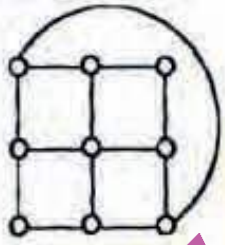
INFORMATION TECHNOLOGY

ONE MARKS QUESTIONS (1-20)

1. A set of Boolean connectives is functionally complete if all Boolean functions can be synthesized using those. Which of the following sets of connectives is NOT functionally complete?
   a. EX-NOR
   b. implication, negation
   c. OR, negation
   d. NAND

2. sample space has two events A and B such that probabilities
   $P(A \cap B)=1/2$, $P(A)=1/3$,
   $P(\overline{B})=1/3$. What is $P(A \cup B)$?
   a. 11/12
   b. 10/12
   c. 9/12
   d. 8/12

3. What is the chromatic number of the following graph?



   a. 2
   b. 3
   c. 4
   d. 5

4. What is the size of the smallest MIS (Maximal Independent Set) of a chain of nine nodes?
   a. 5
   b. 4
   c. 3
   d. 2

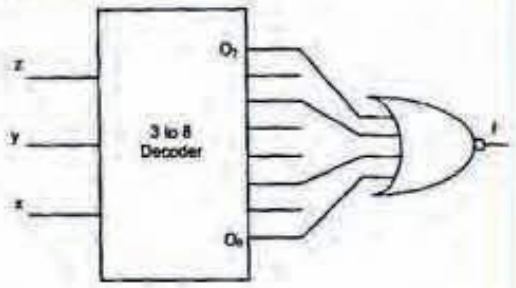
5. Which of the following regular expressions describes the language over {0, 1} consisting of strings that contain exactly two 1's?
   a. $(0+1)^*\,11(0+1)^*$
   b. 0^*110^*
   c. $0^*10^*10^*$
   d. $(0+1)^*1(0+1)01(0+1)^*$

6. Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following is NECESSARILY true?
   a. $m \le 2^n$
   b. $n \le m$
   c. M has one accept state
   d. $m = 2^n$

7. The following bit pattern represents a floating point number in IEEE 754 single precision format:
   11000001101000000000000000000000
   The value of the number in decimal form is
   a. -10
   b. -13
   c. -26
   d. None of the above

8. Consider the following Boolean function of four variables
   $f(A,B,C,D) = \sum(2,3,6,7,8,9,10,11,12,13)$
   The function is
   a. independent of one variable
   b. independent of two variables
   c. independent of three variables
   d. dependent on all the variables

9. What Boolean function does the circuit below realize?



   a. $xz + \overline{xz}$
   b. $x\overline{z} + \overline{x}z$
   c. $\overline{xy} + yz$
   d. $xy + \overline{yz}$

10. Arrange the following functions in increasing asymptotic order:
A. $n^{1/3}$
B. e^n
C. $e^{7/4}$
D. $n \log^9 n$
E. 1.0000001^n
a. a, d, c, e, b
b. d, a, c, e, b
c. a, c, d, e, b
d. a, c, d, b, e

11. For problems X and Y, Y is NP-complete and X reduces to Y in polynomial time. Which of the following is TRUE?
a. If X can be solved in polynomial time, then so can Y
b. X is NP-complete
c. X is NP-hard
d. X is in NP, but not necessarily NP-complete

12. Which of the following is TRUE?
a. The cost of searching an AVL tree is θ(log n) but that of a binary search tree is O(n)
b. The cost of searching an AVL tree is θ(log n) but that of a complete binary tree is θ(n log ii)
c. The cost of searching a binary search tree is O(log n) but that of an AVL tree is θ (n)
d. The cost of searching an AVL tree is θ (n log n) but that of a binary search tree is O(n)

13. Match the programming paradigms and languages given in the following table.

Classification	Languages
I) Imperative	a) Prolog
II) Object oriented	b) Lisp
III) Functional	c) C, Fortran 77, Pascal
IV) Logic	d) C++, Smalltalk, Java

a. I-c, II-d, III-b, IV-a
b. I-a, II-d, III-c, IV-b
c. I-d, II-c, III-b, IV-a
d. I-c, II-d, III-a, IV-b

14. Consider the execution of the following commands in a shell on a Linux operating system.
bashS cat alpha
Mathematics
bashS in alpha beta
bash$ rm alpha
beshS cat >> beta << SAME
Information Technology
SANE
bash$ cat beta
The output of the last command will be:
a. Mathematics information Technology SAME
b. Mathematics Information Technology
c. Information Technology
d. Information Technology SAME

