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	COMPUTER SCIENCE	

- Suppose A is a finite set with n elements. The number of elements and the rank of the largest equivalence relation on A are
 - $\{n, 1\}$
 - $\{n, n\}$
 - $\{n^2, 1\}$
 - $\{1, n^2\}$
- Consider the set of integers I . Let D denote "divides with an integer quotient" (e.g. $4D8$ but $4D7$). Then D is
 - Reflexive, not symmetric, transitive
 - Not reflexive, not antisymmetric, transitive
 - Reflexive, antisymmetric, transitive
 - Not reflexive, not antisymmetric, not transitive
- A bag contains 19 red balls and 19 black balls. Two balls are removed at a time repeatedly and discarded if they are of the same colour, but if they are different, black ball is discarded and red ball is returned to the bag. The probability that this process will terminate with one red ball is
 - 1
 - $1/21$
 - 0
 - 0.5
- If $x = -1$ and $x = 2$ are extreme points of $f(x) = \alpha \log|x| + \beta x^2 + x$ then
 - $\alpha = -6, \beta = -1/2$
 - $\alpha = 2, \beta = -1/2$
 - $\alpha = 2, \beta = 1/2$
 - $\alpha = -6, \beta = 1/2$
- Let $f(x) = \log|x|$ and $g(x) = \sin x$. If A is the range of $f(g(x))$ and B is the range of $g(f(x))$ then $A \cap B$ is
 - $[-1, 0]$
 - $[-1, 0]$
 - $[-\infty, 0]$
 - $[-\infty, 1]$

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	COMPUTER SCIENCE	

6. The proposition $(P \Rightarrow Q) \wedge (Q \Rightarrow P)$ is a
- (a) tautology (b) contradiction
(c) contingency (d) absurdity
7. If $T(x)$ denotes x is a trigonometric function, $P(x)$ denotes x is a periodic function and $C(x)$ denotes x is a continuous function then the statement “*It is not the case that some trigonometric functions are not periodic*” can be logically represented as
- (a) $\neg \exists x [T(x) \wedge \neg P(x)]$
(b) $\neg \exists x [T(x) \vee \neg P(x)]$
(c) $\neg \exists x [\neg T(x) \wedge \neg P(x)]$
(d) $\neg \exists x [T(x) \wedge P(x)]$
8. The number of elements in the power set of $\{\{1,2\}, \{2,1,1\}, \{2,1,1,2\}\}$ is
- (a) 3 (b) 8
(c) 4 (d) 2
9. The function $f: [0, 3] \rightarrow [1, 29]$ defined by $f(x) = 2x^3 - 15x^2 + 36x + 1$ is
- (a) injective and surjective
(b) surjective but not injective
(c) injective but not surjective
(d) neither injective nor surjective
10. If vectors $\vec{a} = 2\hat{i} + \lambda\hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - 2\hat{j} + 3\hat{k}$ are perpendicular to each other, then value of λ is
- (a) $2/5$ (b) 2
(c) 3 (d) $5/2$

11. Consider the schema

Sailors(sid,sname, rating, age) with the following data

sid	sname	rating	age
22	Dustin	7	45
29	Borg	1	33
31	Pathy	8	55
32	Robert	8	25
58	Raghu	10	17
64	Herald	7	35
71	Vishnu	10	16
74	King	9	35
85	Archer	3	26
84	Bob	3	64
96	Flinch	3	17

For the query

`SELECT S.rating, AVG(S.age) AS avgage FROM Sailors S`

Where $S.age \geq 18$

`GROUP BY S.rating`

`HAVING 1 < (SELECT COUNT(*) FROM Sailors S2 where S.rating = S2.rating)`

The number of rows returned is

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

12. Consider a table that describes the customers :

Customers(custid, name, gender, rating)

The *rating* value is an integer in the range 1 to 5 and only two values (*male and female*) are recorded for *gender*. Consider the query “how many male customers have a rating of 5”? The best indexing mechanism appropriate for the query is

- (a) Linear hashing
- (b) Extendible hashing
- (c) B+ tree
- (d) Bit-mapped index

13. Consider the following schema :

Sailors(sid, sname, rating, age)

Boats(bid, bname, colour)

Reserves(sid, bid, day)

Two boats can have the same name but the colour differentiates them.

