gate 1

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2007
CS:Computer science and Engineering
Q.1-Q.20 carry one mark each

1) Consider the following two statements about the function $f(x) = |x|$:
P: $f(x)$ is continuous for all real values of x
Q:$f(x)$ is differentiable for all real values of x
Which of the following is **TRUE** ?
   a) P is true and Q is false
   b) P is false and Q is true
   c) Both P and Q are true
   d) Both P and Q is false

(GATE EE 2025)

2) Let S be set of n elements. The number of ordered pairs in the largest and the smallest equivalence relations on S are

(A) n and n (B) n^2 and n (C) n^2 and 0 (D) n and 1

(GATE EE 2025)

3) What is the maximum number of different Boolean functions involving n Boolean variables?

(A) n^2 (B) 2^{2^n} (C) 2^{2^n} (D) 2^{n^2}

(GATE EE 2025)

4) Let G be the non planar graph with the minimum possible number of edges.Then G has
   a) 9 edges and 5 vertices
   b) 9 edges and 6 vertices
   c) 10 edges and 5 vertices
   d) 10 edges and 6 vertices

(GATE EE 2025)

5) Consider the DAG with $V = \{1, 2, 3, 4, 5, 6\}$,shown below.

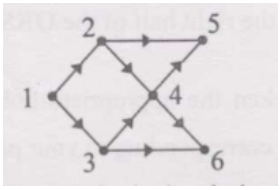

Fig. 5.

Which of the following is **NOT** a topological ordering?

a) 1 2 3 4 5 6
b) 1 3 2 4 5 6
c) 1 3 2 4 6 5
d) 3 2 4 1 6 5

(GATE EE 2025)

6) Which of the following problem is undecidale?
   a) Membership problem for CFGs
   b) Ambiguity problem for CFGs
   c) Finiteness problem for FSAs
   d) Equivalence problem for FSAs

(GATE EE 2025)

7) Which of the following is **TRUE**
   a) Every subset of a regular set is regular
   b) Every finite subset of a non-regular set is regular
   c) The union of two non-regular sets is not regular
   d) Infinite union of finite sets is regular

(GATE EE 2025)

8) How many 3-to-8 line decoders with an enable input are needed to construct a 6-to-64 line decoder without using any other logic gates?

   a) 7 b) 8 c) 9 d) 10

(GATE EE 2025)

9) Consider the following Boolean function of four variables:
   $f(w, x, y, z) = \sum 1, 3, 4, 6, 9, 11, 12, 14$
   the function is
   a) independent of one variable
   b) independent of two variables
   c) independent of three variables
   d) dependent of all the variables

(GATE EE 2025)

10) Consider a 4-way set associateve cache cosisting of 128 lines with a line size of 64 words. The CPU generates a 20-bit address of a word in main memory. The number of bits in the TAG,LINE and WORD fields are respectively:

    a) $9, 6, 5$ b) $7, 7, 6$ c) $7, 5, 8$ d) $9, 5, 6$

(GATE EE 2025)

11) Consider a disk pack with 16 surfaces ,$128 tracks per surface and 256$ sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively:

    a) 256 Mbyte,19Bytes
    b) 256 Mytes,28Bytes
    c) 512 Mytes,20Bytes
    d) 64 Mytes,28Bytes

(GATE EE 2025)

12) The height of a binary tree is the maximum number of edges in any root to leaf path. The maximum number of nodes in a binary tree of height h is:

a) $2^h - 1$ b) $2^{h-1} - 1$ c) $2^{h+1} - 1$ d) 2^{h+1}

(GATE EE 2025)

13) The maximum number of binary trees thst can be formed with three unlabeled nodes is:

a) 1 b) 5 c) 4 d) 3

(GATE EE 2025)

14) Which of the following sorting algorithms has the lowest worst-case complexity?

a) Merge sort
b) Bubble sort
c) Quick sort
d) Selection sort

(GATE EE 2025)

15) Consider the following segment of C-code:
int j, n;
$j = 1$;
while ($j <= n$)
$j = j * 2$;
The number of comparisions made in the execution of the loop for any $n > 0$ is:

a) $\lceil \log_2 n \rceil + 1$ b) n c) $\lceil \log_2 n \rceil$ d) $\lfloor \log_2 n \rfloor + 1$

(GATE EE 2025)

16) Group 1 contains some CPU scheduling algorithms and Group 2 contains some applications. Match entries in Group 1 to entries in Group 2.

Group 1	**Group 2**
P. Gang Scheduling	1. guarenteed Scheduling
Q. Rate monotonic Scheduling	2. Real time Scheduling
R. Fair Share scheduling	3.Theard Scheduling

a) P-3;Q-2;R-1
b) P-1;Q-2;R-3
c) P-2;Q-3;R-1
d) P-1;Q-3;R-2

(GATE EE 2025)

17) Consider the following statements about user level threads and kernel level threads. Which one of the following statements is **FALSE**?

a) Context switch time is longer for kernel level theards then for user level theards .
b) User level threads do not need any hardware support.
c) Related kernel level threads can be scheduled on different processors in multi-processor system
d) Blocking one kernel thread can block all other related threads

(GATE EE 2025)

18) Which of the following is a top-down parser?

a) Recurssive descent parser
b) Operator precedence parser.
c) An LR (k) parser.
d) An LALR(k) parser.