15. A processor that has carry, overflow and sign flag bits as part of its program status word (4W) performs addition of the following two 2's complement numbers 01001101 and 11101001, 4fter the execution of this addition operation, the status of the carry overflow and sign flags, respectively will be:
a. 1, 1, 0
b. 1, 0, 0
c. 0, 1, 0
d. 1, 0, 1

16. A paging scheme uses a Translation Look-aside Buffer (TLB). A TLB-access takes 10 ns and a main memory access takes 50 as. What is the effective access time (in ns) if the TLB hit ratio is 90% and there is no page-fault?
a. 54
b. 60
c. 65
d. 75

17. Find if the following statements in the context of software testing are TRUE or FALSE.
(S1) Statement coverage cannot guarantee execution of loops in a program under test.
(S2) Use of independent path testing criterion guarantees execution of each loop in a program under test more than once.
a. True, True
b. True, False
c. False, True
d. False, False

18. How many bytes of data can be send in 15 seconds over a serial link with baud rate of

9600 in asynchronous mode with odd parity and two stop bits in the frame?

a. 10,000 bytes
b. 12,000 bytes
c. 15,000 bytes
d. 27,000 bytes

19. Which of the following is TRUE only of XML but NOT HTML?

a. It is derived from SGML.
b. It describes content and layout
c. It allows user defined tags
d. It is restricted only to be used with web browsers

20. Provide the best matching between the entries in the two columns given in the table below

I) Proxy server	a) Firewall
II) KaZaA, DC++	b) Caching
III) SLIP	c) P2P
IV)DNS	d) PPP

a. I-a, II-d, III-c, IV-b
b. I-b, II-d, III-c, IV-a
c. I-a, II-c, III-d, IV-b
d. I-b, II-c, III-d, IV-a

TWO MARKS QUESTIONS (21-75)

21. Which of the following first order formulae is logically valid? Here $\alpha(x)$ is a first order formula with x as free variable, and β is a first order formula with no free variable.

a. $[\beta \rightarrow (\exists x, \alpha(x))] \rightarrow [\forall x, \beta \rightarrow \alpha(x)]$
b. $[\exists x, \beta \rightarrow \alpha(x)] \rightarrow [\beta \rightarrow (\forall x, \alpha(x))]$
c. $[(\exists x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$
d. $[(\forall x, \alpha(x)) \rightarrow \beta] \rightarrow [\forall x, \alpha(x) \rightarrow \beta]$

22. Which of the following is the negation of $[\forall x, \alpha \rightarrow (\exists y, \beta \rightarrow (\forall u, \exists v, \gamma))]$?

a. $[\exists x, \alpha \rightarrow (\forall y, \beta \rightarrow (\exists u, \forall v, \gamma))]$
b. $[\exists x, \alpha \rightarrow (\forall y, \beta \rightarrow (\exists u, \forall v, \neg\gamma))]$
c. $[\forall x, \neg\alpha \rightarrow (\exists y, \neg\beta \rightarrow (\forall u, \exists v, \neg\gamma))]$
d. $[\exists x, \alpha \wedge (\forall y, \beta \wedge (\exists u, \forall v, \neg\gamma))]$

23. What is the probability that in a randomly chosen group of r people at least three people have the same birthday?

a. $1 - \frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r}$
b. $\left[\frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r} + {}^rC_2 \cdot 365 \cdot \frac{364 \cdot 363 \cdots (364 - (r-2) + 1)}{364^{r-2}}\right]$
c. $1 - \left[\frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r} + {}^rC_2 \cdot 365 \cdot \frac{364 \cdot 363 \cdots (364 - (r-2) + 1)}{364^{r-2}}\right]$
d. $\frac{365 \cdot 364 \cdots (365 - r + 1)}{365^r}$

24. The exponent of 11 in the prime factorization of 300! is

a. 27
b. 28
c. 29
d. 30

25. In how many ways can b blue balls and r red balls be distributed in n distinct boxes?

a. $\frac{(n+b-1)!(n+r-1)!}{(n-1)!\,b!\,(n-1)!\,r!}$
b. $\frac{n!\,(b+r)!}{(n-1)!\,(n-1)!\,(b+r)!}$
c. $\frac{n!}{b!\,r!}$
d. $\frac{(n+(b+r)-1)!}{n!\,(b+r-1)!}$

26. Consider the field C of complex numbers with addition and multiplication. Which of the following form(s) a subfield of C with addition and multiplication?

