

COMPUTER SCIENCE & GATE INFORMATION TECHNOLOGY SOLVED PAPER

2015
SET - 1

Duration: 3 hrs

Maximum Marks: 100

INSTRUCTIONS

1. There are a total of 65 questions carrying 100 marks.
2. This question paper consists of 2 sections, General Aptitude (GA) for 15 marks and the subject specific GATE paper for 85 marks. Both these sections are compulsory.
3. The GA section consists of 10 questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-marks each. The subject specific GATE paper section consists of 55 questions, out of which question numbers 11 to 35 are of 1-mark each, while question numbers 36 to 65 are of 2-marks each.
4. Questions are of Multiple Choice Question (MCQ) or Numerical Answer type. A multiple choice question will have four choices for the answer with only one correct choice. For numerical answer type questions, the answer is a number and no choices will be given.
5. Questions not attempted will result in zero mark. Wrong answers for multiple choice type questions will result in NEGATIVE marks. For all 1 mark questions, $\frac{1}{3}$ mark will be deducted for each wrong answer. For all 2 marks questions, $\frac{2}{3}$ mark will be deducted for each wrong answer.
6. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.

GENERAL APTITUDE

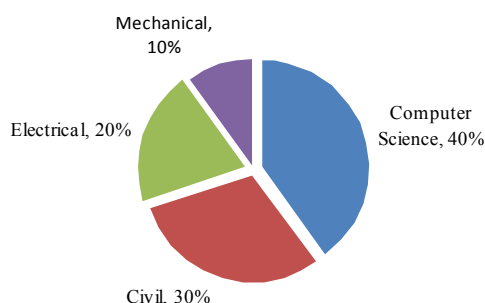
QUESTION 1 TO 5 CARRY ONE MARK EACH

1. Given Set A = {2, 3, 4, 5} and Set {11, 12, 13, 14, 15}, two numbers are randomly selected, one from each set. What is the probability that the sum of the two numbers equals 16?
(a) 0.20 (b) 0.25
(c) 0.30 (d) 0.33
2. Which of the following options is the closest in meaning to the sentence below?
She enjoyed herself immensely at the party.
(a) She had a terrible time at the party
(b) She had a horrible time at the party
(c) She had a terrific time at the party
(d) She had a terrifying time at the party
3. Which one of the following combinations is incorrect?
(a) Acquiescence – Submission
(b) Wheedle – Roundabout
(c) Flippancy – Lightness
(d) Profligate – Extravagant
4. Based on the given statements, select the most appropriate option to solve the given question.
If two floors in a certain building are 9 feet apart, how many steps are there in a set of stairs that extends from the first floor to the second floor of the building?
Statements:
I. Each step is $\frac{3}{4}$ foot high
II. Each step is 1 foot wide.
(a) Statement I alone is sufficient, but statement II alone is not sufficient
(b) Statement II alone is sufficient, but statement I alone is not sufficient
(c) Both statements together are sufficient, but neither statement alone is sufficient
(d) Statement I and II together are not sufficient

5. Didn't you buy _____ when you went shopping?
 (a) any paper (b) much paper
 (c) no paper (d) a few paper

QUESTION 6 TO 10 CARRY TWO MARKS EACH

6. The pie chart below has the breakup of the number of students from different departments in an engineering college for the year 2012. The proportion of male to female students in each department is 5:4. There are 40 males in Electrical Engineering. What is the difference between the numbers of female students in the Civil department and the female students in the Mechanical department?



7. The given statement is followed by some courses of action. Assuming the statement to be true, decide the correct option.
Statement: There has been a significant drop in the water level in the lakes supplying water to the city.

Course of action:

- I. The water supply authority should impose a partial cut in supply to tackle the situation.
 - II. The government should appeal to all the residents through mass media for minimal use of water.
 - III. The government should ban the water supply in lower areas.
- (a) Statements I and II follow
 (b) Statements I and III follow
 (c) Statements II and III follow
 (d) All statements follow
8. Select the alternative meaning of the underlined part of the sentence.
 The chain snatchers took to their heels when the police party arrived.
 (a) took shelter in a thick jungle
 (b) open indiscriminate fire
 (c) took to flight
 (d) unconditionally surrendered
9. The number of students in a class who have answered correctly, wrongly, or not attempted each question in exam, are listed in the table below. The marks for each question are also listed. There is no negative or partial marking.

Q. No	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	14	6
2	3	15	27	2
3	1	11	29	4
4	2	23	18	3
5	5	31	12	1

What is the average of the marks obtained by the class in the examination?

- (a) 2.290 (b) 2.970
 (c) 6.795 (d) 8.795
10. The probabilities that a student passes in Mathematics, Physics and Chemistry are m , p , and c respectively. Of these subjects, the student has 75% chance of passing in at least one, a 50% chance of passing in at least two and a 40% chance of passing in exactly two.
 Following relation are drawn in m , p , c .
 I. $p + m + c = 27/20$
 II. $p + m + c = 13/20$
 III. $(p) \times (m) \times (c) = 1/10$
 (a) only relation I is true
 (b) only relation II is true
 (c) relations II and III are true
 (d) relations I and III are true

TECHNICAL SECTION

QUESTION 11 TO 35 CARRY ONE MARK EACH

11. Suppose that everyone in a group of N people wants to communicate secretly with the $N-1$ others using symmetric key cryptographic system. The communication between any two persons should not be decodable by the others in the group. The number of keys required in the system as a whole to satisfy the confidentiality requirement is
 (a) $2N$ (b) $N(N-1)$
 (c) $N(N-1)/2$ (d) $(N-1)2$
12. Which one of the following fields of an IP header is NOT modified by a typical IP router?
 (a) Checksum
 (b) Source address
 (c) Time To Live (TTL)
 (d) Length
13. Which one of the following is TRUE at any valid state in shift – reduce parsing?
 (a) Viable prefixes appear only at the bottom of the stack and not inside
 (b) Viable prefixes appear only at the top of the stack and not inside
 (c) The stack contains only a set of viable prefixes
 (d) The stack never contains viable prefixes

