Q. No. 1 – 25 Carry One Mark Each

1. Consider an undirected random graph of eight vertices. The probability that there is an edge between a pair of vertices is ½. What is the expected number of unordered cycles of length three?

(A) 1/8 (B) 1 (C) 7 (D) 8

Ans. (C)

Exp: $P(\text{edge}) = \frac{1}{2}$

Number of ways we can choose the vertices out of 8 is 8_{c_3}

(Three edges in each cycle)

Expected number of unordered cycles of length 3 $= 8_{C_3}\left(\frac{1}{2}\right)^3 = 7$

2. Which of the following statements is/are TRUE for undirected graphs?

P: Number of odd degree vertices is even.

Q: Sum of degrees of all vertices is even.

(A) P only (B) Q only

(C) Both P and Q (D) Neither P nor Q

Ans: (C)

Exp: Q: Sum of degrees of all vertices

$= 2 \times (\text{number of edges})$

3. Function f is known at the following points:

x	0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
f(x)	0	0.09	0.36	0.81	1.44	2.25	3.24	4.41	5.76	7.29	9.00

The value of $\int_0^3 f(x)\,dx$ computed using the trapezoidal rule is

(A) 8.983 (B) 9.003 (C) 9.017 (D) 9.045

Ans: (D)

Exp: $\int_0^3 f(x)\,dx = \frac{h}{2}\left[f(x_0) + f(x_{10}) + 2\left(f(x_1) + f(x_2) + \ldots + f(x_9)\right)\right]$

$= \frac{0.3}{2}\left[9.00 + 2(25.65)\right] = 9.045$

4. Which one of the following functions is continuous at $x = 3$?

(A) $f(x) = \begin{cases} 2, & \text{if } x = 3 \\ x-1, & \text{if } x > 3 \\ \dfrac{x+3}{3}, & \text{if } x < 3 \end{cases}$

(B) $f(x) = \begin{cases} 4, & \text{if } x = 3 \\ 8-x & \text{if } x \neq 3 \end{cases}$

(C) $f(x) = \begin{cases} x+3, & \text{if } x \le 3 \\ x-4 & \text{if } x > 3 \end{cases}$

(D) $f(x) = \dfrac{1}{x^3 - 27}, \quad \text{if } x \neq 3$

Ans: (A)

Exp: $\lim\limits_{x \to 3+} f(x) = \lim\limits_{x \to 3+} (x-1) = 2 = f(2)$

$\lim\limits_{x \to 3-} f(x) = \lim\limits_{x \to 3-} \left(\dfrac{x+3}{3}\right) = 2 = f(2)$

$\therefore f(x)$ is continuous at $x = 3$

5. Which one of the following expressions does NOT represent exclusive NOR of x and y?

(A) $xy + x'y'$ (B) $x \oplus y'$ (C) $x' \oplus y$ (D) $x' \oplus y'$

Ans: (D)

Exp: (A) $x \quad y = xy + \bar{x}\,\bar{y}$

(B) $x \oplus y = x\bar{\bar{y}} + \bar{x}\,\bar{y} = xy + \bar{x}\,\bar{y} = x \quad y$

(C) $\bar{x} \oplus y = (\bar{x})\bar{y} + \bar{\bar{x}}\, y = \bar{x}\,\bar{y} + xy = x \quad y$

(D) $\bar{x} \oplus \bar{y} = (\bar{x})y + x\bar{y} = x \oplus y$

6. In a k-way set associative cache, the cache is divided into v sets, each of which consists of k lines. The lines of a set are placed in sequence one after another. The lines in set s are sequenced before the lines in set (s+1). The main memory blocks are numbered 0 onwards. The main memory block numbered j must be mapped to any one of the cache lines from

(A) $(j \bmod v) * k$ to $(j \bmod v) * k + (k-1)$

(B) $(j \bmod v)$ to $(j \bmod v) + (k-1)$

(C) $(j \bmod k)$ to $(j \bmod k) + (v-1)$

(D) $(j \bmod k) * v$ to $(j \bmod k) * v + (v-1)$

Ans: (B)

7. What is the time complexity of Bellman-Ford single-source shortest path algorithm on a complete graph of n vertices?

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

Ans: (C)

Exp: Bellman-ford time complexity: $\theta(|v||E|)$

For complete graph: $|E| = \frac{n(n-1)}{2}$

$|v| = n$

$\therefore \theta\left(n \times \frac{n(n-1)}{2}\right) = \theta(n^2)$

8. Which of the following statements are TRUE?

(1) The problem of determining whether there exists a cycle in an undirected graph is in P.

(2) The problem of determining whether there exists a cycle in an undirected graph is in NP.

(3) If a problem A is NP-Complete, there exists a non-deterministic polynomial time algorithm to solve A.