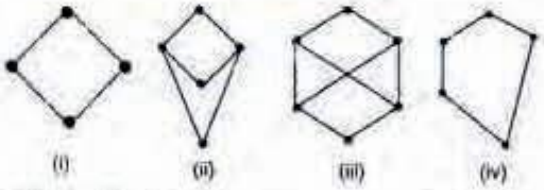
(S1) the set of real numbers
(S2) {a+ib| a and b are rational numbers}
(S3) {a+ib| $a^2 + b^2 \leq 1$}

a. Only S1
b. S1 and S3
c. S2 and S3
d. S1 and S2

27. G is a simple undirected graph. Some vertices of G are of odd degree. Add a node v to G and make it adjacent to each odd degree vertex of G. The resultant graph is sure to be

a. regular
b. complete
c. Hamiltonian
d. Euler

28. Consider the following Masse diagrams.



Which all of the above represent a lattice?

a. (i) and (iv) only
b. (ii) and (iii) only
c. (iii) only
d. (i), (ii) and (iv) only

29. If M is a square matrix with a zero determinant, which of the following assertion(s) is (are) correct?

(S1) Each row of PS can be represented as a linear combination of the other rows

(S2) Each column of M can be represented as a Linear combination of the other columns

(S3) MX =0 has a nontrivial solution

(S4) PS has an inverse

a. S3 and S2
b. S1 and 54
c. S1 and S3
d. S1, S2 and S3

30. Consider the function $f(x) = x^2 - 2x$. Suppose an execution of the Newton-Raphson method to find a zero of $f(x)$ starts with an approximation $x_1 = 2$. What is the value of x_2, the approximation of x that the algorithm produces after two iterations, rounded to three decimal places?

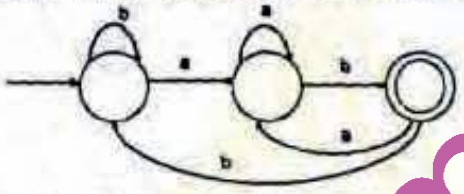
a. 2.417
b. 2.419
c. 2.423
d. 2.425

31. If f(x) is defined as follows, what is the minimum value of f(x) for $x \in (0,2]$?

$$f(x) = \begin{cases} \frac{25}{8x} & \text{when } x \le \frac{3}{2} \\ x + \frac{1}{x} & \text{otherwise} \end{cases}$$

a. 2
b. $2\frac{1}{12}$
c. $2\frac{1}{6}$
d. $2\frac{1}{2}$

32. If the final states and non-final states in the DFA below are interchanged, then which o the following languages over the alphabet {a, b} will be accepted by the new OFA?



a. Set of all strings that do not end with ab
b. Set of all strings that begin with either an a or a b
c. Set of all strings that do not contain the substring ab
d. The set described by the regular expression (aa*|ba)*b*

33. Consider the following Languages.

$L_1 = \{a^i b^j c^k | i = j, k \ge 1\}$

$L_2 = \{a^i b^j | i = 2i, j, k \ge 0\}$

Which of the following is true?

a. L_1 is not a CFL but L_2 is
b. $L_1 \cap L_2 = \phi$ and L_1 is non-regular
c. $L_1 \cup L_2$ is not a CFL but L_2 is
d. There is a 4-state PDA that accepts L_1, but there is no DPDA that accepts L_2

34. Consider a CFG with the following productions.

$S \rightarrow AA|B$

$A \rightarrow 0A \mid A0|1$

$B \rightarrow 0B00|1$

S is the start symbol, A and B are non-terminals and 0 and 1 are the terminals. The language generated by this grammar is

a. $\{0^n 1 0^{2n} | n \ge 1\}$
b. $\{0^i 1 0^j 1 0^k | i, j, k \ge 0\} \cup \{0^n 1 0^{2n} | n \ge 1\}$
c. $\{0^i 1 0^j | i = j \ge 0\} \cup \{0^n 1 0^{2n} | n \ge 1\}$
d. The set of all strings over {0, 1} containing at least two 0's.

35. Which of the following languages is (are) non-regular?

$L_1 = \{0^m 1^n | 0 \le m \le n \le 10000\}$

L_2 = {w | w reads the same forward and backward

L_3 = {w $\in$ {0, 1}*|w contains an even number of U's and an even number of 1's

a. L_2 and L_3 only
b. L_1 and L_2 only
c. L_3 only

d. L_2 only

36. Consider the following two finite automata, M_1 accepts L_1 and M_2 accepts L_2

Which one of the following is TRUE?

