# Graduate Aptitude Test in Engineering 2017

**Question Paper Name:** Computer Science and Information Technology 11th Feb 2017 Session 1
**Subject Name:** Computer Science and Information Technology
**Duration:** 180
**Total Marks:** 100

## Organizing Institute:

## Indian Institute of Technology Roorkee

**Question Number : 1** **Correct : 1 Wrong : -0.33**

The statement $(\neg p) \Rightarrow (\neg q)$ is logically equivalent to which of the statements below?

I. $p \Rightarrow q$

II. $q \Rightarrow p$

III. $(\neg q) \vee p$

IV. $(\neg p) \vee q$

(A) I only (B) I and IV only (C) II only (D) II and III only

**Question Number : 2** **Correct : 1 Wrong : -0.33**

Consider the first-order logic sentence $F: \forall x(\exists y R(x, y))$. Assuming non-empty logical domains, which of the sentences below are *implied* by $F$?

I. $\exists y(\exists x R(x, y))$

II. $\exists y(\forall x R(x, y))$

III. $\forall y(\exists x R(x, y))$

IV. $\neg\exists x(\forall y \neg R(x, y))$

(A) IV only (B) I and IV only (C) II only (D) II and III only

**Question Number : 3** **Correct : 1 Wrong : -0.33**

Let $c_1,\ldots,c_n$ be scalars, not all zero, such that $\sum_{i=1}^{n} c_i a_i = 0$ where $a_i$ are column vectors in $\mathbf{R}^n$.

Consider the set of linear equations

$$Ax = b$$

where $A=[a_1,\ldots,a_n]$ and $b=\sum_{i=1}^{n} a_i$. The set of equations has

(A) a unique solution at $x = J_n$ where $J_n$ denotes a $n$-dimensional vector of all 1

(B) no solution

(C) infinitely many solutions

(D) finitely many solutions

**Question Number : 4** **Correct : 1 Wrong : -0.33**

Consider the following functions from positive integers to real numbers:

$$10,\ \sqrt{n},\ n,\ \log_2 n,\ \frac{100}{n}.$$

The CORRECT arrangement of the above functions in increasing order of asymptotic complexity is:

(A) $\log_2 n,\ \frac{100}{n},\ 10,\ \sqrt{n},\ n$

(B) $\frac{100}{n},\ 10,\ \log_2 n,\ \sqrt{n},\ n$

(C) $10,\ \frac{100}{n},\ \sqrt{n},\ \log_2 n,\ n$

(D) $\frac{100}{n},\ \log_2 n,\ 10,\ \sqrt{n},\ n$

**Question Number : 5** **Correct : 1 Wrong : -0.33**

Consider the following table:

| Algorithms | Design Paradigms |
|---|---|
| (P) Kruskal | (i) Divide and Conquer |
| (Q) Quicksort | (ii) Greedy |
| (R) Floyd-Warshall | (iii) Dynamic Programming |

Match the algorithms to the design paradigms they are based on.

(A) (P) ↔ (ii). (Q) ↔ (iii). (R) ↔ (i)

(B) (P) ↔ (iii). (Q) ↔ (i). (R) ↔ (ii)

(C) (P) ↔ (ii). (Q) ↔ (i). (R) ↔ (iii)

(D) (P) ↔ (i). (Q) ↔ (ii). (R) ↔ (iii)

**Question Number : 6** **Correct : 1 Wrong : -0.33**

Let $T$ be a binary search tree with 15 nodes. The minimum and maximum possible heights of $T$ are:
*Note: The height of a tree with a single node is 0.*

(A) 4 and 15 respectively

(B) 3 and 14 respectively

(C) 4 and 14 respectively

(D) 3 and 15 respectively

**Question Number : 7** **Correct : 1 Wrong : -0.33**

The $n$-bit fixed-point representation of an unsigned real number $X$ uses $f$ bits for the fraction part. Let $i = n - f$. The range of decimal values for $X$ in this representation is

(A) $2^{-f}$ to $2^{i}$ (B) $2^{-f}$ to $(2^{i} - 2^{-f})$ (C) 0 to $2^{i}$ (D) 0 to $(2^{i} - 2^{-f})$

## Question Number : 8 Correct : 1 Wrong : -0.33

Consider the C code fragment given below.

```
typedef struct node {
  int data;
  node* next;
} node;

void join(node* m, node* n){
  node* p = n;
  while(p->next != NULL) {
    p = p->next;
  }
  p->next = m;
}
```

Assuming that `m` and `n` point to valid `NULL`-terminated linked lists, invocation of `join` will

(A) append list `m` to the end of list `n` for all inputs.

