GATE 2004
IT : Information Technology

Enter your Roll Number Here: ☐☐☐☐☐☐☐☐☐☐ Enter your Test ID here: ☐☐☐
Duration: 3 Hours Maximum Marks:150

Read the following instructions carefully:

1. This question paper contains 90 objective questions. Q.1 to Q.30 carry **One** mark each and Q.31 to Q.90 carry **Two** marks each.
2. Answer all the questions.
3. Questions must be answered on special machine gradable **O**bjective **R**esponse **S**heet (**ORS**) by darkening the appropriate bubble (marked A, B, C, D) against the question number on the left hand side of the **ORS**, using **HB** pencil. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely using a good soft eraser.
4. There will be **NEGATIVE** marking. In Q.1 to Q.30, **0.25** mark will be deducted for each wrong answer and in Q.31 to Q.90, **0.5** mark will be deducted for each wrong answer. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.
5. Write your registration number, name and name of the Centre at the specified locations on the right half of the **ORS**.
6. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
7. No charts or tables are provided in the examination hall.
8. Use the blank pages given at the end of the question paper for rough work.
9. Choose the **closest** numerical answer among the choice given.
10. Please check all pages and report, if there is any discrepancy.

Website: www.gateforum.com **Email: support@gateforum.com**

Address: 17A, 30th Cross, Tilak Nagar, Jayanagar 4th 'T' Block, Bangalore – 560 041.
Ph: 080 – 51310203.

Centres:

- **Mumbai**
  GATE FORUM
  110, Shopper's Point
  1st Floor , S. V. Road
  Opp. Andheri Railway Station.
  Andheri (W) Mumbai.
  Tel: (022) 2623 7471 / 72
- **Kolkata**
  GATE FORUM
  4A, ELGIN Road
  Next to Bhavanipur College
  Kolkata-700020
  Tel: (033) 30947075, 30947160
- **Jaipur**
  GATE FORUM
  C-16 , Greater Kailash Colony,
  Behind New Vidhan Sabha, Lal Kothi, Jaipur, Rajasthan.
  PIN : 302001,Tel:(0141) 5103580
- **Trivandrum**
  GATE FORUM
  TC 14/ 1679 , Behind Sanskrit College, Palayam, Trivandrum
  Kerala PIN : 695034.
  Tel : (471) 2322914,
- **Nagpur**
  GATE FORUM
  3rd Floor, Samarth Chambers
  W.H.C Road, Opp. Chauhan Traders,
  Nagpur - 440 010,
  Maharashtra
- **Dhanbad**
  GATE FORUM
  Flat NO: 3 B, HEM Tower,
  Luby Circular Road,
  Dhanbad – 826001
  Tel: (0326) 3108848
- **Durgapur**
  GATE FORUM
  2nd floor, Nachan Road
  Opposite Bank of India,
  Benachity.
  Durgapur - 713213
- **Pune**
  GATE FORUM
  5, Kalpana Building
  opp. Hotel Surya
  Off Ghole Road
  Pune - 411004
  Tel : (020) 25538396 / 25510078
- **Guwahati**
  GATE FORUM
  Maniram Dewan Road
  Opposite to Regalia Marriage Hall,
  Chandmari
  Guwahati 781003
  Tel. 91 98640 75835
- **Hubli / Dharwad**
  GATE FORUM
  Plot no. 101, Shri Venktesh Krupa,
  Shiv Basav Nagar,
  BELGAUM Pin 591 010
  (Land mark: Naganoor swami Kalyan Mantap
- Hyderabad
  GATE FORUM
  Suite Number 515,Model House
  Hyderabad - 82
  Ph: +91-40-5583 3454
  +91-40-5583 3242

Q.1 – Q.30 Carry One Mark Each

1. In a population of N families, 50% of the families have three children, 30% of the families have two children and the remaining families have one child. What is the probability that a randomly picked child belongs to a family with two children?

(A) $\frac{3}{23}$ (B) $\frac{6}{23}$ (C) $\frac{3}{10}$ (D) $\frac{3}{5}$

2. In a class of 200 students, 125 students have taken Programming Language course, 85 students have taken Data Structures course, 65 students have taken Computer Organization course; 50 students have taken both Programming Language and Data Structures, 35 students have taken both Data Structures and Computer Organization; 30 students have taken both Data Structures and Computer Organizational, 15 students have taken all the three course.

How many students have not taken any of the three courses?

(A) 15 (B) 20 (C) 25 (D) 35

3. Let $a(x,y), b(x,y)$ and $c(x,y)$ be three statements with variables x and y chosen from some universe. Consider the following statement:

$$(\exists x)(\forall y)\left[\left(a(x,y)\wedge b(x,y)\right)\vee \neg c(x,y)\right]$$

Which one of the following is its equivalent?

(A) $(\forall x)(\exists y)\left[\left(a(x,y)\vee b(x,y)\right)\rightarrow c(x,y)\right]$

(B) $(\exists x)(\forall y)\left[\left(a(x,y)\vee b(x,y)\right)\wedge \neg c(x,y)\right]$

(C) $\neg(\forall x)(\exists y)\left[\left(a(x,y)\wedge b(x,y)\right)\rightarrow c(x,y)\right]$

(D) $\neg(\forall x)(\exists y)\left[\left(a(x,y)\vee b(x,y)\right)\rightarrow c(x,y)\right]$

4. Let R_1 be a relation from $A=\{1,3,5,7\}$ to $B=\{2,4,6,8\}$ and R_2 be another relation from B to $C=\{1,2,3,4\}$ as defined below:

(i) An element x in A is related to an element y in B (under R_1) if x+y is divisible by 3.