14. The height of a tree is the length of the longest root-to-leaf path in it. The maximum and minimum number of nodes in a binary tree of height 5 are
 (a) 63 and 6, respectively
 (b) 64 and 5, respectively
 (c) 32 and 6, respectively
 (d) 31 and 5, respectively
15. Match the following:
 P: Prim's algorithm for minimum spanning tree
 Q: Floyd – Warshall algorithm for all pairs shortest paths
 R: Mergesort
 S: Hamiltonian circuit
 (I) Backtracking (II) Greedy method
 (III) Dynamic programming
 (IV) Divide and conquer
 (a) P-III, Q-II, R-IV, S-I
 (b) P-I, Q-II, R-IV, S-III
 (c) P-II, Q-III, R-IV, S-I
 (d) P-II, Q-I, R-III, S-IV
16. Which one of the following is NOT equivalent to $p \leftrightarrow q$?
 (a) $(\neg p \vee q) \wedge (p \wedge \neg q)$ (b) $(\neg p \vee q) \wedge (q \rightarrow p)$
 (c) $(\neg p \wedge q) \vee (p \wedge \neg q)$ (d) $(\neg p \wedge \neg q) \vee (p \wedge q)$
17. SELECT operation in SQL is equivalent to
 (a) the selection operation in relational algebra
 (b) the selection operation in relational algebra, except that SELECT in SQL retains duplicates
 (c) the projection operation in relational algebra
 (d) the projection operation in relational algebra, except that SELECT in SQL retains duplicates
18. For any two languages L_1 and L_2 such that L_1 is context-free and L_2 is recursively enumerable but not recursive, which of the following is/are necessarily true?
 I. $\overline{L_1}$ (complement of L_1) is recursive
 II. $\overline{L_2}$ (complement of L_2) is recursive
 III. $\overline{L_1}$ is context-free
 IV. $\overline{L_1} \cup L_2$ is recursively enumerable
 (A) I only (B) III only
 (C) III and IV only (D) I and IV only
19. For a set A, the power set of A is denoted by 2^A . If $A = \{5, \{6\}, \{7\}\}$, which of the following options are TRUE?
 I. $\phi \in 2^A$ II. $\phi \in 2^A$
 III. $\{5, \{6\}\} \in 2^A$ IV. $\{5\{6\}\} \subseteq 2^A$
 (a) I and III only (b) II and III only
 (c) I, II and III only (d) I, II and IV only
20. Consider a 4-bit Johnson counter with an initial value of 0000. The counting sequence of this counter is
 (a) 0, 1, 3, 7, 15, 14, 12, 8, 0
 (b) 0, 1, 3, 5, 7, 9, 11, 13, 15, 0
 (c) 0, 2, 4, 6, 8, 10, 12, 14, 0
 (d) 0, 8, 12, 14, 15, 7, 3, 1, 0
21. Which of the following statements is/are FALSE?
 I. XML overcomes the limitations in HTML to support a structured way of organizing content.
 II. XML specification is not case sensitive while HTML specification is case sensitive.
 III. XML supports user defined tags while HTML uses pre-defined tags.
 IV. XML tags need not be closed while HTML tags be closed
 (a) II only (b) I only
 (c) II and IV only (d) III and IV only
22. A file is organized so that the ordering of data records is the same as or close to the ordering of data entries in some index. Then that index is called
 (a) Dense (b) Sparse
 (c) Clustered (d) Unclustered
23. Which of the following is/are correct inorder traversal sequence(s) of binary search tree(s)?
 I. 3, 5, 7, 8, 15, 19, 25 II. 5, 8, 9, 12, 10, 15, 25
 III. 2, 7, 10, 8, 14, 16, 20 IV. 4, 6, 7, 9, 18, 20, 25
 (a) I and IV only (b) II and iii only
 (c) II and IV only (d) II only
24. Suppose two hosts use a TCP connection to transfer a large file. Which of the following statements is/are FALSE with respect to the TCP connection?
 I. If the sequence number of a segment is m, then the sequence number of the subsequent segment is always $m + 1$.
 II. If the estimated round trip time at any given point of time is t sec the value of the retransmission timeout is always set to greater than or equal to t sec.
 III. The size of the advertised window never changes during the course of the TCP connection.
 IV. The number of unacknowledged bytes at the sender is always less than or equal to the advertised window.
 (a) III only (b) I and III only
 (c) I and IV only (d) II and IV only
25. For computers based on three-address instruction formats, each address field can be used to specify which of the following.
S1: A memory operand
S2: A processor register
S3: An implied accumulator register
 (a) Either S1 or S2 (b) Either S2 or S3
 (c) Only S2 and S3 (d) All of S1, S2 and S3
26. Consider a system with byte-addressable memory, 32-bit logical addresses, 4 kilobyte page size and page table entries of 4 bytes each. The size of the page table in the system in megabytes is _____.

27. The following two functions P1 and P2 that share a variable B with an initial value of 2 execute concurrently.
- ```

P1 () {
 C = B - 1;
 B = 2 * C;
}
P2 () {
 D = 2 * B;
 B = D - 1;
}

```
28.  $\lim_{x \rightarrow \infty} x^{1/x}$  is
- (a)  $\infty$  (b) 0  
(c) 1 (d) Not defined
29. Which one of the following is the recurrence equation for the worst case time complexity of the Quicksort algorithm for sorting  $n$  ( $\geq 2$ ) numbers? In the recurrence equations given in the options below,  $c$  is a constant.
- (a)  $T(n) = 2T(n/2) + cn$   
(b)  $T(n) = T(n-1) + T(1) + cn$   
(c)  $T(n) = 2T(n-1) + cn$   
(d)  $T(n) = T(n/2) + cn$
30. If  $g(x) = 1 - x$  and  $h(x) = \frac{x}{x-1}$ , then  $\frac{g(h(x))}{h(g(x))}$  is
- (a)  $\frac{h(x)}{g(x)}$  (b)  $\frac{-1}{x}$   
(c)  $\frac{g(x)}{h(x)}$  (d)  $\frac{x}{(1-x)^2}$
31. In one of the pairs of protocols given below, both the protocols can use multiple TCP connections between the same client and the server. Which one is that?
- (a) HTTP, FTP (b) HTTP, TELNET  
(c) FTP, SMTP (d) HTTP, SMTP
32. What are the worst-case complexities of insertion and deletion of a key in a binary search tree?
- (a)  $\theta(\log n)$  for both insertion and deletion  
(b)  $\theta(n)$  for both insertion and deletion  
(c)  $\theta(n)$  for insertion and  $\theta(\log n)$  for deletion  
(d)  $\theta(\log n)$  for insertion and  $\theta(n)$  for deletion
33. The output of the following C program is \_\_\_\_.
- ```

void f1(int a, int b)
{
    int c;
    c=a; a=b; b=c;
}
void f2(int *a, int *b)
{
    int c;
    c=*a; *a=*b; *b=c;
}
int main ()
{
    int a=4, b=5, c=6;
    f1(a, b);
    f2(&b, &c);
    printf("%d", c-a-b);
}