(GATE EE 2025)

19) In Ethernet when Manchester encoding is used,the bit rate is:

a) Half the baud rate
b) Twice the baud rate

c) Same as baud rate
d) None of these

(GATE EE 2025)

20) Which one of the following uses UDP asthe transport protocol ?
a) HTTP
b) Telnet
c) DNS
d) SMTP

(GATE EE 2025)

Q.21 to Q.75 carry two marks each

21) How many different non-isomorphic Abelian group of order 4 are there?

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

(GATE EE 2025)

22) Let $Graph(x)$ be a predicate which denotes that x is a graph. Let $connected(x)$ be predicate which denotes that x is connected.which of the following first order logic sentences **DOES NOT** repressent the statement :"Not every graph is connected" ?
a) $\neg\forall x\,(Graph(x) \implies Connected(x))$
b) $\exists x\,(Graph(x) \wedge \neg Connected(x))$
c) $\neg\forall x\,(Graph(x) \vee Connected(x))$
d) $\forall x\,(Graph(x) \implies \neg Connected(x))$

(GATE EE 2025)

23) Which of the following graphs has an Eulerian circuit?
a) Any k-regular graphs where k is an even number.
b) a complete graph on 90 vertices.
c) The complement on a cycle on 25 vertices.
d) None of these

(GATE EE 2025)

24) Suppose we uniformly and randomly select a permutation from the 20! permutations of $1, 2, 3, ..., 20$. What is the probability that 2 appears at an earlier position than any other even number in selected permutation ?
a) $\frac{1}{2}$
b) $\frac{1}{10}$
c) $\frac{9!}{20!}$
d) None of these

(GATE EE 2025)

25) Let a 4×4 matrix with eigen values $-5, -2, 1, 4$ Which of the following is the eigen value of

$$\begin{pmatrix} A & I \\ I & A \end{pmatrix} \tag{1}$$

,where I is the 4×4 identity matrix ?
a) -5
b) -7
c) 2
d) 1

(GATE EE 2025)

26) consider the set $S = \{a, b, c, d\}$.Consider the following four partitions $\pi_1, \pi_2, \pi_3, \pi_4$ on S : $\pi_1 = \left\{\overline{abcd}\right\}, \pi_2 = \left\{\overline{ab}, \overline{cd}\right\}, \pi_3 = \left\{\overline{abc}, \overline{d}\right\}, \pi_4 = \left\{\overline{a}, \overline{b}, \overline{c}, \overline{d}\right\}$ Let α br the partial order set of partitions

$S' = \{\pi_1, \pi_2, \pi_3, \pi_4\}$ defined as follows :$\pi_i \alpha \pi_j$, if and only if π_i refines π_j .The poset diagram for (S', α) is

