COMPUTER SCIENCE & ENGINEERING

SECTION - A

This question contains 10 subparts, each carrying 1 mark. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A, B, C or D corresponding to the most appropriate answer.

(Marks: 10 × 1 = 10)

1. The probability that it will rain today is 0.5. The probability that it will rain tomorrow is 0.6. The probability that it will rain either today or tomorrow is 0.7. What is the probability that it will rain today and tomorrow?
   a. 0.3
   b. 0.25
   c. 0.35
   d. 0.4

2. The Newton—Raphson method is used to find the root of the equation $x^2 - 2 = 0$. If the iterations are started from -1, the iterations will
   a. converge to -1
   b. converge to $\sqrt{2}$
   c. converge to $-\sqrt{2}$
   d. not converge

3. The determinant of the matrix
$$\begin{bmatrix} 6 & -8 & 1 & 1 \\ 0 & 2 & 4 & 6 \\ 0 & 0 & 4 & 8 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$
   is
   a. 11
   b. -48
   c. 0
   d. -24

4. The concatenation of two lists is to be performed in O(1) time. Which of the
   a. singly linked list
   b. doubly linked list
   c. circular doubly linked list
   d. array implementation of list

5. The correct matching for the following pairs is
   List I
   A. All pairs shortest paths
   B. Quick Sort
   C. Minimum weight spanning tree
   D. Connected Components
   List II
   1. Greedy
   2. Depth—First Search
   3. Dynamic Programming
   4. Divide and Conquer
   Codes;

	A	B	C	D
a.	2	4	1	3
b.	3	4	1	2
c.	3	4	2	1
d.	4	1	2	3

6. In the following grammar
   $X :: = X \oplus Y / Y$
   $Y :: = Z \odot Y / Z$
   $Z :: = id$
   Which of the following is true?
   a. '$\oplus$' is left associative while '$\odot$' is right associative
   b. Both '$\oplus$' and '$\odot$' are left associative
   c. '$\oplus$' is right associative while '$\odot$' is left associative
   d. None of the above

7. Which of the following is essential for converting an infix expression to the postfix form efficiently?
   a. An operator stack
   b. An operand stack
   c. An operand stack and an operator stack
   d. A parse tree

8. A language L allows declaration of arrays whose sizes are not known during compilation. It is required to make efficient use of memory. Which one of the following is true?
   a. A compiler using static memory allocation can be written for L
   b. A compiler cannot be written for L an interpreter must he used
   c. A compiler using dynamic memory allocation can be written for L
   d. None of the above

9. The conditional expansion facility of macro processors is provided to
   a. test a condition during the execution of the expanded program

b. to expand certain model statements depending upon the value of a condition during the execution of the expanded program
c. to implement recursion
d. to expand certain model statements depending upon the value of a condition during the process of macro expansion

10. Heap allocation is required for languages
1. that support recursion
2. that support dynamic data structures
3. that use dynamic scope rules
4. none of the above

This question contains 5 subparts, each carrying 1 mark. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A, B, C, or D corresponding to the most appropriate answer.

(5 × 1 = 5)

11. Let * be defined as x * y = $\bar{x}$ + y. Let z = x * y. Value of z * x is
a. $\bar{x} + y$
b. x
c. 0
d. 1

12. RST 7.5 interrupt in 8085 microprocessor executes the interrupt service routine from interrupt vector location
a. 0000H
b. 0075H
c. 003CH
d. 0034H

13. Purpose of a start bit in R8232 serial communication protocol is
a. to synchronies receiver for receiving every byte
b. to synchronies receiver for receiving a sequence of bytes
c. a parity bit
d. to synchronies receiver for receiving the last byte

14. The correct matching for the following pairs is
List I
A. DMA I/O
B. Cache
C. Interrupt I/O
D. Condition Code Register
List II
1. High speed RAM
2. Disk
3. Printer
4. ALU
Codes;

