GATE CS - 1995

SECTION - A

1. This question has 25 parts. Each part carries 1 mark. Choose the correct alternative for each part.

1.1 A single instruction to clear the lower four bits of the accumulator in 8085 assebly language?

   (a) XRI OFH   (b) ANI FOH   (c) XRI FOH   (d) ANI OFH

1.2 Which of the following statements is true?

   (a) ROM is a Read/Write memory
   (b) PC points to the last instruction that was executed
   (c) Stack works on the principle of LIFO
   (d) All instructions affect the flags

1.3 In a vectored interrupt

   (a) the branch address is assigned to a fixed location in memory
   (b) the interrupt source supplies the branch information to the processor through an interrupt vector
   (c) the branch address is obtained from a register in the processor
   (d) none of the above

1.4 In the following Pascal program segment, what is the value of X after the execution of the program segment?

   X:=-10; Y:=20;
   If X > Y then if X < 0 then X:=abs(X) else X:=2*X;

   (a) 10   (b) -20   (c) -10   (d) None

1.5 Merge sort uses

   (a) Divide and conquer strategy   (b) Backtracking approach
   (c) Heuristic search   (d) Greedy approach

1.6 The principle of locality justifies the use of

   (a) interrupts   (b) DMA
   (c) Polling   (d) Cache Memory

1.7 In a paged segmented scheme of memory management, the segment table itself must have a page table because

   (a) the segment table is often too large to fit in one page
   (b) each segment is spread over a number of pages

(c) segment tables point to page table and not to the physical locations of the segment

(d) the processor's description base register points to a page table

1.8 Which of the following page replacement algorithms suffers from Belady's anamoly?

(a) Optimal replacement   (b) LRU

(c) FIFO   (d) Both (a) and (c)

1.9 In some programming languages, an identifier is permitted to be a letter following by any number of letters or digits. If L and D denote the sets of letters and digits respectively, which of the following expressions defines an identifier?

(a) $(L \cup D)^+$ (b) $L(L \cup D)^*$ (c) $(L.D)^*$ (d) $L.(L.D)^*$

1.10 Consider a grammar with the following productions

$S \rightarrow a \propto b | b \propto c | aB$

$S \rightarrow \propto S | b$

$S \rightarrow \propto b\, b | ab$

$S \propto \rightarrow bd\, b | b$

The above grammar is:

(a) Context free   (b) Regular

(c) Context sensitive   (d) LR(k)

1.11 What are x and y in the following macro definition?

```
        macro              Add x,y
                           Load y
                           Mul x
                           Store y
        end macro
```

(a) Variables   (b) Identifiers

(c) Actual parameters   (d) Formal parameters

1.12 What is the distance of the following code 000000, 010101, 000111, 011001, 111111?

(a) 2   (b) 3   (c) 4   (d) 1

1.13 Which of the following strings can definitely be said to be tokens without looking at the next input character while compiling a Pascal program?

     I.   begin   II.   program   III. <>

(a) I   (b) II   (c) III

(d) All of the above

1.14   A linker is given object modules for a set of programs that were compiled separately. What information need to be included in an object module?

(a) Object code

(b) Relocation bits

(c) Names and locations of all external symbols defined in the object module

(d) Absolute addresses of internal symbols

1.15   Which scheduling policy is most suitable for a time shared operating system?

(a) Shortest Job First   (b) Round Robin

(c) First Come First Serve   (d) Elevator

1.16   For merging two sorted lists of sizes m and n into a sorted list of size m+n, we required comparisons of

(a) $O(m)$ (b) $O(n)$

(c) $O(m+n)$ (d) $O(\log m + \log n)$

1.17   A binary tree T has n leaf nodes. The number of nodes of degree 2 in T is:

(a) $\log_2 n$ (b) $n-1$ (c) n   (d) 2^n

1.18   The probability that a number selected at random between 100 and 999 (both inclusive) will not contain the digit 7 is:

