1) edges + ... + Number of graphs with $(n^2-n)/2$ edges
Number of graphs with $(n^2-3n)/2$ edges $= C((n^2-n)/2, (n^2-3n)/2) + C((n^2-n)/2, (n^2-3n)/2+1) + ... + C((n^2-n)/2, (n^2-n)/2)$
$= C((n^2-n)/2, n) + C((n^2-n)/2, n-1) + ... + C((n^2-n)/2, 0)$
$= \sum_{k=0}^{n} C((n^2-n)/2, k)$

80. A point is randomly selected with uniform probability in the $X-Y$ plane within the rectangle with corners at (0,0), (1,0), (1,2) and (0,2). If p if the length of the position vector at the point, the expected value of p^2 is
(1) 2/3 (2) 1 (3) 4/3 (4) 5/3

Answer: (4)
Explanation:
If u represent a point by (x,y) then $p^2 = x^2 + y^2$
The sum of this function over this area is $= \int_0^1 \int_0^2 x^2 + y^2 \, dx \, dy$ i.e.10/3.
Therefore, expected value=(10/3)/area of the rectangle i.e.5/3.

81. Let $G_1 = (V, E_1)$ and $G_2 = (V, E_2)$ are two connected graphs on the same vertex set V with more than two vertices. If $G_1 \cap G_2 = (V, E_1 \cap E_2)$ is not a connected graph, then the graph $G_1 \cap G_2 = (V, E_1 \cap E_2)$
(1) cannot have a cut vertex
(2) must have a cycle
(3) must have a cut-edge (bridge)
(4) has chromatic number strictly greater than those G_1 and G_2

Answer: (2).
Explanation:
Since the intersection is not connected G_1 and G_2 should have at least one edge that is not in common.In union of these graphs these two edges which are not common forms a cycle.

82. Let $A[1, \ldots, n]$ be an array storing a bit (1 or 0) at each location, and f(m) is a function whose time complexity is $\theta(m)$. Consider the following program fragment written in a C like language:

```
counter = 0;
for (i=1; i<=n; i++)
{if (A[i] == 1) counter++;
   else {(f(counter); counter = 0;}
}
```

The complexity of the program fragment is
(1) $\Omega(n^2)$ (2) $\Omega(n \; log \; n)$ and $\Omega(n^2)$ (3) $\theta(n)$ (4) $o(n)$

Answer: (3)
Explanation:
If you observe this program, this first calculates consecutive number of 1's in the array and calls the function with the number of 1's it found. It calls the function for every segment of 1's. Because the array can have at max n 1's, the complexity of the program is equal to $\theta(n)$.

83. The time complexity of the following C function is (assume $n > 0$)

```
int recursive (int n) {
if (n == 1)
return 1;
else
return(recursive(n-1) + recursive(n-1));
}
```

(1) O(n) (2) O(n log n) (3) O(n^2) (4) O(2^n)

Answer: (4)
Explanation:
Recurrence relation for the C programs is,
T(n)=1 when n=1
T(n)=2T(n-1)+1
On solving this recursion we get
$T(n) = 2^k T(n-k) + 2^{(k-1)} + ... + 1$
recursion stops when n-k=1 i.e.k=n-1.
$T(n) = 2^{(n-1)}.1 + 2^{(n-2)} - 1$ (By reducing the last terms as they form a GP series)
Therefore $T(n) = O(2^n)$.

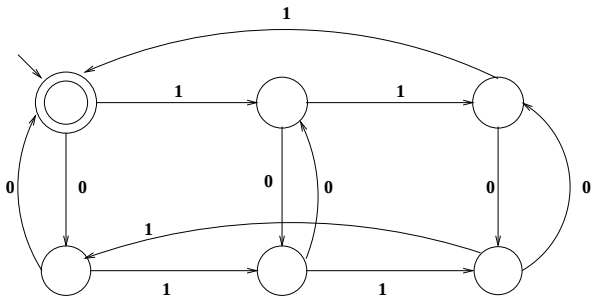
84. The recurrence equation $T(1) = 1$
$T(n) = 2T(n-1) + n, n \geq 2$
evaluates to
(1) 2^{n+1} - n - 2 (2) 2^n - n (3) 2^{n+1} - 2n - 2 (4) 2^n + n

Answer: (1)
Explanation:
Using the concept of generating functions we get,
$F_x = 2F_{x-1} - n$
$x^2 - 2x = 0$
$x = 2$, therefore solution is $\alpha 2^n + a_n$ where $a_n = c_n + d$
substituting a_n in $F_x = 2F_{x-1} + 1$ we get,
c=-1 and d=-2
Therefore, $T(n) = \alpha 2^n - n - 2$
substituting this in $T(1) = 1$ we get $\alpha = 2$
Therefore $T(n) = 2^{(n+1)} - n - 2$.

85. A program takes as input a balanced binary search tree with n leaf nodes and computes the value of a function g(x) for each node x. If the cost of computing $g(x)$ is min { no. of leaf-nodes in the left-subtree of x, no. of leaf-nodes in the right-subtree of x } then the worst-case time complexity of the program is
(1) $\Theta(n)$ (2) $\Theta(nlogn)$ (3) $\Theta(n^2)$ (4) $\Theta(n^2\ log\ n)$

Answer: (1)
Explanation:
The tree has n leaves, therefore it has $n-1$ internal nodes.So in total it has $2n-1$ nodes.
Calculating the number of leaves for every node has in its subtree takes time equal to O(2n-1)i.e, O(n), if we do it in bottom wise. Calculating g(x) also takes O(1) for each node, therefore it also takes O(n). Therefore total complexity of calculating becomes $\theta(n)$.

86. The following finite state machine accepts all those binary strings in which the number of 1′s and 0′s are respectively
(1) divisible by 3 and 2 (2) odd and even
(3) even and odd (4) divisible by 2 and 3



Answer: (1)
Explanation:

87. The language $\{a^m b^n c^{m+n} | m, n \geq 1\}$ is
    (1) regular
    (2) context-free but not regular
    (3) context sensitive but not context free
    (4) type-0 but not context sensitive

    Answer: (2)
    Explanation:
    First of all it is not regular as it has to remember the sum of number of a's and b's.
    It is context free as we can design a PDA which pushes X when it sees a or b and pops X when it sees c.

88. Consider the following grammar G:

$$\begin{aligned} S &\rightarrow bS \mid aA \mid b \\ A &\rightarrow bA \mid aB \\ B &\rightarrow bB \mid aS \mid a \end{aligned}$$

    Let $N_a(w)$ and $N_b(w)$ denote the number of a's and b's in a string w respectively. The language $L(G) \subset \{a, b\}^+$ generated by G is
    (1) $\{w | N_a(w) > 3N_b(w)\}$
    (2) $\{w | N_b(w) > 3N_a(w)\}$
    (3) $\{w | N_a(w) = 3k, k \in \{0, 1, 2, ...\}\}$
    (4) $\{w | N_b(w) = 3k, k \in \{0, 1, 2, ...\}\}$

    Answer: (3)
    Explanation:
    By simple checking with an example it is clear that C is the answer.
    Grammar doesn't accept aaaab or abbbb or abbb, therefore a,b, or d are not the answers, whereas machine accepts aaab which tells us that c is the answer.

89. L_1 is a recursively enumerable language over Σ. An algorithm A effectively enumerates its words as $w1, w2, w3, \ldots$. Define another language L_2 over $\Sigma \cup \{\#\}$ as $\{w_i \# w_j : w_i, w_j \in L_1,\ i < j\}$. Here # is a new symbol. Consider the following assertions:

    S_1: L_1 is recursive implies L_2 is recursive
    S_2: L_2 is recursive implies L_1 is recursive

    Which of the following statements is true?
    (1) Both S_1 and S_2 are true
    (2) S_1 is true S_2 is not necessarily true
    (3) S_2 is true S_1 is not necessarily true
    (4) Neither is necessarily true

Answer: (1)
Explanation:
The second machine works as follows.
It takes w_i and checks if it can enumerated using the first machine. Then it checks for the w_j. It also checks that i¡j or not. If yes it says yes otherwise no.
IF L_1 is recursive then second machine always gives the answer , therefore L_2 is also recursive. So, s_1 is true.
Similarly, let L_2 be recursive and L_1 non-recursive. L_2 needs a Turing machine that enumerates the strings of L_1. L_1 is not a recursive means that it goes into infinite loop for some string(s), thus taking L_1 into an infinite loop. This suggests that L_2 is not recursive, a contradiction. Therefore L_1 has to be recursive. So S_2 is also correct. Hence (A) is the answer.

90. Choose the best matching between the programming styles in Group 1 and their characteristics in Group 2.

Group 1	**Group 2**
P. Functional	1. Command-based, procedural
Q. Logic	2. Imperative, abstract data types
R. Object-oriented	3. Side-effect free,declarative,expression evaluation
S. Imperative	4. Declarative, clausal representation, theorem proving

(1) P-2, Q-3, R-4, S-1
(2) P-4, Q-3, R-2, S-1
(3) P-3, Q-4, R-1, S-2
(4) P-3, Q-4, R-2, S-1

Answer: (4)

End of the question paper

GATE CS 2005

GATE CS 2005

All questions carry 1 marks each.

Q. 1. What does the following C statement declare:

```
int (*f) (int *);
```

(1) A function that takes an integer pointer as argument and returns an integer
(2) A function that takes an integer as argument and returns an integer pointer
(3) A pointer to a function that takes an integer pointer as argument and returns an integer
(4) A function that takes an integer pointer as argument and returns a function pointer

Ans: 3

Q. 2. An abstract data type (ADT) is
(1) Same as an abstract class
(2) A data type that can not be instantiated
(3) A data type for which only the operations defined on it can be used, but none else
(4) all of above

Ans: 3

Q. 3. A common property of logic programming languages and functional languages is:
(1) both are procedural language (2) both are based on λ-calculus
(3) both are declarative (4) both use Horn-clauses

Ans: 3

Q. 4. Which one of the following are essential features of an object-oriented programming language?
(i) Abstraction and encapsulation
(ii) Strictly-typedness
(iii) Type-safe property coupled with sub-type rule
(iv) Polymorphism in the presence of inheritance
(1) (i) and (ii) only (2) (i) and (iv) only
(3) (i),(ii) and (iv) only (4) (i),(iii) and (iv) only

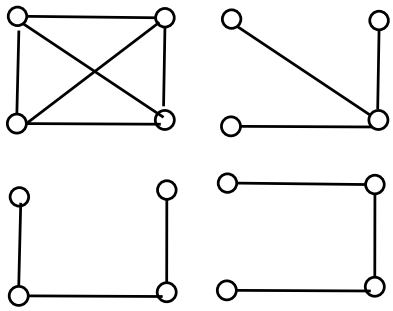
Ans: 2

Q. 5. A program P reads in 500 integers in the range [0,100] representing the scores of 500 students. It then prints the frequency of each score above 50. What would be the best way for P to store frequencies?
(1) An array of 50 numbers
(2) An array of 100 numbers
(3) An array of 500 numbers
(4) A dynamically allocated array of 550 numbers

Ans: 1
We need to only store number of integers of a specific value between 51 and 100. The array of 50 numbers will be sufficient for the task. Each entry in the array, $A[i], 0 < i < 50$, represents frequency of integer: $50 + i + 1$.

Q. 6. An undirected graph G has n nodes. Its adjacency matrix is given by an $n \times n$ square matrix whose
(i) diagonal elements are 0's and
(ii) non-diagonal elements are 1's
Which one of the following is TRUE?
(1) Graph G has no minimal spanning tree(MST)
(2) Graph G has a unique MST of cost $n-1$
(3) Graph G has multiple distinct MSTs each of cost $n-1$
(4) Graph G has multiple spanning trees of different costs

Ans: 3
The graph G in the question is fully connected graph with each edge having weight of 1. This graph has multiple distinct MSTs each of cost $n-1$. To illustrate let's consider a graph of size 4. The multiple distinct MSTs formed with this graph are also shown in the figure.



Q. 7. The time complexity of computing the transitive closure of binary relation on a set of n elements is known to be
(1) $O(n)$ (2) $O(n\ log\ n)$ (3) $O(n^{\frac{3}{2}})$ (4) $O(n^3)$

Ans: 4
The transitive closure of a binary relation R on a set X is the smallest transitive relation on X that contains R. Warshall's algorithm is used for computing transitive closure of R on set X. The complexity of Warshall's algorithm is $O(n^3)$.

In Warshall's original formulation of the algorithm, the graph is unweighted and represented by a Boolean adjacency matrix. Then the addition operation is replaced by logical conjunction (AND) and the minimum operation by logical disjunction (OR).

Q. 8. Let A, B and C be non-empty sets and let

$$X = (A - B) - C \text{ and } Y = (A - C) - (B - C)$$

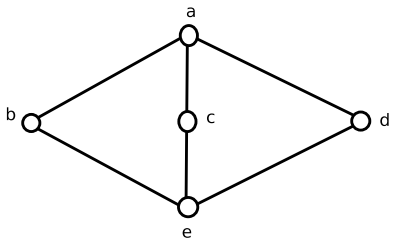
Which one of the following is true?
(1) $X = Y$ (2) $X \subset Y$ (3) $Y \subset X$ (4) none of these

Ans: 1
In $X = (A - B) - C$, we are first selecting all the elements in A which are not in B. The resultant set is then selected to exclude all the elements in C. Thus, we are retaining elements in A, which are not in B or C.

In $Y = (A - C) - (B - C)$, we are first selecting all the elements in A which are not in C. Let's call it as A'. We are then selecting all the elements in B which are not in C. Let's call it as B'. Then we are retaining only those elements, which are in A' and not in B'. Thus, we again obtain elements in A, which are not in B or C.

Thus, the answer is $X = Y$ i.e. **1**

Q. 9. The following is the Hasse diagram of the poset $[\{a, b, c, d, e\}, \prec]$ The poset is:



(1) not a lattice
(2) a lattice but not a distributive lattice
(3) a distributive lattice but not a boolean algebra
(4) a boolean algebra

Ans: 2

Lattice is a partially ordered set(poset) in which any two elements have a least upper bound(LUB) and a greatest lower bound(GLB).

Distributive lattices are lattices for which the operations of join and meet distribute over each other.

Boolean algebra is an algebraic structure (a collection of elements and operations on them obeying defining axioms) that captures essential properties of both set operations and logic operations. Specifically, it deals with the set operations of intersection, union, complement; and the logic operations of AND, OR, NOT. Boolean algebra is a distributive lattice.

The given poset is a lattice as every pair of elements has a LUB and a GLB.

Pair	LUB	GLB	Pair	LUB	GLB
a,b	a	b	b,d	a	e
a,c	a	c	b,e	b	e
a,d	a	d	c,d	a	e
a,e	a	e	c,e	c	e
b,c	a	e	d,e	d	e

However, the lattice is not distributive. Since it is not distributive, it can not be boolean algebra. Thus, the given poset is **a lattice but not a distributive lattice**

Q. 10. Let G be a simple connected planar graph with 13 vertices and 19 edges. Then, the number of faces in the planar embedding of the graph is:
(1) 6 (2) 8 (3) 9 (4) 13

Ans: 2
Euler's formula states that if a finite, connected, planar graph is drawn in the plane without any edge intersections, and v is the number of vertices, e is the number of edges and f is the number of faces (regions bounded by edges, including the outer, infinitely-large region), then, v, e and f are related by

$$v - e + f = 2$$

Given that $v = 13, e = 19$, we get $f = 2 - v + e = 2 - 13 + 19 = 8$.

Q. 11. Let G be a simple graph with 20 vertices and 100 edges. The size of the minimum vertex cover of G is 8. Then, the size of the maximum independent set of G is
(1) 12 (2) 8 (3) less than 8 (4) more than 12

Ans: 1

Independent, or stable set in a graph $G(V, E)$ is a set of vertices $V' \subset V$ such that for every two vertices in V', there is no edge connecting the two. In other words, each edge in the graph is incident to at most one vertex in the set. The size of an independent set is the number of vertices it contains.

A maximum independent set is a largest independent set for a given graph.

A vertex covering for a graph G is a set of vertices V so that every edge of G is incident to at least one vertex in V. The minimum vertex covering is the smallest vertex cover. We say V covers the edges of the graph. The vertex covering number $w_v(G)$ for a graph G is the size of the minimum vertex covering.

For any graph $G(V, E)$: $w_V(G) + \|maximum\ independent\ set\| = \|V\|$ With $w_V(G) = 8$, and $\|V\| = 20$, we get $\|maximum\ independent\ set\| = 20 - 8 = 12$

Q. 12. Let $f(x)$ be the continuous probability density function of a random variable X. The probability that $a < X \leq b$, is
(1) $f(b-a)$ (2) $f(b) - f(a)$ (3) $\int_a^b f(x)dx$ (4) $\int_a^b xf(x)dx$

Ans: 3
This is based on standard formula. In case of a continuous probability density function, the probability that $a < X \leq b$ is equal to area under the curve between $X = a$ and $X = B$, which is represented by $\int_a^b f(x)dx$.

Q. 13. The set $\{1, 2, 4, 7, 8, 11, 13, 14\}$ is a group under multiplication modulo 15. The inverses of 4 and 7 are respectively:
(1) 3 and 13 (2) 2 and 11 (3) 4 and 13 (4) 8 and 14

Ans: 3
In the given group, we have 1 as an identity element since $(1 \times a)\%15 = a$. In this context, for each element a in the group, there is an element b in the group such that $(a \times b)\%15 = 1$. b is an inverse of a. We can see that 4 is inverse of itself i.e. $(4 \times 4)\%15 = 1$ and 13 is inverse of 7 i.e. $(7 \times 13)\%15 = 1$

Q. 14. The grammar $A \rightarrow AA \mid (A) \mid \epsilon$ is not suitable for predictive parsing because the grammar is:
(1) ambiguous (2) left recursive
(3) right recursive (4) an operator grammar

Ans: 2
Predictive parsers can not handle *left recursive* grammars.

Q. 15. Consider the following circuit
Which one of the following is true?

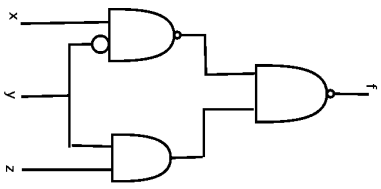


Figure 32: Figure for Q. 15

(1) f is independent of X (2) f is independent of Y
(3) f is independent of Z (4) none of X, Y, Z is redundant

Ans: 1

Simplifying f using Demorgan's law, we get

$$\begin{aligned} f &= (\overline{(\overline{x\overline{y}}).(yz)}) \\ &= (\overline{\overline{x}+y}) + \overline{y} + \overline{z} \\ &= x\overline{y} + \overline{y} + \overline{z} \\ &= \overline{y}(x+1) + \overline{z} \\ &= \overline{y} + \overline{z} \end{aligned}$$

Thus, f is independent of X.

Q. 16. The range of integers that can be represented by an n bit 2's complement number system is:
(1) -2^{n-1} to $(2^{n-1}-1)$ (2) $-(2^{n-1}-1)$ to $(2^{n-1}-1)$
(3) -2^{n-1} to 2^{n-1} (4) $-(2^{n-1}+1)$ to $(2^{n-1}-1)$

Ans: 1

Q. 17. The hexadecimal representation of 657_8 is
(1) 1AF (2) D78 (3) D71 (4) 32F

Ans: 1
First find the decimal number corresponding to 657_8,

$$\begin{aligned} (657)_8 &= (6\times 8^2 + 5\times 8^1 + 7\times 8^0)_{10} \\ &= (384+40+7)_{10} = (431)_{10} \end{aligned}$$

$(431)_{10} = (1AF)_{16}$

Q. 18. The switching expression corresponding to

$f(A,B,C,D) = \sum(1,4,5,9,11,12)$

is
(1) BC'D + A'C'D + AB'D (2) ABC' + ACD + B'C'D'
(3) ACD' + A'BC' + AC'D' (4) A'BD + ACD' + BCD'

Ans: 1
$f(A,B,C,D) = \sum(1,4,5,9,11,12)$ can be represented in the following K-map:

```
   CD
AB\   00  01  11  10
     ---------------
  00 |   | 1 |   |   |  f = BC'D + A'C'D + AB'D
     |---------------
  01 | 1 | 1 |   |   |
     |---------------
  11 | 1 |   |   |   |
     |---------------
  10 |   | 1 | 1 |   |
     ---------------
```

Q. 19. Which one of the following is true for a CPU having a single interrupt request line and a single interrupt grant line?

(1) Neither vectored interrupt nor multiple interrupt devices are possible
(2) Vectored interrupts are not possible but multiple interrupting devices are possible
(3) Vectored interrupts and multiple interrupting devices are both possible
(4) Vectored interrupt is possible but multiple interrupting devices are not possible

Ans: 3

Q. 20. Normally user programs are prevented from handling I/O directly by I/O instructions in them. For CPUs having explicit I/O instructions, such I/O protection is ensured by having I/O instructions privileged. In a CPU, with memory mapped I/O, there is no explicit I/O instruction. Which one of the following is TRUE for a CPU with memory mapped I/O?
(1) I/O protection is ensured by operating system routine(s)
(2) I/O protection is ensured by hardware trap
(3) I/O protection is ensured during system configuration
(4) I/O protection is not possible

Ans: 1
The access mechanism of memory mapped I/O is similar to memory location access.

Q. 21. What is the swap space in the disk used for?
(1) Saving temporary HTML pages (2) Saving process data
(3) Storing super-block (4) Storing device drivers

Ans: 2

Q. 22. Increasing the RAM of a computer typically improves performance because:
(1) Virtual memory increases (2) Larger RAMs are faster
(3) Fewer page faults occur (4) Fewer segmentation faults occur

Ans: 3

Q. 23. Packets of the same session may be routed through different paths in:
(1) TCP, but not UDP (2) TCP and UDP
(3) UDP, but not TCP (4) Neither TCP nor UDP

Ans: 2

Q. 24. The *a*ddress resolution protocol (ARP) is used for:
(1) Finding the IP address from the DNS
(2) Finding the IP address of the default gateway
(3) Finding the IP address that corresponds to a MAC address
(4) Finding the MAC address that corresponds to an IP address

Ans: 4
Address Resolution Protocol (ARP) is the method for finding a host's hardware address when only its network layer address is known. Thus, ARP is used for finding the MAC address that corresponds to an IP address.

Q. 25. The maximum window size for data transmission using the *s*elective reject protocol with n-bit frame sequence number is:
(1) 2^n (2) 2^{n-1} (3) $2^n - 1$ (4) 2^{n-2}

Ans: 3

Q. 26. In a network of LANs connected by bridges, packets are sent from one LAN to another through

intermediate bridges. Since more than one path may exist between two LANs, packets may have to be routed through multiple bridges. Why is the *s*panning three algorithm used for bridge-routing?
(1) For shortest path routing between LANs
(2) For avoiding loops in the routing paths
(3) For fault tolerance
(4) For minimizing collisions

Ans: 2

Q. 27. An organization has a class B network and wishes to form subnet for 64 departments. The subnet mask would be:
(1) 255.255.0.0 (2) 255.255.64.0
(3) 255.255.128.0 (4) 255.255.252.0

Ans: 4
Since it is class B network, we have leading 10 followed by 14 network bits and remaining 16 bits for host. Subnetting is the process of allocating bits from the host portion as a network portion. Thus, to support 64 subnets, we need to allocate first 6 bits ($2^6 = 64$) of host portion to subnet. We get 11111111111111111111110000000000, which is 255.255.252.0.

Q. 28. Which one the following is the key factor for preferring B+-trees to binary search trees for indexing database relations?
(1) Database relations have a large number of records
(2) Database relations are sorted on the primary key
(3) B+-trees require less memory than binary search trees
(4) Data transfer from disk in in blocks

Ans: 4

Q. 29. Which one of the following statements about normal forms is FALSE?
(1) BCNF is stricter than 3NF
(2) Lossless, dependency-preserving decomposition into 3NF is always possible
(3) Lossless, dependency-preserving decomposition into BCNF is always possible
(4) Any relation with two attributes is in BCNF

Ans: 3

Q. 30. Let r be a relation instance with schema $R = (A, B, C, D)$. We define $r_1 = \pi_{A,B,C}(R)$ and $r_2 = \pi_{A,D}(r)$. Let, $s = r_1 * r_2$ where * denotes natural join. Given that the decomposition of r into r_1 and r_2 is lossy, which one of the following is TRUE?
(1) $s \subset r$ (2) $r \cup s = r$ (3) $r \subset s$ (4) $r * s = s$

Ans: 2
Since the decomposition is lossy, we will be loosing information in S, which is natural join between decomposed parts of R. However, $r \cup s = r$.

Q. 31 to Q. 80 carry two marks each
Q. 31. Consider the following C program:

```
1  void foo (int n, int sum = 0 )  {
2       int k = 0, j = 0;
3       if  ( n==0 )  return;
4       k = n % 10;  j = n / 10;
5       sum = sum + k;
6       foo (j, sum);
7       printf ( "%d,", k);
8  }
9
10 int main(){
```

```
11      int a = 2048, sum = 0;
12      foo  (a, sum);
13      printf ( "%d\n", sum);
14 }
```

What does the program prints
(1) 8, 4, 0, 2, 14 (2) 8, 4, 0, 2, 0 (3) 2, 0, 4, 8, 14 (4) 2, 0, 4, 8, 0

Ans: 4
The invocations and printing is depicted below:

```
foo( 2048, 0 )
  foo( 204, 8 )             k = 8   sum = 8
    foo( 20, 12 )           k = 4   sum = 12
      foo( 2, 12 )          k = 0   sum = 12
        foo( 0, 14 )        k = 2   sum = 14
        printf ( "%d,", k);  2,
      printf ( "%d,", k);    0,
    printf ( "%d,", k);      4,
  printf ( "%d,", k);        8,
printf ( "%d\n", sum);       0
```

Note that `sum` is not pass-by-reference to `foo`. It is pass-by-value. Thus, the changes to `sum` in `foo` are not reflected in `main`, thus line 13 will print 0.