	A	B	C	D
a.	4	3	1	2
b.	2	1	3	4
c.	4	3	2	1
d.	2	3	4	1

15. An N-bit carry look ahead adder, where N is a multiple of 4 employs ICs 74181 (4 bit ALU) and 74182 (4 bit carry look ahead generator).
The minimum addition time using the best architecture for this adder is
a. proportional to N
b. proportional to log N
c. a constant
d. none of the above

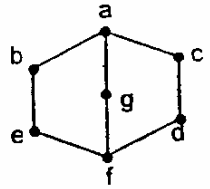
This question contains 10 subparts. Each carrying 1 mark. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A. B. C. or D. corresponding to the most appropriate answer.

(10 × 1 = 10)

16. Let (Z.*) be an algebraic structure, where Z is the set of integers and the operation * is defined by n*m= maximum(n.m). Which of the following statements is true for (Z,*)?
a. (Z.*) is a monoid
b. (Z.*) is an Abelian group
c. (Z.*) is a group
d. None of the above

17. Which of the following propositions is a tautology?
a. $(p \vee q) \rightarrow p$
b. $p \vee (q \rightarrow p)$
c. $p \vee (p \rightarrow q)$
d. $p \rightarrow (p \rightarrow q)$

18. In the lattice defined by the Hasse diagram given in Fig 3.3, how many complements does the element ‘e’ have?



a. 2
b. 3

c. 0
d. 1

19. Given Σ = {a, b}, which one of the following sets is not countable?
a. Set of all strings over Σ
b. Set of all languages over Σ
c. Set of all regular languages over Σ
d. Set of all languages over Σ accepted by Turing machines

20. Locality of reference implies that the page reference being made by a process
a. will always he to the page used in the previous page reference
b. is likely to be to one of the pages used in the last few page references
c. will always be to one of the pages existing in memory
d. will always lead to a page fault

21. The correct matching for the following pairs is
List I
A. Disk scheduling
B. Batch processing
C. Time sharing
D. Interrupt processing
List II
1. Round robin
2. SCAN
3. LIFO
4. FIFO
Codes;

	A	B	C	D
a.	3	4	2	1
b.	4	3	2	1
c.	2	4	1	3
d.	3	4	3	2

22. I/O redirection
a. implies changing the name of a file
b. can be employed to use an existing file as input file for a program
c. implies connecting 2 programs through a pipe
d. none of the above

23. When an interrupt occurs, an operating system
a. ignores the interrupt
b. always changes state of interrupted process to 'blocked' and schedules another process
c. always resumes execution of interrupted process after processing the interrupt
d. may change state of interrupted process to 'blocked' and schedule another process

24. Thrashing
a. reduces page I/O
b. decreases the degree of multiprogramming
c. implies excessive page I/O
d. improves the system performance

25. Dirty bit for a page in a page table
a. helps avoid unnecessary writes on a paging device
b. helps maintain LRU information
c. allows only read on a page
d. none of the above

This question contains 10 subparts. each carrying 2 marks. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A. B. C or D corresponding to the most appropriate answer.

(10 × 2 = 20)

26. What is the maximum value of the function $f(x) = 2x^2 - 2x + 6$ in the interval [0, 2]?
a. 6
b. 10
c. 12
d. 5.5

27. Let A = (a_{ij}) be an n-rowed square matrix and I_{12} be the matrix obtained by interchanging the first and second rows of the n-rowed Identity matrix. Then AI_{12} is such that its first
a. row is the same as its second row
b. row is the same as the second row of 4
c. column is the same as the second column of A
d. row is all zero

28. Using the forward Euler method to solve $y''(t) = f(t), y(0) = 0$ with a step size of h, we obtain the following values of y in the first four iterations:
a. $0, hf(0), h(f(0) + f(h))$ and $h(f(0) + f(h) + f(2h))$
b. $0, 0, h^2 f(0)$ and $2h^2 f(0) + f(h)$
c. $0, 0, h^2 f(0) and 3h^2 f(0)$
d. $0, 0, hf(0) + h^2 f(0)$ and $hf(0) + h^2 f(0) + hf(h)$

