COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

Q. No. 1 – 25 Carry One Mark Each

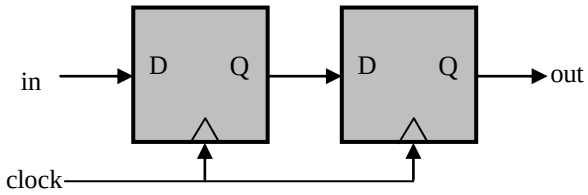
1. Let $\oplus$ and $\odot$ denote the Exclusive OR and Exclusive NOR operations, respectively. Which of the following is NOT CORRECT?

(A) $\overline{P \oplus Q} = P \odot Q$ (B) $\bar{P} \oplus Q = P \odot Q$

(C) $\bar{P} \oplus \bar{Q} = P \oplus Q$ (D) $(P \oplus \bar{P}) \oplus Q = (P \odot \bar{P}) \odot \bar{Q}$

Answer: (D)

2. Consider the sequential circuit shown in the figure, where both flip-flops used are positive edge-triggered D flip-flops.



The number of states in the state transition diagram of this circuit that have a transition back to the same state on some value of "in" is _____.

Answer: (2)

3. Consider the following C program

```
#include<stdio.h>
struct Ournode{
    char x,y,z;
};
int main(){
    struct Ournode p =  {'1', '0', 'a' +2};
    struct Ournode *q = &p;
    printf("%c,  %c",   *((char*)q+1),   *((char*)q+2));
```

```
    return 0;
}
```

The output of this program is:

(A) 0, c (B) 0, a+2 (C) 0, a+2 (D) 0, c

Answer: (A)

4. In an Entity-Relationship (ER) model, suppose *R* is a many-to-one relationship from entity set *E1* to entity set *E2*. Assume that *E1*&*E2* participate totally in *R* and that the cardinality of *E1* is greater than the cardinality of *E2*.

Which one of the following is true about *R*?

(A) Every entity in *E1* is associated with exactly one entity in *E2*

(B) Some entity in *E1* is associated with more than one entity in *E2*

(C) Every entity in *E2* is associated with exactly one entity in *E1*

(D) Every entity in *E2* is associated with at most one entity in *E1*

Answer: (A)

5. The following are some events that occur after a device controller issues an interrupt while process *L* is under execution.

(P) The processor pushes the process status of *L* onto the control stack

(Q) The processor finishes the execution of the current instruction.

(R) The processor executes the interrupt service routine.

(S) The processor pops the process status of *L* from the control stack.

(T) The processor loads the new PC value based on the interrupt.

Which one of the following is the correct order in which the events above occur?

(A) QPTRS (B) PTRSQ (C) TRPQS (D) QTPRS

Answer: (A)

6. Let N be an NFA with n states. Let k be the number of states of a minimal DFA equivalent to N. Which one of the following is necessarily true?

(A) $k \geq 2^n$ (B) $k \geq n$ (C) $k \leq n^2$ (D) $k \leq 2^n$

Answer: (D)

7. Consider the following C program:

```
#include <stdio.h>
int counter = 0;
int calc(int a, int b){
    int c;
    counter++;
    if (b==3) return (a*a*a);
    else {
    c = calc(a,  b/3) ;
    return(c*c*c);
    }
}
int main(){
    calc (4,81);
    printf ("%d",  counter);
}
```

The output of this program is_____

Answer: (4)

8. Consider the following processor design characteristics.

I. Register-to-register arithmetic operations only

II. Fixed-length instruction format

III. Hardwired control unit

Which of the characteristics above are used in the design of a RISC processor?

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

Answer: (B)

9. The postorder traversal of a binary tree is 8, 9, 6, 7, 4, 5, 2, 3, 1. The inorder traversal of the same tree is 8, 6, 9, 4, 7, 2, 5, 1, 3. The height of a tree is the length of the longest path from the root to any leaf. The height of the binary tree above is_____

Answer: (4)

10. Consider a long-lived TCP session with an end-to-end bandwidth of 1 Gbps(=10^9 bits-per-second). The session starts with a sequence number of 1234. The minimum time (in seconds,rounded to the closet integer) before this sequence number can be used again is ___.

