

1. $\lim_{x \rightarrow \infty} \frac{x - \sin x}{x + \cos x}$ equals

(A) 1

(B) -1

(C) ∞

(D) $-\infty$

ANS: (A)

$$\lim_{x \rightarrow \infty} \frac{1 - \frac{\sin x}{x}}{1 + \frac{\cos x}{x}}$$

$$= \frac{1-0}{1+0}=1$$

2. If P, Q, R are subsets of the universal set U, then

$$(P \cap Q \cap R) \cup (P' \cap Q \cap R) \cup Q' \cup R'$$

(A) $Q' \cup R'$

(B) $P \cup Q' \cup R'$

(C) $P' \cup Q' \cup R'$

(D) U

Ans: (D)

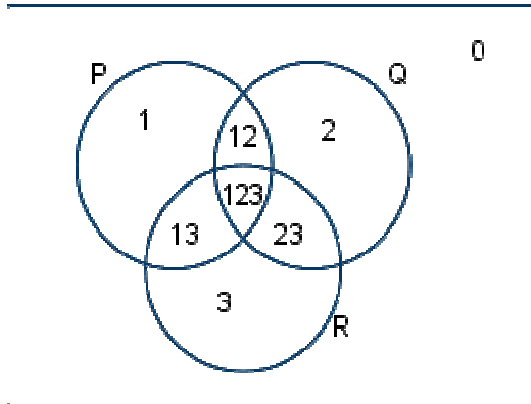
$P \cap Q \cap R$ covers part - 123

$P' \cap Q \cap R$ covers part - 23

Q' covers part - 1,13,3,0

R' covers part - 1,2,12,0

So it covers all parts i.e., U



3. The following system of equations

$$X_1 + X_2 + 2X_3 = 1$$

$$X_1 + 2X_2 + 3X_3 = 2$$

$$X_1 + 4X_2 + \alpha X_3 = 4$$

has a unique solution. The only possible value(s) for α is/are

- (A) 0
- (B) either 0 or 1
- (C) one of 0, 1 or -1
- (D) any real number

Ans: (C)

find augmented matrix. rank of that matrix = 3 if $\alpha \neq 5$; otherwise it is 2. For unique solution, rank of augmented matrix = number of unknowns. Here in this case $\alpha \neq 5$, then system has a unique solution.

4. In the IEEE floating point representation the hexadecimal value 0x00000000 corresponds to

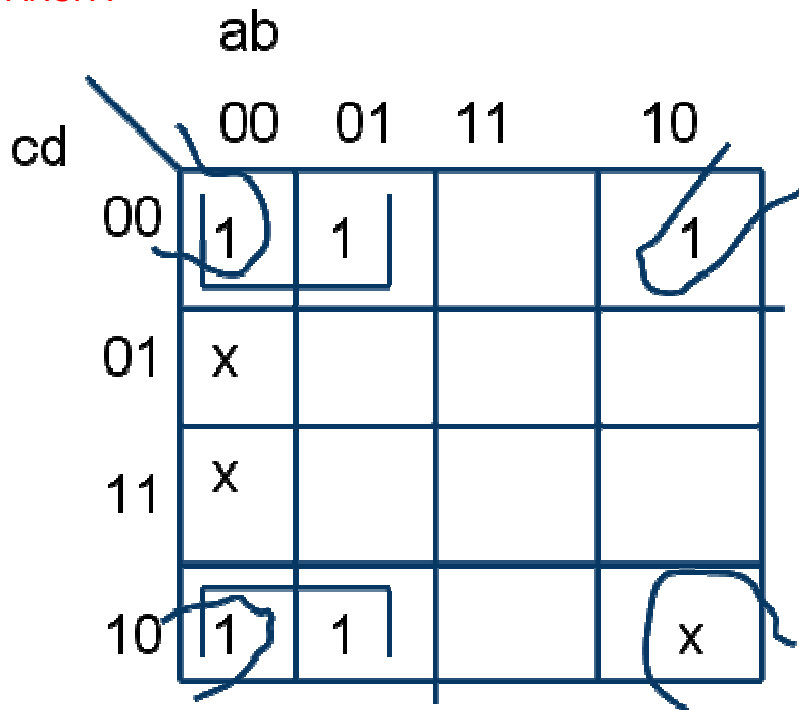
- (A) The normalized value 2^{-127}
- (B) The normalized value 2^{-126}
- (C) The normalized value +0
- (D) The special value +0

ANS D

5. In the Karnaugh map shown below, X denotes a don't care term. What is the minimal form of the function represented by the Karnaugh map?

- (A) $\bar{b}. \bar{d} + \bar{a}. \bar{d}$
 (B) $\bar{a}. \bar{b} + \bar{b}. \bar{d} + \bar{a}. b. \bar{d}$
 (C) $\bar{b}. \bar{d} + \bar{a}. b. \bar{d}$
 (D) $\bar{a}. \bar{b} + \bar{b}. \bar{d} + \bar{a}. \bar{d}$

ANS: A



6. Let r denote number system radix. The only value(s) of r that satisfy the equation $\sqrt{121_r} = 11_r$ is / are

- (A) decimal 10
 (B) decimal 11
 (C) decimal 10 and 11

(D) any value >2

ANS D

$$121_r = r^2 + 2r + 1$$

$$11_r = r + 1$$

$$\sqrt{121_r} = 11_r$$

$$\sqrt{r^2 + 2r + 1} = r + 1 \text{-----} > \text{equation 1}$$

above eq can be satisfied by any r value > 2

7. The most efficient algorithm for finding the number of connected components in an undirected graph on n vertices and m edges has time complexity

- (A) $\Theta(n)$
- (B) $\Theta(m)$
- (C) $\Theta(m + n)$
- (D) $\Theta(mn)$

Ans.) C

DFS traversal can be used to find it.