```
34. Match the following:
- P: Condition coverage
Q: Equivalence class partitioning
R: Volume testing
S: Alpha testing
- (I) Black-box testing (II) System testing
(III) White-box testing (IV) Performance testing
- (a) P-II, Q-III, R-I, S-IV
(b) P-III, Q-IV, R-II, S-I
(c) P-III, Q-I, R-IV, S-II
(d) P-III, Q-I, R-II, S-IV
35. In the LU decomposition of the matrix $\begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix}$, if the diagonal elements of U are both 1, then the lower diagonal entry ℓ_{22} of L is ____.
- QUESTION 36 TO 65 CARRY TWO MARKS EACH**
36. The graph shown below has 8 edges with distinct integer edge weights. The Minimum Spanning Tree (MST) is of weight 36 and contains the edges: $\{(A, C), (B, C), (B, E), (E, F), (D, F)\}$. The edge weights of only those edges which are in the MST are given in the figure shown below. The minimum possible sum of weights of all 8 edges of this graph is ____.
-
37. Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 Rotations Per Minute (RPM). It has 60 sectors per track and each sector can store 512 bytes of data. Consider a file stored in the disk. The file contains 2000 sectors. Assume that every sector access necessitates a seek, and the average rotational latency for accessing each sector is half of the time for one complete rotation. The total time (in milliseconds) needed to read the entire file is ____.
38. Consider the following pseudo code, where x and y are positive integers.
- ```

begin
q := 0
r := x

```

```

while $r \geq y$ do
 being
 $r := r - y$
 $q := q + 1$
 end
end

```

end

The post condition that needs to be satisfied after the program terminates is

- (a)  $\{r = qx + y \wedge r < y\}$
- (b)  $\{x = qy + r \wedge r < y\}$
- (c)  $\{y = qx + r \wedge 0 < r < y\}$
- (d)  $\{q + 1 < r - y \wedge y > 0\}$

39. Consider the following relations:  
Students

| Roll No. | Student Name |
|----------|--------------|
| 1        | Raj          |
| 2        | Rohit        |
| 3        | Raj          |

Performance

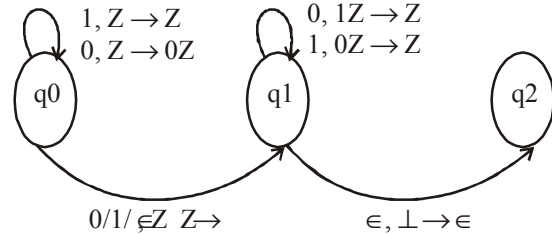
| Roll No | Course  | Marks |
|---------|---------|-------|
| 1       | Math    | 80    |
| 1       | English | 70    |
| 2       | Math    | 75    |
| 3       | English | 80    |
| 2       | Physics | 65    |
| 3       | Math    | 80    |

Consider the following SQL query. SELECT S. Student\_Name, sum (P.Marks)  
FROM Student S, Performance P  
WHERE S.Roll\_No. = P.Roll\_No.  
GROUP BY S.Student\_Name

The number of rows that will be returned by the SQL query is \_\_\_\_\_.

40. Consider a uniprocessor system executing three tasks  $T_1$ ,  $T_2$  and  $T_3$ , each of which is composed of an infinite sequence of jobs (or instances) which arrive periodically at intervals of 3, 7 and 20 milliseconds, respectively. The priority of each task is the inverse of its period, and the available tasks are scheduled in order of priority, with the highest priority task scheduled first. Each instance of  $T_1$ ,  $T_2$  and  $T_3$  requires an execution time of 1, 2 and 4 milliseconds, respectively. Given that all tasks initially arrive at the beginning of the 1<sup>st</sup> millisecond and task preemptions are allowed, the first instance of  $T_3$  completes its execution at the end of \_\_\_\_\_ milliseconds.

41. Consider the NPDA  $\langle Q = \{q_0, q_1, q_2\}, \Sigma = \{0, 1\}, \Gamma = \{0, 1, \perp\}, \delta, q_0, \perp, F = \{q_2\} \rangle$ , where (as per usual convention)  $Q$  is the set of states,  $\Sigma$  is the input alphabet,  $\delta$  is the state transition function,  $q_0$  is the initial state,  $\perp$  is the initial stack symbol, and  $F$  is the set of accepting states. The state transition is as follows:



Which one of the following sequences must follow the string 101100 so that the overall string is accepted by the automation?

- (a) 10110
  - (b) 10010
  - (c) 01010
  - (d) 01001
42. What is the output of the following C code? Assume that the address of  $x$  is 2000 (in decimal) and an integer requires four bytes of memory?
- ```

int main()
{
  unsigned int x[4][3] = {{1,2,3}, {4,5,6}, {7, 8, 9}, {10, 11, 12}};
  printf("%u, %u, %u", x+3, *(x+3), *(x+2)+3);
}

```
- (a) 2036, 2036, 2036
 - (b) 2012, 4, 2204
 - (c) 2036, 10, 10
 - (d) 2012, 4, 6
43. The binary operator \neq is defined by the following truth table.

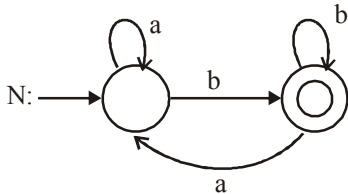
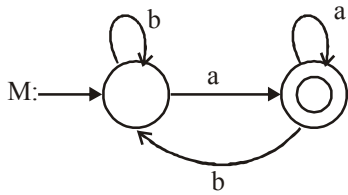
p	q	$p \neq q$
0	0	0
0	1	1
1	0	1
1	1	0

Which one of the following is true about the binary operator \neq ?

- (a) Both commutative and associative
- (b) Commutative but not associative
- (c) Not commutative but associative
- (d) Neither commutative nor associative

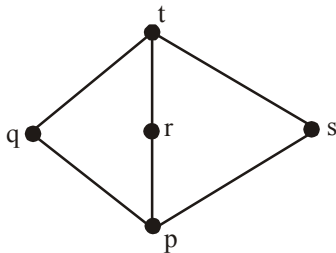
44. The least number of temporary variables required to create three-address code in static single assignment form for the expression $q+r/3+s-t*5+u*v/w$ is _____.

45.



Consider the DFAs M and N given above. The number of states in a minimal DFA that accepts the languages $L(M) \cap L(N)$ is _____.

46. Consider a main memory with five page frames and the following sequence of page references: 3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3. Which one of the following is true with respect to page replacement policies First In First Out (FIFO) and Least Recently Used (LRU)?
- Both incur the same number of page faults
 - FIFO incurs 2 more page faults than LRU
 - LRU incurs 2 more page faults than FIFO
 - FIFO incurs 1 more page faults than LRU
47. Suppose $L = \{p, q, r, s, t\}$ is a lattice represented by the following Hasse diagram:



For any $x, y \in L$, not necessarily distinct, $x \vee y$ and $x \wedge y$ are join and meet of x, y respectively. Let $L^3 = \{(x, y, z) : x, y, z \in L\}$ be the set of all ordered triplets of the elements of L . Let p_r be the probability that an element $(x, y, z) \in L^3$ chosen equiprobably satisfies $x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$. Then

- $p_r = 0$
- $p_r = 1$
- $0 < p_r \leq \frac{1}{5}$
- $\frac{1}{5} < p_r < 1$

48. Let $G = (V, E)$ be a simple undirected graph, and s be a particular vertex in it called the source. For $x \in V$, let $d(x)$ denote the shortest distance in G from s to x . A Breadth First Search (BFS) is performed starting at s . Let T be resultant BFS tree. If (u, v) is an edge of G that is not in T , then which one of the following CANNOT be the value of $d(u) - d(v)$?