Answer: (34)

11. Consider a matrix $A = uv^T$ where $u = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, $v = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. Note that v^T denotes the transpose of v. The largest eigen value of A is _____.

Answer: (3)

12. Consider the following statements regarding the slow start phase of the TCP congestion control algorithm. Note that *cwnd* stands for the TCP congestion window and MSS denotes the Maximum Segment Size.

(i) The *cwnd* increases by 2 MSS on every successful acknowledgment
(ii) The *cwnd* approximately doubles on every successful acknowledgment
(iii) The*cwnd* increases by 1 MSS on every round trip time
(iv) The*cwnd* approximately doubles every round trip time

Which one of the following is CORRECT?

(A) Only (ii) and (iii) are true
(B) Only (i) and (iii) are true
(B) Only (iv) is true
(D) Only (i) and (iv) are true

Answer: (C)

13. Which one of the following statements is **FALSE**?

(A) Context-free grammar can be used to specify both lexical and syntax rules.

(B) Type checking is done before parsing.

(C) High-level Language programs can be translated to different Intermediate Representations.

(D) Arguments to a function can be passed using the program stack.

Answer: (B)

14. Match the following:

	Field		**Length in bits**
P.	UDP Header's Port Number	**I.**	48
Q.	Ethernet MAC Address	**II.**	8
R.	IPv6 Next Header	**III.**	32
S.	TCP Header's Sequence Number	**IV.**	16

(A) P-III, Q-IV, R-II, S-I (B) P-II, Q-I, R-IV, S-III

(C) P-IV, Q-I, R-II, S-III (D) P-IV, Q-I, R-III, S-II

Answer: (C)

15. Consider the following two tables and four queries in SQL.

Book (isbn, bname), Stock (isbn, copies)

Query 1:
```
SELECT B.isbn, S.copies
FROM Book B INNER JOIN Stock S
ON B.isbn=S.isbn:
```

Query 2:
```
SELECT B.isbn, S.copies
FROM Book B LEFT OUTER JOIN Stock S
ON B.isbn=S.isbn:
```

Query 3:
```
SELECT B, isbn, S.copies
FROM Book B RIGHT OUTER JOIN Stock S
ON B.isbn=S.isbn:
```

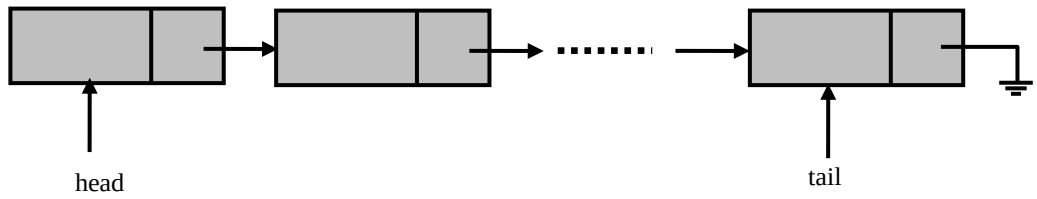
Query 4: SELECT B, isbn, S.copies
FROM Book B FULL OUTER JOIN Stock S
ON B.isbn=S.isbn:

Which one of the queries above is certain tohave an output that is a superset of the outputs of the other three queries?

(A) Query 1 (B) Query 2 (C) Query 3 (D) Query 4

Answer: (D)

16. A queue is implemented using a non-circular singly linked list. The queue has a head pointer and a tail pointer, as shown in the figure. Let *n* denote the number of nodes in the queue. Let `enqueue` be implemented by inserting a new node at the head and `dequeue` be implemented by deletion of a node from the tail.



Which one of the following is the time complexity of the most time-efficient implementation of `enqueue` and `dequeue`, respectively, for this data structure?