29. A polynomial p(x) is such that p(0) = 5, p(1) = 4, p(2) = 9 and p(3) = 20. The minimum degree it can have is
    a. 1
    b. 2
    c. 3
    d. 4

30. A binary search tree contains the values 1, 2, 3, 4, 5, 6, 7, 8. The tree is traversed in pre-order and the values are printed out. Which of the following sequences is a valid output?
    a. 53124786
    b. 53126487
    c. 53241678
    d. 53124768

31. Let T(n) be the function defined by $T(1)=1, T(n)=2T(\lfloor n/2 \rfloor)+\sqrt{n}$ for $n \geq 2$. Which of the following statements is true?
    a. $T(n)=O(\sqrt{n})$
    b. $T(n)=O(n)$
    c. $T(n)=O(\log n)$
    d. None of the above

32. A priority queue Q is used to implement a stack S that stores characters. PUSH (C) is implemented as INSERT (Q. C, K) where K is an appropriate integer key chosen by the implementation. POP is implemented as DELETEMIN (Q). For a sequence of operations. the keys chosen are in
    a. Non-increasing order
    b. Non-decreasing order
    c. strictly increasing order
    d. strictly decreasing order

33. Given the following Pascal-like program segment

```
Procedure A;
x, y : integer;
  Procedure B ;
    x, z : real ;
    S1
  end B ;
    Procedure C ;
      i : integer ;
      S2
    end C ;
end A ;
```

The variables accessible in S1 and S2 are
    a. x of A, y, x of B and z in S1 and x of B, y and un S2
    b. x of B, y and z in S1 and x of B, i and z in S2
    c. x of B, z and y in S1 and x of A, i and in S2
    d. None of the above

34. The expression (a*b)* c op…..
where 'op' is one of '+', '*' and '↑' (exponentiation) can be evaluated on a CPU with a single register without storing the value of (a * b) if
    a. 'op' is' '+' or '*'
    b. 'op' is 'T' or '*'
    c. 'op' is '1' or '+'
    d. not possible to evaluate without storing

35. The trapezoidal method to numerically obtain $\int_a^b f(x)\,dx$ has an error E bounded by $\frac{b-a}{12}h^2 \max f''(x)\, x \in [a,b]$
where h is the width of the trapezoids. The minimum number of trapezoids guaranteed to ensure $E \leq 10^{-4}$ in computing ln 7 using $f = \frac{1}{x}$ is.
    a. 60
    b. 100
    c. 600
    d. 10.000

This question contains 5 subparts, each carrying 2 marks. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A. B. C or D corresponding to the most appropriate answer.
(5 × 2 = 10)

36. Let $f(x,y,z)=\bar{x}+\bar{y}x+xz$ be a switching function. Which one of the following is valid?
    a. $\bar{y}x$ is a prime implicant of f
    b. xz is a minterm of f

c. xz is an implicant of *f*
d. y is a prime implicant of *f*.

37. Contents of A register after the execution of the following 8085 microprocessor program is

```
MVI   A, 55H
MVI   C, 25H
ADD C
DAA
```

a. 7A H
b. 80 H
c. 50 H
d. 22 H

38. A micro instruction into be designed to specify
(a) none or one of the three micro operations of one kind and
(b) none or upto six micro operations of another kind
The minimum number of bits in the micro-instruction is
a. 9
b. 5
c. 8
d. none of the above

39. Given $\sqrt{224)_r} = 13)_r$,
The value of the radix r is:
a. 10
b. 8
c. 5
d. 6

40. Consider the logic circuit shown in Fig. 5.5. The functions f_1, f_2 and f (in canonical sum of products form in decimal notation) are

$f_1(w,x,y,z) = \Sigma\, 8,9,10$
$f_2(w,x,y,z) = \Sigma\, 7,8,12,13,14,15$
$f(w,x,y,z) = \Sigma\, 7,9$
The function f_1 is
a. Σ 9, 10
b. Σ 9
c. Σ 1, 8, 9
d. Σ 8, 10, 15

This question contains 10 subparts. each carrying 2 marks. Each subpart contains a multiple choice question. Write in your answer book the subpart number and the letter A, B, C or D corresponding to the most appropriate answer.