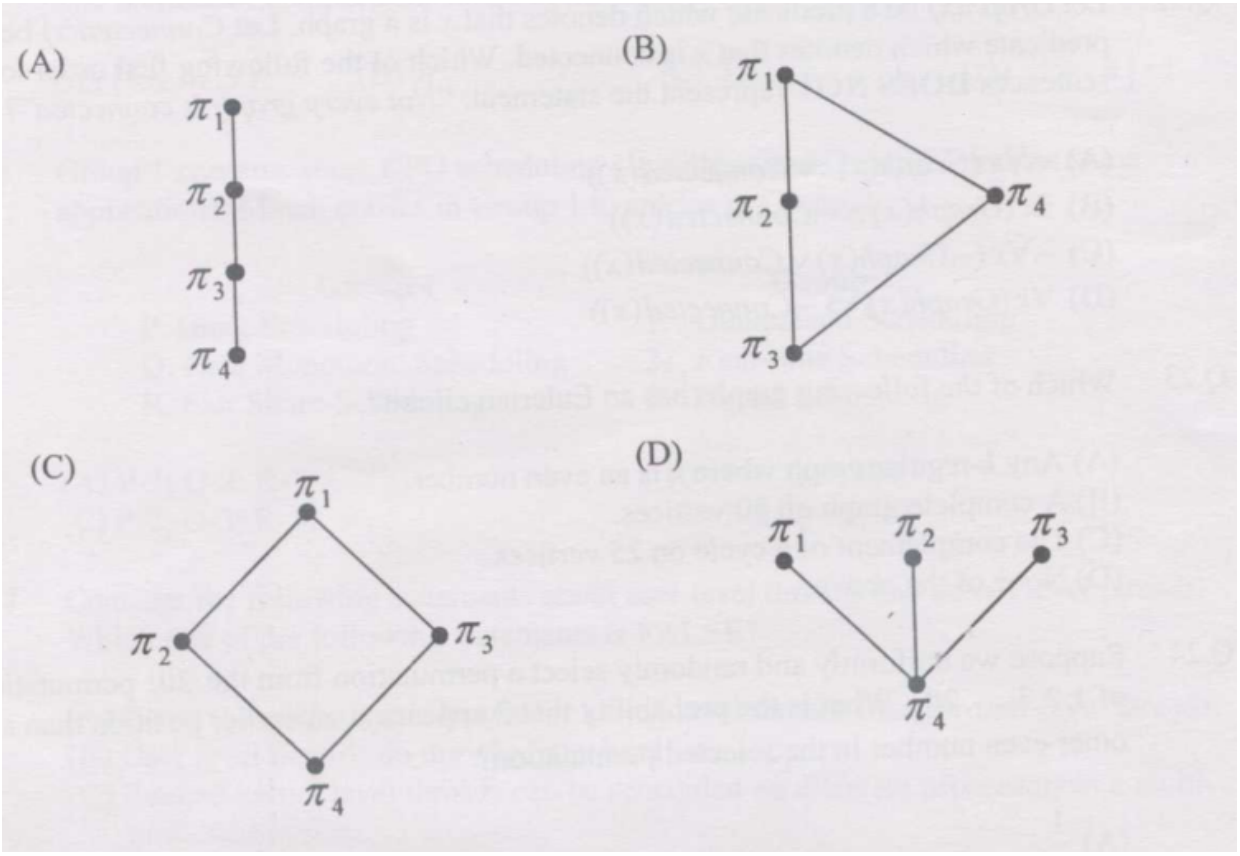

Fig. 26.

(GATE EE 2025)

27) Consider the set of (*column*) vectors defined by $X = \left\{x \in R^3 | x_1 + x_2 + x_3, where \quad x^r = [x_1, x_2, x_3]^T\right\}$ Which of the following is **TRUE**?

a) $\left\{[1, -1, 0]^T, [1, 0, -1]^T\right\}$is basis for subspace X.

b) $\left\{[1, -1, 0]^T, [1, 0, -1]^T\right\}$ is a linerly independent set ,but it does not span X and therefore is not a basis of X

c) X is not a subspace of R^3

d) None of these

(GATE EE 2025)

28) Consider the series $x_{n+1} = \frac{x_n}{2} + \frac{9}{8x_n}, x_0 = 0.5$ obtained from the Newton-Raphson method The series converges to

a) 1.5 b) $\sqrt{2}$ c) 1.6 d) 1.4

(GATE EE 2025)

29) A minimum state deterministic finite automaton accepting the language
{
$L = \{w \mid w \in \{0, 1\}$· number of 0s and 1s in w are divisible by 3 and 5,respectively }

a) 15 states b) 11 states c) 10 states d) 9 states

(GATE EE 2025)

30) The language $L = \left\{0^i 21^i | i \geq 0\right\}$ over the alphabet $\{0, 1, 2\}$ is
a) not recurssive
b) is recurssive and is a deterministic CFL
c) is a regular language
d) is not a deterministic CFL but a CFL

(GATE EE 2025)

31) Which of the following languages is regular?
a) $\left\{ww^R | w \in \{0,1\}^+\right\}$
b) $\left\{ww^R x | x, w \in \{0,1\}^+\right\}$
c) $\left\{wxw^R | x, w \in \{0,1\}^+\right\}$
d) $\left\{xww^R | x, w \in \{0,1\}^+\right\}$

(GATE EE 2025)

32) Let $f(w, x, y, z) = \sum(0, 4, 5, 7, 8, 9, 13, 15)$. Which of the following expressions are **NOT** equivalent to f ?
$(P)\ x'y'z' + w'xy' + wy'z + xz$
$(Q) w'y'z' + wx'y' + xz$
$(R)\ w'y'z' + wx'y' + xyz + xy'z$
$(S) x'y'z' + wx'y' + w'y$
a) P only
b) Q and S
c) R and S
d) S only

(GATE EE 2025)

33) Define the connective * for the Boolean variables X and Y. Considerthe following expresions P,Q and R.
$P : X = Y * Z \quad Q : Y = X * Z \quad R : X * Y * Z = 1$
Which of the following is **TRUE** ?

a) Only P and Q are valid.
b) Only Q and R are valid.
c) Only P and R are valid.
d) All P,Q,R are valid.

(GATE EE 2025)

34) Suppose that only one multiplexer and one inverter are allowed to be used to implement any Boolean function of n variables . What is the minimum size of the multiplexer needed?

a) 2^n line to 1 line
b) 2^{n+1} line to 1 line
c) 2^{n-1} line to 1 line
d) 2^{n-2} line to 1 line

(GATE EE 2025)

35) In a look-ahead carry generator, the carry generate function G_i and the carry propagate function P_i for inputs A_i and B_i are given by :
The expressions for the sum bit S_i and the carry bit C_{i+1} of thelook-ahead carry adder are given by : $S_i = P_i \oplus C_i$ and $C_{i+1} = G_i + P_i C_i$ where C_0 is the input carry.
Consider a two-level logic implementation of the look-ahead carry generator . Assume that all P_i and G_i are available for the carry generate circuit and that the AND and OR gates can have any number of inputs. The number of AND and OR gates needed to implement the look-ahead carry generator for a 4-bit adder with S_3, S_2, S_1, S_0 and C_4 as its outputs are respectively:

a) $6, 3$ b) $10, 4$ c) $6, 4$ d) $10, 5$

(GATE EE 2025)