(A) $\theta(1), \theta(1)$ (B) $\theta(1), \theta(n)$ (C) $\theta(n), \theta(1)$ (D) $\theta(n), \theta(n)$

Answer: (B)

17. Let G be a finite group on 84 elements. The size of a largest possible proper subgroup of G is____.

Answer: (42)

18. The set of all recursively enumerable languages is

(A) closed under complementation.

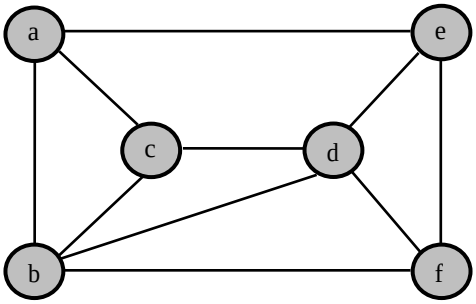
(B) closed under intersection.

(C) a subset of the set of all recursive languages.

(D) an uncountable set.

Answer: (B)

19. The chromatic number of the following graph is _____.



Answer: (3)

20. A 32-bit wide main memory unit with a capacity of 1 GB is built using 256M × 4-bit DRAM chips. The number of rows of memory cells in the DRAM chip is 2^{14}. The time taken to perform one refresh operation is 50 nanoseconds. The refresh period is 2 milliseconds. The percentage (rounded to the closest integer) of the time available for performing the memory read/write operations in the main memory unit is_____

Answer: (60%)

21. Which one of the following is a closed form expression for the generating function of the sequence $\{a_n\}$, where $a_n = 2n+3$ for all n = 0, 1, 2…?

(A) $\frac{3}{(1-x)^2}$ (B) $\frac{3x}{(1-x)^2}$ (C) $\frac{2-x}{(1-x)^2}$ (D) $\frac{3-x}{(1-x)^2}$

Answer: (D)

22. Consider a system with 3 processes that share 4 instances of the same resource type. Each process can request a maximum of *K* instances. Resource instances can be requested and released only one at a time. The largest value of *K* that will always avoid deadlock is ____.

Answer: (2)

23. Consider a process executing on an operating system that uses demand paging. The average time for a memory access in the system is *M* units if the corresponding memory page is available in memory and *D* units if the memory access causes a page fault. It has been experimentally measured that the average time taken for a memory access in the process is *X* units.

Which one of the following is the correct expression for the page fault rate experienced by the process?

(A) $(D-M)/(X-M)$ (B) $(X-M)/(D-M)$

(C) $(D-X)/(D-M)$ (D) $(X-M)/(D-X)$

Answer: (B)

24. Two people P and Q decide to independently roll two identical dice, each with 6 faces numbered 1 to 6. The person with the lower number wins. In case of a tie, they roll the dicerepeatedly until there is no tie. Define a trial as a throw of the dice by P and Q. Assume that all 6 numbers on each dice are equi-probable and that all trials are independent. Theprobability (rounded to 3 decimal places) that one of them wins on the third trial is _____.

Answer: (0.023)

25. The value of $\int_0^{\pi/4} x\cos\left(x^2\right)dx$ correct to three decimal places (assuming that $\pi = 3.14$) is ____.

Answer: (0.29)

26. Consider Guwahati *(G)* and Delhi *(D)* whose temperatures can be classified as high*(H)*, medium *(M)* and low *(L)*. Let $P(H_G)$ denote the probability that Guwahati has high temperature. Similarly $P(M_G)$ *and* $P(L_G)$ denotes the probability of Guwahati having medium and low temperatures respectively. Similarly, we use $P(H_D), P(M_D)$ *and* $P(L_D)$ for Delhi.

The following table gives the conditional probabilities for Delhi's temperatures given Guwahati's temperature

	H_D	M_D	L_D
H_G	0.40	0.48	0.12
M_G	0.10	0.65	0.25
L_G	0.01	0.50	0.49

Consider the first row in the table above. The first entry denotes that if Guwahati has high temperature (H_G) then probability of Delhi also having a high temperature (H_D) is 0.40 i.e., $P(H_D / H_G) = 0.40$. Similarly, the next two entries are $P(M_D / H_G) = 0.48$ and $P(L_D / H_G) = 0.12$ Similarly for the other rows.