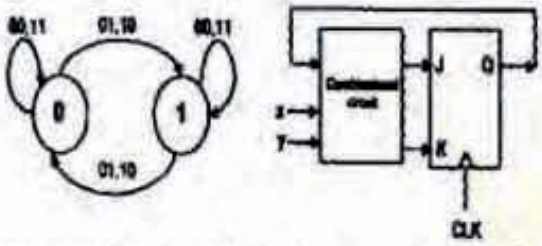
a. $L_1 = L_2$

b. $L_1 \subset L_2$

c. $L_1 \cap L_2 = \Phi$

d. $L_1 \cup L_2 \neq L_1$

37. Consider the following state diagram and its realization by a JK flip flop



The combinational circuit generates J and K in terms of x, y and Q.

The Boolean expressions flu J and K are

a. $\overline{x \oplus y}$ *and* $\overline{x \oplus y}$

b. $\overline{x \oplus y}$ *and* $x \oplus y$

c. $x \oplus y$ *and* $\overline{x \oplus y}$

d. $x \oplus y$ *and* $x \oplus y$

38. Assume the LA (X)- the effective address equal to (he ont nt of location X, with X incremented by one word length after the effect e address is calculated; LA -(X) is the effective address equal to the contents of location X, with X decremented by one word length before the effective address is calculated. LA = (X) is the effective address equal to the contents of location X, with X incremented by one word length after the effective address is calculated. The format of the instruction is (opeode, source, destination), which means (destination ← source op destination). Using X as a stack pointer, which of the following instructions can pop the top two elements from the stack, perform the addition operation and push the result back to the stack

a. ADD (X)-, (X)

b. ADD (X), (X)-

c. ADD-(X), (X)+

d. ADD-(X), (X)

39. Consider a CPU where all the instructions require 7 clock cycles to complete execution. There are 140 instructions in the instruction set. It is found that 125 control signals are needed to be generated by the control unit. While designing the horizontal microprogrammed control unit, single address field format is used for branch control logic. What are the minimum size of the control word and control address register

a. 125, 7

b. 125, 10

c. 135, 9

d. 135, 1

40. A non-pipelined single cycle processor operating at 100 MHz is convened into a synchronous pipelined processor with five stages requiring 2.5 nsec, 1.5 nsec, 2 nsec, 1.5 nsec and 2.5 psec, respectively. The delay of the latches is 0.5 nsce. The speedup of the pipeline processor for a large number of instructions is

a. 4.5

b. 4.0

c. 3.33

d. 3.0

41. Assume that a main memory with only 4 pages, each of 16 bytes, is initially empty. The CPU generates the following sequence of virtual addresses and uses the Least Recently Used (LRU) page replacement policy

0,4,8,20,24,36,44, 12, 68,72, 80, 84,28, 32, 88, 92

How many page faults does this sequence cause? What are the page numbers of the pages present in the main memory at the end of the sequence?

a. 6 and 1, 2, 3, 4

b. 7 and 1, 2, 4, 5

c. 8 and 1, 2, 4, 5

d. 9 and 1, 2, 3, 5

42. The two numbers given below are multiplied using the Booth's algorithm.

Multiplicand: 0101 1010 1110 1110

Multiplier: 0111011110111101

How many additions/subtractions are required for the multiplication of the above two numbers?

a. 6
b. 8
c. 10
d. 12

43. If we use Radix Sort to sort n integers in the range $(n^{k/2}, n^k]$ for some $k > 0$ which is independent of n, the time taken would be

a. $\theta(n)$
b. $\theta(kn)$
c. $\theta(n \log n)$
d. $\theta(n^2)$

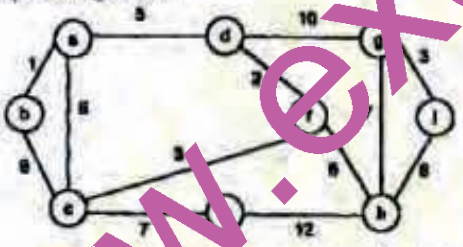
44. When $n = 2^{2^k}$ for some $k \geq 0$, the recurrence relation

$T(n) = \sqrt{2}T(n/2) + \sqrt{n}, T(1) = 1$

evaluates to

a. $\sqrt{n}(\log n + 1)$
b. $\sqrt{n} \log n$
c. $\sqrt{n} \log \sqrt{n}$
d. $n \log \sqrt{n}$

45. For the undirected, weighted graph given below, which of the following sequences of edges represents a correct execution of Prim's algorithm to construct a Minimum Spanning Tree?



a. (a, b), (b, e), (f, c), (g, i), (d, a), (g, h), (e, f), (f, h)
b. (b, e), (e, f), (f, d), (d, a), (a, b), (g, h), (f, i), (g, i)
c. (d, f), (f, c), (d, a), (a, b), (c, e), (f, h), (g, h), (g, i)
d. (h, g), (g, i), (h, f), (f, c), (f, d), (d, a), (a, b), (c, e)

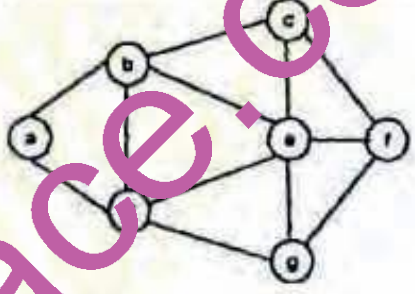
46. The following three are known to be the preorder, in order and post order sequences of a binary tree. But it is not known which is which.