The two relations

$\rho(\text{Tempsids}, (\pi_{sid, bid} \text{Reserves}) / (\pi_{bid} (\sigma_{bname='Ganga'} \text{Boats}))),$

$\pi_{sname} (\text{Tempsids} \bowtie \text{Sailors})$

If / is division operation, the above set of relations represents the query


- (a) Names of sailors who have reserved all boats called *Ganga*
 - (b) Names of sailors who have not reserved any *Ganga* boat
 - (c) Names of sailors who have reserved at least one *Ganga* boat
 - (d) Names of sailors who have reserved at most one *Ganga* boat
14. Type IV JDBC driver is a driver
- (a) which is written in C++
 - (b) which requires an intermediate layer
 - (c) which communicates through Java sockets
 - (d) which translates JDBC function calls into API not native to DBMS
15. Consider the following table : *Faculty(facName, dept, office, rank, dateHired)*

facName	dept	office	rank	dateHired
Ravi	Art	A101	Professor	1975
Murali	Math	M201	Assistant	2000
Narayanan	Art	A101	Associate	1992
Lakshmi	Math	M201	Professor	1982
Mohan	CSC	C101	Professor	1980
Sreeni	Math	M203	Associate	1990
Tanuja	CSC	C101	Instructor	2001
Ganesh	CSC	C105	Associate	1995

(Assume that no faculty member within a single department has same name. Each faculty member has only one office identified in *office*). 3NF refers to third normal form and BCNF refers to Boyce-Codd normal form

Then *Faculty* is

- (a) Not in 3NF, in BCNF
- (b) In 3NF, not in BCNF
- (c) In 3NF, in BCNF
- (d) Not in 3NF, not in BCNF

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	COMPUTER SCIENCE	

16. Consider the following query :

```
SELECT E.eno, COUNT(*)
FROM Employees E
GROUP BY E.eno
```

If an index on *eno* is available, the query can be answered by scanning only the index if

- (a) the index is only hash and clustered
- (b) the index is only B+ tree and clustered
- (c) index can be hash or B+ tree and clustered or non-clustered
- (d) index can be hash or B+ tree and clustered

17. If C is a skew-symmetric matrix of order n and X is $n \times 1$ column matrix, then $X^T CX$ is a

- (a) scalar matrix
- (b) null matrix
- (c) unit matrix
- (d) matrix will all elements 1

18. Consider the recurrence equation

$$T(n) = \begin{cases} 2T(n-1), & \text{if } n > 0 \\ 1 & \text{otherwise} \end{cases}$$

Then $T(n)$ is (in big O order)

- (a) $O(n)$
- (b) $O(2^n)$
- (c) $O(1)$
- (d) $O(\log n)$

19. Consider the program

```
void function(int n) {
    int i, j, count=0;
    for (i=n/2; i <= n; i++)
        for (j = 1; j <= n; j = j*2)
            count++;
}
```

The complexity of the program is

- (a) $O(\log n)$
- (b) $O(n^2)$
- (c) $O(n^2 \log n)$
- (d) $O(n \log n)$

20. Match the following and choose the correct answer for the order A,B,C,D

A. Strassen matrix multiplication	p. Decrease and Conquer
B. Insertion sort	q. Dynamic Programming
C. Guassian Elimination	r. Divide and Conquer
D. Floyd shortest path algorithm	s. Transform and Conquer

- | | |
|----------------|----------------|
| (a) r, s, p, q | (b) r, p, s, q |
| (c) q, s, p, r | (d) s, p, q, r |

21. For $\Sigma = \{a, b\}$ the regular expression $r = (aa)^*(bb)^*b$ denotes

- (a) Set of strings with 2 a 's and 2 b 's
- (b) Set of strings with 2 a 's 2 b 's followed by b
- (c) Set of strings with 2 a 's followed by b 's which is a multiple of 3
- (d) Set of strings with even number of a 's followed by odd number of b 's