(ii) An element x in B is related to an element y in C (under R_2) if x+y is even but not divisible by 3.

Which is the composite relation R_1R_2 from A to C?

(A) $R_1R_2=\{(1,2),(1,4),(3,3),(5,4),(7,3)\}$

(B) $R_1R_2=\{(1,2),(1,3),(3,2),(5,2),(7,3)\}$

(C) $R_1R_2=\{(1,2),(3,2),(3,4),(5,4),(7,2)\}$

(D) $R_1R_2 = \{(3,2),(3,4),(5,1),(5,3),(7,1)\}$

5. What is the maximum number of edges in an acyclic undirected graph with n vertices?

(A) n - 1 (B) n (C) n + 1 (D) 2n - 1

6. What values of x, y and z satisfy the following system of linear equations?

$$\begin{bmatrix}1 & 2 & 3\\ 1 & 3 & 4\\ 2 & 2 & 3\end{bmatrix}\begin{bmatrix}x\\ y\\ z\end{bmatrix} = \begin{bmatrix}6\\ 8\\ 12\end{bmatrix}$$

(A) $x = 6, y = 3, z = 2$ (B) $x = 12, y = 3, z = -4$

(C) $x = 6, y = 6, z = -4$ (D) $x = 12, y = -3, z = 0$

7. Which one of the following regular expressions is NOT equivalent to the regular expression $(a + b + c)^*$?

(A) $(a^* + b^* + c^*)^*$ (B) $(a^* b^* c^*)^*$

(C) $((ab)^* + c^*)^*$ (D) $(a^* b^* + c^*)^*$

8. What is the minimum number of NAND gates required to implement a 2-input EXCLUSIVE-OR function without using any other logic gate?

(A) 3 (B) 4 (C) 5 (D) 6

9. Which one of the following statements is FALSE?

(A) There exist context free languages such that all the context free grammars generating them age ambiguous.

(B) An unambiguous context free grammar always has a unique parse tree for each string of the language generated by it.

(C) Both deterministic and non-deterministic pushdown automata always accept the same set of languages

(D) A finite set of string from one alphabet is always a regular language.

10. What is the minimum size of ROM required to store the complete truth table of an 8-bit $\times$ 8-bit multiplier?

(A) 32 K $\times$ 16 bits (B) 64 K $\times$ 16 bits (C) 16 K $\times$ 32 bits (D) 64 K $\times$ 32 bits

11. What is the bit rate of a video terminal unit with 80 characters/line, 8 bits/character and horizontal sweep time of 100μs (including 20 μs of retrace time)?

(A) 8 Mbps (B) 6.4 Mbps (C) 0.8 Mbps (D) 0.64 Mbps

12. Consider a system with 2 level caches. Access times of Level 1 cache, Level 2 cache and main memory are 1 ns, 10ns, and 500 ns, respectively. The hit rates of Level 1 and Level 2 caches are 0.8 and 0.9, respectively. What is the average access time of the system ignoring the search time within the cache?

(A) 13.0 ns (B) 12.8 ns (C) 12.6 ns (D) 12.4 ns

13. Let P be a singly linked list. Let Q be the pointer to an intermediate node x in the list. What is the worst-case time complexity of the best known algorithm to delete the node x from the list?

(A) O(n) (B) $O(\log^2 n)$ (C) $O(\log n)$ (D) O(1)

14. Which one of the following is NOT shared by the threads of the same process?

(A) Stack (B) Address Space
(C) File Descriptor Table (D) Message Queue

15. Let x be an integer which can take a value of 0 or 1. The statement if$(x == 0)$ $x = 1$; else x = 0; is equivalent to which one of the following?

(A) $x = 1 + x;$ (B) $x = 1 - x;$ (C) $x = x - 1;$ (D) $x = 1\%x;$

16. Which of the following commands or sequences of commands will rename a file x to file y in a Unix system?

I. mv y, x II. mv x, y III. cp y, x (rm x) IV. cp x, y (rm x)

(A) II and III (B) II and IV (C) I and III (D) II only

17. In a software project, COCOMO (Constructive Cost Model) is used to estimate

(A) effort and duration based on the size of the software
(B) size and duration based on the effort of the software
(C) effort and cost based on the duration of the software
(D) size, effort and duration based on the cost of the software

18. The diagram that helps in understanding and representing user requirements for a software project using UML (Unified Modeling Language) is:

(A) Entity Relationship Diagram (B) Deployment Diagram
(C) Data Flow Diagram (D) Use Case Diagram

19. A software organization has been assessed at SEI CMM Level 4. Which of the following does the organization need to practice beside Process Change Management and Technology Change Management in order to achieve Level 5?

(A) Defect Detection (B) Defect Prevention
(C) Defect Isolation (D) Defect Propagation

20. A software configuration management tool helps in
(A) keeping track of the schedule based on the milestones reached
(B) maintaining different versions of the configurable items
(C) managing manpower distribution by changing the project structure
(D) all of the above

21. Which level of locking provides the highest degree of concurrency in a relational database?
(A) Page (B) Table (C) Row
(D) Page, table and row level locking allow the same degree of concurrency

22. Which one of the following statements is FALSE?
(A) Packet switching leads to better utilization of bandwidth resources than circuit switching.
(B) Packet switching results in less variation in delay than circuit switching.
(C) Packet switching requires more per packet processing than circuit switching.
(D) Packet switching can lead to reordering unlike in circuit switching.