(10 × 2 = 20)

41. A partial order ≤ is defined on the set $S = \{x, a_1, a_2 .... a_n, y\}$ as $x \le a_i$ for all i and $a_i \le y$ for all i, where n ≥ is
a. n!
b. n + 2
c. n
d. 1

42. Let G be a graph with 100 vertices numbered 1 to 100. Two vertices i and j are adjacent iff $|i-j| = 8$ *or* $|i-j| = 12$. The number of connected components in G is
a. 8
b. 4
c. 12
d. 25

43. The number of equivalence relations on the set {1, 2, 3, 4} is
a. 15
b. 16
c. 24
d. 4

44. Which one of the following regular expressions over {0. 1} denotes the set of all strings not containing 100 as a substring?
a. $0^*(1^+0)^*$
b. 0*1010*
c. 0*1*01*
d. 0*(10+l)*

45. Which one of the following is not decidable?
a. Given a turning machine M. a string s and an integer k. M accept. s within k steps
b. Equivalence of two given turning machines
c. Language accepted by a given finite state machine is non empty'
d. Language generated by a context free grammar is non empty

46. Which of the following languages over {a, b, c} is accepted by deterministic pushdown automata?
a. $\{w \subset w^R \mid w \in \{a,b\}^*\}$
b. $\{ww^R \mid w \in \{a,b,c\}^*\}$
c. $\{a^n b^n c^n \mid n \ge 0\}$
d. $\{w \mid w$ is a palindrome over {a, b, c}$\}$

Note: w^R is the string obtained by reversing 'w'.

47. An operating system contains 3 user processes each requiring 2 units of resource R. The minimum number of units of R such that no deadlocks will ever arise is
    a. 3
    b. 5
    c. 4
    d. 6

48. Each process P_i, i = 1….9 is coded as follows

```
repeat
        P(mutex)
        {critical section)
        v (mutex)
forever
```

The code for P_{10} is identical except that it uses v(mutex) in place of P(mutex). What is the largest number of processes that can be inside the critical section at any moment?
    a. 1
    b. 2
    c. 3
    d. none of above

49. For a database relation R(a, b, c, d), where the domains of a, b, c, d include only atomic values, only the following functional dependencies and those that can be inferred from them hold:
    $a \rightarrow c$
    $b \rightarrow d$
    The relation is
    a. in first normal form but not in second normal form
    b. in second normal form but not in third normal form
    c. in third normal form
    d. none of the above

50. Let R (a. b, c) and S (d, e, f) be two relations in which d is the foreign key of S that refers to the primary key of R. Consider the following four operations on R and S
    1. Insert into R
    2. Insert into S
    3. Delete from R
    4. Delete from S

    Which of the following statements is true about the referential integrity constraint above?
    a. None of (1), (2), (3) or (4) can cause its violation
    b. All of (1), (2), (3) and (4) can cause its violation
    c. Both (1) and (4) can cause its violation
    d. Both (2) and (3) can cause its violation

51. A D flip-flop is to be connected to an 8085 microprocessor chip as a 1-bit Output port with a port address of FF hex. Data bit D_3 should be involved in the data transfer from CPU to the flip-flop. The flip-flop should be cleared on power ON.
    a. Using only one NAND gate (fan in of 10). one NOT gate and one D flip-flop, draw the required interface logic circuit (only the relevant signals should be shown)
    (3)
    b. Write a program to generate a square wave on the output of the flip-flop. ON and OFF periods of the square wave should be 7 bus cycles each
    (2).