Q. 32. consider the following C program

```
double foo (double);     /* Line 1 */
int main () {
   double da, db;
   // input da
   db = foo (da);
}
double foo (double a)  {
   return a;
}
```

The above code is compiled without any error or warning. If Line 1 is deleted, the above code will show:
(1) no compile error or warning
(2) some compile warnings not leading to unintended results
(3) some compile warnings due to type mismatch eventually
leading to unintended results
(4) compiler errors

Ans: 4
The compiler does not get declaration of `foo`, when it encounters it in `main` leading to compilation error.

Q. 33. Postorder traversal of given binary search tree, T produces the following sequence of keys

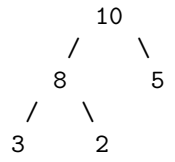
`10, 9, 23, 22, 27, 25, 15, 50, 95, 60, 40, 29`

Which one of the following sequences of the keys can be the results of in-order traversal of the tree T?
(1) `9, 10, 15, 22, 23, 25, 27, 29, 40, 50, 60, 95`
(2) `9, 10, 15, 22, 40, 50, 60, 95, 23, 25, 27, 29`
(3) `29, 15, 9, 10, 25, 22, 23, 27, 40, 60, 50, 95`
(4) `95, 50, 60, 40, 27, 23, 22, 25, 10, 9, 15, 29`

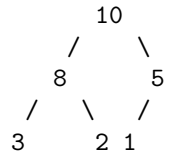
Ans: 1
In-order traversal of BST produces sorted list of elements in the BST.

Q. 34. A priority queue is implemented as a max heap. Initially it has 5 elements. The level order traversal of the heap is given below
`10, 8, 5, 3, 2`
Two new elements `1` and `7` are inserted in the heap in that order. A level order traversal of the heap after insertion of the elements is:
(1) `10, 8, 7, 5, 3, 2, 1` (2) `10, 8, 7, 2, 3, 1, 5`
(3) `10, 8, 7, 1, 2, 3, 5` (4) `10, 8, 7, 3, 2, 1, 5`

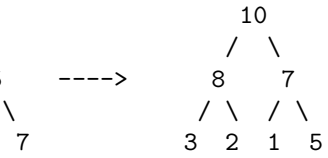
Ans: 4
Refer to Q. 87 and Q. 88 in GateGenie Practice Test 1.



After inserting `1`, we get



The insertion of 7 violates heap-property and we need to swap it with its immediate parent `5` to restore heap property. Thus, we get finally



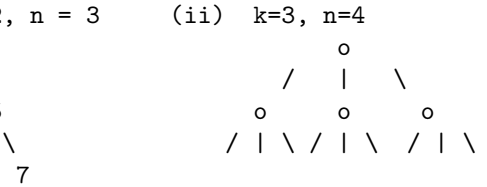
Thus, the level order traversal of heap results in the following sequence: `10, 8, 7, 3, 2, 1, 5`

Q. 35. How many distinct binary search trees can be created out of 4 distinct keys?
(1) 5 (2) 14 (3) 24 (4) 42

Ans: 2
The total number of distinct BSTs created from n keys is $\frac{\binom{2n}{n}}{n+1}$. Substituting $n = 4$, we get total number of 14 BSTs.

Q. 36. In a complete k-ary tree, every internal node has exactly k children. The number of leaves in such a tree with n internal node is:
(1) nk (2) $(n-1)k+1$ (3) $n(k-1)+1$ (4) $n(k-1)$

Ans: 3
We can solve this empirically with two examples:



In both the cases, the number of leaves is $n(k-1)+1$. In (i) we have, number of leaves $= 3\times(2-1)+1 = 4$, while in (ii) we have number of leaves $= 4 \times (3-1)+1 = 9$.

Q. 37. Suppose $T(n) = 2T\frac{n}{2} + n,\ T(0) = T(1) = 1$. Which one of the following is FALSE?
(1) $T(n) = O(n^2)$ (2) $T(n) = \theta(n\ log\ n)$
(3) $T(n) = \omega(n^2)$ (4) $T(n) = O(n\ log\ n)$

Ans: 3

Q. 38. Let $G(V, E)$ be an undirected graph with positive edge weights. Dijkstra's single source shortest path algorithm can be implemented using the binary heap data structure with time complexity
(1) $O(|V|^2)$ (2) $O(\ |E| + |V|\ log\ |V|\ )$
(3) $O(|V|\ log\ |V|\ )$ (4) $O((\ |E| + |V|\ )\ log\ |V|\ )$

Ans: 4

Q. 39. Suppose there are $\lceil log\ n \rceil$ sorted lists of $\lfloor n/log\ n \rfloor$ elements each. The time complexity of producing a sorted list of all these elements is: (Use a heap data structure)
(1) $O(n\ log\ log\ n)$ (2) $\theta(n\ log\ n)$ (3) $\Omega(n\ log\ n)$ (4) $\Omega(n^{\frac{3}{2}})$

Ans: 2

Q. 40. Let $P, Q,$ and R be three atomic prepositional assertions. Let X denotes $(PvQ) \rightarrow R$ and Y denotes $(P \rightarrow Q)v(Q \rightarrow R)$. Which one of the following is a tautology?
(1) $X \equiv Y$ (2) $X \rightarrow Y$ (3) $Y \rightarrow X$ (4) $\neg Y \rightarrow X$

Ans: 2
$X \rightarrow Y$ is true for all combinations of input values. Hence it is tautology.

Q. 41. What is the first order predicate calculus statement equivalent to the following?
(1) $\forall(x)[\text{teacher}(x) \rightarrow \exists(y)[\text{student}(y) \rightarrow \text{likes}(y, x)]]$
(2) $\forall(x)[\text{teacher}(x) \rightarrow \exists(y)[\text{student}(y) \wedge \text{likes}(y, x)]]$
(3) $\exists(y)\forall(x)[\text{teacher}(x) \rightarrow [\text{student}(y) \wedge \text{likes}(y, x)]]$
(4) $\forall(x)[\text{teacher}(x) \wedge \exists(y)[\text{student}(y) \rightarrow \text{likes}(y, x)]]$

Ans: 2

Q. 42. Let R and S be any two equivalence relations on a non-empty set A. Which one of the following statements is TRUE?
(1) $R \cup S$, $R \cap S$ are both equivalence relations
(2) $R \cup S$ is an equivalence relation
(3) $R \cap S$ is an equivalence relation
(4) Neither $R \cup S$ nor $R \cap S$ is an equivalence relation

Ans: 3

Q. 43. Let $f : B \rightarrow C$ and $g : A \rightarrow B$ be two functions. Let $h = f\ o\ g$. Given that h is an onto function, which one of the following is TRUE?
(1) f and g both should be onto function
(2) f should be onto, but g need to be onto
(3) g should be onto, but f need not be onto
(4) both f and g need to be onto

Ans: 2

Q. 44. What is the minimum number of ordered pairs of non-negative numbers that should be chosen to ensure that there are two pairs (a, b) and (c, d) in the chosen set such that

$$a \equiv c \bmod 3 \text{ and } b \equiv d \bmod 5$$

(1) 4 (2) 6 (3) 16 (4) 24

Ans: 3

This can be solved using pigeonhole principle.

Q. 45. Consider three decision problems P_1, P_2 and P_3. It is known that P_1 is decidable and P_2 is undecidable. Which one of the following is TRUE?
(1) P_3 is decidable if P_1 is reducible to P_3
(2) P_3 is undecidable if P_3 is reducible to P_2
(3) P_3 is undecidable if P_2 is reducible to P_3
(4) P_3 is decidable if P_3 is reducible to P_2's complement

Ans: 3
To prove any decision problem to be undecidable, we need to take known undecidable problem and reduce it to the problem under consideration.

Q. 46. Consider the set H of all 3×3 matrices of the type

$$\begin{bmatrix} a & f & e \\ 0 & b & d \\ 0 & 0 & c \end{bmatrix}$$

where a, b, c, d, e, f are real numbers and $abc \neq 0$, under the matrix multiplication operation, the set H is
(1) a group
(2) a monoid but not a group
(3) a semi group but not a monoid
(4) neither a group nor a semigroup

Ans: 1

Q. 47. Which one the following graphs is NOT planar?
(1) G_1 (2) G_2 (3) G_3 (4) G_4

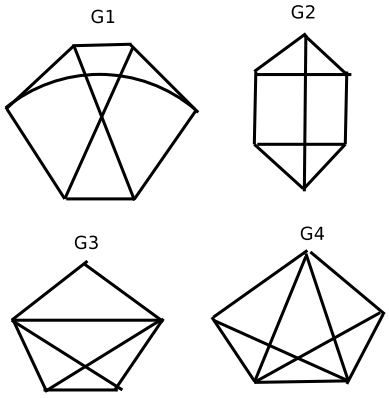


Figure 33: Figure for Q. 47

Ans: 1

Q. 48. Consider the following system of equations in three real variables x_1, x_2 and x_3.

$$\begin{aligned} 2x_1 - x_2 + 3x_3 &= 1 \\ 3x_1 + 2x_2 + 5x_3 &= 2 \\ -x_1 + 4x_2 + x_3 &= 3 \end{aligned}$$

The system of equation has

(1) no solution
(2) a unique solution
(3) more than one but a finite number of solutions
(4) an infinite number of solutions

Ans: 2
The question is similar to GateGenie Practice Test 1 Q. 35.

$$\begin{bmatrix} 2 & -1 & 3 & 1 \\ 3 & 2 & 5 & 2 \\ -1 & 4 & 1 & 3 \end{bmatrix}$$

To obtain x1 in the first equation, interchange the row 3 and 1:

$$\begin{bmatrix} -1 & 4 & 1 & 3 \\ 3 & 2 & 5 & 2 \\ 2 & -1 & 3 & 1 \end{bmatrix}$$

To eliminate $2x_1$ term in third equation, add 2 times row 1 to row 3

$$\begin{bmatrix} -1 & 4 & 1 & 3 \\ 3 & 2 & 5 & 2 \\ 0 & 7 & 5 & 7 \end{bmatrix}$$

To eliminate $3x_1$ term in third equation, add 3 times row 1 to row 2

$$\begin{bmatrix} -1 & 4 & 1 & 3 \\ 0 & 14 & 8 & 11 \\ 0 & 7 & 5 & 7 \end{bmatrix}$$

To remove $7x_2$ term in third equation, we add $(-1/2x_2)$ term in third equation. Add $-1/2$ time row 2 to row 3.

$$\begin{bmatrix} -1 & 4 & 1 & 3 \\ 0 & 14 & 8 & 11 \\ 0 & 0 & 1 & 3/2 \end{bmatrix}$$

If we bring back this augmented matrix in equation notation, it looks something like the following:

$$\begin{aligned} -x_1 + 4x_2 + x_3 &= 3 \\ 14x_2 + 8x_3 &= 11 \\ x_3 &= 3/2 \end{aligned}$$

Solving it, we get $x_1 = -50/28, x_2 = -1/14, x_3 = 3/2$.

Q. 49. What are the eigen values of the following 2×2 matrix?

$$\begin{bmatrix} 2 & -1 \\ -4 & 5 \end{bmatrix}$$

(1) -1 and 1 (2) 1 and 6 (3) 2 and 5 (4) 4 and -1

Ans: 2
The characteristic equation of matrix is

$$\begin{aligned} (A - \lambda I)x &= 0 && (1) \\ &= \begin{bmatrix} 2 & -1 \\ -4 & 5 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} && (2) \\ &= \begin{bmatrix} (2-\lambda) & -1 \\ -4 & (5-\lambda) \end{bmatrix} && (3) \\ 0 &= (2-\lambda)(5-\lambda) - (-4)(-1) && (4) \\ 0 &= \lambda^2 - 7\lambda + 6 && (5) \\ 0 &= (\lambda - 1)(\lambda - 6) && (6) \end{aligned}$$

which has roots 1 and 6, which are eigen values.

Q. 50. Let $G(x) = \frac{1}{(1-x)^2} = \sum_{i=0}^{\infty} g(i)x^i$, where $|x| < 1$. What is $g(i)$?
(1) i (2) $i+1$ (3) $2i$ (4) 2^i

Ans: 2
This is based on standard formula for summation of geometric series.

Q. 51. Box P has 2 red balls and 3 blue balls, box Q has 3 red balls and 1 blue ball. A ball is selected as follows: (i) select a box; (ii)choose a ball from selected box such that each ball in the box is equally likely to be chosen. The probabilities of selecting boxes P and Q are $\frac{1}{3}$ and $\frac{2}{3}$, respectively. Given that a ball is selected in the above process is a red ball, the probability that it came from the box P is:
(1) $\frac{4}{19}$ (2) $\frac{5}{19}$ (3) $\frac{2}{9}$ (4) $\frac{19}{30}$

Ans: 1
This problem can be solved using Bayes theorem. We have been asked to compute probability that the ball comes from box P when it is red. Thus, we need to compute Pr(ball from box P| ball is red). Let's denote ball from box P by P, ball from box Q by Q and ball is red by R. By Bayes theorem

$$\begin{aligned} Pr(P \mid R) &= \frac{Pr(R \mid P).Pr(P)}{Pr(R) = Pr(R \mid P).Pr(P) + Pr(R \mid Q).Pr(Q)} \\ &= \frac{2/5 \times 1/3}{2/5 \times 1/3 + 3/4 \times 2/3} = \frac{2/15}{19/30} = \frac{4}{19} \end{aligned}$$

Note here that the balls in each box are selected in equally likely fashion. It means that $Pr(R \mid P) = \frac{2}{5}$ and $Pr(R \mid Q) = \frac{3}{4}$.

Q. 52. A random bit string of length n is constructed by tossing a fair coin n times and setting a bit to 0 or 1 depending on outcomes head and tail, respectively. The probability that two such randomly generated strings are not identical is:
(1) $\frac{1}{2^n}$ (2) $1 - \frac{1}{n}$ (3) $\frac{1}{n!}$ (4) $1 - \frac{1}{2^n}$

Ans: 4
Let's assume that p_i is probability of getting head or tail in each toss. $p_i = \frac{1}{2}$. If the two n-bit strings are identical, then the probability of generating them will be,

$$\begin{aligned} Pr(n\text{-bit string are identical}) &= \prod_{i=1}^{n} p_i = \prod_{i=1}^{n} \frac{1}{2} = \frac{1}{2^n} \\ Pr(n\text{-bit string are not identical}) &= 1 - Pr(n\text{-bit string are identical}) \\ &= 1 - \frac{1}{2^n} \end{aligned}$$

Q. 53. Consider the machine M:
The language generated by M is:

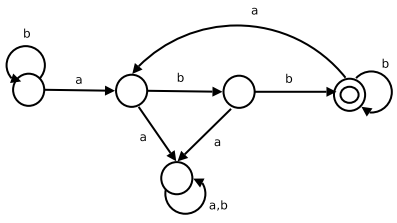


Figure 34: Figure for Q. 53

(1) $\{w \in \{a,b\}* \mid$ every a in w is followed by exactly two $b's\}$
(2) $\{w \in \{a,b\}* \mid$ every a in w is followed by at least two $b's\}$
(3) $\{w \in \{a,b\}* \mid w$ contains substring $abb\}$
(4) $\{w \in \{a,b\}* \mid w$ does not contain 'aa' as substring$\}$

Ans: 2
Here, options (2), (3) and (4) represent language generated by the given DFA. The regular expression corresponding to the strings accepted by the DFA is $b*(abb^+)*$. Here every a is followed by at least two b's, w contains substring abb and w does not contain aa as substring.

Q. 54. Let N_f and N_p denote classes of languages accepted by non-deterministic finite automata and non-deterministic push down automata, respectively. Let D_f and D_p denote classes of language accepted by deterministic finite automata and deterministic push down automata respectively. Which one of the following is TRUE?
(1) $D_f \subset N_f$ and $D_p \subset N_p$ (2) $D_f \subset N_f$ and $D_p = N_p$
(3) $D_f = N_f$ and $D_p = N_p$ (4) $D_f = N_f$ and $D_p \subset N_p$

Ans: 4
The answer is based on standard lemmas. Refer Hopcroft-Ullman **Introduction to Automata Theory, Languages and Computation**.

Q. 55. Consider the languages:

$$L_1 = \{a^n b^n c^m \mid n, m > 0\}$$
$$L_2 = \{a^n b^m c^m \mid n, m > 0\}$$

Which one the following statement is FALSE?
(1) $L_1 \cap L_2$ is a context-free language
(2) $L_1 \cup L_2$ is a context-free language
(3) L_1 and L_2 are context-free languages
(4) $L_1 \cap L_2$ is a context-sensitive language

Ans: 1
Note here that L_1 and L_2 are context-free languages. The class of context free languages are not closed under intersection. Hence, the statement "$L_1 \cap L_2$ is a context-free language" is false.

Q. 56. Let L_1 be recursive language, and L_2 be a recursively enumerable but not a recursive language. Which one of the following is TRUE?
(1) $\overline{L_1}$ is recursive and $\overline{L_2}$ is recursively enumerable
(2) $\overline{L_1}$ is recursive and $\overline{L_2}$ is not recursively enumerable
(3) $\overline{L_1}$ and $\overline{L_2}$ are recursively enumerable
(4) $\overline{L_1}$ is recursively enumerable and $\overline{L_2}$ is recursive

Ans: 2
The answer is based on standard lemmas. Refer Hopcroft-Ullman **Introduction to Automata Theory, Languages and Computation**.

Q. 57. Consider the languages:

$$\begin{aligned} L_1 &= \{ww^R \mid w \in \{0,1\}*\} \\ L_2 &= \{w\#w^R \mid w \in \{0,1\}*\}, \# \text{ is a special symbol} \\ L_3 &= \{ww \mid w \in \{0,1\}*\} \end{aligned}$$

Which one of the following is TRUE?
(1) L_1 is deterministic CFL (2) L_2 is deterministic CFL
(3) L_3 is a CFL, but not deterministic CFL (4) L_3 is deterministic CFL

Ans: 2

1. $L_1 = \{ww^R \mid w \in \{0,1\}*\}$ is non-deterministic CFL. We need an ϵ transition to switch from w and w^R.
2. $L_2 = \{w\#w^R \mid w \in \{0,1\}*\}$ is a deterministic CFL. Here, # provides indication of switching from w and w^R.

3. $L_3 = \{ww \mid w \in \{0,1\}*\}$ is not CFL.

Q. 58. Consider the following two problems on directed graph:
α: Given $G(V, E)$, does G have an independent set of size $|V| - 4$?
β: Given $G(V, E)$, does G have an independent set of size 5?
(1) α is in P and β is NP-complete (2) α is NP-complete and β is in P
(3) Both α and β are NP-complete (4) Both α and β are in P

Ans: 3
Q. 59. Consider the grammar:

$$E \rightarrow E + n \mid E \times n \mid n$$

For a sentence $n + n \times n$, the handle in the right sentential form of the reduction are:
(1) $n, E + n$ and $E + n \times n$ (2) $n, E + n$ and $E + E \times n$
(3) $n, n + n$ and $n + n \times n$ (4) $n, E + n$ and $E \times n$

Ans: 4

Right Sentential Form	Handle	Reducing Production
$n + n \times n$	n	$E \rightarrow n$
$E + n \times n$	$E + n$	$E \rightarrow E + n$
$E \times n$	$E \times n$	$E \rightarrow E \times n$
E		

Q. 60. Consider the grammar

$$S \rightarrow (S) \mid a$$

Let the number of states in SLR(1), LR(1) and LALR(1) parsers for the grammar be n_1, n_2 and n_3 respectively. The following relationship holds good:
(1) $n_1 < n_2 < n_3$ (2) $n_1 = n_3 < n_2$
(3) $n_1 = n_2 = n_3$ (4) $n_1 \geq n_3 \geq n_2$

Ans: 3
The answer can be verified by constructing SLR(1), LR(1) and LALR(1) parsers.

Q. 61. Consider the line number 3 of the following program.

```
int min ( ) {                /* Line 1 */
    int I, N;                /* Line 2 */
    fro (I=0, I<N, I++);      /* Line 3 */
}
```

Identify the compiler's response about this line while creating the object-module?
(1) No compilation error (2) Only a lexical error
(3) Only syntactic error (4) Both lexical and syntactic errors

Ans: 3
The errors such as `fro` and `,` instead of `;` in for construct are syntactic errors.

Q. 62. Consider the following circuit involving a positive edge triggered D FF.
Consider the following timing diagram. Let A_i represent the logic level on the line in the ith clock

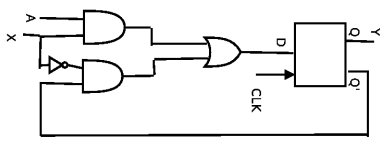


Figure 35: Figure for Q. 62

period.

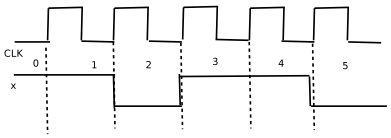


Figure 36: Figure for Q. 62

Let A_i represent the complement of A. The correct output sequence on Y over the clock periods 1 through 5 is:

(1) $A_0\ A_1\ A_1'\ A_3\ A_4$ (2) $A_0\ A_1\ A_2'\ A_3\ A_4$
(3) $A_1\ A_2\ A_2'\ A_3\ A_4$ (4) $A_1\ A_2'\ A_3\ A_4\ A_5'$

Ans: 1

Q. 63. The following diagram represent a finite state machine which takes as input as binary number from least significant bit.
Which one of the following is TRUE?

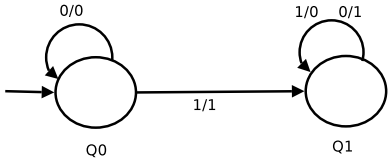


Figure 37: Figure for Q. 63

(1) It computes 1's complement of the input number
(2) It computes 2's complement of the input number
(3) It increments the input number
(4) It decrements the input number

Ans: 2
The FSM keeps 0 and 1 unchanged till the first occurrence of 1 and then changes each 0 to 1 and 1 to 0. Thus, it computes 2's complement of the input number. It is a trick to compute 2's complement of the input number quickly.

Q. 64. Consider the following circuit
The flip flops are positive edge triggered D FFs. Each state is designated as a two bit string Q_0Q_1. Let

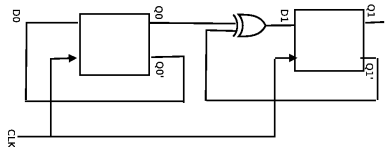


Figure 38: Figure for Q. 64

the initial state be 00, the state transition sequence is

1. 00 -> 11 -> 01
   ^ |
   | |
   ----

2. 00 -> 11
   ^ |

```
        |    |
         ----

3.    00 -> 10 -> 01 -> 11
       ^                 |
       |                 |
        -----------------

4.    00 -> 11 -> 01 -> 10
       ^                  |
       |                  |
        ------------------
```

Q. 65. Consider a three word machine instruction:
`ADD A[R0], @B`
The first operand(destination) `A[R0]` uses indexed addressing mode with `R0` as the index register. The second operand (source), `@B` uses indirect addressing mode. `A` and `B` are memory addresses residing at the second and third words respectively. The first word of the instruction specifies the opcode, the index register destination, and source and destination addressing modes. During execution of `ADD` instruction, the two operands are added and stored in the destination (first operand).

The number of memory cycles needed during the execution cycle of the instruction is:
(1) 3 (2) 4 (3) 5 (4) 6

Ans: 4

Operation	No. of Memory Cycles
Fetch instruction `ADD A[R0], @B`	3
Fetch source `A[R0]`	1
Fetch destination `@B`	1
Store result at `A[R0]`	1
Total memory cyles	**6**

Q. 66. Match each of the high level language statements given on the left hand side with the most natural addressing mode from those listed on the right hand side.

```
(1) A[I] = B[J];     (a) Indirect addressing
(2) while(*A++);     (b) Indexed addressing
(3) int temp = *x;   (c) Auto increment
```

(1) `(1,c), (2,b), (3,a)` (2) `(1,a), (2,c), (3,b)`
(3) `(1,b), (2,c), (3,a)` (4) `(1,a), (2,b), (3,c)`

Ans: 3

Q. 67. Consider a direct mapped cache of size 32 KB with block size 32 bytes. The CPU generates 32 bit addresses. The number of bits needed for cache indexing and the number of tag bits are respectively
(1) 10,17 (2) 10,22 (3) 15,17 (4) 5,17

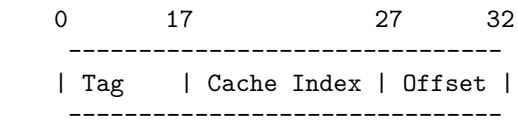
Ans: 1
We are given that the CPU generates 32 bit address.

```
0                              32
 -------------------------------
| Tag    | Cache Index | Offset |
 -------------------------------
```

The number of pages in cache = $\frac{32\ KB}{32\ byte} = \frac{2^{15}}{2^5} = 2^{10}$. It means that we need 10 bits to address the pages in cache, which is number of bits required for cache indexing.

We need 5 bits to address location in cache in the block size of 32 bytes.