23. Which one of the following statements is FALSE?
(A) TCP guarantees a minimum communication rate
(B) TCP ensures in-order delivery
(C) TCP reacts to congestion by reducing sender window size
(D) TCP employs retransmission to compensate for packet loss

24. Which one of the following statements is FALSE?
(A) HTTP runs over TCP
(B) HTTP describes the structure of web pages
(C) HTTP allows information to be stored in a URL
(D) HTTP can be used to test the validity of a hypertext link

25. A sender is employing public key cryptography to send a secret message to a receiver. Which one of the following statements is TRUE?
(A) Sender encrypts using receiver's public key
(B) Sender encrypts using his own public key
(C) Receiver decrypts using sender's public key
(D) Receiver decrypts using his own public key

26. A subnet has been assigned a subnet mask of 255.255.255.192. What is the maximum number of hosts that can belong to this subnet?
(A) 14 (B) 30 (C) 62 (D) 126

27. A host is connected to a Department network which is part of a University network. The University network, in turn, is part of the Internet. The largest network in which the Ethernet address of the host is unique is:

(A) the subnet to which the host belongs (B) the Department network
(C) the University network (D) the Internet

28. In TCP, a unique sequence number is assigned to each

(A) byte (B) word (C) segment (D) message

29. Which of the following objects can be used in expressions and scriplets in JSP (Java Server Pages) without explicitly declaring them?

(A) session and request only (B) request and response only
(C) response and session only (D) session, request and response

30. Consider the following statements:

I. telnet, ftp and http are application layer protocols.

II. EJB (Enterprise Java Beans) components can be deployed in a J2EE (Java2 Enterprise Edition) application server.

III. If two languages conform to the Common Language Specification (CLS) of the Microsoft.NET framework, then a class defined in any one of them may be inherited in the other.

Which statements are true?

(A) I and II only (B) II and III only (C) I and III only (D) I, II and III

Q.31 – 90 Carry Two Marks Each

31. Let p, q. r and s be four primitive statements. Consider the following arguments:

$P: \left[(\neg p \vee q) \wedge (r \rightarrow s) \wedge (p \vee r)\right] \rightarrow (\neg s \rightarrow q)$

$Q: \left[(\neg p \wedge q) \wedge \left[q \rightarrow (p \rightarrow r)\right]\right] \rightarrow \neg r$

$R: \left[\left[(q \wedge r) \rightarrow P\right] \wedge (\neg q \vee p)\right] \rightarrow r$

$S: \left[p \wedge (p \rightarrow r) \wedge (q \vee \neg r)\right] \rightarrow q$

Which of the above arguments are valid?

(A) P and Q only (B) P and R only
(C) P and S only (D) P, Q, R and S

32. Let A be an $n \times n$ matrix of the following form.

$$A = \begin{bmatrix} 3 & 1 & 0 & 0 & 0 & \dots & 0 & 0 & 0 \\ 1 & 3 & 1 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 1 & 3 & 1 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 1 & 3 & 1 & \dots & 0 & 0 & 0 \\ \dots & & & & & & & & \\ \dots & & & & & & & & \\ 0 & 0 & 0 & 0 & 0 & \dots & 1 & 3 & 1 \\ 0 & 0 & 0 & 0 & 0 & \dots & 0 & 1 & 3 \end{bmatrix}_{n \times n}$$

What is the value of the determinant of A?

(A) $\left(\frac{5+\sqrt{3}}{2}\right)^{n-1}\left(\frac{5\sqrt{3}+7}{2\sqrt{3}}\right)+\left(\frac{5-\sqrt{3}}{2}\right)^{n-1}\left(\frac{5\sqrt{3}-7}{2\sqrt{3}}\right)$

(B) $\left(\frac{7+\sqrt{5}}{2}\right)^{n-1}\left(\frac{7\sqrt{5}+3}{2\sqrt{5}}\right)+\left(\frac{7-\sqrt{5}}{2}\right)^{n-1}\left(\frac{7\sqrt{5}-3}{2\sqrt{5}}\right)$

(C) $\left(\frac{3+\sqrt{7}}{2}\right)^{n-1}\left(\frac{7\sqrt{5}+5}{2\sqrt{7}}\right)+\left(\frac{3-\sqrt{7}}{2}\right)^{n-1}\left(\frac{3\sqrt{7}-5}{2\sqrt{7}}\right)$

(D) $\left(\frac{3+\sqrt{5}}{2}\right)^{n-1}\left(\frac{3\sqrt{5}+7}{2\sqrt{5}}\right)+\left(\frac{3-\sqrt{5}}{2}\right)^{n-1}\left(\frac{3\sqrt{5}-7}{2\sqrt{5}}\right)$

33. Let X and Y be two exponentially distributed and independent random variables with mean α and β, respectively. If Z = min(X,Y), then the mean of Z is given by

(A) $\frac{1}{\alpha+\beta}$ (B) $\min(\alpha,\beta)$ (C) $\frac{\alpha\beta}{\alpha+\beta}$ (D) $\alpha+\beta$

34. Let $H_1, H_2, H_3, \dots$ be harmonic numbers. Then, for $n \varepsilon Z^+$, $\sum_{j=1}^{n} H_j$ can be expressed as

(A) $nH_{n+1}-(n+1)$ (B) $(n+1)H_n - n$

(C) $nH_n - n$ (D) $(n+1)H_{n+1}-(n+1)$

35. In how many ways can we distribute 5 distinct balls, $B_1, B_2, \dots, B_5$ in 5 distinct cells, $C_1, C_2, \dots, C_5$ such that Ball B_i is not in cell $C_i, \forall i = 1,2,\dots,5$ and each cell contains exactly one ball?

