Q. 1 – Q. 5 carry one mark each.

Q.1 Out of the following four sentences, select the most suitable sentence with respect to grammar and usage.

(A) I will not leave the place until the minister does not meet me.

(B) I will not leave the place until the minister doesn't meet me.

(C) I will not leave the place until the minister meet me.

(D) I will not leave the place until the minister meets me.

Q.2 A rewording of something written or spoken is a _____.

(A) paraphrase (B) paradox (C) paradigm (D) paraffin

Q.3 Archimedes said, "Give me a lever long enough and a fulcrum on which to place it, and I will move the world."

The sentence above is an example of a _____ statement.

(A) figurative (B) collateral

(C) literal (D) figurine

Q.4 If 'relftaga' means carefree, 'otaga' means careful and 'fertaga' means careless, which of the following could mean 'aftercare'?

(A) zentaga (B) tagafer (C) tagazen (D) relffer

Q.5 A cube is built using 64 cubic blocks of side one unit. After it is built, one cubic block is removed from every corner of the cube. The resulting surface area of the body (in square units) after the removal is _____.

(A) 56 (B) 64 (C) 72 (D) 96

Q. 6 – Q. 10 carry two marks each.

Q.6 A shaving set company sells 4 different types of razors, Elegance, Smooth, Soft and Executive. Elegance sells at Rs. 48, Smooth at Rs. 63, Soft at Rs. 78 and Executive at Rs. 173 per piece. The table below shows the numbers of each razor sold in each quarter of a year.

Quarter \ Product	Elegance	Smooth	Soft	Executive
Q1	27300	20009	17602	9999
Q2	25222	19392	18445	8942
Q3	28976	22429	19544	10234
Q4	21012	18229	16595	10109

Which product contributes the greatest fraction to the revenue of the company in that year?

(A) Elegance (B) Executive (C) Smooth (D) Soft

Q.7 Indian currency notes show the denomination indicated in at least seventeen languages. If this is not an indication of the nation's diversity, nothing else is.

Which of the following can be logically inferred from the above sentences?

(A) India is a country of exactly seventeen languages.

(B) Linguistic pluralism is the only indicator of a nation's diversity.

(C) Indian currency notes have sufficient space for all the Indian languages.

(D) Linguistic pluralism is strong evidence of India's diversity.

Q.8 Consider the following statements relating to the level of poker play of four players **P**, **Q**, **R** and **S**.

I. **P** always beats **Q**
II. **R** always beats **S**
III. **S** loses to **P** only sometimes
IV. **R** always loses to **Q**

Which of the following can be logically inferred from the above statements?

(i) **P** is likely to beat all the three other players
(ii) **S** is the absolute worst player in the set

(A) (i) only (B) (ii) only (C) (i) and (ii) (D) neither (i) nor (ii)

Q.9 If $f(x) = 2x^7 + 3x - 5$, which of the following is a factor of f(x)?

(A) (x^3+8) (B) (x-1) (C) (2x-5) (D) (x+1)

Q.10 In a process, the number of cycles to failure decreases exponentially with an increase in load. At a load of 80 units, it takes 100 cycles for failure. When the load is halved, it takes 10000 cycles for failure. The load for which the failure will happen in 5000 cycles is _____.

(A) 40.00 (B) 46.02 (C) 60.01 (D) 92.02

END OF THE QUESTION PAPER

Q. 1 - Q. 25 carry one mark each.

Q.1 Let p, q, r, s represent the following propositions.

p: $x \in \{8, 9, 10, 11, 12\}$

q: x is a composite number

r: x is a perfect square

s: x is a prime number

The integer $x \geq 2$ which satisfies $\neg((p \Rightarrow q) \wedge (\neg r \vee \neg s))$ is _____ .

Q.2 Let a_n be the number of n-bit strings that do NOT contain two consecutive 1s. Which one of the following is the recurrence relation for a_n?

(A) $a_n = a_{n-1} + 2a_{n-2}$

(B) $a_n = a_{n-1} + a_{n-2}$

(C) $a_n = 2a_{n-1} + a_{n-2}$

(D) $a_n = 2a_{n-1} + 2a_{n-2}$

Q.3

$$\lim_{x \to 4} \frac{\sin(x-4)}{x-4} = \_\_\_\_\_.$$

Q.4 A probability density function on the interval $[a, 1]$ is given by $1/x^2$ and outside this interval the value of the function is zero. The value of a is _____ .

Q.5 Two eigenvalues of a 3×3 real matrix P are $(2 + \sqrt{-1})$ and 3. The determinant of P is _____ .

Q.6 Consider the Boolean operator # with the following properties:
$x\#0 = x$, $x\#1 = \bar{x}$, $x\#x = 0$ and $x\#\bar{x} = 1$. Then $x\#y$ is equivalent to

(A) $x\bar{y} + \bar{x}y$

(B) $x\bar{y} + \bar{x}\bar{y}$

(C) $\bar{x}y + xy$

(D) $xy + \bar{x}\bar{y}$

Q.7 The 16-bit 2's complement representation of an integer is 1111 1111 1111 0101; its decimal representation is _____ .

Q.8 We want to design a synchronous counter that counts the sequence 0-1-0-2-0-3 and then repeats. The minimum number of J-K flip-flops required to implement this counter is _____ .