If it is known that $P(H_G) = 0.2$, $P(M_G) = 0.5$ *and* $P(L_G) = 0.3$, then the probability (correct to two decimal places) that Guwahati has high temperature given that Delhi has high temperature is _____.

Answer: (0.6)

27. Assume that multiplying a matrix $G_1$of dimension $p \times q$ with another matrix G_2 of dimension $q \times r$ requires pqrscalar multiplications. Computing the product of n matrices $G_1G_2G_3...G_n$can be done by parenthesizing in different ways. Define G_i G_{i+1}as an explicitly computed pair for a given paranthesization if they are directly multiplied. For example, in the matrix multiplication chain $G_1G_2G_3G_4G_5G_6$using parenthesization$(G_1(G_2G_3))(G_4(G_5G_6)))$. *G2G3* and *G5G6* are the only explicitly computed pairs.

Consider a matrix multiplication chain $F_1F_2F_3F_4F_5$, where matrices F_1, F_2, F_3, $F_4$and $F_5$are of dimensions 2× 25, 25×3. 3×16. 16×1 and 1×1000. respectively, In the parenthesization of $F_1F_2F_3F_4F_5$that minimizes the total number of scalar multiplications, the explicitly computed pairs is are

(A) $F_1F_2$and F_3F_4only

(B) F_2F_3 only

(C) F_3F_4only

(D) $F_1F_2$and F_4F_5only

Answer: (C)

28. The instruction pipeline of a RISC processor has the following stages: Instruction Fetch (IF), Instruction Decode (ID), Operand Fetch (OF), Perform Operation (PO) and Write back (WB). The IF, ID, OF and WB stages take 1 clock cycle each for every instruction. Consider a sequence of 100 instructions. In the PO stage. 40 instructions take 3 clock cycles each. 35 instructions take 2 clock cycles each, and the remaining 25 instructions take 1 clock cycle each. Assume that there are no data hazards and no control hazards. The number of clock cycles required for completion of execution of the sequence of instructions is_____.

Answer: (219)

29. Consider the following solution to the producer-consumer synchronization problem. The shared buffer size is *N*. Three semaphores *empty*. *full* and *mutex* are defined with respective initial values of 0. *N* and 1. Semaphore *empty* denotes the number of available slots in thebuffer, for the consumer to read from. Semaphore *full* denotes the number of available slots in the buffer. for the producer to write to. The placeholder variables. denoted by `P, Q, R,and S.` in the code below can be assigned either *empty* or *full*. The valid semaphore operations arc: *`wait ()`* and *`signal().`*

Producer:	Consumer:

do {
wait(P);
wait(mutex);
//Add item to buffer
signal (mutex);
signal (Q);
}while(1);
	do {
	wait(R);
	wait(mutex);
	//Consume item to buffer
	signal (mutex);
	signal (S);
	}while(1) ;

Which one of the following assignments to P, Q, R and S will yield the correct solution?

(A) P: full, Q: full, R: empty, S: empty

(B) P: empty, Q: empty, R: full, S: full

(C) P: full, Q: empty, R: empty, S: full

(D) P: empty, Q: full, R: full, S: empty

Answer: (C)

30. A lexical analyzer uses the following patterns to recognize three tokens T_1. T_2. and T_3 over the alphabet {*a*, *b*, *c*}.

*T*1: *a*?(*b*|*c*)**a*

T_2: *b*?(*a*|*c*)**b*

T_3: *c*?(*b*|*a*)**c*

Note that '*x*? means 0 or 1 occurrence of the symbol *x* Note also that the analyzer outputs the token that matches the longest possible prefix.

It the string *bbaacabc*is processed by the analyzer, which one of the following is the sequence of tokens it outputs?

