COMPUTER SCIENCE & ENGINEERING

SECTION A (100 Marks)

This Question has 25 parts. Each part carries 1 Mark. Choose the correct alternative for each part.

(25 x 1)

1. A single instruction to clear the lower four bits of the accumulator in 8085 assembly language is
   a. XRI OFH
   b. ANI FOH
   c. XRI FOH
   d. AM OFH
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 insructions affect the flags
3. In a vectored interrupt
   a. The branch address is assigned to a fixed location in memory
   b. The interrupting 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
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 of the above
5. Merge sort uses
   a. Divide and conquer strategy
   b. Backtracking approach
   c. Heuristic search
   d. Greedy approach
6. The principle of locality justifies the use of
   a. Interrupts
   b. DMA
   c. Polling
   d. Cache Memory
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 tables and not to the physical locations of the segment
   d. The processor's description base register points to a page table
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)
9. In some programming languages, an identifier is permitted to be a letter followed 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. $L.(L.D)^*$
10. Consider a grammar with the following productions

$S \rightarrow a\alpha b \mid b\alpha c \mid aB$

$S \rightarrow aS \mid b$

$S \rightarrow \alpha bb \mid ab$

$b\alpha \rightarrow bdb \mid b$

The above grammar is
   a. Context free
   b. Regular

c. Context sensitive
d. LR(k)

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

12. What is the distance of the following code?
000000, 010101, 101010, 000111, 011001, 111111
a. 2
b. 3
c. 4
d. 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

14. A linker is given object modules for a set of programs that were compiled separately. What, information need not 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

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

16. For merging two sorted lists of sizes m and it into a sorted list of size m + n, we require comparisons of
a. O(m)
b. O(n)
c. O(m + n)
d. O(log m + log n)

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

18. The probability that a number selected at random between 100 and 999 (both inclusive) will not contain the digit 7 is
a. 16/25
b. $(9/10)^3$
c. 27/75
d. 18/25

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 not reflexive and hence not an equivalence relation.
d. None of the above.

20. The number of elements in the power set P(S) of the set
S = {{ϕ}, 1, {2, 3}} is
a. 2
b. 4
c. 8
d. None of the above

21. In the interval [0, π], the equation x = cos x has
a. No solution
b. Exactly one solution
c. Exactly two solutions
d. An infinite number of solutions

22. If at every point of a certain curve, the slope of the tangent equals $\frac{-2x}{y}$ the curve is
a. A straight line
b. A parabola
c. A circle
d. An ellipse

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

24. The rank of the following (n + 1) x (n + 1) matrix, where a is a real number is

    a. 1
    b. 2
    c. n
    d. Depends on the value of a

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

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

(25 x 2)

26. 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

27. 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 4Kx16?
    a. 10 address, 16 data lines
    b. 11 address, 8 data lines
    c. 12 address, 16 data lines
    d. 12 address, 12 data lines

28. Assume that X and Y are nonzero 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

29. 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

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

$\bar{A} + AB = 0, \quad AB = AC, \quad AB + \bar{A}\bar{C} + CD = \bar{C}\bar{D}$

    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

31. 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

32. 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

33. 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. $-1, -1+2\omega, -1+2\omega^2$

34. 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 a string
concat(s1,s2) : s1s2

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

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

```
S → xxW  {print "1"}
S → y    {print "2"}
W → Sx   {print "3"}
```

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

a. 23131
b. 11233
c. 11231
d. 33211

36. A variant record in Pascal is defined by

```
type varirec = record
                 number : integer;
                 case (var1, var2) of
                   var1 : (x,y : integer);
                   var2 : (p,q : real)
                 end
               end
```

Suppose an array of 100 such 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

37. The number of is in the binary representation of (3*4096 + 15*256 + 5*16 + 3) are

a. 8
b. 9
c. 10
d. 12

38. A unit vector perpendicular to both the vectors

$a = 2i - 3j + k$ and $b = i + j - 2k$ is

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

39. 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. 2/3
b. 4/5
c. 1/2
d. 1/3

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

41. In a virtual memory system, the address space specified by the address lines of the CPU 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

42. Let A be the set of all nonsingular matrices over real numbers and let * be the matrix multiplication operator. 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.