8. Given f_1 , f_3 and f in canonical sum of products form (in decimal) for the

$$f_1 = \text{Sm}(4, 5, 6, 7, 8)$$

$$f_3 = \text{Sm}(1, 6, 15)$$

$$f = \text{Sm}(1, 6, 8, 15)$$

then f_2 is

(A) Sm(4,6)

(B) Sm(4,8)

(C) Sm(6,8)

(D) Sm(4,6,8)

ANS:C

$$f = f_1 . f_2 + f_3$$

$$(4,5,6,7,8).f_2 + (1,6,15) = (1,6,8,15)$$

option C will satisfy above equation.

9. Which of the following is true for the language

$\{a^p \mid a \text{ p is a prime}\}$?

(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

Ans:(D)

10. Which of the following are decidable?

I. Whether the intersection of two regular languages is infinite

II. Whether a given context-free language is regular

III. Whether two push-down automata accept the same language

IV. Whether a given grammar is context-free

(A) I and II

- (B) I and IV
- (C) II and III
- (D) II and IV

Ans : B

Explanation: I is true because intersection of two regular languages is always regular. so we can build dfa for intersection language and one can check for the finiteness in polynomial time(checking for loop). IV is also true because given a grammar whether it is contextfree or not can be easily identified by writing some simple string recognition program(**context-free grammar (CFG)** is a grammar in which every production rule is of the form $V \rightarrow w$ where V is a single nonterminal symbol, and w is a string of terminals and/or nonterminals (possibly empty))can be easily identified.

11. Which of the following describes a handle (as applicable to LR-parsing) appropriately?

- (A) It is the position in a sentential form where the next shift or reduce operation will occur
- (B) It is non-terminal whose production will be used for reduction in the next step
- (C) It is a production that may be used for reduction in a future step along with a position in the sentential form where the next shift or reduce operation will occur
- (D) It is the production p that will be used for reduction in the next step along with a position in the sentential form where the right hand side of the production may be found

Ans (D)

12. Some code optimizations are carried out on the intermediate code because

- (A) They enhance the portability of the compiler to other target processors
- (B) Program analysis is more accurate on intermediate code than on machine code
- (C) The information from data flow analysis cannot otherwise be used for optimization
- (D) The information from the front end cannot otherwise be used for optimization

Ans (A)

13. If L and \bar{L} are recursively enumerable then L is

- (A) regular
- (B) context-free
- (C) context-sensitive
- (D) recursive

ANS: D

14. What is the maximum size of data that the application layer can pass on to the TCP layer below?

(A) Any size

(B) 2^{16}

bytes-size of TCP header

(C) 2^{16}

bytes

(D) 1500 bytes

Ans (A)

Application layer can pass any length data. TCP layer will divide that data into frames.

15. Which of the following tuple relational calculus expression(s) is/are equivalent to

$\forall t \in r(p(t))$?

I. $\exists t \in r(p(t))$

- II. $\exists t \notin r(p(t))$
- III. $\neg \exists t \in r(\neg p(t))$
- IV. $\exists t \notin r(\neg p(t))$

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

Ans: C

16. A clustering index is defined on the fields which are of type

- (A) non-key and ordering
- (B) non-key and non-ordering
- (C) key and ordering
- (D) key and non-ordering

Ans : (A)

17. Which of the following system calls results in the sending of SYN packets?

- (A) socket
- (B) bind
- (C) listen
- (D) connect

Ans: D

In the process of establishing a connection between two endpoints, the user process on active end point invokes the connect() system call. The active end point then sends a SYN packet.

The passive end point invokes an accept() system call and sends ACK to the other system then the connection is established.

18. Which combination of the integer variables x, y and z makes the variable a get the value 4 in the following expression?

$a = (x > y) ? ((x > z) ? x : z) : ((y > z) ? y : z)$

(A) $x = 3, y = 4, z = 2$

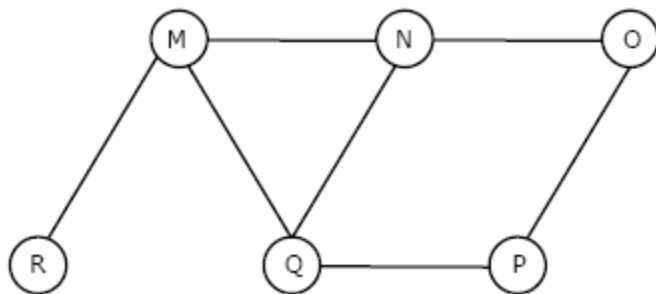
(B) $x = 6, y = 5, z = 3$

(C) $x = 6, y = 3, z = 5$

(D) $x = 5, y = 4, z = 5$

Ans: A, It returns the max of (x,y,z)

19. The Breadth First Search algorithm has been implemented using the queue data structure. One possible order of visiting the nodes of the following graph is



(A) MNOPQR

(B) NQMPOR

(C) QMNPRO

(D) QMNPOR

Ans.) C

20. The data blocks of a very large file in the Unix file system are allocated using

- (A) contiguous allocation
- (B) linked allocation
- (C) indexed allocation
- (D) an extension of indexed allocation

Ans: D

Unix uses inodes to store information about the files. which uses indexed allocation.