- 1
- 0
- 1
- 2

49. Let G be a connected planar graph with 10 vertices. If the number of edges on each face is three, then the number of edges in G is _____.

50. Consider the operations

$$f(X, Y, Z) = X'YZ + XY' + Y'Z'$$

$$g(X, Y, Z) = X'YZ + X'YZ' + XY$$

Which one of the following is correct?

- Both $\{f\}$ and $\{g\}$ are functionally complete
- Only $\{f\}$ is functionally complete
- Only $\{g\}$ is functionally complete
- Neither $\{f\}$ nor $\{g\}$ is functionally complete

51. Consider the following 2×2 matrix A where two elements are unknown and are marked by a and b . The eigenvalues of this matrix are -1 and 7 . What are the values of a and b ?

$$A = \begin{pmatrix} 1 & 4 \\ b & a \end{pmatrix}$$

- $a = 6, b = 4$
- $a = 4, b = 6$
- $a = 3, b = 5$
- $a = 5, b = 3$

52. $\int_{\pi}^{2/\pi} \frac{\cos(1/x)}{x^2} dx$ _____.

53. Suppose that the stop-and-wait protocol is used on a link with a bit rate of 64 kilobits per second and 20 milliseconds propagation delay. Assume that the transmission time for the acknowledgement and the processing time at nodes are negligible. Then the minimum frame size in bytes to achieve a link utilization of at least 50% is _____.

54. A positive edge-triggered D flip-flop is connected to a positive edge-triggered JK flip-flop as follows. The Q output of the D flip-flop is connected to both the J and K inputs of the JK flip-flop, while the Q output of the JK flip-flop is connected to the input of the D flip-flop. Initially, the output of the D flip-flop is set to logic one and the output of the JK flip-flop is cleared. Which one of the following is the bit sequence (including the initial state) generated at the Q output of the JK flip-flop when the flip-flops are connected to a free running common clock? Assume that $J = K = 1$ is the toggle mode and $J = K = 0$ is the state-holding mode of the JK flip-flop. Both the flip-flops have non-zero propagation delays.

- 0110110.....
- 0100100....
- 011101110....
- 011001100...

55. Consider the following C function.

```
int fun1 (int n)
{
    int i, j, k, p, q = 0;
    for (i = 1; i < n; ++i)
    {
        p = 0;
        for(j = n; j > 1; j = j/2)
            ++p;
        for(k = 1; k < p; k = k*2)
            ++q;
    }
    return q;
}
```

Which one of the following most closely approximates the return value of the function fun1?

- (A) n^3 (B) $n(\log n)^2$
(C) $n \log n$ (D) $n \log(\log n)$

56. Consider a non-pipelined processor with a clock rate of 2.5 gigahertz and average cycles per instruction of four. The same processor is upgraded to a pipelined processor with five stages; but due to the internal pipelined delay, the clock speed is reduced to 2 gigahertz. Assume that there are no stalls in the pipeline. The speed up achieved in this pipelined processor is _____.

57. Consider an Entity-Relationship(ER) model in which entity sets E_1 and E_2 are connected by an $m:n$ relationship R_{12} . E_1 and E_3 are connected by a $1:n$ (1 on the side of E_1 and n on the side of E_3) relationship R_{13} .

E_1 has two single-valued attributes a_{11} and a_{12} of which a_{11} is the key attribute. E_2 has two single-valued attributes a_{21} and a_{22} of which a_{21} is the key attribute. E_3 has two single-valued attributes a_{31} and a_{32} of which a_{31} is the key attribute. The relationships do not have any attributes.

If a relational model is derived from the above ER model, then the minimum number of relations that would be generated if all the relations are in 3NF is _____.

58. $\sum_{x=1}^{99} \frac{1}{x(x+1)}$ _____.

59. Let a_n represent the number of bit strings of length n containing two consecutive 1s. What is the recurrence relation for a_n ?

- (A) $a_{n-2} + a_{n-1} + 2^{n-2}$
(B) $a_{n-2} + 2a_{n-1} + 2^{n-2}$
(C) $2a_{n-2} + a_{n-1} + 2^{n-2}$
(D) $2a_{n-2} + 2a_{n-1} + 2^{n-2}$

60. Consider the following C program segment.

```
while (first <= last)
{
    if (array[middle] < search)
        first = middle + 1;
    else if (array[middle] == search)
        found = TRUE;
    else last = middle - 1;
    middle = (first + last)/2;
}
if (first > last) notPresent = TRUE;
```

The cyclomatic complexity of the program segment is _____.

61. Consider a max heap, represented by the array: 40, 30, 20, 10, 15, 16, 17, 8, 4.

Array Index	1	2	3	4	5	6	7	8	9
Value	40	30	20	10	15	16	17	8	4

Now consider that a value 35 is inserted into this heap. After insertion, the new heap is

- (a) 40, 30, 20, 10, 15, 16, 17, 8, 4, 35
(b) 40, 35, 20, 10, 30, 16, 17, 8, 4, 15
(c) 40, 30, 20, 10, 35, 16, 17, 8, 4, 15
(d) 40, 35, 20, 10, 15, 16, 17, 8, 4, 30
62. Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on track 50. The additional distance that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm is used compared to the SCAN (Elevator) algorithm (assuming that SCAN algorithm moves towards 100 when it starts execution) is _____ tracks.
63. Consider a LAN with four nodes S_1, S_2, S_3 and S_4 . Time is divided into fixed-size slots, and a node can begin its transmission only at the beginning of a slot. A collision is said to have occurred if more than one node transmit in the same slot. The probability of generation of a frame in a time slot by S_1, S_2, S_3 and S_4 are 0.1, 0.2, 0.3 and 0.4, respectively. The probability of sending a frame in the first slot without any collision by any of these four stations is _____.