(a) $\dfrac{16}{25}$ (b) $\left(\dfrac{9}{10}\right)^3$ (c) $\dfrac{27}{75}$ (d) $\dfrac{18}{25}$

1.19.   Let R be a symmetric and transitive relation on a set A. Then

(a) R is reflexive and hence an equivalence relation

(b) R is reflexive and hence a partial order

(c) R is reflexive and hence not an equivalence relation

(d) None of the above

1.20.   The number of elements in he power set $P(S)$ of the set $S = \{(\phi), 1, (2, 3)\}$ is:

(a) 2   (b) 4   (c) 8

(d) None of the above

1.21. In the interval $[0, \pi]$ the equation $x = \cos x$ has

(a) No solution   (b) Exactly one solution

(c) Exactly two solutions   (d) An infinite number of solutions

1.22. If at every point of a certain curve, the slope of the tangent equals $\dfrac{-2x}{y}$ the curve is

(a) a straight line   (b) a parabola

(c) a circle   (d) an ellipse

1.23. The value of k for which $4x^2 - 8xy + ky^2 = 0$ does not represent a pair of straight lines (both passing through the origin) is:

(a) 0   (b) 2   (c) 9   (d) 3

1.24. The rank of the following $(n+1) \times (n+1)$ matrix, where a is a real number is

$$\begin{bmatrix} 1 & a & a^2 & \cdots & a^n \\ 1 & a & a^2 & \cdots & a^n \\ \vdots & \vdots & \vdots & & \vdots \\ \vdots & \vdots & \vdots & & \vdots \\ 1 & a & a^2 & \cdots & a^n \end{bmatrix}$$

(a) 1   (b) 2   (c) n

(d) Depends on the value of a

1.25 The minimum number of edges in a connected cyclic graph on n vertices is:

(a) n - 1   (b) n   (c) n + 1

(d) None of the above

2. This question has 25 parts. Each part carries 2 Marks. Choose the correct alternative for each part.

2.1 A sequence of two instructions that multiplies the contents of the DE register pair by 2 and stores the result in the HL register pair (in 8085 assembly language) is:

(a) XCHG and DAD B   (b) XTHL and DAD H

(c) PCHL and DAD D   (d) XCHG and DAD H

2.2. The capacity of a memory unit is defined by the number of words multiplied by the number of bits/word. How many separate address and data lines are needed for a memory of 4 K × 16?

(a) 10 address, 16 data lines   (b) 11 address, 8 data lines

(c) 12 address, 16 data lines　　　　　　　　(d) 12 address, 12 data lines

2.3. Assume that X and Y are non-zero positive integers. What does the following Pascal program segment do?

```
while X <>Y do
if    X > Y then
    X:=X – Y
else
    Y:=Y – X;
write(X);
```

(a) Computes the LCM of two numbers
(b) Divides the larger number by the smaller number
(c) Computes the GCD of two numbers
(d) None of the above

2.4. What is the value of X printed by the following program?

```
program COMPUTE (input, output);
    var
                X:integer;
    procedure FIND (X:real);
                begin
                X:=sqrt(X);
                end;
    begin
                X:=2
                Find(X)
                Writeln(X)
    end
```

(a) 2　　　　　　　　　　　　　　　　(b) $\sqrt{2}$
(c) Run time error　　　　　　　　　　(d) None of the above

2.5. What values of A, B, C and D satisfy the following simultaneous Boolean equations?

$$\overline{A} + AB = 0, AB = AC, AB + A\overline{C} + CD = \overline{CD}$$

(a) A = 1, B = 0, C = 0, D = 1　　　　(b) A = 1, B = 1, C = 0, D = 0
(c) A = 1, B = 0, C = 1, D = 1　　　　(d) A = 1, B = 0, C = 0, D = 0

2.6. The sequence …………… is an optimal non-preemptive scheduling sequence for the following jobs which leaves the CPU idle for ……………………. unit(s) of time.