The number of bits in CPU address = no. of tag bits + number of bits in cache index + no. of bits in offset
no. of tag bits = 32 - 10 - 5 = 17



Q. 68. A 5-stage pipelined CPU has the following sequence of stages:

1. IF- instruction fetch from instruction memory
2. RD- instruction decode and register read
3. EX- execute ALU operations for data and address computation
4. MA- data memory access, for write access, the register read at RD state is used
5. WB- Register write back

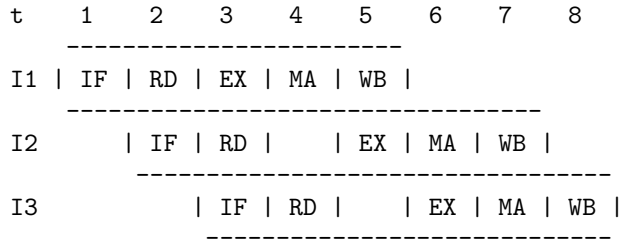
Consider the following sequence of instructions:

$$I_1 : \ L\ R0,\ loc\ 1;\ R0 \Leftarrow M[loc1]$$
$$I_2 : \ A\ R0,\ R0\ 1;\ R0 \Leftarrow R0 + R0$$
$$I_3 : \ S\ R2,\ R0\ 1;\ R2 \Leftarrow R2 - R0$$

Let each stage take one clock cycle. What is the number of clock cycles taken to complete the above sequence of instructions starting from the fetch of I_1?
(1) 8 (2) 10 (3) 12 (4) 15

Ans: 1
The examination of instructions reveals that we have dependency between each instruction. The $R0$ computed in I_1 is used in I_2, causing read after write(RAW) hazard. The RAW hazard is also caused in I_3 which uses R_0 from I_2. The RAW hazard can be eliminated using forwarding technique, which minimizes stalls due to RAW hazard.

The first instruction will need 5 memory cyles. I_1 loads $R0$ with the data in memory location `loc`. The $R0$ can be forwarded to I_2 after `MA` stage, since the value is loaded in $R0$ after `MA` stage. In I_2, the value of R_0 is available after `EX` stage and can be forwarded to I_3 after `EX` stage of I_2. The pipeline is depicted in the figure below. We require a total of 8 cycles.



Q. 69. A device with data transfer rate 10 KB/sec is connected to a CPU. Data is transferred byte-wise. Let the interrupt overhead be 4 μsec. The byte transfer time between the device interfaces register and CPU or memory is negligible. What is the minimum performance gain of operating the device under interrupt mode over operating it under program controlled mode?
(1) 15 (2) 25 (3) 35 (4) 45

Q. 70. Consider a disk drive with the following specifications: 16 surfaces, 512 tracks/surface, 512 sectors/track, 1 KB/sector, rotation speed 3000 rpm. The disk is operated in cycle stealing mode whereby whenever one 4 byte word is ready it is sent to memory; similarly, for writing, the disk interface reads a 4 byte word from the memory in each DMA cycle. Memory cycle time is 40 nsec. The maximum percentage of time that the CPU gets blocked during DMA operation is
(1) 10 (2) 25 (3) 40 (4) 50

Ans: 2

Q. 71. Suppose n processes $P_1, \ldots, P_n$, share m identical resource units , which can be reserved and released one at a time. The maximum resource requirement of process P_i is s_i, where $s_i > 0$. Which one of the following is a sufficient condition for ensuring that deadlock does not occur?
(1) $\forall i, s_i < m$ (2) $\forall i, s_i < n$
(3) $\Sigma_{i=1}^{n} s_i < (m + n)$ (4) $\Sigma_{i=1}^{n} s_i < (m * n)$

Ans: 3
The total number of units occupied = m. Since, each P_i can request one resource unit at a time, thus, we get maximum of n more request for the resource unit. Thus, we can support less than $m + n$ sum total of maximum requirement $\Sigma_{i=1}^{n} s_i$ without deadlock.

Q. 72. Consider the following code fragment:

```
if ( fork() == 0 )
    { a = a + 5; printf( "%d,%d\n", a, &a); }
else { a = a - 5; printf( "%d,%d\n", a, &a); }
```

Let u and v be the values printed by the parent process, and x, y be the values printed by the child process. Which one of the following is TRUE?
(1) $u = x + 10$ and $v = y$ (2) $u = x + 10$ and $v \neq y$
(3) $u + 10 = x$ and $v = y$ (4) $u + 10 = x$ and $v \neq y$

Ans: 4
The child and parent processes have different address space, so $v \neq y$.

Q. 73. In a packet switching network, packets are routed from source to destination along the single path having two intermediate nodes. If the message size is 24 bytes and each packet contains header of 3 bytes, then the optimum packet size is
(1) 4 (2) 6 (3) 7 (4) 9

Q. 74. Suppose the round trip propagation delay for a 10 Mbps Ethernet having 48-bit jamming signal is 46.4 μs. The minimum frame size is
(1) 94 (2) 416 (3) 464 (4) 512

Q. 75. Let E_1 and E_2 be two entities in an E/R diagram with simple single-valued attributes. R_1 and R_2 are relationship between E_1 and E_2, where R_1 is one-to-many and R_2 is many-to-many. R_1 and R_2 do not have any attributes of their own. What is minimum number of tables required to represent this situation in the relational model?
(1) 2 (2) 3 (3) 4 (4) 5

Ans: 3
We require two tables, one each for for modelling E_1 and E_2. Two more tables will be required for

modelling R_1 and R_2. Thus, we need in all four tables.

Q. 76. The following table has two attributes `A` and `C`, where `A` is the primary key and `C` is the foreign key referencing with on-delete cascade.

A	C
2	4
3	4
4	3
5	2
7	2
9	5
6	4

The set of all tuples that must be additionally deleted to preserve referential integrity when a tuple (2,4) is deleted is

(1) (3,4) and (6,4) (2) (5,2) and (7,2)
(3) (5,2), (7,2), and (9,5) (4) (3,4), (4,3), and (6,4)

Ans: 3
Since we are deleting `2`, we should delete all tuples which are referencing to `2` such as `(5,2), (7,2)`. Additionally, we need to delete `(9,5)` to satisfy delete cascade following deletion of `5`.

Q. 77. The relation **book**(title, price) contains the titles and prices of different books. Assuming that no two books have the same price, what does the following SQL query list?

```
select title from Book B where (select count(*) from book as T where T.price > B.price)
< 5
```

(1) Titles of the four most expensive books
(2) Title of the fifth most inexpensive book
(3) Title of the fifth most expensive book
(4) Titles of the five most expensive books

Ans: 1
The sub-query `select count(*) from book as T where T.price > B.price` arranges the books in descending order of expensiveness. The most expensive book will be ranked first and so on. The query returns first four such most expensive books.

Q. 78. Consider a relation schema $R = (A, B, C, D, E, H)$ on which the following functional dependencies hold:
$\{A \rightarrow B, BC \rightarrow D, E \rightarrow C, D \rightarrow A\}$
What are the candidate keys for R?

(1) AE, BE (2) AE, BE, DE
(3) AEH, BEH, BCH (4) AEH, BEH, DEH

Ans: 4

Common data for questions 79 and 80:
Consider the following data path of a CPU.
The ALU, the bus and all the registers in the data path are of identical size. All operations including incrementation of the PC and the GPCRs are to be carried out in the ALU. Two clock cycles are needed for memory read operation - the first one for loading address in the MAR and the next one for loading data from memory bus into MDR.

Q. 79. The instruction `ADD R0 R1` has the register transfer interpretations $R0 \Leftarrow R0 + R1$. The minimum number of clock cycles needed for execution cycle of this instruction is

(1) 2 (2) 3 (3) 4 (4) 5

Ans: 2

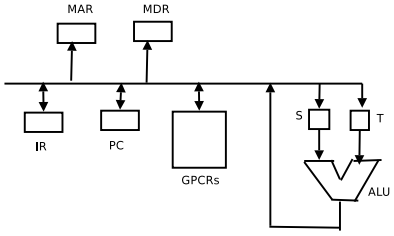


Figure 39: Figure for Q. 79-80

Operation	No. of clock Cycles
Loading instruction	1
Transfer $R0 \rightarrow s$ and $R1 \rightarrow t$	1
Addition and storage to R0	1
Total clock cyles	**3**

Q. 80. The instruction `call Rn, sub` is a two word instruction. Assuming that the PC is incremented during the fetch cycle of the first word of the instruction, its register transfer interpretation is

$$\begin{aligned} Rn &\Leftarrow PC + 1; \\ PC &\Leftarrow M[PC]; \end{aligned}$$

The minimum number of CPU cycles needed during the execution cycle of this instruction is
(1) 2 (2) 3 (3) 4 (4) 5

Ans: 4

Operation	No. of clock Cycles
Reading instruction and PC increment	2
Memory read $M[PC]$	2
Transferring $M[PC]$ to PC	1
Total clock cyles	**5**

Linked Answer Questions: Q. 81a to Q. 85b carry two marks each
Statement for Linked Answer Questions 81a and 81b
Consider the following C-function:

```
double foo (int n){
    int i;
    double sum;
    if (n==0) return 1.0;
    else  {
      sum = 0.0;
      for (i=0; i<n; i++)
         sum += foo(i);
      return sum;
    }
}
```

Q. 81a. The space complexity of the above function is:
(1) $O(1)$ (2) $O(n)$ (3) $O(n!)$ (4) $O(n^n)$

Ans: 2

Q. 81b. Suppose we modify the above function `foo()` and store values of `foo(i), 0 <= I < n` as and when they are computed. With this modification, the time complexity for function `foo()` is significantly reduced. The space complexity of modified function would be:
(1) $O(1)$ (2) $O(n)$ (3) $O(n^2)$ (4) $O(n!)$

Ans: 2

Statement for Linked Answer Questions 82a and 82b
Let s and t be two vertices in an undirected graph $G = (V, E)$ having distinct positive edge weights. Let $[x, y]$ be the partition of V such that $s \in X$ and $t \in Y$. Consider the edge e having minimum weight amongst all those edges that have one vertex in X and one vertex in Y.
Q. 82a. The edge e must definitely belong to
(1) the minimum weighted spanning tree of G
(2) the weighted shortest path from s to t
(3) each path from s to t
(4) the weighted longest path from s to t

Ans: 1

Q. 82b. Let the weight of an edge e denote the congestion on that edge. The congestion on a path is defined to be the maximum of the congestion on the edges of the path. We wish to find the path from s to t having minimum congestion. Which one of the following paths is always such a path of minimum congestion?
(1) a path from s to t in the minimum weighted spanning tree
(2) a weighted shortest path from s to t
(3) an Euler walk from s to t
(4) a Hamiltonian path from s to t

Ans: 2

Statement for Linked Answer Questions 83a and 83b
Consider the following expression grammar. The semantic rules for expression evaluation are stated next to each grammar production.

$$\begin{aligned} E \rightarrow \text{number} \quad & E.val = number.val \\ |E' +' E \quad & E^{(1)}.val = E^{(2)}.val + E^{(3)}.val \\ |E' \times' E \quad & E^{(1)}.val = E^{(2)}.val \times E^{(3)}.val \end{aligned}$$

Q. 83a. The above grammar and the semantic rules are fed to `yacc` tool (which is an LALR(1) parser generator) for parsing and evaluating arithmetic expressions. Which one of the following is true about the action of `yacc` for the given grammar?
(1) It detects recursion and eliminates recursion
(2) It detects *s*hift-reduce conflict, and resolves
(3) It detects *s*hift-reduce conflict, and resolves the conflict in favor of a *s*hift over a *r*educe action
(4) It detects *s*hift-reduce conflict, and resolves the conflict in favor of a *r*educe over a *s*hift action

Ans: 3
Refer to description of `yacc` tool in **Compilers: Principles, Techniques and Tools** by *Aho, Sethi, Ullman*.

Q. 83b. Assume the conflicts in the part(a) of this question are resolved and an LALR(1) parser is generated for parsing arithmetic expressions as per given grammar. Consider an expression `3 x 2 +`

1. What precedence and associativity properties does the generated parser realize?
(1) Equal precedence and left associativity, expression is evaluated to 7
(2) Equal precedence and right associativity, expression is evaluated to 9
(3) Precedence of 'x' is higher than that if '+', both operators are left associative; expression is evaluated to 7
(4) Precedence of '+' is higher than that of 'x', both operators are left associative; expression is evaluated to 9

Ans: 2

Statement for Linked Answer Questions 84a and 84b
We are given 9 tasks $T_1, T_2, \ldots, T_9$. The execution of each task requires one unit of time. We can execute one task at a time. Each task T_i has a profit P_i and a deadline d_i. Profit P_i is earned if the task is completed before the end of the d_i^{th} unit of time.

Task	T1	T2	T3	T4	T5	T6	T7	T8	T9
Profit	15	20	30	18	18	10	23	16	25
Deadline	7	2	5	3	4	5	2	7	3

Q. 84a. Are all tasks completed in the schedule that gives maximum profit?
(1) All tasks are completed (2) T1 and T6 are left out
(3) T1 and T8 are left out (4) T4 and T6 are left out

Ans: 4
The problem can be solved as 0-1 Knapsack problem and find the tasks, which when scheduled earn maximum profit. Arranging the tasks by in ascending order of deadline and within that descending order of profit:

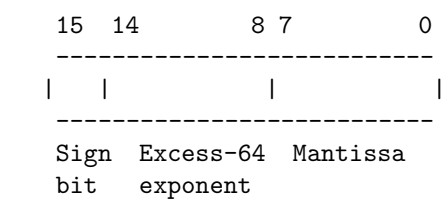
Task	T7	T2	T9	T4	T5	T3	T6	T8	T1
Profit	23	20	25	18	18	30	10	16	15
Deadline	2	2	3	3	4	5	5	7	7

Each task takes unit time. Thus, we could able to complete `T7, T2, T9, T5, T3, T8, T1`. The tasks `T4` and `T6` are left out as they can not meet deadline.

Q. 84b. What is the maximum profit earned?
(1) 147 (2) 165 (3) 167 (4) 175

Ans: 1
The total profit = $23 + 20 + 25 + 18 + 30 + 16 + 15 = 147$

Statement for Linked Answer Questions 85a and 85b
Consider the following floating point format.



Mantissa is a pure fraction in sign-magnitude form.
Q. 85a. The decimal number 0.239×2^{13} has the following hexadecimal representation (without normalization and rounding off):
(1) 0D 24 (2) 0D 4D (3) 4D 0D (4) 4D 3D

Ans: 4

$$(-1)^s \times 2^{E-64} \times \text{Mantissa}$$

Since the number 0.239×2^{13} is positive, sign bit is 0. Since we have 2^{13}, E is 77 i.e. $(1001101)_2$. Mantissa is binary form of 0.239.

$$\begin{aligned} 0.239 \times 2 &= 0.4780 \\ 0.478 \times 2 &= 0.9560 \\ 0.956 \times 2 &= 1.9121 \\ 0.912 \times 2 &= 1.8241 \\ 0.824 \times 2 &= 1.6481 \\ 0.648 \times 2 &= 1.2961 \\ 0.296 \times 2 &= 0.5920 \\ 0.592 \times 2 &= 1.1841 \end{aligned}$$

Thus, we get

```
15 14     8 7       0
  ------------------
 |0|1001101|00111101|  = 4D 3D
  ------------------
```

Q. 85b. The normalized representation for the above format is specified as follows: The mantissa has an implicit 1 preceding the binary(radix) point. Assume that only 0's are padded in while shifting a field. The normalized representation of the above number (0.239×2^{13}) is
(1) OA 20 (2) 11 34 (3) 49 D0 (4) 4A E8

Ans: 4
The normalized representation is given as

$$(-1)^s \times (1 + \text{significant}) \times 2^{E-64}$$

We get, $00111101 \times 2^{13} = 1.11101 \times 2^{10}$

$$(-1)^0 \times (1 + 0.11101000) \times 2^{(74-64)}$$

Thus, we get,

```
15 14     8 7       0
  ------------------
 |0|1001010|11101000|  = 4A E8
  ------------------
```

Answers GateGenie Practice Test No. 1

Answers: Test No. 1

Q. 01 *Maths-Probability*
Ans: 1
According to the definition of conditional probability and assuming that $Pr(C) > 0$ and $Pr(D) > 0$,

$$\frac{Pr(C|D)}{Pr(D|C} = \frac{Pr(C \cap D)/Pr(D)}{Pr(C \cap D)/Pr(C)} = \frac{Pr(C)}{Pr(D)} = \frac{0.2}{0.06}$$

Thus, $Pr(C) = 0.2$ and $Pr(D) = 0.06$ i.e 1

Q. 02 *Maths-Probability*
Ans: 3

Q. 03 *Maths-Relation*
Ans: 1
Suppose $A = \{a, b\}$ and $B = \{1, 2\}$, the set $B \times A$ will contain

$$\{(1, a), (1, b), (2, 1), (2, b)\}$$

However if either of the set in relation, for instance, A or B in $B \times A$, is $\{\}$ or ϕ i.e it doesn't contain any element, the relation is also an empty set i.e. $\{\}$.

Thus, $B \times A = \{\} = \phi$ i.e. 1

Q. 04 *Maths-Derivatives/Integration*
Ans: 1

Q. 05 *Hardware*
Ans: 2
Get binary representation for $-45 = 10101101$ The quick trick to get 2's complement:

1. Scan the number from right to left i.e. from LSB to MSB.
2. Retain all the zeroes until we encounter 1. Keep that 1 unchanged.
3. After that change 1 to 0 and 0 to 1 till the left end except the sign bit.

Here, we have 1010 1101

1. We start from rightmost 1, keep it unchanged: 1010 110**1**
2. Change the 0 to 1: 1010 11**0**1 becomes 1010 11**1**1. Repeat the cycle till the MSB bit.
3. Since the first bit is a sign bit, keep it unchanged.

Thus, the 2's complement is 1101 0011 i.e. 2

Q. 06 *Hardware*
Ans: 2

Q. 07 *Hardware*
Ans: 2

Q. 08 *Hardware*
Ans: 3

Q. 09 *Theory of Computation*
Ans: 4

1. rs^* represents strings starting with r and having zero or more s. The string rss^* starts with r but it contains one or more s. These are not equivalent.
2. $(r * s*)$ contains strings like $\epsilon, r, s, rs, rr, ss, rss, rrss, \ldots$. However the grammar, $(r + s)^*$ doesn't ensure that the string starts with only r. The example strings are $r, s, rrss, ssrr$ etc.
3. Not all strings in $(r+s)^*$ are present in $r^* + s^*$. Refer comment for option (2) for more explanation. The $r^* + s^*$ contains strings containing either r's or s's.
4. The correct answer is 4. The identity is a standard result. $(0 + 1)^* = (1^*0^*)^*$

Q. 10 *Theory of Computation*
Ans: 2
It follows from the closure properties of regular set. $L1 \cap L2$ is also regular.

Q. 11 *Theory of Computation*
Ans: 1
It is possible to have a subset of regular language which is not regular or a subset of CFL which is not CFL. For example,

1. $L = \{0^*1^*\}$ is a regular language. Let $L_s = \{o^n 1^n\}$. $L_s \subseteq L$. Clearly L_s is not regular.
2. $L_c = \{0^i 1^i o^j 1^j | i, j \geq 0\}$ is CFL. $L_{cs} = \{0^i 1^i o^j | j \geq i\}$. $L_{cs} \subseteq L$. $L_c s$ is not CFL.

Hence I and II are incorrect.

Q. 12 *Data Structure*
Ans: 3

Q. 13 *Data Structure*
Ans: 3

Q. 14 *Data Structure*
Ans: 3

Q. 15 *Data Structure*
Ans: 3

Q. 16 *Data Structure*
Ans: 2
Complete binary tree with 16 nodes will have 15 leaf nodes. Only root has no parent and hence no incoming edge also. Hence, no. of edges = 16 + 14 = 30 OR by summing number of edges at each level, 16 + 8 + 4 + 2 = 30.

Q. 17 *Data Structure*
Ans: 3

Q. 18 *Compilers*
Ans: 2
Remember the functions of various phases of compilers:

Lexical Analyzer: Token formation and entry into Symbol table

Semantic Analysis: The source program is checked for semantic errors. The type information gathering and checking is also done in semantic analysis phase.

Code generation phase prepares machine level code for the source program.

The type checking is carried out in semantic analysis. i.e. 2.

Q. 19 *Compilers*
Ans: 3
Given a regular expression r and input string x, we can use DFA to determine if x is a string of $L(r)$. In order to construct DFA from regular expression, we use Thompson's construction on r and then subset construction. *Refer Compilers: Principles, Techniques and Tools by Aho, Sethi and Ullaman for details about Thompson's construction and subset construction.*

To simulate the DFA on input x, it requires time proportional to the length of x, and the time is independent of the number of states in the DFA. It requires maximum $2^{|r|}$ states to keep track of all possible sequences. $|r|$ is the length of regular expression. Thus, **the space complexity is** $O(2^{|r|})$ **and the time complexity is** $O(|x|)$ **i.e. 3**. Note that the space and time complexity for NFA is $O(r)$ and time complexity $O(|r| \times |x|)$ respectively.

Q. 20 *Compilers*
Ans: 2
The left recursive grammar causes recursive-descent parser to go into infinite loop. For example, the following is a left recursive grammar:

$$S \rightarrow SS|a$$

At each step, the recursive-descent parser, which is a top down parser, looks to expand a non-terminal using one of its productions. The left recursive grammar has the following form of productions:

$$A \rightarrow Ab$$

As a result, when it tries to expand A, it again gets A and the cycle continues leading to an infinite loop. The recursive-descent parser needs $LL(1)$ grammar, which doesn't contain left recursion and left factors. However, the recursive-descent parser is able to handle right-recursive grammars.

Q. 21 *Operating Systems-Processes*
Ans: 2
Consider the statements:

1. The mail program runs as different processes for each user, so there is no question of sharing program counter and stack. This statement is false.
2. Although the same program is associated with different processes, it is nevertheless considered as different execution sequences. This statement is correct.
3. The statement two is actually implied by statement 3. This statement is also correct.

The false statement is I i.e. 2

Q. 22 *Operating Systems*
Ans: 3
Suppose at any instance, all 4 processes are holding 1 tape drive each as follows

	Hold	Need	Available
P_1	1	1	2
P_2	1	1	
P_3	1	1	
P_4	1	1	

The two tape drives can be allocated to P_1, which will finish execution and gives its drives back to available pool, so that the other processes will get access to tapes. Any execution sequence will lead to

safe state here. **The system with 4 processes ensures dead-lock free environment i.e 3.**

Q. 23 *Operating Systems-Memory management*
Ans: 1
The logical address looks as follows:

Page Number m-n bits	Offset n bits	

The size of the page, which is also equal to frame size is defined by hardware. If the logical address is m bit long, we have n bits for offset and higher order $m - n$ bits for pages.

1. We have in all 8 pages. To store info. about 8 pages we require 3 bits. This means page number needs 3 bits.
2. To address 1024 ($= 2^{10}$) words in each page, we need 10 bits, since $2^{10} = 1024$. Thus, the offset need 10 bits.

The total address size = number of bits for page index + number of bits for offset = 10 + 3 = 13 bits i.e. 1.

Q. 24 *Compilers*
Ans: 1

1. L_1 generates strings having equal number of 1's and 0's not containing 10 substring. For example, $01, 0011, 000111, \ldots$
2. L_2 generates strings having same number of 1's and 0's and does not have 10 substring. For example, $01, 0011, 000111, \ldots$
3. L_3 generates either 01 or language which doesn't guarantee equal number of 1s and 0s. The string generated by L3 are,
   $01, 00011, 00111, 000111, 0011, etc.$

L_1 and L_2 are equivalent.

Q. 25 *Data Structure*
Ans: 3

Q. 26 *Operating Systems*
Ans: 2

Q. 27 *Databases*
Ans: 2

Q. 28 *Databases*
Ans: 3

Q. 29 *CN*
Ans: 1

Q. 30 *CN*
Ans: 4

Q. 31 *Databases-Concurrency/Transaction*
Ans: 3

1. `distinct` key work is used to remove duplicates. Hence no automatic removal of duplicates

2. Trivially wrong. No need of index to execute a query.

3. Same name can not be repeated in the same relation.

Hence the answer 3 is correct.

Q. 32 *Databases*
Ans: 3
Consider a case of 4 relations A, B, C, and D.

- For $A \times B$, cost is 10 with 10 rows and C is say 100 rows then if $(A \times B) \times C$ is 1000 rows with some additional cost of joining.
- What if $C \times D$ is 10 rows, then $(A \times B) \times (C \times D)$ is 100 rows and the cost will also be low as finally we are just joining 10×10 relation.

Q. 33 *Maths-Probability*
Ans: 4
The problem can be tackled with **Pigeon Hole Principle**. It states that

If you put $n + 1$ pigeons in n holes then at least one hole would have more than one pigeon.

Consider 4 different colors as 4 holes, now we want to find out the minimum number of pencils such that at least one whole contains more than 4 pencils. If we start with 4 holes-`red, blue, green, yellow`.

- Start putting a red, blue, green and yellow pencil in respective hole. Now each hole has exactly one pencil.
- If we repeat this again, then each hole will contain exactly 2 pencils.
- Repeat the same third times to have exactly 3 pencils in each hole.
- Now if we select a random pencil and put in a hole, at least one hole will hold 4 pencils, which is what we desire.

The total number of pencils selected = 4 + 4 + 4 + 1 = 13 i.e. 4

Q. 34 *Maths-Relation*
Ans: 4
One could see from the matrix for R that

- All entries in the diagonal are not 1, hence the matrix is *n*ot reflexive.
- All entries in the diagonal are not 0, hence the relation is also *n*ot irreflexive.

The relation is transitive since

$$(2,3),(3,1) \Rightarrow (2,1)$$
$$(3,2),(2,3) \Rightarrow (3,3)$$
$$(2,3),(3,2) \Rightarrow (2,2)$$

The answer is that the relation is **neither reflexive nor irreflexive but transitive** i.e. D.