Q.9 A processor can support a maximum memory of 4 GB, where the memory is word-addressable (a word consists of two bytes). The size of the address bus of the processor is at least _____ bits.

Q.10 A queue is implemented using an array such that ENQUEUE and DEQUEUE operations are performed efficiently. Which one of the following statements is **CORRECT** (n refers to the number of items in the queue)?

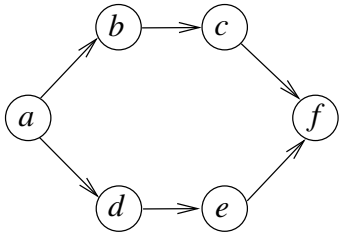
(A) Both operations can be performed in $O(1)$ time

(B) At most one operation can be performed in $O(1)$ time but the worst case time for the other operation will be $\Omega(n)$

(C) The worst case time complexity for both operations will be $\Omega(n)$

(D) Worst case time complexity for both operations will be $\Omega(\log n)$

Q.11 Consider the following directed graph:



The number of different topological orderings of the vertices of the graph is _____ .

Q.12 Consider the following C program.

```
void f(int, short);
void main()
{
     int i = 100;
     short s = 12;
     short *p = &s;
     __________ ;    // call to f()
}
```

Which one of the following expressions, when placed in the blank above, will **NOT** result in a type checking error?

(A) `f(s,*s)`

(B) `i = f(i,s)`

(C) `f(i,*s)`

(D) `f(i,*p)`

Q.13 The worst case running times of *Insertion sort*, *Merge sort* and *Quick sort*, respectively, are:

(A) $\Theta(n \log n)$, $\Theta(n \log n)$, and $\Theta(n^2)$

(B) $\Theta(n^2)$, $\Theta(n^2)$, and $\Theta(n \log n)$

(C) $\Theta(n^2)$, $\Theta(n \log n)$, and $\Theta(n \log n)$

(D) $\Theta(n^2)$, $\Theta(n \log n)$, and $\Theta(n^2)$

Q.14 Let G be a weighted connected undirected graph with distinct positive edge weights. If every edge weight is increased by the same value, then which of the following statements is/are **TRUE**?

P: Minimum spanning tree of G does not change

Q: Shortest path between any pair of vertices does not change

(A) P only

(B) Q only

(C) Neither P nor Q

(D) Both P and Q

Q.15 Consider the following C program.

```
#include<stdio.h>
void mystery(int *ptra, int *ptrb) {
      int *temp;
      temp = ptrb;
      ptrb = ptra;
      ptra = temp;
}
int main() {
      int a=2016, b=0, c=4, d=42;
      mystery(&a, &b);
      if (a < c)
            mystery(&c, &a);
      mystery(&a, &d);
      printf("%d\n", a);
}
```

The output of the program is _____ .

Q.16 Which of the following languages is generated by the given grammar?

$$S \longrightarrow aS \mid bS \mid \varepsilon$$

(A) $\{a^n b^m \mid n, m \geq 0\}$

(B) $\{w \in \{a,b\}^* \mid w$ has equal number of a's and b's $\}$

(C) $\{a^n \mid n \geq 0\} \cup \{b^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$

(D) $\{a,b\}^*$

Q.17 Which of the following decision problems are undecidable?

I. Given NFAs N_1 and N_2, is $L(N_1) \cap L(N_2) = \Phi$?

II. Given a CFG $G = (N, \Sigma, P, S)$ and a string $x \in \Sigma^*$, does $x \in L(G)$?

III. Given CFGs G_1 and G_2, is $L(G_1) = L(G_2)$?

IV. Given a TM M, is $L(M) = \Phi$?

(A) I and IV only

(B) II and III only

(C) III and IV only

(D) II and IV only

Q.18 Which one of the following regular expressions represents the language: *the set of all binary strings having two consecutive* 0*s and two consecutive* 1*s*?

(A) $(0+1)^*0011(0+1)^* + (0+1)^*1100(0+1)^*$

(B) $(0+1)^*(00(0+1)^*11 + 11(0+1)^*00)(0+1)^*$

(C) $(0+1)^*00(0+1)^* + (0+1)^*11(0+1)^*$

(D) $00(0+1)^*11 + 11(0+1)^*00$

Q.19 Consider the following code segment.

```
x = u - t;
y = x * v;
x = y + w;
y = t - z;
y = x * y;
```

The minimum number of *total* variables required to convert the above code segment to *static single assignment* form is _____ .

Q.20 Consider an arbitrary set of CPU-bound processes with unequal CPU burst lengths submitted at the same time to a computer system. Which one of the following process scheduling algorithms would minimize the average waiting time in the ready queue?

(A) Shortest remaining time first

(B) Round-robin with time quantum less than the shortest CPU burst

(C) Uniform random

(D) Highest priority first with priority proportional to CPU burst length

Q.21 Which of the following is **NOT** a superkey in a relational schema with attributes V, W, X, Y, Z and primary key VY?

(A) $VXYZ$

(B) $VWXZ$

(C) $VWXY$

(D) $VWXYZ$

Q.22 Which one of the following is **NOT** a part of the ACID properties of database transactions?