(A) 44 (B) 96 (C) 120 (D) 3125

36. If matrix $X = \begin{bmatrix} a & 1 \\ -a^2 + a - 1 & 1 - a \end{bmatrix}$ and $X^2 - X + I = 0$ (I is the identity matrix and O is the zero matrix), then the inverse of X is:

(A) $\begin{bmatrix} 1-a & -1 \\ a^2 & a \end{bmatrix}$ (B) $\begin{bmatrix} 1-a & -1 \\ a^2 - a + 1 & a \end{bmatrix}$

(C) $\begin{bmatrix} -a & 1 \\ -a^2 + a - 1 & a - 1 \end{bmatrix}$ (D) $\begin{bmatrix} a^2 - a + 1 & a \\ 1 & 1 - a \end{bmatrix}$

37. What is the number of vertices in an undirected connected graph with 27 edges, 6 vertices of degree 2, 3 vertices of degree 4 and remaining of degree 3?

(A) 10 (B) 11 (C) 18 (D) 19

38. If $f(1) = 2, f(2) = 4$ and $f(4) = 16,$ what is the value of $f(3)$ using Lagrange's interpolation formula?

(A) 8 (B) $8\frac{1}{3}$ (C) $8\frac{2}{3}$ (D) 9

39. Consider the following iterative root finding methods and convergence properties:

Iterative root finding methods	Convergence properties
(Q) False Position	(I) Order of convergence = 1.62
(R) Newton Raphson	(II) Order of convergence = 2
(S) Secant	(III) Order of convergence = 1 with guarantee of convergence
(T) Successive Approximation	(IV) Order of convergence = 1 with no guarantee of convergence

(A) Q - II R - IV S - III T - I
(B) Q - III R - II S - I T - IV
(C) Q - II R - I S - IV T - III
(D) Q - I R - IV S - II T - III

40. Let $M = (K, \Sigma, \Gamma, \Delta, s, F)$ be a pushdown automaton, where

$K = \{s, f\}, F = \{f\}, \Sigma = \{a, b\}, \Gamma = \{a\}$ and

$\Delta = \{((s, a, \varepsilon), (s, a)), ((s, b, \varepsilon), (s, a)), ((s, a, \varepsilon), (f, \varepsilon)), ((f, a, a), (f, \varepsilon)), ((f, b, a), (f, \varepsilon))\}$

Which one of the following strings is not a member of $L(M)$?

(A) aaa (B) aabab (C) baaba (D) bab

41. Let $M = (K, \Sigma, \delta, s, F)$ be a finite state automaton, where

$K = \{A, B\}, \Sigma = \{a, b\}, s = A, F = \{B\}$,
$\delta(A, a) = A, \delta(A, b) = B, \delta(B, a) = B$ and $\delta(B, b) = A$

A grammar to generate the language accepted by M can be specified as $G = (V, \Sigma, R, S)$, where $V = K \cup \Sigma$, and S = A.

Which one of the following set of rules will make $L(G) = L(M)$?

(A) $\{A \to aB, A \to bA, B \to bA, B \to aA, B \to \varepsilon\}$

(B) $\{A \to aA, A \to bB, B \to aB, B \to bA, B \to \varepsilon\}$

(C) $\{A \to bB, A \to aB, B \to aA, B \to bA, B \to \varepsilon\}$

(D) $\{A \to aA, A \to bA, B \to aB, B \to bA, A \to \varepsilon\}$

42. Using a 4-bit 2's complement arithmetic, which of the following additions will result in an overflow?

(i) 1100 + 1100 (ii) 0011 + 0111 (iii) 1111 + 0111

(A) (i) only (B) (ii) only

(C) (iii) only (D) (i) and (iii) only

43. The number $(123456)_8$ is equivalent to

(A) $(A72E)_{16}$ and $(22130232)_4$ (B) $(A72E)_{16}$ and $(22131122)_4$

(C) $(A73E)_{16}$ and $(22130232)_4$ (D) $(A62E)_{16}$ and $(22120232)_4$

44. The function $AB'C + A'BC + ABC' + A'B'C + AB'C'$ is equivalent to

(A) $AC' + AB + A'C$ (B) $AB' + AC' + A'C$

(C) $A'B + AC' + AB'$ (D) $A'B + AC + AB'$

45. A serial transmission T1 uses 8 information bits, 2 start bits, 1 stop bit and 1 parity bit for each character. A synchronous transmission T2 uses 3 eight bit sync characters followed by 30 eight bit information characters. If the bit rate is 1200 bits/second in both cases, what are the transfer rates of T1 and T2?

(A) 100 characters/sec, 153 characters/sec

(B) 80 characters/sec, 136 characters/sec

(C) 100 characters/sec, 136 characters/sec

(D) 80 characters/sec, 153 characters/sec

46. If we use internal data forwarding to speed up the performance of a CPU (R1, R2 and R3 are registers and M[100] is a memory reference), then the sequence of operations

$R1 \rightarrow M[100]$

$M[100] \rightarrow R2$

$M[100] \rightarrow R3$

Can be replaced by

(A)

$R1 \rightarrow R3$

$R2 \rightarrow M[100]$

(B)

$M[100] \rightarrow R2$

$R1 \rightarrow R2$

$R1 \rightarrow R3$

(C)

$R1 \rightarrow M[100]$

$R2 \rightarrow R3$

(D)

$R1 \rightarrow R2$

$R1 \rightarrow R3$

$R1 \rightarrow M[100]$

47. Consider a pipeline processor with 4 stages S1 to S4. We want to execute the following loop: for $(i = 1; i <= 1000; i++)\{I1, I2, I3, I4\}$ where the time taken (in ns) by instructions $I1$ to $I4$ for stages S1 to S4 are given below:

	S1	S2	S3	S4
I1:	1	2	1	2
I2:	2	1	2	1
I3:	1	1	2	1
I4:	2	1	2	1

The output of I1 for $i = 2$ will be available after

(A) 11 ns (B) 12 ns (C) 13 ns (D) 28 ns

48. Consider a fully associative cache with 8 cache blocks (numbered 0-7) and the following sequence of memory block requests:

4, 3, 25, 8, 19, 6, 25, 8, 16, 35, 45, 22, 8, 3, 16, 25, 7

If LRU replacement policy is used, which cache block will have memory block 7?