I. MBCAFHPYK
II. KAMCBYPFH
III. MABCKYFPH

Pick the true statement from the following.

a. I and II are pre order and in order sequences, respectively
b. I and III are preorder and post order sequences, respectively
c. II is the in order sequence, but nothing more can be said about he other two sequences
d. II and III are the preorder and in order sequences, respectively

47. Consider the following sequences of nodes for the undirected graph given below.



I. abefdgc
II. abefcgd
III. adgebcf
IV. adbcgef

A Depth First Search (DES) is started at node a. The nodes are listed in the order they are first visited. Which all of the above s (are) possible output(s)?

a. I and III only
b. II and III only
c. II, III and IV only
d. I, II and III only

48. Consider a hash table of size 11 that uses open addressing with linear probing. Let h(k) = k mod 11 be the hash function used. A sequence of records with keys

43 36 92 87 11 4 71 13 14

is inserted into an initially empty hash table, the bins of which are indexed from zero to ten. What is the index of the bin into which the last record is inserted?

a. 3
b. 4
c. 6
d. 7

49. What is the output printed by the following C code?

```
#include <stdio.h>
int main()
{
    char a[6] = "world";
    int i,j;

    for(i=0, j=5; i<j; a[i++] = a[j--])
        ;
    printf("%s\n",a);
}
```

a. dlrow
b. Null string
c. dlrld
d. worow

50. Consider the C program below. What does it print?

```
#include <stdio.h>
#define swap1(a,b) tmp = a; a = b; b = tmp
void swap2(int a, int b)
{
    int tmp;
    tmp = a; a = b; b = tmp;
}

void swap3(int *a, int *b)
{
    int tmp;
    tmp = *a; *a = *b; *b = tmp;
}

int main()
{
    int num1 = 5, num2 = 4, tmp;

    if(num1 > num2)  { swap1(num1, num2);   }
    if(num1 < num2)  { swap2(num1+1, num2); }
    if(num1 >= num2) { swap3(&num1, &num2); }

    printf("%d,%d", num1, num2);
}
```

a. 5, 5
b. 5, 4
c. 4, 5
d. 4, 4

51. Consider the C program given below. What does it print?

```
#include <stdio.h>

int main()
{
    int i;
    int a[8] = {1,2,3,4,5,6,7,8};

    for(i=0; i<3; i++){
        a[i] = a[i] + 1;
        i++;
    }
    i--;
    for(j=7; j>4; j--){
        int i = j/2;
        a[i] = a[i] - 1;
    }
    printf("%d,%d",i,a[i]);
}
```

a. 2, 3
b. 2, 4
c. 3, 2
d. 3, 3

52. A C program is given below

```
#include <stdio.h>

int main()
{
    int i,j;
    char a[2][3] = { {'a', 'b', 'c'}, {'d', 'e', 'f'} };
    char b[3][2];
    char *p = *b;

    for(i=0; i<2; i++){
        for(j=0; j<3; j++){
            *(p + 2*j + i) = a[i][j];
        }
    }
}
```

What should be the contents of the array bat the end of the program?

a. *a b*
   c d
   e f
b. *a d*
   b e
   c f
c. *b*
   d
   f
d. *a e*
   d c
   b f

53. The following is a code with two threads, producer and consumer, that can run in parallel. Further, S and Q are binary semaphores equipped with the standard P and V operations.

```
semaphore S = 1, Q = 0;
integer   x;

producer:                    | consumer:
while( true )do              | while( true )do
    P(S);                    |     P(Q);
    x = produce();           |     consume(x);
    V(Q);                    |     V(S);
done                         | done
```

Which of the following is TRUE about the program above?

a. The process can deadlock
b. One of the threads can starve
c. Some of the items produced by the producer may be lost
d. Values generated and stored in 'x' by the producer will always be consumed before the producer can generate a new value

54. An operating system implements a policy that requires a process to release all resources before making a request for

another resource. Select the TRUE statement from the following:

a. Both starvation and deadlock can occur
b. Starvation can occur but deadlock cannot occur
c. Starvation cannot occur but deadlock can occur
d. Neither starvation nor deadlock can occur

