GATE – 2016

CS : COMPUTER SCIENCE & INFORMATION TECHNOLOGY

Set - 2

No. of Questions : 65 *Maximum Marks : 100*

INSTRUCTIONS

1. Total of 65 questions carrying 100 marks, out of which 10 questions carrying a total of 15 marks are in General Aptitude (GA)
2. The Engineering Mathematics will carry around **15% of the total marks,** the General Aptitude section will carry **15% of the total marks** and the **remaining 70% of the total marks.**
3. **Types of Questions**
   (*a*) Multiple Choice Questions (MCQ) carrying 1 or 2 marks each in all papers and sections. These questions are objective in nature, and each will have a choice of four options, out of which the candidate has to mark the correct answer(s).
   (*b*) Numerical Answer Questions of 1 or 2 marks each in all papers and sections. For these questions the answer is a real number, to be entered by the candidate using the virtual keypad. No choices will be shown for these type of questions.
4. For **1-mark** multiple-choice questions, **1/3 marks** will be deducted for a wrong answer. Likewise, for **2-marks** multiple-choice questions, **2/3** marks will be deducted for a wrong answer. There is no negative marking for numerical answer type questions.

GENERAL APTITUDE (GA)

(Q. 1 – 5) : Carry One Mark Each.

1. The man who is now Municipal Commissioner worked as_____.

(*a*) the security guard at a university

(*b*) a security guard at the university

(*c*) a security guard at university

(*d*) the security guard at the university

2. Nobody knows how the Indian cricket team is going to cope with the difficult and seamer-friendly wickets in Australia.

Choose the option which is closest in meaning to the underlined phrase in the above sentence.

(*a*) put up with

(*b*) put in with

(*c*) put down to

(*d*) put up against

3. Find the odd one in the following group of words.

mock, deride, praise, jeer

(*a*) mock

(*b*) deride

(*c*) praise

(*d*) jeer

4. Pick the odd one from the following options.

(*a*) CADBE (*b*) JHKIL

(*c*) XVYWZ (*d*) ONPMQ

5. In a quadratic function, the value of the product of the roots (α, β) is 4. Find the value of

$$\frac{\alpha^n + \beta^n}{\alpha^{-n} + \beta^{-n}}$$

(*a*) n^4

(*b*) 4^n

(*c*) 2^{2n-1}

(*d*) 4^{n-1}

(Q. 6 – 10) : Carry Two Marks Each.

6. Among 150 faculty members in an institute, 55 are connected with each other through Facebook® and 85 are connected through WhatsApp®. 30 faculty members do not have Facebook® or WhatsApp® accounts. The number of faculty members connected only through Facebook® accounts is_____.

(*a*) 35

(*b*) 45

(*c*) 65

(*d*) 90

7. Computers were invented for performing only high-end useful computations. However, it is no understatement that they have taken over our world today. The internet, for example, is ubiquitous. Many believe that the internet itself is an unintended consequence of the original invention. With the advent of mobile computing on our phones, a whole new dimension is now enabled. One is left wondering if all these developments are good or, more importantly, required.

Which of the statement(s) below is/are logically valid and can be inferred from the above paragraph?

(i) The author believes that computers are not good for us.

(ii) Mobile computers and the internet are both intended inventions

(*a*) (i) only (*b*) (ii) only

(*c*) both (i) and (ii) (*d*) neither (i) nor (ii)

8. All hill-stations have a lake. Ooty has two lakes.

Which of the statement(s) below is/are logically valid and can be inferred from the above sentences?

(i) Ooty is not a hill-station.

(ii) No hill-station can have more than one lake.

(*a*) (i) only (*b*) (ii) only

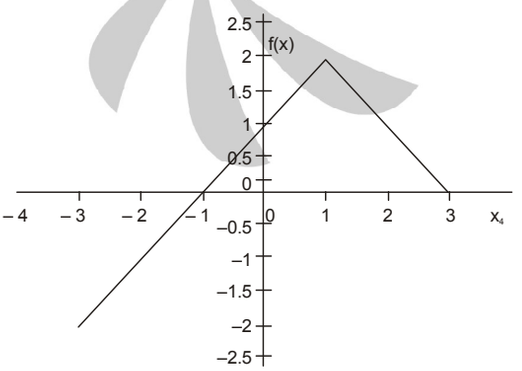
(*c*) both (i) and (ii) (*d*) neither (i) nor (ii)

9. In a 2 × 4 rectangle grid shown below, each cell is a rectangle. How many rectangles can be observed in the grid?

(*a*) 21 (*b*) 27

(*c*) 30 (*d*) 36

10.



Choose the correct expression for f(x) given in the graph.

(*a*) $f(x) = 1 - |x - 1|$ (*b*) $f(x) = 1 + |x - 1|$

(*c*) $f(x) = 2 - |x - 1|$ (*d*) $f(x) = 2 + |x - 1|$

TECHNICAL SECTION

(Q. 1 – 25) : Carry One Mark Each.

1. Consider the following expressions:

(i) false (ii) Q

(iii) true (iv) $P \vee Q$

(v) $\neg Q \vee P$

The number of expressions given above that are logically implied by $P \wedge (P \Rightarrow Q)$ is _____.

2. Let f(x) be a polynomial and g(x) = f′(x) be its derivative. If the degree of (f(x) + f(–x)) is 10, then the degree of (g(x) – g(– x)) is _____.

3. The minimum number of colours that is sufficient to vertex-colour any planar graph is _____.

4. Consider the systems, each consisting of m linear equations in n variables.

(i) If m < n, then all such systems have a solution

(ii) If m > n, then none of these systems has a solution

(iii) If m = n, then there exists a system which has a solution

Which one of the following is **CORRECT**?

(*a*) I, II and III are true

(*b*) Only II and III are true

(*c*) Only III is true

(*d*) None of them is true

5. Suppose that a shop has an equal number of LED bulbs of two different types. The probability of an LED bulb lasting more than 100 hours given that it is of Type 1 is 0.7, and given that it is of Type 2 is 0.4. The probability that an LED bulb chosen uniformly at random lasts more than 100 hours is_____.