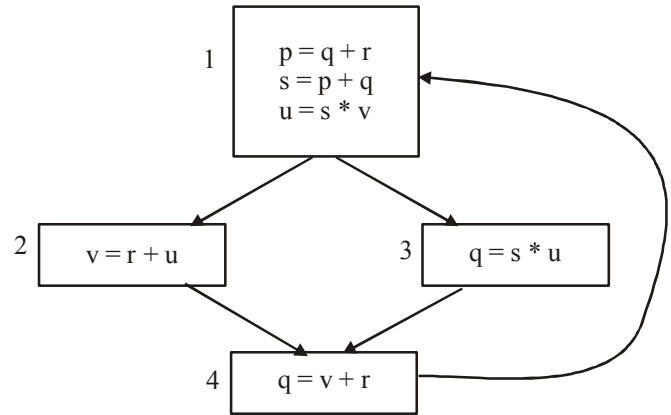
64. An algorithm performs $(\log N)^{1/2}$ find operations, N insert operations, $(\log N)^{1/2}$ delete operations, and $(\log N)^{1/2}$ decrease-key operations on a set of data items with keys drawn from a linearly ordered set. For a delete operation, a pointer is provided to the record that must be deleted. For the

decrease-key operation, a pointer is provided to the record that has its key decreased. Which one of the following data structures is the most suited for the algorithm to use, if the goal is to achieve the best asymptotic complexity considering all the operations?

- (a) Unsorted array
- (b) Min-heap
- (c) Sorted array
- (d) Sorted doubly linked list

65. A variable x is said to be live at a statement S_i in a program if the following three conditions hold simultaneously:

- I. There exists a statement S_j that uses x
- II. There is a path from S_i to S_j in the flow graph corresponding to the program
- III. The path has no intervening assignment to x including at S_i and S_j



The variables which are live at the statement in basic block 2 and at the statement in basic block 3 of the above control flow graph are

- (A) p, s, u
- (B) r, s, u
- (C) r, u
- (D) q, v

HINTS & SOLUTIONS

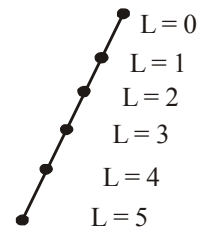
GENERAL APTITUDE

1. (a) Number of possible combinations of two number one from each set = $4_{C_1} \times 5_{C_1} = 20$
Combinations having sum 16 are (2, 14), (3, 13), (4, 12) and (5, 11)
Required Probability = $\frac{4}{20} = 0.20$
2. (c)
3. (b) As a verb wheedle is to cajole or attempt to persuade by flattery. As a adjective roundabout is indirect circuitous or circumlocutionary; that doesnot do some they in a direct way.
4. (a) I. Each step is $\frac{3}{4}$ foot high.
No. of steps = $\frac{9 \times 4}{3} = 12$
Statement I alone is sufficient to answer.
5. (a)
6. 32 Let total number of students be x
Then, $\frac{5}{9} \times 20\% \text{ of } x = 40$
$$\frac{5}{9} \times \frac{20x}{100} = 40$$
$$x = 360$$

No. of females in civil department = $\frac{4}{9} \times 30\% \text{ of } x$
No. of females in Mechanical department = $\frac{4}{9} \times 10\% \text{ of } x$
Difference = $\frac{4}{9} \left[\frac{3x}{10} - \frac{x}{10} \right] = \frac{4}{9} \times \frac{x}{5}$
$$= \frac{4}{9} \times \frac{360}{5} = 32$$
7. (a)
8. (c)
9. (b)
$$\frac{21 \times 2 + 15 \times 3 + 11 \times 11 \times 1 + 23 \times 2 + 31 \times 5}{21 \quad 15 \quad 11 \quad 23 \quad 31} = 2.970$$
10. (a) $P(\text{atleast two}) - P(\text{exactly 2})$
 $= 0.5 - 0.4 = 0.1$
 $0.75 = p + m + c + 0.1 - (0.5 + 0.11 \times 2)$
 $\therefore p + m + c = 0.65 + 0.7 = 1.35 = \frac{27}{20}$

TECHNICAL SECTION

11. (c) In Symmetric Key Cryptography, if 'N' number of users is keen to partake, then $N(N-1)/2$ number of keys is required to satisfy the confidentiality requirements of any users.
12. (b) Option (a), (Checksum) needs to be reorganized by each visited Router since Time to Live value is customized. Option (b), (Source Address) can't be customized by an IP router. Only NAT (Network Address Translation) can transform it.
Option (c), (TTL) is decremented by each visited router. When it arrives at to zero, then packet will be rejected. Option (d), (Length) also customized whenever there is a need of performing the destruction process.
13. (b) Viable prefixes appear only at the top of the stack and not inside is valid in shift reduce parsing, because we will write the shift reduce parsing program for every variable such that if any variable contain more than one possibility, it will choose the correct production.
14. (a) We know that the maximum no. of nodes in a binary tree with (height) $h = 2^{h+1} - 1$.
Here $h = 5$, then, we easily calculate the h as:
 $h = 2^5 + 1 - 1 = 64 - 1 = 63$
And the minimum no. of nodes with height h is $h + 1$.
 $\therefore h = 5$



15. (c) Prim's Algorithm always select minimum distance between two of its positions which is not anything but greedy method. Floyd-Warshall always varies its distance at each iteration, which is nothing but dynamic programming. In Merge Sort first, we always divided the data and merge to it with complete sorting. Hence divide and conquer.
16. (c) We can present $p \leftrightarrow q$ as:
$$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$$
$$\equiv (7p \vee q) \wedge (7q \vee p) (\because p \rightarrow q = 7p \vee q)$$
$$\equiv (7p \wedge q) \vee (q \wedge 7q) \vee (7p \wedge p) \vee (q \wedge p)$$
$$\text{(using distributive laws)}$$
$$\equiv (7p \wedge 7q) \vee (q \wedge p) \text{ (using complement laws and commutative laws)}$$
$$\therefore p \leftrightarrow q \text{ is NOT equivalent to } (7p \wedge q) \vee (q \wedge 7q)$$

