

CS & IT - GATE 2014 - Paper

CS and IT PAPER NO. 3

Q. No. 1 – 5 Carry One Mark Each

General Aptitude Questions

1. While trying to collect an envelope from under the table, Mr. X fell down and
I II III
was losing consciousness.
IV
Which one of the above underlined parts of the sentence is NOT appropriate?
(A) I (B) II (C) III (D) IV
2. If she _____ how to calibrate the instrument, she _____ done the experiment.
(A) knows, will have (B) knew, had
(C) had known, could have (D) should have known, would have
3. Choose the word that is opposite in meaning to the word "coherent".
(A) sticky (B) well-connected (C) rambling (D) friendly
4. Which number does not belong in the series below?
2, 5, 10, 17, 26, 37, 50, 64
(A) 17 (B) 37 (C) 64 (D) 26
5. The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

Q.No	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	2	23	18	3

What is the average of the marks obtained by the class in the examination?

- (A) 1.34 (B) 1.74 (C) 3.02 (D) 3.91

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Q. No. 6 – 10 Carry One Mark Each

6. A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is
- (A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.
 (B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.
 (C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.
 (D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

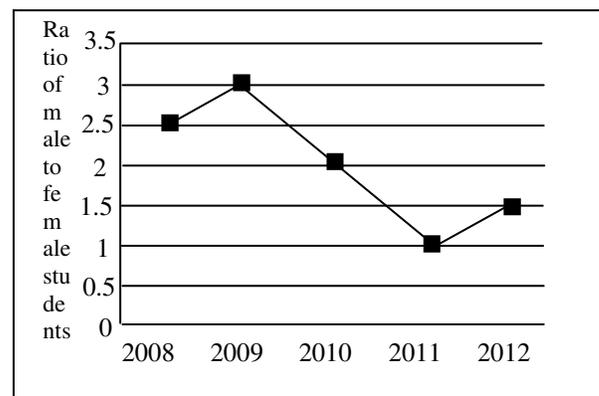
7. By the beginning of the 20th century, several hypotheses were being proposed, suggesting a paradigm shift in our understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

Which of the following inference(s) may be drawn from the above passage?

- (i) Our understanding of the universe changes based on the positions of stars
 (ii) Paradigm shifts usually occur at the beginning of centuries
 (iii) Stars are important objects in the universe
 (iv) Experimental evidence was important in confirming this paradigm shift
- (A) (i), (ii) and (iv) (B) (iii) only (C) (i) and (iv) (D) (iv) only
8. The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013
- (A) increased by 5 % (B) decreased by 13%
 (C) decreased by 20% (D) decreased by 11%

9. The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?

- (A) 1:1
 (B) 2:1
 (C) 1.5:1
 (D) 2.5:1



10. Consider the equation: $(7526)_8 - (Y)_8 = (4364)_8$, where $(X)_N$ stands for X to the base N. Find Y.
- (A) 1634 (B) 1737 (C) 3142 (D) 3162