(B) either cause a null pointer dereference or append list `m` to the end of list `n`.

(C) cause a null pointer dereference for all inputs.

(D) append list `n` to the end of list `m` for all inputs.

## Question Number : 9 Correct : 1 Wrong : -0.33

When two 8-bit numbers $A_7 \cdots A_0$ and $B_7 \cdots B_0$ in 2's complement representation (with $A_0$ and $B_0$ as the least significant bits) are added using a **ripple-carry adder**, the sum bits obtained are $S_7 \cdots S_0$ and the carry bits are $C_7 \cdots C_0$ . An overflow is said to have occurred if

(A) the carry bit $C_7$ is 1

(B) all the carry bits $(C_7, \cdots, C_0)$ are 1

(C) $(A_7 \cdot B_7 \cdot \overline{S_7} + \overline{A_7} \cdot \overline{B_7} \cdot S_7)$ is 1

(D) $(A_0 \cdot B_0 \cdot \overline{S_0} + \overline{A_0} \cdot \overline{B_0} \cdot S_0)$ is 1

## Question Number : 10 Correct : 1 Wrong : -0.33

Consider the following context-free grammar over the alphabet $\sum = \{a, b, c\}$ with $S$ as the start symbol:

$S \rightarrow abScT \mid abcT$
$T \rightarrow bT \mid b$

Which one of the following represents the language generated by the above grammar?

(A) $\{(ab)^n(cb)^n \mid n \geq 1\}$
(B) $\{(ab)^n cb^{m_1} cb^{m_2} \ldots cb^{m_n} \mid n, m_1, m_2, \ldots, m_n \geq 1\}$
(C) $\{(ab)^n(cb^m)^n \mid m, n \geq 1\}$
(D) $\{(ab)^n(cb^n)^m \mid m, n \geq 1\}$

## Question Number : 11 Correct : 1 Wrong : -0.33

Consider the C `struct` defined below:

```
struct data {
   int marks [100];
   char grade;
   int cnumber;
};
struct data student;
```

The base address of `student` is available in register R1. The field `student.grade` can be accessed efficiently using

(A) Post-increment addressing mode, (R1)+
(B) Pre-decrement addressing mode, −(R1)
(C) Register direct addressing mode, R1
(D) Index addressing mode, X(R1), where X is an offset represented in 2's complement 16-bit representation.

**Question Number : 12** **Correct : 1 Wrong : -0.33**

Consider the following intermediate program in three address code

```
p = a - b
q = p * c
p = u * v
q = p + q
```

Which one of the following corresponds to a *static single assignment* form of the above code?

(A)
```
p1 = a - b
q1 = p1 * c
p1 = u * v
q1 = p1 + q1
```

(B)
```
p3 = a - b
q4 = p3 * c
p4 = u * v
q5 = p4 + q4
```

(C)
```
p1 = a - b
q1 = p2 * c
p3 = u * v
q2 = p4 + q3
```

(D)
```
p1 = a - b
q1 = p * c
p2 = u * v
q2 = p + q
```

**Question Number : 13** **Correct : 1 Wrong : -0.33**

Consider the following C code:

```
#include <stdio.h>
int *assignval(int *x, int val) {
      *x = val;
      return x;
}

void main () {
      int *x = malloc(sizeof(int));
      if(NULL == x) return;
       x = assignval(x,0);
       if(x) {
            x = (int *)malloc(sizeof(int));
            if(NULL == x) return;
             x = assignval(x,10);
       }
      printf("%d\n", *x);
      free(x);
}
```

The code suffers from which one of the following problems:

(A) compiler error as the return of `malloc` is not typecast appropriately

(B) compiler error because the comparison should be made as `x == NULL` and not as shown

(C) compiles successfully but execution may result in dangling pointer

(D) compiles successfully but execution may result in memory leak

**Question Number : 14** **Correct : 1 Wrong : -0.33**

Consider a TCP client and a TCP server running on two different machines. After completing data transfer, the TCP client calls `close` to terminate the connection and a FIN segment is sent to the TCP server. Server-side TCP responds by sending an ACK, which is received by the client-side TCP. As per the TCP connection state diagram (RFC 793), in which state does the client-side TCP connection wait for the FIN from the server-side TCP?

(A) LAST-ACK
(B) TIME-WAIT
(C) FIN-WAIT-1
(D) FIN-WAIT-2

## Question Number : 15 Correct : 1 Wrong : -0.33

A sender S sends a message $m$ to receiver R, which is digitally signed by S with its private key. In this scenario, one or more of the following security violations can take place.