17. (d) SELECT operation in SQL perform vertical partitioning which is made by projection operation in relational calculus, but SQL is multi-sets. Hence the projection operation in relational algebra, except that SELECT in SQL retains duplicates answer is correct.
18. (d) $I \Rightarrow \overline{L_1}$ is recursive
This one is true, because L_1 is context free which is nonentity but recursive, recursive language is closed under complement. Hence it is true.
 $II \Rightarrow \overline{L_2}$ (complement of L_2) is recursive
If L_2 and L_2 both are recursive enumerable then L_2 is recursive
Hence, statement II is false
 $III \Rightarrow \overline{L_1}$ is context free
Which is false because context free language does not closed under complement.
 $IV \Rightarrow \overline{L_1} \cup L_2$ is recursive enumerable.
 $\overline{L_1}$ recursive, because every recursive language is also recursive enumerable.
 $\overline{L_2}$ recursive enumerable.
 $\overline{L_1} \cup L_2 \Rightarrow$ recursive enumerable, because recursive enumerable language closed under union.
19. (c) $2^A \rightarrow$ Power set of A i.e., set of all subsets of A. Since empty set is a subset of every set
 $\therefore \phi \subseteq 2^A$ and $\phi \in 2^A$
Since $5, \langle 6 \rangle \subseteq$ and $5 \notin 2A$
 $\therefore 5, \langle 6 \rangle \in 2^A$ and $5, \langle 6 \rangle \subseteq 2^A$
 \therefore I, II and III are TRUE
20. (d) 0000 – 0
1000 – 8
1100 – 12
and so on.
21. (c) I. XML overcomes the limitations in HTML to support a structured way of organizing content. There for, it is true.
II. HTML is case insensitive while XML is case sensitive Hence it is false.
III. XML supports user defined tags while HTML uses predefined tags. Hence it is true.
IV XML tags must be closed Hence it is false.
22. (a) According to the given question, we can say that each data record in the data file has one entry in the index file. So it must be dense index.
23. (a) In-order traversal of binary search tree gives ascending orders and in BST, at every node root element is greater than and equal to all element present in left sub-tree and less than or equal to all the elements in right sub-tree.
24. (b) **I: FALSE**
The sequence number of the subsequent segment depends on the number of 8-byte characters in the current segment.
II: TRUE
Depending on the value of α or expected RTT it may or may not be greater than 1.
III: FALSE
It is the size of the receiver's buffer that's never changed. Receive Window is the part of the receiver's buffer that's changing all the time depending on the processing ability at the receiver's side and the network traffic.
IV: TRUE
The number of unappreciated bytes that A sends cannot exceed the size of the receiver's window. But if it can't exceed the receiver's window, then it definitely has no way to exceed the receiver's buffer as the window size is always less than or equal to the buffer size. On the other hand, for urgent messages, the sender CAN send it in even although the receiver's buffer is full.
25. (a) Given that Logical Address (LA) = 32 bits
Logical Address Size (LAS) = $2^{32} = 448$
Page size = 4 kB
 \therefore number of pages $\frac{LAS}{P.S} = \frac{44B}{4KB} = 2^{20}$
Size of the page table entry = 4 bytes
 \therefore Page table size = $2^{20} \times 4 = 4 MB$
26. If we execute P2 process after P1 process, then we get B=3
If we execute P1 process after P2 process, then we get B=4
If we did preemption between P1 and P2 processes, then we get B = 2 (Preemption have done from P1 to P2) or B = 3 (Preemption have done from P2 to P1). So, among 2 and 3 values, only one value will be saved in B. So, total no. of different values that B can possibly take after the execution is 3.
27. (c)
28. (c) Let $y = \lim_{x \rightarrow \infty} x^{\frac{1}{x}}$
 $\ln y = \lim_{x \rightarrow \infty} \frac{\ln x}{x}$ (Taking Logorihms)
 $\ln y = \lim_{x \rightarrow \infty} \frac{\frac{1}{x}}{1} \left(\frac{\infty}{\infty} \text{ form and using L-Hospital rule} \right)$
 $\ln y = 0$
Hence, $y = 1$
29. (b) When the pivot is the smallest or largest element at partitioning on a block of size n the result capitulates one empty sub-block, one element (pivot) in the correct place and sub block of size $n-1$
Hence recurrence relation
 $T(n) = T(n-1) + T(1) + cn$

30. (a) $g(x) = 1 - x$... (1)

$$h(x) = \frac{x}{x-1} \quad \dots (2)$$

Replace x by $h(x)$ in ... (1)

Replace x by $g(x)$ in ... (2)

$$g(h(x)) = 1 - h(x)$$

$$= 1 - \frac{x}{x-1} = \frac{-1}{x-1}$$

$$h(g(x)) = \frac{\frac{-1}{x-1}}{\frac{-1}{x-1} - 1} = \frac{-1}{-1 - (x-1)} = \frac{-1}{-x} = \frac{1}{x}$$

$$\frac{g(h(x))}{h(g(x))} = \frac{\frac{-1}{x-1}}{\frac{1}{x}} = \frac{-x}{x-1} = \frac{1-x}{1-x} = 1$$

$$\frac{g(h(x))}{h(g(x))} = \frac{\frac{x}{x-1}}{1-x} = \frac{x}{(x-1)(1-x)} = \frac{x}{-(x-1)^2}$$

$$\frac{g(h(x))}{h(g(x))} = \frac{h(x)}{g(x)} = \frac{\frac{x}{x-1}}{\frac{-1}{x-1}} = -x$$

31. (d) HTTP (Hyper Text Transfer Protocol) and SMTP (Simple Message Transfer Protocol) protocols can use several TCP associations between the same client and the server.

32. (b) If we judge a single string of binary search tree, then we have to sketch all the nodes for insertion or deletion in worst case hence $\theta(n)$ for both.

33. -5 In function "main()" $f1$ is called by value, so local variables a, b, c of $f1$ are customized but not the local variables a, b, c of main function.

$f2$ is called by reference.

```
int main() {
```

```
int a = 4, b = 5, c = 6
```

```
f1(a, b)
```

```
f2(&b, &c)
```

```
printf("%d", c-a-b);
```

```
}
```

```
f2(int *a, int *b)
```

```
{
```

```
int c;
```

```
c = *a; c = 5
```

```
*a = b; [will change 'b' value of main to c value of main]
```

```
*b = c; [will change 'c' value of main to c value of f2]
```

```
}
```

34. (d) Condition coverage is also known as predicate coverage in which each of the Boolean expression estimated to both true and false. Which is nothing but white-box testing, which tests internal structures of a function? Hence P matches with III.

Equivalence class partitioning is a software testing method that divides the input data of a software unit into partitions of corresponding data from which test cases can be derived, which is nothing but black box testing.

Hence

Q Matches with I.

Volume testing submits to testing a software application with certain amount of data which is nothing but system testing.

Hence

R matches with II.

Alpha testing is replicated or actual operation testing by potential client/stakeholders, which is nothing but performance testing.

Hence

R matches with IV

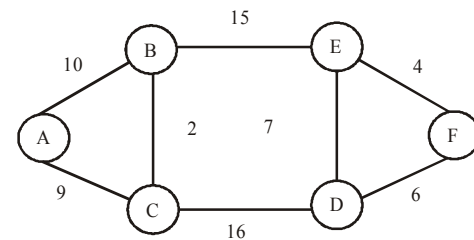
35. 5 $A = LU \Rightarrow \begin{bmatrix} 2 & 2 \\ 4 & 9 \end{bmatrix} = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$

$$\begin{bmatrix} l_{11} & l_{11}u_{12} \\ l_{21} & l_{21}u_{12} + l_{22} \end{bmatrix}$$

$$\therefore l_{11} = 2; l_{11}u_{12} = 2 \Rightarrow u_{12} = 1$$

$$l_{21} = 4; l_{21}u_{12} + l_{22} = 9 \Rightarrow l_{22} = 5$$

36. 69



$$\text{Total sum} = 10 + 9 + 2 + 15 + 7 + 16 + 4 + 6 = 69$$

37. 14020

Given that

Seek time = 4ms

60s \rightarrow 10000 rotations

60s \rightarrow 10000 rotations

$$\frac{60}{10000} \text{ 6ms } 1 \text{ rotation time}$$

$$\therefore \text{Rotational Latency} = \frac{1}{2} \times 6\text{ms} = 3\text{ms}$$

1 track \rightarrow 600 sectors

6ms 600 sectors (1 rotation means 600 sectors or 1 track)

$$1 \text{ sector} \rightarrow \frac{6\text{ms}}{600} = 0.01\text{ms}$$

$$2000 \text{ sector} \rightarrow 2000(0.01) = 20\text{ms}$$

\therefore Total time

$$\begin{aligned} \text{needed to read the entire tile is} &= 2000(4 + 3) + 20 \\ &= 8000 + 6000 + 20 \\ &= 14020\text{ms} \end{aligned}$$

38. (b) The loop terminator when $r < y$. so, $r < y$ is one post condition.
In each iteration q is incremented by 1 and y is subtracted from r . Initial value of r is x .

