1. Consider the relation scheme R = (A, B, C, D, E, F, G, H, I, J) and the set of functional dependencies {{A, B} → {C}, {B} → {E, F}, {A, D} → {G, H}, {G} → {I}, {H} → {J}} on R. What is the key for R?

(A) {A, B}

(B) {A, B, D}

(C) {A, B, D, G, H}

(D) {A}

2. Given the following statements:

S1: Every table with two single-valued attributes is in INF, 2NF, 3NF and BCNF.

S2: AB→C, D→E, E→C is a minimal cover for the set of functional dependencies AB→C, D→E, AB→E, E→C.

Which one of the following statements is CORRECT?

(A) S1 is true and S2 is false

(B) Both S1 and S2 is true

(C) S1 is false and S2 is true

(D) Both S1 and S2 are false

3. Which of the following is/are correct inorder traversal sequence(s) of binary search tree(s)?

I. 4, 6, 7, 9, 18, 20, 25

II. 5, 8, 9, 12, 10, 15, 25

III. 2, 7, 10, 8, 14, 16, 20

IV. 3, 5, 7, 8, 15, 19, 25

(A) I and IV only

(B) II and III only

(C) I and II only

(D) IV only

4. Which one of the follwoing is the recurrence equation for the worst case time complexity of the Quicksort algorithm for sorting n (≥ 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) $T(n) = T(n/2) + c\lg n$

5. Let R be the relation on the set of positive integers such that aRb if and only if a and b are distinct and have a common divisor other than 1. Which one of the following statements about R is true?

(A) R is symmetric and reflexive but not transitive

(B) R is reflexive but not symetric and not transitive

(C) R is transitive but not symmetric and not reflexive

(D) R is symmetric but not reflexive and not transitive

6. Total number of possible Binary Search Trees with 7 different keys is

(A) 7

(B) 21

(C) 132

(D) 429

7. Suppose that the numbr of bacteria in a colony triple every hour. If 100 bacteria are used to begin a new colony, how many bacteria will be in the colony in 10 hours?

(A) 5,904,990

(B) 5,904,900

(C) 590,490

(D) 590,499

8. Let f and g be functions from $\{1, 2, 3, 4\}$ to $\{a, b, c, d\}$ and from $\{a, b, c, d\}$ to $\{1, 2, 3, 4\}$ respectively, with $f(1) = d$, $f(2) = c$, $f(3) = a$, and $f(4) = b$, and $g(a) = 2$, $g(b) = 1$, $g(c) = 3$, and $g(d) = 2$.

Which of the following is correct?

(A) Only inverse of f exists

(B) Only inverse of g exists

(C) inverse of both f and g exist

(D) Inverse of both f and g do not exist

9. Let A and B be sets in a finite universal set U. List the following in order of increasing size: $|A|$, $|A \cup B|$, $|A \cap B|$, $|\varnothing|$

(A) $|\varnothing| \leq |A \cap B| \leq |A \cup B| \leq |A|$

(B) $|\varnothing| \leq |A| \leq |A \cap B| \leq |A \cup B|$

(C) $|\varnothing| \leq |A \cup B| \leq |A \cap B| \leq |A|$

(D) $|\varnothing| \leq |A \cap B| \leq |A| \leq |A \cup B|$

10. You are asked to arrange the functions sqrt(n), log n, n log n, $n!$, 3^n, 4^n, and n^2 in a list so that each function is big-O of the next function.

(A) log n, sqrt(n), n^2, n log n, 3^n, 4^n, $n!$

(B) log n, sqrt(n), n^2, n log n, $n!$, 3^n, 4^n

(C) log n, sqrt(n), n log n, n^2, $n!$, 3^n, 4^n

(D) log n, sqrt(n), n log n, n^2, 3^n, 4^n, $n!$

11. Suppose that a password for a computer system must have at least 8, but no more than 12, characters, where each character in the passowrd is a lowercase English letter, an uppercase English letter, a digit, or one of the six special character *, >, <, !, +, and =. Determine how long it takes a hacker to try every possible password, assuming that it takes one nanosecond for a hacker to check each possible password.