(A) $T_1T_2T_3$ (B) $T_1T_1T_3$ (C) $T_2T_1T_3$ (D) T_3T_3

Answer: (D)

31. Consider a matix P whose only eigenvectors are the multiplies of $\begin{bmatrix} 1 \\ 4 \end{bmatrix}$.

Consider the following statements:

(I) P does not have an inverse

(II) P has a repeated eigenvalue

(III) P cannot be diagonalized

Which one of the following options is CORRECT?

(A) Only I and III are necessarily true

(B) Only II is necessarily true

(C) Only I and II are necessarily true

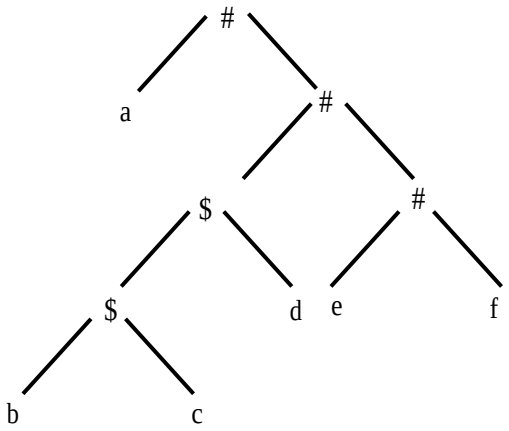
(D) Only II and III are necessarily true

Answer: (D)

32. A processor has 16 integer registers (R0, R1….R15) and 64 floating point registers (F0,Fl…….F63). It uses a 2-byte instruction format. There are four categories of instructions: Type-1, Type-2, Type-3, and Type-4. Type-1 category consists of four instructions, each with 3 integer register operands (3Rs). Type-2 category consists of eight instructions, each with 2 floating point register operands (2Fs). Type-3 category consists of fourteen instructions, each with one integer register operand and one floating point register operand (1R+1F). Type-4 category consists of X instructions, each with a floating point register operand (IF).The maximum value of N is_____.

Answer: (32)

33. Consider the following parse tree for the expression a#bcd#e#f. involving two binary operators $ and #.



Which one of the following is CORRECT for the given parse tree?

(A) $ has higher precedence and is left associative; # is right associative

(B) # has higher precedence and is left associative; $ is right associative

(C) $ has higher precedence and is left associative; # is left associative

(D) # has higher precedence and is right associative; $ is left associative

Answer: (A)

34. Consider the minterm list form of a Boolean function *F* given below:

$$F(P,Q,R,S)=\sum m(0,2,5,7,9,11)+d(3,8,10,12.14)$$

Here, m denotes a minterm and d denotes a don't care term. The number of essential prime implicants of the function F is _____

Answer: (3)

35. Consider the relations $r(A,B)$ and $s(B,C)$, where s.B is a primary key and r.B is a foreign key referencing s. B. Consider the query

$$Q: r \bowtie (\sigma_{B<S}(s))$$

Let LOJ denote the natural left outer-join operation. Assume that r and s contain no null values.

Which one of the following queries is NOT equivalent to Q?

(A) $\sigma_{B<s}(r \bowtie s)$

(B) $\sigma_{B<s}(rLOJs)$

(C) $rLOJ(\sigma_{B<s}(s))$

(D) $\sigma_{B<s}(r)LOJs$

Answer: (C)

36. Consider the following C code. Assume that unsigned long int type length is 64 bits.

```
unsigned long int fun(unsigned long int n){
unsigned long int i,   j = 0,   sum = 0;
    for   (i = n;  i> 1;   i = i/2)
                j++;
    for{ ;   j > 1;   j = j/2)   sum++;
    return(sum);
    }
```

The value returned when we call fun with the input 2^{40} is

(A) 4 (B) 5 (C) 6 (D) 40

Answer: (B)