Job	Arrival time	Burst time
1	0.0	9
2	0.6	5
3	1.0	1

(a) {3,2,1),1   (b) (2,1,3},0   (c) {3,2,1),0   (d) {1,2,3},5

2.7. The address sequence generated by tracing a particular program executing in a pure demand paging system with 100 records per page with 1 free main memory frame is recorded as follows. What is the number of page faults?

0100, 0200, 0430, 0499, 0510, 0530, 0560, 0120, 0220, 0240, 0260, 0320, 0370

(a) 13   (b) 8   (c) 7   (d) 10

2.8. If the cube roots of unity are 1, ω and ω^2, then the roots of the following equation are $(x-1)^3 + 8 = 0$

(a) -1, $1 + 2\omega$, $1 + 2\omega^2$ (b) 1, $1 - 2\omega$, $1 - 2\omega^2$

(c) -1, $1 - 2\omega$, $1 - 2\omega^2$ (d) -1, $1 + 2\omega$, $-1 + 2\omega^2$

2.9. A language with string manipulation facilities uses the following operations

head(s): first character of a string

tail(s): all but the first character of astring

concat(s1,s2):s1 s2

for the string acbc what will be the output of

concat(head(s), head(tail(tail(s))))

(a) ac   (b) bc   (c) ab   (d) cc

2.10. A shift reduce parser carries out the actions specified within braces immediately after reducing with the corresponding rule of grammar

$S \rightarrow xxW$ {print"1"}

$S \rightarrow y$ {print"2"}

$W \rightarrow Sz$ {print"3"}

What is the translation of xxxxyzz using the syntax directed translation scheme described by the above rules?

(a) 23131   (b) 11233   (c) 11231   (d) 33211

2.11. A variant record in Pascal is defined by

$$\text{type varirec} \quad = \quad \text{record}$$

number : integer;
case (var1,var2) of
var1: (x,y : integer);
var2: (p.q.: real)

end

end

Suppose an array of 100 records was declared on a machine which uses 4 bytes for an integer and 8 bytes for a real. How much space would the compiler have to reserve for the array?

(a) 2800   (b) 2400   (c) 2000   (d) 1200

2.12. The number of 1's in the binary representation of
$(3 * 4096 + 15 * 256 + 5 * 16 + 3)$ are:

(a) 8   (b) 9   (c) 10   (d) 12

2.13. A unit vector perpendicular to both the vectors
$a = 2i - 2j + k$ and $b = 1 + j - 2k$ is:

(a) $\frac{1}{\sqrt{3}}(i + j + k)$ (b) $\frac{1}{3}(i + j - k)$ (c) $\frac{1}{3}(i - j - k)$ (d) $\frac{1}{\sqrt{3}}(i + j - k)$

2.14. A bag contains 10 white balls and 15 black balls. Two balls are drawn in succession. The probability that one of them is black and the other is white is:

(a) $\frac{2}{3}$ (b) $\frac{4}{5}$ (c) $\frac{1}{2}$ (d) $\frac{2}{1}$

2.15. The iteration formula to find the square root of a positive real number b using the Newton Raphson method is

(a) $x_{k+1} = 3(x_k + b)/2x_k$ (b) $x_{k+1} = 3(x_{k+b})/2x_k$

(c) $x_{k+1} = x_k - 2x_k/(x_k^2 + b)$ (d) None of the above

2.16. In a virtual memory system the address space specified by the address lines of the CUP must be _____ than the physical memory size and _____ than the secondary storage size.