Q.21 – Q.75 Carry Two Marks Each

21. The minimum number of equal length subintervals needed to

approximate $\int_1^2 x e^x dx$ to an accuracy of at least $\frac{1}{3} \times 10^{-6}$ using the trapezoidal rule is

- (A) 1000e
- (B) 1000
- (C) 100e
- (D) 100

Ans:(A)

$$\text{error} = -\frac{(b-a)^3}{12n^2} f''(\xi),$$

where ξ is some number between a and b .

$$\text{error} = -\frac{(2-1)^3}{12n^2} f''(\xi) = -\frac{(1)^3}{12n^2} f''(\xi)$$

$$f'(x) = x e^x + e^x$$

$$f''(x) = x e^x + e^x + e^x = (x+2)e^x$$

maximum error will be at $\xi = 2$

if we substitute $\epsilon = 2$ then error will be $-\frac{(1)^3}{12n^2} * 3e^2$

if we equate $-\frac{(1)^3}{12n^2} * 3e^2 = \frac{1}{3} * 10^{-6}$ then we will get $n = 1000e$

http://en.wikipedia.org/wiki/Trapezoidal_rule

22. The Newton-Raphson iteration $x_{n+1} = \frac{1}{2} \left(x_n + \frac{R}{x_n} \right)$

can be used to compute the

- (A) square of R
- (B) reciprocal of R
- (C) square root of R
- (D) logarithm of R

ANS:(C)

take $f(x) = x^2 - R = 0$

$$x_{n+1} = x_n - [f(x_n) / f'(x_n)]$$

substitute $f(x) = x^2 - R$

it will give $x_{n+1} = \frac{1}{2} \left(x_n + \frac{R}{x_n} \right)$

23. Which of the following statements is true for every planar graph on n vertices?

- (A) The graph is connected
- (B) The graph is Eulerian
- (C) The graph has a vertex-cover of size at most $3n/4$
- (D) The graph has an independent set of size at least $n/3$

Ans.) C

Since Every Planar graph $G(V, E)$ is 4-colorable, the vertex set can be divided into 4 independent sets, So by the pigeon hole principle there will be at least one independent set with size $|V|/4$, So the size of the maximum independent set is atleast $|V|/4$, by which the size of the minimum vertex cover is atmost $3|V|/4$.

24.

Let $P = \sum_{1 \leq i \leq 2k} i$ (i is odd) $Q = \sum_{1 \leq i \leq 2k} i$ (i is even), where k is a positive integer. Then

- (A) $P = Q - K$
- (B) $P = Q + K$
- (C) $P = Q$
- (D) $P = Q + 2K$

Ans.) A

Can be easily proved by induction on k

25. A point on a curve is said to be an extremum if it is a local minimum or a local maximum. The number of distinct extrema for the curve $3x^4$

$- 16x^3 + 24x^2 + 37$ is

- (A) 0

(B) 1

(C) 2

(D) 3

Ans:(B)

$$f(x) = 3x^4 - 16x^3 + 24x^2 + 37$$

$$f'(x) = 0 \text{ then } x=0,2,2.$$

do the first derivative test at points 0,2.

<http://www.tutorvista.com/content/math/calculus/application-derivatives/maxima-minima.php>

26. If P, Q, R are Boolean variables, then $(P + Q)(P.\bar{Q} + P.R)(P.\bar{R} + \bar{Q})$

Simplifies to

(A) $P.\bar{Q}$

(B) $P.\bar{R}$

(C) $P.\bar{Q} + R$

(D) $P.\bar{R} + Q$

Ans :A

$$= (P.\bar{Q} + P.R + P.Q.R)(P.\bar{R} + \bar{Q})$$

$$= (P.\bar{Q} + P.R)(P.\bar{R} + \bar{Q})$$

$$= (P.\bar{Q} + P.R.\bar{Q})$$

$$= P.\bar{Q}$$

27. Aishwarya studies either computer science or mathematics everyday. If she studies computer science on a day, then the probability that she studies mathematics the next day is 0.6. If she studies mathematics on a day, then the probability that she studies computer science the next day is 0.4. Given that Aishwarya studies computer science on Monday, what is the probability that she studies computer science on Wednesday?

- (A) 0.24
- (B) 0.36
- (C) 0.4
- (D) 0.6

Ans: C

Prob of studying maths on Tuesday is = 0.6

Prob of studying computers on Tuesday is = $1 - 0.6 = 0.4$

Prob of studying computers on Wednesday is = $0.6 \cdot 0.4 + 0.4 \cdot 0.4 = 0.24 + 0.16 = 0.4$

28. How many of the following matrices have an eigen value 1?

$$\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & -1 \\ 1 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

- (A) one
- (B) two
- (C) three
- (D) four

Ans:(A)

29. Let X be a random variable following normal distribution with mean +1 and variance 4. Let Y be another normal variable with mean -1 and variance unknown. If $P(X \leq -1)$

= $P(Y \geq 2)$ standard deviation of Y is

(A) 3

(B) 2

(C) $\sqrt{2}$

(D) 1

30. Let fsa and pda be two predicates such that $fsa(x)$ means x is a finite state automaton, and $pda(y)$ means that y is a pushdown automaton. Let $equivalent$ be another predicate such that $equivalent(a, b)$ means a and b are equivalent.