52. Let L = $(a_1, a_2, \ldots\ldots, a_n)$ $n \geq 0$ be a list whose Pascal representation is

```
type list = record
next : ↑ list; val : integer end
```

The following function returns a list in which a_{2i} and a_{2i-1}, $1 \leq 1 \leq \left\lfloor \frac{n}{2} \right\rfloor$ are interchanged. Complete the function by filling in the boxes. Write the line number and the content of the box in your answer sheet.

```
1   function change (p : ↑ list) : ↑ list ;
2   var q,t : ↑ list ;
3   begin
4   if p = nil then change := p
5   else if p ↑ .next = nil then change : = [ ]
6   else begin
7         q : = p↑ .next ;
8         [ ] : = q ;
9         t : =q ↑ .next ;
10        [ ] : =p ;
11        [ ] : = change (t)
12  end
13  end
```

(5)

53. Consider a graph whose vertices are points in the plane with integer co-ordinates (x, y) such that $1 \leq x \leq n$ and $1 \leq y \leq n$. where

$n \geq 2$ is an integer. Two vertices (x_1, y_1) and (x_2, y_2) are adjacent iff $|x_1 - x_2| \leq 1$. The weight of an edge $\{(x_1, y_1), (x_2, y_2)\}$ is $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$.

a. What is the weight of a minimum weight spanning tree in this graph? Write only the answer without any explanations.

(2)

b. What is the weight of a maximum weight spanning tree in this graph? Write only the answer without any explanations.

(3)

54. Consider the following program in Pseudo—Pascal syntax.

```
Program what;
var z : integer ;
procedure recur (x) ;
begin if x ≤ 40 then
   begin x :=x + z;
        recur (x) ;
        z :=x + 10
   end
end ( * recur * )
begin ( * what * )
   z := 10 ;
   recur (z) ;
   writeln(z)
end
```

a. Suppose the parameter to the procedure 'recur' is passed by value.
   (i) What value is printed by the program?
   (ii) How many times is 'recur' called?

b. What value is printed by the program if the parameter is passed by reference?

(2)

55. Consider the grammar

S → bSe
S → PQR
P → bPc
P → ε
Q → cQd
Q → ε
R → dRe
R → ε

where S, P, Q, R are non-terminal symbols with S being the start symbol: b, c, d, e are terminal symbols and 'ε' is the empty string. This grammar generates strings of the form $b^i c^j d^k e^m$ for some I, j, k, m ≥ 0.

a. What is the condition on the values of i, j, k, m?

(3)

b. Find the smallest string that has two parse trees.

(2)

SECTION - B

Answer any TEN questions from this section. All questions carry equal marks.

56. Consider a hash table with n buckets, where external (overflow) chaining is used to resolve collisions. The hash function is such that the probability that a key value is hashed to a particular bucket is 1/n. The hash table is initially empty and K distinct values are inserted in the table.

a. What is the probability that bucket number 1 is empty after the K th insertion?

(1)

b. What is the probability that no collision has occurred in any of the K insertions?

(2)

c. What is the probability that the first collision occurs at the K th insertion?

(2)

57. Let F be the set of one-to-one functions from the set {l,2,…..,n} to the set {l,2,…….m}, where $m \geq n \geq 1$.

a. How many functions are members of F?

(1)

b. How many functions fin F satisfy the property f(i) = 1 for some i, $1 \leq i \leq n$?

(2)

c. How many functions fin F satisfy the property f(i) < f(j) for all $1 \le i < j \le n$?

(2)

58. Let R be a reflexive and transitive relation on a set A. Define a new relation Eon A. as

{F = {(a, b) | (a, b) ∈R and (b, a) ∈ R}

a. Prove that F is an equivalence relation on A.