(A) About 450,000 years

(B) About 414,000 years

(C) About 350,000 years

(D) About 314,000 years

12. There are 38 different time periods during which classes at a university can be scheduled. If there are 677 different classes, how many different rooms will be needed?

(A) 17

(B) 18

(C) 19

(D) None of the above

13. There are six runners in the 100-yard dash. How many ways are there for three medals to be awarded if ties are possible?

(A) 20

(B) 120

(C) 540

(D) 873

14. A student has three mangos, two papayas, and two kiwi fruits. If the student eats one piece of fruit each day, and only the type of fruit matters, in how many different ways can these fruits be consumed?

(A) 6

(B) 24

(C) 84

(D) 210

15. How many ways are there to assign 24 students to five faculty advisor?

(A) 24^5

(B) ${}^{24}C_5$

(C) 5^{24}

(D) None of the above

16. Assume, there are sorted lists with m elements and n elements. The number of comparisons to merge these two lists into one sorted list will be

(A) log (mn)

(B) mn

(C) m + n – 1

(D) max(mlgn, nlgn)

17. A binary tree T has 10 leaves. The number of internal nodes in binary tree T having two children is

(A) 19

(B) 9

(C) 21

(D) 1023

18. The number of min-terms after minimizing the following Boolean expression is _____ .

(W' + XY' + X'Z + XZ'W + X'Z'W)'

(A) 4

(B) 3

(C) 2

(D) 1

19. Consider a main memory with five page farmes 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)?

(A) Both incur the same number of page fault

(B) FIFO incurs 2 more page faults than LRU

(C) LRU incurs 2 more page faults than FIFO

(D) FIFO inurs 1 more page faults than LRU

20. Functionality of a software is tested using

(A) Glassbox testing

(B) Whitebox testing

(C) Blackbox testing

(D) Glassbox testing and Whitebox testing

21. Boehm has proposed

(A) V model

(B) Waterfall model

(C) Prototyping model

(D) Spring model

22. What scheduling policy will you use when the system's efficiency is measured by the percentage of jobs completed?

(A) FCFS

(B) Round Robin

(C) Shortest Job First

(D) All of the above

23. The cardinality of the set of even positive integers less than 20 is

(A) 9

(B) 10

(C) 11

(D) 19

24. Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 rotations per minute (RPM). It has 600 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

(A) 14000

(B) 14020

(C) 14040

(D) 14060

25. Assume that there are 3 page.frames which are initially empty. If the page reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is

(A) 7

(B) 8

(C) 9

(D) 10

26. A source S = {S1, S2, S3} emits symbols with P = {1/4, 1/4, 1/2}. The entropy of source S is

(A) 1 bit per symbol

(B) 1.5 bit per symbol

(C) 2 bits per symbol

(D) 3 bits per symbol

27. Which of the following instructions is privilage instruction?

(A) INTR XX

(B) INT XX

(C) OUT XX

(D) MOV A, B

28. Which of the following instructions can not be excuted in user mode?

(A) INT XX

(B) IN XX

(C) CALL XX

(D) JMP XX

29. Opening system is designed as

(A) Hardware unit

(B) Application softwere

(C) System software

(D) Middle ware

30. For launching a satellite, which of the following operating system should be used?

(A) Batch operating system

(B) time-shared operating system

(C) Real-time operating system

(D) Distributed operating system.

31. Which of the following language is most appropriate for the design of operating system (OS)?

(A) Fortran

(B) CoBoL

(C) Python

(D) C

32. In phase shift keying digital modulation scheme, the bandwidth allocated is 4 MHz. The number of phase levels are 16. The digital data ratio should be

(A) 4 mbps

(B) 8 mbps

(C) 16 mbps

(D) 32 mbps

33. Which of the following is a transport layer protocol?

(A) IP protocol

(B) ICMP protocol

(C) UDP protocol

(D) ARP protocol

34. In TCP/IP protocol suit, the IP protocol is:

(A) connection-oriented and reliable.