6. Suppose that the eigenvalues of matrix A are 1, 2, 4. The determinant of $(A^{-1})^T$ is _____.

7. Consider an eight-bit ripple-carry adder for computing the sum of A and B, where A and B are integers represented in 2's complement form. If the decimal value of A is one, the decimal value of B that leads to the longest latency for the sum to stabilize is_____.

8. Let, $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$ where x_1, x_2, x_3, x_4 are Boolean variables, and $\oplus$ is the XOR operator. Which one of the following must always be TRUE?

(*a*) $x_1 x_2 x_3 x_4 = 0$

(*b*) $x_1 x_3 + x_2 = 0$

(*c*) $\overline{x}_1 \oplus \overline{x}_3 = \overline{x}_2 \oplus \overline{x}_4$

(*d*) $x_1 + x_2 + x_3 + x_4 = 0$

9. Let X be the number of distinct 16-bit integers in 2's complement representation. Let Y be the number of distinct 16-bit integers in sign magnitude representation. Then X – Y is _____.

10. A processor has 40 distinct instructions and 24 general purpose registers. A 32-bit instruction word has an opcode, two register operands and an immediate operand. The number of bits available for the immediate operand field is_____.

11. Breadth First Search (BFS) is started on a binary tree beginning from the root vertex. There is a vertex t at a distance four from the root. If t is the n-th vertex in this BFS traversal, then the maximum possible value of n is_____.

12. The value printed by the following program is_____.

```
void f(int* p, int m){
   m = m + 5;
   *p = *p + m;
   return;
}
void main()
{
   int i=5, j=10;
   f(&i, j);
printf("%d", i+j);
}
```

13. Assume that the algorithms considered here sort the input sequences in ascending order. If the input is already in ascending order, which of the following are TRUE?

I. Quicksort runs in $\Theta(n^2)$ time

II. Bubblesort runs in $\Theta(n^2)$ time

III. Mergesort runs in $\Theta(n)$ time

IV. Insertion sort runs in $\Theta(n)$ time

(*a*) I and II only (*b*) I and III only

(*c*) II and IV only (*d*) I and IV only

14. The Floyd-Warshall algorithm for all-pair shortest paths computation is based on

(*a*) Greedy paradigm

(*b*) Divide-and-Conquer paradigm.

(*c*) Dynamic Programming paradigm.

(*d*) neither Greedy nor Divide-and-Conquer nor Dynamic Programming paradigm.

15. N items are stored in a sorted doubly linked list. For a delete operation, a pointer is provided to the record to be deleted. For a *decrease-key* operation, a pointer is provided to the record on which the operation is to be performed. An algorithm performs the following operations on the list in this order: $\Theta(N)$ delete, $O(\log N)$ insert, $O(\log N)$ find, and $\Theta(N)$ decrease-key. What is the time complexity of all these operations put together?

(*a*) $O(\log^2 N)$ (*b*) $O(N)$

(*c*) $O(N^2)$ (*d*) $\Theta(N^2 \log N)$

16. The number of states in the minimum sized DFA that accepts the language defined by the regular expression

$(0 + 1)^* (0 + 1) (0 + 1)^*$ is _____.

17. Language L_1 is defined by the grammar:

$S_1 \rightarrow aS_1b \mid \varepsilon$

Language L_2 is defined by the grammar:

$S_2 \rightarrow abS_2 \mid \varepsilon$

Consider the following statements:

P: L_1 is regular

Q: L_2 is regular

Which one of the following is TRUE?

(*a*) Both P and Q are true

(*b*) P is true and Q is false

(*c*) P is false and Q is true

(*d*) Both P and Q are false

18. Consider the following types of languages: L_1 : Regular, L_2 : Context-free, L_3 : Recursive, L_4 : Recursively enumerable. Which of the following is/are TRUE?

I. $\bar{L}_3 \cup L_4$ is recursively enumerable

II. $\bar{L}_2 \cup L_3$ is recursive

III. $L_1^* \cap L_2$ is context-free

IV. $L_1 \cap \bar{L}_2$ is context-free

(*a*) I only (*b*) I and III only

(*c*) I and IV only (*d*) I, II and III only

19. Match the following:

(P) Lexical analysis	(i) Leftmost derivation
(Q) Top down parsing	(ii) Type checking
(R) Semantic analysis	(iii) Regular expressions
(S) Runtime environments	(iv) Activation records

(*a*) P ↔ i, Q ↔ ii, R ↔ iv, S ↔ iii

(*b*) P ↔ iii, Q ↔ i, R ↔ ii, S ↔ iv

(*c*) P ↔ ii, Q ↔ iii, R ↔ i, S ↔ iv

(*d*) P ↔ iv, Q ↔ i, R ↔ ii, S ↔ iii

20. In which one of the following page replacement algorithms it is possible for the page fault rate to increase even when the number of allocated frames increases?

(*a*) LRU (Least Recently Used)

(*b*) OPT (Optimal Page Replacement)

(*c*) MRU (Most Recently Used)

(*d*) FIFO (First In First Out)

21. B+ Trees are considered BALANCED because

(*a*) the lengths of the paths from the root to all leaf nodes are all equal.

(*b*) the lengths of the paths from the root to all leaf nodes differ from each other by at most 1.

(*c*) the number of children of any two non-leaf sibling nodes differ by at most 1.

(*d*) the number of records in any two leaf nodes differ by at most 1.

22. Suppose a database schedule S involves transactions T_1, ..., T_n. Construct the precedence graph of S with vertices representing the transactions and edges representing the conflicts. If S is serializable, which one of the following orderings of the vertices of the precedence graph is guaranteed to yield a serial schedule?

(*a*) Topological order

(*b*) Depth-first order

(*c*) Breadth-first order

(*d*) Ascending order of transaction indices

23. Anarkali digitally signs a message and sends it to Salim. Verification of the signature by Salim requires

(*a*) Anarkali's public key

(*b*) Salim's public key

(*c*) Salim's private key

(*d*) Anarkali's private key

24. In an Ethernet local area network, which one of the following statements is TRUE?

(*a*) A station stops to sense the channel once it starts transmitting a frame.

(*b*) The purpose of the jamming signal is to pad the frames that are smaller than the minimum frame size.

(*c*) A station continues to transmit the packet even after the collision is detected.