(2)

b. Define a relation ≤ on the equivalence classes of E as $E_1 \le F_2$, if $\exists a,b$ such that $a \in E_1, b \in E_2$ and $(a,b) \in R$. Prove that ≤ is a partial order.

(3)

59. Consider the following function.

```
Function F (n, m : integer) : integer ;
begin
    If (n <= 0) or (m <= 0) then F:= 1
    else
        F :=F (n–1, m) + F (n, m–1);
end :
```

Use the recurrence relation $\binom{n}{k} = \binom{n-1}{k} + \binom{n-1}{k-1}$ to answer the following questions.

Assume that n, in are positive integers. Write only the answers without any explanation.

a. What is the value of F(n, 2)?

(2)

b. What is the value of F(n,m)?

(2)

c. How many recursive calls are made to the function F, including the original call, when evaluating F (n, m)?

(1)

60. A size—balanced binary tree is a binary tree in which for every node, the difference between the number of nodes in the left and right subtree is at most 1. The distance of a node from the root is the length of the path from the root to the node. The height of a binary tree is the maximum distance of a leaf node from the root.

a. Prove, by using induction on h, that a size-balanced binary tree of height h contains at least 2^h nodes.

(3)

b. In a size-balanced binary tree of height h ≥ 1, how many nodes are at distance h-1 from the root? Write only the answer without any explanations.

(2)

61. An array A contains n ≥ 1 positive integers in the locations A[l], A[2],……., A[n]. The following program fragment prints the length of a shortest sequence of consecutive elements of A, A[i], A[i + 1], ……, A[j] such that the sum of their values is ≥ M, a given positive number. It prints 'n + 1' if no such sequence exists. Complete the program by filling in the boxes. In each case use the simplest possible expression. Write only the line number and the contents of the box.

(5)

```
1   begin
2       i := 1; j := 1;
3       Sum := [      ] ;
4       min := n ; finish := false ;
5       While not finish do
6       If [      ] then
7           If j = n then finish := true.
8           else
9           begin
10              j := j + 1 ;
11              sum := [      ] ;
12          end
13      else
14      begin
15          If (j – i) < min then min := j – i;
16          sum := sum – A[i] ;
17          i := i + 1 ;
18      end
19      writeln (min + 1) ;
20  end
```

62. Consider the following piece of 'C' code fragment that removes duplicates from an ordered list of integers.

```
Node *remove-duplicates (Node *head, int *j)
{
    Node *t1, *t2;
    *j = 0;
    t1 = head;
    if (t1 != NULL) t2 = t1 → next;
    else return head;
    *j = 1;
    if (t2 == NULL) return head;
    while (t2 != NULL)
    {
        if (t1.val != t2.val)  ——→ S1
        {
            (*j)++; t1 → next = t2; t1 = t2;  ——→ S2
        }
        t2 = t2 → next;
    }
    t1 → next = NULL;
    return head;
}
```

63. Assume the list contains ii elements (n≥2) in the following questions.

a. How many times is the comparison in statement SI made?

(1)

b. What is the minimum and the maximum number of times statements marked S2 get executed?

(2)

c. What is the significance of the value in the integer pointed to, by j when the function completes?

(2)

64. A B^+ - tree of order d is a tree in which each internal node has between d and 2d key values. An internal node with M key values M + 1 children. The root (if it is an internal node) has between 1 and 2d key values. The distance of a node from the root is the length of the path from the root to the node. All leaves are at the same distance from the root. The height of the tree is the distance of a leaf from the root.

a. What is the total number of key values in the internal nodes of a B^+-tree with 1 leaves ($l \geq 2$)?

(2)

b. What is the maximum number of internal nodes in a B^+-tree of order 4 with 52 leaves?

(1)

c. What is the minimum number of leaves in a B^+-tree of order d and height h ($h \geq 1$)?