(B) connection-less and reliable.

(C) connection-oriented and unreliable.

(D) connection-less and unreliable

35. There is no modulation in case of

(A) Base band transmission

(B) Broad band transmission

(C) TV Broad cast

(D) Radio broad cast

36. The maximum data rate of fast ethernet is:

(A) 10 Mbps

(B) 100 Mbps

(C) 1000 Mbps

(D) 10,000 Mbps

37. An 100 Mbps ethernet switch has 10 ports. The capacity of each port is:

(A) 100 Mbps simplex

(B) 100 Mbps semi-duplex

(C) 100 Mbps duplex

(D) 10 Mbps duplex

38. The CSMA/CD protocol of ethernet is a:

(A) Centralised and non-contention based protocol.

(B) Centralised and contention based protocol.

(C) Distributed and non-contention based protocol.

(D) Distributed and contention based protocol.

39. If b_n is the sum of all binary trees formed in following way:

'A root b_n and two subtrees with b_i and b_{n-i-1} nodes for all $i = 0, \ldots n-1$ then $b_n =$

(A) $\sum_{i=0}^{n-1} b_i \, b_{n-i-1}, \; b_0 = 1, \; n \geq 1$

(B) $\sum_{i=0}^{n} b_i \, b_{n-i-1}, \; b_0 = 1, \; n \geq 1$

(C) $\sum_{i=0}^{n+1} b_i \, b_{n-i-1}, \; b_0 = 0, \; n \geq 1$

(D) $\sum_{i=0}^{n} b_i \, b_{n-i-1}, \; b_0 = 0, \; n \geq 1$

40. Given 3 dimensional array A($1 : m_1, 1 : m_2, 1 : m_3$) and α address of A(1, 1, 1), each element of array require one unit of memory. The address of A(i, j, k) is

(A) $\alpha + i.m_1m_2 + j.m_3 + (k - 1)$

(B) $\alpha + i.m_2m_3 + j.m_3 + k$

(C) $\alpha + (i - 1)m_2m_3 + (j - 1)m_3 + (k - 1)$

(D) $\alpha + i.m_2m_1 + j.m_3 + k$

41. The depth of a complete binary tree with n nodes is

(A) $\lfloor \log_2 n \rfloor + 1$

(B) $\log_{10} n + 1$

(C) $\lceil \log_2 n \rceil + 1$

(D) $\lceil \log_{10} n \rceil + 1$

42. Which of the following sorting algorithms is not stable

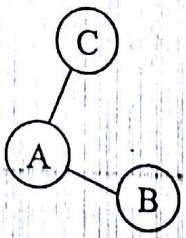
(A) Bubble sort

(B) Insertion sort

(C) Selection-sort

(D) Merge sort

43. What type of rotation is required to convert the following Non-AVL tree into an AVL tree?



(A) Left

(B) Right

(C) Right left

(D) Left right

44. Which of the follwing is correct statement for a B-tree, B-tree is non empty.

(A) The root node has at most two children

(B) All the internal nodes including the root node have $\left\lceil \frac{m}{2} \right\rceil$ children

(C) All the internal nodes other than the root node have at least $\left\lceil \frac{m}{2} \right\rceil$ children

(D) All external nodes are not at same level

45. In ER diagram 1 : 1 or 1 : N relationship type corresponds to _____ in relational model

(A) Candidate key

(B) Primary key

(C) Secondary key

(D) Foreign key

46. A functional depending $X \rightarrow Y$ is a full functional dependency if for any attribute $A \in X$,

(A) $(X - \{A\}) \rightarrow Y$

(B) $(X - \{A\}) \not\rightarrow Y$

(C) $A \rightarrow Y$

(D) None of the above

47. Let R_1 and R_2 be two relation schemas. A set of attributes X in R_1 have the same domains as primary key attributes Y of R_2 then attributes X refer to relation R_2. If t_1, t_2 are twotuples in R_1 and R_2 respectively. For X to be foreign key of R_1.