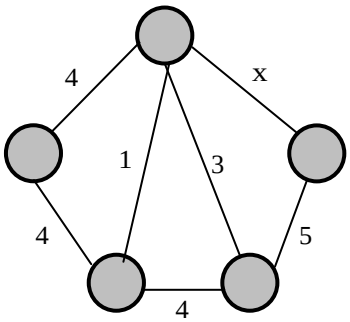
37. The size of the physical address space of a processor is 2^Pbytes. The word length is 2^Wbytes. The capacity of cache memory is 2^N bytes. The size of each cache block is 2^M words. For a K-way set-associative cache memory, the length (in number of bits) of the tag field is

(A) P-N- $\log_2 K$ (B) $P - N + \log_2 K$

(C) $P - N - M - W - \log_2 K$ (D) $P - N - M - W + \log_2 K$

Answer: (B)

38. Consider the following undirected graph G:



Choose a value for x that will maximize the number of minimum weight (MWSTs) of G. The number of MWSTs of G for this value of x is_____.

Answer: (4)

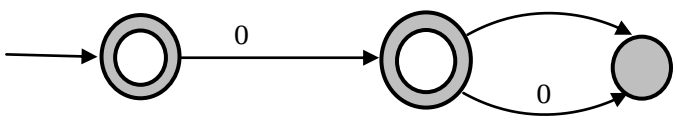
39. Given a language L, define L^ias follows:

$$L^0=\{\varepsilon\}$$

$$L^i = L^{i-1}.\ L \text{ for all } i>0$$

The order of a language L is defined as the smallest k such that $L^k=L^{k+1}$.

Consider the language L_1(over alphabet 0) accepted by the following automaton.



The order *of* $L_1$is

Answer: (2)

40. Let *N* be the set of natural number.

Consider the following sets

P: Set of Rational numbers (positive and negative)

Q: Set of functions from {0, 1} to N

R: Set of functions from N to {0, 1}

S: Set of finite subset of N.

Which of the sets above are countable?

(A) *Q* and *S* only (B) *P* and *S* only (C) *P* and *R* only (D) *P*, *Q* and *S* only

Answer: (D)

41. Consider a storage disk with 4 platters (numbered as 0.1. 2 and 3). 200 cylinders (numbered as 0. 1. .... 199). and 256 sectors per track (numbered as 0. 1. ... 255). The following 6 disk requests of the form [sector number. cylinder number. platter number] are received by the disk controller at the same time:

[120, 72, 2], [180, 134, 1], [60, 20, 0], [212, 86, 3], [56, 116, 2],[118, 16, 1]

Currently the head is positioned at sector number 100 of cylinder 80. and is moving: towardshigher cylinder numbers. The average power dissipation in moving the head over 100 cylinders is 20 milliwatts and for reversing the direction of the head movement once is 15milliwatts. Power dissipation associated with rotational latency and switching of head between different planers is negligible.

The total power consumption in milliwatts to satisfy all of the above disk requests using the Shortest Seek Time First disk scheduling algorithm is _____.

Answer: (85)

42. Consider the following program written in pseudo-code. Assume that *x* and *y* are integers.

```
Count(x,y)    {
if (y != 1){
     if (x!= 1) {
     printf ("*");
```

```
        Count (x/2, y);
        }
        else {
        y = y-1;
        Count(1024,  y) ;
        }
        }
}
```

The number of times that the `print` statement is executed by the call `Count(1024, 1024)` is____.

Answer: (10230)

43. Consider the following problems. $L(G)$denotes the language generated by a grammar G. $L(M)$denotes the language accepted by a machine M.

(I) For an unrestricted grammar G and a string w whether $w \in L(G)$

(II) Given a Turing machine M, whether $L(M)$is regular

(III) Given two grammars $G_1$and G_2. whether $L(G_1)=L(G_2)$

(IV) Given an NFA N. whether there is a deterministic PDA P such that N and P accept the same language.

Which one of the following statements is correct?