(*d*) The exponential backoff mechanism reduces the probability of collision on retransmissions.

25. Identify the correct sequence in which the following packets are transmitted on the network by a host when a browser requests a webpage from a remote server, assuming that the host has just been restarted.

(*a*) HTTP GET request, DNS query, TCP SYN

(*b*) DNS query, HTTP GET request, TCP SYN

(*c*) DNS query, TCP SYN, HTTP GET request

(*d*) TCP SYN, DNS query, HTTP GET request

(Q. 26 – 55) : Carry Two Marks Each.

26. A binary relation R on N × N is defined as follows: (a,b)R(c,d) if $a \le c$ or $b \le d$. Consider the following propositions:

P : R is reflexive

Q : R is transitive

Which one of the following statements is TRUE?

(*a*) Both P and Q are true

(*b*) P is true and Q is false

(*c*) P is false and Q is true

(*d*) Both P and Q are false

27. Which one of the following well-formed formulae in predicate calculus is NOT valid?

(*a*) $(\forall x p(x) \Rightarrow \forall x q(x)) \Rightarrow (\exists x \neg p(x) \vee \forall x q(x))$

(*b*) $(\exists x p(x) \vee \exists x q(x)) \Rightarrow \exists x(p(x) \vee q(x))$

(*c*) $\exists x(p(x) \wedge q(x)) \Rightarrow (\exists x p(x) \wedge \exists x q(x))$

(*d*) $\forall x(p(x) \vee q(x)) \Rightarrow (\forall x p(x) \vee \forall x q(x))$

28. Consider a set U of 23 different compounds in a Chemistry lab. There is a subset S of U of 9 compounds, each of which reacts with exactly 3 compounds of U. Consider the following statements:

I. Each compound in U\S reacts with an odd number of compounds.

II. At least one compound in U\S reacts with an odd number of compounds.

III. Each compound in U\S reacts with an even number of compounds.

Which one of the above statements is ALWAYS TRUE?

(*a*) Only I

(*b*) Only II

(*c*) Only III

(*d*) None

29. The value of the expression 13^{99} (mod 17), in the range 0 to 16, is_____

30. Suppose the functions F and G can be computed in 5 and 3 nanoseconds by functional units U_F and U_G, respectively. Given two instances of U_F and two instances of U_G, it is required to implement the computation $F(G(X_i))$ for $1 \le i \le 10$. Ignoring all other delays, the minimum time required to complete this computation is_____nanoseconds.

31. Consider a processor with 64 registers and an instruction set of size twelve. Each instruction has five distinct fields, namely, opcode, two source register identifiers, one destination register identifier, and a twelve-bit immediate value. Each instruction must be stored in memory in a byte-aligned fashion. If a program has 100 instructions, the amount of memory (in bytes) consumed by the program text is_____.

32. The width of the physical address on a machine is 40 bits. The width of the tag field in a 512 KB 8-way set associative cacheis_____bits.

33. Consider a 3 GHz (gigahertz) processor with a three-stage pipeline and stage latencies τ_1, τ_2, and τ_3 such that $\tau_1 = 3\tau_2/4 = 2\tau_3$. If the longest pipeline stage is split into two pipeline stages of equal latency, the new frequency is_____GHz, ignoring delays in the pipeline registers.

34. A complete binary min-heap is made by including each integer in [1,1023] exactly once. The depth of a node in the heap is the length of the path from the root of the heap to that node. Thus, the root is at depth 0. The maximum depth at which integer 9 can appear is _____.

35. The following function computes X^Y for positive integers X and Y.

```
int exp(int X, int Y) {
   int res = 1, a = X, b = Y;
while ( b != 0 ){
if ( b%2 == 0) { a = a*a; b = b/2;}
else        { res = res*a; b = b-1;
}
}
return res;
}
```

Which one of the following conditions is TRUE before every iteration of the loop?

(*a*) $X^Y = a^b$

(*b*) $(res * a)^Y = (res * X)^b$

(*c*) $X^Y = res * a^b$

(*d*) $X^Y = (res * a)^b$

36. Consider the following *New-order* strategy for traversing a binary tree:

- Visit the root;
- Visit the right subtree using *New-order;*
- Visit the left subtree using *New-order;*

The New-order traversal of the expression tree corresponding to the reverse polish expression 3 4 * 5 – 2 ^ 6 7 * 1 + – is given by:

(*a*) + – 1 6 7 * 2 ^ 5 – 3 4 *

(*b*) – + 1 * 6 7 ^ 2 – 5 * 3 4

(*c*) – + 1 * 7 6 ^ 2 – 5 * 4 3

(*d*) 1 7 6 * + 2 5 4 3 * – ^ –

37. Consider the following program:

```
int f(int *p, int n)
{
   if (n <= 1) return 0;
   else return max(f(p+1,n-1),p[0]-
p[1]);
}
int main()
{
   int a[] = {3,5,2,6,4};
   printf("%d", f(a,5));
}
```

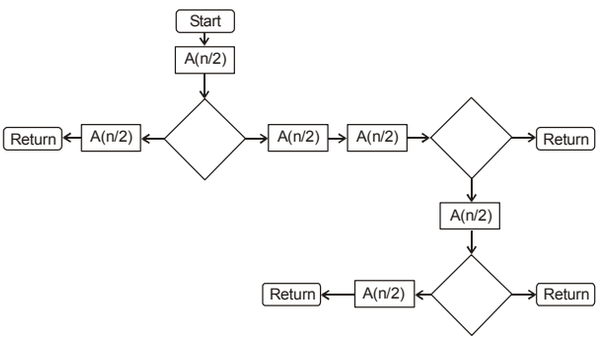
Note: max(x,y) returns the maximum of x and y.

The value printed by this programis_____.

38. Let A_1, A_2, A_3, and A_4 be four matrices of dimensions 10 × 5, 5 × 20, 20 × 10, and 10 × 5, respectively. The minimum number of scalar multiplications required to find the product $A_1 A_2 A_3 A_4$ using the basic matrix multiplication method is_____.

39. The given diagram shows the flowchart for a recursive function A(n). Assume that all statements, except for the recursive calls, have O(1) time complexity. If the worst case time complexity of this function is $O(n^\alpha)$, then the least possible value (accurate up to two decimal positions) of α is_____.