(A) $t_1[X] \neq t_2[Y]$

(B) $t_1[X] = t_2[Y]$

(C) $t_1[Y] = t_2[X]$

(D) $t_1[Y] \neq t_2[X]$

48. Operator overloading in C++ is

(A) making a new C++ operator

(B) giving near meaning to existing C++ operators

(C) giving C++ operators more than they can handle

(D) None of the above

49. The scope-resolution operator usually _____

(A) resolve ambiguities

(B) passes arguments to objects

(C) provide class growth

(D) does not specify a particular class.

50. A template, in C++, provides a way to make a family of _____

(A) Programs

(B) Variables

(C) Pointers

(D) Functions

Q. No. 51-55 : Read the follwing passage and answer the questions that follow:

Expectedly, tobacco companies are resisting a new regulation that the mandatory pictorial warnings on cigarette packages be made larger. The legal challenges to the new rule is likely to be finally settled in the weeks ahead, but till then, as per the Supreme Court's directives, the larger warnings must be printed. For now, cartons will have up to 85 percent of the packet devoted to graphic messaging. Having lost the argument on the health effects of cigarette consumption, as well as passive smoking, cigarette-makers are pleading that tobacco-growers will be adversely affected. Experience in other countries suggests that they are fighting a losing battle.

Australia has become something of a shining example for the rest of the world to follow in clamping down on suggestive branding. In 2012, it pioneered a move to have cigarettes sold in logo-free plain cartons to deter smokers. This month, the European Court of Justice backed a measure to cover two-thirds of a cigarette packet with health cautions in the 28 member-states of the European Union. Earlier, the ECJ had prohibited the use of descriptive terms such as "light" and "mild" to differentiate among cigaretters. This was in addition to the mandatory disclosure on cigarette packs of the ingredients.

51. Tobacco companies are opposing

(A) mandatory warning against the use of tobacco

(B) pictorial warnings

(C) the larger size of pictorial warning mandated by the government

(D) All kinds of warnings against the use of tobacco.

52. The size and nature of the message on the cigarette packets will be

(A) decided later

(B) as before

(C) decided by manufacturer

(D) 85% of the message on the packet

53. The cigarette makers now insist that

(A) tobacco does not harm health

(B) passive smoking does not harm people

(C) tobacco growers will suffer losses

(D) they are making better and less harmful cigarettes

54. In Australia cigarettes are sold

(A) only to adults

(B) only on prescription

(C) only with graphic warnings

(D) only in cartons without a logo

55. European Court of Justice has recently directed that

(A) All countries of the world to cover two thirds of a cigarette packets with health cautions.

(B) All the member countries of the European union to cover two thirds of a cigarette packet with health cautions

(C) to disclose if a cigarette was strong

(D) the ingredients should be discloused on cigarette packets.

56. The area enclosed between the two circles whose polar equations are $r = 2\sqrt{2}$ and $r = 4 \cos \theta$ is

(A) $\frac{2\pi - 1}{2}$

(B) $4(\pi - 1)$

(C) $\frac{4\pi - 1}{4}$

(D) $2(\pi - 1)$

57. If the characteristic equation of the matrix $\begin{pmatrix} 2 & 1 & s \\ 0 & 1 & 0 \\ 1 & 1 & t \end{pmatrix}$ is $x^3 - 5x^2 + 7x - 3 = 0$, then the ordered pair (s, t) is equal to

(A) (1, 2)

(B) (2, 1)

(C) (2, 2)

(D) (4, 2)

58. Let $f(x, y) = x^2 - 2xy + y^3$, $x, y \in \mathbb{R}$. Then which one of the following statement is true?

(A) f has no saddle point.