(A) 1,2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only

Ans: (A)

Exp: 1. Cycle detection using DFS: $O(v + E) = O(v^2)$

It is polynomial problem

2. Every P-problem is NP $(P \subset NP)$

3. $NP - \text{complete} \in NP$

Hence, NP-complete can be solved in non-deterministic polynomial time

9. Which of the following statements is/are FALSE?

(1) For every non-deterministic Turing machine, there exists an equivalent deterministic Turing machine.

(2) Turing recognizable languages are closed under union and complementation.

(3) Turing decidable languages are closed under intersection and complementation

(4) Turing recognizable languages are closed under union and intersection.

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

Ans: (C)

Exp: (1) NTM $\cong$ DTM

(2) REL's are closed under union & but not complementation

(3) Turing decidable languages are recursive

And recursive languages are closed under intersection and complementation

(4) RELs are closed under union & Intersection

10. Three concurrent processes X, Y, and Z execute three different code segments that access and update certain shared variables. Process X executes the P operation (i.e., wait) on semaphores a, b and c; process Y executes the P operation on semaphores b, c and d; process Z executes the P operation on semaphores c, d, and a before entering the respective code segments. After completing the execution of its code segment, each process invokes the V operation (i.e., signal) on its three semaphores. All semaphores are binary semaphores initialized to one. Which one of the following represents a deadlock-

free order of invoking the P operations by the processes?

(A) $X : P(a)P(b)P(c) \quad Y : P(b)P(c)P(d) \quad Z : P(c)P(d)P(a)$

(B) $X : P(b)P(a)P(c) \quad Y : P(b)P(c)P(d) \quad Z : P(a)P(c)P(d)$

(C) $X : P(b)P(a)P(c) \quad Y : P(c)P(b)P(d) \quad Z : P(a)P(c)P(d)$

(D) $X : P(a)P(b)P(c) \quad Y : P(c)P(b)P(d) \quad Z : P(c)P(d)P(a)$

Ans: (B)

Exp: Suppose X performs P(b) and preempts, Y gets chance, but cannot do its first wait i.e., P(b), so waits for X, now Z gets the chance and performs P(a) and preempts, next X gets chance. X cannot continue as wait on ‘a’ is done by Z already, so X waits for Z. At this time Z can continue its operations as down on c and d. Once Z finishes, X can do its operations and so Y. In any of execution order of X, Y, Z one process can continue and finish, such that waiting is not circular. In options (A),(C) and (D) we can easily find circular wait, thus deadlock

11. An index is clustered, if

(A) it is on a set of fields that form a candidate key.

(B) it is on a set of fields that include the primary key.

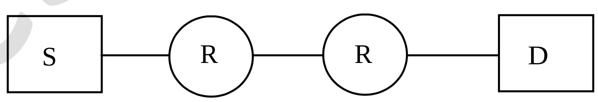
(C) the data records of the file are organized in the same order as the data entries of the index.

(D) the data records of the file are organized not in the same order as the data entries of the index.

Ans: (C)

Exp: Clustered index is built on ordering non key field and hence if the index is clustered then the data records of the file are organized in the same order as the data entries of the index.

12. Assume that source S and destination D are connected through two intermediate routers labeled R. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.



(A) Network layer – 4 times and Data link layer-4 times

(B) Network layer – 4 times and Data link layer-3 times

(C) Network layer – 4 times and Data link layer-6 times

(D) Network layer – 2 times and Data link layer-6 times

Ans: (C)

Exp: Each packet will visit network layer at S and D once and at two intermediate nodes R, R also once, so 4 times in total. Packet will visit Data link layer at S and D once (same as Network Layer), but in addition it will visit data link layer of routers(R, R) each two times. Once at the beginning when packet reaches R and goes up from Physical-Data Link-Network and second time in the reverse order while coming out of router in order Network-Data link-Physical. Hence 6 times in total.

13. The transport layer protocols used for real time multimedia, file transfer, DNS and email, respectively are

(A) TCP, UDP, UDP and TCP (B) UDP, TCP, TCP and UDP

(C) UDP, TCP, UDP and TCP (D) TCP, UDP, TCP and UDP

Ans: (C)

14. Using public key cryptography, X adds a digital signature σ to message M, encrypts <M, σ>, and sends it to Y, where it is decrypted. Which one of the following sequences of keys is used for the operations?