22. Consider the grammar with productions

$$S \rightarrow aSb | SS | \varepsilon$$

This grammar is

- | | |
|----------------------------------|------------------------------|
| (a) not context-free, not linear | (b) not context-free, linear |
| (c) context-free, not linear | (d) context free, linear |


23. Identify the language generated by the following grammar

$$S \rightarrow AB$$


$$A \rightarrow aAb | \varepsilon$$

$$B \rightarrow bB | b$$

- | | |
|--|---|
| (a) $\{a^m b^n \mid n \geq m, m > 0\}$ | (b) $\{a^m b^n \mid n \geq m, m \geq 0\}$ |
| (c) $\{a^m b^n \mid n > m, m > 0\}$ | (d) $\{a^m b^m \mid n > m, m \geq 0\}$ |

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24. Let L_1 be regular language, L_2 be a deterministic context free language and L_3 a recursively enumerable language, but not recursive. Which one of the following statements is false?
- (a) $L_3 \cap L_1$ is recursive
(b) $L_1 \cap L_2 \cap L_3$ is recursively enumerable
(c) $L_1 \cup L_2$ is context free
(d) $L_1 \cap L_2$ is context free
25. Let $L = \{a^p \mid p \text{ is a prime}\}$. Then which of the following is true
- (a) It is not accepted by a Turing Machine
(b) It is regular but not context free
(c) It is context free but not regular
(d) It is neither regular nor context free, but accepted by a Turing Machine
26. Which of the following are context free?
 $A = \{a^n b^n a^m b^m \mid m, n \geq 0\}$
 $B = \{a^m b^n a^m b^n \mid m, n \geq 0\}$
 $C = \{a^m b^n \mid m \neq 2n, m, n \geq 0\}$
- (a) A and B only
(b) A and C only
(c) B and C only
(d) C only
27. Let S be an NP-complete problem. Q and R are other two problems not known to be NP. Q is polynomial time reducible to S and S is polynomial time reducible to R . Which of the following statements is true?
- (a) R is NP-complete
(b) R is NP-hard
(c) Q is NP-complete
(d) Q is NP-hard
28. The number of structurally different possible binary trees with 4 nodes is
- (a) 14
(b) 12
(c) 336
(d) 168

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	COMPUTER SCIENCE	


29. Using public key cryptography, X adds a digital signature σ to a message M , encrypts $\langle M, \sigma \rangle$ and sends it to Y , where it is decrypted. Which one of the following sequence of keys is used for operations?
- Encryption : X 's private key followed by Y 's private key. Decryption : X 's public key followed by Y 's public key
 - Encryption : X 's private key followed by Y 's public key; Decryption : X 's public key followed by Y 's private key
 - Encryption : X 's private key followed by Y 's public key; Decryption : Y 's private key followed by X 's public key.
 - Encryption : X 's public key followed by Y 's private key; Decryption : Y 's public key followed by X 's private key.
30. Which of the following are used to generate a message digest by the network security protocols?
- SHA-256
 - AES
 - DES
 - MD5
- P and S only
 - P and Q only
 - R and S only
 - P and R only
31. In the IPv4 addressing format, the number of networks allowed under Class C addresses is
- 2^{20}
 - 2^{24}
 - 2^{14}
 - 2^{21}
32. An Internet Service Provider (ISP) has the following chunk of CIDR-based IP addresses available with it: 245.248.128.0/20. The ISP wants to give half of this chunk of addresses to Organization A , and a quarter to Organization B , while retaining the remaining with itself. Which of the following is a valid allocation of addresses to A and B ?
- 245.248.136.0/21 and 245.248.128.0/22
 - 245.248.128.0/21 and 245.248.128.0/22
 - 245.248.132.0/22 and 245.248.132.0/21
 - 245.248.136.0/24 and 245.248.132.0/21