(A) 4 (B) 5 (C) 6 (D) 7

49. A CPU has only three instructions I1, I2 and I3, which use the following signals in time steps T1-T5:

I1: T1:Ain, Bout, Cin
T2:PCout, Bin
T3:Zout, Ain
T4:PCin, Bout
T5:End

I2: T1:Cin, Bout, Din
T2:Aout, Bin
T3:Zout, Ain
T4:Bin, Cout
T5:End

I3: T1:Din, Aout
T2:Din, Bout
T3:Zout, Ain
T4:Dout, Ain
T5:End

Which of the following logic functions will generate the hardwired control for the signal Ain?

(A) T1.I1 + T2.I3 + T4.I3 + T3

(B) (T1 + T2 + T3). I3 + T1.I1

(C) (T1 + T2). I1 + (T2 + T4). I3 + T3

(D) (T1 + T2). I2 + (T1 + T3). I1 + T3

50. In an enhancement of a design of a CPU, the speed of a floating point until has been increased by 20% and the speed of a fixed point unit has been increased by 10%. What is the overall speedup achieved if the ratio of the number of floating point operations to the number of fixed point operations is 2:3 and the floating point operation used to take twice the time taken by the fixed point operation in the original design?

(A) 1.155 (B) 1.185 (C) 1.255 (D) 1.285

51. The storage area of a disk has innermost diameter of 10 cm and outermost diameter of 20 cm. The maximum storage density of the disk is 1400 bits/cm. The disk rotates at a speed of 4200 RPM. The main memory of a computer has 64-bit word length and 1μs cycle time. If cycle stealing is used for data transfer from the disk, the percentage of memory cycles stolen for transferring one word is:

(A) 0.5% (B) 1% (C) 5% (D) 10%

52. A program attempts to generate as many permutations as possible of the string 'abcd' by pushing the characters a, b, c, d in the same order onto a stack, but it may pop off the top character at any time. Which one of the following strings CANNOT be generated using this program?

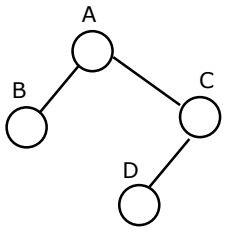
(A) abcd (B) dcba (C) cbad (D) cabd

53. An array of integers of size n can be converted into a heap by adjusting the heaps rooted at each internal node of the complete binary tree starting at the node $\lfloor (n-1)/2 \rfloor$, and doing this adjustment up to the root node (root node is at index 0) in ther order $\lfloor (n-1)/2 \rfloor, \lfloor (n-3)/2 \rfloor, \ldots, 0$. The time required to construct a heap in this manner is

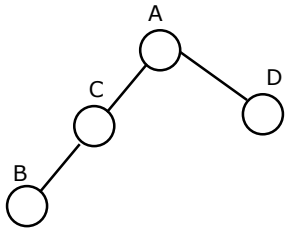
(A) $O(\log n)$ (B) $O(n)$ (C) $O(n \log \log n)$ (D) $O(n \log n)$

54. Which one of the following binary trees has its in-order and preorder traversals as BCAD and ABCD, respectively?

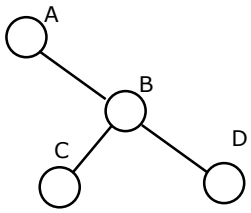
(A)



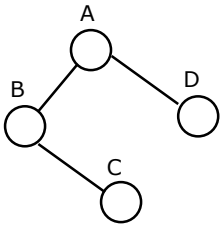
(B)



(C)



(D)

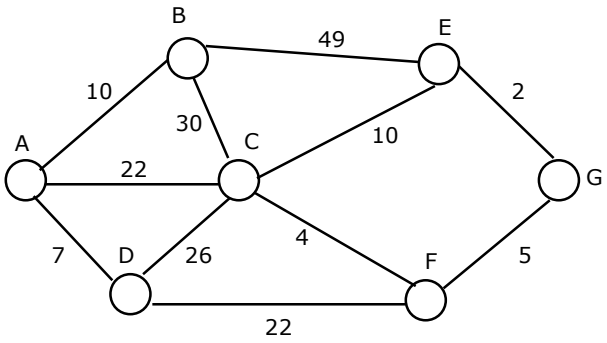


55. Let $f(n), g(n)$ and $h(n)$ be functions defined for positive integers such that $f(n) = O(g(n), g(n)) \neq O(f(n)), g(n) = O(h(n))$, and $h(n) = O(g(n))$. Which one of the following statements is FALSE?

(A) $f(n) + g(n) = O(h(n)) + h(n))$ (B) $f(n) = O(h(n))$

(C) $h(n) \neq O(f(n))$ (D) $f(n)h(n) \neq O(g(n)h(n))$

56. Consider the undirected graph below:



Using Prim's algorithm to construct a minimum spanning tree starting with node A, which one of the following sequences of edges represents a possible order in which the edges would be added to construct the minimum spanning tree?