Q. 35 *Maths-Linear Algebra*
Ans: 3
A linear system is consistent if it has one or infinitely many solutions. Lets solve the problem to determine if the system has one or infinitely more or no solution. The augmented matrix corresponding to the system is:

$$\begin{bmatrix} 0 & 1 & -4 & 8 \\ 2 & -3 & 2 & 1 \\ 5 & -8 & 7 & 1 \end{bmatrix}$$

To obtain x1 in the first equation, interchange the row 1 and 2:

$$\begin{bmatrix} 2 & -3 & 2 & 1 \\ 0 & 1 & -4 & 8 \\ 5 & -8 & 7 & 1 \end{bmatrix}$$

To eliminate $5x_1$ term in third equation, add -5/2 times row 1 to row 3

$$\begin{bmatrix} 2 & -3 & 2 & 1 \\ 0 & 1 & -4 & 8 \\ 0 & -1/2 & 2 & -3/2 \end{bmatrix}$$

Use the x_2 term to eliminate the (-1/2 x_2) term in third equation. Add 1/2 time row 2 to row 3

$$\begin{bmatrix} 2 & -3 & 2 & 1 \\ 0 & 1 & -4 & 8 \\ 0 & 0 & 0 & 5/2 \end{bmatrix}$$

If we bring back this augmented matrix in equation notation, it looks something like the following:

$$\begin{aligned} 2x_1 - 3x_2 + 2x_3 &= 1 \\ x_2 - 4x_3 &= 8 \\ 0 &= 5/2 \end{aligned}$$

We can't find any set of values of x_1, x_2 and x_3 which satisfies

$$0x_1 + 0x_2 + 0x_3 = 5/2$$

The equation system has no solution. Hence the system is **inconsistent**.

Q. 36 *Maths-Numerical Methods*
Ans: 3
Basis of secant method: If we've two approximations to roots x_i and x_{i-1}, the $(i+1)$th approximation can be given by

$$x_{i+1} = x_i - \frac{f(x_i)}{(f(x_i) - f(x_{i-1}))/(x_i - x_{i-1})} \tag{7}$$

The exit criteria: $f(x_i) - f(x_{i-1})$ is too small. The method converges if f(x) is small.

The quick plot of the function reveals

x	-1	0	2	3	4
f(x)	-2	1	-1	4	21

It is evident that one root is in between $(-1, 0)$, second between $(0, 2)$ and the third between $(2, 3)$, since these are the intervals when the function changes its sign. For finding the smallest positive root, we start with two trial points $x_0 = 0$ and $x_1 = 1.5$.

- **1st iteration**:
  Given,
  $$x_0 = 0, f(x_0) = 1, x_1 = 1.5, f(x_1) = -1.125$$
  Using eq. (1), we get,
  $$x_2 = 0.7059, f(x_2) = 0.4592$$
- **2nd iteration**:
  Now the x_1 in previous iteration becomes x_0 for the second iteration, and x_2 from the first becomes x_1 in the second. Thus, we have,
  $$x_0 = 1.5, x_1 = 0.7059, f(x_0) = -1.125, f(x_1) = 0.4592$$
  Using eq. (1), we get,
  $$x_2 = 0.9361, f(x_2) = 0.0677$$

- **3rd iteration**:
  Now the x_1 in second iteration becomes x_0 for the third iteration, and x_2 from second becomes x_1 in the third. Thus, we have,

  $$x_0 = 0.7059, x_1 = 0.9361, f(x_0) = 0.4592, f(x_1) = 0.0677$$

  Using eq. (1), we get,

  $$x_2 = 0.9757, f(x_2) = 0.0484$$

- **4th iteration**:
  Now the x_1 in third iteration becomes x_0 for the fourth iteration, and x_2 from third becomes x_1 in the fourth. Thus, we have,

  $$x_0 = 0.9361, x_1 = 0.9757, f(x_0) = 0.0677, f(x_1) = 0.0484$$

  Using eq. (1), we get,

  $$x_2 = 1.0777, f(x_2) = -0.1550$$

- **5th iteration**:
  Now the x_1 in fourth iteration becomes x_0 for the fifth iteration, and x_2 from fourth becomes x_1 in the fifth. Thus, we have,

  $$x_1 = 0.9757, x_2 = 1.0777, f(x_0) = 0.0484, f(x_1) = -0.1550$$

  Using eq. (1), we get,

  $$x_2 = 1, f_2 = 0$$

At 5th iteration, the method converges since $f_2 = 0$. It takes 5 iterations to get the smallest positive root.

Q. 37 *Maths*
Ans: 4
Let r be the radius and h be the height of the cylinder. The volume of the cup is

$$\pi r^2 h = 64$$

Thus, the radius and height are related by

$$h = 64/(\pi r^2) \tag{8}$$

The surface area of cup is

$$\begin{aligned} f(r) &= \pi r^2 + 2\pi r h & (9)\\ &= \pi r^2 + 128/r & (10) \end{aligned}$$

The first derivative of surface area is $f'(r)$

$$f'(r) = 2\pi r - 128/r^2$$

Equating $f'(r)$ to 0,

$$\begin{aligned} 0 &= 2\pi r - 128/r^2 & (11)\\ r &= 4/\pi^{1/3} & (12) \end{aligned}$$

The second derivative of surface area is

$$f''(r) = 2\pi + 256/r^3 \tag{13}$$

Substituting, r from eq. (6) into eq.(7) yields

$$f''(r) = 6\pi$$

Eq. (6) is local minima for $f(r)$. Since its the only critical point for $r \to 0$, it must be a global minimum. The height and radius relation is given in eq.(2). Substituting, $r = 4/\pi^{1/3}$ in eq.(2) yields,

$$h = 4/\pi^{1/3}$$

Thus, **the radius and height of the cup is** $4/\pi^{1/3}$.

Q. 38 *Maths-DMS*
Ans: 2
The relation is

$$\{< 2,2 >, < 3,3 >, < 6,6 >, < 8,8 >, < 2,8 >, < 2,6 >, < 3,6 >\}$$

We could see that

- The relation is reflexive as $< 2,2 >$, $< 3,3 >$, $< 6,6 >$, and $< 8,8 >$ are present.
- The relation is transitive.
- The relation is antisymmetric. That means, the pair $(x,y),(y,x)$ is present if and only if $x = y$.

The relation is **reflexive, antisymmetric and transitive**. That means, its is a *partially ordered set or Poset*.

Q. 39 *Maths-DMS*
Ans: 2
The binomial distribution has parameters n and p, where

p: probability of successfully transmitting a single digit.

n: total number of bits to be transmitted.

According to binomial distribution, the probability of exactly i errors in n transmitted bit is given by,

$$p(i) = \binom{n}{i} p^{n-i}(1-p)^i \tag{14}$$

When there is no error, $i = 0$, substituting $i = 0$ in eq.(8) we get the probability for error-free transmission.

$$p(i) = p^n$$

Thus, the probability of error free transmission is p^n.

Q. 40 *CN*
Ans: 2

Q. 41 *CN*
Ans: 4

Q. 42 *CN*
Ans: 2

37	0	0	1	0	0	1	0	1
240	1	1	1	1	0	0	0	0
32	0	0	1	0	0	0	0	0

Q. 43 *Hardware*
Ans: 4

Q. 44 *Hardware*
Ans: 1

Q. 45 *Hardware*
Ans: 2

Q. 46 *PL*
Ans: 2

Q. 47 *Theory of Computation*
Ans: 4

- By induction, to get string of length 2, we need 3 productions:

$$S \to PQ, P \to x, Q \to y$$

- To get strings of length 3, we need 5 productions:

$$S \to SQ, S \to PQ, P \to x, P \to y$$

$$S \Rightarrow SQ \Rightarrow PQQ \Rightarrow xQQ \Rightarrow xyQ \Rightarrow xyy$$

Thus we need $2n - 1$ productions to get string of length n.

Q. 48 *Theory of Computation*
Ans: 1

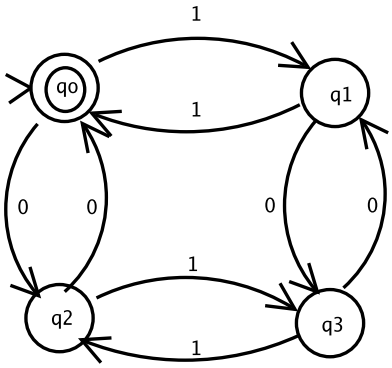


Figure 40: Fig. for Q. 48

Q. 49 *Theory of Computation*
Ans: 1

- L_1**:** A PDA accepts L_1. In PDA, a's are pushed on stack and popped with each occurrence of b. Once a and b matches, it accepts at least on c and declares successful acceptance.
- L_2**:** A PDA accepts a^i and b^i part as described above. At this point, the stack is empty and there is no way PDA can remember the number of a and b. It can not ensures if the number of c are greater than that of a or b. L_2 is not accepted by PDA.
- L_3**:** Again with similar argument as L_2 we can conclude that L_3 is not accepted by PDA.

Only L_1 is accepted by PDA and hence it is context free language.

Q. 50 *Theory of Computation*
Ans: 4
All the above functions are total recursive functions. The total recursive functions are like recursive languages. Turing Machine halts on each and every input of recursive languages. All of the above functions

are Turing calculable.

Q. 51 *Theory of Computation*
Ans: 2
Prefix property states that whenever w is in L, no prefix of w is in L. Since the grammar does not have prefix property, the grammar is not $LR(0)$.

Q. 52 *Theory of Computation*
Ans: 1

Q. 53 *Data Structure*
Ans: 6
$\binom{4}{2} = 6$

```
        Node1
        /   \
    Node2    Node3
```

This is the fixed structure. Now we need to put in rest of the two nodes in any of the 4 possible places, i.e. $\binom{4}{2}$

Q. 54 *Data Structure-Knapsack Problem*
Ans: 4
Call $\sum w_i x_i$ for each and the $\sum p_i x_i$

Q. 55 *Data Structure*
Ans: 1

Q. 56 *Data Structure*
Ans: 4

Q. 57 *Data Structure*
Ans: 2

Q. 58 *Data Structure-RecurranceRelation*
Ans: 2

Q. 59 *Data Structure-Spanning Tree*
Ans: 2

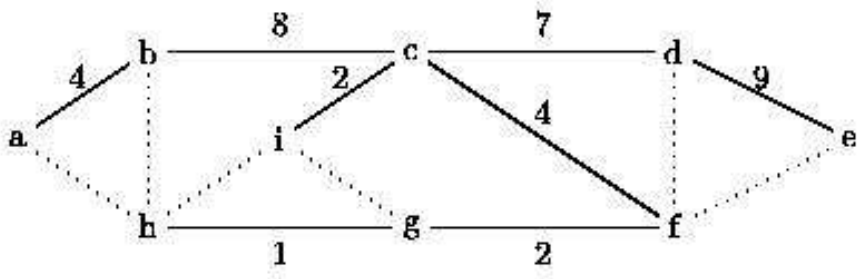


Figure 41: Fig. for Q. 59

Q. 60 *Data Structures-Trees*

Ans: 3

Q. 61 *Data Structures-Linked List-Queue*
Ans: 3

Q. 62 *Data Structures-Graph Theory*
Ans: 3

Q. 63 *Data Structures-OPEN*
Ans: 1
Here parity of black is preserved and the parity of white is neglected. Hence, we get the following table:

n_b	n_w	remaining
even	even	white
even	odd	white
odd	even	black
odd	odd	black

Q. 64 *Data Structures-OPEN*
Ans: 2

Q. 65 *Compilers-*
Ans: 1
Here we need to understand how the lexical analyzer forms the token from the input program/statements. It removes white spaces and then collects token.

The lexical analysis phase reads the characters in the source program and groups them into streams of tokens in which each token represent logically cohesive sequence of characters, such as an identifier, a keyword(if, while, for et.), a punctuation character like ;, or a multi-character operator like ++.
In the example above, the tokens are:

```
1. if
2. (
3. x
4. >
5. 10
6. )
7. y
8. ++
9. ;
10. else
11. y
12. --
13: ;
```

Note here that, ++ and – are treated as a single token and not as two tokens like + and + or - and -, but as ++ and –. Thus, The total number of tokens are 13 i.e. 1

Q. 66 *Compilers*
Ans: 2
Observe the parse tree (a), it grows toward left, while (b) grows to-wards right.

The left one (a) represent the following sequence of operations:

$$\begin{aligned} list &\rightarrow list - digit \\ &\rightarrow list - digit - digit \\ &\rightarrow digit - digit - digit \\ &\rightarrow 9 - digit - digit \\ &\rightarrow 9 - 5 - digit \\ &\rightarrow 9 - 5 - 2 \end{aligned}$$

This shows that the operators are evaluated in left associative manner that is from left to right. Thus (a) represent.

The second parse tree evaluates in right associative manner that is from right to left.

The grammar is obviously ambiguous since it produces two different parse trees for the same expression.

The reality is:

1. The parse tree (a) represent left associative evaluation while that of (b) right associative evaluation.
2. The grammar is ambiguous.

Both the statements are false. i.e. 2

Q. 67 *Compilers*
Ans: 4
The expression $8 - 5 + 2$ can be generated in the following manner: Lets give number to each step.

$$\begin{aligned} expr &\rightarrow expr_1 + term \\ &\rightarrow expr_1 - term + term \\ &\rightarrow term - term + term \\ &\rightarrow 8 - 5 + 2 \end{aligned}$$

Now apply the semantic rules also in the similar fashion:

$$expr.t := expr_1.t \mid\mid term.t \mid\mid '+'$$

Apply the semantic rule for $expr \rightarrow expr1 + term$

$$expr.t := expr_1.t \mid\mid term.t \mid\mid ' -' \mid\mid term.t \mid\mid '+'$$

Apply the semantic rule for $expr \rightarrow term$

$$expr.t := term.t \mid\mid term.t \mid\mid ' -' \mid\mid term.t \mid\mid '+'$$

which implies: '8' '5' '-' '2' '+'. The answer is 85-2+ i.e. 4

Q. 68 *Compilers*
Ans: 1

Q. 69 *Compilers*
Ans: 3

Q. 70 *Compilers*
Ans: 4

The grammar given in the question is not LL(1) grammar as it has left recursion in the following productions:

$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \end{aligned}$$

In order to convert this grammar to LL(1) grammar, we need to remove left recursion and factoring. The left factoring is not a problem here. The left recursive production

$$A \rightarrow A\alpha_1 \mid \beta;$$

is simplified into two productions namely,

$$\begin{aligned} A &\rightarrow \beta A' \\ A' &\rightarrow \alpha_1 A' \mid \epsilon \end{aligned}$$

Thus the grammar is converted into right recursive grammar. The conversion does not change the language defined by the production. You could verify the same.

- Consider $E \rightarrow E + T \mid T$, here, $A = E$, $\alpha_1 = +T$, $\beta = T$. This production is converted to

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow +TE' \mid \epsilon \end{aligned}$$

- Consider $T \rightarrow T * F|F$, here $A = T$, $\alpha_1 = *F$ and $\beta = F$. This production is splitted into

$$\begin{aligned} T &\rightarrow FT' \\ T' &\rightarrow *FT' \mid \epsilon \end{aligned}$$

- In case of production of F, there is no left recursion. The production concerning F remains as it is.

Thus, $LL(1)$ grammar has the following productions:

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow +TE' \mid \epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow *FT' \mid \epsilon \\ F &\rightarrow (E) \mid \texttt{id} \end{aligned}$$

Hence answer is (4)

Q. 71 *Operating Systems-Processes*
Ans: 3
The Batch Systems executes job in FCFS manner keeping CPU idle during loading new job as in (2), to improve the situation, the jobs with similar profiles were batched together as in (4), to improve CPU utilization by overlapping I/O and computation, spooling was used as in option(3) and to keep CPU more busy, then came time sharing, or multitasking or hands-on computer systems, which switches the CPU between different tasks more frequently.

It implies that the correct ascending order in terms of CPU utilization is: `2, 4, 3, 1` i.e. 3

Q. 72 *Operating Systems*
Ans: 3
The basics expected here are about FCFS and Round Robin scheduling. The question can be tackled with in seconds if you know the following rule: *When the time quantum is larger than the burst time, round robin degenerated to FCFS scheduling.*

- With FCFS, the processes will finish execution with in 5+4+6+3=17 units.

- With Round Robin scheduling with time quantum of 6 units the total time required is also same as FCFS.

Q. 73 *Operating Systems-Deadlocks*
Ans: 1

Q. 74 *Operating Systems-Paging*
Ans: 2

Case 1: The entry is in associative register it takes 200 ns to access the word memory. This happens 75% of time(w_1). Let this be c_1.

Case 2: If the page is not in associative register - 400 nanoseconds: 200 nanoseconds to access the page table and 200 nanoseconds to access the word in memory. This happens 25% of time(w_2). Let this be c_2

Thus, effective access time is

$$\begin{aligned} &= w_1c_1 + w_2c_2 \\ &= (0.75 \times 200\ ns) + (0.25 \times 400\ ns) \\ &= 250\ ns \end{aligned}$$

Q. 75 *Operating Systems*
Ans: 2
Suppose total number of frames are m, and f_i be the memory requirement of ith process, then the total memory requirement is

$$S = \sum_{1}^{k} f_i$$

In proportional allocation scheme, the amount of frames allocated to process P_i with size s_i is $= s_i/S * m$. For the given data,

$$m = 62S = 10 + 127 = 137$$

The process P_1 gets,

$$(10/137) * 62 = 4\ frames$$

The process P_2 gets,

$$(127/137) * 62 = 57\ frames$$

. The answer is 2.

Q. 77 *PL*
Ans: 2
The program calculates number of 1's in an integer. Hence ans is 3, i.e. option 2. See the loop execution:

num	$num - 1$	num & $(num - 1)$
1011	1010	1010
1010	1001	1000
1000	0111	0000

The loop executes 3 times, i.e. it finds number of 1's in an integer.

Q. 76 *PL*
Ans: 3
The invocation tree will be:

```
main                        output
 |
 -- abc("123)                  1 (7)
```

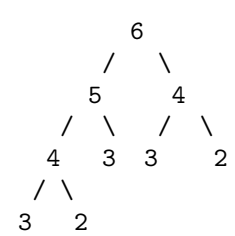
```
|
|-- abc("23")           2 (3)
|    |
|    |-- abc("3")       3 (1)
|    |    |
|    |    |--abc("");
|    |
|    |-- abc("3")       3 (2)
|         |
|         |--abc("");
|
|-- abc("23")           2 (6)
     |
     |-- abc("3")       3 (4)
     |    |
     |    |--abc("");
     |
     |-- abc("3")       3 (5)
          |
          |--abc("");
```

So, collecting the sequence (1) to (7), we get the sol. as in option 3.

Q. 78 *PL*
Ans: 3
Do not assume that its a short circuit evaluation and hence y– in the last case, when x becomes 0 will also be executed. Hence option 3

Q. 79 *PL*
Ans: 3
In union, a value stored as float (4 char) can be read as long (4 char) or any thing like that which can break the programs. Hence unions are not recommended.

Q. 80 *PL*
Ans: 2



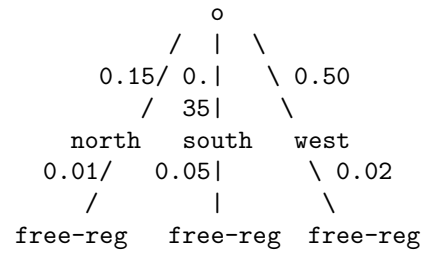
Q. 81 *Maths-Probability*
Ans: 2
Refer to the explanation of **Q. 82**

Q. 82 *Maths-Probability*
Ans: 1
Let's denote the events:

D_i = Registration from ith Indian part ($i = 1, 2, 3$ for north, south and west respectively)

C = The registration is a free registration

(a) We've been asked to find out the probability that a randomly chosen registration is a free registration. This can be represented in the following manner:



The fig represent that a free registration can either be a free registration from south or north or west.

- $P(E_1)$ = Prob. that a registration is from north India and its a free registration = $P(C|D_1) * P(D_1)$
- $P(E_2)$ = Prob that a registration is from south India and its a free registration = $P(C|D_2) * P(D_2)$
- $P(E_3)$ = Prob that a registration is from west India and its a free registration = $P(C|D_3) * P(D_3)$

This is a case that we know different free registration events and we want to find out the total probability of a registration being a free-registration. This is achieved using total probability theorem:

$$\begin{aligned} P(C) &= P(E_1) + P(E_2) + P(E_3) \\ &= P(C|D_1).P(D_1) + P(C|D_2).P(D_2) + P(C|D_3).P(D_3) \\ &= (0.01).(0.15) + (0.02).(0.35) + (0.02).(0.5) \\ &= 0.029 \end{aligned}$$

Hence ans: The probability that a randomly chosen registration is a free registration is 0.029.

(b) We're required to find out the probability that a randomly chosen registration comes from south India given that its a free registration. Here, note that the situation is like we know that the event has happened, that a registration is a free registration. However we want to know which of the mutually exclusive and collectively exhaustive event has occurred. Here such events are:

- D_1: Registration from north India
- D_2: Registration from south India
- D_3: Registration from west India

We're interested in $P(D_2|C)$ = (Reg. from south India — free reg). Bayes rule is applied in such situations. With P(C)=0.029 from (a),

$$\begin{aligned} P(D_2|C) &= P(C|D_2) * P(D_2)/P(C) \\ &= 0.05 * 0.35/0.029 \\ &= 0.603 \end{aligned}$$

Hence ans : The probability that a registration is from south India, given that its a free registration is 60%.

Q. 83 *Hardware*
Ans: 3

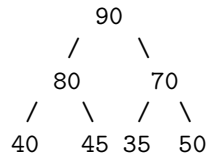
Q. 84 *Hardware*
Ans: 1

Q. 85 *Maths-DMS*
Ans: 1

$$\begin{aligned} R &= \{<1,3>,<3,1>,<2,4>,<4,2>\} \\ S &= \{<1,4>,<4,1>\} \\ R \cup S &= \{<1,3>,<3,1>,<2,4>,<4,2>,<1,4>,<4,1>\} \\ R \cap S &= \{\}, \quad |R \cup S| = 6, \quad |R \cap S| = 0 \end{aligned}$$

Q. 86 *Maths-DMS*
Ans: 2

Q. 87 *Data Structures-Heaps*
Ans: 1

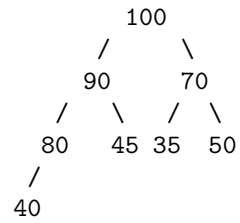


Construct the max-heap and take breadth-first traversal.

Q. 89 *Databases- Query*
Ans: 1

Q. 90 *Databases-Query*
Ans: 2
The sub-query in option 2 gives the hostel-nos for which CSE students are living. So, we need to get the compliment of the same, which we got using NOT IN clause.

Q. 88 *Data Structures-Heaps*
Ans: 2



Answers GateGenie Practice Test No. 2

Answers: Test No. 2

Q. 01 *Engg Maths*
Ans: 1
n indistinguishable objects(red balls) can be placed in k distinguishable bins in

$$\binom{n+k-1}{k-1}$$

ways. With $n = 10$, $k = 5$, we have

$$\binom{10+5-1}{5-1} = \binom{14}{4} = \frac{14!}{4!10!} = 1001$$

ways

Q. 02 *Engg Maths*
Ans: 2
The matrix is invertible iff it has not 0 as eigen value.

Q. 03 *Engg Maths*
Ans: 3
It is not reflexive. It is symmetric, antisymmetric and transitive so its a partial order.

Q. 04 *Engg Maths*
Ans: 2
A countable union of countable sets is countable. Countably infinite and denumerable are alternates of countable. The set is not uncountable.

Q. 05 *Hardware*
Ans: 1

Q. 06 *Hardware*
Ans: 3

Q. 07 *Hardware*
Ans: 2

Q. 08 *Hardware*
Ans: 2

Q. 09 *Theory of Computation*
Ans: 3

1. DFA makes precisely one transition for an input symbol from each state. The statement is correct. The statement is implied from DFA definition
2. NFA makes more than one transition for an input symbol from each state. To check if the string is accepted by NFA we need to check more than one path labeled w and select one which terminates at a final state. The statement is correct.
3. The statement is false. Read explanation about statement 2.
4. The statement is true. DFA has a unique transition for a give input symbol w and state q to other state. This suggests that on a given string w, DFA terminates in one and only state.

Q. 10 *Theory of Computation*
Ans: 2

1. $r_1 = \epsilon$ is a regular expression representing a set $\{\epsilon\}$. It's a regular expression.
2. $r_2 = 0^*1^*$ is a regular expression.

Q. 11 *Theory of Computation*
Ans: 3

Q. 12 *Data Structure and Analysis*
Ans: 3
The new algorithm will only reduce the number of comparisons but will not reduce the complexity.

Q. 13 *Data Structure and Analysis*
Ans: 1
In quick sort, partitioning is key as it needs selecting the pivot and then partitioning the array into two parts with one part $>$ pivot and other $\leq$ pivot. Merging is trivial where nothing is required.

Q. 14 *Data Structure and Analysis*
Ans: 1
It is not used in Tower of Hanoi. Is used in rest of the programs. For Fibonacci numbers, intermediate calculation are stored in memory. Matrix Chain Multiplication also uses intermediate results. Edit Distance also needs intermediate results.

Q. 15 *Data Structure and Analysis*
Ans: 1
It is by definition. A tree edge should not create a cycle or a self loop.

Q. 16 *Data Structure and Analysis*
Ans: 4
By definition. Also to make a guess, a bridge in real life connects two parts. hence its removal should separate them.

Q. 17 *Data Structure and Analysis*
Ans: 4

Q. 18 *Data Structure and Analysis*
Ans: 3
Just try a simple example:

```
      Root
     /    \
Node1  Node1
```

So, 3 nodes $= 2^n - 1 = 3$. Thus, $n = 2$, height $= 2$

Q. 19 *Compilers*
Ans: 2

Q. 20 *Compilers*
Ans: 2

Q. 21 *Compilers*
Ans: 1

Q. 22 *Compilers*

Ans: 2

Q. 23 *Operating Systems*
Ans: 4

Q. 24 *Operating Systems*
Ans: 1
CPU bound processes requires lot of processor time, resulting in long wait for I/O bound processes for the processor. This effect is called convoy effect. It results in lower CPU and I/O devices utilization. **Q. 25** *Operating Systems*
Ans: 2

In P operation semaphore value is reduced by 1.