(a) smaller, smaller   (b) smaller, larger

(c) larger, smaller   (d) larger, larger

2.17. Let A be the set of all non-singular matrices over real number and let* be the matrix multiplication operation. Then

(a) A is closed under* but < A, *> is not a semigroup

(b) <A, *> is a semigroup but not a monoid

(c) <A, *> is a monoid but not a group

(d) <A, *> is a group but not an abelian group

2.18. The solution of differential equation $y'' + 3y' + 2y = 0$ is of the form

(a) $C_1 e^x + C_2 e^{2x}$ (b) $C_1 e^{-x} + C_2 e^{3x}$ (c) $C_1 e^{-x} + C_2 e^{-2x}$ (d) $C_1 e^{-2x} + C_2 2^{-x}$

2.19. If the proposition $\neg p \Rightarrow v$ is true, then the truth value of the proposition $\neg p V (p \Rightarrow q)$, where $\neg$ is negation, 'V' is inclusive or and $\Rightarrow$ is implication, is

(a) true   (b) multiple valued

(c) false   (d) cannot be determined

2.20. Which of the following definitions below generates the same language as L, where $L = \{x^n y^n \text{ such that } n >= 1\}$?

I. $E \rightarrow xE\,y \mid xy$

II. $x\,y \mid (x^+ xyy^+)$

III. $x^+ y^+$

(a) I only   (b) I and II   (c) II and III   (d) II only

2.21. The postfix expression for the infix expression

$A + B * (C + D) / F + D * E$ is:

(a) AB + CD + *F/D + E*   (b) ABCD + *F/DE*++

(c) A *B + CD/F *DE++   (d) A + *BCD/F* DE++

2.22. Which of the following statements is true?

I.   As the number of entries in a hash table increases, the number of collisions increases.

II. Recursive programs are efficient

III. The worst case complexity for Quicksort is $O(n^2)$

IV. Binary search using a linear linked list is efficient.

(a) I and II   (b) II and III   (c) I and IV   (d) I and III

2.23. A finite state machine with the following state table has a single input x and a single out z.

present state	next state, z	
	x=1	x=0
A	D, 0	B, 0
B	B, 1	C, 1
C	B, 0	D, 1
D	B, 1	C, 0

If the initial state is unknown, then the shortest input sequence to reach the final state C is:

(a) 01   (b) 10   (c) 101   (d) 110

2.24. Let $\Sigma = \{0,1\}, L = \Sigma^*$ and $R = \{0^n1^n$ such that $n > 0\}$ then the languages $L \cup R$ and R are respectively

(a) regular, regular   (b) not regular, regular

(c) regular, not regular   (d) not regular, no regular

2.25. A computer system has a 4K word cache organized in block-set-associative manner with 4 blocks per set, 64 words per block. The number of bits in the SET and WORD fields of the main memory address format is:

(a) 15, 40   (b) 6, 4   (c) 7, 2   (d) 4, 6

3. Consider the following high level program segment. Give the contents of the memory locations for variables W, X, Y and Z after the execution of the program segment. The values of the variables A and B are 5 CH and 92H, respectively. Also indicate error conditions if any.

```
var
    A, B, W, X, Y    :unsigned byte;
    Z                :unsigned integer, (each integer is represented by two
                      bytes)
begin
    X                :=A+B
    Y                :=abs(bA-b);
    W                :=A-B
    Z                :=A*B
End;
```

4.   (a) Consider the following Pascal function where A and B are non-zero positive integers. What is the value of GET(3,2)?

```
function GET(A,B:integer);integer;
begin
        if B = 0 then
    GET:=1
else if A < B then
    GET:=0
else
    GET:=GET(A-1,B)+GET(A-1,B-1)
end ;
```

(b) The Pascal procedure given for computing the transpose of an N × N (N>1) matrix A of integers has an error. Find the error and correct it.

Assume that the following declaration are made in the main program

```
const
    MAXSIZE=20;
type
    INTARR=array [1.,MAXSIZE,1..MAXSIZE] of integer;
Procedure TRANSPOSE (var A: INTARR; N : integer);
var
    I, J, TMP, integer;
begin
    for I:=1 to NO – 1 do
    for J:=1 to N do
    begin
            TMP: = A[I,J];
            A[I,J]:=A[J,I];
            A(J,I}:=TMP
    end
end;
```

5.   A computer installation has 1000k of main memory. The jobs arrive and finish in the following sequences.

Job 1 requiring 200k arrives

Job 2 requiring 350k arrives

Job 3 requiring 300k arrives

Job 1 finishes

Job 4 requiring 120k arrives

Job 5 requiring 150k arrives

Job 6 requiring 80k arrives

(a) Draw the memory allocation table using Best Fit and First fit algorithms.