(2)

65. Construct a finite state machine with minimum number of states, accepting all strings over {a, b} such that the number of a′s is divisible by two and the number of b′s is divisible by three.

(5)

66. Given that L is a language accepted by a finite state machine, show that L^P and L^R are also accepted by some finite state machines, where

$L^P = \{s \mid ss' \in L$ for some string s'$\}$.

$L^R = \{s \mid s$ obtainable by reversing some string in L$\}$

(5)

67. A language L is a subset of Pascal with the following constructs:

a. Expressions involving the operators '+' and '<' only
b. Assignment statements
c. 'while' statements and
d. Compound statements with the syntax 'begin……..end'

Give an unambiguous grammar for L.

68. The language L defined by the following grammar allows use of real or integer data in expressions and assignment statements.

$\langle \text{assign-stmt} \rangle$: : = $\langle \text{LHS} \rangle$:= $\langle E \rangle$

$\langle E \rangle$: : = $\langle E \rangle + \langle T \rangle \mid \langle T \rangle$

$\langle T \rangle$: : = $\langle T \rangle * \langle V \rangle \mid \langle V \rangle$

$\langle V \rangle$: : = id $\mid (\langle E \rangle)$

$\langle \text{LHS} \rangle$: : = id

It is required to convert expression and assignment strings of L into postfix strings that use the type-specific operators (+, i), (+, r), (*, i), (*, r), (:=, i) and (:=, r).
Write a syntax directed translation scheme to convert expression and assignment strings into the post-fix form You may assume that the name and type of a variable can be obtained by making the

function calls 'give-type (id)' and 'give-name(id)' respectively.

(5)

69. Consider the following program fragment in Pascal:

```
Program Main ;
    var X : integer ;
    procedure A ;
      var Y : integer ;
      procedure B ;
        var Z : integer ;
        procedure C ;
          var Z : integer ;
          begin (* procedure C *)
          :
          end (* procedure C *)
begin (* procedure B *)
    :
  C : (* call to C *)
  A : (* call to A *)
    :
end (* procedure B *)
    begin (* procedure A *)
        :
        B ; (* call to B *)
        :
    end (* procedure A *)
begin (* Main *)
        :
        A ; (* call to A *)
        :
end (* Main *)
```

Assume that there are no calls to any procedures other than the ones indicated above. It is known that at some point of time during the execution of this program five activation records exist on the run-time stack. Describe the run-time stack at this point of time by clearly indicating the following: the top of the stack, the contents of the static link and dynamic link, and allocation of the local variables in each record.

(5)

70. Following is a state table for some finite state machine.

Present State	Next State, Output	
	input = 0	input = 1
A	B, 1	H, 1
B	F, 1	D, 1
C	D, 0	E, 1
D	C, 0	F, 1
E	D, 1	C, 1
F	C, 1	C, 1
G	C, 1	D, 1
H	C, 0	A, 1

a. Find the equivalence partition on the states of the machine.

(2)

b. Give the state table for the minimal machine. (Use appropriate names for the equivalent states. For example if states X and Y are equivalent then use XY as the name for the equivalent state in the minimal machine).

(3)

71. Let $f = (\bar{w}+y)(\bar{x}+y)(w+\bar{x}+z)(\bar{w}+z)(\bar{x}+z)$

a. Express f as the minimal sum of products. Write only the answer.

(3)

b. If the output line is stuck at 0, for how many input combinations will the value of f be incorrect?

(2)

72. Following floating point number format is given

f is a fraction represented by a 6-bit mantissa (includes sign bit) in sign magnitude form e is a 4-bit exponent (includes sign hit) in sign magnitude form
n = (f, e) = f . 2^e is a floating point number.
Let A = 54.75 in decimal and
B = 9.75 in decimal

a. Represent A and B as floating point numbers in the above format.

(2)

b. Show the steps involved in floating point addition of A and B.

(2)

c. What is the percentage error (upto one position beyond decimal point) in the addition operation in (b)?