(I) S can launch a birthday attack to replace $m$ with a fraudulent message.
(II) A third party attacker can launch a birthday attack to replace $m$ with a fraudulent message.
(III) R can launch a birthday attack to replace $m$ with a fraudulent message.

Which of the following are possible security violations?

(A) (I) and (II) only

(B) (I) only

(C) (II) only

(D) (II) and (III) only

## Question Number : 16 Correct : 1 Wrong : -0.33

The following functional dependencies hold true for the relational schema $R\{V, W, X, Y, Z\}$:

$$V \rightarrow W$$
$$VW \rightarrow X$$
$$Y \rightarrow VX$$
$$Y \rightarrow Z$$

Which of the following is irreducible equivalent for this set of functional dependencies?

(A) $V \rightarrow W$, $V \rightarrow X$, $Y \rightarrow V$, $Y \rightarrow Z$

(B) $V \rightarrow W$, $W \rightarrow X$, $Y \rightarrow V$, $Y \rightarrow Z$

(C) $V \rightarrow W$, $V \rightarrow X$, $Y \rightarrow V$, $Y \rightarrow X$, $Y \rightarrow Z$

(D) $V \rightarrow W$, $W \rightarrow X$, $Y \rightarrow V$, $Y \rightarrow X$, $Y \rightarrow Z$

**Question Number : 17** **Correct : 1 Wrong : -0.33**

Consider the following grammar:

$P \rightarrow xQRS$
$Q \rightarrow yz \mid z$
$R \rightarrow w \mid \varepsilon$
$S \rightarrow y$

What is FOLLOW($Q$)?

(A) $\{R\}$ (B) $\{w\}$ (C) $\{w, y\}$ (D) $\{w, \$\}$

**Question Number : 18** **Correct : 1 Wrong : -0.33**

Threads of a process share

(A) global variables but not heap.
(B) heap but not global variables.
(C) neither global variables nor heap.
(D) both heap and global variables.

**Question Number : 19** **Correct : 1 Wrong : 0**

Let $X$ be a Gaussian random variable with mean $0$ and variance $\sigma^2$. Let $Y = max(X, 0)$ where $max(a, b)$ is the maximum of $a$ and $b$. The median of $Y$ is _____.

**Question Number : 20** **Correct : 1 Wrong : 0**

Let $T$ be a tree with 10 vertices. The sum of the degrees of all the vertices in $T$ is _____.

## Question Number : 21 Correct : 1 Wrong : 0

Consider the Karnaugh map given below, where x represents "*don't care*" and blank represents 0.

| $dc$ \ $ba$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | | x | x | |
| 01 | 1 | | | x |
| 11 | 1 | | | 1 |
| 10 | | x | x | |

Assume for all inputs ($a$, $b$, $c$, $d$), the respective complements ($\overline{a}, \overline{b}, \overline{c}, \overline{d}$) are also available. The above logic is implemented using 2-input NOR gates only. The minimum number of gates required is _____.

## Question Number : 22 Correct : 1 Wrong : 0

Consider the language $L$ given by the regular expression $(a+b)^* b\,(a+b)$ over the alphabet $\{a, b\}$. The smallest number of states needed in a deterministic finite-state automaton (DFA) accepting $L$ is _____.

## Question Number : 23 Correct : 1 Wrong : 0

Consider a database that has the relation schema EMP (EmpId, EmpName, and DeptName). An instance of the schema EMP and a SQL query on it are given below.

| EMP | | |
|---|---|---|
| EmpId | EmpName | DeptName |
| 1 | XYA | AA |
| 2 | XYB | AA |
| 3 | XYC | AA |
| 4 | XYD | AA |
| 5 | XYE | AB |
| 6 | XYF | AB |
| 7 | XYG | AB |
| 8 | XYH | AC |
| 9 | XYI | AC |
| 10 | XYJ | AC |
| 11 | XYK | AD |
| 12 | XYL | AD |
| 13 | XYM | AE |

```
SELECT AVG(EC.Num)
FROM EC
WHERE (DeptName, Num) IN
      (SELECT DeptName, COUNT(EmpId) AS
                                EC(DeptName, Num)
       FROM EMP
       GROUP BY DeptName)
```

The output of executing the SQL query is _____ .

## Question Number : 24 Correct : 1 Wrong : 0

Consider the following CPU processes with arrival times (in milliseconds) and length of CPU bursts (in milliseconds) as given below :

| Process | Arrival time | Burst time |
|---|---|---|
| P1 | 0 | 7 |
| P2 | 3 | 3 |
| P3 | 5 | 5 |
| P4 | 6 | 2 |

If the pre-emptive shortest remaining time first scheduling algorithm is used to schedule the processes, then the average waiting time across all processes is _____ milliseconds.