(b) Which algorithm performs better for this sequence?

6.   What is the number of binary trees with 3 nodes which when traversed in post-order give the sequence A, B, C? Draw all these binary trees.

7.   (a) Determine the number of divisors of 600.

(b) Compute without using power series expansion $\lim_{x \to 0} \dfrac{\sin x}{0}$

SECTION – B
Answer any TEN questions.

8.   Construct the LL(1) table for the following grammar.

1. Expr → _Expr
2. Expr → (Expr)
3. Expr → Var Expr Tail
4. ExprTail → _Expr
5. ExprTail → λ
6. Var → Id Var Tail
7. VarTail → (Expr)
8. VarTail → λ
9. Goal → Expr$

9.   (a) Translate the arithmetic expression $a * -(b + c)$ into syntax tree.

(b) A grammar is said to have cycles if it is the case that
$$A \Rightarrow +_A$$
Show that no grammar that has cycles can be LL(I).

10.   (a) Using the scope rules of Pascal determine the declaration that apply to each occurrence of the names A and B in the following program segment.

procedure T(U, V, X, Y: integer);

var

    A: record

        A, B : integer

    end;

```
        B: record
              B, A : integer
         end;
      begin
         with A do
               begin
                   A:=4;
                   B:=V
       end;
       with B do
            begin
                  A:=X;
                  B:=Y
             end
       end;
```

(b) Find the lexical errors in the following Pascal statement:

   if A > 1, then B = 2.5A else read (C);

11.   Let L be a language over Σ i.e., $L \leq \Sigma^*$. Suppose L satisfies the two conditions given below

   (i)   L is in NP and

   (ii) For every n, there is exactly one string of length n that belongs to L.

   Let L^c be the complement of L over Σ^*. Show that L^c is also in NP.

12.   Consider the following sequence of numbers

   92, 37, 52, 12, 11, 25

   Use bubblesort to arrange the sequence in ascending order. Give the sequence at the end of each of the first five passes.

13.   Obtain the principal (canonical) conjunctive normal form of the propositional formula

$$(p \wedge q) V (\neg q \wedge r)$$

   Where '$\wedge$' is logical and, 'v' is inclusive or and $\neg$ is negation.

14.   If the overhead for formatting a disk is 96 bytes for 4000 byte sector,

   (a) Compute the unformatted capacity of the disk for the following parameters:

   Number of surfaces: 8

   Outer diameter of the disk: 12 cm

   Inner diameter of the disk: 4 cm

   Inter track space: 0.1 mm

Number of sectors per track: 20

(b) if the disk in (a) is rotating at 360 rpm, determine the effective data transfer rate which is defined as the number of bytes transferred per second between disk and memory.

15. (a) Implement a circuit having the following output expression using an inverter and NAND gate $Z = \overline{A} + \overline{B} + C$.

(b) What is the equivalent minimal Boolean expression (in sum of products form) for the Karnaugh map given below?

CD \ AB	00	01	11	10
00	1			1
01		1	1	
11		1	1	
10	1			1

16. The following is an 8085 assembly language program:

```
        MVI B, OAH
        MVI A, 05H
        LXI H, IC40H
        CALL   SUB
        HLT
SUB CMP M
        RZ
        INX H
        DCR B
        JNZ    SUB
        RET
```

(a) What does the program do?

(b) What are the contents of registers A and B initially?

(c) What are the contents of HL register pair after the execution of the program?

17. (a) An asynchronous serial communication controller that uses a start stop scheme for controlling the serial I/O of a system is programmed for a string of length seven bits, one parity bit (odd parity) and one step bit. The transmission rate is 1200 bits/second.