Flowchart for Recursive Function A(n)



40. The number of ways in which the numbers 1, 2, 3, 4, 5, 6, 7 can be inserted in an empty binary search tree, such that the resulting tree has height 6, is_____.

Note: The height of a tree with a single node is 0.

41. In an adjacency list representation of an undirected simple graph G = (V,E), each edge (u, v) has two adjacency list entries: [v] in the adjacency list of u, and [u] in the adjacency list of v. These are called twins of each other. A twin pointer is a pointer from an adjacency list entry to its twin. If |E| = m and |V| = n, and the memory size is not a constraint, what is the time complexity of the most efficient algorithm to set the twin pointer in each entry in each adjacency list?

(*a*) $\Theta(n^2)$

(*b*) $\Theta(n + m)$

(*c*) $\Theta(m^2)$

(*d*) $\Theta(n^4)$

42. Consider the following two statements:

I. If all states of an NFA are accepting states then the language accepted by the NFA is Σ^*.

II. There exists a regular language A such that for all languages B, $A \cap B$ is regular.

Which one of the following is CORRECT?

(*a*) Only I is true

(*b*) Only II is true

(*c*) Both I and II are true

(*d*) Both I and II are false

43. Consider the following languages:

$L_1 = \{a^n b^m c^{n+m} : m, n = \geq 1\}$

$L_2 = \{a^n b^n c^{2n} : n \geq 1\}$

Which one of the following is TRUE?

(*a*) Both L_1 and L_2 are context-free

(*b*) L_1 is context-free while L_2 is not context-free

(*c*) L_2 is context-free while L_1 is not context-free

(*d*) Neither L_1 nor L_2 is context-free

44. Consider the following languages.

$L_1 = \{\langle M \rangle \mid M$ takes at least 2016 steps on some input$\}$,

$L_2 = \{\langle M \rangle \mid M$ takes at least 2016 steps on all inputs$\}$ and

$L_3 = \{\langle M \rangle \mid M$ accepts $\varepsilon\}$,

where for each Turing machine M, $\langle M \rangle$ denotes a specific encoding of M. Which one of the following is TRUE?

(*a*) L_1 is recursive and L_2, L_3 are not recursive

(*b*) L_2 is recursive and L_1, L_3 are not recursive

(*c*) L_1, L_2 are recursive and L_3 is not recursive

(*d*) L_1, L_2, L_3 are recursive

45. Which one of the following grammars is free from left recursion?

(*a*) $S \rightarrow AB$
$A \rightarrow Aa \mid b$
$B \rightarrow c$

(*b*) $S \rightarrow Ab \mid Bb \mid c$
$A \rightarrow Bd \mid \varepsilon$
$B \rightarrow e$

(*c*) $S \rightarrow Aa \mid B$
$A \rightarrow Bb \mid Sc \mid \varepsilon$
$B \rightarrow d$

(*d*) $S \rightarrow Aa \mid Bb \mid c$
$A \rightarrow Bd \mid \varepsilon$
$B \rightarrow Ae \mid \varepsilon$

46. A student wrote two context-free grammars G1 and G2 for generating a single C-like array declaration. The dimension of the array is at least one. For example,

int a[10][3];

The grammars use D as the start symbol, and use six terminal symbols **int ; id [ ] num.**

Grammar G1 Grammar G2

$D \rightarrow$ **intL;** $D \rightarrow$ **intL;**

$L \rightarrow$ **id[E** $L \rightarrow$ **idE**

$E \rightarrow$ **num]** $E \rightarrow$ **E[num]**

$E \rightarrow$ **num][E** $E \rightarrow$ **[num]**

Which of the grammars correctly generate the declaration mentioned above?

(*a*) Both G1 and G2

(*b*) Only G1

(*c*) Only G2

(*d*) Neither G1 nor G2

47. Consider the following processes, with the arrival time and the length of the CPU burst given in milliseconds. The scheduling algorithm used is preemptive shortest remaining-time first.

Process	Arrival Time	Burst Time
P_1	0	10
P_2	3	6
P_3	7	1
P_4	8	3

The average turn around time of these processes is_____milliseconds.

48. Consider the following two-process synchronization solution.

Process 0

```
--------
Entry: loop while (turn == 1);
critical section)
Exit: turn=1;
```

Process 1

```
--------
Entry: loop while (turn == 0);
critical section)
Exit: turn=0;
```

The shared variable turn is initialized to zero. Which one of the following is TRUE?

(*a*) This is a correct two-process synchronization solution

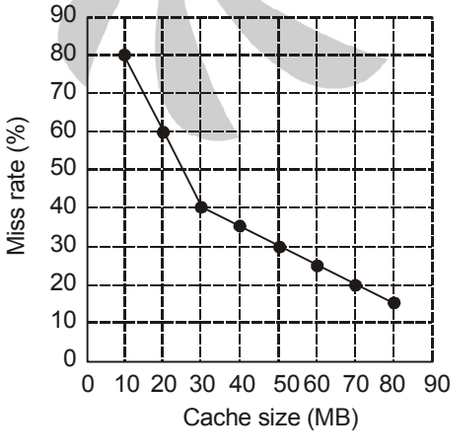
(*b*) This solution violates mutual exclusion requirement

(*c*) This solution violates progress requirement

(*d*) This solution violates bounded wait requirement

49. Consider a non-negative counting semaphore S. The operation P(S) decrements S, and V(S) increments S. During an execution, 20 P(S) operations and 12 V(S) operations are issued in some order. The largest initial value of S for which at least one P(S) operation will remain blocked is_____.

50. A file system uses an in-memory cache to cache disk blocks. The miss rate of the cache is shown in the figure. The latency to read a block from the cache is 1 ms and to read a block from the disk is 10 ms. Assume that the cost of checking whether a block exists in the cache is negligible. Available cache sizes are in multiples of 10 MB.



The smallest cache size required to ensure an average read latency of less than 6 ms is_____ MB.