Computer Science and Information Technology

Q. No. 1 – 25 Carry One Mark Each

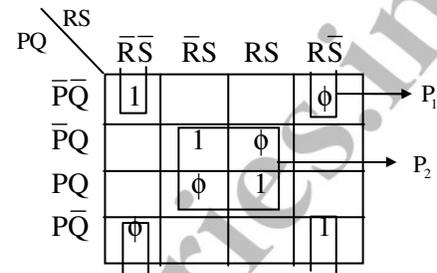
1. Consider the following statements:
P: Good mobile phones are not cheap
Q: Cheap mobile phones are not good
L: P implies Q
M: Q implies P
N: P is equivalent to Q
Which one of the following about L, M, and N is **CORRECT**?
(A) Only L is TRUE. (B) Only M is TRUE.
(C) Only N is TRUE. (D) L, M and N are TRUE.
2. Let X and Y be finite sets and $f : X \rightarrow Y$ be a function. Which one of the following statements is TRUE?
(A) For any subsets A and B of X, $|f(A \cup B)| = |f(A)| + |f(B)|$
(B) For any subsets A and B of X, $f(A \cap B) = f(A) \cap f(B)$
(C) For any subsets A and B of X, $|f(A \cap B)| = \min\{|f(A)|, |f(B)|\}$
(D) For any subsets S and T of Y, $f^{-1}(S \cap T) = f^{-1}(S) \cap f^{-1}(T)$
3. Let G be a group with 15 elements. Let L be a subgroup of G. It is known that $L \neq G$ and that the size of L is at least 4. The size of L is _____.
4. Which one of the following statements is TRUE about every $n \times n$ matrix with only real eigenvalues?
(A) If the trace of the matrix is positive and the determinant of the matrix is negative, at least one of its eigenvalues is negative.
(B) If the trace of the matrix is positive, all its eigenvalues are positive.
(C) If the determinant of the matrix is positive, all its eigenvalues are positive.
(D) If the product of the trace and determinant of the matrix is positive, all its eigenvalues are positive.
5. If V_1 and V_2 are 4-dimensional subspaces of a 6-dimensional vector space V, then the smallest possible dimension of $V_1 \cap V_2$ is _____.
6. If $\int_0^{2\pi} |x \sin x| dx = k\pi$, then the value of k is equal to _____.

7. Consider the following minterm expression for F.

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

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

- (A) $Q\bar{S} + \bar{Q}S$
 (B) $\bar{Q}\bar{S} + QS$
 (C) $\bar{Q}\bar{R}\bar{S} + \bar{Q}R\bar{S} + Q\bar{R}S + QRS$
 (D) $\bar{P}\bar{Q}\bar{S} + \bar{P}QS + PQS + P\bar{Q}\bar{S}$



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

$$f(x, y, a, b)$$

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

Which one of the following digital logic blocks is the most suitable for implementing this function?

- (A) Full adder (B) Priority encoder (C) Multiplexor (D) Flip-flop

9. Consider the following processors (ns stands for nanoseconds). Assume that the pipeline registers have zero latency.

P1: Four-stage pipeline with stage latencies 1 ns, 2 ns, 2 ns, 1 ns.

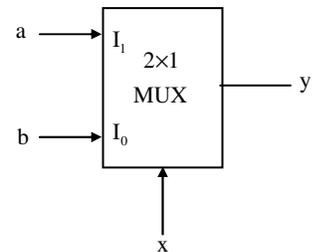
P2: Four-stage pipeline with stage latencies 1 ns, 1.5 ns, 1.5 ns, 1.5 ns.

P3: Five-stage pipeline with stage latencies 0.5 ns, 1 ns, 1 ns, 0.6 ns, 1 ns.

P4: Five-stage pipeline with stage latencies 0.5 ns, 0.5 ns, 1 ns, 1 ns, 1.1 ns.

Which processor has the highest peak clock frequency?