42. In designing a computer's cache system, the cache block (or cache line) size is an important parameter. Which one of the following statements is correct in this context?
- Smaller block size incurs lower cache miss penalty
 - Smaller block size implies better spatial locality
 - Smaller block size implies smaller cache tag
 - Smaller block size implies lower cache hit time
43. Consider an instruction of the type LW R1, 20(R2) which during execution reads a 32 bit word from memory and stores it in a 32 bit register R1. The effective address of the memory location is obtained by adding a constant 20 and contents of R2. Which one best reflects the source operand
- Immediate addressing
 - Register addressing
 - Register Indirect addressing
 - Indexed addressing
44. A sorting technique is called stable if
- If it takes $O(n \log n)$ time
 - It uses divide and conquer technique
 - Relative order of occurrence of non-distinct elements is maintained
 - It takes $O(n)$ space
45. Match the following and choose the correct answer in the order A, B, C


A. Heap Construction	p. $O(n \log n)$
B. Hash table construction with linear probing	q. $O(n^2)$
C. AVL Tree construction	r. $O(n)$

(Bounds given may or may not be asymptotically tight)


- q, r, p
- p, q, r
- q, p, r
- r, q, p

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	COMPUTER SCIENCE	

46. In a compact one dimensional array representation for lower triangular matrix (all elements above diagonal are zero) of size $n \times n$, non zero elements of each row are stored one after another, starting from first row, the index of $(i, j)^{\text{th}}$ element in this new representation is
- (a) $i + j$ (b) $j + \frac{i(i-1)}{2}$
(c) $i + j - 1$ (d) $i + \frac{j(j-1)}{2}$
47. Which of the following permutation can be obtained in the same order using a stack assuming that input is the sequence 5, 6, 7, 8, 9 in that order?
- (a) 7, 8, 9, 5, 6 (b) 5, 9, 6, 7, 8
(c) 7, 8, 9, 6, 5 (d) 9, 8, 7, 5, 6
48. Quick sort is run on 2 inputs shown below to sort in ascending order
- A. 1, 2, 3..... n
B. $n, n - 1, n - 2 \dots\dots 1$
- Let $C1$ and $C2$ be the number of comparisons made for A and B respectively.
- Then
- (a) $C1 > C2$ (b) $C1 = C2$
(c) $C1 < C2$ (d) Cannot say anything for arbitrary n
49. A binary search tree is used to locate the number 43. Which one of the following probe sequence is not possible?
- (a) 61, 52, 14, 17, 40, 43 (b) 10, 65, 31, 48, 37, 43
(c) 81, 61, 52, 14, 41, 43 (d) 17, 77, 27, 66, 18, 43
50. The characters of the string K R P C S N Y T J M are inserted into a hash table of size of size 10 using hash function
- $$h(x) = (\text{ord}(x) - \text{ord}(A) + 1)$$
- If linear probing is used to resolve collisions, then the following insertion causes collision
- (a) Y (b) C
(c) M (d) P

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	COMPUTER SCIENCE	

51. Suppose the numbers 7, 5, 1, 8, 3, 6, 0, 9, 4, 2 are inserted in that order into an initially empty binary search tree. The binary search tree uses the reversal ordering on natural numbers i.e. 9 is assumed to be smallest and 0 is assumed to be largest. The in-order traversal of the resultant binary search tree is
- (a) 9, 8, 6, 4, 2, 3, 0, 1, 5, 7 (b) 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
(c) 0, 2, 4, 3, 1, 6, 5, 9, 8, 7 (d) 9, 8, 7, 6, 5, 4, 3, 2, 1, 0
52. A priority queue is implemented as a Max-heap. Initially it has 5 elements. The level order traversal of the heap is 10, 8, 5, 3, 2. Two new elements '1' and '7' are inserted into the heap in that order. The level order traversal of the heap after the insertion of the elements is
- (a) 10, 8, 7, 5, 3, 2, 1 (b) 10, 8, 7, 2, 3, 1, 5
(c) 10, 8, 7, 1, 2, 3, 5 (d) 10, 8, 7, 3, 2, 1, 5
53. The minimum number of stacks needed to implement a queue is
- (a) 3 (b) 1
(c) 2 (d) 4
54. A strictly binary tree with 10 leaves
- (a) cannot have more than 19 nodes
(b) has exactly 19 nodes
(c) has exactly 17 nodes
(d) has exactly 20 nodes
55. What is the maximum height of any AVL tree with 7 nodes? Assume that height of tree with single node is 0.
- (a) 2 (b) 3
(c) 4 (d) 5