Which of the following first order logic statements represents the following:

Each finite state automaton has an equivalent pushdown automaton

(A) $(\forall x fsa(x)) \Rightarrow (\exists y pda(y) \wedge equivalent(x, y))$

(B) $\sim \forall y (\exists x fsa(x) \Rightarrow pda(y) \wedge equivalent(x, y))$

(C) $\forall x \exists y (fsa(x) \wedge pda(y) \wedge equivalent(x, y))$

(D) $\forall x \exists y (fsa(y)) \wedge pda(x) \wedge equivalent(x, y)$

Ans.) C

Can be stated as "for each finite automaton(x) there exists an equivalent push down automaton(y)"

31. P and Q are two propositions. Which of the following logical expressions are equivalent?

I. $P \vee \sim Q$

II. $\sim(\sim P \wedge Q)$

III. $(P \wedge Q) \vee (P \wedge \sim Q) \vee (\sim P \wedge \sim Q)$

IV. $(P \wedge Q) \vee (P \wedge \sim Q) \vee (\sim P \wedge Q)$

(A) Only I and II

- (B) Only I, II and III
- (C) Only I, II and IV
- (D) All of I, II III and IV

Ans: B

II is equivalent to $P \vee \sim Q$

III: $(P \wedge Q) \vee (P \wedge \sim Q) \vee (\sim P \wedge \sim Q) = P \vee (\sim P \wedge \sim Q) = P \vee \sim Q$

IV: $(P \wedge Q) \vee (P \wedge \sim Q) \vee (\sim P \wedge Q) = P \vee (\sim P \wedge Q) = P \vee Q$

32. For a magnetic disk with concentric circular tracks, the seek latency is not linearly proportional to the seek distance due to

- (A) non-uniform distribution of requests
- (B) arm starting and stopping inertia
- (C) higher capacity of tracks on the periphery of the platter
- (D) use of unfair arm scheduling policies

ANS B

33. Which of the following is/are true of the auto-increment addressing mode?

- I. It is useful in creating self-relocating code
- II. If it is included in an Instruction Set Architecture, then an additional ALU is required for effective address calculation
- III. The amount of increment depends on the size of the data item accessed

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

ANS: C

34. Which of the following must be true for the RFE (Return From Exception) instruction on a general purpose processor?

- I. It must be a trap instruction
- II. It must be a privileged instruction
- III. An exception cannot be allowed to occur during execution of an RFE instruction

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

Ans:B

35. For inclusion to hold between two cache levels L1 and L2 in a multi-level cache hierarchy, which of the following are necessary?

- I. L1 must be a write-through cache
- II. L2 must be a write-through cache
- III. The associativity of L2 must be greater than that of L1
- IV. The L2 cache must be at least as large as the L1 cache

- (A) IV only

(B) I and IV only

(C) I, II and IV only

(D) I, II, III and IV

ANS: B is correct

Inclusion: if data at L1 is always a subset of data at L2 hence The L2 cache must be at least as large as the L1 cache.

In a **write-through** cache, every write to the cache causes a synchronous write to the backing store. hence L1 must be write-through cache. and L2 need not be write-through.

36. Which of the following are NOT true in a pipelined processor?

I. Bypassing can handle all RAW hazards

II. Register renaming can eliminate all register carried WAR hazards

III. Control hazard penalties can be eliminated by dynamic branch prediction

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

ANS: C ??

<http://www.cs.iastate.edu/~prabhu/Tutorial/PIPELINE/dataHazClass.html#RAW>

37. The use of multiple register windows with overlap causes a reduction in the number of memory accesses for

I. Function locals and parameters

II. Register saves and restores

III. Instruction fetches

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

ANS: A

38. In an instruction execution pipeline, the earliest that the data TLB (Translation Lookaside Buffer) can be accessed is

- (A) Before effective address calculation has started
- (B) During effective address calculation
- (C) After effective address calculation has completed
- (D) After data cache lookup has completed

ANS:C

39. Consider the following functions:

$$f(n) = 2^n$$

$$g(n) = n!$$

$$h(n) = n^{\log n}$$

Which of the following statements about the asymptotic behaviour of $f(n)$, $g(n)$, and $h(n)$ is true?

- (A) $f(n) = O(g(n))$; $g(n) = O(h(n))$
- (B) $f(n) = \Omega(g(n))$; $g(n) = O(h(n))$
- (C) $g(n) = O(f(n))$; $h(n) = O(f(n))$
- (D) $h(n) = O(f(n))$; $g(n) = \Omega(f(n))$

Ans.) D

$g(n) = \Omega(f(n))$ is obvious

$h(n) = O(f(n))$ can be understood by applying logarithm to $f(n)$ and $g(n)$.