55. If the time-slice used in the round-robin scheduling policy is more than the maximum time required to execute any process, then the policy will

a. degenerate to shortest job first
b. degenerate to priority scheduling
c. degenerate to first come first serve
d. none of the above

56. Match the following flag bits used in the context of virtual memory management on the left side with the different purposes on the right side of the table below

Name of the bit	Purpose
I) Dirty	a) Page initialization
II) R/W	b) Write-back policy
III) Reference	c) Page protection
IV) Valid	d) Page replacement policy

a. I-d, II-a, III-b, IV-c
b. I-b, II-c, III-a, IV-d
c. I-c, II-d, III-a, IV-b
d. I-b, II-c, III-d, IV-a

57. Which of the following is NOT considered when computing function point for a software project?

(O1) External inputs and outputs
(O 2) Programming language to be used for the implementation
(O 3) User interactions
(O 4) External interfaces
(O 5) Number of programmers in the software project
(O 6) Files used by the system

a. O2, O3
b. O1, O5
c. O4, O6
d. O2, O5

58. A software project plan has identified ten tasks with each having dependencies as given in the following table:

Task	Depends On
T1	-
T2	T1
T3	T1
T4	T1
T5	T2
T6	T3
T7	T3, T4
T8	T4
T9	T5, T7, T8
T10	T6, T9

Answer the following questions:

(Q1) What is the maximum number of tasks that can be done concurrently?

(Q2) What is the minimum time required to complete the project, assuming that each task requires one time unit and there is no restriction on the number of tasks that can be done in parallel?

a. 5, 3
b. 4, 4
c. 4, 5
d. 5, 4

59. A software engineer is required to implement two sets of algorithms for a single set of matrix operations in an object oriented programming language: the two sets of algorithms are to provide precisions of 10^{-3} and 10^{-6}, respectively. She decides to implement two classes, Low Precision Matrix and HighPrecisio4Matrjx, providing precisions 10^{-3} and 10^{-6} respectively.

Which one of the following is the best alternative for the implementation?

(S1) The two classes should be kept independent.

(S2) Low Precision Matrix should be derived from High Precision Matrix.

(S3) High Precision Matrix should be derived from Low Precision Matrix

(S4) One class should be derived from the other: the hierarchy is immaterial

a. S1
b. S2
c. S3
d. S4

60. Which of the following requirement specifications can be validated?

S1: If the system fails during any operation, there should not be any loss of data

S2: The system must provide reasonable performance even under maximum load conditions

S3: The software executable must be deployable under MS Windows 95, 2000 and XP

S4: User interface windows must fit on a standard monitor's screen

a. S4 and S3
b. S4 and S2
c. S3 and S1
d. S2 and S1

61. Let R (A, B, C, D) he a relational schema with the following functional dependencies: A→B, B→C (C→D and D→B. The decomposition of R into (A, B), (B, C) and (B, D)

a. gives a lossless join, and is dependency preserving
b. gives a lossless join, but is not dependency preserving
c. does not give a lossless join, but is dependency preserving
d. does not give a lossless join and is not dependency preserving

62. Let R(A, B, C, D, E, P,G) be a relational schema in which the following functional dependencies are known to hold: AB→CD, DE→P, C→E, P→C and B→G. The relational schema B is

a. in BCNF
b. in 3NF, but not in BCNF
c. in 2NF, but not in 3NF
d. not in 2NF

63. Consider the following three schedules of transactions T1, T2 and T3 [Notation: In the following, YO represents the action Y (R for read, W for write) performed by transaction N on object O.)

(S1)	1RA	2RA	3RC	2WB	3WA	3WC	1WA	1WB	1WA	1WB
(S2)	2RA	1RA	2WA	2WB	3WA	1WA	1WB	1WB	1WB	3WC
(S3)	2RA	3RC	3WA	2WA	2WB	3WC	1WA	1WB	1WB	1WB

Which of the following statements is TRUE?

a. S1, S2 and S3 are all conflict equivalent to each other
b. No two of S1, S2 and 53 are conflict equivalent to each other
c. S2 is conflict equivalent to S3, but not to S1
d. S1 is conflict equivalent to S2, but not to S3