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	COMPUTER SCIENCE	

56. Which one of the following property is correct for a red-black tree?
- Every simple path from a node to a descendant leaf contains the same number of black nodes
 - If a node is red, then one children is red and another is black
 - If a node is red, then both its children are red
 - Every leaf node (sentinel node) is red
57. The in-order and pre-order traversal of a binary tree are d b e a f c g and a b d e c f g respectively. The post order traversal of a binary tree is
- e d b g f c a
 - e d b f g c a
 - d e b f g c a
 - d e f g b c a
58. A virtual memory system uses FIFO page replacement policy and allocates a fixed number of frames to the process. Consider the following statements
- M: Increasing the number of page frames allocated to a process sometimes increases the page fault rate
- N: Some programs do not exhibit locality of reference
- Which one of the following is true?
- Both M and N are true and N is the reason for M
 - Both M and N are true but N is not the reason for M
 - Both M and N are false
 - M is false, but N is true
59. Consider three CPU intensive processes, which require 10, 20, 30 units and arrive at times 0,2,6 respectively. How many context switches are needed if shortest remaining time first is implemented? Context switch at 0 is included but context switch at end is ignored
- 1
 - 2
 - 3
 - 4

60. A process executes the following code

```
for (i = 0; i < n; i++) fork( );
```

The total number of child processes created is

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

61. Consider the following scheduling :

A. Gang scheduling	s. Guaranteed scheduling
B. Rate Monotonic scheduling	t. Thread scheduling
C. Fair share scheduling	u. Real time scheduling

Matching the table in the order A, B, C gives


- (a) t, u, s (b) s, t, u
(c) u, s, t (d) u, t, s

62. A system uses FIFO policy for page replacement. It has 4 page frames with no pages loaded to begin with. The system first accesses 50 distinct pages in some order and then accesses the same 50 pages in reverse order. How many page faults will occur?

- (a) 96 (b) 100
(c) 97 (d) 92

63. Which of the following is false?

- (a) User level threads are not scheduled by the kernel
(b) Context switching between user level threads is faster than context switching between kernel level threads
(c) When a user thread is blocked all other threads of its processes are blocked
(d) Kernel level threads cannot utilize multiprocessor systems by splitting threads on different processors or cores

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64. Which of the following is not true with respect to deadlock prevention and deadlock avoidance schemes?
- In deadlock prevention, the request for resources is always granted if resulting state is safe
 - In deadlock avoidance, the request for resources is always granted, if the resulting state is safe
 - Deadlock avoidance requires knowledge of resource requirements a priori
 - Deadlock prevention is more restrictive than deadlock avoidance
65. Which one of the following are essential features of object oriented language?
- Abstraction and encapsulation
 - Strictly-typed
 - Type-safe property coupled with sub-type rule
 - Polymorphism in the presence of inheritance
- A and B only
 - A, D and B only
 - A and D only
 - A, C and D only
66. Which languages necessarily need heap allocation in the run time environment?
- Those that support recursion
 - Those that use dynamic scoping
 - Those that use global variables
 - Those that allow dynamic data structures

67. Consider the code segment

```

int i, j, x, y, m, n;
n=20;
for (i = 0, i < n; i++)
{
    for (j = 0; j < n; j++)
    {
        if (i % 2)
        {
            x += ((4*j) + 5*i);
            y += (7 + 4*j);
        }
    }
}
m = x + y;

```

Which one of the following is false?