## Question Number : 25 Correct : 1 Wrong : 0

Consider a two-level cache hierarchy with L1 and L2 caches. An application incurs **1.4** memory accesses per instruction on average. For this application, the miss rate of L1 cache is **0.1**; the L2 cache experiences, on average, 7 misses per 1000 instructions. The miss rate of L2 expressed correct to two decimal places is _____.

## Question Number : 26 Correct : 2 Wrong : -0.66

Let $G = (V, E)$ be *any* connected undirected edge-weighted graph. The weights of the edges in $E$ are positive and distinct. Consider the following statements:

(I) Minimum Spanning Tree of $G$ is always unique.
(II) Shortest path between any two vertices of $G$ is always unique.

Which of the above statements is/are necessarily true?

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

## Question Number : 27 Correct : 2 Wrong : -0.66

A multithreaded program P executes with $x$ number of threads and uses $y$ number of locks for ensuring mutual exclusion while operating on shared memory locations. All locks in the program are *non-reentrant*, i.e., if a thread holds a lock $l$, then it cannot re-acquire lock $l$ without releasing it. If a thread is unable to acquire a lock, it blocks until the lock becomes available. The *minimum* value of $x$ and the *minimum* value of $y$ together for which execution of P can result in a deadlock are:

(A) $x = 1, y = 2$
(B) $x = 2, y = 1$
(C) $x = 2, y = 2$
(D) $x = 1, y = 1$

**Question Number : 28** **Correct : 2 Wrong : -0.66**

The value of $\lim_{x\to 1}\frac{x^7-2x^5+1}{x^3-3x^2+2}$

(A) is 0
(B) is -1
(C) is 1
(D) does not exist

**Question Number : 29** **Correct : 2 Wrong : -0.66**

Let $p$, $q$, and $r$ be propositions and the expression $(p \to q) \to r$ be a contradiction. Then, the expression $(r \to p) \to q$ is

(A) a tautology.
(B) a contradiction.
(C) always TRUE when $p$ is FALSE.
(D) always TRUE when $q$ is TRUE.

**Question Number : 30** **Correct : 2 Wrong : -0.66**

Let $u$ and $v$ be two vectors in $\mathbf{R}^2$ whose Euclidean norms satisfy $\|u\| = 2\|v\|$. What is the value of $\alpha$ such that $w = u + \alpha v$ bisects the angle between $u$ and $v$?

(A) 2
(B) 1/2
(C) 1
(D) $-1/2$

**Question Number : 31** **Correct : 2 Wrong : -0.66**

Let $A$ be $n \times n$ real valued square symmetric matrix of rank 2 with $\sum_{i=1}^{n}\sum_{j=1}^{n} A_{ij}^2 = 50$. Consider the following statements.

(I) One eigenvalue must be in $[-5, 5]$
(II) The eigenvalue with the largest magnitude must be strictly greater than 5

Which of the above statements about eigenvalues of $A$ is/are necessarily CORRECT?

(A) Both (I) and (II)
(B) (I) only
(C) (II) only
(D) Neither (I) nor (II)

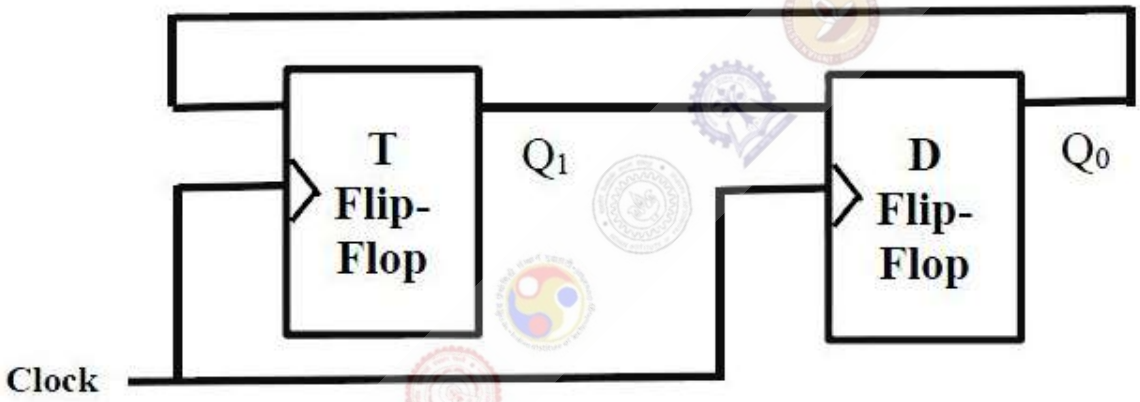
## Question Number : 32 Correct : 2 Wrong : -0.66