40. The minimum number of comparisons required to determine if an integer appears

more than $n/2$ times in a sorted array of n integers is

- (A) $\Theta(n)$
- (B) $\Theta(\log n)$
- (C) $\Theta(\log^* n)$
- (D) $\Theta(1)$

Ans: B

If there exists an element which appears more than $n/2$ times, it will be the middle element (because the array is sorted)

To check whether that middle element is coming for at least $n/2$ times, we would do the binary search on both left and right sides of the middle element.

41. A B-tree of order 4 is built from scratch by 10 successive insertions. What is the maximum number of node splitting operations that may take place?

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

Ans: (C)

Ex: lets take 1,2,3,4,5,6,7,8,9,10 elements.

Insertion of 1,2,3 - 0 splits

insertion of 4 ----- 1 split

insertion of 5 ----- 0 split

insertion of 6 ----- 1 split

insertion of 7 ----- 0 split

insertion of 8 ----- 1 split

at this point, root has 4 children.

Insertion of 9 will split the node as well as the root ----- 2 splits

insertion of 10 ----- 0 split

Total = 5 splits

42. G is a graph on n vertices and $2n-2$ edges. The edges of G can be partitioned into two edge-disjoint spanning trees. Which of the following is NOT true for G ?

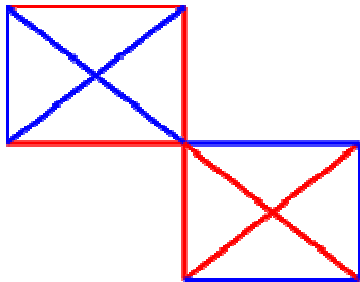
(A) For every subset of k vertices, the induced subgraph has at most $2k-2$ edges.

(B) The minimum cut in G has at least two edges.

(C) There are two edge-disjoint paths between every pair of vertices .

(D) There are two vertex-disjoint paths between every pair of vertices .

Ans.) D



The graph above is union of two disjoint spanning trees indicated by blue and red lines and has a vertex that is common among all paths between a pair of vertices.

A is true because the induced sub graph on k vertices can be constructed as the union of the induced sub graphs on k vertices

of two edge-disjoint spanning trees and each of the induced spanning trees has at most $k-1$ edges

So the induced sub graph has at most $k-1+k-1 = 2k-2$ edges.

B is true otherwise G cannot be partitioned into two edge disjoint spanning trees

C is true otherwise G has a minimum cut of one edge.

43. Consider the Quicksort algorithm. Suppose there is a procedure for finding a pivot element which splits the list into two sub-lists each of which contains at least one-fifth of the elements. Let $T(n)$ be the number of comparisons required to sort n elements. Then

(A) $T(n) \leq 2T(n/5) + n$

(B) $T(n) \leq T(n/5) + T(4n/5) + n$

(C) $T(n) \leq 2T(4n/5) + n$

(D) $T(n) \leq 2T(n/2) + n$

Ans.) C

$$T(n) = T(a) + T(b) + n, a \geq n/5, b \geq n/5 \text{ and } a+b=n \Rightarrow a \leq 4n/5 \text{ and } b \leq 4n/5$$

$$\Rightarrow T(n) \leq 2T(4n/5) + n$$

44. The subset-sum problem is defined as follows: Given a set S of n positive integers and a positive integer W , determine whether there is a subset of S Whose elements sum to W .

An algorithm Q solves this problem in $O(nW)$ time. Which of the following statements is false?

(A) Q solves the subset-sum problem in polynomial time when the input is encoded in unary

(B) Q solves the subset-sum problem in polynomial time when the input is encoded in binary

(C) The subset sum problem belongs to the class NP

(D) The subset sum problem is NP-hard

Ans.) B

45. Dijkstra's single source shortest path algorithm when run from vertex a in the above graph, computes the correct shortest path distance to

(A) only vertex a

(B) only vertices a, e, f, g, h

(C) only vertices a, b, c, d

(D) all the vertices

Ans.) D

Even though the graph has negative weights, it correctly computes the shortest path distances to all the vertices.

There will not be any problem with the Dijkstra's algorithm operating on negative edge weights

as long as the shortest path distance computed for the currently removed vertex is the actual shortest path distance

46. You are given the postorder traversal, P, of a binary search tree on the n elements 1, 2, ..., n. You have to determine the unique binary search tree that has P as its postorder traversal. What is the time complexity of the most efficient algorithm for doing this?

(A) $\Theta(\log n)$

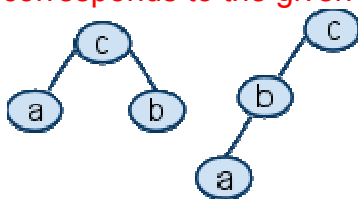
(B) $\Theta(n)$

(C) $\Theta(n \log n)$

(D) None of the above, as the tree cannot be uniquely determined

Ans.) D

For example if the post order is a,b,c. there will be atleast two possible trees that corresponds to the given post order.



47. We have a binary heap on n elements and wish to insert n more elements (not necessarily one after another) into this heap. The total time required for this is

(A) $\Theta(\log n)$

(B) $\Theta(n)$

(C) $\Theta(n \log n)$

(D) $\Theta(n^2)$

Ans: B

Constructing a heap for $2n$ elements takes $O(n)$ time

48. Which of the following statements is false?

(A) Every NFA can be converted to an equivalent DFA

(B) Every non-deterministic Turing machine can be converted to an equivalent deterministic Turing machine

(C) Every regular language is also a context-free language

(D) Every subset of a recursively enumerable set is recursive

Ans.) D

consider a R.E which is a union of two R.E's

49. Given below are two finite state automata (\rightarrow indicates the start state and F indicates a final state.)

Y:		a	b
	$\rightarrow 1$	1	2
	2(F)	2	1

Z:		a	b
	$\rightarrow 1$	2	2
	2(F)	1	1

Which of the following represent the product automaton $Z \times Y$?