- (a) The code contains loop invariant computation
- (b) There is scope of common sub-expression elimination in this code
- (c) There is scope of strength reduction in this code
- (d) There is scope of dead code elimination in this code

68. Consider the following table :

A. Activation record	p. Linking loader
B. Location counter	q. Garbage collection
C. Reference counts	r. Subroutine call
D. Address relocation	s. Assembler

Matching A, B, C, D in the same order gives :

- (a) p, q, r, s
- (b) q, r, s, p
- (c) r, s, q, p
- (d) r, s, p, q

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	COMPUTER SCIENCE	

69. Consider a disk sequence with 100 cylinders. The request to access the cylinder occur in the following sequence :

4, 34, 10, 7, 19, 73, 2, 15, 6, 20

Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 2 ms to move from one cylinder to adjacent one and shortest seek time first policy is used?

- (a) 190 (b) 238
(c) 233 (d) 276

70. A counting semaphore was initialised to 7. Then 20 P (wait) operations and x V (signal) operations were completed on this semaphore. If the final value of semaphore is 5, then the value x will be

- (a) 0 (b) 13
(c) 18 (d) 5

71. A 32 bit *adder* is formed by cascading 4 bit CLA *adder*. The gate delays (latency) for getting the sum bits is

- (a) 16 (b) 18
(c) 17 (d) 19

72. We consider the addition of two 2's compliment numbers $b_{n-1}b_{n-2}\dots b_0$ and $a_{n-1}a_{n-2}\dots a_0$. A binary adder for adding two unsigned binary numbers is used to add two binary numbers. The sum is denoted by $c_{n-1}c_{n-2}\dots c_0$. The carry out is denoted by c_{out} . The overflow condition is identified by

- (a) $c_{out} (\overline{a_{n-1}} \oplus \overline{b_{n-1}})$ (b) $\overline{a_{n-1}}b_{n-1}\overline{c_{n-1}} + \overline{a_{n-1}}b_{n-1}c_{n-1}$
(c) $c_{out} \oplus c_{n-1}$ (d) $a_{n-1} \oplus b_{n-1} \oplus c_{n-1}$



73. Consider the function

```
int fun(x: integer)
{
  If x > 100 then fun = x - 10;
  else
    fun = fun(fun(x + 11));
}
```

For the input x = 95, the function will return

- (a) 89
- (b) 90
- (c) 91
- (d) 92

74. Consider the function

```
int func(int num) {
int count = 0;
while(num) {
    count++;
    num >>= 1;
}
return(count) ;
}
```

For func(435) the value returned is

- (a) 9
- (b) 8
- (c) 0
- (d) 10

75. In IEEE floating point representation, the hexadecimal number 0xC0000000 corresponds to

- (a) -3.0
- (b) -1.0
- (c) -4.0
- (d) -2.0

76. Which of the following set of components is sufficient to implement any arbitrary Boolean function?

- (a) XOR gates, NOT gates
- (b) AND gates, XOR gates and 1
- (c) 2 to 1 multiplexer
- (d) Three input gates that output $(A.B) + C$ for the inputs A, B, C

77. Consider the following :

A. Condition Coverage	p. Black box testing
B. Equivalence Class partitioning	q. System testing
C. Volume Testing	r. White box testing
D. Beta Testing	s. Performance testing

Matching A, B, C, D in the same order gives.

- (a) r, p, s, q (b) p, r, q, s (c) s, r, q, p (d) q, r, s, p

78. Consider the results of a medical experiment that aims to predict whether someone is going to develop myopia based on some physical measurements and heredity. In this case, the input dataset consists of the person's medical characteristics and the target variable is binary: 1 for those who are likely to develop myopia and 0 for those who aren't. This can be best classified as

- (a) Regression (b) Decision Tree
(c) Clustering (d) Association Rules

79. Which of the following related to snowflake schema is true?


- (a) Each dimension is represented by a single dimensional table
(b) Maintenance efforts are less
(c) Dimension tables are normalised
(d) It is not an extension of star schema

80. Consider the following C function


```
#include <stdio.h>
int main(void)
{
    char c[] = "ICRBCSIT17";
    char *p=c;
    printf("%s", c+2[p] - 6[p] - 1);
    return 0;
}
```

The output of the program is

- (a) SI (b) IT (c) T1 (d) 17

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