36) The control signal functions of a 4-bit binary counter are given below (*whereXis*"*don′tcare*"):

Clear	Clock	Load	Count	Function
1	X	X	X	Clear to 0
0	X	0	0	No change
0	↑	1	X	Load input
0	↑	1	1	Count next

The counter is connected as follows:

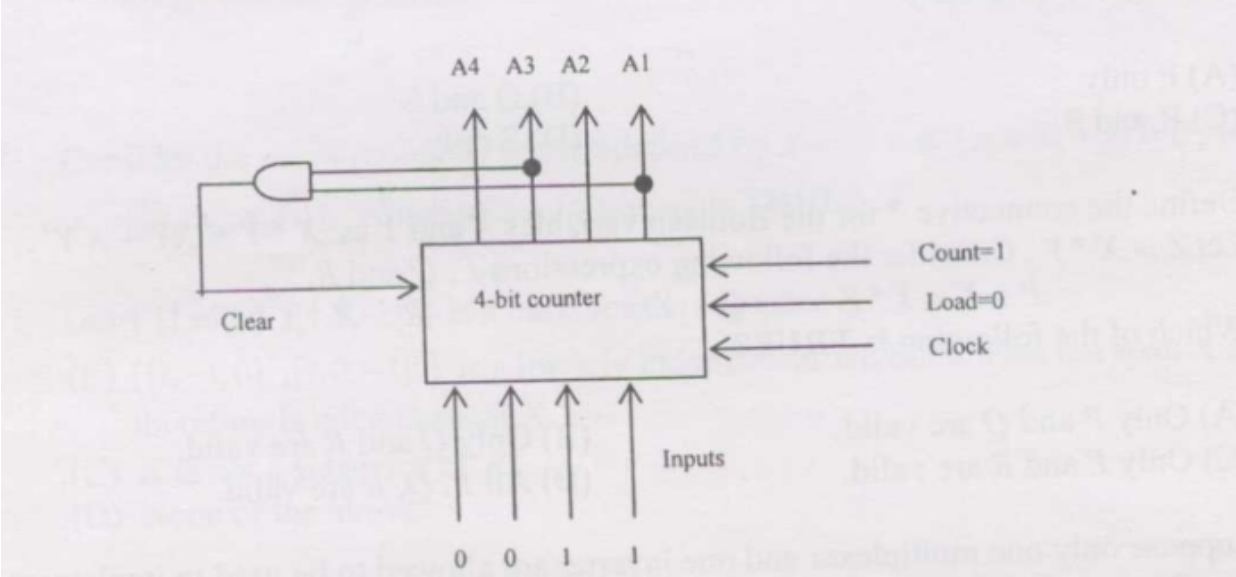

Fig. 36.

Assume that the counter and gate delays are negligible. If the counter starts at 0 ,then it cycles through the following sequence :

a) $0, 3, 4$
b) $0, 3, 4, 5$
c) $0, 1, 2, 3, 4$
d) $0, 1, 2, 3, 4, 5$

(GATE EE 2025)

37) Consider a pipelined processor with the following four stages :
IF: Instruction Fetch
ID: Instruction Decode and Operand Fetch
EX : Execute
WB : Write Back
The IF,ID and WB stages take one clock cycle each to complete the operation. The number of clock cycles for the EX stage depends on the instruction. The ADD and SUB instructions need I clock cycle and the MUL instruction needs 3 clock cycles in the EX stage. Operand forwarding is used in the pipelined processor. What is the number of clock cycles taken to complete the following sequence of instrustions?
ADD R2,R1,R0 $R2 \longleftarrow R1 + R0$
MUL R4,R3,R2 $R2 \longleftarrow R1 + R0$ SUB R6,R5,R4 $R6 \longleftarrow R3 - R4$
a) 7
b) 8

c) 10
d) 14

(GATE EE 2025)

38) The following postfix expression with the single digit operands is evaluated using a stack :

$$823 \wedge /23 * +51* \tag{2}$$

Note that $\wedge$ is the exponentiation operator. The top two elements of the stack after the first $*$ is evaluated are :

a) $6, 1$
b) $5, 7$
c) $3, 2$
d) $1, 5$

(GATE EE 2025)

39) The inorder and preorder traversal of a binary tree are:
d b e a f c g and a b d e c f g , respectively
The postorder traversal of binary tree is

a) d e b f g c a
b) e d b g f c a
c) e d b f g c a
d) d e f g b c a

(GATE EE 2025)

40) Considr a hash table of size seven,with starting index zero,and a hash function $(3x + 4)$ mod7. Assuming that the hash table is initially empty,which of the following contents of the table when the sequence $1, 3, 8, 10$ is inserted into the table using closed hashings? Note that - denotes an empty location in the table.

a) $8, -, -, -, -, -, 10$
b) $1, 8, 10, -, -, -, 3$
c) $1, -, -, -, -, -, 3$
d) $1, 10, 8, -, -, -, 3$

(GATE EE 2025)

41) In an unweighted, undirected connected graph,the shortest path from node S to every other node is computed most efficiently,in terms of time complexity ,by

a) Dijkstra's algorithm starting from S.
b) Warshall's algorithm
c) performing a DFS starting from S.
d) performing a BFS starting from S.