(A)		a	b
	$\rightarrow P$	S	R
	Q	R	S
	R(F)	Q	P
	S	Q	P

(B)		a	b
	$\rightarrow P$	S	Q
	Q	R	S
	R(F)	Q	P
	S	P	Q

(C)		a	b
	$\rightarrow P$	Q	S
	Q	R	S
	R(F)	Q	P
	S	Q	P

(D)		a	b
	$\rightarrow P$	S	Q
	Q	S	R
	R(F)	Q	P
	S	Q	P

Ans.) A

50. Which of the following statements are true?

I. Every left-recursive grammar can be converted to a right-recursive grammar and vice-versa

II. All ϵ -productions can be removed from any context-free grammar by suitable transformations

III. The language generated by a context-free grammar all of whose productions are of the form $X \rightarrow w$ or $X \rightarrow wY$ (where, w is a string of terminals and Y is a non-terminal), is always regular

IV. The derivation trees of strings generated by a context-free grammar in Chomsky Normal Form are always binary trees

(A) I, II, III and IV

(B) II, III and IV only

(C) I, III and IV only

(D) I, II and IV only

Ans) A

51. Match the following:

E. Checking that identifiers are declared before their use P. $L = \{ a^n b^m c^n d^m \mid n \geq 1, m \geq 1 \}$

F. Number of formal parameters in the declaration of a function agrees with the number of actual parameters in use of that function Q. $X \rightarrow XbX \mid XcX \mid dXf \mid g$

G. Arithmetic expressions with matched pairs of parentheses R. $L = \{ w cw \mid w \in (a+b)^* \}$

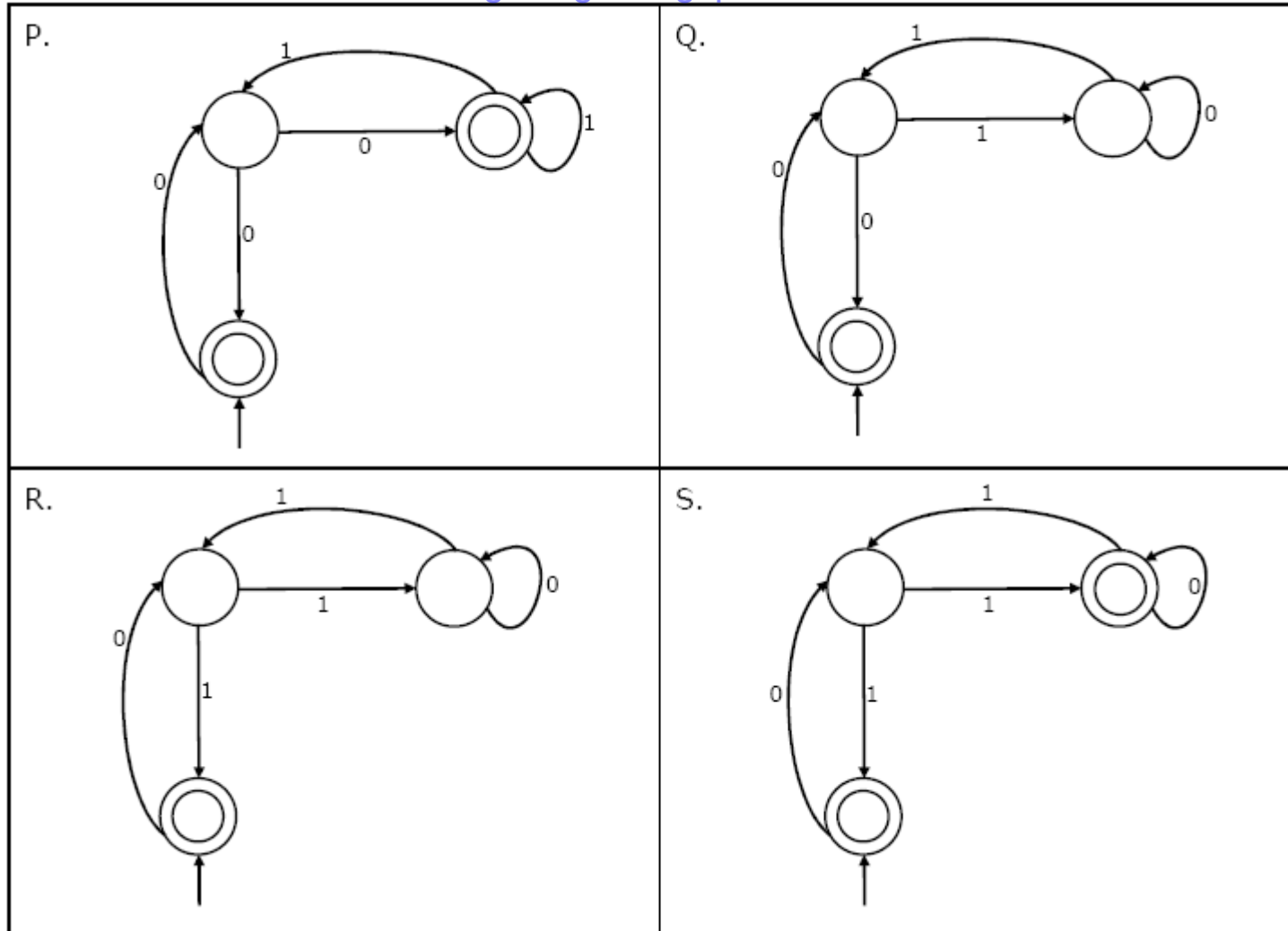
H. Palindromes S. $X \rightarrow bXb \mid cXc \mid \epsilon$