A computer network uses polynomials over *GF(2)* for error checking with 8 bits as information bits and uses $x^3 + x + 1$ as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as

(A) 01011011010
(B) 01011011011
(C) 01011011101
(D) 01011011100

## Question Number : 33 Correct : 2 Wrong : -0.66

Consider a combination of T and D flip-flops connected as shown below. The output of the D flip-flop is connected to the input of the T flip-flop and the output of the T flip-flop is connected to the input of the D flip-flop.




Initially, both $Q_0$ and $Q_1$ are set to 1 (before the 1st clock cycle). The outputs

(A) $Q_1 Q_0$ after the 3rd cycle are 11 and after the 4th cycle are 00 respectively
(B) $Q_1 Q_0$ after the 3rd cycle are 11 and after the 4th cycle are 01 respectively
(C) $Q_1 Q_0$ after the 3rd cycle are 00 and after the 4th cycle are 11 respectively
(D) $Q_1 Q_0$ after the 3rd cycle are 01 and after the 4th cycle are 01 respectively

## Question Number : 34 Correct : 2 Wrong : -0.66

If $G$ is a grammar with productions

$$S \rightarrow SaS \mid aSb \mid bSa \mid SS \mid \epsilon$$

where $S$ is the start variable, then which one of the following strings is not generated by $G$?

(A) *abab* (B) *aaab* (C) *abbaa* (D) *babba*

**Question Number : 35** **Correct : 2 Wrong : -0.66**

Consider the following two functions.

```
void fun1(int n) {
        if(n == 0) return;
        printf("%d", n);
        fun2(n - 2);
        printf("%d", n);
}
```

```
void fun2(int n) {
        if(n == 0) return;
        printf("%d", n);
        fun1(++n);
        printf("%d", n);
}
```

The output printed when `fun1(5)` is called is

(A) 53423122233445
(B) 53423120112233
(C) 53423122132435
(D) 53423120213243

**Question Number : 36** **Correct : 2 Wrong : -0.66**

Consider the C functions `foo` and `bar` given below:

```
int foo(int val) {
   int x = 0;
   while(val > 0) {
      x = x + foo(val--);
   }
   return val;
}

int bar(int val) {
   int x = 0;
   while(val > 0) {
       x = x + bar(val-1);
   }
   return val;
}
```

Invocations of `foo(3)` and `bar(3)` will result in :

(A) Return of 6 and 6 respectively.
(B) Infinite loop and abnormal termination respectively.
(C) Abnormal termination and infinite loop respectively.
(D) Both terminating abnormally.

## Question Number : 37 Correct : 2 Wrong : -0.66

Consider the context-free grammars over the alphabet $\{a,b,c\}$ given below. $S$ and $T$ are non-terminals.

$G_1: S \rightarrow aSb|T,\ T \rightarrow cT|\epsilon$

$G_2: S \rightarrow bSa|T,\ T \rightarrow cT|\epsilon$

The language $L(G_1) \cap L(G_2)$ is

(A) Finite.

(B) Not finite but regular.

(C) Context-Free but not regular.

(D) Recursive but not context-free.

## Question Number : 38 Correct : 2 Wrong : -0.66

Consider the following languages over the alphabet $\sum = \{a,b,c\}$.
Let $L_1 = \{ a^n b^n c^m \mid m,n \geq 0\}$ and $L_2 = \{ a^m b^n c^n \mid m,n \geq 0 \}$.

Which of the following are context-free languages?

I. $L_1 \cup L_2$
II. $L_1 \cap L_2$

(A) I only

(B) II only

(C) I and II

(D) Neither I nor II

## Question Number : 39 Correct : 2 Wrong : -0.66

Let $A$ and $B$ be finite alphabets and let $\#$ be a symbol outside both $A$ and $B$. Let $f$ be a total function from $A^*$ to $B^*$. We say $f$ is *computable* if there exists a Turing machine $M$ which given an input $x$ in $A^*$, always halts with $f(x)$ on its tape. Let $L_f$ denote the language $\{x\#f(x) \mid x \in A^*\}$. Which of the following statements is true:

(A) $f$ is computable if and only if $L_f$ is recursive.

(B) $f$ is computable if and only if $L_f$ is recursively enumerable.

(C) If $f$ is computable then $L_f$ is recursive, but not conversely.