In V operation semaphore value is increased by 1

Initial val - number of P + number of V = 10 - 6 + 4 = 8

Q. 26 *Operating Systems*
Ans: 2

Paging avoids problem of external fragmentation, however it suffers from problem of internal fragmentation.

Suppose a certain system has 2048 bytes of page size and the process needs 72,766 bytes. The total number of pages required is

$$\begin{aligned} 72766/2048 &= 35 \\ 72766\%2048 &= 1086 \end{aligned}$$

Thus, the process requires 35 complete pages and 1086 additional bytes of one more page. Thus, the amount of bytes wasted as a result of internal fragmentation is

$$2048 - 1086 = 962 \; bytes$$

Thus, 962 bytes are wasted as a result of internal fragmentation.

Q. 27 *Databases*
Ans: 4

$$\begin{aligned} A &\rightarrow B, C \\ B &\rightarrow E. \end{aligned}$$

Hence $A \rightarrow A, B, C, E$. We need to include D. Hence candidate key is D.

Q. 28 *Databases*
Ans: 3
As B+ trees has pointer to the next key, it is very efficient for range queries.

Q. 29 *Computer Networks*
Ans: 1

Q. 30 *Computer Networks*
Ans: 4
The Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of the IP address space for private internets:

```
10.0.0.0        -   10.255.255.255
172.16.0.0      -   172.31.255.255
192.168.0.0     -   192.168.255.255
```

Q. 31 *Databases*
Ans: 4
B and C are common in relations R and S. Hence we need to see for common values in B and C. (b, c) and (a, d) are common values for B and C in R and S. Now, we need to take Cartesian product of rows contains these common values. Thus, we get,

R (a,d) for A
S (d,e) for D

Hence, Cartesian product will be

A	D	B	C
a	d	b	c
a	e	b	c
d	d	b	c
d	e	b	c

Observe the first two columns, they are the Cartesian product. Rest two columns are same. The remaining pair forms $(A, B, C, D) = (c, a, d, b)$. Hence option 4

Q. 32 *Databases*
Ans: 2

1. Insertion of 1 and 2 is straight forward.
2. Insertion of 3 makes first split of with 2 being lifted at the root node.(fig 2).
3. Insertion of 4 again is simple as shown.
4. Insertion of 5 now adds the complications. You can consider it to be added next to 3,4 and trying form the node 3, 4, 5. In this scenario, 4 will be lifted up by one level. Hence the resulting tree will have 2 and 4 at the root level and 1, 3, and 5 as three leaf nodes as show in last fig.
5. Now, try to insert 6,7. You will get like a binary search tree with 4 as root node, 2 and 6 at level 2 and 1, 3, 5, 7 at level 3.
6. Try inserting more values in continuation, till 15 and now you will get a tree with 8 at the root, 4 and 12 at level 2 and so on.
7. Do try to go till 15 to clear your concepts of addition.

Q. 33 *Engg Maths*
Ans: 2

$$\begin{aligned} D_3 &= \{n \mid n\%3 = 0\} \quad \Rightarrow |D_3| = 1000/3 = 333 \\ D_5 &= \{n \mid n\%5 = 0\} \quad \Rightarrow |D_5| = 1000/5 = 200 \\ D_3 \cap D_5 &= \{n \mid n\%3 = 0 \; and \; n\%5 = 0\} \end{aligned}$$

Since 15 is LCM of 3 and 5, $D_3 \cap D_5$ contains exactly those numbers which are divisible by 15.

$$|D_3 \cap D_5| = 1000/15 = 66$$

Thus,

$$\begin{aligned} |D_3 \cup D_5| &= |D_3| + |D_5| - |D_3 \cap D_5| \\ &= 333 + 200 - 66 \\ &= 467. \end{aligned}$$

Q. 34 *Engg Maths*
Ans: 1

1. If we have $(a, b)\#(a, b)$ since $ab = ab$. The relation is reflexive
2. If we have $(a, b)\#(c, d)$ then we have $ad = bc$. Accordingly, $bc = ad$ yields $(c, d)\#(a, b)$. The relation is symmetric.
3. If we have $(a, b)\#(c, d)$ and $(c, d)\#(e, f)$, we get $ad = bc$ and $cf = de$.

This implies,

$$(ad)(cf) = (bc)(de) \Rightarrow af = be$$

We got the last result by canceling cd from both sides

Q. 35 *Engg Maths*
Ans: 3

- Arrange the edges in ascending order of weight.
- Add selectively the edges, such that addition of edge doesn't form a cycle.

The edges added are in the following order:

`BD, DF, AE, CE, BE`

The total length is 24.

Q. 36 *Engg Maths*
Ans: 2

Q. 37 *Engg Maths*
Ans: 3

- F_1: One to one but not onto
- F_2: one-to-one as well as onto, so it is invertible.
- F_3: Onto but not one to one
- F_4: neither onto nor one to one.

Q. 38 *Engg Maths*
Ans: 1

Q. 39 *Engg Maths*
Ans: 1
A group needs to satisfy three properties:

1. Association

   $$a * (b * c) = (a * b) * c$$

   - this is satisfied
2. Identify:

   $$a * e = e * a = a$$

   - identity element is 1
3. Inverse:

   $$a * a^{(-1)} = a^{(-1)} * a = e$$

   No such inverse exists.

Thus, it will not form a group.

Q. 40 *Computer Networks*
Ans: 3

Q. 41 *Computer Networks*
Ans: 3

Q. 42 *Computer Networks*
Ans: 4

Q. 43 *Hardware*
Ans: 1

Q. 44 *Hardware*
Ans: 2

Q. 45 *Hardware*
Ans: 1

Q. 46 *Programming Language*
Ans: 3
The program determines if the number is a perfect number. A perfect number is one whose divisors add up to the number.

Q. 47 *Theory of Computation*
Ans: 3
The regular expression will be:

$$(a \mid b \mid \epsilon)(ab \mid abb)^*$$

The DFA will be as shown in Fig. 31. The answer follows from DFA.

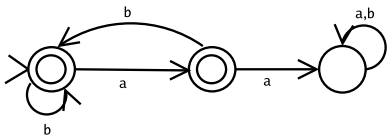


Figure 42: Fig. for Q. 47

Q. 48 *Theory of Computation*
Ans: 3
L_1 and L_2 are context free languages. Observe that L_2 is in fact a regular language, having grammar $a(ba)^*$. $L1$ is language containing strings having equal number of a's and b's.

- The class of context free languages are closed under intersection with regular sets. Thus, $L_3 = L_1 \cap L_2$ is context free language.
- The class of context free languages are not closed under kleen closure. However, here

  $$L_4 = L_1.L_1^* = \{a^i b^i a^i b^i \mid i \leq 0\}$$

  which is context free.

Q. 49 *Theory of Computation*
Ans: 4
If the language is accepted by a PDA by empty stack or final state, the language is CFL.

Since L_1. is accepted by PDA by empty stack, while L_2 is accepted by PDA by final states. This means that both L_1 and L_2 are context free languages(CFL). However, the information provided is not sufficient to establish their equivalence.

Q. 50 *Theory of Computation*
Ans: 2
Rank of a variable V is the length of longest path in the graph beginning at V. The above grammar can be represented in the following graph The longest path from S in the graph is 3 and from A is 2, hence

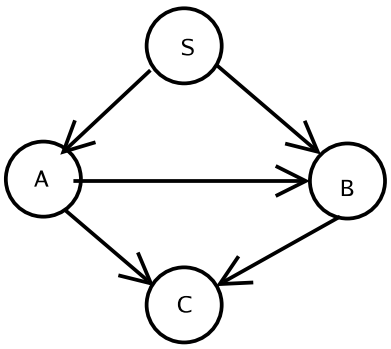


Figure 43: Fig. for Q. 50

the rank of $S_r = 3$ and $A_r = 2$. The maximum length of string produced by this grammar will be

$$2^{max(rank)} = 2^3 = 8$$

Q. 51 *Theory of Computation*
Ans: 3
We need to look at the transitions of Turing machine on input alphabets 0 and 1.

1. In state q_0, when it encounters 0, it replaces it with X, changes state to q_1 and moves to right.
2. In state q_1, when it encounters 1, it replaces it with Y, changes state to q_2 and moves to left.
3. In state q_1, when 0 is encountered, simply it moves right.
4. In state q_2, when 0 is encountered, simply it moves to left.

Lets analyze TM"s transitions:

- **Step A:** At start when TM is in q_0, when it sees 0, it replaces it with X and moves right. It changes state to q_1.
- **Step B:** Now here it will either encounter 0, 1 or B and TM is in state q_1,
  - When it sees 0, it simply moves to right. This is true while in state q_1, as long as it sees 0, it simply keeps moving to right.
  - When it sees 1, it changes 1 to Y and moves to left. It changes state to q_2. Note here TM reverses its direction.
  - When it sees B, it simply stops, rejecting the string.
- **Step C:** Now in q_2, it will either sees $0, 1, X$ or B. Lets analyze the behavior of TM in q_2:
  - On 0, it keeps on moving left till it encounters X.
  - On X, it changes state to q_0 and reverses its movement to right.

Step A, B, C repeats till the string is rejected or in state q_0, the TM sees Y.

When it sees Y in q_0, it changes state to q_3 and moves to right. In q_3, TM keeps moving right on encountering Y. When it encounters B in T_3 it enters in q_4 and halts.

The key movements:

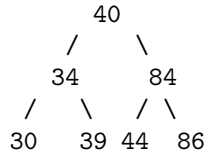
- The first 0 while moving from left to right is replaced by X.
- The first 1 while moving from left to right is replaced by Y and TM reverses its direction.
- The input is accepted when all 0 and 1 are replaced by X and Y in a matching fashion. For each 0, one 1 is replaced. This is a sort of matching of 0's to 1's. The TM halts on string having equal number of 0's and 1's. The 0's appears consecutive and 1's appear consecutive. There is no 101 substring.

The language accepted is 0^n1^n.

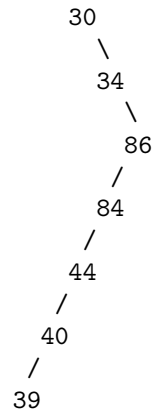
Q. 52 *Theory of Computation*
Ans: 2
The correct statement follows from following theorem:
If L_1 and L_2 is a pair of complementary language, then either,

- both L_1 and L_2 are recursive
- neither L_1 and L_2 is recursively enumerable
- one is recursively enumerable but not recursive, the other is not recursively enumerable

Q. 54 *Data Structure and Analysis*
Ans: 2



Q. 53 *Data Structure and Analysis*
Ans: 3



Q. 55 *Data Structure and Analysis*
Ans: 3
Series of insertion will result into following stages:

1. `insert(30)`

   30

2. `insert(34)`

```
    30
      \
      34
```

3. `insert(86)`

```
    30
     \
     34
      \
      86
```

Which after single left rotation becomes

```
      34
     /  \
    30   86
```

4. `insert(84)`

```
      34
     /  \
    30   86
        /
       84
```

5. `insert(44)`

```
      34
     /  \
    30   86
        /
       84
      /
     44
```

A typical double right rotation is of the form:

A is the node that the rotation is performed on. This rotation is performed when A is unbalanced to the right (the right subtree is 2 higher than the left subtree), C is left-heavy (the left subtree of C is 1 higher than the right subtree of C) and B is right-heavy. T1, T2, T3, and T4 represent subtrees (a node was added to T3 which made B right-heavy, made C left-heavy and unbalanced A). This consists of a single right at node C, followed by a single left at node A.

```
  A      SRR at C       A        SLR at A        B
 / \     ---------->   /   \     ---------->    /   \
T1  C                T1    B                  A     C
   / \                    / \                / \   / \
  B  T4                 T2  C              T1 T2 T3 T4
 / \                       / \
T2 T3                     T3 T4
```

We apply this to our current tree and get:

```
A - 34, B 84, C - 86

    34           34              84
   /  \         /  \            /  \
  30   86      30   84         34   86
      /            /  \       /  \
     84           44  86     30  44
    /
   44
```

6. `insert(40)`

```
      84
     /  \
    34   86
   /  \
  30  44
     /
    40
```

Here we apply double left rotation:

C is the node that the rotation is performed on. This rotation is performed when C is unbalanced to the left (the left subtree is 2 higher than the right subtree), A is right-heavy (the right subtree of A is 1 higher than the left subtree of A) and B is left-heavy. T1, T2, T3, and T4 represent subtrees (a node was added to T2 which made B left-heavy, made A right-heavy and unbalanced C). This consists of a single left rotation at node A, followed by a single right at node C.

```
    C     SLR at A          C        SRR at C        B
   / \   ---------->      /   \     --------->    /   \
  A  T4                   B     T4                A     C
 / \                     / \                     / \   / \
T1  B                   A   T3                 T1 T2 T3 T4
   / \                 / \
  T2 T3              T1 T2
```

Here:

```
C=84, A = 34, B = 44
      84                84              44
     /  \              /  \            /  \
    34   86           44   86         34   84
   /  \              /               /  \    \
  30  44            34              30  40   86
     /             /  \
    40            30  40
```

7. `insert(39)`

```
      44
     /  \
    34   84
   /  \    \
  30  40   86
     /
    39
```

Q. 56 *Data Structure and Analysis*
Ans: 2
With simple recursive calls, we invoke the program with (n-1) disks. Hence at every recursive call, we reduce the number of disks by 1 , upto 1. Hence n.

Q. 57 *Data Structure and Analysis*
Ans: 2
infix is:

$$(a + b) + (c * d)$$

and hence prefix as

$$+(+ab)(*cd) \quad \Rightarrow \quad ++ab*cd$$

Q. 58 *Data Structure and Analysis*
Ans: 4

Q. 59 *Programming Language*
Ans: 4
As there is no break statement, i value of 1,3, or 5 will print `1 5 3 0` or `5 3 0` or `3 0`. If the value of i is any thing other than 1, 3, or 5 then it will print 0. Only 4 possible outputs are:

- 1 5 3 0
- 5 3 0
- 3 0
- 0

Q. 60 *Data Structure and Analysis*
Ans: 1
the final statement should be

```
return 1 + count( root -> left ) + count( root -> right)
```

Q. 61 *Data Structure and Analysis*
Ans: 3
As such, its always better you know the exact algorithms to such problems. Still, if you are not aware then, this is how you can approach the problem.

- `r->next` is being assigned somewhere, as it is being set in next statement. Hence it needs temporary storage i.e. t. Also, first blank has to be t as the last statement uses t and hence t needs an assignment.
- Once you get this, option 3 is obvious. Still, we will try to find out the next blank. Now, r is being assigned new value in the next statement, hence most probably r is going to be the correct value.

This is more or less using intuitive way. To approach formally:

- r points to the linked list to be reversed. l is pointing to already reversed link list. t is temp. variable. We need to first store the next pointer (into t) and then make current node" next pointer point to the reversed list(statement 2). l now should point to the current node, which is part of reversed list and then finally r to point to the stored (next) pointer.

Q. 62 *Data Structure and Analysis*
Ans: 2
Solve the problem as s as source. A B C D has the cost of 2 + 2 + 4 = 8, which is minimum compared to other costs like A C D or A C E D.

Q. 63 *Data Structure and Analysis*
Ans: 3

- Shifting by reversal is an elegant method. Just try a small example to make it clear. It will need N swap operations.
- First option will need N-1 shifts per pass and hence x * (N-1) and is not efficient.
- Second needs extra space. Generally, extra space is not a good idea in any algorithm.
- The last one again uses extra space and needs some other data structure which is not a good idea.

Q. 64 *Data Structure and Analysis*
Ans: 2
During look-ahead, selection of a location with minimum in this iteration only rather than some time later when it may not have any possible next move location and by using this concept, the knight never backtracks.

Q. 65 *Compilers*
Ans: 3
The tokens generated are

```
int, max, (, i, '','',   j, ), int, i, '','' , j, ;
/*, */, {, return, i, > , j, ?, i, :, j, ;, }
```

/* and */ are treated as a single token and the words between /* */ are ignored. Thus, there are in all 25 tokens.

Q. 66 *Compilers*
Ans: 3
Suppose, $s = aaab$, $|s| = 4$. The substrings are $a, a, a, b, aa, aa, ab, aaa, aab$. Total substrings are 10. Here there is a trend, with strings of length n, we have

- substrings of length $1 = n$
- substrings of length $2 = n - 1$
- substrings of length $3 = n - 3$
- ...
- ...
- substring of length $n = 1$

Total substring $= 1 + 2 + ... + (n-1) + n = n(n+1)/2$

Q. 67 *Compilers*
Ans: 4
If we construct minimized DFA from these regular expressions, we get the exactly same DFA. This is also implied with simple calculation as follows:

$$\begin{aligned} R_1 &= (a|b)^* = (a^*b^*)^* \\ R_2 &= (a^*|b^*)^* = ((a^*)^*(b^*)^*)^* = (a^*b^*)^* \\ R_3 &= ((\epsilon|a)b^*)^* = (b^*|ab^*)^* \\ &= (b^{**}|(ab^*)^*) = (b^*ab^*)^* \end{aligned}$$

$R_1 = R_2$, however, R_3 is subset of R_1 and R_2. Hence R_1, R_2 and R_3 is recognized by the same DFA.

Q. 68 *Compilers*
Ans: 3
The rules for $FOLLOW(A)$ are:

- **Rule 1:** If S is start symbol and $ is input right end-marker.

- **Rule 2:** If there is production $A \to \alpha B\beta$, then everything in $FIRST(\beta)$ except for ϵ is placed in $FOLLOW(B)$
- **Rule 3:** If there is a production $A \to \alpha B$ or $A \to \alpha B\beta$ where $FIRST(\beta)$ contains ϵ, then everything in $FOLLOW(A)$ is in $FOLLOW(B)$.

To calculate, FOLLOW(F),

- Rule 1 is not applicable, since F is not a start symbol.
- Apply rule 2 to production $E \to FT'$. Here $\beta = T'$, $B = F$, so

$$FOLLOW(F) = FIRST(T') - \epsilon = \{*, \epsilon\} - \epsilon = \{*\} \tag{15}$$

- Apply rule 3 to production $E \to FT'$ and $T' \to *FT' \mid \epsilon$

$$FOLLOW(F) = FOLLOW(T) = FOLLOW(T') = \{+,), \$\} \tag{16}$$

- We stop here as we can't add any more elements in $FOLLOW(F)$.

Thus $FOLLOW(F)$ = Eq.(9) $\cup$ Eq.(10) $= \{*, +,), \$\}$

Q. 69 *Compilers*
Ans: 1

Q. 70 *Compilers*
Ans: 4
The grammar looks like $LL(1)$ grammar as it doesn't have left recursion and left factors. However, the construction of a parsing table for this grammar reveals that there are multiple defined entries, for example $M[S', e]$ contains $\{S' \to eS, S' \to \epsilon\}$. Hence it is not $LL(1)$ grammar.

Q. 71 *Operating Systems*
Ans: 1
The total seek time is sum of difference between successive head positions.

1. The FCFS schedule is 143, 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130. The total seek distance is 7081.
2. The SSTF schedule is 143, 130, 86, 913, 948, 1022, 1470, 1509, 1750, 1774. The total seek distance is 1745.
3. The SCAN schedule is 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 4999, 130, 86. The total seek distance is 9769.

Q. 72 *Operating Systems*
Ans: 2
From explanation of 71, it is known that FCFS - 7081, SSTF - 1745, SCAN - 9769. SSTF results in less head movement, hence it is better.

Q. 73 *Operating Systems*
Ans: 1
Whenever a program is to be executed, it needs to be brought into the memory from disk, where it is residing. When the program needs to be swapped out to disk, again some time is required.

For effective CPU utilization, the time quantum must be substantially greater than the context switch time.

Time required to transfer process from memory =

$$100K/1000K = 1/10 \; seconds = 100 \; milliseconds \tag{17}$$

Add avg. latency to Eq.(11), it becomes 108 milliseconds for one way transfer between disk and memory for the given program. The time required two way transfer is 216 ms. Thus, for efficient CPU utilization, time quantum should be substantially greater than 216 ms. The acceptable answer from options is 2.048 sec.

Q. 74 *Operating Systems*
Ans: 3
To load total assembler, it takes

$$100 + 120 + 50 + 20 = 290K.$$

However, overlays allows us to load only those instructions and data which is required by the program at a given time. Since the assembler is partitioned into Pass 1 and Pass 2, we can load them separately. However, we need to keep symbol table and common support routines in the memory.

We have two situations as far as memory residency is concerned:

- **Case 1:** Pass 1 + Symbol Table + Common support routines + overlay driver, which requires, $100 + 50 + 20 + 10 = 180K$
- **Case 2:** Pass 2+ Symbol Table + Common support routines + overlay driver, which requires, $120 + 50 + 20 + 10 = 200K$

We require maximum of case 1 and case 2 memory. Thus we need 200 K of memory for the assembler.

Q. 75 *Operating Systems*
Ans: 2

- We get good locality of reference when using stack and sequential search. In case of stack we always access top of the stack. In case of sequential search, we always access elements which are sequential.
- Hash and Pointer(Indirection) are designed to scattered references and have bad locality of reference.

Q. 77 *Programming Language*
Ans: 3
The program invocation is given below: The * prints the values in order i.e. 6 9 9

LineNo	k-glob	fun(k)	gun(k)
15	2	-	-
9	2	-	4
10	2	-	6*
3	9	9*	-
17	9*	-	-

Q. 78 *Programming Language*
Ans: 2

LineNo	k-glob	fun(k)	gun(k)
15	2	-	-
10	2	-	6
3	2	12*	-
12	2	-	12*
17	2*	-	-

Q. 76 *Programming Language*
Ans: 3
Draw the invocation graph :

```
1234
|- 4          ** prints 4
|- 123
    | - 3     ** prints 3
    |- 12
        |- 2  ** prints 2
        |- 1  ** prints 1
```

Essentially it prints digits of a number in reverse order.

Q. 79 *Programming Language*
Ans: 4
$*s1$ is a variable and the location it points to is allocated on a heap and hence is not a variable location and hence strcpy can not be used at that location. The location where s1 is pointing can be changed, i.e. value of $s1$ can be changed but not the contents at location pointed to by $s1$.

In $s1[]$, $s2$ is pointing to a location which is allocated at on a stack and each of the location is a variable. Here $s2$ points to a fixed location and can not be changed but each of the location contents is considered as a variable and hence strcpy can be used here. For details*ref. Kerninghan and Ritchie.*

Q. 80 *Programming Language*
Ans: 1
line 5 expands to:

```
c = a=a+b, b=a-b, a=a-b
```

Hence, c is assigned value of `c = a=a+b`, which is `( 2 + 5) = 7` Note that here , operator is not coming into picture. Rest is trivial.

Q. 81 *Engg Maths*
Ans: 1

P(chip defective | declared defective) =
$$\frac{P(\text{declared defective} \mid \text{defective}).P(\text{defective})}{P(\text{declared defective})}$$

p(declared defective) = p(declared defective | defective) . p(defective) + p(declared defective | good) . p(good)

$$= 0.94.0.02 + 0.05.0.98 = 0.0678$$

p(chip defective | declared defective) =

$$= 0.0188/0.0678 = 0.27 = 27\%$$

Q. 82 *Engg Maths*
Ans: 2

$$\begin{aligned} P(X > 240) &= 1 - P(X \leq 240) \\ &= 1 - Fz(\frac{240 - 200}{256^{0.5}}) \\ &= 1 - Fz(2.5) = 0.00621 \end{aligned}$$

Q. 83 *Hardware*
Ans: 1

Q. 84 *Hardware*
Ans: 3
The time required for serial/unpipelined execution is sum of time taken for execution in each of the functional unit:

$$10 + 8 + 10 + 10 + 7 = 45\ ns$$

Time required for pipelined execution = The time for largest clock cycle + Pipeline overhead = $10 + 1 = 11\ ns$

Thus, the speedup is $45/11 = 4.1\ ns$

Q. 85 *Engg Maths*
Ans: 1

$$\begin{aligned} P(X \geq 240 | X \geq 210) &= \frac{p(x \geq 240)}{p(x \geq 210)} \\ &= \frac{1 - F_z(\frac{240-200}{16})}{1 - F_z(\frac{210-200}{16})} \\ &= \frac{0.00621}{0.265} \\ &= 0.023 \end{aligned}$$

Q. 86 *Engg Maths*
Ans: 4
The characteristic equation of matrix is

$$\begin{aligned} (A - \lambda I)x &= 0 && (18) \\ &= \begin{bmatrix} 2 & 3 \\ 3 & -6 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} && (19) \\ 0 &= (2 - \lambda)(6 - \lambda) - (3)(3) && (20) \\ 0 &= \lambda^2 + 4\lambda - 21 && (21) \end{aligned}$$

which has roots 3 and -7, which are eigen values.

Q. 87 *Data Structure and Analysis*
Ans: 3
Given, Min. number of nodes with height

$$nh = 1 \quad (22)$$

Number of nodes upto height

$$nh_{i-1} = 2^{h-1} - 1 \quad (23)$$

Thus, the min. number of nodes at at height = Eq.(16) + Eq.(17)

$$= (2^{h-1} - 1) + 1 = 2^{h-1}$$

The maximum number of nodes at height = $2^h - 1$.
Thus, the option is 3.

Q. 88 *Programming Language*
Ans: 2
Here 5/9 evaluates to 0 and hence complete expression return 0.

Q. 89 *Databases*
Ans: 3

- `select c.name`: select name of customers

- `a1.cid = c.cid and a2.cid = c.cid`: This is to make sure that both accounts are of same customer. but at the same time actual accounts are different.
- `a1.type = 'current' and a2.type = 'savings'`: The two account types are different, current and savings
- `a1.branchid <> a2.branchid` : The two accounts are in different branches.

So, name of customers with different types of accounts at different branches.

Q. 90 *Databases*
Ans: 4
We need to have two sub-queries, one returning number of current accounts and other for savings.

Also, we need to connect the sub-queries with outer query. Thus, the format should be: outer query with select for name, first sub-query with current accounts connecting branch names second sub-query with savings accounts connecting branch names.