(B) All critical points of f lies on a parabola $2y^2 = 3x$

(C) $27f(x, y) + 2 \geq 0$, $\forall$ (x, y)

(D) $27f(x, y) + 4 \geq 0$, $\forall$ (x, y)

59. If e^{-x} and e^{-4x} are two fundamental solutions of the equation $y'' + ay' + by = 0$, then the particular integral of the differential equation $y'' + ay' + by = 2e^{-4x}$ is

(A) $-\frac{3}{2}xe^{-4x}$

(B) $-\frac{2}{3}xe^{-4x}$

(C) $-\frac{3}{2}e^{-4x}$

(D) $-\frac{2}{3}e^{-4x}$

60. Newton's forward difference formula is used to fit a cubic polynomial in the following data:

x	0	1	2	3
$f(x)$	1	2	1	10

Then $f(-2)$ is equal to

(A) -14

(B) -55

(C) -31

(D) -39

61. Let $f(x)$ be a second degree polynomial such that $f(0) = 2$, $f(1) = 3k$, and $f(2) = 10$. If E is the exact value of the integral $\int_0^2 f(x)dx$ and T is the estimated value of the same integral by the Trapezoidal rule such that $E - T = 1$, then k is equal to

(A) 1

(B) 2

(C) $\frac{1}{3}$

(D) 3

62. The nullity of the matrix $\begin{pmatrix} 1 & -2 & 3 \\ 2 & -4 & 6 \\ 3 & -6 & 9 \end{pmatrix}$ is

(A) 0

(B) 1

(C) 2

(D) 3

63. Let $A = \begin{pmatrix} 3 & 2 & -1 \\ 1 & 6 & 3 \\ 2 & -4 & 0 \end{pmatrix}$. Then $det(adj\ (A))$ is equal to

(A) 54^2

(B) 64^2

(C) 64

(D) 64^3

64. Let $M = [m_{ij}]$ be a 3×3 matrix with real entries, and $N = [n_{ij}]$ be a matrix similar to M. If the characteristic polynomial of M is $x^3 + x$ then a value of n_{22} can be

(A) 1

(B) ω

(C) ω^2

(D) $1 + \omega + \omega^2$

65. A value of $c \in [1/2, 3]$ for which the Lagrange mean value theorem holds for the function $f(x) = x + x^{-1}$ is

(A) $\sqrt{\frac{3}{2}}$

(B) $\sqrt{\frac{2}{3}}$

(C) $\sqrt{\frac{3}{5}}$

(D) $\sqrt{\frac{5}{3}}$

66. The value of $\tanh^{-1}\left(\frac{1}{2}\right)$ is equal to

(A) $\frac{1}{2}$

(B) $\log\sqrt{3}$

(C) $\sqrt{2}$

(D) $\log\left(\frac{1}{9}\right)$

67. $\lim_{x\to\infty}\left(x\tan\left(\frac{1}{x}\right)\right)^{x^2}$ is equal to

(A) e^3

(B) $e^{1/3}$

(C) e^2

(D) $\sqrt{e}$

68. Which of the following NOT correct for the ring $R = \{a + b\sqrt{2} : a, b \in \mathbb{R}\}$?

(A) R is commutative

(B) R is associative

(C) R has an identity

(D) R has idempotent other than 0 and 1.

69. $\lim_{x\to 0} \dfrac{\cos\left(\frac{\pi}{2}\cos x\right)}{\sin(\sin x)}$ equals

(A) 0

(B) $\frac{1}{2}$

(C) $\frac{\pi}{2}$

(D) π

70. Let R be a ring of real 2×2 matrices $\begin{pmatrix} x & y \\ -y & x \end{pmatrix}$, and $\mathbb{C}$ be a ring of complex numbers $x + iy$. If $\phi : R \to \mathbb{C}$ is defined by $\phi\left(\begin{pmatrix} x & y \\ -y & x \end{pmatrix}\right) = x + iy$, then which one of the following is NOT correct

(A) ϕ is a homomorphism.

(B) ϕ is one-one.

(C) ϕ is not a homomorphism.

(D) ϕ is onto.