51. Consider the following database schedule with two transactions, T_1 and T_2.

$S = r_2(X); r_1(X); r_2(Y); w_1(X); r_1(Y); w_2(X); a_1; a_2$

where $r_i(Z)$ denotes a read operation by transaction T_i on a variable Z, $w_i(Z)$ denotes a write operation by T_i on a variable Z and a_i denotes an abort by transaction T_i.

Which one of the following statements about the above schedule is TRUE?

(*a*) S is non-recoverable

(*b*) S is recoverable, but has a cascading abort

(*c*) S does not have a cascading abort

(*d*) S is strict

52. Consider the following database table named water_schemes :

water_schemes		
scheme_no	**district_name**	**capacity**
1	Ajmer	20
1	Bikaner	10
2	Bikaner	10
3	Bikaner	20
1	Churu	10
2	Churu	20
1	Dungargarh	10

The number of tuples returned by the following SQL query is_____.

```
with total(name, capacity) as
select  district_name, sum(capacity)
from water_schemes
group by district_name
with total_avg(capacity) as
select avg(capacity)
from  total
select name
from total, total_avg
where total.capacity =
total_avg.capacity
```

53. A network has a data transmission bandwidth of 20×10^6 bits per second. It uses CSMA/CD in the MAC layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is_____bytes.

54. For the IEEE 802.11 MAC protocol for wireless communication, which of the following statements is/are TRUE?

I. At least three non-overlapping channels are available for transmissions.

II. The RTS-CTS mechanism is used for collision detection.

III. Unicast frames are ACKed.

(*a*) All I, II, and III (*b*) I and III only

(*c*) II and III only (*d*) II only

55. Consider a 128×10^3 bits/second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is_____.

ANSWERS

General Aptitude (GA)

1. (*b*)	**2.** (*a*)	**3.** (*c*)	**4.** (*d*)	**5.** (*b*)	**6.** (*a*)	**7.** (*b*)	**8.** (*d*)
9. (*c*)	**10.** (*c*)						

Technical Section

1. (3)	**2.** (9)	**3.** (4)	**4.** (*c*)	**5.** (0.55)	**6.** (0.125)	**7.** (–1)
8. (*c*)	**9.** (1)	**10.** (16)	**11.** (31)	**12.** (30)	**13.** (*d*)	**14.** (*c*)
15. (*c*)	**16.** (2)	**17.** (*c*)	**18.** (*d*)	**19.** (*b*)	**20.** (*d*)	**21.** (*a*)
22. (*a*)	**23.** (*a*)	**24.** (*d*)	**25.** (*c*)	**26.** (*a*)	**27.** (*d*)	**28.** (*b*)
29. (4)	**30.** (30)	**31.** (500)	**32.** (24)	**33.** (4)	**34.** (8)	**35.** (*c*)
36. (*c*)	**37.** (3)	**38.** (1500)	**39.** (2.32)	**40.** (64)	**41.** (*b*)	**42.**(*d*)
43. (*b*)	**44.** (*c*)	**45.** (*b*)	**46.** (*a*)	**47.** (8.25)	**48.** (*c*)	**49.** (7)
50. (30)	**51.** (*c*)	**52.** (2)	**53.** (200)	**54.** (*b*)	**55.** (4)	

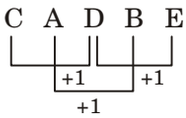
EXPLANTIONS

GENERAL APTITUDE (GA)

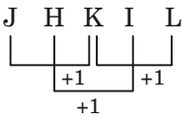
2. 'Cope with' means to put up with an unpleasant difficult situation.

3. From the given words mock, deride and jeer are synonyms of mockery. So, the word 'praise' is odd one.

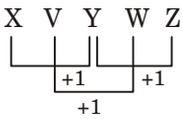
4. From option (a)



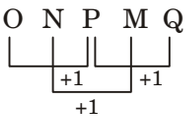
From option (b)



From option (c)



From option (d)



In options A, B and C, the letters skipped between consecutive pair of letters in the English alphabet is in increasing order (i,e) A and B, H and I and V and W but in option 'D' N and M are present instead of M and N so, option 'D' is odd one from the group.

5. Given $\dfrac{\alpha^n+\beta^n}{\alpha^{-n}+\beta^{-n}} = \dfrac{\alpha^n+\beta^n}{\dfrac{1}{\alpha^n}+\dfrac{1}{\beta^n}}$

$$\frac{\alpha^n+\beta^n}{\dfrac{\beta^n+\alpha^n}{\alpha^n\times\beta^n}} = \alpha^n\times\beta^n$$

$$\alpha^n\times\beta^n = (\alpha\times\beta)^n$$

$$= (4)^n$$

(Since the value of the product of the roots $\alpha \times \beta = 4$)

So, the required value is 4^n.

6. Total number of faculty members = 150

The number of faculty members having facebook® account = FB = 55

The number of faculty members having whatsApp® = W = 85

The number of faculty members do not have facebook® (or) WhatsApp® accounts = 30

The number of faculty members having any account = 150 – 30 = 120

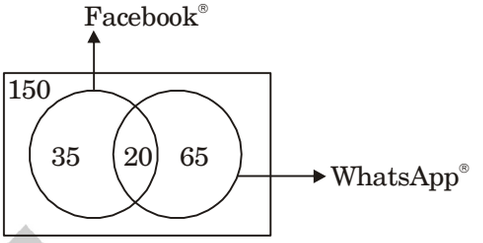
The faculty members having both the accounts

= (FB + W) – (FB or W)

= (55 + 85) – 120 = 20

∴ The number of faculty members connected only through Facebook® accounts

= 55 – 20 = 35



9. In given 2 × 4 rectangle grid, the following type of rectangles are present.

The number of one figured rectangles = 8

The number of two figured rectangles = 10

The number of three figured rectangles = 4

The number of four figured rectangles = 5

The number of six figured rectangles = 2

The number of eight figured rectangles = 1

Total no. of rectangles = 8 + 10 + 4 + 5 + 2 + 1 = 30

∴ The No. of rectangles observed in the given grid = 30.

10. At x = 3 from given graph f(x) must be equals to zero

From option a

$f(x) = 1 - |x - 1|$

at x = 3

$f(x) = 1 - |3 - 1| = 1 - 2 = -1$

So, it is false.