Connecting mean, we need to use branch name of outer query in the sub-query so that inner query returns number for the same branch.

Answers GateGenie Practice Test No. 3

Answers: Test No. 3

Q. 01 *Engg Maths*
Ans: 3

Q. 02 *Engg Maths*
Ans: 3
In case of triangular matrix, the value of determinant is equal to multiplication of diagonal elements.

$$2 * 6 * 7 * 3 = 252$$

i.e. 3

Q. 03 *Engg Maths*
Ans: 1

Q. 04 *Engg Maths*
Ans: 2
The correct statement is that D and $\{A\}$ are members of set B. $\{D, \{A\}\}$ will be present in power set of B ($2^{\{B\}}$). $\{\{A\}\}$ is subset of B.

Q. 05 *Hardware*
Ans: 3
In 1's complement system there are two arithmetic zeroes: $+0$ and -0

Q. 06 *Hardware*
Ans: 1

Q. 07 *Hardware*
Ans: 3

Q. 08 *Hardware*
Ans: 2
The average latency to desired information is halfway around the disk.

Rotations per min = 7200
Rotations per sec = 120
Time required for 1 rotation = $\frac{1}{120}$ sec

The average rotation time = $\frac{0.5}{7200}$ = 4.2 ms

Q. 09 *Theory of Computation*
Ans: 2
The answer follows from definition of DFA. NFA has transition function which maps to 2^Q.

Q. 10 *Theory of Computation*
Ans: 4

Q. 11 *Theory of Computation*
Ans: 1

Q. 12 *Data Structure and Analysis*
Ans: 2

Q. 13 *Data Structure and Analysis*
Ans: 3

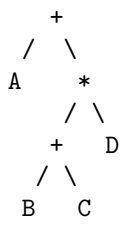
Q. 14 *Theory of Computation*
Ans: 3
If you know the way binary is calculated then its quite obvious. If you are not sure, here is how you can approach the problem:

dec2bin has to reduce for every recursive call, hence has to be `/` . A %2 operation provides lsb of the binary representation i.e. 0 or 1. Hence % in printf.

Q. 15 *Programming Language*
Ans: 2
it will increment like: `1 2 4 8 16 32 64`

Q. 16 *Data Structure and Analysis*
Ans: 2

Q. 17 *Data Structure and Analysis*
Ans: 4
First make groups using parenthesis. Easiest way to solve such problems is to form the expression tree and then take pre-order(pre-fix), in-order(in-fix), post-order(post-fix). Here is the way to construct the tree of expression:



Take the in-order and you have the answer.

Q. 18 *Computer Networks*
Ans: 1
Repeater has the least processing delay because it just takes a packet and transmits the regenerated frame.

Q. 19 *Compilers*
Ans: 2

Q. 20 *Compilers*
Ans: 4
Context free languages are accepted by PDA. For first three languages we could design PDA which accepts strings from these languages.

1. For the first language, PDA pushes n a's on stack and pop a on each occurrence of b. When it sees c, it pushes it on stack and pop c on each occurrence of d.

2. For second language, PDA pushes a and b on stack and pop b on occurrence of c and a on getting d.

3. Third language is similar to first.

4. For fourth we could not design PDA, hence it is not CFL.

Q. 21 *Compilers*
Ans: 3

Q. 22 *Compilers*
Ans: 3

Q. 23 *Operating Systems*
Ans: 3

Q. 24 *Operating Systems*
Ans: 4

Q. 25 *Operating Systems*
Ans: 2

Q. 26 *Operating Systems*
Ans: 3
It satisfies Hold and Wait condition necessary for deadlock occurrence.

Q. 27 *Databases*
Ans: 1

Q. 28 *Databases*
Ans: 3

Q. 29 *Computer Networks*
Ans: 3
255.255.240.0 is

11111111.11111111.11111000.00000000

The number of bits left is = No. of zeros = 3 + 8 = 11. The number of hosts that can be handled by each subnet is $2^11 - 2$ since 0 and -1 are reserved. Thus, we have in all 2048-2 = 2046 host handling capacity.

Q. 30 *Computer Networks*
Ans: 2

- **Improved security** - Subnetting will allow an organization to separate internal networks on the internetwork but will not be visible to external networks.
- **Isolation of network traffic** - With the help of routers and subnetting, network traffic can be kept to a minimum.

Q. 31 *Databases*
Ans: 3

Q. 32 *Databases*
Ans: 3
Consider:

- **X = (S left outer join R)**: This will have 100 rows, with `d = null` for $40 (= 100 - 60)$ rows.
- **X full outer join T**: Here the common values of d in tables X and T can be between 50 and 60.
    1. **Minimum value of common values of d between X and T**:
    Out of 80 values of d in R, 20 were not found in X (since X has only 60 non-null values of d). These 20 can all be the ones that were common between X and T In this case the common values between X and T will be 50.

2. **Maximum value of common values of d between X and T:**
   Now assume that 20 values of d that were lost, none was common between S and T. But this is not possible, because S has 80 tuples and 70 values are common with T. So at least 10 common values will get lost. Thus max. value of common d's will b 60.

Now full outer join ($X + T$ - common values of d in X and T) will be either 100 + 90 - 50 or 100 + 90 - 60. Thus the answer is 140,130. Hence 3.

Q. 33 *Engg Maths*
Ans: 2
The answer is directly from standard formula for GCD.

Q. 34 *Engg Maths*
Ans: 4

1. Since $R(A_1 \cup A_2) = R(A_1) \cup R(A_2)$, statement 1 and 3 are correct.
2. $R(A_1 \cup A_2) \subseteq R(A_1) \cap R(A_2)$ is true. Now, if $y \in R(A_1 \cap A_2)$ then $\exists x \in R(A_1 \cap A_2)$, xRy. Since $x \in A_1$ and $x \in A_2$, it follows that $y \in R(A_1)$ and $y \in R(A_2)$. So $y \in R(A_1) \cap R(A_2)$.

Q. 35 *Engg Maths*
Ans: 2
Taking advantage of 0s in third column, start cofactor expansion down the third column to obtain 3×3 matrix.

$$= (-1)^(1+3) * 2 * \begin{bmatrix} 0 & 3 & -4 \\ -5 & -8 & 3 \\ 0 & 5 & -6 \end{bmatrix} \quad (24)$$

$$= 2 * (-1)^{2+1} * -5 * \begin{bmatrix} 3 & -4 \\ 5 & -6 \end{bmatrix} \quad (25)$$

$$= 20 \quad (26)$$

Q. 36 *Engg Maths*
Ans: 3
Suppose

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

A is invertible if $ad - bc \neq 0$.

$$A^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

Substituting appropriate values, $a = 3 = 4 = 5$and $= 6$ we get (3) as answer.

Q. 37 *Engg Maths*
Ans: 1

Q. 38 *Engg Maths*
Ans: 4
The question is based on standard properties of implication operations, universal and existential quantifiers. The 4th statement is incorrect. The correct form of 4 is:

$$\exists x,\ p(x) \rightarrow \forall x,\ q(x) \equiv \forall x,\ (p(x) \rightarrow q(x))$$

Q. 39 *Engg Maths*
Ans: 1

Q. 40 *Computer Networks*

Ans: 3
Total packet size transmitted over the network

$$= 512 + 10 + 20 + 30 = 572 \text{ bytes}$$

At 10 Mbps, 572 bytes take $572 * 8 * 10^{-7}$ seconds. The actual data transferred is 512 bytes, so time taken to transmit 512 bytes is $(572/512) * 10^{-7}$ seconds. The number of bits transmitted per second

$$= \frac{512}{572} * 10^7 = 8.95 \; Mbps$$

Thus, the answer is (3).

Q. 41 *Computer Networks*
Ans: 4

Q. 42 *Computer Networks*
Ans: 2
The Round Trip Time (RTT) of the system is

$$\begin{aligned} RTT &= 2 \times \frac{5 \; km}{2 \times 10^5 \; km/sec} \\ &= 50 \; microseconds \end{aligned}$$

In order for collision detection to function properly, the time for sending a packet should be more than the RTT. Thus, the minimum frame size =

$$\frac{50 * 10^{-6} * 100 * 10^6}{8} = 625 \; bytes$$

Q. 43 *Hardware*
Ans: 1
NOR is not associative. Consider LHS and RHS of statement 1, we get

$$\begin{aligned} LHS &= (X \odot Y) \odot Z \\ &= ((x+y)' + z)' = xz' + yz' \\ RHS &= X \odot (Y \odot Z) \\ &= (x + (y+z)')' = x'y + x'z \end{aligned}$$

LHS not equal RHS. Hence it is false.

Q. 44 *Hardware*
Ans: 3

Q. 45 *Hardware*
Ans: 2
In order to implement the function of 3 variables with 4:1 mux, we need to do the following trick: note that the bold numbers gives output 1:

	I_0	I_1	I_2	I_3
A'	0	**1**	**2**	3
A	4	**5**	**6**	7
	0	1	A	A'

In first column, since both the values are 0, we put 0, in second one, both are 1, hence we put 1 in the bottom, in third one, only below term is 1, hence A and in last column, upper term is 1, hence A'. The mux will have $I_0 = 0$, $I_1 = 1$, $I_2 = A$ and $I_3 = A'$ and $S_1 = B$ and $S_0 = C$.

Q. 46 *Programming Language*

Ans: 4
count is defined to be automatic int and for that default value is undefined. It is not initialized. Hence the contents of count will be some random value, or garbage.

Q. 47 *Theory of Computation*
Ans: 1

- When we construct multi-tape TM from single tape TM, we use $2k$ tracks per tape for multi-tape TM, where k is number of tracks in single tape TM.
- While simulating multi-tape TM on a single tape TM, the head has to move at least $2k$ cells per move. Thus for k moves, we get

$$\sum_{i=1}^{k} 2i = 2k^2$$

  which means quadratic slowdown. Thus acceptance by multi-tape is faster by $O(n^2)$.

Q. 48 *Theory of Computation*
Ans: 1
Since M halts on w, L is recursive. From theorem, for a pair of language, L and L', which are complementary, then

- both are recursive
- neither of them are recursively enumerable
- one of them is recursively enumerable but not recursive, the other one is not recursively enumerable.

Since L is recursive, L' has to be recursive.

Q. 49 *Theory of Computation*
Ans: 2

$$V = \{S, [q_0, X, q_0], [q_0, X, q_1], [q_1, X, q_1], [q_1, X, q_0], [q_0, Z_0, q_0], \\ [q_0, Z_0, q_1], [q_1, X, q_0], [q_1, X, q_1]\}$$

Q. 50 *Theory of Computation*
Ans: 1

We need to construct CFG using rules for converting grammar accepted by PDA to CFG.

- Add a start state based on start state and initial symbol on PDA stack. Identify the states, which contains $[q_0, Z, *]$, * means any states, then such state is added as part of initial production.

$$S \to [q_0, Z_0, q_0] S \to [q_0, Z_0, q_1]$$

- For transition, $(q_0, 0, Z_0) = q_0, XZ_0$, the following productions will be added:

$$\begin{aligned}
[q_0, Z_0, q_0] &\to 0\,[q_0, X, q_0]\ [q_0, Z_0, q_0] \\
[q_0, Z_0, q_0] &\to 0\,[q_0, X, q_1]\ [q_1, Z_0, q_0] \\
[q_0, Z_0, q_0] &\to 0\,[q_0, X, q_1]\ [q_1, Z_0, q_0] \\
[q_0, Z_0, q_0] &\to 0\,[q_0, X, q_0]\ [q_0, Z_0, q_1] \\
[q_0, Z_0, q_0] &\to 0\,[q_0, X, q_0]\ [q_1, Z_0, q_1]
\end{aligned}$$

  Remember the simple trick here:

  When $(q_0, 0, Z_0) = q_0, XZ_0$ is production, Left of production is $[q_0, Z_0, q_0]$, the first q_0 is from $(q_0, 0, Z_0)$ and second q_0 is from q_0, XZ_0.

Now get all states, which have form $[q_0, X, *][*, Z_0, *]$ Similarly add productions for the

$$(q_0, 0, X) = q_0, XX.$$

- Special case, for $(q_0, 1, X) = q_2, \epsilon$, then add $[q_0, X, q_1] \to 1$.
  Add $[q_1, X, q_1] \to 1$ for $(q_1, \epsilon, X) = q_1, \epsilon$
- Removing variables which doesn't have any production. Removing productions involving such variables.

The productions for the above N(M) is:

$$\begin{aligned}
S &\to [q_0, Z_0, q_1] \\
[q_0, Z_0, q_1] &\to 0\,[q_0, X, q_1]\ [q_1, Z_0, q_1] \\
[q_1, X, q_1] &\to 0\,[q_0, X, q_1]\ [q_1, X, q_1] \\
[q_0, X, q_1] &\to 1 \\
[q_1, X, q_1] &\to 1 \\
[q_1, Z_0, q_1] &\to \epsilon \\
[q_1, X, q_1] &\to \epsilon
\end{aligned}$$

Q. 51 *Theory of Computation*
Ans: 2
The automata D can be constructed as:

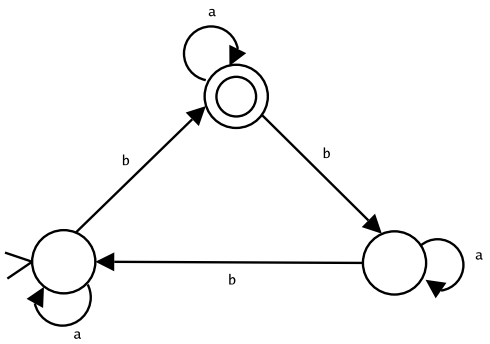


Figure 44: Fig. for Q. 51

Q. 52 *Theory of Computation*
Ans: 3
L is CFL. To check ambiguity, consider a string generated by the language: *aabaaa*. There is a single parse tree/leftmost derivation to get this string. Hence it is not ambiguous.

Q. 53 *Data Structure and Analysis*
Ans: 1
Basic starting point could be to look for degree of nodes and then try to match the points. If it does then try if the edges are between possible matching points.

Q. 54 *Programming Language*
Ans: 2
Addition is $O(n^2)$ and Multiplication is $O(n^3)$.

Q. 55 *Computer Networks*
Ans: 4

The subnet mask is always extended by masking off the next bit in the address, from left to right. Thus, the last octet in the subnet mask will always be one of these: 128, 192, 224, 240, 248, 252, 254 or 255.

Q. 56 *Data Structure and Analysis*
Ans: 2

$$\frac{\binom{2n}{n}}{n+1} = 14$$

Q. 57 *Data Structure and Analysis*
Ans: 2

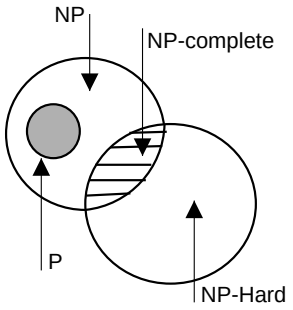
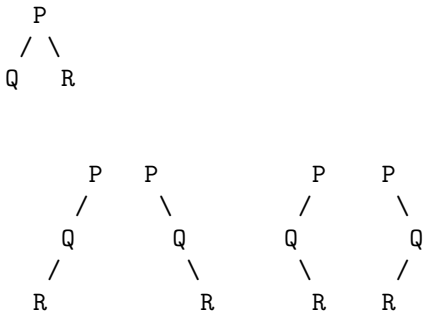


Figure 45: Fig. for Q. 57

Q. 58 *Data Structure and Analysis*
Ans: 2

Q. 59 *Data Structure and Analysis*
Ans: 4
As 33 is added, it has to be right of 30, and then to the left of 36

Q. 60 *Data Structure and Analysis*
Ans: 4
Possible 5 ways are:



Q. 61 *Data Structure and Analysis*
Ans: 2
Column major format will be

1,1	2,1	3,1	...
1,2	2,2	3,2	...

Hence, any entry (i, j) will have access pattern: col. no * number of cols + row. no , i.e ans 2

Q. 62 *Data Structure and Analysis*
Ans: 4
We need to find best sequence, means best route between cities which essentially related to shortest-paths.

Q. 63 *Data Structure and Analysis*
Ans: 2
As only left parentheses are stored on to the stack, there can be max. of 2 parentheses on the stack.

Q. 64 *Data Structure and Analysis*
Ans: 2
As the Minimum number of edges are 2, which can connect three nodes which will require 2 color and rest all the nodes can be colored with any of the color as they are not connected, the ans. is 2.

Q. 65 *Compilers*
Ans: 2

Q. 66 *Compilers*
Ans: 3

Q. 67 *Compilers*
Ans: 2

1. Statement 1 - $R_1 = R_2$ is correct, since

$$\begin{aligned} R_1 &= (a \mid b)^* = (a^*b^*)^* \\ R_2 &= (aa^*|bb^*)^* = ((aa^*)^*(bb^*)^*)^* \\ &= (aa^*bb^*)^* = (a^*b^*)^* \end{aligned}$$

2. Statement 2: Looking at argument of statement 1, statement 2 is false since $R_1 = R_2$

3. Statement 3:

$$\begin{aligned} R_1 &= (a^*b^*)^* \\ R_2 &= (a^*b^*)^* \\ R3 &= ((\epsilon; |a)b^*)^* = (b^*|ab^*)^* = \\ &= (b^{**}|(ab^*)^*) = (b^*ab^*)^* \end{aligned}$$

   Thus

$$R_3 \subseteq R_1 \text{ and } R_3 \subseteq R_2$$

4. Statement 4: $R_1 = R_2 \quad \Rightarrow (R_1 \subseteq R_2 \text{ and } R_2 \subseteq R_1)$.

Q. 68 *Compilers*
Ans: 2
The rules for FIRST(X) are:

- Rule 1: If X is a terminal, then FIRST(X) = X.
- Rule 2. If there is production $X \to Y_1Y_2 \ldots Y_n$, then place a in FIRST(x) if, for some i, a is in FIRST(Y_i) and ϵ is in all of FIRST(Y_1), ..., FIRST(Y_{i-1}). If FIRST(Y_i) = ϵ; for $i = 1, 2, \ldots, n$, then add ϵ to FIRST(X).

To calculate, FIRST(E),

- Rule 1 is not applicable, since E is non-terminal.

- Apply rule 2 to production $E \to TE'$.

$$\text{FIRST}(E) = \text{FIRST}(T) = \text{FIRST}(F) = \{(, id\}$$

The answer is 2.

Q. 69 *Compilers*
Ans: 3

Sr.	Input	state	val	Production used
0	3*5+4n	-	-	
1	*5+4n	3	3	
2	*5+4n	F	3	$F \to digit$
3	*5+4n	T	3	$T \to F$
4	5+4n	T*	3	
5	+4n	T*5	3 _ 5	
6	+4n	T*F	3 _ 5	$F \to digit$
7	+4n	T	15	$T \to T * F$
8	+4n	E	15	$E \to T$
9	4n	E+	15 _	
10	n	E+4	15 _ 4	
11	n	E+F	15 _ 4	$F \to digit$
12	n	E+T	15 _ 4	$T \to F$
13	n	E	19	$E \to E + T$
14		E n	19 _	
15		L	19	$L \to En$

The total number of moves are 15.

Q. 70 *Compilers*
Ans: 3

Q. 71 *Operating Systems*
Ans: 4

- The selection of time quantum does affect turn around time, and performance of round robin scheduling.
- Context will be switched at the end of time quantum, so the frequency of context switch goes up.

The answer is 4 as all the three factors are affected by time quantum.

Q. 72 *Operating Systems*
Ans: 2
Note that the array is stored in row major form. That is one row is stored in a page. Since the array is accessed in column major form i.e. loop on j is outer loop, each access $A[i][j]$ generates a page fault, as it refers to new row each time. Thus, the total number of faults =

$$128 * 128 = 16384$$

Q. 73 *Operating Systems*
Ans: 4
The virtual address in binary form is

$$00010001000100100011010001010110$$

Since the page size is 2^{12}, the page table size is 2^{20}. Therefore the low-order 12 bits

$$010001010110$$

are used as the displacement into the page, while the remaining 20 bits

00010001000100100011

are used as the displacement in the page table.

Q. 74 *Operating Systems*
Ans: 1
Effective access time = memory access time + page fault rate × (probability of empty or unmodified page × time to access empty or unmodified page + probability of page modification × time to access modified page)

We have been given that,
Effective access time = 0.20 microsecond
Memory access time = 0.1 microsecond
Probability of empty or modified page = 0.1
Time to access empty or unmodified page = 8000 microseconds
probability of modified page = 0.7
Time to access modified page = 20000 microseconds

Substituting these values in the formula, we get,

$$0.2 = 0.1 + P(0.3(8000) + 0.7(20000)) \Rightarrow P = 6.1 \times 10^{-6}$$

Q. 75 *Operating Systems*
Ans: 2
The reference string needs to be constructed first. Since the page is of 100 bytes each, we have a reference string,

1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6

If we apply LRU replacement algorithm with 5 frames, we get 8 page faults.

Q. 77 *Programming Language*
Ans: 3
One good way of solving such problems is to first find the aliases and then solve them. Following are the aliases:

- `global x == Q(x)`
- `P(x) == Q(z)` for function P
- `global x == Q(z)` for main function

```
Pgm. Flow:          Global x/Q(x)/P(y)   P(x)/Q(z)-for P
main-14                   3              Undefined
P   - 8                   3                 6
Q   - 2                   3                 6
Q   - 3                   3                 9
P   -10                   3                 9 *(print)
main-16                   3                 -
Q   - 2                   3                 -
Q   - 3                   6  *(print)
```

Q. 76 *Programming Language*
Ans: 4
Two arrays after series of operations will be:

```
Index 1  2  3  4
q     3  4  2  1
p     4  3  1  2
```

Hence, take index 2,3,4 for both.

Q. 78 *Programming Language*
Ans: 1

```
k   j    j % k
2   8      0
3   7      1
4   6      2
5   5      0
```

Q. 79 *Programming Language*
Ans: 2

```
c = a + b
z = (x + (x*y) )
x=2
y =5
z=12
```

Q. 80 *Programming Language*
Ans: 4

```
3 5 + 3 2 2 * + +
8 3 2 2 * + + ( max depth=4)
8 3 4 + +
8 7 +
15
```

Q. 81 *Engg Maths*
Ans: 3

Q. 82 *Engg Maths*
Ans: 4

Q. 81 *Hardware*
Ans: 4

$$\text{Performance of machine} = 1 \,/\, \text{execution time}$$

Thus, Perf A / Perf B = Exec. Time B/Exec. Time A

$$= 15/10 = 150\%$$

A is 50% faster than B i.e. 4

Q. 82 *Hardware*
Ans: 1
Avg. disk access = avg. seek time + avg. rotational delay + transfer time + controller overhead

Given,
avg. seek time = 9 ms.
avg. rotational delay = 0.5/7200 = 4.15 ms
transfer time = 0.5 KB/4 MB/sec = 0.125 ms
controller overhead = 1 ms

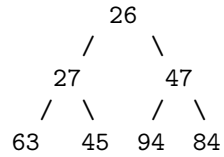
Avg disk access = 9 + 4.15 + 0.125 + 1 = 14.3 ms

For more explanation on avg rotational delay look at explanation of question 8.

Q. 85 *Engg Maths*
Ans: 2
A semi-group by definition is closed and associative.

Q. 86 *Engg Maths*
Ans: 4

Q. 87 *Data Structure and Analysis*
Ans: 1
Final Heap will be:

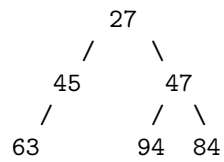


You even need not construct the tree. The simplest way is that there are 7 nodes, i.e. 6 nodes for left and right subtree. For a heap, its quite obvious that the division has to be 3-3, as heap is a complete binary tree.

Q. 89 *Databases*
Ans: 4
Need to consider following things for the query:

- Volatility mean up or down of 10 % = 1.10 or 0.90 times the last closing value.
- today = the Volatility is for today, hence need to check for transdate = today()

Q. 88 *Data Structure and Analysis*
Ans: 2



Q. 90 *Databases*
Ans: 2
Query can be inferred by analyzing line by line

- Select clause: what it prints, this also has the hint that its the last date which is printed
- from - self join and hence must be some thing related to two shares, mostly comparing some values
- where - `s1.currentclosing = s2.currentclosing` Two closing amounts are same
- `s1.transdate <> s2.transdate` the transaction dates are different
- `and s1.name = s2.name` for the same share
- `and s1.transdate = today()` One of the transaction dates id today.

So, to club all inferences together, it selects the last date when a share whose closing values is same as todays closing value.

Answers GateGenie Practice Test No. 4

Answers: Test No. 4

Q. 01 *Engg Maths*
Ans: 2
$A = \{M, I, S, S, I, S, S, I, P, P, I\} \Rightarrow \mid A \mid = 11$

Q. 02 *Engg Maths*
Ans: 2
The total words = 6
Repetition frequency per word = N:2, A:3, B:1
No of permutation

$$= \frac{6!}{3!2!1!} = 60$$

Q. 03 *Engg Maths*
Ans: 3
Each pair of vertex determine an edge. The number of edges =

$$\binom{n}{2} = \frac{n * (n-1)}{2} = \frac{12.11}{2} = 66$$

Q. 04 *Engg Maths*
Ans: 3
The partial order is reflexive and antisymmetric, which means that aRb and bRa iff $a = b$. This implies that there is only one cycle starting at a and ending at a, which is a self loop of a to itself. For example, if $A = \{a, b, c\}$ then $R = \{(a, a), (b, b), (c, c)\}$. This means a self loop at each of a, b and c.

Q. 05 *Hardware*
Ans: 1

Q. 06 *Hardware*
Ans: 1

Q. 07 *Hardware*
Ans: 1

Q. 08 *Hardware*
Ans: 1

Q. 09 *Theory of Computation*
Ans: 2

Q. 10 *Theory of Computation*
Ans: 4
Since L is acceptable by multi-tape Turing machine, it is recursive. The complement must also be then recursive.