- (A) P1 (B) P2 (C) P3 (D) P4



10. Let A be a square matrix size $n \times n$. Consider the following pseudocode. What is the expected output?

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


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16. Let Σ be a finite non-empty alphabet and let $2\Sigma^*$ be the power set of Σ^* . Which one of the following is **TRUE**?
- (A) Both $2\Sigma^*$ and Σ^* are countable
(B) $2\Sigma^*$ is countable Σ^* is uncountable
(C) $2\Sigma^*$ is uncountable and Σ^* is countable
(D) Both $2\Sigma^*$ and Σ^* are uncountable
17. One of the purposes of using intermediate code in compilers is to
- (A) make parsing and semantic analysis simpler.
(B) improve error recovery and error reporting
(C) increase the chances of reusing the machine-independent code optimizer in other compilers.
(D) improve the register allocation.
18. Which of the following statements are **CORRECT**?
- 1) Static allocation of all data areas by a compiler makes it impossible to implement recursion.
2) Automatic garbage collection is essential to implement recursion.
3) Dynamic allocation of activation records is essential to implement recursion.
4) Both heap and stack are essential to implement recursion.
- (A) 1 and 2 only (B) 2 and 3 only (C) 3 and 4 only (D) 1 and 3 only
19. In the context of modular software design, which one of the following combinations is desirable?
- (A) High cohesion and high coupling (B) High cohesion and low coupling
(C) Low cohesion and high coupling (D) Low cohesion and low coupling
20. A system uses 3 page frames for storing process pages in main memory. It uses the Least Recently Used (LRU) page replacement policy. Assume that all the page frames are initially empty. What is the total number of page faults that will occur while processing the page reference string given below?
- 4, 7, 6, 1, 7, 6, 1, 2, 7, 2
21. What is the optimized version of the relation algebra expression $\pi_{A_1}(\pi_{A_2}(\sigma_{F_1}(r)))$, where A_1, A_2 are sets of attributes in with $A_1 \subset A_2$ and F_1, F_2 are Boolean expressions based on the attributes in r ?
- (A) $\pi_{A_1}(\sigma(F_1 \wedge F_2)(r))$ (B) $\pi_{A_1}(\sigma(F_1 \vee F_2)(r))$
(C) $\pi_{A_2}(\sigma(F_1 \wedge F_2)(r))$ (D) $\pi_{A_2}(\sigma(F_1 \vee F_2)(r))$
22. A prime attribute of a relation scheme R is an attribute that appears
- (A) in all candidate keys of R . (B) in some candidate key of R .
(C) in a foreign keys of R . (D) only in the primary key of R .

23. In the following pairs of OSI protocol layer/sub-layer and its functionality, the **INCORRECT** pair is
- (A) Network layer and Routing
 (B) Data Link Layer and Bit synchronization
 (C) Transport layer and End-to-end process communication
 (D) Medium Access Control sub-layer and Channel sharing
24. A bit-stuffing based framing protocol uses an 8-bit delimiter pattern of 01111110. If the output bit-string after stuffing is 01111100101, then the input bit-string is
- (A) 0111110100 (B) 0111110101
 (C) 0111111101 (D) 0111111111
25. Host A (on TCP/IP v4 network A) sends an IP datagram D to host B (also on TCP/IP V4 network B). Assume that no error occurred during the transmission of D. When D reaches B, which of the following IP header field(s) may be different from that of the original datagram D?
- (i) TTL (ii) Checksum (iii) Fragment Offset
- (A) (i) only (B) (i) and (ii) only
 (C) (ii) and (iii) only (D) (i), (ii) and (iii)

Q. No. 26 – 55 Carry Two Marks Each

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

Prefix	Output Interface Identifier
131.16.00/12	3
131.28.0.0/14	5
131.19.0.0/16	2
131.22.0.0/15	1

- The identifier of the output interface on which this packet will be forwarded is _____.
27. Every host in an IPv4 network has a 1-second resolution real-time clock with battery backup. Each host needs to generate up to 1000 unique identifiers per second. Assume that each host has a globally unique IPv4 address. Design a 50-bit globally unique ID for this purpose. After what period (in seconds) will the identifiers generated by a host wrap around?
28. An IP router with a Maximum Transmission Unit (MTU) of 1500 bytes has received an IP packet of size 4404 bytes with an IP header of length 20 bytes. The values of the relevant fields in the header of the third IP fragment generated by the router for this packet are
- (A) MF bit: 0, Datagram Length: 1444; Offset: 370
 (B) MF bit: 1, Datagram Length: 1424; Offset: 185
 (C) MF bit: 1, Datagram Length: 1500; Offset: 370
 (D) MF bit: 0, Datagram Length: 1424; Offset: 2960

29. Consider the transactions T1, T2, and T3 and the schedules S1 and S2 given below.

T1 : r1 (X) ; r1 (z) ; w1 (X) ; w1 (z)

T2 : r2 (X) ; r2 (z) ; w2 (z)

T3 : r3 (X) ; r3 (X) ; w3 (Y)

S1: r1(X); r3(Y); r3(X); r2(Y); r2(Z); w3(Y); w2(Z); r1(Z); w1(X); w1(Z)

S2: r1(X); r3(Y); r2(Y); r3(X); r1(Z); r2(Z); w3(Y); w1(X); w2(Z); w1(Z)

Which one of the following statements about the schedules is **TRUE**?