(A) Atomicity

(B) Consistency

(C) Isolation

(D) Deadlock-freedom

Q.23 A database of research articles in a journal uses the following schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, YEAR, PRICE)

The primary key is (VOLUME, NUMBER, STARTPAGE, ENDPAGE) and the following functional dependencies exist in the schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE) $\rightarrow$ TITLE
(VOLUME, NUMBER) $\rightarrow$ YEAR
(VOLUME, NUMBER, STARTPAGE, ENDPAGE) $\rightarrow$ PRICE

The database is redesigned to use the following schemas.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, PRICE)
(VOLUME, NUMBER, YEAR)

Which is the weakest normal form that the new database satisfies, but the old one does not?

(A) 1NF
(B) 2NF
(C) 3NF
(D) BCNF

Q.24 Which one of the following protocols is **NOT** used to resolve one form of address to another one?

(A) DNS
(B) ARP
(C) DHCP
(D) RARP

Q.25 Which of the following is/are example(s) of stateful application layer protocols?

(i) HTTP
(ii) FTP
(iii) TCP
(iv) POP3

(A) (i) and (ii) only
(B) (ii) and (iii) only
(C) (ii) and (iv) only
(D) (iv) only

Q. 26 - Q. 55 carry two marks each.

Q.26 The coefficient of x^{12} in $(x^3+x^4+x^5+x^6+\cdots)^3$ is _____ .

Q.27 Consider the recurrence relation $a_1 = 8$, $a_n = 6n^2 + 2n + a_{n-1}$. Let $a_{99} = K \times 10^4$. The value of K is _____ .

Q.28 A function $f : \mathbb{N}^+ \to \mathbb{N}^+$, defined on the set of positive integers $\mathbb{N}^+$, satisfies the following properties:

$$f(n) = f(n/2) \quad \textbf{if } n \text{ is even}$$
$$f(n) = f(n+5) \quad \textbf{if } n \text{ is odd}$$

Let $R = \{i \mid \exists j : f(j) = i\}$ be the set of distinct values that f takes. The maximum possible size of R is _____ .

Q.29 Consider the following experiment.

Step 1. Flip a fair coin twice.

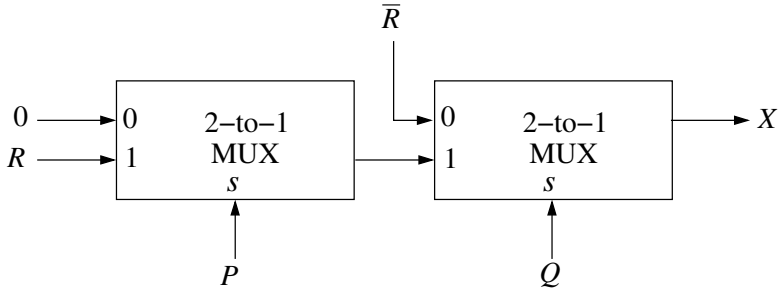
Step 2. If the outcomes are (TAILS, HEADS) then output Y and stop.

Step 3. If the outcomes are either (HEADS, HEADS) or (HEADS, TAILS), then output N and stop.

Step 4. If the outcomes are (TAILS, TAILS), then go to Step 1.

The probability that the output of the experiment is Y is (up to two decimal places) _____ .

Q.30 Consider the two cascaded 2-to-1 multiplexers as shown in the figure.



The minimal sum of products form of the output X is

(A) $\bar{P}\bar{Q}+PQR$

(B) $\bar{P}Q+QR$

(C) $PQ+\bar{P}\bar{Q}R$

(D) $\bar{Q}\bar{R}+PQR$

Q.31 The size of the data count register of a DMA controller is 16 bits. The processor needs to transfer a file of 29,154 kilobytes from disk to main memory. The memory is byte addressable. The minimum number of times the DMA controller needs to get the control of the system bus from the processor to transfer the file from the disk to main memory is _____ .

Q.32 The stage delays in a 4-stage pipeline are 800, 500, 400 and 300 picoseconds. The first stage (with delay 800 picoseconds) is replaced with a functionally equivalent design involving two stages with respective delays 600 and 350 picoseconds. The throughput increase of the pipeline is _____ percent.

Q.33 Consider a carry lookahead adder for adding two n-bit integers, built using gates of fan-in at most two. The time to perform addition using this adder is

(A) $\Theta(1)$

(B) $\Theta(\log(n))$

(C) $\Theta(\sqrt{n})$

(D) $\Theta(n)$

Q.34 The following function computes the maximum value contained in an integer array `p[]` of size `n (n >= 1)`.

```
int max(int *p, int n) {
    int a=0, b=n-1;

    while (__________) {
        if (p[a] <= p[b]) { a = a+1; }
        else              { b = b-1; }
    }

    return p[a];
}
```

The missing loop condition is

(A) `a != n`

(B) `b != 0`

(C) `b > (a + 1)`

(D) `b != a`

Q.35 What will be the output of the following C program?

```
void count(int n){
     static int d=1;

     printf("%d ", n);
     printf("%d ", d);
     d++;
     if(n>1) count(n-1);
     printf("%d ", d);
}

void main(){
     count(3);
}
```

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

(B) 3 1 2 1 1 1 2 2 2

(C) 3 1 2 2 1 3 4

(D) 3 1 2 1 1 1 2

Q.36 What will be the output of the following pseudo-code when parameters are passed by reference and dynamic scoping is assumed?

```
a=3;
void n(x) {x = x * a; print(x);}
void m(y) {a = 1; a = y - a; n(a); print(a);}
void main() {m(a);}
```

(A) 6, 2

(B) 6, 6

(C) 4, 2

(D) 4, 4

Q.37 An operator `delete`(i) for a binary heap data structure is to be designed to delete the item in the i-th node. Assume that the heap is implemented in an array and i refers to the i-th index of the array. If the heap tree has depth d (number of edges on the path from the root to the farthest leaf), then what is the time complexity to re-fix the heap efficiently after the removal of the element?