(D) If $f$ is computable then $L_f$ is recursively enumerable, but not conversely.

## Question Number : 40 Correct : 2 Wrong : -0.66

Recall that Belady's anomaly is that the page-fault rate may *increase* as the number of allocated frames increases. Now, consider the following statements:

S1: *Random page replacement* algorithm (where a page chosen at random is replaced) suffers from Belady's anomaly
S2: *LRU page replacement* algorithm suffers from Belady's anomaly

Which of the following is CORRECT?

(A) S1 is true, S2 is true
(B) S1 is true, S2 is false
(C) S1 is false, S2 is true
(D) S1 is false, S2 is false

## Question Number : 41 Correct : 2 Wrong : -0.66

Consider a database that has the relation schemas EMP(EmpId, EmpName, DeptId), and DEPT(DeptName, DeptId). Note that the DeptId can be permitted to be NULL in the relation EMP. Consider the following queries on the database expressed in tuple relational calculus.

(I) $\{t \mid \exists u \in \text{EMP}(t[\text{EmpName}] = u[\text{EmpName}] \wedge \forall v \in \text{DEPT}(t[\text{DeptId}] \neq v[\text{DeptId}]))\}$

(II) $\{t \mid \exists u \in \text{EMP}(t[\text{EmpName}] = u[\text{EmpName}] \wedge \exists v \in \text{DEPT}(t[\text{DeptId}] \neq v[\text{DeptId}]))\}$

(III) $\{t \mid \exists u \in \text{EMP}(t[\text{EmpName}] = u[\text{EmpName}] \wedge \exists v \in \text{DEPT}(t[\text{DeptId}] = v[\text{DeptId}]))\}$

Which of the above queries are safe?

(A) (I) and (II) only
(B) (I) and (III) only
(C) (II) and (III) only
(D) (I), (II) and (III)

## Question Number : 42 Correct : 2 Wrong : -0.66

In a database system, unique timestamps are assigned to each transaction using Lamport's logical clock. Let $TS(T_1)$ and $TS(T_2)$ be the timestamps of transactions $T_1$ and $T_2$ respectively. Besides, $T_1$ holds a lock on the resource R, and $T_2$ has requested a conflicting lock on the same resource R. The following algorithm is used to prevent deadlocks in the database system assuming that a killed transaction is restarted with the same timestamp.

if $TS(T_2) < TS(T_1)$ then
    $T_1$ is killed
else $T_2$ waits.

Assume any transaction that is not killed terminates eventually. Which of the following is TRUE about the database system that uses the above algorithm to prevent deadlocks?

(A) The database system is both deadlock-free and starvation-free.

(B) The database system is deadlock-free, but not starvation-free.

(C) The database system is starvation-free, but not deadlock-free.

(D) The database system is neither deadlock-free nor starvation-free.

## Question Number : 43 Correct : 2 Wrong : 0

Consider the following grammar:

```
stmt   -> if expr then expr else expr; stmt | ò
expr   -> term relop term | term
term   -> id | number
id     -> a | b | c
number -> [0-9]
```

where **relop** is a relational operator (e.g., < , > , ...). ò refers to the empty statement, and **if**, **then**, **else** are terminals.

Consider a program $P$ following the above grammar containing ten **if** terminals. The number of control flow paths in $P$ is _____. For example, the program

```
if e1 then e2 else e3
```

has 2 control flow paths, $e_1 \rightarrow e_2$ and $e_1 \rightarrow e_3$.

**Question Number : 44** **Correct : 2 Wrong : 0**

In a RSA cryptosystem, a participant A uses two prime numbers $p = 13$ and $q = 17$ to generate her public and private keys. If the public key of A is 35, then the private key of A is _____.

**Question Number : 45** **Correct : 2 Wrong : 0**

The values of parameters for the Stop-and-Wait ARQ protocol are as given below:

Bit rate of the transmission channel = 1 Mbps.
Propagation delay from sender to receiver = 0.75 ms.
Time to process a frame = 0.25 ms.
Number of bytes in the information frame = 1980.
Number of bytes in the acknowledge frame = 20.
Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is _____ (correct to 2 decimal places).

## Question Number : 46 Correct : 2 Wrong : 0

Consider a database that has the relation schema CR(StudentName, CourseName). An instance of the schema CR is as given below.

| CR | |
|---|---|
| StudentName | CourseName |
| SA | CA |
| SA | CB |
| SA | CC |
| SB | CB |
| SB | CC |
| SC | CA |
| SC | CB |
| SC | CC |
| SD | CA |
| SD | CB |
| SD | CC |
| SD | CD |
| SE | CD |
| SE | CA |
| SE | CB |
| SF | CA |
| SF | CB |
| SF | CC |

The following query is made on the database.

$$T1 \leftarrow \pi_{CourseName}(\sigma_{StudentName='SA'}(\text{CR}))$$
$$T2 \leftarrow CR \div T1$$

The number of rows in $T2$ is _____.