So, loop iterates $\frac{x}{y}$ times and q will be equal to $\frac{x}{y}$

and $r = x \% y \Rightarrow x = qy + r$

So, (b) is correct answer.

39. (2) Output table is

Raj	310
Rohit	140

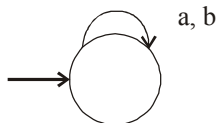
40. 13
- | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| T_1 | T_2 | T_1 | T_3 | T_1 | T_2 | T_1 | T_3 | T_1 | ... |
| 1 | 2 | 4 | 5 | 7 | 8 | 10 | 11 | (13) | 14 |

41. (d) 42. (c)

43. (a) It is clear that from the truth table, the binary operation $\#$ is equivalent to XOR i.e., \oplus , which satisfies both commutative and associative i.e., $p \# q \equiv q \# p$ and $p \# (q \# r) \equiv (p \# q) \# r$

44. 3

45. 1 M accepts the strings which end with a and N accepts the strings which end with b. Their intersection should accept empty language.



46. (a)

47. (d) Number of elements in $L^3 =$ Number of ways in which we can choose 3 elements from 5 with repetition $= 5 \times 5 \times 5 = 125$. Now, when we take $x = t$, then also the given condition is satisfied for any y and z . Here, y and z can be taken in $5 \times 5 = 25$ ways.
Take $x = r, y = p, z = p$, these, also the given condition

is satisfied. So, $p_r = \frac{25}{125} = \frac{1}{5}$.

For $x = p, y = r, z = t$, the given condition is not satisfied.

So, $p_r \neq 1$.

So, (d) correct option.

48. (d)

49. 24 By Euler's formula,
 $|V| + |R| = |E| + 2$ (1) where $|V|, |E|, |R|$ are respectively number of vertices, edges and faces (regions)
Given $|V| = 10$ (2) and number of edges on each face is three

$$\therefore 3|R| = 2|E| \Rightarrow |R| = \frac{2}{3}|E| \text{ (3)}$$

Subtracting (2), (3) in (1), we get

$$10 - \frac{2}{3}|E| + |E| = 2 \Rightarrow \frac{|E|}{3} = 8 \Rightarrow |E| = 24$$

50. (b)

51. (d) Given that $\lambda_1 = -1$ and $\lambda_2 = 7$ are eigen values of A
By the properties, $\lambda_1 + \lambda_2 = \text{tr } A$, traces of A i.e., sum of the diagonal elements and $\lambda_1 \cdot \lambda_2 = \text{determinant of A}$.

$$\Rightarrow 1 + a = 6$$

$$a = 5$$

And \downarrow

$$a - 4b = -7$$

$$5 - 4b = -7$$

$$-4b = -7 - 5$$

$$-4b = -12 \Rightarrow b = 3$$

52. (-1) $\int_{\frac{1}{\pi}}^{\frac{2}{\pi}} \frac{\cos\left(\frac{1}{x}\right)}{x^2} dx$

$$\text{Put } \frac{1}{x} = t$$

$$\Rightarrow \frac{-1}{x^2} dx = dt$$

And

$$x = \frac{2}{\pi} \Rightarrow t = \frac{\pi}{2}$$

$$x = \frac{1}{\pi} \Rightarrow t = \pi$$

$$\left(\because \int_a^b f(x) dx = - \int_b^a f(x) dx \right)$$

$$\int_{\frac{\pi}{2}}^{\pi} \cos t dt$$

$$\sin t \Big|_{\frac{\pi}{2}}^{\pi} = \sin \pi - \sin \left(\frac{\pi}{2} \right) = -1$$

53. 320 Given that $B = 64$ kbps

$$T_p = 20 \text{ ms}$$

$$\eta \geq 50\%$$

$$\text{For } \eta \geq 50\% \Rightarrow L \geq BR$$

$$\Rightarrow L = 64 \times 10^3 \times 2 \times 20 \times 10^{-3}$$

$$= 2560 \text{ bits} = 320 \text{ bytes}$$

54. (a)

$Q_{\text{prev.}}$	O	Q
—	1	0
0	0	1
1	1	1
1	1	0
0	0	1
1	1	1

D flipflop outputs its input and Jk flipflop output toggles its output when 1 is given to both J and K inputs.

$$Q = D_{\text{prev}} (Q_{\text{prev}}) + (D_{\text{prev}}) (Q_{\text{prev}}).$$

55. (c)

```
int fun1(int n){
    int i, j, k, p, q = 0;
    for (i = 1; i < n; ++p) → n times
    {
        p = 0
        For(j = n; j > 1; j = j/2)
            ++p;
        log(log n) times
        for (k = 1; k < p; k = k * 2)
            ++q;
    }
    return q;
}
```

56. 3.2 $\therefore \text{nlog}(\text{logn})$
Speed up = old execution time / new execution time.

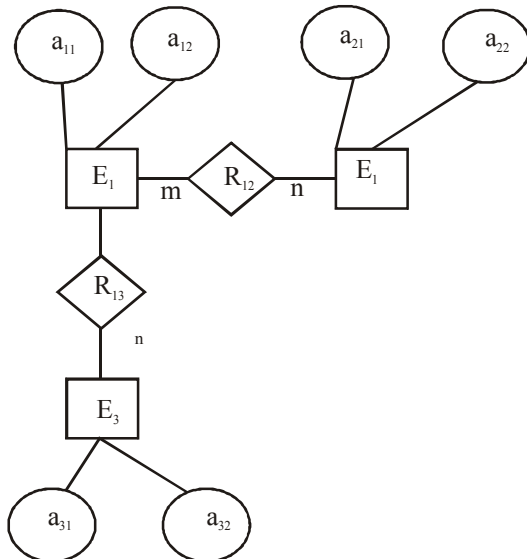
$$\frac{\text{CPI}_{\text{old}}}{\text{CF}_{\text{old}}} \div \frac{\text{CPI}_{\text{new}}}{\text{CF}_{\text{new}}}$$

(where CF is clock frequency and CPI is cycles per instruction. So, CPI/CF gives time per instruction)

$$\frac{4}{\frac{2.5}{\frac{1}{2}}} = 3.2$$

Without pipelining an instruction was taking 4 cycles. After pipelining to 5 stages we need to see the maximum clock cycle a stage can take and this will be the CPI assuming no stalls.