42) Consider the following C function:

```
int {int  n }
 {static \quad int\quad $r=0$
if(n<=0) return 1;
if(n>3)
{$r=n$;
return {n-2}+2; }
return {n-1}+r;
}
```

What is the value of f(5) ?

a) 5 b) 7 c) 9 d) 18

(GATE EE 2025)

43) A complete n-ary tree is a tree in which each node has n chidren or no children. Let I be the number of internal nodes and L be the number of leaves in a complete n-ary tree. If$L = 41$, and $I = 10$, what is the value of n?

a) 3 b) 4 c) 5 d) 6

(GATE EE 2025)

44) In the following C function ,let $n \geq m$.

```
int gcd(m,n)
{
if (n%m==0) return 0;
n=n%m;
return gcd(m,n);
}
```

a) $\Theta(\log_2 n)$ b) $\Omega(n)$ c) $\Theta(\log_2 \log_2 n)$ d) $\Theta(\sqrt{n})$

(GATE EE 2025)

45) What is time complexity of the following recurssive function:

```
int DoSomething (int n){
if(n<=2)
return 1;
else
    return (DoSomething(floor(sqrt(n)))  +n );
}
```

a) $\Theta(n)$ b) $\Theta(n \log_2 n)$ c) $\Theta(\log_2 n)$ d) $\Theta(\log_2 \log_2 n)$

(GATE EE 2025)

46) Consider the following C program segment where CellNode represents a node in a binary tree:

```
struct CellNode {
struct CellNode *leftChild ;
  int element;
  struct CellNode *rightChild ;
  };
  int GetValue(struct CellNode *ptr) {
    int value  =0 ;
    if (ptr != NULL){
       if ((ptr->leftChild==NULL)&& (ptr->rightChild==NULL))
         value =1;
       else
       value=value +GetValue(ptr->leftChild==NULL)
                   +GetValue(ptr->rightChild==NULL);
  }
```

```
  return (value) ;
}
```

The value returned by GetValue when a pointer to the root of a binary tree is passsed as its argument is:

a) the number of nodes in the tree
b) the number of internal nodes in the tree.
c) the number of leaf nodes in the tree.
d) the height of the tree

(GATE EE 2025)

47) Consider the process of inserting an element into a Max Heap,where the Max Heap is represent by an array. Suppose we perform a binary search on the path from the new leaf to the root to find the position for the newly inserted element, the number of comparisions performed is:

a) $\Theta(\log_2 n)$
b) $\Theta(\log_2 \log_2 n)$
c) $\Theta(n)$

(GATE EE 2025)

48) Which of the following is **TRUE** about the formulae in Conjunctive Normal form ?

a) For any formula,there is a truth assignment for which atleast half the clauses evaluate to true.
b) For any formula,there is a truth assignment for which all the clauses evaluate to true.
c) there is a formula such that for each truth assignment,at most one-fourth of the claues evaluate to true
d) None of the above

(GATE EE 2025)

49) Let w be the minimum weights among all the edge weights in an undirected connected graph.Let e be specific edge of weight w.Which of thefollowing is **FALSE** ?

a) There is a minimum spanning tree containing e.
b) If e is not in a minimum spanning tree T,then in a cycle formed by adding e to T,all edges have the same wieght.
c) Every minimum spanning tree has an edge of the weight w.
d) e is present in every minimum spanning tree.

(GATE EE 2025)

50) An array of n numbers is given,where n is an even number .The maximum as well as the minimum of these n numbers has to be determined.Which of the following is **TRUE** about the number of comparisions needed?

a) At least $2n - c$ comparisions , for some constant c,are needed.
b) At most $1.5n - 2$ comparisions are needed.
c) At least $nlog_2n$ comparisions are needed.
d) None of the above

(GATE EE 2025)

51) Consider the following C code segment:

```
int IsPrime(n)
{
int i,n;
for(i=2;i<=sqrt(n);i++)
if (n%i==0)
    {printf("Not Prime\n");return 0;}
    return 1;
```

```
}
```

Let $T(n)$ denote the number of times for loop is executed by the program on input n. Which of the following is **TRUE**?

a) $T(n) = O\left(\sqrt{n}\right)$ and $T(n) = \Omega\left(\sqrt{n}\right)$
b) $T(n) = O\left(\sqrt{n}\right)$ and $T(n) = \Omega(1)$
c) $T(n) = O(n)$ and $T(n) = \Omega\left(\sqrt{n}\right)$
d) None of the above

(GATE EE 2025)