## Question Number : 47 Correct : 2 Wrong : 0

The number of integers between 1 and 500 (both inclusive) that are divisible by 3 or 5 or 7 is _____.

## Question Number : 48 Correct : 2 Wrong : 0

Let $A$ be an array of 31 numbers consisting of a sequence of 0's followed by a sequence of 1's. The problem is to find the smallest index $i$ such that $A[i]$ is 1 by probing the minimum number of locations in $A$. The *worst case* number of probes performed by an *optimal* algorithm is _____.

## Question Number : 49 Correct : 2 Wrong : 0

Consider a RISC machine where each instruction is exactly 4 bytes long. Conditional and unconditional branch instructions use PC-relative addressing mode with Offset specified in bytes to the target location of the branch instruction. Further the Offset is always with respect to the address of the next instruction in the program sequence. Consider the following instruction sequence

```
Instr. No.        Instruction
     i   :     add   R2, R3, R4
     i+1 :     sub   R5, R6, R7
     i+2 :     cmp   R1, R9, R10
     i+3 :     beq   R1,  Offset
```

If the target of the branch instruction is `i`, then the decimal value of the `Offset` is _____.

## Question Number : 50 Correct : 2 Wrong : 0

Instruction execution in a processor is divided into 5 stages, *Instruction Fetch* (IF), *Instruction Decode* (ID), *Operand Fetch* (OF), *Execute* (EX), and *Write Back* (WB). These stages take **5, 4, 20, 10,** and **3 nanoseconds (ns)** respectively. A pipelined implementation of the processor requires buffering between each pair of consecutive stages with a delay of **2 ns**. Two pipelined implementations of the processor are contemplated:

(i) a naive pipeline implementation (NP) with 5 stages and
(ii) an efficient pipeline (EP) where the OF stage is divided into stages OF1 and OF2 with execution times of **12 ns** and **8 ns** respectively.

The speedup (correct to two decimal places) achieved by EP over NP in executing 20 independent instructions with no hazards is _____.

## Question Number : 51 Correct : 2 Wrong : 0

Consider a 2-way set associative cache with 256 blocks and uses LRU replacement. Initially the cache is empty. Conflict misses are those misses which occur due to contention of multiple blocks for the same cache set. Compulsory misses occur due to first time access to the block. The following sequence of accesses to memory blocks

```
(0,128,256,128,0,128,256,128,1,129,257,129,1,129,257,129)
```

is repeated 10 times. The number of *conflict misses* experienced by the cache is _____ .

## Question Number : 52 Correct : 2 Wrong : 0

Consider the expression $(a-1)*(((b+c)/3)+d\ ))$. Let X be the minimum number of registers required by an *optimal* code generation (without any register spill) algorithm for a load/store architecture, in which *(i) only load and store instructions can have memory operands* and *(ii) arithmetic instructions can have only register or immediate operands*. The value of X is _____ .

## Question Number : 53 Correct : 2 Wrong : 0

Consider the following C program.

```
#include <stdio.h>
#include <string.h>

void printlength(char *s, char *t) {
   unsigned int c = 0;
   int len = ((strlen(s) - strlen(t)) > c) ? strlen(s): strlen(t);
   printf("%d\n", len);
}

void main() {
   char *x = "abc";
   char *y = "defgh";
   printlength(x,y);
}
```

Recall that `strlen` is defined in `string.h` as returning a value of type `size_t`, which is an `unsigned int`. The output of the program is _____.

## Question Number : 54 Correct : 2 Wrong : 0

A cache memory unit with capacity of $N$ words and block size of $B$ words is to be designed. If it is designed as a direct mapped cache, the length of the TAG field is 10 bits. If the cache unit is now designed as a 16-way set-associative cache, the length of the TAG field is _____ bits.

## Question Number : 55 Correct : 2 Wrong : 0

The output of executing the following C program is _____ .

```
#include <stdio.h>

int total(int v) {
   static int count = 0;
   while(v) {
      count += v&1;
      v >>= 1;
   }
   return count;
}

void main() {
   static int x = 0;
   int i = 5;
   for(; i > 0; i--) {
      x = x + total(i);
   }
   printf("%d\n", x);
}
```

**Question Number : 56** **Correct : 1 Wrong : -0.33**

After Rajendra Chola returned from his voyage to Indonesia, he _____ to visit the temple in Thanjavur.