(A) E - P, F - R, G - Q, H - S (B) E - R, F - P, G - S, H - Q

(C) E - R, F - P, G - Q, H - S (D) E - P, F - R, G - S, H - Q

Ans.) C

52. Match the following NFA's with the regular expressions they correspond to



1. $\epsilon + 0(01^*1 + 00)^*01^*$

2. $\epsilon + 0(10^*1 + 00)^*0$

3. $\epsilon + 0(10^*1 + 10)^*1$

4. $\epsilon + 0(10^*1 + 10)^*10^*$

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

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

Ans.) C

One possible approach to select the right option would be the elimination trick

For example R-1 is not a right match because $001 \in (1)$ but is not accepted by R

53. Which of the following are regular sets?

I. $\{a^n b^{2m} \mid n \geq 0, m \geq 0\}$

II. $\{a^n b^m \mid n = 2m\}$

III. $\{a^n b^m \mid n \neq m\}$

IV. $\{xycy \mid (x, y) \in \{a,b\}^*\}$

(A) I and IV only

(B) I and III only

(C) I only

(D) IV only

Ans: (A)

II is not regular because to scan bs, we should remember the number a's

III is not regular for the same reason

I is regular because the language is a's followed by even number of b's

iv is regular because the language contains all possible strings with a,bs which contain only 1 c.

54. Which of the following are true?

I. A programming language which does not permit global variables of any kind and has no nesting of procedures/functions, but permits recursion can be implemented with static storage allocation

II. Multi-level access link (or display) arrangement is needed to arrange activation records only if the programming language being implemented has nesting of procedures/functions

III. Recursion in programming languages cannot be implemented with dynamic storage allocation

IV. Nesting procedures/functions and recursion require a dynamic heap allocation scheme and cannot be implemented with a stack-based allocation scheme for activation records

V. Programming languages which permit a function to return a function as its result cannot be implemented with a stack-based storage allocation scheme for activation records

(A) II and V only

(B) I, III and IV only

(C) I, II and V only

(D) II, III and V only

laxmi's question

55. An LALR(1) parser for a grammar G can have shift-reduce (S-R) conflicts if and only if

- (A) The SLR(1) parser for G has S-R conflicts
- (B) The LR(1) parser for G has S-R conflicts
- (C) The LR(0) parser for G has S-R conflicts
- (D) The LALR(1) parser for G has reduce-reduce conflicts

Ans:B

56. In the slow start phase of the TCP congestion control algorithm, the size of the congestion window

- (A) does not increase
- (B) increases linearly
- (C) increases quadratically
- (D) increases exponentially

Ans: B

57. If a class B network on the Internet has a subnet mask of 255.255.248.0, what is the maximum number of hosts per subnet?

- (A) 1022
- (B) 1023
- (C) 2046
- (D) 2047

Ans: C

number of bits for subnet mask = 21

number of bits for host = 11

number of hosts = $2^{11}-2 = 2046$

58. A computer on a 10Mbps network is regulated by a token bucket. The token bucket is filled at a rate of 2Mbps. It is initially filled to capacity with 16Megabits. What is the maximum duration for which the computer can transmit at the full 10Mbps?

- (A) 1.6 seconds
- (B) 2 seconds
- (C) 5 seconds
- (D) 8 seconds

Ans: If the capacity of the token bucket is C bytes, Token arrival rate is R bytes/sec, and the Maximum possible transmission rate is M bytes/sec then the time(S) in seconds it is possible to transmit is $S = C/(M-R)$ seconds , so $16/(10-2) = 2$ seconds.

59. A client process P needs to make a TCP connection to a server process S. Consider the following situation: the server process S executes a socket (), a bind () and a listen () system call in that order, following which it is preempted. Subsequently, the client process P executes a socket () system call followed by connect () system call to connect to the server process S. The server process has

not executed any accept () system call. Which one of the following events could take place?

- (A) connect () system call returns successfully
- (B) connect () system call blocks
- (C) connect () system call returns an error
- (D) connect () system call results in a core dump

Ans: B or C ??