(A) Only I and II are undecidable

(B) Only III is undecidable

(C) Only II and IV are undecidable

(D) Only I. II and III are undecidable

Answer: (D)

44. Consider an IP packet with a length of 4.500 bytes that includes a 20-byte IPv4 header anda 40-byte TCP header. The packet is forwarded to an lPv4 router that supports a MaximumTransmission Unit (MTU) of 600 bytes. Assume that the length of the IP header in all the outgoing frag1ments of this packet is 20 bytes. Assume that the fragmentation offset valuestored in the first fragment is 0.

The fragmentation offset value stored in the third fragment is _____.

Answer: (144)

45. Consider the first-order logic sentence

$$\phi \equiv \exists s \exists t \exists u \forall v \forall w \forall x \forall y \ \psi(s,t,u,v,w,x,y)$$

Where $\psi(s,t,u,v,w,x,y)$ is a quantifier-free first-order logic formula using only predicate symbols and possibly equality, but no function symbols. Suppose φ has a model with a universe containing 7 elements.

Which one of the following statements is necessarily true?

(A) There exists at least one model of φ with universe of size less than or equal to 3.

(B) There exists no model of φ with universe of size less than or equal to 3.

(C) There exists no model of φ with universe of size greater than 7.

(D) Every model of φ has a universe of size equal to 7.

Answer: (A)

46. Let *G* be a simple undirected graph. Let T_D be a depth first search tree of *G*. Let $T_B$be a breadth first search tree of *G*. Consider the following statements.

(I) No edge of *G* is a cross edge with respect to T_D(A cross edge in *G* is between two nodes neither of which is an ancestor of the other in T_D.).

(II) For every edge (*u*, *v*) of G, if u is at depth *i*and v is at depth *j* in T_B, then $|i - j| = 1$.

Which of the statements above must necessarily be true?

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

Answer: (A)

47. In a system. there are three types of resources: *E*, *F* and *G*. Four processes P_0. P_1, $P_2$and P_3execute concurrently. At the outset. the processes have declared their maximum resourcerequirements using a matrix named Max as given below. For example. Max(P1,Fl is the maximum nwnber of instances of *F* that P_2would require. The number of instances of theresources allocated to the various processes at any given state is given by a matrixnamedAllocation.

Consider a state of the system with the Allocation matrix as shown below, and in which 3instances of *E* and 3 instances of Fare the only resources available.

Allocation			
	E	F	G
P_0	1	0	1
P_1	1	1	2
P_2	1	0	3
P_3	2	0	0

Max			
	E	F	G
P_0	4	3	1
P_1	2	1	4
P_2	1	3	3
P_3	5	4	1

From the perspective of deadlock avoidance. which one of the following is true?

(A) The system is in *safe* state.

(B) The system is not in *safe* state. but would be *safe* if one more instance of *E* were available

(C) The system is not in *safe* state. but would be *safe* if one more instance of *F* were available

(D) The system is not in *safe* state. but would be *safe* if one more instance of *G* were available

Answer: (A)

48. Let *G* be a graph with 100! Vertices, with each vertex labelled by a distinct permutation ofthe numbers 1,2, ..., 100. There is an edge between vertices u and *v* if and only if the label of *u* can be obtained by swapping two adjacent numbers in the label of *v*. Let *y* denote the degree of a vertex in *G*. and *z* denote the number of connected components in *G*.

Then $y+10z =$ _____.

Answer: (109)

49. Consider a simple communication system where multiple nodes arc connected by a sharedbroadcast medium (like Ethernet or wireless). The nodes in the system use the following carrier-sense based medium access protocol. A node that receives a packet to transmit will carrier-sense the medium for *5* units of time. If the node does not detect any other transmission in this duration it starts transmitting its packet in the next time unit. If the nodedetects another transmission it waits until this other transmission finishes, and then begins to carrier-sense for *5* time units again. Once they start to transmit nodes do not perform

any collision detection and continue transmission even if a collision occurs. All transmission last for20 units of time. Assume that the transmission signal travels at the speed of 10 meters per unit time in the medium.

Assume that the system has two nodes P and Q. located at a distance *d* meters from each other. P starts transmitting a packet at time *t=O* after successfully completing its carrier-sense phase. Node Q has a packet to transmit at time *r=O* and begins to carrier-sense the medium.