(A) was wishing (B) is wishing (C) wished (D) had wished

**Question Number : 57** **Correct : 1 Wrong : -0.33**

Research in the workplace reveals that people work for many reasons _____.

(A) money beside (B) beside money (C) money besides (D) besides money

**Question Number : 58** **Correct : 1 Wrong : -0.33**

Rahul, Murali, Srinivas and Arul are seated around a square table. Rahul is sitting to the left of Murali. Srinivas is sitting to the right of Arul. Which of the following pairs are seated opposite each other?

(A) Rahul and Murali
(B) Srinivas and Arul
(C) Srinivas and Murali
(D) Srinivas and Rahul

**Question Number : 59** **Correct : 1 Wrong : -0.33**

Find the smallest number $y$ such that $y \times 162$ is a perfect cube.

(A) 24 (B) 27 (C) 32 (D) 36

**Question Number : 60** **Correct : 1 Wrong : -0.33**

The probability that a $k$-digit number does NOT contain the digits 0, 5, or 9 is

(A) $0.3^k$ (B) $0.6^k$ (C) $0.7^k$ (D) $0.9^k$

**Question Number : 61** **Correct : 2 Wrong : -0.66**

"The hold of the nationalist imagination on our colonial past is such that anything inadequately or improperly nationalist is just not history."

Which of the following statements best reflects the author's opinion?

(A) Nationalists are highly imaginative.
(B) History is viewed through the filter of nationalism.
(C) Our colonial past never happened.
(D) Nationalism has to be both adequately and properly imagined.

**Question Number : 62** **Correct : 2 Wrong : -0.66**

Six people are seated around a circular table. There are at least two men and two women. There are at least three right-handed persons. Every woman has a left-handed person to her immediate right. None of the women are right-handed. The number of women at the table is

(A) 2 (B) 3 (C) 4 (D) Cannot be determined

**Question Number : 63** **Correct : 2 Wrong : -0.66**

The expression $\frac{(x+y)-|x-y|}{2}$ is equal to

(A) the maximum of $x$ and $y$
(B) the minimum of $x$ and $y$
(C) 1
(D) none of the above

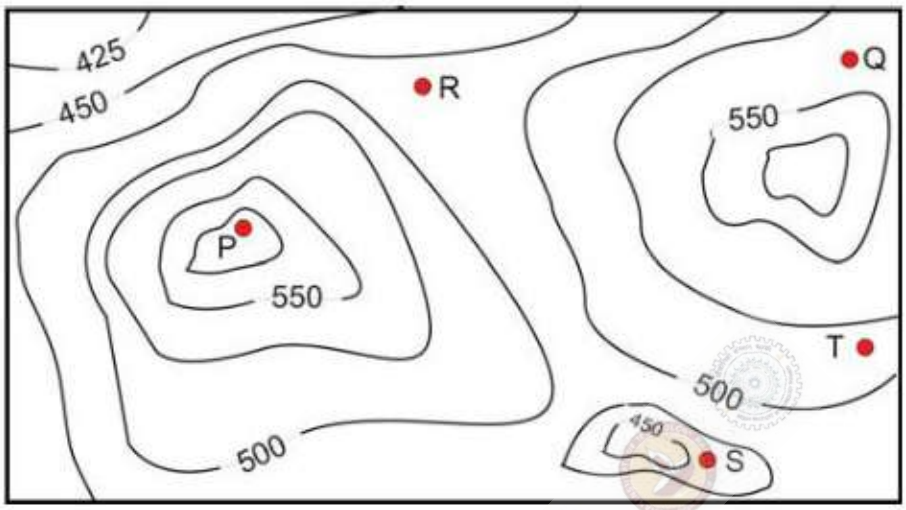
**Question Number : 64** **Correct : 2 Wrong : -0.66**

Arun, Gulab, Neel and Shweta must choose one shirt each from a pile of four shirts coloured red, pink, blue and white respectively. Arun dislikes the colour red and Shweta dislikes the colour white. Gulab and Neel like all the colours. In how many different ways can they choose the shirts so that no one has a shirt with a colour he or she dislikes?

(A) 21 (B) 18 (C) 16 (D) 14

**Question Number : 65** **Correct : 2 Wrong : -0.66**

A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25 m intervals in this plot. If in a flood, the water level rises to 525 m, which of the villages P, Q, R, S, T get submerged?




(A) P, Q (B) P, Q, T (C) R, S, T (D) Q, R, S