64. A 1Mbps satellite link connects two ground stations. The altitude of the satellite is 36,504 k and speed of the signal is 3×10^8 m/s. What should be the packet size for a channel utilization of 25% for a satellite link using go-back-127 sliding window protocol? Assume that the acknowledgment packets are negligible in size and that there are no errors during communication

a. 120 bytes
b. 60 bytes
c. 240 bytes
d. 90 bytes

65. The minimum frame size required for a CSMA/CD based computer network running at 1Gbps on a 200 m cable with a link speed of 2×10^8 m/s is

a. 125 bytes
b. 250 bytes
c. 500 bytes
d. None of the above

66. Data transmitted on a link uses the following 2D parity scheme for error detection:

Each sequence of 28 bits is arranged in a 4 x 7 matrix (rows r_0 through r_3, and columns d_7 through d_1) and is padded with a column d_0 and row r_4 of parity bits computed using the Even parity scheme. Each bit of column d_0 (respectively, row r_4) gives the parity of the corresponding row (respectively, column). These 40 bits are transmitted over the data link.

	d_7	d_6	d_5	d_4	d_3	d_2	d_1	d_0
r_0	0	1	0	1	0	0	1	1
r_1	1	1	0	0	1	1	1	0
r_2	0	0	0	1	0	1	0	0
r_3	0	1	1	0	1	0	1	0
r_4	1	1	0	0	0	1	1	0

The table shows data received by a receiver and has n corrupted bits. What is the minimum possible value of n?

a. 1
b. 2
c. 3
d. 4

67. Two popular routing algorithms are Distance Vector (DV) and Link State (LS) routing. Which of the following are true?

S1: Count to infinity is a problem only with DV and not IS routing

S2: In LS, the shortest path algorithm is run only at one node

S3: In DV, the shortest path algorithm is run only at one node

S4: DV requires lesser number of network messages than LS

a. S1, S2 and S4 only
b. S2 and S3 only
c. S1, S2 and S3 only
d. S1 and S4 only

68. Which of the following statements are TRUE?

S1: TCP handles both congestion and flow control

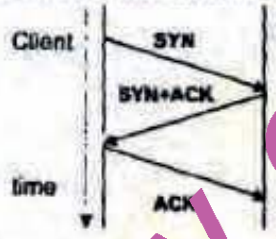
S2: UDP handles congestion but not flow control

S3: Fast retransmit deals with congestion but not flow control

S4: Slow start mechanism deals with both congestion and flow control

a. S1, S2 and S3 only
b. S1 and S3 only
c. S3 and S4 only
d. S2, S3 and S4 only

69. The three way handshake for TCP connection establishment is shown below.



Which of the following statements are TRUE?

S1: Loss of SYN + ACK from the server will not establish a connection

S2: Loss of ACK from the client cannot establish the connection

S3: The server moves LISTEN →SYN_RCVD→ SYN_SENT → ESTABLISHED in the state machine on no packet loss

S4: The server moves LISTEN→SYN_RCVD→ESTABLISHED in the state machine on no packet loss.

a. S2 and S3 only
b. S1 and S4 only
c. S1 and S3 only
d. S2 and S4 only

70. The total number of keys required for a set of it individuals to be able to communicate with each other using secret key and public key cryptosystems, respectively are:

a. n(n -1) and 2n
b. $2n$ and $\frac{n(n-1)}{2}$
c. $\frac{n(n-1)}{2}$ and $2n$
d. $\frac{n(n-1)}{2}$ and n

Common Data Questions (71, 72 & 73)

A Binary Search Tree (BST) stores values in the range 37 to 573. Consider the following sequences of keys

I. 81, 537, 102, 439, 285, 376, 305
II. 52, 97, 121, 195, 242, 381, 472
III. 142, 248, 520, 386, 345, 270, 307
IV. 550, 139, 507, 395, 463, 402, 270

71. Suppose the BST has been unsuccessfully searched for key 273. Which all of the above sequences list nodes in the order in which we could have encountered them in the search?

a. II and III only
b. I and III only
c. III and IV only
d. III only

72. Which of the following statements is TRUE?

a. I, II and IV are in order sequences of three different BSTs
b. I is a preorder sequence of some BST with 439 as the root
c. II is an in order sequence of some BST where 121 is the root and 52 is a leaf
d. IV s a post order sequence of some BST with 149 as the root

73. How many distinct BSTs can be constructed with 3 distinct keys?

a. 4
b. 5
c. 6
d. 9

Common Data for Question 74 and 75:

Consider the following relational schema:

Student (school-id, sch-roll-no, sname, saddress)

School (school-id, sch-name, sch-address, sch-phone)

Enrolment (school-id, sch-roll-no, erollno, examname)

ExamResult (erollno, examname, marks)