(A) $O(1)$

(B) $O(d)$ but not $O(1)$

(C) $O(2^d)$ but not $O(d)$

(D) $O(d\,2^d)$ but not $O(2^d)$

Q.38 Consider the weighted undirected graph with 4 vertices, where the weight of edge $\{i, j\}$ is given by the entry W_{ij} in the matrix W.

$$W = \begin{bmatrix} 0 & 2 & 8 & 5 \\ 2 & 0 & 5 & 8 \\ 8 & 5 & 0 & \text{x} \\ 5 & 8 & \text{x} & 0 \end{bmatrix}$$

The largest possible integer value of x, for which at least one shortest path between some pair of vertices will contain the edge with weight x is _____ .

Q.39 Let G be a complete undirected graph on 4 vertices, having 6 edges with weights being 1, 2, 3, 4, 5, and 6. The maximum possible weight that a minimum weight spanning tree of G can have is _____ .

Q.40 $G = (V, E)$ is an undirected simple graph in which each edge has a distinct weight, and e is a particular edge of G. Which of the following statements about the minimum spanning trees (MSTs) of G is/are **TRUE**?

I. If e is the lightest edge of some cycle in G, then every MST of G includes e

II. If e is the heaviest edge of some cycle in G, then every MST of G excludes e

(A) I only (B) II only (C) both I and II (D) neither I nor II

Q.41 Let Q denote a queue containing sixteen numbers and S be an empty stack. `Head`(Q) returns the element at the head of the queue Q **without** removing it from Q. Similarly `Top`(S) returns the element at the top of S **without** removing it from S. Consider the algorithm given below.

```
while Q is not Empty do
    if S is Empty OR Top(S) ≤ Head(Q) then
        x := Dequeue(Q);
        Push(S,x);
    else
        x := Pop(S);
        Enqueue(Q,x);
    end
end
```

The maximum possible number of iterations of the **while** loop in the algorithm is _____ .

Q.42 Consider the following context-free grammars:

G_1: $S \to aS|B$, $B \to b|bB$

G_2: $S \to aA|bB$, $A \to aA|B|\varepsilon$, $B \to bB|\varepsilon$

Which one of the following pairs of languages is generated by G_1 and G_2, respectively?

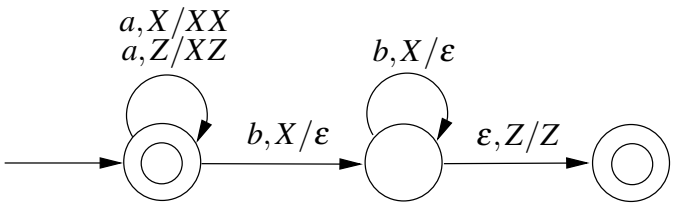
(A) $\{a^m b^n | m > 0 \text{ or } n > 0\}$ and $\{a^m b^n | m > 0 \text{ and } n > 0\}$

(B) $\{a^m b^n | m > 0 \text{ and } n > 0\}$ and $\{a^m b^n | m > 0 \text{ or } n \geq 0\}$

(C) $\{a^m b^n | m \geq 0 \text{ or } n > 0\}$ and $\{a^m b^n | m > 0 \text{ and } n > 0\}$

(D) $\{a^m b^n | m \geq 0 \text{ and } n > 0\}$ and $\{a^m b^n | m > 0 \text{ or } n > 0\}$

Q.43 Consider the transition diagram of a PDA given below with input alphabet $\Sigma = \{a, b\}$ and stack alphabet $\Gamma = \{X, Z\}$. Z is the initial stack symbol. Let L denote the language accepted by the PDA.



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

(A) $L = \{a^n b^n | n \geq 0\}$ and is not accepted by any finite automata

(B) $L = \{a^n | n \geq 0\} \cup \{a^n b^n | n \geq 0\}$ and is not accepted by any deterministic PDA

(C) L is not accepted by any Turing machine that halts on every input

(D) $L = \{a^n | n \geq 0\} \cup \{a^n b^n | n \geq 0\}$ and is deterministic context-free

Q.44 Let X be a recursive language and Y be a recursively enumerable but not recursive language. Let W and Z be two languages such that $\overline{Y}$ reduces to W, and Z reduces to $\overline{X}$ (reduction means the standard many-one reduction). Which one of the following statements is **TRUE**?

(A) W can be recursively enumerable and Z is recursive.

(B) W can be recursive and Z is recursively enumerable.

(C) W is not recursively enumerable and Z is recursive.

(D) W is not recursively enumerable and Z is not recursive.

Q.45 The attributes of three arithmetic operators in some programming language are given below.

Operator	Precedence	Associativity	Arity
$+$	High	Left	Binary
$-$	Medium	Right	Binary
$*$	Low	Left	Binary

The value of the expression $\mathbf{2-5+1-7*3}$ in this language is _____ .