The maximum distance *d* (in meters. rounded to the closest integer) that allows Q to successfully avoid a collision between its proposed transmission and P's ongoing transmission is _____.

Answer: (50)

50. Consider the following languages:

I. $\{a^m b^n c^p d^q \mid m+p = n+q$, where $m, n, p, q \geq 0\}$

II. $\{a^m b^n c^p d^q \mid m = n$ and $p = q$, where $m, n, p, q \geq 0\}$

III. $\{a^m b^n c^p d^q \mid m = n = p$ and $p \neq q$, where $m, n, p, q \geq 0\}$

IV. $\{a^m b^n c^p d^q \mid mn = p+q$, where $m, n, p, q \geq 0\}$

Which of the languages above are context-free?

(A) I and IV only (B) I and II only

(C) II and III only (D) II and IV only

Answer: (B)

51. Consider the following four relational schemas. For each schema all non-trivial functionaldependencies are listed. The underlined attributes are the respective primary keys.

Schema I: Registration (<u>rollno</u>, courses)
Field 'courses' is a set-valued attribute
containing the set of courses a student
hasregistered for:
Non-trivial functional dependency:
Rollno → courses

Schema II: Registration (<u>rollno, courseid,</u> email)
Non-trivial functional dependency:
rollno, courseid → email
email → rollno

Schema III: Registration (rollno, courseid, marks, grade)
Non-trivial functional dependencies:
rollno, courseid → marks, grade
marks → grade

Schema IV: Registration (rollno, courseid, credit)
Non-trivial functional dependencies:
rollno, courseid → credit
courseid → credit

Answer: (B)

52. Consider the following C program:

```
#include<stdio.h>
void fun1(char *s1, char *s2){
     char *tmp;
     tmp = s1;
     s1 = s2;
     s2 = tmp;
}
void fun2(char **s1, char **s2){
     char *tmp;
     tmp = *s1;

     *s1 = *s2;
     *s2 = tmp;
}
int main (){
     char *str1 = "Hi",   *str2 = "Bye";
     fun1(str1,  str2);      printf("%s %s ",  str1, str2);
     fun2(&str1,  &str2); printf("%s %s",  str1,  str2);
     return 0;
}
```

The output of the program above is

(A) Hi Bye Bye Hi (B) Hi Bye Hi Bye

(C) Bye Hi Hi Bye (D) Bye Hi Bye Hi

Answer: (A)

53. The number of possible min-heaps containing each value from {1,2,3,4, 5, 6, 7} exactly once is _____.

Answer: (80)

54. Consider the weights and values of items listed below. Note that there is only one unit of each item.

Item number	Weight (in Kgs)	Value (in Rupees)
1	10	60
2	7	28
3	4	20
4	2	24

The task is to pick a subset of these items such that their total weight is no more than 11 Kgs and their total value is maximized. Moreover, no item may be split. The total value of items picked by an optimal algorithm is denoted by V_{opt}. A greedy algorithm sorts the items by their value-to-weight ratios in descending order and packs them greedily, starting from the first item in the ordered list. The total value of items picked by the greedy algorithm is denoted V_{greedy}

The value of V_{opt}.-V_{greedy}is_____.

Answer: (16)

55. Consider the unsigned 8-bit fixed point binary number representation below.

$b_7\ b_6\ b_5\ b_4\ b_3.b_2\ b_1\ b_0$

Where the position of the binary point is between b_3 and b_2. Assume b_7 is the most significant bit. Some of the decimal numbers listed below **cannot** be represented **exactly** in the above representation:

(i) 31.500

(ii) 0.875

(iii) 12.100

(iv) 3.001

Which one of the following statements is CORRECT?

(A) None of (i). (ii). (iii). (iv) can be exactly represented

(B) Only (ii) cannot be exactly represented

(C) Only (iii) and (iv) cannot be exactly represented

(D) Only (i) and (ii) cannot be exactly represented

Answer: (C)