- (A) Only S1 is conflict-serializable.
- (B) Only S2 is conflict-serializable.
- (C) Both S1 and S2 are conflict-serializable.
- (D) Neither S1 nor S2 is conflict-serializable.

30. Consider the relational schema given below, where eId of the relation dependent is a foreign key referring to empId of the relation employee. Assume that every employee has at least one associated dependent in the dependent relation.

employee (empId, empName, empAge)

dependent (depId, eId, depName, depAge)

Consider the following relational algebra query

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

The above query evaluates to the set of empIds of employees whose age is greater than that of

- (A) some dependent.
- (B) all dependents.
- (C) some of his/her dependents.
- (D) all of his/her dependents

31. A system contains three programs and each requires three tape units for its operation. The minimum number of tape units which the system must have such that deadlocks never arise is _____.

Q.32 An operating system uses *shortest remaining time first* scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

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

The average waiting time (in milliseconds) of the processes is _____.

33. Consider a paging hardware with a TLB. Assume that the entire page table and all the pages are in the physical memory. It takes 10 milliseconds to search the TLB and 80 milliseconds to access the physical memory. If the TLB hit ratio is 0.6, the effective memory access time (in milliseconds) is _____.
34. Consider the basic block given below.
 $a = b + c$
 $c = a + d$
 $d = b + c$
 $e = d - b$
 $a = e + b$
The minimum number of nodes and edges present in the DAG representation of the above basic block respectively are
(A) 6 and 6 (B) 8 and 10 (C) 9 and 12 (D) 4 and 4
35. Which one of the following problems is undecidable?
(A) Deciding if a given context-free grammar is ambiguous.
(B) Deciding if a given string is generated by a given context-free grammar.
(C) Deciding if the language generated by a given context-free grammar is empty.
(D) Deciding if the language generated by a given context-free grammar is finite.
36. Consider the following languages over the alphabet $\Sigma = \{0, 1, c\}$
 $L_1 = \{0^n 1^n \mid n \geq 0\}$
 $L_2 = \{wcw^r \mid w \in \{0, 1\}^*\}$
 $L_3 = \{ww^r \mid w \in \{0, 1\}^*\}$
Here w^r is the reverse of the string w . Which of these languages are deterministic Context-free languages?
(A) None of the languages (B) Only L_1
(C) Only L_1 and L_2 (D) All the three languages
37. Suppose you want to move from 0 to 100 on the number line. In each step, you either move right by a unit distance or you take a shortcut. A shortcut is simply a pre-specified pair of integers i, j with $i < j$. Given a shortcut i, j if you are at position i on the number line, you may directly move to j . Suppose $T(k)$ denotes the smallest number of steps needed to move from k to 100. Suppose further that there is at most 1 shortcut involving any number, and in particular from 9 there is a shortcut to 15. Let y and z be such that $T(9) = 1 + \min(T(y), T(z))$. Then the value of the product yz is _____.

38. Consider the decision problem 2CNFSAT defined as follows:
 $\{ \phi \mid \phi \text{ is a satisfiable propositional formula in CNF with at most two literal per clause} \}$
 For example, $\phi = (x_1 \vee x_2) \wedge (x_1 \vee \bar{x}_3) \wedge (x_2 \vee x_4)$ is a Boolean formula and it is in 2CNFSAT.
 The decision problem 2CNFSAT is
 (A) NP-Complete.
 (B) solvable in polynomial time by reduction to directed graph reachability.
 (C) solvable in constant time since any input instance is satisfiable.
 (D) NP-hard, but not NP-complete.
39. Suppose we have a balanced binary search tree T holding n numbers. We are given two numbers L and H and wish to sum up all the numbers in T that lie between L and H. Suppose there are m such numbers in T. If the tightest upper bound on the time to compute the sum is $O(n^a \log^b n + m^c \log^d n)$, the value of $a + 10b + 100c + 1000d$ is _____.
40. Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?
 (A) $(97 \times 97 \times 97)/100^3$ (B) $(99 \times 98 \times 97)/100^3$
 (C) $(97 \times 96 \times 95)/100^3$ (D) $(97 \times 96 \times 95)/(3! \times 100^3)$
41. Consider the pseudocode given below. The function Dosomething () takes as argument a pointer to the root of an arbitrary tree represented by the leftMostChild-rightSibling representation. Each node of the tree is of type treeNode.

```

typedef struct treeNode* treeptr;

Struct treeNode
{
    Treeptr leftMostchild, rightSibling;
};

Int Dosomething (treeptr tree)
{
    int value =0;
    if (tree != NULL) {
        If (tree -> leftMostchild == NULL)
        else
            value = Dosomething (tree->leftMostchild);
        value = value + Dosometing (tree->rightsibling);
    }
    return (value);
}
    
```