Q.46 Consider the following Syntax Directed Translation Scheme (SDTS), with non-terminals {S, A} and terminals {**a**, **b**}.

S $\longrightarrow$ **a**A { print 1 }
S $\longrightarrow$ **a** { print 2 }
A $\longrightarrow$ S**b** { print 3 }

Using the above SDTS, the output printed by a bottom-up parser, for the input **aab** is:

(A) 1 3 2

(B) 2 2 3

(C) 2 3 1

(D) syntax error

Q.47 Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one-level page table per process and each page table entry requires 48 bits, then the size of the per-process page table is _____ megabytes.

Q.48 Consider a disk queue with requests for I/O to blocks on cylinders 47, 38, 121, 191, 87, 11, 92, 10. The C-LOOK scheduling algorithm is used. The head is initially at cylinder number 63, moving towards larger cylinder numbers on its servicing pass. The cylinders are numbered from 0 to 199. The total head movement (in number of cylinders) incurred while servicing these requests is _____ .

Q.49 Consider a computer system with ten physical page frames. The system is provided with an access sequence $(a_1, a_2, \ldots, a_{20}, a_1, a_2, \ldots, a_{20})$, where each a_i is a distinct virtual page number. The difference in the number of page faults between the last-in-first-out page replacement policy and the optimal page replacement policy is _____ .

Q.50 Consider the following proposed solution for the critical section problem. There are n processes: $P_0 \ldots P_{n-1}$. In the code, function `pmax` returns an integer not smaller than any of its arguments. For all i, `t[i]` is initialized to zero.

Code for P_i:

```
do {
     c[i]=1; t[i] = pmax(t[0],...,t[n-1])+1; c[i]=0;
     for every j ≠ i in {0,...,n-1} {
          while (c[j]);
          while (t[j] != 0 && t[j]<=t[i]);
     }
     Critical Section;
     t[i]=0;
     Remainder Section;
} while (true);
```

Which one of the following is **TRUE** about the above solution?

(A) At most one process can be in the critical section at any time

(B) The bounded wait condition is satisfied

(C) The progress condition is satisfied

(D) It cannot cause a deadlock

Q.51 Consider the following two phase locking protocol. Suppose a transaction T accesses (for read or write operations), a certain set of objects $\{O_1, \ldots, O_k\}$. This is done in the following manner:

Step 1. T acquires exclusive locks to $O_1, \ldots, O_k$ in increasing order of their addresses.

Step 2. The required operations are performed.

Step 3. All locks are released.

This protocol will

(A) guarantee serializability and deadlock-freedom

(B) guarantee neither serializability nor deadlock-freedom

(C) guarantee serializability but not deadlock-freedom

(D) guarantee deadlock-freedom but not serializability

Q.52 Consider that B wants to send a message m that is digitally signed to A. Let the pair of private and public keys for A and B be denoted by K_x^- and K_x^+ for $x = A, B$, respectively. Let $K_x(m)$ represent the operation of encrypting m with a key K_x and $H(m)$ represent the message digest. Which one of the following indicates the **CORRECT** way of sending the message m along with the digital signature to A?

(A) $\{m, K_B^+(H(m))\}$ (B) $\{m, K_B^-(H(m))\}$ (C) $\{m, K_A^-(H(m))\}$ (D) $\{m, K_A^+(m)\}$

Q.53 An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes. Assume that the size of the IP header is 20 bytes.

The number of fragments that the IP datagram will be divided into for transmission is _____ .

Q.54 For a host machine that uses the token bucket algorithm for congestion control, the token bucket has a capacity of 1 megabyte and the maximum output rate is 20 megabytes per second. Tokens arrive at a rate to sustain output at a rate of 10 megabytes per second. The token bucket is currently full and the machine needs to send 12 megabytes of data. The minimum time required to transmit the data is _____ seconds.

Q.55 A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds.

Assuming no frame is lost, the sender throughput is _____ bytes/second.

Q. No	Type	Section	Key	Marks
1	MCQ	GA	D	1
2	MCQ	GA	A	1
3	MCQ	GA	A	1
4	MCQ	GA	C	1
5	MCQ	GA	D	1
6	MCQ	GA	B	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	B	2
10	MCQ	GA	B	2
1	NAT	CS-1	11.0 : 11.0	1
2	MCQ	CS-1	B	1
3	NAT	CS-1	1.0 : 1.0	1
4	NAT	CS-1	0.5 : 0.5	1
5	NAT	CS-1	15.0 : 15.0	1
6	MCQ	CS-1	A	1
7	NAT	CS-1	-11.0 : -11.0	1
8	NAT	CS-1	3.0 : 4.0	1
9	NAT	CS-1	31.0 : 31.0	1
10	MCQ	CS-1	A	1
11	NAT	CS-1	6.0 : 6.0	1
12	MCQ	CS-1	D	1
13	MCQ	CS-1	D	1
14	MCQ	CS-1	A	1
15	NAT	CS-1	2016.0 : 2016.0	1
16	MCQ	CS-1	D	1
17	MCQ	CS-1	C	1
18	MCQ	CS-1	B	1
19	NAT	CS-1	10.0 : 10.0	1
20	MCQ	CS-1	A	1
21	MCQ	CS-1	B	1
22	MCQ	CS-1	D	1
23	MCQ	CS-1	B	1
24	MCQ	CS-1	C	1
25	MCQ	CS-1	C	1
26	NAT	CS-1	10.0 : 10.0	2
27	NAT	CS-1	197.9 : 198.1	2
28	NAT	CS-1	2.0 : 2.0	2
29	NAT	CS-1	0.33 : 0.34	2
30	MCQ	CS-1	D	2
31	NAT	CS-1	456.0 : 456.0	2
32	NAT	CS-1	33.0 : 34.0	2
33	MCQ	CS-1	B	2
34	MCQ	CS-1	D	2
35	MCQ	CS-1	A	2
36	MCQ	CS-1	D	2
37	MCQ	CS-1	B	2
38	NAT	CS-1	12.0 : 12.0	2
39	NAT	CS-1	7.0 : 7.0	2