52) Consider the grammer with non-terminals $N = \{S, C, S_1\}$,terminals $T = \{a, b, i, t, e\}$,with S as the start symbol and following set of rules:
$S \longrightarrow iCtSS_1|a$
$S_1 \longrightarrow eS|\epsilon$
$C \longrightarrow b$
The grammer is **NOT** $LL(1)$ because:

a) it is left recurssive
b) it is right recurssive
c) it is ambigious
d) it is not context-free

(GATE EE 2025)

53) Consider the following two statements:
P:Every regular grammer is LL(1)
Q:Every regular set a LR(1) grammer
Which of the following is **TRUE**?

a) Both P and Q are true
b) P is true and Q is false
c) P is false and Q is true
d) Both P and Q are false

(GATE EE 2025)

54) In a simplified computer the instructions are:
OPR_j, R_i - Performs $R_j OPR_i$ and stores the result in register R_i.
OPm, R_i-Performs val OPR_i and stores the result in R_i, val denotes the content of the memory location m .
$MOVm, R_i$- Moves the content of the memory location m to register R_i.
$MOVR_i, m$ - Moves the content of register R_i to memory location m.
The computer has only two registers ,and OP is either ADD or SUB .Consider the following basic block :
$t_1 = a + b$
$t_2 = c + d$
$t_3 = e - t_2$
$t_4 = t_1 - t_3$
Assume that all operands are initially in memmory.The final value of computation should be in the memory.What is the minimum number of MOV instructions in the code genertated for this basic block?

a) 2
b) 3
c) 5
d) 6

(GATE EE 2025)

55) An operating system uses Shortest Remaining Time first (SRT) process scheduling algorithm . Consider the arrival times and execution times for the following processes:

process	Execution time	Arrival time
P1	20	0
P2	25	15
P3	10	30
P4	15	45

What is the total waiting time for process P2?

a) 5 b) 15 c) 40 d) 55

(GATE EE 2025)

56) A virtual memory system uses First In First Out ($FIFO$) page replacement policy and allocates a fixed number of frames to a process. Consider the following statements :
P:Incressing the number of page frames allocated a process sometimes increases the page fault rate.
Q:Some programs do not exhibit locality of reference.
Which one of the following is **TRUE**

a) Both P and Q are true and Q is reason for P
b) Both P and Q aare true but Q is not reason for P
c) P is false, Q is true
d) Both P and Q are false

(GATE EE 2025)

57) A single processor system has three resourse types X,Y and Z, which are shared by three processes. There are 5 units of each resourse type.Consider the following scenario ,where the column **alloc** denotes the number of units of each resource type allocated to each process, and the column **request** denotes the number of units of each resource type requested by a process in order to complete execution. Which of these processes will finish **LAST** ?

	alloc			**request**		
	X	Y	Z	X	Y	Z
P0	1	2	1	1	0	3
P1	2	0	1	0	1	2
P3	2	2	1	1	2	0

a) P0
b) P1
c) P2
d) None of the above, since the system is in deadlock.

(GATE EE 2025)

58) Two processes,P1 and P2,need to access a critical section of code.Consider the following Synchronization construct used by the processes:

```
/* P1 */
while (true) {
    wants1 = true;
    while (wants2 == true);
    /* Critical Section */
    wants1 = false;
}
/* Remainder section */
```

```
/* P2 */
while (true) {
    wants2 = true;
    while (wants1 == true);
    /* Critical Section */
    wants2 = false;
}
/* Remainder section */
```

Here, wants1 and wants2 are shared variables, initialized to false Which one of the following

statements is **TRUE** about the above construct?

a) It does not ensure mutual exclusion.
b) It does not ensure bounded waiting.
c) It requires that processes enter the critical section in strict alternation.
d) It does not prevent deadlocks, but ensures mutual exclusion.

(GATE EE 2025)

59) Information about a collection of students is given by the relation
studInfo(*studId*, *name*, *sex*)
The relation **e**nroll((*studId*, *courseId*)
gives which student has enrolled for (*ortaken*) what course(*s*). Assume that every course is taken by at least one male and at least one female student. What does the following relational algebra expression represent?

$$\Pi_{\text{courseId}}\left(\left[\Pi_{\text{studId}}\sigma_{\text{sex}=\text{“}female\text{”}}(\text{studInfo}) \times \Pi_{\text{courseId}}(\text{enroll})\right] - \text{enroll}\right) \tag{3}$$

a) Courses in which all the female students are enrolled.
b) Courses in which a proper subset of female students are enrolled.
c) Courses in which only male students are enrolled.
d) None of the above.

(GATE EE 2025)

60) Consider the relation **employee**(*name*, *sex*, *supervisorName*) with name as the key. Consider the following Tuple Relational Calculus query:

$$\{e.\text{name} \mid employee(e) \wedge (\forall x)[\, employee(x) \vee x.\text{supervisorName} = e.\text{name} \vee x.\text{sex} = \text{“}male\text{”}\,]\}$$

a) Names of employees with a male supervisor.
b) Names of employees with no immediate male subordinates.
c) Names of employees with no immediate female subordinates.
d) Names of employees with a female supervisor.