When the pointer to the root of a tree is passed as the argument to **DoSomething**, the value returned by the function corresponds to the

- (A) number of internal nodes in the tree.
- (B) height of the tree.
- (C) number of nodes without a right sibling in the tree.
- (D) number of leaf nodes in the tree.

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

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

- Which one of the following statements about the function **ProcessArray** is **CORRECT**?
- (A) It will run into an infinite loop when x is not in listA.
 - (B) It is an implementation of binary search
 - (C) It will always find the maximum element in listA.
 - (D) It will return -1 even when x is present in listA.

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

- Which one of the following is CORRECT?
- (A) P, Q and R are true (B) Only Q and R are true
(C) Only P and Q are true (D) Only R is true
50. There are two elements x, y in a group $(G, *)$ such that every element in the group can be written as a product of some number of x 's and y 's in some order. It is known that
- $$x * x = y * y = x * y * x * y = y * x * y * x = e$$
- where e is the identity element. The maximum number of elements in such a group is _____.
51. If G is a forest with n vertices and k connected components, how many edges does G have?
(A) $\lfloor n/k \rfloor$ (B) $\lceil n/k \rceil$ (C) $n - k$ (D) $n - k + 1$
52. Let δ denote the minimum degree of a vertex in a graph. For all planar graphs on n vertices with $\delta \geq 3$, which one of the following is **TRUE**?
- (A) In any planar embedding, the number of faces is at least $\frac{n}{2} + 2$
(B) In any planar embedding, the number of faces is less than $\frac{n}{2} + 2$
(C) There is a planar embedding in which the number of faces is less than $\frac{n}{2} + 2$
(D) There is a planar embedding in which the number of faces is at most $\frac{n}{\delta + 1}$
53. The CORRECT formula for the sentence, "not all rainy days are cold" is
(A) $\forall d (\text{Rainy}(d) \wedge \sim \text{Cold}(d))$ (B) $\forall d (\sim \text{Rainy}(d) \rightarrow \text{Cold}(d))$
(C) $\exists d (\sim \text{Rainy}(d) \rightarrow \text{Cold}(d))$ (D) $\exists d (\text{Rainy}(d) \wedge \sim \text{Cold}(d))$
54. Consider the following relational schema:
Employee (empId, empName, empDept)
Customer (custId, custName, salesRepId, rating)
SalesRepId is a foreign key referring to empId of the employee relation. Assume that each employee makes a sale to at least one customer. What does the following query return?
SELECT empName
FROM employee E
WHERE NOT EXISTS (SELECT custId
FROM customer C
WHERE C.salesRepId = E.empId
AND C.rating <> 'GOOD')

- (A) Names of all the employees with at least one of their customers having a 'GOOD' rating.
(B) Names of all the employees with at most one of their customers having a 'GOOD' rating.
(C) Names of all the employees with none of their customers having a 'GOOD' rating.
(D) Names of all the employees with all their customers having a 'GOOD' rating.
55. Let \oplus denote the Exclusive OR (XOR) operation. Let '1' and '0' denote the binary constants. Consider the following Boolean expression for F over two variables P and Q.

$$F(P, Q) = ((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0))$$

The equivalent expression for F is

- (A) $P+Q$ (B) $\overline{P+Q}$ (C) $P \oplus Q$ (D) $\overline{P \oplus Q}$