40	MCQ	CS-1	B	2
41	NAT	CS-1	256.0 : 256.0	2
42	MCQ	CS-1	D	2
43	MCQ	CS-1	D	2
44	MCQ	CS-1	C	2
45	NAT	CS-1	9.0 : 9.0	2
46	MCQ	CS-1	C	2
47	NAT	CS-1	384.0 : 384.0	2
48	NAT	CS-1	346.0 : 346.0	2
49	NAT	CS-1	1.0 : 1.0	2
50	MCQ	CS-1	A	2
51	MCQ	CS-1	A	2
52	MCQ	CS-1	B	2
53	NAT	CS-1	13.0 : 13.0	2
54	NAT	CS-1	1.1 : 1.1	2
55	NAT	CS-1	2500.0 : 2500.0	2

Q. 1 – Q. 5 carry one mark each.

Q.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

Q.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

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

mock, deride, praise, jeer

(A) mock (B) deride (C) praise (D) jeer

Q.4 Pick the odd one from the following options.

(A) CADBE (B) JHKIL (C) XVYWZ (D) ONPMQ

Q.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 – Q. 10 carry two marks each.

Q.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

Q.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)

Q.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.

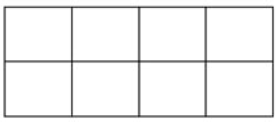
(A) (i) only

(B) (ii) only

(C) both (i) and (ii)

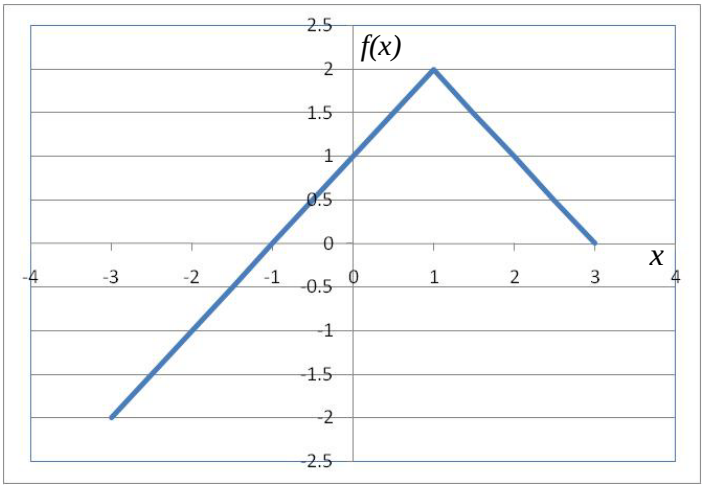
(D) neither (i) nor (ii)

Q.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

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

END OF THE QUESTION PAPER

Q. 1 - Q. 25 carry one mark each.

Q.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 _____ .

Q.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 _____ .

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

Q.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

Q.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 _____ .

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

Q.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 _____ .

Q.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) $\bar{x}_1 \oplus \bar{x}_3 = \bar{x}_2 \oplus \bar{x}_4$

(D) $x_1 + x_2 + x_3 + x_4 = 0$

Q.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 _____ .

Q.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 _____ .

Q.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 _____ .