(1)

73. A concurrent system consists of 3 processes using a shared resource R in a non-preemptible and mutually exclusive manner. The processes have unique priorities in the range 1…..3, 3 being the highest priority. It is required to synchronize the processes such that the resource is always allocated to the highest priority requester. The pseudo code for the system is as follows.

Shared data

```
mutex : semaphore = 1; /* initialized to 1 */

process [3] : semaphore = 0 ; /* all initialized to 0 */

R_requested [3] : boolean = false; /* all initialized to false */

busy : boolean = false ; /* initialized to false */
```

Code for processes

begin process

```
my–priority : integer ;

my–priority : = . . . ; /* in the range 1···3 */
repeat

    request_R(my–priority);

    P (proceed [my–priority]);

    {use shared resource R}

    release_R (my–priority) ;

forever

end process ;
```

Procedures

```
procedure request_R (priority) ;

P (mutex) ;

if busy = true then

        R_requested [priority] := true ;

else

   begin

        V (proceed [priority]) ;

        busy := true ;

   end

V(mutex) ;
```

Give the pseudo code for the procedure release_R.

(5)

74. A program P reads and processes 1000 consecutive records from a sequential file F stored on device D without using any file system facilities. Given the following

Size of each record = 3200 bytes

Access time of *D* = 10 msecs

Data transfer rate of *D* = 800×10^3 bytes/second

CPU time to process each record = 3 msecs

What is the elapsed time of P if

a. F contains unblocked records and P does not use buffering?

(1)

b. F contains unblocked records and P uses one buffer (i.e., it always 'reads ahead' into the buffer)?

(2)

c. records of F are organized using a blocking factor of 2 (i.e., each block on D contains two records of F) and P uses one buffer?

(2)

You may assume that the CPU time needed to transfer a record from a buffer to a local variable of P is negligible.

75. An operating system handles requests to resources as follows.

A process (which asks for some resources, uses them for some time and then exits the system) is assigned a unique timestamp when it starts. The timestamps are monotonically increasing with time. Let us denote the timestamp of a process P by TS(P).

When a process P requests for a resource the OS does the following:

(i) If no other process is currently holding the resource, the OS awards the resource to P.

(ii) If some process Q with TS(Q)<TS(P) is holding the resource, the OS makes P wait for the resource.

(iii) If some process Q with TS(Q)>TS(P) is holding the resource, the OS restarts Q and awards the resource to P.

(Restarting means taking back the resources held by a process. killing it and starting it again with the same timestamp)

When a process releases a resource, the process with the smallest timestamp (if any) amongst those waiting for the resource is awarded the resource.

a. Can a deadlock ever arise? If yes, show how. If not, prove it.

(3)

b. Can a process P ever starve? If yes, show how. If not, prove it. (2)

76. Consider the following relational database schema:

EMP (<u>eno</u> name, age)

PROJ (<u>pno</u> name)

INVOLVED (<u>eno, pno</u>)

EMP contains information about employees. PROJ about projects and INVOLVED about which employees are involved in which projects. The underlined attributes are the primary keys for the respective relations.

a. What is the relational algebra expression containing one or more of $\{\sigma, \pi, x, u, -\}$ which is equivalent to the SQL query.

```
select eno
from EMP, INVOLVED
where EMP.eno = INVOLVED.eno
and INVOLVED.pno = 3.
```

(1)

b. State in English (in not more than 15 words)

(4)

What the following relational algebra expressions are designed to determine

(i) $\pi_{eno}(INVOLVED)-\pi_{eno}((\pi_{eno}(INVOLVED)\times\pi_{pno}(PROJ))-INVOLVED)$

(ii) $\pi_{age}(EMP)-\pi_{Eage<EMP.age}(\rho_E(EMP)\times EMP))$.

(Note:$\rho_E(EMP)$ conceptually makes a copy of EMP and names it K (ρ is called the rename operator)