(A) (E, G), (C, F), (F, G), (A, D), (A, B), (A, C)

(B) (A, D), (A, B), (A, C), (C, F), (G, E), (F, G)

(C) (A, B), (A, D), (D, F), (F, G), (G, E), (F, C)

(D) (A, D), (A, B), (D, F), (F, C), (F, G), (G, E)

57. Consider a list of recursive algorithms and a list of recurrence relations as shown below. Each recurrence relation corresponds to exactly one algorithm and is used to derive the time complexity of the algorithm.

Recursive Algorithm	**Recurrence Relation**
(P) Binary search	(I) $T(n) = T(n-k) + T(k) + cn$
(Q) Merge sort	(II) $T(n) = 2T(n-1) + 1$
(R) Quick sort	(III) $T(n) = 2T(n/2) + cn$
(S) Tower of Hanoi	(IV) $T(n) = T(n/2) + 1$

Which of the following is the correct match between the algorithms and their recurrence relations?

(A) P - II Q - III R - IV S - I

(B) P - IV Q - III R - I S - II

(C) P - III Q - II R - IV S - I

(D) P - IV Q - II R - I S - III

58. Consider the following C program which is supposed to compute the transpose of a given 4×4 matrix M. Note that, there is an X in the program which indicates some missing statements. Choose the correct option to replace X in the program.

```
#include <stdio.h>
#define ROW 4
#define COL 4
int M[ROW][COL] ={1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16};
main()
{
    int i,j,t;
    for (i=0;i<4;++i)
        {
                X
        }
    for(i=0;i<4;++i)
       for(j=0;j<4;++j)
            printf("%d", M[i][j]);
            }
```

(A)
```
for(j=0;j<4;++j){
            t= M[i][j];
            M[i][j]= M[j][i];
            M[j][i]=t;
            }
```

(B)
```
for(j=0;j<4;++j){
          M[i][j]=t;
          t= M[j][i];
          M[j][i]= M[i][j];
          }
```

(C)
```
for(j=i;j<4;++j){
          t= M[j][i];
          M[i][j]= M[j][i];
          M[j][i]=t;
          }
```

(D)
```
for(j=i;j<4;++j){
          M[i][j]=t;
          t= M[j][i];
          M[j][i]= M[i][j];
          }
```

59. What is the output of the following program?

```
#include <stdio.h>

int funcf(int x);
int funcg(int y);
main ()
{
    int x = 5, y = 10, count;
    for (count = 1; count <=2; ++count){
                    y+=funcf(x) + funcg(x);
                    printf("%d",y);
    }
}
funcf (int x) {
            int y;
            y=funcg(g);
            return(y);
}
funcg (int x) {
             static int y = 10;
             y+=1;
             return (y+x);
}
```

(A) 43 80 (B) 42 74 (C) 33 37 (D) 32 32

60. Choose the correct option to fill the ?1 and ?2 so that the program prints an input string in reverse order. Assume that the input string is terminated by a new line character.

```
#include <stdio.h>
void wrt_it (void);
int main (void)
{
    printf("Etner Text");
    printf("/n");
    wrt_it();
    printf("/n");
    return 0;
}
```

```
void wrt_it(void)
{
    int c;
    if (?1)
       wrt_it();
    ?2
}
```

(A) ?1 is getchar() !='/n'
    ?2 is getchar(c);

(B) ?1 is (c=getchar() !='/n'
    ?2 is getchar(c);

(C) ?1 is c !='/n'
    ?2 is putchar(c);

(D) ?1 is (c=getchar()) !='/n'
    ?2 is putchar(c);

61. Consider the following C program:

```
#include <stdio.h>
typedef struct {
                    char *a;
                    char *b;
                    } t;
void f1 (t s);
void f2 (t *p);
main()
{
                    static t s = {"A", "B"};
                    printf("%s %s \n", s.a, s.b);
                    f1(s);
                    printf("%s %s \n", s.a, s.b);
                    f1(&s);
}
void f1 (t s)
{
                    s.a = "U";
                    s.b = "V",
                    printf("%s %s \n", s.a, s.b);
                    return;
}
```

```
void f2 (t *p)
                    p → a = "V";
                    p → b = "W";
                   printf("%s %s \n", p → a,p → b);
                   return;
                   }
```

What is the output generated by the program?

(A)	(B)	(C)	(D)
AB	*AB*	*AB*	*AB*
UV	*UV*	*UV*	*UV*
VW	*AB*	*UV*	*VW*
VW	*VW*	*VW*	*UV*

62. A disk has 200 tracks (numbered 0 through 199). At a given time, it was servicing the request of reading data from track 120, and at the previous request, service was for track 90. the pending requests (in order of their arrival) are for track numbers.

30 70 115 130 110 80 20 25.

How many times will the head change its direction for the disk scheduling policies SSTF (Shortest Seek Time First) and FCFS (First Come First Serve)?

(A) 2 and 3 (B) 3 and 3 (C) 3 and 4 (D) 4 and 4

63. In a certain operating system, deadlock prevention is attempted using the following scheme. Each process is assigned a unique timestamp, and is restarted with the same timestamp if killed. Let P_h be the process holding a resource R, P_r be a process requesting for the same resource R, and $T(P_h)$ and $T(\hat{Pr})$ be their timestamps respectively. The decision to wait or preempt one of the processes is based on the following algorithm.

if $T(P_r) < T(P_h)$ then
kill P_r
else
wait

Which one of the following is TRUE?