From option b

$f(x) = 1 + |x - 1|$

at x = 3

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

So, it is false.

From option c

$f(x) = 2 - |x - 1|$

at x = 3

$f(x) = 2 - |3 - 1| = 2 - 2 = 0$

So, it is true

From option d

$f(x) = 2 + |x - 1|$

at x = 3

$f(x) = 2 + |3 - 1| = 2 + 2 = 4$

So, it is false.

TECHNICAL SECTION

1. (*a*) $P \wedge (P \rightarrow Q) \Rightarrow Q$

(*b*) $P \wedge (P \rightarrow Q) \Rightarrow P \vee Q$

(*c*) $P \wedge (P \rightarrow Q) \Rightarrow \sim Q \vee P$

So, the number of expression is 3.

2. From the given question

If f(x) is a polynomial of degree 'n'

Then f′(x) is a polynomial of degree (n – 1)

f(x) + f(–x) is a polynomial of degree 10

$\therefore$ g(x) – g(–x) is a polynomial of degree 9

: 10 : SET-2 Afternoon Session

(OR)

If degree of {f(x) + f(x)} = 10, then the largest even exponent of x in f(x) = 10.

Now, the largest odd exponent of x in g(x) = 9

$\therefore$ degree of {g(x) – g(–x)} = 9

3. By 4 – color theorem, Every planar graph is 4 – colorable

4. Statement I

Consider 2 equations in three variables.

$x - y + z = 1$

$-x + y - z = 2$

This system has no solution (inconsistent)

$x = 1$ and $y = 1$

$\therefore$ Statement I is false

Statement II

Consider 3 equations in two variables.

$x + y = 2$,

$x - y = 0$,

$3x + y = 4$

This system has a unique solution

$\therefore$ Statement II is false.

Statement III

Consider a system with 2 equations and two variables

$x + y = 2$ and $x - y = 0$.

The system has a solution $x = 1$ and $y = 1$

$\therefore$ Statement III is true

5. From the given question

A $\rightarrow$ event of selection of type-1 bulb

B $\rightarrow$ event of selection of type-2 bulb

E $\rightarrow$ event of selection of bulb glow for more than 100 hrs

Now we use P(A)P(E / A) + P(B)P(E / B)

$$= \frac{1}{2} \times 0.7 + \frac{1}{2} \times 0.4 = 0.55$$

6. Given the eigen values of matrix A is

$$\lambda = 1, 2, 4$$

$$|A| = 1 \times 2 \times 4 = 8$$

$$\Rightarrow \quad |A^{-1}| = \frac{1}{|A|} = \frac{1}{8}$$

$$\therefore \quad \left|\left(A^{-1}\right)^{T}\right| = |A^{-1}|$$

$$= \frac{1}{8} = 0.125$$

So the determinant of $(A^{-1})^T$ is $\frac{1}{8}$ (i.e. 0.125).

7. When all bits in 'B' register is '1', then it gives only the highest delay.

$\therefore$ '–1' in 8 bit notation of 2's complement is 1111 1111

9. The number of distinct values

For 2's complement – (2^{n-1}) to + $(2^{n-1} - 1)$

For sign magnitude – $(2^{n-1} - 1)$ to + $(2^{n-1} - 1)$

In 2's complement, let n = 2

$\therefore$ (-2^{2-1}) to $(2^{2-1} - 1)$

– 2 to +1 $\Rightarrow$ –2, –1, 0, +1

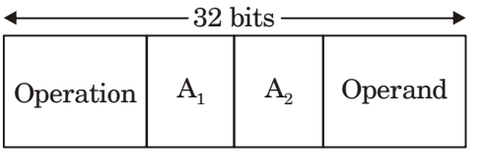
$\therefore$ X = 4

n = 2 in sign magnitude $\Rightarrow$ –1 to +1

$\therefore$ Y = 3

$\therefore$ X – Y = 4 – 3 = 1

10.



$\log_2^{40}$	$\log_2^{24}$	$\log_2^{24}$	
6	5	5	xxx

$\therefore$ 32 – 16 = 16

So, the number of bits available for the immediate operand field is 16.

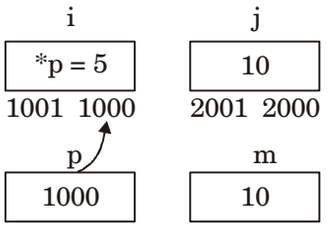
11. Maximum possible value of n for which we have complete tree and our 't' node is the last leaf node at height 4.

So, the maximum possible value of n

$$= 1 + 2 + 4 + 8 + 16$$

$$= 31$$

12.



m = m + 5; // m = 15

*p = *p + m; // * p = *p + m = 5 + 15

*p = 20 (i.e., i = 20)

i + j = 20 + 10 = 30

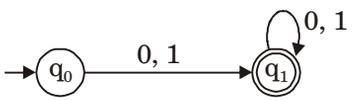
So, the output of the given program is 30.

13. 1. Quicksort will take worst case, if the input is in ascending order i.e $\Theta(n^2)$

2. Insertion sort runs in $\Theta(n)$ time.

14. Dynamic programming

16.



Given regular expression

$$(r) = (0 + 1)^* (0 + 1) (0 + 1)^*$$
$$= 2$$

So, the number of states in minimal DFA is 2.

17. From the given question

$L_1 : S_1 \rightarrow aS_1 b \mid \varepsilon$

$L_2 : S_2 \rightarrow abS_2 \mid \varepsilon$

$L_1 : \{a^n b^n \mid n > 0\} \rightarrow$ CFL

$L_2 : (ab)^* \rightarrow$ RL

So, the given statements P is false and Q is true.

18. From the given question

L_1 : Regular

L_2 : CFL (Context-free)

L_3 : Recursive language

L_4 : REL (Recursively enumerable.)

(i) $\bar{L}_3$ is Recursive

$\bar{L}_3 \cup L_4$ is REL (Recursively enumerable)

(ii) $\bar{L}_2$ is recursive

$\bar{L}_3$ is recursive

$\Rightarrow \bar{L}_2 \cup L_3$ is also recursive

(iii) L_1^* is regular

L_2 is CFL (Context-free)

$\Rightarrow L_1^* \cup L_2$ is CFL

Since CFL is closed under the intersection with RL

$\therefore$ RL $\cap$ CFL is CFL

(iv) L_1 is RL

$\bar{L}_2$ is recursive

$\Rightarrow L_1 \cup \bar{L}_2$ is CFL is not possible

So, the statements (i), (ii) and (iii) are correct.