Q.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);
}
```

Q.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

Q.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.

Q.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) $\Theta(N^2 \log N)$

Q.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 _____ .

Q.17 Language L_1 is defined by the grammar: $S_1 \rightarrow aS_1b|\varepsilon$
Language L_2 is defined by the grammar: $S_2 \rightarrow abS_2|\varepsilon$

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

Q.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. $\overline{L_3} \cup L_4$ is recursively enumerable

II. $\overline{L_2} \cup L_3$ is recursive

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

IV. $L_1 \cup \overline{L_2}$ is context-free

(A) I only

(B) I and III only

(C) I and IV only

(D) I, II and III only

Q.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 $\leftrightarrow$ i, Q $\leftrightarrow$ ii, R $\leftrightarrow$ iv, S $\leftrightarrow$ iii

(B) P $\leftrightarrow$ iii, Q $\leftrightarrow$ i, R $\leftrightarrow$ ii, S $\leftrightarrow$ iv

(C) P $\leftrightarrow$ ii, Q $\leftrightarrow$ iii, R $\leftrightarrow$ i, S $\leftrightarrow$ iv

(D) P $\leftrightarrow$ iv, Q $\leftrightarrow$ i, R $\leftrightarrow$ ii, S $\leftrightarrow$ iii

Q.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)

Q.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.

Q.22 Suppose a database schedule S involves transactions $T_1, \ldots, T_n$. 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

Q.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.

Q.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.

Q.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 - Q. 55 carry two marks each.

Q.26 A binary relation R on $\mathbb{N} \times \mathbb{N}$ is defined as follows: $(a,b)R(c,d)$ if $a \leq c$ or $b \leq d$. 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.

Q.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) $\forall x\, (p(x) \vee q(x)) \Rightarrow (\forall x\, p(x) \vee \forall x\, q(x))$

Q.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 $U \setminus S$ reacts with an odd number of compounds.

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

III. Each compound in $U \setminus S$ 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

Q.29 The value of the expression $13^{99} \pmod{17}$, in the range 0 to 16, is _____ .

Q.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 $1 \leq i \leq 10$. Ignoring all other delays, the minimum time required to complete this computation is _____ nanoseconds.

Q.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 _____ .

Q.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 cache is _____ bits.

Q.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.

Q.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 _____ .

Q.35 The following function computes $\texttt{X}^{\texttt{Y}}$ 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) $\texttt{X}^{\texttt{Y}} = \texttt{a}^{\texttt{b}}$

(B) $(\texttt{res} * \texttt{a})^{\texttt{Y}} = (\texttt{res} * \texttt{X})^{\texttt{b}}$

(C) $\texttt{X}^{\texttt{Y}} = \texttt{res} * \texttt{a}^{\texttt{b}}$

(D) $\texttt{X}^{\texttt{Y}} = (\texttt{res} * \texttt{a})^{\texttt{b}}$

Q.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 * - ^ -`

Q.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));
}
```

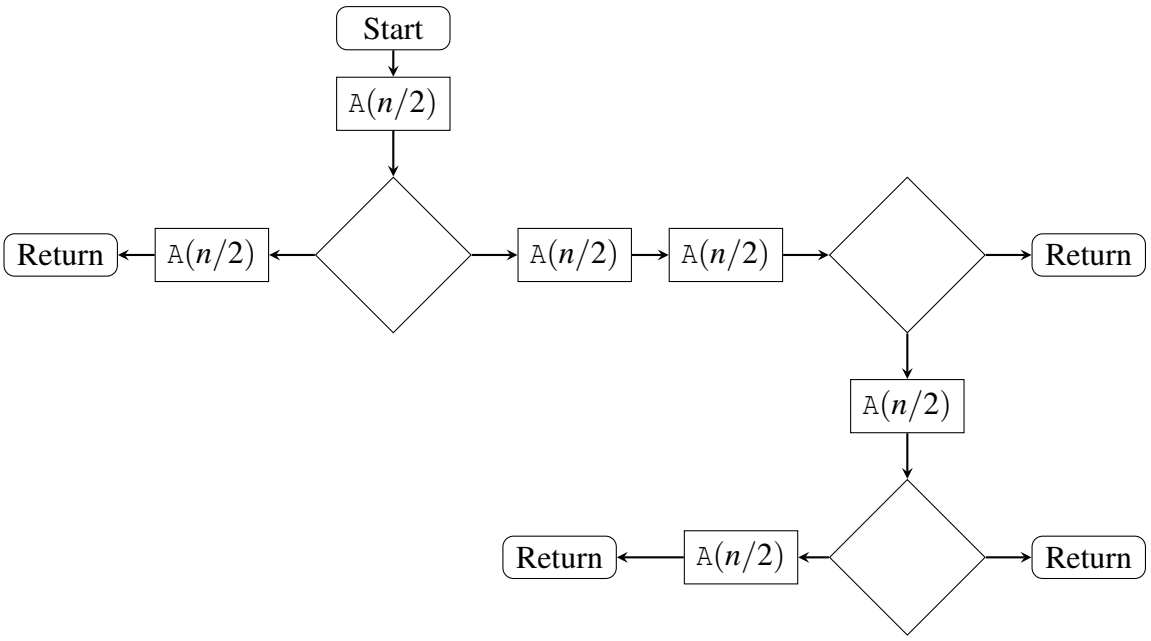
Note: `max(x,y)` *returns the maximum of* `x` *and* `y`.

The value printed by this program is _____ .

Q.38 Let A_1, A_2, A_3, and A_4 be four matrices of dimensions $10 \times 5, 5 \times 20, 20 \times 10$, and 10×5, respectively. The minimum number of scalar multiplications required to find the product $A_1A_2A_3A_4$ using the basic matrix multiplication method is _____ .

Q.39 The given diagram shows the flowchart for a recursive function $\mathtt{A}(n)$. 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 $\mathtt{A}(n)$



Q.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.

Q.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) $\Theta(n^4)$

Q.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

Q.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.