(GATE EE 2025)

61) Consider the table **employee**(*empId*, *name*, *department*, *salary*)
and the two queries Q_1, Q_2 below. Assuming that department 5 has more than one employee, and we want to find the employees who get higher salary than anyone in department 5, which one of the statements is TRUE for any arbitrary employee table?
Q_1:

```
Select e.empId
From employee e
Where not exists
    (Select * From employee s
     Where s.department = "5" and s.salary >= e.salary)
```

Q_2:

```
Select e.empId
From employee e
Where e.salary > Any
    (Select distinct salary
     From employee s
     Where s.department = "5")
```

a) Q_1 is the correct query.
b) Q_2 is the correct query.
c) Both Q_1 and Q_2 produce the same answer.

d) Neither Q_1 nor Q_2 is the correct query.

(GATE EE 2025)

62) Which one of the following statements is **FALSE** ?
a) Any relation with two attributes is in BCNF.
b) A relation in which every key has only one attribute is in 2NF.
c) A prime attribute can be transitively dependent on a key in a 3NF relation.
d) A prime attribute can be transitively dependent on a key in a BCNF relation.

(GATE EE 2025)

63) The order of a leaf node in a B^+-tree is the maximum number of (value, data record pointer) pairs it can hold. Given that the block size is 1K bytes, data record pointer is 7 bytes long, the value field is 9 bytes long and a block pointer is 6 bytes long, what is the order of the leaf node?

a) 63 b) 64 c) 67 d) 68

(GATE EE 2025)

64) Consider the following schedules involving two transactions. Which one of the following statements is **TRUE**?

$$S_1 : r_1(X);\ r_1(Y);\ r_2(X);\ r_2(Y);\ w_2(Y);\ w_1(X) \quad (4)$$

$$S_2 : r_1(X);\ r_2(X);\ r_2(Y);\ w_2(Y);\ r_1(Y);\ w_1(X) \quad (5)$$

a) Both S_1 and S_2 are conflict serializable.
b) S_1 is conflict serializable and S_2 is not conflict serializable.
c) S_1 is not conflict serializable and S_2 is conflict serializable.
d) Neither S_1 nor S_2 is conflict serializable.

(GATE EE 2025)

65) There are n stations in a slotted LAN. Each station attempts to transmit with a probability p in each time slot. What is the probability that **ONLY** one station transmits in a given time slot?

a) $np(1-p)^{n-1}$ b) $(1-p)^{n-1}$ c) $p(1-p)^{n-1}$ d) $1-(1-p)^{n-1}$

(GATE EE 2025)

66) In a token ring network the transmission speed is 10^7 bps and the propagation speed is 200 metres/μs. The 1-bit delay in this network is equivalent to:
a) 500 metres of cable.
b) 200 metres of cable.
c) 20 metres of cable.
d) 50 metres of cable.

(GATE EE 2025)

67) The address of a class B host is to be split into subnets with a 6-bit subnet number. What is the maximum number of subnets and the maximum number of hosts in each subnet?
a) 62 subnets and 262142 hosts.
b) 64 subnets and 262142 hosts.
c) 62 subnets and 1022 hosts.
d) 64 subnets and 1024 hosts.

(GATE EE 2025)

68) The message 11001001 is to be transmitted using the CRC polynomial $x^3 + 1$ to protect it from errors. The message that should be transmitted is:

a) 1100101000 b) 1100101011 c) 11001010 d) 11001010011

(GATE EE 2025)

69) The distance between two stations M and N is L kilometres. All frames are K bits long. The propagation delay per kilometre is t seconds. Let R bits/second be the channel capacity. Assuming that processing delay is negligible, the **minimum** number of bits for the sequence number field in a frame for maximum utilization, when the *sliding window protocol* is used, is:

a) $\left\lceil \log_2 \frac{2LtR+2K}{K} \right\rceil$
b) $\left\lceil \log_2 \frac{2LtR}{K} \right\rceil$
c) $\left\lceil \log_2 \frac{2LtR+K}{K} \right\rceil$
d) $\left\lceil \log_2 \frac{2LtR+K}{2K} \right\rceil$

(GATE EE 2025)

70) Match the following:

P. SMTP	1. Application layer
Q. BGP	2. Transport layer
R. TCP	3. Data link layer
S. PPP	4. Network layer
	5. Physical layer

a) P-2, Q-1, R-3, S-5
b) P-1, Q-4, R-2, S-3
c) P-1, Q-4, R-2, S-5
d) P-2, Q-4, R-1, S-3

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Common Data Questions

Common Data for Questions 71, 72, 73:

Consider the following program segment. Here R1, R2 and R3 are the general purpose registers.

Program Segment:

Instruction	Operation	Instruction size (no. of words)
MOV R1, (3000)	R1 ← M[3000]	2
LOOP: MOV R2, (R3)	R2 ← M[R3]	1
ADD R2, R1	R2 ← R1 + R2	1
MOV (R3), R2	M[R3] ← R2	1
INC R3	R3 ← R3 + 1	1
DEC R1	R1 ← R1 - 1	1
BNZ LOOP	Branch on not zero	2
HALT	Stop	1

Assume that the content of memory location 3000 is 10 and the content of the register R3 is 2000. The content of each of the memory locations from 2000 to 2010 is 100. The program is loaded from the memory location 1000. All the numbers are in decimal.