(A) The scheme is deadlock free, but not starvation free

(B) The scheme is not deadlock free, but starvation free

(C) The scheme is neither deadlock free nor starvation free

(D) The scheme is both deadlock free and starvation free

64. A process executes the following segment of code:

```
for(i=1;i<=n;i++)
    fork():
```

The number of new processes created is:

(A) n (B) $\frac{n(n+1)}{2}$ (C) $2^n - 1$ (D) $3^n - 1$

65. The semaphore variables full, empty and mutex are initialized to 0, n and 1, respectively. Process P_1 repeatedly adds one item at a time to a buffer of size n, and process P_2 repeatedly removes one item at a time from the same buffer suing the programs given below. In the program, K, L, M and N are unspecified statements.

```
P1:  while (1) {
         K; P(mutex);
         Add an item to the buffer;
         V(mutex);L;
     }
P2:  while (1) {
         M; P(mutex);
         Remove an item from the buffer;
         V(mutex);N;
     }
```

The statements K, L, M and N are respectively

(A) P(full), V(empty), P(full), V(empty)

(B) P(full), V(empty), P(empty), V(full)

(C) P(empty), V(full), P(empty), V(full)

(D) P(empty), V(full), P(full), V(empty)

66. In a virtual memory system, size of virtual address is 32bit, size of physical address is 30 bit, page size is 4 Kbyte and size of each page table entry is 32-bit. The main memory is byte addressable. Which one of the following is the maximum number of bits that can be used for storing protection and other information in each page table entry?

(A) 2 (B) 10 (C) 12 (D) 14

67. In a particular Unix Os, each data block is of size 1024 bytes, each node has 10 direct data block addresses and three additional addresses: one for single indirect block, one for double indirect block and one for triple indirect block. Also, each block can contain addresses for 128 blocks. Which one of the following is approximately the maximum size of a file in the file system?

(A) 512 MB (B) 2 GB (C) 8 GB (D) 16 GB

68. A software project involves execution of 5 tasks T1, T2, T3, T4 and T5 of duration 10, 15, 18, 30 and 40 days, respectively. T2 and T4 can start only after T1 completes. T3 can start after T2 completes. T5 can start only after both T3 and T4 complete. What is the slack time of the task T3 in days?

(A) 0 (B) 3 (C) 18 (D) 30

69. Consider the following program module:

```
int module1 (int x, int y)
while (x!=y) {
    if (x>y)
       x=x-y;
    else y = y – x;
    }
return x;
}
```

What is Cyclomatic complexity of the above module?

(A) 1 (B) 2 (C) 3 (D) 4

70. Assume that the delivered liens of code L of a software is related to the effort E in person months and duration t in calendar months by the relation $LP*(E/B)^{1/3}*t^{4/3}$, where P and B are two constants for the software process and skills factor. For a software project, the effort was estimated to be 20 person months and the duration was estimated to be 8 months. However, the customer asked the project team to complete the software project in 4 months. What would be the required effort in person months?

(A) 10 (B) 40 (C) 160 (D) 320

71. A software was tested using the error seeding strategy in which 20 errors were seeded in the code. When the code was tested using the complete test suite, 16 of the seeded errors were detected. The same test suite also detected 200 non-seeded errors. What is the estimated number of undetected errors in the code after this testing?

(A) 4 (B) 50 (C) 200 (D) 250

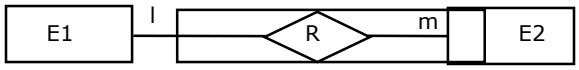
72. What is the availability of a software with the following reliability figures?

Mean Time Between Failure (MTBF) = 25 days

Mean Time To Repair (MTTR) = 6 hours

(A) 1% (B) 24% (C) 99% (D) 99.009%

73. Consider the following entity relationship diagram (ERD), where two entities E1 and E2 have a relation R of cardinality 1:m.



The attributes of E1 are A11, A12 and A13 where A11 is the key attribute. The attributes of E2 are A21, A22 and A23 where A21 is the key attribute and A23 is a multi-valued attribute. Relation R does not have any attribute. A relational database containing minimum number of tables with each table satisfying the requirements of the third normal form (3NF) is designed from the above ERD. The number of tables in the database is:

(A) 2 (B) 3 (C) 5 (D) 4

74. A relational database contains two table student and department in which student table has columns roll_no, name and dept_id and department table has columns dept_id and detp_name. the following insert statements were executed successfully to populate the empty tables:

Insert into department values (1, 'Mathematics')

Insert into department values (2, 'Physics')

Insert into student values (1, 'Navin',1)

Insert into student values (2, 'Mukesh',2)

Insert into student values (3, 'Gita',1)

How many rows and columns will be retrieved by the following SQL statement?

Select * from student, department

(A) 0 row and 4 columns
(B) 3 rows and 4 columns
(C) 3 rows and 5 columns
(D) 6 rows and 5 columns

75. A relation Empdtl is defined with attributes empcode (unique), name, street, city, state and pincode. For any pincode, there is only one city and state. Also, for any given street, city and state, thereis just one pincode. In normalization terms, Empdtl is a relation in

(A) 1 NF only
(B) 2 NF and hence also in 1 NF
(C) 3 NF and hence also in 2 NF and 1 NF
(D) BCNF and hence also in 3 NF, 2NF and 1NF

76. A table T1 in a relational database has the following rows and columns:

Roll no	Marks
1	10
2	20
3	30
4	Null

The following sequence of SQL statements was successfully executed on table T1.
Update T1 set marks = marks + 5
Select avg(marks) from T1
What is the output of the select statement?
(A) 18.75 (B) 20 (C) 25 (D) Null

77. Consider the following schedule S of transactions T1 and T2:

T1	T2
Read (A)	
A = A – 10	
	Read (A)
	Temp = 0.2*A
	Write (A)
	Read(B)
Write(A)	
Read(B)	
B=B+10	
Write(B)	
	B=B+Temp
	Write(B)

Which of the following is TRUE about the schedule S?
(A) S is serializable only as T1, T2
(B) S is serializable only as T2, T1
(C) S is serializable both as T1, T2 and T2, T1
(D) S is serializable either as T1 or as T2

78. Consider two tables in a relational database with columns and rows as follows:

Table: Student

Roll_no	Name	Dept_id
1	ABC	1
2	DEF	1
3	GHI	2
4	JKL	3

Table: Department

Dept_id	Dept_Name
1	A
2	B
3	C

Roll_no is the primary key of the Student table, Dept_id is the primary key of the Department table and Studetn.Dept_id is a foreign key from Department.Dept_id.