(i) What is the complete bit stream that is transmitted for the string '0110101'?

(ii) How many such strings can be transmitted per second?

(b) Consider a CRT display that has a text mode display format of 80 × 25 characters with a 9 × 12 character cell. What is the size of the video buffer RAM for the display to be used in monochrome (1 bit per pixel) graphics mode?

18. The following is an incomplete Pascal function to convert a given decimal integer (in the range -8 to +7) into a binary integer in 2's complement representation. Determine the expression A, B, C that complete program.

function TWOSCOMP (N:integer):integer;

var

RAM, EXPONENT:integer;

BINARY :integer;

begin

if(N>=-8) and (N<=+7) then

      begin

if N<0 then

      N : = A;

BINARY:=0;

EXPONENT:=1;

while N<>0 do

      begin

         REM:=N mod 2;

         BINARY:=BINARY + B*EXPONENT;

         EXPONENT:=EXPONENT*10;

         N :=C

      end

TWOSCOMP:=BINARY

end

end;

19. Consider the following program segment for concurrent processing using semaphore operators P and V for synchronization. Draw the precedence graph for the statements S1 to S9.

var

a, b, c, d, e, f, g, h, i, j, k : semaphore;

begin

cobegin

      begin S1; V(a); V(b) end;

      begin P(a); S2; V(c); V(d) end;

      begin P(c); S4; V(c) end;

```
begin P(d); S5; V(f) end;
begin P(e); P(f); S7; V(k) end;
begin P(b); S3;V(g);V(h) end;
begin P(g); S6; V(i) end;
begin P(h); P(i); S8; V(j) end;
begin P(j); P(j); P(k); S9 end;
coend
end;
```

20.   The head of a moving head disk with 100 tracks numbered 0 to 99 is currently serving a request at tract 55. If the queue of requests kept in FIFO order is

   10, 70, 75, 23, 65

Which of the two disk scheduling algorithms FCFS (First Come First Served) and SSTF (Shortest Seek Time First) will require less head movement? Find the head movement for each of the algorithms.

21.   Let G_1 and G_2 be subgroups of a group G.

(a) Show that $G_1 \cap G_2$ is also a group of G

(b) Is $G_1 \cup G_2$ always a subgroup of G?

22.   How many minimum spanning trees does the following graph have? Draw them. (Weights are assigned to the edge).
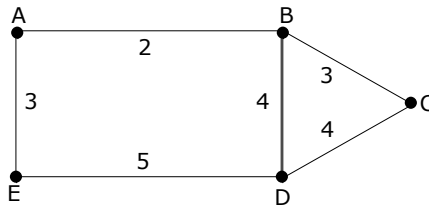
23.   Prove using mathematical induction for $n \geq 5, 2^n > n^2$

24.   Prove that in finite graph, the number of vertices of odd degree is always even.

25.   (a) Find the minimum value of $3 - 4x + 2x^2$.

(b) Determine the number of positive integers (≤ 720) which are not divisibly by any of numbers 2, 3, and 5.

26. (a) Consider the relation scheme R(A, B, C) with the following functional dependencies:

A, B → C,   C → A

Show that the scheme R is the Third Normal Form (3NF) but not in Boyce-Code Normal Form (BCNF).

(b) Determine the minimal keys of relation R.

27. Consider the relation scheme.

AUTHOR	(ANAME, INSTITUTION, ACITY, AGE)
PUBLISHER	(PNAME, PCITY)
BOOK	(TITLE, ANAME, PNAME)

Express the following queries using (one or more of)SELECT, PROJECT, JOIN and DIVIDE operations.

(a) Get the names of all publishers.

(b) Get values of all attributes of all authors who have published a book for the publisher with PNAME = 'TECHNICAL PUBLISHERS'.

(c) Get the names of all authors who have published a book for any publisher located in Madras.