21. A Tree is called balanced, if the length of the paths from the root to all leaf nodes are all equal.

22. If a schedule(s) is serializable, the topological order of a graph (also called precedence graph) yields a serial schedule.

23. Sign is sender's private key and the receiver side verification of the signature is done with sender public key.

24. According to the concept of binary exponential backoff algorithm the exponential backoff mechanism reduces the probability of collision on retransmissions.

25. Theere are following steps in which packets are transmitted on the network by a host when a browser requests a webpage from a remote server :

Step 1 : The client(browser) initiates a DNS query for remote server. It may be that they already have this server in their DNS cache, in which case the client may simply send a TCP SYN directly to the application server.

Step 2 : The client will next send a connection request to the application server. This will be a TCP SYN packet, the first in the TCP three-way handshake.

Step 3 : Next, after the TCP connection has been established, the client will request data from the server. In the web-based application, the client performs an HTTP GET.

26. A binary relation R on N $\times$ N is defined as (a, b) R(C, d)

Reflexive: (a, a) R(a, a)

Since $a \le a$, and $a \le a$

Transitive: (a, b) R (c, d) and (c, d) R(m, n) then (a, b) R(m, n)

Suppose (a, b) R(c, d)

$\Rightarrow$ $a \le c$ and $b \le d$

and (c, d) R(m, n)

$\Rightarrow$ $c \le m$, $d \le n$

Since $a \le c$, and $c \le m$ so $a \le m$

$b \le d$ and $d \le n$, so $b \le n$

$\therefore$ (a, b) R(m, n)

(OR)

P. we have $a \le a$ and $b \le b$

$\Rightarrow$ (a, b) R(a, b)

$\Rightarrow$ R is reflexive

$\therefore$ P is true

Q. Let (a, b) R(c, d) and (c, d) R (e, f)

$\Rightarrow$ {$a \le c$ and $b \le d$} and { $c \le e$ and $d \le f$}

$\Rightarrow$ {$a \le e$ and $b \le f$}

$\Rightarrow$ (a, b) R (e, f)

$\Rightarrow$ R is transitive

Hence both the statements P and Q are true.

27. (A) The well formed formula is valid, because L.H.S $\Leftrightarrow$ R.H.S

(B) The well formed formula is valid, because L.H.S $\Leftrightarrow$ R.H.S.

(C)

1. $\exists_x\{p(x) \wedge q(x)\}$	premise
2. $p(a) \wedge q(a)$	(1) E.S
3. $p(a)$	(2) simplification
4. $q(a)$	(2) simplification
5. $\exists_x p(x)$	(3) E.G
6. $\exists_x q(x)$	(4) E.G
7. $\exists_x p(x) \wedge \exists_x q(x)$	(5), (6) conjunction

Proved

(D) Let p(x): x is a musician

and q(x): x is a filmstar

Let U = {Amitabh Bachchan, Arjun Rampal, Akshay Kumar, Ravi Shankar, Bismillah Khan }

Be the universe of discourse.

Here antecedent of the implication is true but consequent is false.

So option (D) is not valid.

28. Let us denote the problem by a non directed graph with 23 vertices (compounds). If two compounds in chemistry lab react with each other, then there exists an edge between the corresponding vertices. In the graph, we have 9 vertices with degree 3 (i.e. odd degree). By sum of degrees of vertices theorem atleast one of the remaining vertices should have odd degree.

29. By Fermat's theorem,

If P is a prime number and P is not a divisor of a, then $a^{P-1} = 1 \pmod P$

Here, 17 is a prime number and 17 is not a divisor of 13.

$\therefore \quad 13^{16} = 1 \pmod P$

$13^{99} = (13)^{96}.(13)^3$

$= (13^{16})^6.2197$

$= 1^6.2197 \pmod{17}$

$\therefore \quad 13^{99} \pmod{17} = 2197 \pmod{17} = 4$

(The remainder obtained by dividing 2197 with 17)

So, the value of the given expression is 4.

30. From the given question

5*G + 3*F = 3*5 + 5*3 = 30 ns

31. According to question

One instruction needs 34 bits

So number of bytes needed

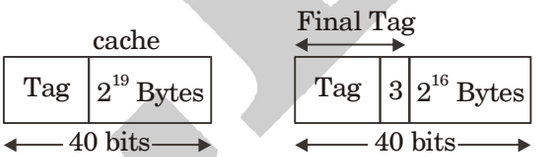
= 5 (Since 1 byte = 8 bits)

$\therefore$ Program size = 100

$\therefore$ Size of the memory (in bytes) = 500

So the amount of memory consumed by the program text is 500 bytes.

32.



It uses 8 way set associative

$\therefore$ Tag size = 24 bits.

So the width of the tag field is 24 bits.

33. From question

Stage 1 (t_1)	**Stage 2 (t_2)**	**Stage 3 (t_3)**
$(3/4)t_2$	$1t_2$	$(3/8)t_2$

Old pipeline Clock frequency is 3GHz if time is t_2.

Stage 1 (t_1)	Stage 21(t_{21})	Stage 22(t_{22})	Stage 3(t_3)
$(3/4)t_2$	$(t_2/2)$	$(t_2/2)$	$(3/8)t_2$

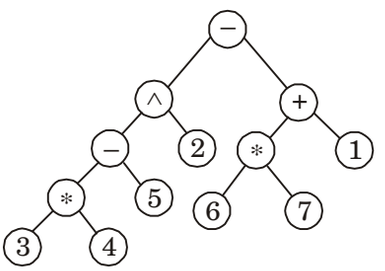
Clock frequency of new pipeline with time

$(3/4)t_2 \rightarrow \frac{4}{3} \times 3$ GHz = 4 GHz

So, the new frequency is 4 GHz.

35. X^Y = res * a^b

36.