57. 5



$E_1(a_{11}, a_{12}), E_2(a_{21}, a_{22}), E_3$ and $R_{13}(a_{11}, a_{31}, a_{32}), R_2(a_{11}, a_{12})$.

But in table (a_{11}, a_{31}, a_{32}) there may be transitive dependency between a_{11} and a_{32} so we should decompose this table into 2 more tables.

58. $0.99 \sum_{x=1}^{99} \frac{1}{x \cdot x - 1}$

$$\sum_{x=1}^{99} \frac{1}{x \cdot x - 1} = \frac{1}{1 \cdot 2} + \frac{1}{2 \cdot 3} + \frac{1}{3 \cdot 4} + \dots + \frac{1}{99 \cdot 100}$$

$$\frac{2-1}{1 \cdot 2} + \frac{3-2}{2 \cdot 3} + \frac{4-3}{3 \cdot 4} + \dots + \frac{100-99}{99 \cdot 100}$$

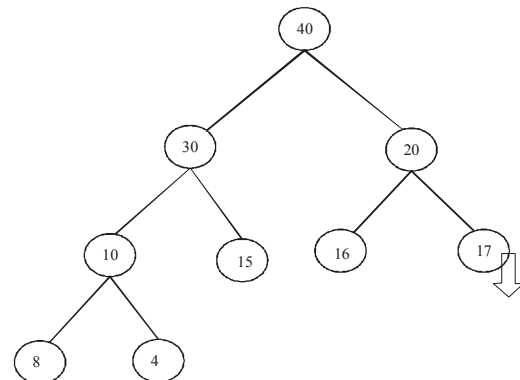
$$= \frac{1}{1} - \frac{1}{2} + \frac{1}{2} - \frac{1}{3} + \frac{1}{3} - \dots + \frac{1}{98} - \frac{1}{99} + \frac{1}{99} - \frac{1}{100}$$

$$= 1 - \frac{1}{100} = \frac{99}{100} = 0.99$$

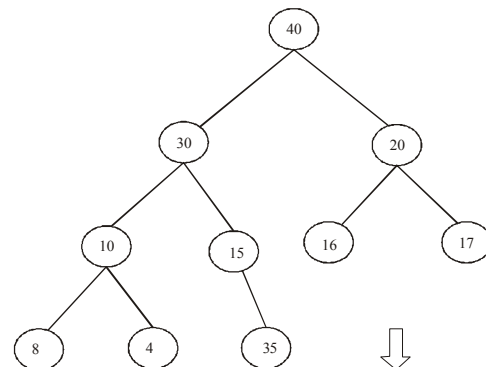
59. (a)

60. 5

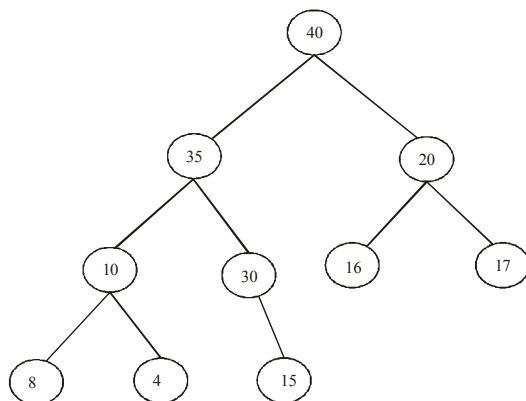
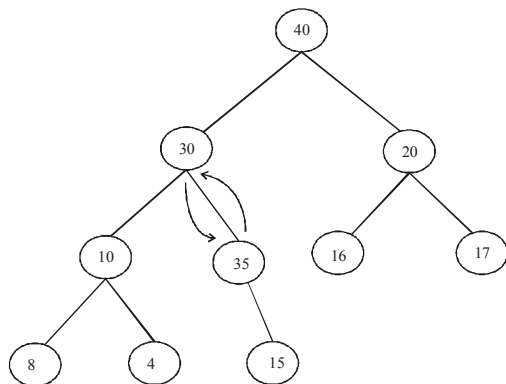
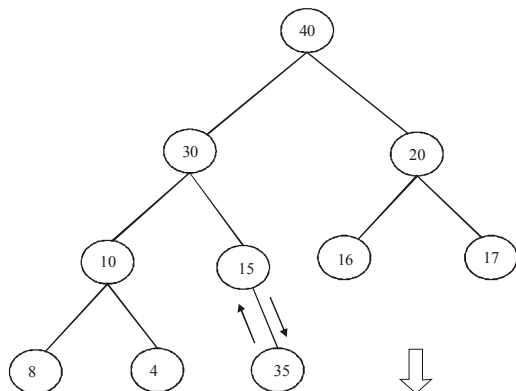
61. (b)



Insert 35 \Rightarrow according to CBT



Heapification



62. 10

63. 0.4404

$$\begin{aligned}
 P &= P(S_1) P(\sim S_2) P(\sim S_3) P(\sim S_4) + \\
 &P(\sim S_1) P(S_2) P(\sim S_3) P(\sim S_4) + \\
 &P(\sim S_1) P(\sim S_2) P(S_3) P(\sim S_4) + \\
 &P(\sim S_1) P(\sim S_2) P(\sim S_3) P(S_4) \\
 &= 0.1 \times 0.8 \times 0.7 \times 0.6 \\
 &+ 0.9 \times 0.2 \times 0.7 \times 0.6 \\
 &+ 0.9 \times 0.8 \times 0.3 \times 0.6 \\
 &+ 0.9 \times 0.8 \times 0.7 \times 0.4 \\
 &= 0.4404.
 \end{aligned}$$

64. (a) If we use unsorted array
 $(\log N)^{1/2}$ find operations will take $\log N^{1/2}$.
 $\theta(N(\log N)^{1/2})$ time
 N insertions will take $N \times \theta(1) = \theta(N)$ time
 $(\log N)^{1/2}$ delete operations will take $(\log N)^{1/2} \theta(1) = \theta(\log N)^{1/2}$ time as pointer to the record which should be deleted is provided
 $(\log N)^{1/2}$ decrease key operations will take $\theta(\log N)^{1/2}$ time
 \therefore On the whole, time complete to perform all these operations is $\theta(N(\log N)^{1/2})$
 If we use sorted array insertions will take more time [$O(N \log N)$ as it should be sorted after insertions]. If we use min heap, again insertions will take more time [$O(N \log N)$ as it should be heapified].

65. (c)