(A) Encryption: X's private key followed by Y's private key; Decryption: X's public key followed by Y's public key

(B) Encryption: X's private key followed by Y's public key; Decryption: X's public key followed by Y's private key

(C) Encryption: X's public key followed by Y's private key; Decryption: Y's public key followed by X's private key

(D) Encryption: X's private key followed by Y's public key; Decryption: Y's private key followed by X's public key

Ans: (D)

15. Match the problem domains in Group I with the solution technologies in Group II.

Group I	Group II
(p) Services oriented computing	(1) Interoperability
(q) Heterogeneous communicating systems	(2) BPMN
(R) Information representation	(3) Publish-find bind
(S) Process description	(4) XML

(A) P – 1, Q – 2, R – 3, S – 4 (B) P – 3, Q – 4, R – 2, S – 1

(C) P – 3, Q – 1, R – 4, S – 2 (D) P – 4, Q – 3, R – 2, S – 1

Ans: (C)

16. A scheduling algorithm assigns priority proportional to the waiting time of a process. Every process starts with priority zero(the lowest priority). The scheduler re-evaluates the process priorities every T time units and decides the next process to schedule. Which one of the following is TRUE if the processes have no I/O operations and all arrive at time zero?

(A) This algorithm is equivalent to the first-come-first-serve algorithm.

(B) This algorithm is equivalent to the round-robin algorithm.

(C) This algorithm is equivalent to the shortest-job-first algorithm.

(D) This algorithm is equivalent to the shortest-remaining-time-first algorithm.

Ans: (B)

17. What is the maximum number of reduce moves that can be taken by a bottom-up parser for a grammar with no epsilon- and unit-production (i.e., of type $A \to \epsilon$ and $A \to a$) to parse a string with n tokens?

(A) n/2 (B) n-1 (C) 2n-1 (D) 2^n

Ans: (C)

Exp: string = abcd

$$
\begin{array}{l}
S \\
\Uparrow \quad (7) \\
YD \\
\Uparrow \quad (6 : Y \to XC) \\
XCD \\
\Uparrow \quad (5 : X \to AB) \\
ABCD \\
\Uparrow \quad (4 : D \to d) \\
ABCd \\
\Uparrow \quad (3 : C \to c) \\
ABcd \\
\Uparrow \quad (2 : B \to b) \\
Abcd \\
\Uparrow \quad (1 : A \to a) \\
abcd
\end{array}
$$

$2 \times (4) - 1 = 7$ reductions

$\Rightarrow 2n - 1$ reductions required

(Note : Unit productions is given as $A \to a$, it was typo)

Above reductions are not in reverse of RMD but when they are reduced in bottom up parsing we will get same number of reductions.

18. Consider the languages $L_1 = \Phi$ and $L_2 = \{a\}$. Which one of the following represents $L_1 L_2^* U L_1^*$?

(A) $\{\epsilon\}$ (B) Φ (C) a^* (D) $\{\epsilon, a\}$

Ans: (A)

EXP: Concatenation of empty language with any language will give the empty language and $L_1^* = \Phi^* = \epsilon$. Hence $L_1 L_2^* U L_1^* = \{\epsilon\}$

19. Which one of the following is the tightest upper bound that represents the time complexity of inserting an object into a binary search tree of n nodes?

(A) O(1) (B) O(log n) (C) O(n) (D) O(n log n)

Ans: (C)

Exp: For Skewed binary search tree on n nodes, the tightest upper bound to insert a node is O(n)

20. Which one of the following is the tightest upper bound that represents the number of swaps required to sort n numbers using selection sort?

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

Ans: (B)

Exp: The maximum number of swaps that takes place in selection sort on n numbers is n

21. In the following truth table, V = 1 if and only if the input is valid.

Inputs				Outputs		
D_0	D_1	D_2	D_3	X_0	X_1	V
0	0	0	0	X	X	0
1	0	0	0	0	0	1
X	1	0	0	0	1	1
X	X	1	0	1	0	1
X	X	X	1	1	1	1

What function does the truth table represent?

(A) Priority encoder (B) Decoder

(C) Multiplexer (D) Demultiplexer

Ans: (A)

Exp: 4 to 2 priority encoder.

22. The smallest integer than can be represented by an 8-bit number in 2's complement form is

(A) -256 (B) -128 (C) -127 (D) 0

Ans: (B)

Exp: $-2^{8-1} = -128$

23. Which one of the following does NOT equal $\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix}$?

(A) $\begin{vmatrix} 1 & x(x+1) & x+1 \\ 1 & y(y+1) & y+1 \\ 1 & z(z+1) & z+1 \end{vmatrix}$

(B) $\begin{vmatrix} 1 & x+1 & x^2+1 \\ 1 & y+1 & y^2+1 \\ 1 & z+1 & z^2+1 \end{vmatrix}$

(C) $\begin{vmatrix} 0 & x-y & x^2-x^2 \\ 0 & y-z & y^2-z^2 \\ 1 & z & z^2 \end{vmatrix}$

(D) $\begin{vmatrix} 2 & x+y & x^2+y^2 \\ 2 & y+z & y^2+z^2 \\ 1 & z & z^2 \end{vmatrix}$

Ans: (A)