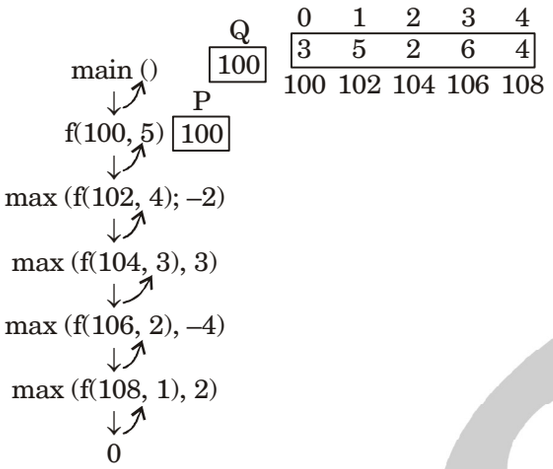


Given expression is 34 * 5 – 2 ∨ 6 7 * 1 + –

Now Converse it into preorder

1. Root
2. RST
3. LST

37. From the given program, we have



So, the value printed by the program is 3.

38. Let m_{14} be the minimum number of scalar multiplication for which multiply sequence is $M_1M_2M_3M_4$.

where $M_1 = A, M_2 = B, M_3 = C, M_4 = D$

Let $d_0 = 10, d_1 = 5, d_2 = 20, d_3 = 10, d_4 = 5$

$\therefore$ $m_{11} = m_{22} = m_{33} = m_{44} = 0$

$m_{12} = 1000$ $m_{23} = 1000$ $m_{34} = 1000$

$m_{13} = 1500$ $m_{24} = 1250$

$$m_{14} = \min \begin{Bmatrix} m_{11} + m_{21} + d_0 \times d_1 \times d_4, \\ m_{12} + m_{34} + d_1 \times d_2 \times d_4, \\ m_{13} + m_{44} + d_0 \times d_3 \times d_4 \end{Bmatrix} = 1500$$

From the given matrices

OR

There are 5 possible cases

A(B(C D)), A((BC)D), ((AB)C)D, (A(BC))D, (AB)(CD).

The scalar multiplications required are 1750, 1500, 3500, 2000, 3000 respectively.

$\therefore$ Minimum number of scalar multiplications

= 1500

40. Formula is 2^n, here n is 6

$2^6 = 64$

The number of ways = $2^n = 2^6 = 64$

(Here n = height of a tree = 6)

42. Both I and II are false.

43. Given language is

L_1: $\{a^n b^m c^{n+m} \mid m, n \geq 1\}$ – CFL

L_2: $\{a^n b^n c^{2n} \mid n \geq 1\}$ – CSL

So, from the above language is is clear that L_1 is context-free language (CFL) but L_2 is not context-free language (CFL)

44. From the given language.

L_1 is Recursive

L_2 is Recursive

and L_3 is Not Recursive

45. From option (*b*)

$$\left.\begin{array}{l} S \to Ab \mid Bb \mid \in \\ A \to Bd \mid \in \\ B \to e \end{array}\right\} \text{Generates finite language}$$

No Recursion at all

So, the given option (*b*) is free from left recursion.

46.

Grammar$_1$:	**Grammar$_2$:**
D → int L;	D → int L;
L → id [E	L → id E
E → num]	E → E[num]
E → num][E	E → [num]

int a[10] [3];

From Grammar$_1$:

D → int L;		D → int L;
→ int id [E];	**(or)**	→ int a[E];
→ int a [num];		→ int a [num] [E
		→ int a [num] [num]
		→ int a [10] [3];

From Grammar$_2$:

D → int L;

→ int id E;

→ int a E[num];

→ int a [num] [num];

→ int a [10] [3];

$\therefore$ Both G_1 and G_2 generates the string.

int a[10] [3];

Hence, both the grammars G_1 and G_2 generate the declaration.

51. As there is no dirty-read in the given schedule, the schedule is both recoverable and cascadeless.

52. The result of the query is:

name

Bikaner

churu

Total	
District name	**Capacity**
Ajmeer	20
Bikaner	40
Churu	30
Dungargarh	10

$$\text{Total} - \text{Average} = \frac{\text{Capacity of (Ajmer + Bikaner +Churu + Dung arg arh)}}{4}$$

$$= \frac{20+40+30+10}{4}$$

$$= \frac{110}{4} = 25$$

Total – avg
capacity
25

So, the number of tables returned by the given SQL query is 2.

53. From the given data

The size of a frame(L) = ?

Transmission bandwidth (B) = 20 Mbps

Propagation time (T_p) = 40 microse conds

$T_x = L/B = 100$ ms

$T_x = 2T_p$

The minimum size of a frame

$(L_{min}) = 2T_p B = 2(40)\ (20)/8 = 200$ Bytes

54. In case of IEEE 802.11 MAC protocol for wireless communication RTS and CTS mechanism is used for collision avoidance, not for collision detection.

55. From the given question, we have 5 step problem

1. Calculate RTT = $2(T_p)$
2. Calculate BR, window size in bits
3. Calculate W = window in packets = BR/L
4. For selective repeat, ASN is set to 2W
5. Sequence number, k

Bandwidth (B) = 128×10^3 bps

Propagation delay (T_p) = 150 msec

Packet size(L) = 1 kilobyte

$$\text{Transmission delay } (T_t) = \frac{L}{B}$$

$$T_t = \frac{1 \times 8 \times 10^3 \text{bits}}{128 \times 10^3 \text{bps}}$$

$$\Rightarrow \quad T_t = \frac{1}{16}\text{sec}$$

$$T_t = 64 \text{ msec}$$

W_S = sender window size

$$\eta = \frac{W_c \times T_t}{T_t + 2T_p}$$

$$1 = \frac{W_S \times 64}{64 + 2 \times 150}$$

$$\frac{364}{64} = W_S$$

$$W_S = 5.6875$$

$W_S + W_R$ = Available sequence numbers for SR,

$W_S = W_R$ (Here W_R = receiver window size)

$ASN = 2 \times W_S$

$ASN = 2 \times 5.6875$

$ASN = 11.375$

No. of bits in the sequence number

$= [\log_2 ASN]$

$= [\log_2 11.375] = 4$

So, the minimum number of bits required for the sequence number field to achieve 100% utilization is 4.

■■