Q.44 Consider the following languages.

$$\begin{aligned} L_1 &= \{\langle M\rangle \mid M \text{ takes at least 2016 steps on some input}\}, \\ L_2 &= \{\langle M\rangle \mid M \text{ takes at least 2016 steps on all inputs}\} \text{ and} \\ L_3 &= \{\langle M\rangle \mid M \text{ accepts } \varepsilon\}, \end{aligned}$$

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

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

(A)
$$\begin{aligned} S &\to AB \\ A &\to Aa \mid b \\ B &\to c \end{aligned}$$

(B)
$$\begin{aligned} S &\to Ab \mid Bb \mid c \\ A &\to Bd \mid \varepsilon \\ B &\to e \end{aligned}$$

(C)
$$\begin{aligned} S &\to Aa \mid B \\ A &\to Bb \mid Sc \mid \varepsilon \\ B &\to d \end{aligned}$$

(D)
$$\begin{aligned} S &\to Aa \mid Bb \mid c \\ A &\to Bd \mid \varepsilon \\ B &\to Ae \mid \varepsilon \end{aligned}$$

Q.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**
$D \rightarrow \textbf{int}\, L;$	$D \rightarrow \textbf{int}\, L;$
$L \rightarrow \textbf{id}\, [E$	$L \rightarrow \textbf{id}\, E$
$E \rightarrow \textbf{num}]$	$E \rightarrow E[\textbf{num}]$
$E \rightarrow \textbf{num}]\, [E$	$E \rightarrow [\textbf{num}]$

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**

Q.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.

Q.48 Consider the following two-process synchronization solution.

```
Process 0                              Process 1
---------                              ----------
Entry: loop while (turn == 1);         Entry: loop while (turn == 0);
  (critical section)                     (critical section)
Exit:  turn = 1;                       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.

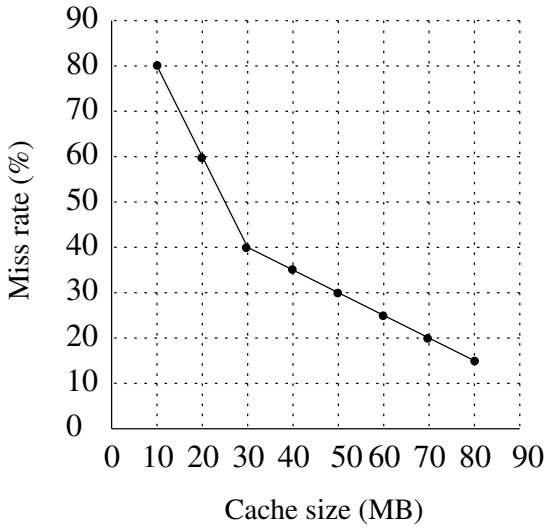
(B) This solution violates mutual exclusion requirement.

(C) This solution violates progress requirement.

(D) This solution violates bounded wait requirement.

Q.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 _____ .

Q.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.

Q.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

Q.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
```

Q.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.

Q.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

Q.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 _____ .

Q. No	Type	Section	Key	Marks
1	MCQ	GA	B	1
2	MCQ	GA	A	1
3	MCQ	GA	C	1
4	MCQ	GA	D	1
5	MCQ	GA	B	1
6	MCQ	GA	A	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	C	2
10	MCQ	GA	C	2
1	NAT	CS-2	4.0 : 4.0	1
2	NAT	CS-2	9.0 : 9.0	1
3	NAT	CS-2	4.0 : 4.0	1
4	MCQ	CS-2	C	1
5	NAT	CS-2	0.55 : 0.55	1
6	NAT	CS-2	0.124 : 0.126	1
7	NAT	CS-2	-1.0 : -1.0	1
8	MCQ	CS-2	C	1
9	NAT	CS-2	1.0 : 1.0	1
10	NAT	CS-2	16.0 : 16.0	1
11	NAT	CS-2	31.0 : 31.0	1
12	NAT	CS-2	30.0 : 30.0	1
13	MCQ	CS-2	D	1
14	MCQ	CS-2	C	1
15	MCQ	CS-2	C	1
16	NAT	CS-2	2.0 : 2.0	1
17	MCQ	CS-2	C	1
18	MCQ	CS-2	D	1
19	MCQ	CS-2	B	1
20	MCQ	CS-2	D	1
21	MCQ	CS-2	A	1
22	MCQ	CS-2	A	1
23	MCQ	CS-2	A	1
24	MCQ	CS-2	D	1
25	MCQ	CS-2	C	1
26	MCQ	CS-2	B	2
27	MCQ	CS-2	D	2
28	MCQ	CS-2	B	2
29	NAT	CS-2	4.0 : 4.0	2
30	NAT	CS-2	28.0 : 28.0	2
31	NAT	CS-2	500.0 : 500.0	2
32	NAT	CS-2	24.0 : 24.0	2
33	NAT	CS-2	3.9 : 4.1	2
34	NAT	CS-2	8.0 : 8.0	2
35	MCQ	CS-2	C	2
36	MCQ	CS-2	C	2
37	NAT	CS-2	3.0 : 3.0	2
38	NAT	CS-2	1500.0 : 1500.0	2
39	NAT	CS-2	2.2 : 2.4	2

40	NAT	CS-2	64.0 : 64.0	2
41	MCQ	CS-2	B	2
42	MCQ	CS-2	B	2
43	MCQ	CS-2	B	2
44	MCQ	CS-2	C	2
45	MCQ	CS-2	B	2
46	MCQ	CS-2	A	2
47	NAT	CS-2	8.2 : 8.3	2
48	MCQ	CS-2	C	2
49	NAT	CS-2	7.0 : 7.0	2
50	NAT	CS-2	30.0 : 30.0	2
51	MCQ	CS-2	C	2
52	NAT	CS-2	2.0 : 2.0	2
53	NAT	CS-2	200.0 : 200.0	2
54	MCQ	CS-2	B	2
55	NAT	CS-2	4.0 : 4.0	2