74. What does the following SQL query output?

```
SELECT sch-name, COUNT (*)
FROM   School C, Enrolment E, ExamResult R
WHERE  E.school-id = C.school-id
       AND
       E.examname = R.examname AND E.erollno = R.erollno
       AND
       R.marks = 100 AND E.school-id IN (SELECT school-id
                                         FROM Student
                                         GROUP BY school-id
                                         HAVING COUNT (*) > 200)
GROUP BY school-id
```

a. for each school with more than 200 students appearing in exams, the name of the school and the number of 100s scored by its students
b. for each school with more than 200 students in it, the name of the school and the number of 100s scored by its students
c. for each school with more than 200 students in it, the name of the school and the number of its students scoring 100 in at least one exam
d. nothing; the query has a syntax error

75. Consider the following tuple relational calculus query:

$$\{t \mid \exists E \in Enrolment\ t = E.school\text{-}id \wedge |\{x \mid x \in Enrolment \wedge x.school\text{-}id = t \wedge (\exists B \in ExamResult\ B.erollno = x.erollno \wedge B.examname = x.examname \wedge B.marks > 35)\}| \div |\{x \mid x \in Enrolment \wedge x.school\text{-}id = t\}| * 100 > 35\}$$

If a student needs to score more than 35 marks to pass an exam, what does the query return?

a. The empty set
b. schools with more than 35% of its students enrolled in some exam or the other
c. schools with a pass percentage above 35% over all exams taken together
d. schools with a pass percentage above 35% over each exam

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Questions 76 and 77:

A binary tree with $n > 1$ nodes has n_1, n_2 and n_3 nodes of degree one, two and three respectively. The degree of a node is defined as the number of its neighbours.

76. n_3 can be expressed as

a. $n_1 + n_2 - 1$
b. $n_1 - 2$
c. $\left[\frac{n_1 + n_2}{2}\right]$
d. $n_2 - 1$

77. Starting with the above tree, while there remains a node v of degree two in the tree, add an edge between the two neighbours of v and then remove v from the tree. How many edges will remain at the end of the process?

a. $2*n_1-3$
b. n_2+2*n_1-2
c. n_3-n_2
d. n_2+n_1-2

Statement for Linked Answer Questions 78 and 79:

A CFG G is given with the following productions where S is the start symbol, A is a non-terminal and a and b are terminals.

$S \rightarrow aS \mid A$

$A \rightarrow aAb \mid bAa \mid \in$

78. Which of the following strings is generated by the grammar above?

a. aabbaba
b. aabaaba
c. abababb
d. aabbaab

79. For the correct answer in Q.78 how many steps are required to derive the string and how many parse trees are there?

a. 6 and 1
b. 6 and 2
c. 7 and 2
d. 4 and 2

Statement for Linked Answer Questions 80 and 81:

Consider a computer with a 4-way set-associative mapped cache of the following characteristics: a total of 1 MD of main memory, a word size of 1 byte, a block size of 228 words and a cache size of 8 KB.

80. The number of bits in the TAG, SET and WORD fields, respectively are:
   a. 7, 6, 7
   b. 8, 5, 7
   c. 8, 6, 6
   d. 9, 4, 7

81. While accessing the memory location 0C795H by the CPU, the contents of the TAG field of the corresponding cache line is
   a. 000011000
   b. 1100011W
   c. 00011000
   d. 110010101

Statement for Linked Answer Questions 82 and 83:

Consider the code fragment written in C below:

```
void f(int n)
{
    if (n <= 1){
        printf("%d",n);
    }
    else{
        f(n/2);
        printf("%d",n%2);
    }
}
```

82. What does f(173) print?
   a. 0101101
   b. 0101[illegible]10
   c. 101[illegible]101
   d. [illegible]02

83. Which of the following implementations will produce the same output for f(173) as the one from Q. 82?

P1:

```
void f(int n)
{
    if (n/2){
        f(n/2);
    }
    printf("%d",n%2);
}
```

P2:

```
void f(int n)
{
    if (n <= 1){
      printf("%d",n);
    }
    else{
      printf("%d",n%2);
      f(n/2);
    }
}
```

   a. Both P1 and P2
   b. P2 only
   c. P1 only
   d. Neither P1 nor P2

Statement for Linked Answer Questions 84 and 85:

Host X has IP address 192.168.1.97 and is connected through two routers R1 and R2 to another host Y with IP address 192.168.1.80. Router R1 has IP addresses 192)68.1.135 and 192.[illegible]110.[illegible]2 has IP addresses 192.163.1.67 and 192.16[illegible].155. The netmask used in the network is 255.255.255.224.

84. Given the information above, how many distinct subnets are guaranteed to already exist in the network
   a. 1
   b. 2
   c. 3
   d. 4

85. Which IP address should X configure its gateway as?
   a. 192.168.1.67
   b. 192.168.1.110
   c. 192.168.1.135
   d. 192.168.1.155