71) Assume that the memory is word addressable. The number of memory references for accessing the data in executing the program completely is:

a) 10 b) 11 c) 20 d) 21

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72) Assume that the memory is word addressable. After the execution of this program, the content of memory location 2010 is:

a) 100 b) 101 c) 102 d) 110

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73) Assume that the memory is byte addressable and the word size is 32 bits. If an interrupt occurs during the execution of the instruction "INC R3", what return address will be pushed on to the stack?

a) 1005 b) 1020 c) 1024 d) 1040

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Common Data for Questions 74, 75

Consider the following Finite State Automaton:

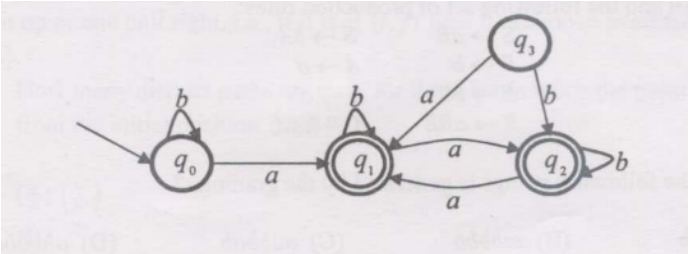

Fig. 73.

74) The language accepted by this automaton is given by the regular expression

a) $b^*ab^*ab^*ab^*$ b) $(a+b)^*$ c) $b^*a(a+b)^*$ d) $b^*ab^*ab^*$

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75) The minimum state automaton equivalent to the above FSA has the following number of states:

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

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Linked Answer Questions: Q.76 to Q.80 carry two marks each

Suppose the letters a,b,c,d,e,f have probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{32}$ respeectively

76) What is the following is the huffman code for the letters a,b,c,d,e,f?

a) 0,10,110,1110,11110,11111
b) 11,10,011,010,001,000
c) 11,10,01,001,0001,0000
d) 110,100,010,000,001,111

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77) What is the average length of the correct answer to Q.76

a) 3 b) 2.1875 c) 2.25 d) 1.9375

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Statement for Linked Answer Questions 78 & 79:

Consider the CFG with $\{S, A, B\}$ as the non-terminal alphabet, $\{a, b\}$ as the terminal alphabet, S as the start symbol and the following set of production rules:

$$S \to aB \qquad S \to bA$$
$$B \to bB \qquad A \to a$$
$$B \to bS \qquad A \to aS$$
$$B \to aBB \qquad A \to bAA$$

78) Which of the following strings is generated by the grammar?

a) aaabb b) aabbbb c) aabbab d) abbbba

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79) For the correct answer to Q.78, how many derivation trees are there?

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

(GATE EE 2025)

Statement for Linked Answer Questions 80 & 81:

Consider a machine having an associated real memory size of 2^{16} bytes. Assume that a direct mapped data cache consisting of 32 lines of 64 bytes each is used in the system. A 50×50 two-dimensional array of bytes is stored in the main memory starting from memory location 1100H. Assume that the data cache is initially empty. The complete array is accessed twice. Assume that the contents of the data cache do not change in between the two accesses.

80) How many data cache misses will occur in total?

a) 48 b) 50 c) 56 d) 59

(GATE EE 2025)

81) Which of the following lines of the data cache will be replaced by new blocks in accessing the array for the second time?

a) line 4 to line 11
b) line 4 to line 12
c) line 0 to line 7
d) line 0 to line 8

(GATE EE 2025)

Statement for Linked Answer Questions 82 & 83:

A process has been allocated 3 page frames. Assume that none of the pages of the process are available in the memory initially. The process makes the following sequence of page references (reference string):

1, 2, 1, 3, 7, 4, 5, 6, 3, 1

82) If optimal page replacement policy is used, how many page faults occur for the above reference string?

a) 7 b) 8 c) 9 d) 10

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83) Least Recently Used (LRU) page replacement policy is a practical approximation to optimal page replacement. For the above reference string, how many more page faults may occur with LRU than with the optimal page replacement policy?

a) 0 b) 1 c) 2 d) 3

(GATE EE 2025)

Statement for Linked Answer Questions 84 & 85:

Suppose that a robot is placed on the Cartesian plane. At each step it is allowed to move either one unit up or one unit right, i.e., if it is at (i, j) then it can move to either $(i + 1, j)$ or $(i, j + 1)$.

84) How many distinct paths are there for the robot to reach the point $(10, 10)$ starting from the initial position $(0, 0)$?

a) $\binom{20}{10}$

b) 2^{20}
c) 2^{10}
d) None of the above

(GATE EE 2025)

85) Suppose that the robot is not allowed to traverse the line segment from $(4, 4)$ to $(5, 4)$. With this constraint, how many distinct paths are there for the robot to reach $(10, 10)$ starting from $(0, 0)$?
a) 2^9
b) 2^8
c) 2^7
d) None of the above

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