Q. 11 *Theory of Computation*
Ans: 1

Q. 12 *Programming Language*

Ans: 4
Because the variables are allocated at run time for every invocation of a procedure, it can support recursion.

Q. 13 *Data Structure and Analysis*
Ans: 1

- 1 Element: (1,1)
- 2 Elements: (2,1) (2,2)
- 3 Elements: (3,1) (3,2) (3,3)

This can be related to

$$(\sum_{i=0}^{n} i) + j$$

Hence option 1. The final representation will be:

(1,1)	(2,1)	(2,2)	(3,1)	(3,2)	(3,3)	...
1	2	3	4	5	6	...

Q. 14 *Programming Language*
Ans: 4

Q. 15 *Programming Language*
Ans: 3
Union A will required max(2,4)=4 bytes and num will req. 2 bytes. So total is 6 bytes each for A. Hence 30 * 6 = 180. **Q. 16** *Programming Language*
Ans: 2

Q. 17 *Programming Language*
Ans: 2

Q. 18 *Programming Language*
Ans: 4

Q. 19 *Compilers*
Ans: 1

Q. 20 *Compilers*
Ans: 2
Since the modules are loaded in the order 100, 500, 400 and 200.

1. The first module of 100 words will be loaded at relative address 0.
2. The second one will be at relative address 100 (0+length of first module) = 0 + 100 = 100,
3. The third one will be at address = 0 + length of first module + length of second module = 0 + 100 + 500 = 600
4. Similarly, the fourth one at address = 0 + 100 + 500 + 400 = 1000.

The relocation constants are 0, 100, 600, 1000 i.e. 2

Q. 21 *Compilers*
Ans: 1
Q. 22 *Compilers*
Ans: 3

Q. 23 *Operating Systems*
Ans: 3

- Since the process acquires all the resources in the beginning, they will remain idle for most part of execution. This leads to lesser device utilization.
- The side-effect of this is several popular resources will be acquired in the beginning by some process, other processes will not able to get them. This may lead to starvation.

Thus, the scheme results in both lesser device utilization as well as starvation i.e. 3.

Q. 24 *Operating Systems*
Ans: 4
Since the set of pages in memory for earlier case is always subset of the later case (after increasing frames), the algorithm does not suffer from Belady's anomaly. The algorithm which does not suffer from such anomaly are known as **stack class of algorithms**. The examples are LRU and Optimal. However, FIFO algorithm exhibits Belady anomaly.

Q. 25 *Operating Systems*
Ans: 2

Q. 26 *Operating Systems*
Ans: 2
The disk is utilized heavily and the CPU is lightly loaded in the given situation.

- The situation like this one: more time in disk I/O and lesser CPU utilization indicates that the system is trashing.
- Increasing degree of multiprogramming in this situation will increase trashing and decrease CPU utilization.

We need to tackle trashing either by reducing degree of multiprogramming by swapping out some of the processes. Adding faster disk will not solve the problem. The correct conclusion is that the system is trashing i.e. 2.

Q. 27 *Databases*
Ans: 4
Q. 28 *Databases*
Ans: 1
Q. 29 *Computer Networks*
Ans: 1

Q. 30 *Computer Networks*
Ans: 4
A gateway because it converts the whole protocol stack to another one

Q. 31 *Databases*
Ans: 3
The schedule is equivalent to

1. $T_1\ T_4\ T_3\ T_2$ and
2. $T_1\ T_3\ T_4\ R_2$

Precedence graph is:

$$T_1 \rightarrow T_3 \rightarrow T_2 \rightarrow T_4$$

Q. 32 *Databases*
Ans: 3

Q. 33 *Engg Maths*
Ans: 2

Q. 34 *Engg Maths*
Ans: 3
The method is as follows:

- Calculate derivative of function, $f'(x) = 2x$
- Repeat
  - Calculate value of function with $x = 7$ for $f(x)$ and $f'(x)$
  - if $f'(x)$ is small, then return x_0
  - $x_1 = x_0 - (f(x)/f'(x))$
  - if $|(x_1 - x_0)/x_1| <$ threshold then return x_1 (convergent solution)
  - $x_0 = x_1$
- For ever

The procedure is simple:

Iteration #	x_0	x_1	$f(x)$	$f(x')$
1	7	5.285	24	14
2	5.285	5.007	2.93	10.57

The roots after iteration 2 is $x_1 = 5.007$

Q. 35 *Engg Maths*
Ans: 1
Eigen values of triangular matrix are entries in the diagonal: 4, 0 and -3

Q. 36 *Engg Maths*
Ans: 2
Leave out the number 100000, we have numbers between 1 to 99999. Now the problem boils down to finding number of strings of 5 digits having sum 7. Consider sum as a set of balls to be put in 5 distinguishable bins. We have to put $n = 7$ balls in $k = 5$ distinguishable bins. This can be done in

$$\binom{n+k-1}{k-1} = \binom{11}{4} = 330$$

Q. 37 *Engg Maths*
Ans: 4
This follows directly from central limit theorem. The central limit theorem is given as below:
For independent random variables $X_1, X_2, \ldots, X_n$ with mean μ_i and variance σ_i

$$Z_n = \frac{\sum X_i - \sum \mu_i}{(\sum \sigma_i^2)^{0.5}}$$

Putting values,

$$\begin{aligned} Z_n &= \frac{nX' - n\mu}{(n\sigma^2)^{0.5}} \\ &= \frac{nX' - n\mu}{n^{0.5} * \sigma} \\ &= \frac{(X' - \mu) * n^{0.5}}{\sigma} \end{aligned}$$

Q. 38 *Engg Maths*
Ans: 3
The examination of relation shows the following equivalence classes,

$$\begin{aligned}[1] &= \{1,5\} \\ [2] &= \{2,3,6\} \\ [4] &= \{4\}\end{aligned}$$

Thus the partition of A induced by R is denoted by option 3:

$$\{\{1,5\},\{2,3,6\},\{4\}\}$$

Q. 39 *Engg Maths*
Ans: 4
The number of partitions on a set S of n elements into k cells is given by the formula,

$$\begin{aligned}f(n,k) &= f(n-1,k-1) + kf(n-1,k) \\ f(n,n) &= f(n,1) = 1\end{aligned}$$

This gives rise to Pascal triangle. Thus, on a set having cardinality 6, 90 partitions are possible.

$$1 + 31 + 90 + 65 + 15 + 1 = 203$$

Q. 40 *Computer Networks*
Ans: 3

Q. 41 *Computer Networks*
Ans: 2
Given
Packet size = 1 KB = $1 \times 1,024 \times 8$ bits = $8,192$ bits
1.5 Mbps = 1,500,000 bits/s
RTT = 100 ms = 0.1 s

Transmit time per packet = Size of packet/Bandwidth

$$\begin{aligned}&= 8,192\ bits/1,500,000\ bits/s \\ &= 0.00546\ s = 5.46\ ms\end{aligned}$$

Total number of packets to be sent = Size of file / Packet size = 1,000 KB / 1 KB = 1,000

Transmit time for all packets = Transmit time per packet × Number of packets = 5.46 ms × 1000 = 5.46 seconds

Total time = Initial 2 RTT + Transmit time for all packets + Propagation + (1000-1) × Time between two successive transmissions
= 2 × RTT + Transmit time for all packets + RTT/2 + 999 × RTT

$$\begin{aligned}&= 2 \times 0.1\ s + 5.46\ s + 0.1\ s/2 + 999 \times 0.1\ s \\ &= 0.2\ s + 5.46\ s + 0.05\ s + 99.9\ s \\ &= 105.61\ sec\end{aligned}$$

Q. 42 *Computer Networks*
Ans: 1
Given
Packet size = 1 KB = 1 × 1,024 × 8 bits = 8,192 bits
Total number of packets to be sent = Size of file / Packet size
= 1,000 KB / 1 KB

RTT = 100 ms = 0.1 s

Since the channel has infinite bandwidth, we can assume the transmission time of a packet to be zero.

We need to send 1000 packets, we will need 1000 / 20 = 50 RTTs to transmit all the data, but note that for the last 20 packets we only need (RTT/2). This is because the first of the 20 packets in the last batch will be received by RTT/2. Since the bandwidth is infinity, all packets can be assumed to have reached the destination within RTT/2 time. So the total RTTs required are 49.5.

Total time = Initial 2 RTT + Required RTTs

$$\begin{aligned} &= 2 \times RTT + 49.5 \times RTT \\ &= 51.5 \times RTT \\ &= 51.5 \times 0.1\ s \\ &= 5.15\ sec \end{aligned}$$

Q. 43 *Hardware*
Ans: 2
We measure the average instruction time on both the machines to access speedup or slowdown.

$$\text{Avg. instruction time} = \text{CPI} \times \text{clock cycle time}$$

- Since there are no stalls/hazards, the average instruction time for ideal machine is the clock cycle times.
- The average clock cycle time for the machine with 40% structural hazard

$$\begin{aligned} &= (1 + 0.4 \times 1) \times \texttt{ideal clock cycle time}/1.05 \\ &= 1.3 \times \texttt{ideal clock cycle time} \end{aligned}$$

  Machine without structural hazard is 1.3 times faster.

Q. 44 *Hardware*
Ans: 1
Hashed symbol table produces randomized references producing bad locality. The binary search tries to search for middle element which is not sequential access. The pure code is good in demand paging environment.

Q. 45 *Hardware*
Ans: 1
In order to implement the function of 3 variables with 4:1 multiplexer(Mux), we need to do the following trick: note that the bold numbers gives output 1:

	I_0	I_1	I_2	I_3
A'	0	**1**	2	**3**
A	4	**5**	**6**	7
	0	1	A	A'

In first column, since both the values are 0, we put 0, in second one, both are 1, hence we put 1 in the bottom, in third one, only below term is 1, hence A and in last column, upper term is 1, hence A'. The mux will have $I_0 = 0$, $I_1 = 1$, $I_2 = A$ and $I_3 = A'$ and $S_1 = B$ and $S_0 = C$.

Q. 46 *Programming Language*
Ans: 3
The function returns number of invocation of itself so far. 1 + (ret. value of recursive function) and hence adds one for every invocation. Simply draw the invocation tree and you will get the count:

```
      (2,2)  return 5
        |
      (2,1)
        +
       /   \
   (1,1)  (2,0)
    |
   (1,0)
```

Q. 47 *Theory of Computation*
Ans: 1
The analysis of transitions of TM M shows that it accepts language 0^*10^*. For more details about approach to analysis *refer GateGenie Paper 2 Q. 51 explanations.*

Q. 48 *Theory of Computation*
Ans: 1
The TM carries out the function of $m - n$ in (0^m10^n).

- When $m \geq n$, the output is difference between m and n.
- When $m < n$, the output is blank.

Q. 49 *Theory of Computation*
Ans: 1
To construct equivalent grammar G' with no useless symbols, we first need to

1. Identify useless symbols
2. Check if all symbols appear in at least one sentential form.

We find that there is no terminal string derivable from B. It implies that B is a useless symbol. We then eliminate B and production $A \to AB$.

$$\begin{aligned} S &\to a \\ A &\to a \end{aligned}$$

Applying step 2, we find that only S and a appear in sentential form since starting from S to generate a string, we never visit A. We then remove A's production.

$$G' = \{\{S\}, \{a\}, \{S \to a\}, S\}.$$

There is only 1 production.
Note: If we apply the steps in reverse order, we'll end up with 2 productions

$$\begin{aligned} S &\to a \\ A &\to a \end{aligned}$$

This is not correct.

Q. 50 *Theory of Computation*
Ans: 3
If we solve the equation, its basically

$$L = L_1 \subseteq L_2$$

- If L_1 and L_2 are context free, L may not be context free. The statement I is incorrect.
- If L_1 is context free, L_2 is regular set then L is context free. The statement II is correct.
- We know that if L_1 and L_2 are regular L is also regular that is accepted by a finite automata. The statement III is correct.

Q. 51 *Theory of Computation*
Ans: 1
L' has the following productions:

$$\begin{aligned} S &\rightarrow C_1A|C_2B \\ A &\rightarrow C_2S|C_1D_1|a \\ B &\rightarrow C_1S|C_2D_2|a \\ C_1 &\rightarrow b \\ C_2 &\rightarrow a \\ D_1 &\rightarrow AA \\ D_2 &\rightarrow BB \end{aligned}$$

Lets construct a graph,

1. For a production, add an edge in the graph from left hand side nonterminal to each right hand side nonterminal. For instance, add D_1A for production $D1 \rightarrow AA$.

The graph corresponding to L' has the following directed edges:

$$\begin{aligned} E(G) &= \{SC_1, SA, SC_2, SB, AS, AC_2, AC_1, AD_1, \\ &\quad BC_1, BC_2, BS, BD_2, D_1A, D_2B\} \end{aligned}$$

It can be noted that all nonterminals except C_1 and C_2 has an outgoing edge. The out degree of C_1 and C_2 is 0. For the rest out degree > 0. Thus, the number of nodes in graph with out degree 0 are 2.

Q. 53 *Data Structure and Analysis*
Ans: 4
First make groups using parenthesis. Easiest way to solve such problems is to form the expression tree and then take pre-order(pre-fix), in-order(in-fix), post-order(post-fix). Here is the way to construct the tree of expression:

```
% B * A + * + % A B % + A C B A B
```

The tree is built from left to right. For pre-fix, the first is the operator followed by operands. Given below are the steps for building the tree:

1. `% B (__)`

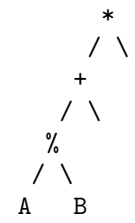
```
  %
 / \
B  (Rest of the expr)
```

2. `% B * A (_)`

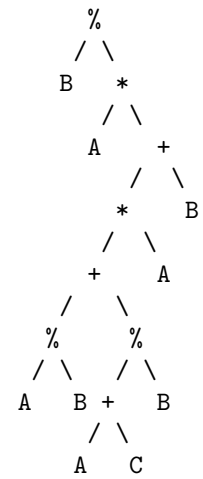
```
  %
 / \
B   *
   / \
  A  (Rest of the expr)
```

3. `% B * A + * + % A B ( _ )`

```
    %
   / \
  B   *
     / \
    A   +
       /  \
```



4. If there is a operator with out operand while reading the expression, it forms part of left tree as the case above. (Rest of the expr)
5. `% B * A + * + % A B % + A C B A B`

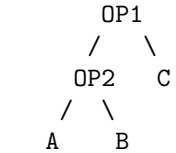


Hence sol: `B A A B % A C + B % + A * B + * %`

Essential part is to understand how tree is constructed step by step. here are few key points to consider:

1. `OP A B`

2. `OP1 OP2 A B C` or `OP1 (OP2 A B) C`



So, if two operators are found together, the first one becomes the root and the second one becomes the left child. When ever one operator and two operand are found together, they for a three-node tree, which can be replaced by a operand or in simply a pair of parenthesis needs to be put around it.

Q. 52 *Theory of Computation*
Ans: 2
Since the Turing machine M generates L in canonical order, L is recursive. If L is recursive, then L', which is a complement of L, must be recursive. That follows the option 2.

Other possibilities for a pair of complement languages.

1. Both are recursive
2. Neither of them are recursively enumerable.
3. one of them is recursively enumerable but not recursive, other is not recursively enumerable.

Q. 54 *Programming Language*
Ans: 3
`y` and `z` are alias for `a`. Hence `P(x,y,y)`

x is 5, therefore

$$\begin{aligned} y++ &= a++ \\ a &= 3 \\ z+ &= x \\ a &= a+5 \\ &= 3+5 \\ &= 8 \end{aligned}$$

Q. 55 *Data Structure and Analysis*
Ans: 2
Each invocation requires 4 bytes. Hence we need to find out depth of recursion, which can be simply by: $n \times 4 = 16$. Hence $n = 4$

Q. 56 *Data Structure and Analysis*
Ans: 2

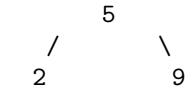
Q. 57 *Data Structure and Analysis*
Ans: 2
Quick sort is O(n log n)

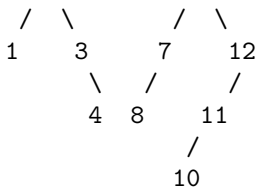
$$\begin{aligned} 100\ log(100 * c) &= 10 \\ 1000\ log(1000 * c) &= x \\ \frac{100 * 2}{1000 * 3} &= \frac{10}{x} \\ x &= \frac{3000 * 10}{200} = 150 \end{aligned}$$

Q. 58 *Computer Networks*
Ans: 1

Q. 59 *Data Structure and Analysis*
Ans: 3

Q. 60 *Data Structure and Analysis*
Ans: 4





Q. 61 *Data Structure and Analysis*
Ans: 3
next insert will be at $(11+1)\%12 = 0$

Q. 62 *Data Structure and Analysis*
Ans: 4
5 coins, each with 2 options heads/tails $= 2^5 = 32$

Q. 63 *Computer Networks*
Ans: 2
Here we require $ln(16)$ the number of bits required to encode any intensity value. Thus, the rate =

$$\begin{aligned} &= 640 \times 480 \times 30 \times ln(16) \\ &= 36.864\ Mbps \end{aligned}$$

Q. 64 *Computer Networks*
Ans: 2
Transmission time in A is

$$\begin{aligned} &= (3.5 * 10^9) * 8/(33.6 * 10^3)\ seconds \\ &= 8.333 * 10^5\ seconds \\ &\equiv 9\ days > 8\ days \end{aligned}$$

So B is faster than A

Q. 65 *Compilers*
Ans: 3
We need to construct set of canonical $LR(0)$ items. The number of states are equal to number of canonical items. To construct set of items:

1. Compute $C = closure(E' \to .E)$
2. for each set of items I in C and each grammar symbol X, if $goto(I, X)$ is non-empty and not in C then add $goto(I, X)$, until no more states can be added to C

$$\begin{aligned} I_0 : E' &\to .E \\ E &\to .E + T \\ E &\to .T \\ T &\to .T * F \\ T &\to .F \\ F &\to .id \\ F &\to .(E) \end{aligned}$$

Transition from I_0 on symbol E,

$$\begin{aligned} I_1 : E' &\to E. \\ E &\to E. + T \end{aligned}$$

Transition from I_0 on symbol T,

$$\begin{aligned} I_2 : E &\rightarrow T. \\ T &\rightarrow T. * F \end{aligned}$$

Keep repeating the process till no more items are added. In all there are 12 items which gets added to the set.

Q. 66 *Compilers*
Ans: 4
Suppose, $s = aaab$, $|s| = 4$. The prefixes are *a, aa, aaa, aaab. aaab* is not a proper prefix. The proper prefix of string s is a prefix, which is not same as string s.

String of length 4 has 3 proper prefixes String of length 5 has 4 proper prefixes

There are at max $n-1$ trailing characters, which can be removed to form a proper prefix. For string of length n we can have $n-1$ proper prefixes. The total number of proper prefixes is $n-1$.

Q. 67 *Compilers*
Ans: 3
The grammar is unambiguous. The construction of $SLR(1)$ parsing table reveals shift reduce conflict, hence the grammar is not $SLR(1)$. The grammar is $LALR(1)$ as there is no conflict in $LALR(1)$ parsing table of the grammar.

Q. 68 *Programming Language*
Ans: 2
Being a lazy language, its evaluates any expression only when required. Hence $y = ++b$ is never evaluated. Hence b gets incremented only once. Thus $c = z = 2 * (2 + 4) = 12, a = 2$ and $b = 4$

Q. 69 *Programming Language*
Ans: 2
This follows from the definition of pure virtual function which is only declared in the base class and every class inheriting that class has to define the function.

Q. 70 *Programming Language*
Ans: 1
The compiler will compiles each file separately. At the time of linking, the linker will detect duplicate variable name and will give error. Variable needs to be define at only once place and at the other place it need to declare as "extern".

Q. 71 *Operating Systems*
Ans: 3
Principle of Best Fit allocation:
Allocate the smallest hole that is big enough. We must search the entire list, unless the list is kept ordered by size. This strategy produces the smallest leftover hole.

212K is put in 300K partition
417K is put in 500K partition
112K is put in 200K partition
426K is put in 600K partition

The order is P_4, P_2, P_3, P_5 i.e. 3

Q. 72 *Operating Systems*
Ans: 4

Time	Process Executing
0-4	P_1
4-7	P_2
7-10	P_3
11-30	P_1

Total Waiting = P_1 wait + P_2 wait + P_3 wait = (0 + 10) + 4 + 7 = 17
Average waiting = 17/3 = 5.66

Q. 73 *Operating Systems*
Ans: 3
Q. 74 *Operating Systems*
Ans: 4
The requests are served in the following order:
Phase 1: 53, 37, 14, reaches 0
Phase 2: 65, 67, 98, 122, 124, 183
The distance traveled = Distance in Phase 1 + Distance in Phase 2
= 53 + 183 = 236

Q. 75 *Operating Systems*
Ans: 1
SSTF would take greatest advantage of the situation. FCFS could cause unnecessary head movement if references to the high-demand cylinders were interspersed with references to cylinders far away.

Q. 76 *Programming Language*
Ans: 2

		Scope	`me`	**Print(me)**
main				
→	printme	global	2	2
→	fun	local	5	
→	→ printme	global	2	2
→	printme	global	2	2

Hence 2 2 2

Q. 77 *Programming Language*
Ans: 1

		Scope	`me`	**Print(me)**
main				
→	printme	global	2	2
→	fun	local	5	
→	→ printme	fun	5	5
→	printme	global	2	2

Hence 2 5 2

Q. 78 *Programming Language*
Ans: 1

Q. 79 *Programming Language*
Ans: 3
r is not initialized and is a automatic variable which contains some random number, can be termed as garbage.

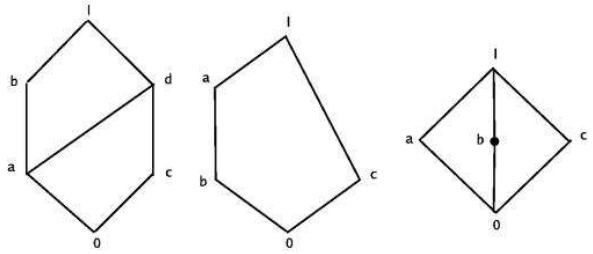
Q. 80 *Programming Language*

Ans: 2
A tokenizer always tries to match maximum string and hence matches (+ + +) as (+ +) + combines first two +'s. Hence c = (a++)+ b;

Q. 81 *Engg Maths*
Ans: 3
The lattice is distributive lattice if for any elements a, b and c in L, we have the following distributed properties:

$$a \cap (b \cup c) = (a \cap b) \cup (a \cap c) a \cup (b \cap c) = (a \cup b) \cap (a \cup c)$$

It can be checked from the following diagrams, that S_2 and S_3 are distributive.



(a) (b) (c)

Figure 46: Figs for Q. 81: Hasse Diagram for (a)S_1 (b) S_2 (c) S_3

Q. 82 *Engg Maths*
Ans: 1
The lattice L is complemented if it is bounded and if every element L has complement.

Q. 83 *Hardware*
Ans: 1
avg. memory access time = Hit time + Miss rate x Miss penalty
Direct mapped avg access time = $2.0 + 0.014 \times 70 = 2.98$
2-way avg access time = $2.0 \times 1.10 + 0.010 \times 70 = 2.9$
Thus, 2-way associative cache results in better access time.

Q. 84 *Hardware*
Ans: 2
CPU time = Instruction count × (CPI × clock cycle time) +
(Memory access/instructions × miss rate × miss penalty × clock cycle times)

Given,
Miss penalty × clock cycle time = 70ns

Direct mapped cache CPU time is

$$= IC \times (2.0 \times 2 + 1.3 \times 0.014 \times 70) = 5.27\ IC$$

2-way associative cache CPU time is

$$= IC \times (2.0 \times 2 \times 1.10 + 1.3 \times 0.014 \times 70) = 5.31\ IC$$

Direct mapped cache has better CPU utilization.

Q. 85 *Engg Maths*
Ans: 2
If every pair of element in Poset A is comparable, then A is linearly ordered set.

1. In S_1, not every pair of element is comparable. For instance, $A = \{1, 2, 3\}$ $P(A) = \{\{1\}, \{2\}, \{3\}, \ldots\}$ $\{1\}$ and $\{2\}$ are not comparable, so is $\{1\}$ and $\{2\}$ and $\{2\}$ and $\{3\}$.
2. In S_2, every pair of element is comparable.
3. In S_3, not every pair of element is comparable. For instance 2 is not comparable with 11.

Q. 86 *Engg Maths*
Ans: 3

- Arrange the edges in the ascending order of weight.
- Add the edges in that order such that no cycle is formed in the graph. If cycle is getting added, discard the edge and select the next one.
- Stop once all vertices are visited.

Start adding, CD CF DG BC BE AB Add the weights on above edges to get the length,

$$4 + 4 + 4 + 6 + 6 + 8 = 32$$

. **Q. 87** *Data Structure and Analysis*
Ans: 3
Final position of buckets will be:

```
0 - 56
1 - 93
2 - 23 - 65 ( move to next empty - 5)
         93 ( move to next empty - 1)
3 - 87
4 - 32
5 - 65 - 26 (move to next empty - 6)
6 - 26
```

Hence 3 collisions.

Q. 88 *Data Structure and Analysis*
Ans: 2
Refer to explanation of the Question above.

Q. 89 *Databases*
Ans: 2

Q. 90 *Databases*
Ans: 2
Need to take care of:

- printing: `authorid and publisherid` - in option 2,3,
- number of books: `count(*)` - 2
- sum(*) will not work for rows...

Hence option 2.