What will happen if we try to execute the following two SQL statements?

(i) update Student set Dept_id = Null where Roll_no =1

(ii) update Department set Dept_id = Null where Dept_id =1

(A) Both (i) and (ii) will fail (B) (i) will fail but (ii) will succeed

(C) (i) will succeed but (ii) will fail (D) Both (i) and (ii) will succeed

79. Consider a table T in a relational database with a key field K. A B-tree of order p is used as an access structure on K, where p denotes the maximum number of tree pointers in a B-tree index node. Assume that K is 10 bytes long; disk block size is 512 bytes; each data pointer P_D is 8 bytes long and each block pointer P_B is 5 bytes long. In order for each B-tree node to fit in a single disk block, the maximum value of p is:

(A) 20 (B) 22 (C) 23 (D) 32

80. In a data link protocol, the frame delimiter flag is given by 0111. Assuming that bit stuffing is employed, the transmitter sends the data sequence 01110110 as

(A) 01101011 (B) 011010110 (C) 011101100 (D) 0110101100

81. In a sliding window ARQ scheme, the transmitter's window size is N and the receiver's window size is M. The minimum number of distinct sequence numbers required to ensure correct operation of the ARQ scheme is:

(A) min (M, N) (B) max (M, N) (C) M + N (D) MN

82. Consider a 10 Mbps token ring LAN with a ring latency of 400μs. A host that needs to transmit seizes the token. Then it sends a frame of 1000 bytes, removes the frame after it has circulated all around the ring, and finally releases the token. This process is repeated for every frame. Assuming that only a single host wishes to transmit, the effective data rate is:

(A) 1 Mbps (B) 2 Mbps (C) 5 Mbps (D) 6 Mbps

83. A 25 Kbps satellite link has a propagation delay of 400 ms. The transmitter employs the "go back n ARQ" scheme with n set to 10. Assuming that each frame is 100 bytes long, what is the maximum data rate possible?

(A) 5 Kbps (B) 10 Kbps (C) 15 Kbps (D) 20 Kbps

84. Consider a parity check code with three data bits and four parity check bits. Three of the code words are 0101011, 1001101 and 1110001. Which of the following are also code words?

I. 0010111 II. 0110110 III. 1011010 IV. 0111010

(A) I and III (B) I, II and III

(C) II and IV (D) I, II, III and IV

85. Consider a simplified time slotted MAC protocol, where each host always has data to send and transmits with probability p=0.2 in every slot. There is no back off and one frame can be transmitted in one slot. If more than one host transmits in the same slot, then the transmissions are unsuccessful due to collision. What is the maximum number of hosts which this protocol can support, if each host has to be provided a minimum throughput of 0.16 frames per time slot?

(A) 1 (B) 2 (C) 3 (D) 4

86. In the TCP/IP protocol suite, which one of the following is NOT part of the IP header?

(A) Fragment offset (B) Source IP address

(C) Destination IP address (D) Destination port number

87. A TCP message consisting of 2100 bytes is passed to IP for delivery across two networks. the first network can carry a maximum payload of 1200 bytes per frame and the second network can carry a maximum payload of 400 bytes per frame, excluding network overhead. Assume that IP overhead per packet is 20 bytes. What is the total IP overhead in the second network for this transmission?

(A) 40 bytes (B) 80 bytes (C) 120 bytes (D) 160 bytes

88. Suppose that the maximum transmit window size for a TCP connection is 12000 bytes. Each packet consists of 2000 bytes. At some point of time, the connection is is slow-start phase with a current transmit window of 4000 bytes. Subsequently, the transmitter receives two acknowledgements. Assume that no

packets are lost and there are no time-outs. What is the maximum possible value of the current transmit window?

(A) 4000 bytes (B) 8000 bytes (C) 10000 bytes (D) 12000 bytes

89. Consider an XML file called intro.xml and a document type definition (DTD) file intro.dtd as follows:

intro.xml

```
<?xml version = "1.0"?>
<!DOCTYPE myMessage SYSTEM "intro.dtd">
<myMessage>
    <message?Welcome to XML</message>
</myMessage>
```

intro.dtd

```
<!ELEMENTmyMessage (message)>
<!ELEMENT message (#PCDATA)>
```

A validating parser will classify intro.xml as

(A) Well formed and validated (B) Well formed but not validated

(C) Validated but not well formed (D) Neither validated not well formed

90. Given below are several usages of the anchor tag in HTML.

I. <A HREF=http://www.gate.ac.in/HTML/BASIC/testpage.html>TestMe</A>

II. <A HREF ="/BASIC/testpage.html">Test Me</A>

III. <A HREF="testpage.html">Test ME</A>

IV. <A HREF ="testpage.html#test">Test Me</A>

Which of the above are valid?

(A) I and II only (B) I and III only

(C) I, II and III only (D) I, II, III and IV