43. The solution of the differntial equation $y'' + 3y' + 2y = 0$ is of the form:
    a. $c_1e^{t} + c_2e^{2t}$
    b. $c_1e^{-t} + c_2e^{3t}$
    c. $c_1e^{-t} + c_2e^{-2t}$
    d. $c_1e^{2t} + c_2 2^{-t}$

44. If the proposition $\neg p \Rightarrow q$ is true, then the truth value of the proposition $\neg p \vee (p \Rightarrow q)$, where '$\neg$' is negation, 'V is inclusive or and .' is implication, is
    a. True
    b. Multiple-valued
    c. False
    d. Cannot be determined

45. Which of the following definitions below generates the same language
    [illegible]
    a. I only
    b. I and II
    c. II and III
    d. II only

46. 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++

47. 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

48. 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

49. Let $\Sigma = \{0, 1\}$, $L = \Sigma^*$ and $R = \{0^n 1^n\}$ 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, Not Regular

50. A computer system has a 4K word cache organised 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, 4
    b. 6, 4
    c. 7, 2
    d. 4, 6

51. 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 5CH and 9214, respectively. Also indicate error conditions if any.

```
var
    A,B,W,E,Y : unsigned byte;
    Z         : unsigned integer; {each integer is represented by two
                                   bytes}
begin
    E := A + B;
    Y := abs (A - B);
    W := A * B
    Z := A*B
end;
```

52. (a) Consider the following Pascal function where A and B are nonzero 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 on page 13 for computing the transpose of an N x N (N > 1) matrix A of integers has an error. Find the error and correct it.

Assume that the following declarations 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 N-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;
```

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

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?

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

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

(b) Compute without using power series expansion

$$\lim_{x \to 0} \frac{\sin x}{x}$$

SECTION B (50 Marks)

Answer any TEN questions

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

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

57. (a) Translate the arithmetic expression a*-(b+c) into a 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(1).

58. (a) Using the scope rules of Pascal determine the declarations that apply to each occurence 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);

59. Let L be a language over Σ, i.e, $L \subseteq \Sigma^*$. 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.

60. Consider the following sequence of numbers

92, 37, 52, 12, 11, 25

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

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

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

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

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

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

Number of surfaces : 8

Outer diameter of the disk : 12cm

Inner diameter of the disk : 4cm

Inter track space 0.1mm

Number of sectors per track 20

(b) If the disk in (a) is rotating at 3600 rpm, determine the effective data transfer rate which is defined as the number of bytes transferred per second between disk and memory.

63. (a) Implement a circuit having the following output expression using an inverter and a 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 on the next page?

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

64. The following is an 8085 assembly language program:

```
        MVI B, OAH
        MVIA, 05H
        LXI H, IC4OH
        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 U initially?

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

65. (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 stop 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 x 25 characters with a 9 x 12 character cell. What is the size of the video buffer RAM for the display to be used in monochrome (1bit per pixel) graphics mode?

66. 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 expressions A, B, C that complete the program.

```
function TWOSCOMP (N : integer) : integer;
var
  REM, 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;
```

67. Consider the following program segment for concurrent processing using semaphore operators P and V for synchronisation. 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(e) 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(k); S9 end;
  coend
end;
```

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

10, 70, 75, 23, 65

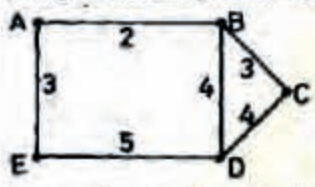
Which of the two disk scheduling algorithms FCFS (First Come First Served) and SSTF (Shortest Seek Time First) will require less head movement? Find the total head movement for each of the algorithms.

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

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

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

70. How many minimum spanning trees does the following graph have? Draw them (Weights are assigned to the edges).



71. Prove using mathematical induction for $n \geq 5$

$2^n > n^2$

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

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

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

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

$A, B \rightarrow C$

$C \rightarrow A$

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

(b) Determine the minimal keys of relation R.

75. 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.