Answers GateGenie Practice Test No. 5

Answers: Test No. 5

Q. 01 *Engg Maths*
Ans: 2

$$A = \{M, I, S, P\} \Rightarrow |\ 2^A\ | = 2^{|A|} = 2^4 = 16$$

Q. 02 *Engg Maths*
Ans: 4

Q. 03 *Engg Maths*
Ans: 1
Since $E(G)$ is empty, all the vertices are isolated. Hence, the set of connected components is -

$$\{\{A\}, \{B\}, \{C\}, \{D\}, \{E\}, \{F\}\}$$

Q. 04 *Engg Maths*
Ans: 2

Q. 05 *Hardware*
Ans: 2

Q. 06 *Hardware*
Ans: 2

Q. 07 *Hardware*
Ans: 1
The cache organization is set associative and cache has 4 sets. The block will be placed in set number $(12\ \%\ 4) = 0$, which spans in block number 0 and 1. The block will be put in either block number 0 or 1.

Q. 08 *Hardware*
Ans: 4
The answer follows from the fact that xor is an odd function.

Q. 09 *Theory of Computation*
Ans: 2
The answer follows from definition of DFA. NFA has transition function which maps to 2^Q.

Q. 10 *Theory of Computation*
Ans: 2

$$L = L_1.L_2 = \{10011, 1011, 111\} \Rightarrow |L| = 3$$

Q. 11 *Theory of Computation*
Ans: 1

1. 0^*1^* does not ensure at least one 0 in the beginning and one 1 at the end.
2. $00^*(0+1)^*1$ ensures the specified condition.
3. $0(0+1)^*1$ ensures the specified condition.

Q. 12 *Data Structure and Analysis*
Ans: 4

Only I is correct. II and III are wrong.

Q. 13 *Data Structure and Analysis*
Ans: 2

- We start with

  7 5 3 1 2 9

- First iteration:

  5 3 1 2 7 9

- Second iteration (answer):

  3 1 2 5 7 9

- Sorted sequence:

  1 2 3 5 7 9

Q. 14 *Data Structure and Analysis*
Ans: 1

Q. 15 *Data Structure and Analysis*
Ans: 4

Q. 16 *Data Structure and Analysis*
Ans: 4
Do the breadth first traversal and you will get the answer.

Q. 17 *Data Structure and Analysis*
Ans: 4
Its the depth up-to which the algorithm runs(generally recurses).

Q. 18 *Data Structure and Analysis*
Ans: 4

1. `insert(43)`

   $\boxed{43}$

2. `insert(26)`

   $\boxed{43} \rightarrow \boxed{26}$

3. `insert(93)`

   $\boxed{26} \rightarrow \boxed{43} \rightarrow \boxed{93}$

4. `delete(26)`

   $\boxed{43} \rightarrow \boxed{93}$

5. `insert(72)`

   $\boxed{43} \rightarrow \boxed{72} \rightarrow \boxed{93}$

6. `insert(52)`

   $\boxed{43} \rightarrow \boxed{52} \rightarrow \boxed{72} \rightarrow \boxed{93}$

7. `delete(72)`

   $\boxed{43} \rightarrow \boxed{52} \rightarrow \boxed{93}$

8. `insert(73)`

   $\boxed{43} \rightarrow \boxed{52} \rightarrow \boxed{73} \rightarrow \boxed{93}$

Q. 19 *Compilers*
Ans: 4
$(1+0)^*$ means concatenation between 0 and 1 in any order in any quantity. The example strings are

$$\epsilon, 1, 01, 11, 0101, 0111, \ldots$$

Q. 20 *Compilers*
Ans: 2

Q. 21 *Compilers*
Ans: 2

Q. 22 *Compilers*
Ans: 4

Q. 23 *Operating Systems*
Ans: 2
At the end of time quanta, one of the two things will happen:

- either the process will release the CPU voluntarily since its execution is done and moves to terminated state, or
- a context switch is executed and the process will be moved to tail of ready queue.

Q. 24 *Operating Systems*
Ans: 2

Q. 25 *Operating Systems*
Ans: 3
The languages using less number of pointers results in better locality of reference cause pointers result in randomized memory access.

Q. 26 *Operating Systems*
Ans: 2
To avoid deadlock, we must request the devices in ascending order of enumeration. This ensures that circular wait does not hold. The correct sequence is

$$1, 4, 12 \; i.e. \; R_2, R_3, R_1 \; i.e. 2$$

Q. 27 *Databases*
Ans: 1
System should write data immediately.

Q. 28 *Databases*
Ans: 3

Q. 29 *Computer Networks*
Ans: 4

Q. 30 *Computer Networks*
Ans: 2
Each packet takes t time for transmission. The first packet reaches B after $(l-1) \times t$ seconds. nth packet will reach B after $(n+l-1) \times t$ seconds.

Q. 31 *Databases*
Ans: 3
By definition of serializability.

Q. 32 *Databases*
Ans: 3
Here the password is matched with any string - back slash - % - any string which selects:

```
Ann     Algo        40      \\%%
Anju    Networks    30      %\\%
An      DB          50      \\%%
Ant     Algo        25      \\%\\%
```

and the name is matched with A - any character - any substring - any character and here the row below does not satisfy the criteria.

```
An      DB          50      \\%%
```

A-any char i.e. n - any substring i.e. nothing - any char(NOTHING HERE) Hence only three rows are selected.

Q. 33 *Engg Maths*
Ans: 2
The quick test for invertability is the value of determinant of the matrix. If the determinant of a matrix is non-zero, then it is invertible. Since $|A| = -30 \neq 0$, the matrix is invertible.

Q. 34 *Engg Maths*
Ans: 1
The system can be decomposed into:

$$\begin{bmatrix} 10 & 0 & 0 \\ 0 & 15 & 0 \\ 0 & 0 & 20 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 1 \\ -1 & 0 & -1 \\ 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \begin{bmatrix} 18 \\ -12 \\ 17 \end{bmatrix} \tag{27}$$

which can be written as follows:

$$\begin{aligned} 10y_1 &= -x_2 + x_3 + 18 && (28)\\ 15y_2 &= -x_1 - x_3 - 12 && (29)\\ 20y_3 &= x_1 - x_2 + 17 && (30)\\ y_1 &= (-x_2 + x_3 + 18)/10 && (31)\\ y_2 &= (-x_1 - x_3 - 12)/15 && (32)\\ y_3 &= (x_1 - x_2 + 17)/20 && (33) \end{aligned}$$

With initial conditions, 0 0 0, we get

$$\begin{aligned} y_1 &= 1.8 && (34)\\ y_2 &= -0.8 && (35)\\ y_3 &= 0.85 && (36) \end{aligned}$$

Use these values of y, as x in Eq.(5), Eq.(6) and Eq.(7),

$$\begin{aligned} x_1 &= y_1 && (37)\\ x_2 &= y_2 && (38)\\ x_3 &= y_3 && (39) \end{aligned}$$

we get,

$$\begin{aligned} y_1 &= 1.965 && (40)\\ y_2 &= -0.9767 && (41)\\ y_3 &= 0.98 && (42) \end{aligned}$$

Q. 35 *Engg Maths*
Ans: 3

Q. 36 *Engg Maths*
Ans: 2

$$a_0 + a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 + a_8 = 90$$

If we group three a's at a time, we get

$$\begin{aligned}(a_0 + a_1 + a_2) + (a_3 + a_4 + a_5) + (a_6 + a_7 + a_8) &= 90 \\ g_1 + g_2 + g_3 &= 90\end{aligned}$$

so at least one g_i has to be at least 30 by pigeonhole principles.

Q. 37 *Engg Maths*
Ans: 2

$$\frac{2n}{2.2.2.\ldots.2(n\ times)} = \frac{2n}{2^n}$$

Q. 38 *Engg Maths*
Ans: 1
We could see that there are two symmetric geometries in the fig. Let's count the number of spanning tress for the half part of the fig. shown below:

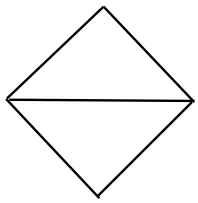


Figure 47: Fig. for Q. 38

There are 8 such spanning trees each half of fig. shown above. The total number of spanning trees is

$$8 \times 8 = 64$$

Q. 39 *Engg Maths*
Ans: 2
Under the rel. R we get

$$[1] = \{1, 2\}, [2] = \{1, 2\}, [3] = \{3\}$$

Since,

$$[1] = [2] \Rightarrow A/R = \{[2], [3]\}$$

Q. 40 *Computer Networks*
Ans: 2
Connection establishment time = 30 msec.
Message transmission time = $2200 \times 8/10^7$ seconds = 1760 microseconds.
Total time = 30 msec + 1760 microseconds + 10 msec = 41.76 msec

Q. 41 *Computer Networks*
Ans: 3
The bandwidth is 1.5 Mbps, and data packets can be sent continuously.

Given
Packet size = 1 KB = 1 × 1,024 × 8 bits = 8,192 bits

1.5 Mbps = 1,500,000 bits/s
RTT = 100 ms = 0.1 s
Transmit time per packet = Size of packet/Bandwidth =

$$\begin{aligned} &= 8,192\ bits/1,500,000\ bits/s \\ &= 0.00546\ s \\ &= 5.46\ ms \end{aligned}$$

Total number of packets to be sent = Size of file / Packet size
= 1,000 KB / 1 KB = 1,000

Transmit time for all packets = Transmit time per packet × number of packets
= 5.46 ms × 1000 = = 5.46 s

Total time = Initial 2 RTT + Transmit time for all packets + Propagation
= 2 × RTT + Transmit time for all packets + RTT/2
= 2 × 0.1 s + 5.46 s + 0.1 s/2
= 0.2 s + 5.46 s + 0.05 s
= 5.71 s

Q. 42 *Computer Networks*
Ans: 4

- Packet size = 1 KB = 1 × 1,024 × 8 bits = 8,192 bits
- Total num. of packets to be sent = Size of file/Packet size = 1,000 KB / 1 KB
- RTT = 100 ms = 0.1 s
- Since the channel has infinite bandwidth, we can assume the transmission time of a packet to be zero.
- Right after the handshaking of 200 ms (2 RTTs) we send one packet. One RTT after we send two packets, the next RTT we send four packets, etc. At n RTTs after the initial handshaking we will have sent:

$$1 + 2 + 4 + \ldots + 2^n = 2^{(n+1)} - 1\ packets.$$

1000 packets will be sent when $n = 9$. The last batch arrives 0.5 later. Then:
Total time = Initial 2 RTT + 9 × RTT + 0.5 × RTT
= 2 × RTT + 9.5 × RTT
= 11.5 × RTT = 11.5 × 0.1 s = 1.15 s

Q. 43 *Hardware*
Ans: 1

- Since in the contiguous allocation, there is no room to grow in the beginning, but there is room to grow in the end. We need to add it at the end. We need to read first 100 blocks in memory, add block in the beginning and write 101 blocks in the memory again. The total number of disk I/0s is 100+101 = 201.
- The linked and indexed allocation just needs to write the block to the disk, resulting in a single disk I/O.

Q. 44 *Hardware*
Ans: 1

- In contiguous allocation we need to read 50 records from disk, add the new block and write 51 blocks back to memory resulting in 101 I/Os.
- In linked allocation in order to locate middle position, we need to read all records up-to the mid record. Add the new block, update link information of the middle block and write middle and new block back to disk. Thus we need in all 52 I/Os.

Q. 45 *Hardware*
Ans: 4

- We need to write the new block to the disk in contiguous allocation resulting in 1 disk I/O.
- In linked allocation, we need to read last block, update its link information and write back last block and new block. This results in 3 disk I/O.
- In indexed allocation, we just need one write.

Q. 46 *Hardware*
Ans: 3

- In contiguous allocation, we will read first 49 blocks, delete the middle record and write back 49 blocks, thus in all 98 I/Os.
- In Linked allocation, we read first 50 blocks and one more block just next to middle block, delete the middle block, update link information of the block just before the deleted block, write back the updated block. This results in 52 disk I/Os
- In case of Indexed allocation, we just delete the index of the page from memory, no I/O incurred.

Q. 47 *Theory of Computation*
Ans: 2

Q. 48 *Engg Maths*
Ans: 1
The graph is traversable if either all vertices are of even degree or exactly two vertices have odd degrees.

1. In I. all vertices have even degree, hence traversable.
2. In II. all vertices have degree 3
3. In III. even if vertices have even degree, the graph is not connected

Q. 49 *Engg Maths*
Ans: 2
Using poison approximation, we get

$$\begin{aligned} \alpha &= 100 \times 0.01 = 1 \\ f(0;1) &= 0.3679 \end{aligned}$$

Q. 50 *Engg Maths*
Ans: 1
In case of without replacement:

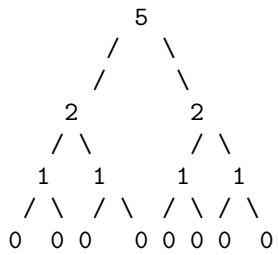
- The all card can be chosen in 52 ways as the card drawn earlier is replaced. Thus the number of ways is 52^5.
- While in case of without replacement, we have 52 ways of selecting first card, 51 ways of selecting second card and so on, we've 48 ways of selecting fifth card. Thus the total number of ways = 52.51.50.49.48

Q. 51 *Theory of Computation*
Ans: 2

Q. 52 *Theory of Computation*
Ans: 1

Q. 53 *Programming Language*
Ans: 3
Bubble sort is $O(n^2)$. Hence if time is reduce by half, input size must reduce by one fourth.

Q. 54 *Data Structure and Analysis*
Ans: 4
It will print 15 asterisks. Construct a call invocation tree. Each call prints asterisk once.



Hence 15 times .

Q. 55 *Computer Networks*
Ans: 4
In a boolean representation, presence/absence of an edge is represented true/false. As the graph is directed, a 20×20 matrix, or 400 boolean values will be required.

Q. 56 *Programming Language*
Ans: 3
Try to hand run the program with each possible answer

- 1
- 3 2 4 5 1
- `push(1)`
- `push(2)`
- `push(3)`
- `pop()` - 3
- `pop()` - 3
- `push(4)`
- `pop()` - 4
- `push(5)`
- `pop()` - 5
- `pop()` - 1

Valid sequence.

To do this, do step wise analysis. For 3 to be popped, 1,2,3 needs to be blindly pushed and hence first three operation. Next is pop 2, which is also possible. Now stack has only one element, i.e 1. To pop 4 now, push 4, pop 4, to pop 5, push 5, pop 5. Again now the remainder is one element - 1. Now, pop that element. Hence the sequence is valid. You need to use stack figure to get it easily.

```
            3
       2    2    2          4          5
 1     1    1    1     1    1     1     1     1
Stack Stack Stack Stack Stack Stack Stack Stack Stack Stack
push  push  push  pop   pop   push  pop   push  pop   pop
 1     2     3                 4           5
Output:           3     2          4            5     1
```

You can repeat for other options.
Summary: This is a crude method. You can solve the problem intelligently also. For any value y to be popped after x such that $y < x$ then all elements $< x$ and $> y$ need to be already popped out. This condition is not satisfied by option three where $x = 5$ and $y = 2$, i.e. 3 and 4 need to be already popped out but 4 is not. Hence this can not be the output of the program.

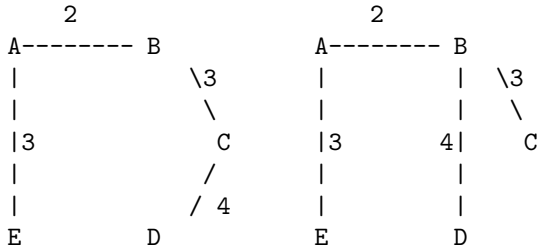
Q. 57 *Data Structure and Analysis*
Ans: 3

$$0, 1, 2, \ldots, N = n + 1$$

Q. 58 *Data Structure and Analysis*
Ans: 2

$$\begin{aligned} &= 2^2 T(n/2^2) + n/2 + n \\ &= n^k T(n/2^k) + n/2^k - 1 + \ldots + n \\ &= n + n[1 + \ldots + 1/2^k - 2 + 1/2^k - 1] \\ &= n + n[1(1 - 1/2^k)/(1 - 1/2)] \\ &= n + 2n(1 - 1/n) \\ &= O(n^2) \end{aligned}$$

Q. 59 *Data Structure and Analysis*
Ans: 2

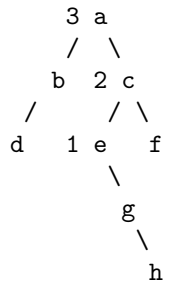


Two spanning trees: In simple graph like this, it can be inferred by the number of options you will have at a time and only at one time you need to choose one of the two edges with weight 4. Hence can directly be found as 2 than actually solving the problem.

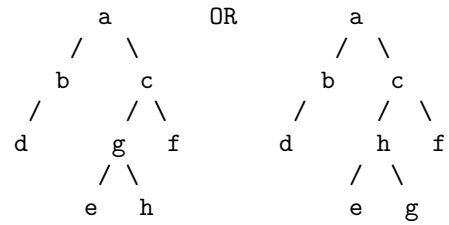
Q. 62 *Data Structure and Analysis*
Ans: 1
GCD of 8 and 12 is 4. Hence, there will be 4 components. The nodes will be:

$$\begin{aligned} i\%4 &= 1 \Rightarrow 1, 5, 9, \ldots \\ i\%4 &= 2 \Rightarrow 2, 6, 10, \ldots \\ i\%4 &= 3 \Rightarrow 3, 7, 11, \ldots \\ i\%4 &= 0 \Rightarrow 4, 8, 12, \ldots \end{aligned}$$

Q. 60 *Data Structure and Analysis*
Ans: 3



Q. 61 *Data Structure and Analysis*
Ans: 3
Correct options are 1 and 3 out of which 1 will make more movement than 3. Finally, tree will look like:



Q. 63 *Data Structure and Analysis*
Ans: 3
There are standard theorems related to each of the statements. Need to know them.

Q. 64 *Data Structure and Analysis*
Ans: 2
Total number of edges in a graph with n vertices is $n(n-1)/2$. A polygon with n-vertices has n edges. All the other edges are the diagonals of the polygon. Therefore the number of edges is

$$\frac{n(n-1)}{2} - n = \frac{n(n-3)}{2}$$

Q. 65 *Compilers*
Ans: 1
C has some keywords which are reserved keywords. The reserved keywords are not entered into symbol table. The entries made in symbol table are those of identifiers. We've `max i j` as entries in the symbol table from the given code snippet. Thus, we have 3 entries in the symbol table.

Q. 66 *Compilers*
Ans: 3

- Rule 1: Each item in I is added to $closure(I)$
- Rule 2: If $A \to a.Bc$ is in $closure(I)$ and $B \to d$ is a production, then add $B \to .d$ to I, if it is not already present.

As a consequence of Rule 1 add the following to $closure(I)$

$$1.E' \to .E$$

As a consequence of Rule 2 add the following to $closure(I)$

$$\begin{aligned} 2.E &\rightarrow .E + T \\ 3.E &\rightarrow .T \\ 4.T &\rightarrow .T * F \\ 5.T &\rightarrow .F \\ 6.F &\rightarrow .id \\ 7.F &\rightarrow .(E) \end{aligned}$$

No more production can be added to closure. The total number of $LR(0)$ items are 7.

Q. 67 *Compilers*
Ans: 1

$$\begin{aligned} E &\rightarrow E + .T \\ T &\rightarrow .T * F \\ T &\rightarrow .F \\ F &\rightarrow .id \\ F &\rightarrow .(E) \end{aligned}$$

Thus there are 5 $LR(0)$ items.

Q. 68 *Compilers*
Ans: 1
$LR(1)$ grammar does not have any conflict. However, while taking union of productions

$$\begin{aligned} A &\rightarrow c., d/e \\ B &\rightarrow c., d/e \end{aligned}$$

generates reduce/reduce conflict. Hence, the grammar is not LALR grammar.

Q. 69 *Compilers*
Ans: 1
Finding equivalence classes is same as minimizing states of DFA. The states which remains in the minimized DFA are equivalence classes. On minimization we get the following states:

$$\{1\}, \{2, 5\}, \{3\}, \{4\}, \{6\}$$

Each state is a equivalence class. Thus there are 5 equivalence classes.

Q. 70 *Programming Language*
Ans: 2
As recursion is before printing, it will print in straight order.

```
1  2  3        -> 3   ^
   |                  |
   |__ 1  2    -> 2   |   Hence, 1  2  3.
        |             |
        |__ 1  -> 1   |
```

Q. 71 *Operating Systems*
Ans: 2

- In fig 1. the processes P_1, P_2 and P_3 are in deadlock state. P_2 waiting on R_3 which is held by P_3, while P_3 is waiting on R_2 which is held by P_1 and P_2.

- In fig. 2, we can observe that P_4 can release instance of R_2, which can be allocated to either P_1 or P_3, breaking the cycle. Deadlock does not occur in fig. 2

Q. 72 *Operating Systems*
Ans: 2

1. Increasing degree of multiprogramming will result in more trashing resulting in less CPU utilization.

2. Add pre paging to the page fetch algorithms The CPU will get more data faster, so it will be more in use. This is only the case if the paging action is amenable to pre fetching (i.e., some of the access is sequential).

3. Increase the page size Increasing the page size will result in fewer page faults if data is being accessed sequentially. If data access is more or less random, more paging action could ensue because fewer pages can be kept in memory and more data is transferred per page fault. So this change is as likely to decrease utilization as it is to increase it.

Q. 73 *Operating Systems*
Ans: 3
Since the value of `flag[j]` is false for different processes, competing to enter into critical section, we get more than one process in the critical section violating mutual exclusion criteria.

Q. 74 *Operating Systems*
Ans: 3
Optimal algorithm has the following replacement policy: Replace the page that will not be used for the longest period of time.

Applying the above principle, we get 7 page faults in the above access pattern.

Q. 75 *Operating Systems*
Ans: 1
Note that the array is stored in row major form. One row of array requires 128 words, that is one page.

Since the array is accessed in row major form i.e. loop on i is outer loop, each access new value of i generates a page fault, as it refers to new row each time. The value of i increments 128 times, generating those many page faults.

Array is stored as follows:

Row 0: Page 0
Row 1: Page 1
.
.
.
Row 128: Page 128

The access pattern:

- **Page 0**: offset $1, 2, 3, \ldots, 128$
  During offset access no page fault is generated as page is already in memory. Page fault occurs when next page is accessed.

- **Page 1**: offset $1, 2, 3, \ldots, 128$
  .

- .

- .

- **Page 128**: offset $1, 2, 3, \ldots, 128$

The total number of faults = 128

Q. 76 *Programming Language*
Ans: 4
Quick observation should give:

1. `sum` - In most of the algorithms, `sum` is initialize to zero.
2. `fact` - Being a multiplier should be initialized to 1.
3. `fact *= i` - This calculates the factorial for running i
4. `sum += fact` - Adds up the factorial values.

Q. 77 *Programming Language*
Ans: 1

Q. 78 *Programming Language*
Ans: 2

Q. 79 *Programming Language*
Ans: 1
concat(head(tail(s), head(concat(head(tail(s)), tail(s))))
= concat(head(tail(abcd), head(concat(head(tail(abcd)), tail(abcd))))
= concat(head(bcd), head(concat(head(bcd)),bcd))
= concat(b, head(concat(b,bcd)))
= concat(b, head(bbcd))
= concat(b, b)
= bb

Q. 80 *Programming Language*
Ans: 1
$P > Q$ is true and $P < 0$ is true hence

$$P = abs(P) = abs(-10) = 10$$

Q. 81 *Engg Maths*
Ans: 1

- P_1 is not partition as 1 is common in two partitions.
- P_2 is not partition as 4 is not present in any of the partitions.
- P_3 is partition.
- P_4 is not partition as 7 does not belong to S.

Q. 82 *Engg Maths*
Ans: 3
f_4 is not function since some students may not be married.

Q. 83 *Hardware*
Ans: 4

Q. 84 *Hardware*
Ans: 2

1. A mouse used with a graphical user interface Buffering may be needed to record mouse movement during times when higher-priority operations are taking place. Spooling and caching are inappropriate. Interrupt driven I/O is most appropriate.

2. A tape drive on a multitasking operating system (assume no device preallocation is available) Buffering may be needed to manage throughput difference between the tape drive and the source or destination of the I/O, Caching can be used to hold copies of data that resides on the tape, for faster access. Spooling could be used to stage data to the device when multiple users desire to read from or write to it. Interrupt driven I/O is likely to allow the best performance.

3. A disk drive containing user files. Buffering can be used to hold data while in transit from user space to the disk, and visa versa. Caching can be used to hold disk-resident data for improved performance. Spooling is not necessary because disks are shared-access devices. Interrupt- driven I/O is best for devices such as disks that transfer data at slow rates.

4. A graphics card with direct bus connection, accessible through memory-mapped I/O Buffering may be needed to control multiple access and for performance (double- buffering can be used to hold the next screen image while displaying the current one). Caching and spooling are not necessary due to the fast and shared-access natures of the device. Polling and interrupts are only useful for input and for I/O completion detection, neither of which is needed for a memory-mapped device.

Q. 85 *Engg Maths*
Ans: 2

- v_1 can be painted with color a,
- v_2, v_3 and v_5 with color b as v_2, v_3 and v_5 are not connected.
- v_4 can be colored with color a as v_2 is in b.
- v_6 can be colored with color a as v_3 or v_5 are in b.

Thus at least 2 colors are required to paint the graph.

Q. 86 *Engg Maths*
Ans: 4
The relation is not symmetric. Hence it is not equivalence relation.

Q. 87 *Data Structure and Analysis*
Ans: 3

Q. 88 *Data Structure and Analysis*
Ans: 4
Using buckets of Radix sort, the sorting is optimized as range is known.

Q. 89 *Databases*
Ans: 4
Join conditions are not used and hence will print Cartesian product of two tables along with the month salary, all of which will be a garbage data.

Q. 90 *Databases*
Ans: 1

1. Need sub-query to find out the minimum value and then to check the same value in outer query along with join condition.
2. no join condition.
3. `group by name`, will print entries with minimum salary for employees with same name
4. `group by sal` again will have problem like in 3.