60. What is printed by the following C program?

```
int f(int x, int *py, int **ppz)
{
    int y, z;

    **ppz += 1; z = **ppz;

    *py += 2; y = *py;

    x += 3;

    return x + y + z;
}
```

```
void main()
{
    int c, *b, **a;

    c=4; b=&c; a=&b;

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

(A) 18

(B) 19

(C) 21

(D) 22

Ans.) B

```
int y, z;

**ppz += 1; z = **ppz; ----- (x=4,c=5,z=5)

*py += 2; y = *py;------(x=4,c=7,z=5,y=7)

x += 3;------(x=7,c=7,z=5,y=7)

return x + y + z;------(19)
```

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

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

main {
    printf ("Enter Text " ); printf( "\ n" );
    reverse() ;printf( "\ n" );
}
```

(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);

Ans.) D

62. The following C function takes a single-linked list of integers as a parameter and rearranges the elements of the list. The function is called with the list containing the integers 1,2,3,4,5,6,7 in the given order. What will be the contents of the list after the function completes execution?

```
struct node {  
    int value;  
    struct node *next;  
};  
  
void rearrange(struct node *list) {  
    struct node *p, *q;  
    int temp;  
    if( !list || !list → next) return;  
    p = list; q = list → next;  
    while(q) {  
        temp = p → value; p → value = q → value;  
        q → value = temp; p = q → next;  
        q = p?p → next : 0;  
    }  
}
```


(A) 1,2,3,4,5,6,7

(B) 2,1,4,3,6,5,7

(C) 1,3,2,5,4,7,6

(D) 2,3,4,5,6,7,1

Ans.) B

The program swaps two successive elements and then goes on to swap the next two successive elements until it reaches the end of the list

63. The P and V operations on counting semaphores, where s is a counting semaphore, are defined as follows:

P(s) : $s = s - 1$;

if $s < 0$ then wait;

V(s) : $s = s + 1$;

if $s \leq 0$ then wakeup a process waiting on s;

Assume that P_b and V_b the wait and signal operations on binary semaphores are provided. Two binary semaphores X_b and Y_b are used to implement the semaphore operations P(s) and V(s) as follows:

P(s) : $P_b(X_b)$;

$s = s - 1$;

if($s < 0$) {

$V_b(X_b)$;

$P_b(Y_b)$;

}

else $V_b(X_b)$;

V(s) : $P_b(X_b)$;

$s = s + 1;$

$\text{if}(s \leq 0) V_b(Y_b);$

$V_b(X_b);$

The initial values of X_b and Y_b are respectively

(A) 0 and 0

(B) 0 and 1

(C) 1 and 0

(D) 1 and 1

Ans: C

X_b has to be 1 since both $P(s)$ and $V(s)$ operations are performing $P_b(x_b)$. If it is 0 all processes executing these operations would be blocked.

If Y_b is 1, it is possible that two processes can execute $P(s)$ one after other (implying 2 processes in critical section), so it has to be 0.

64. Which of the following statements about synchronous and asynchronous I/O is NOT true?

(A) An ISR is invoked on completion of I/O in synchronous I/O but not in asynchronous I/O

(B) In both synchronous and asynchronous I/O, an ISR (Interrupt Service Routine) is invoked after completion of the I/O

(C) A process making a synchronous I/O call waits until I/O is complete, but a process making an asynchronous I/O call does not wait for completion of the I/O

(D) In the case of synchronous I/O, the process waiting for the completion of I/O is woken up by the ISR that is invoked after the completion of I/O

65. Which of the following is NOT true of deadlock prevention and deadlock avoidance schemes?

(A) In deadlock prevention, the request for resources is always granted if the resulting state is safe

(B) In deadlock avoidance, the request for resources is always granted if the result state is safe

(C) Deadlock avoidance is less restrictive than deadlock prevention

(D) Deadlock avoidance requires knowledge of resource requirements a priori

Ans: A

In deadlock prevention there is no guarantee that the request for a resource is granted even though the resulting state is a safe state. Deadlock prevention works by eliminating one of the four necessary conditions for deadlock.

66. A process executes the following code

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

The total number of child processes created is

(A) n

(B) $2^n - 1$

(C) 2^n

(D) $2^{n+1} - 1$

Ans: B

It is same as writing n fork statements one after another.

Each fork generates a child process other than the parent process.

Total number of process is 2^n and total number of child processes is $2^n - 1$.

67. A processor uses 36 bit physical addresses and 32 bit virtual addresses, with a page frame size of 4 Kbytes. Each page table entry is of size 4 bytes. A three level page

table is used for virtual to physical address translation, where the virtual address is used as follows

Bits 30-31 are used to index into the first level page table

Bits 21-29 are used to index into the second level page table

Bits 12-20 are used to index into the third level page table, and

Bits 0-11 are used as offset within the page

The number of bits required for addressing the next level page table (or page frame) in the page table entry of the first, second and third level page tables are respectively

(A) 20, 20 and 20

(B) 24, 24 and 24

(C) 24, 24 and 20

(D) 25, 25 and 24

Ans:(D)

The page size is 4 kbytes. Therefore number of bits required to access a page is 12.

The physical memory size is 2^{36} and page size is 2^{12} . therefore number of bits required to address the physical memory frames is 24.

In the second and third levels, 9 bits are used to index in to the tables and each entry size is 4 bytes.

the size of pages in the second and third level are $2^9 * 4 = 2^{11}$.

there are $2^{36}/2^{11}$ possible locations in the main memory, for storing the page tables. which requires 25 bits.

Therefore the number of bits required to address next level page tables are 25, 25, 24 respectively.

68. Let R and S be two relations with the following schema

R (P,Q,R1,R2,R3)

S (P,Q,S1,S2)

Where {P, Q} is the key for both schemas. Which of the following queries are equivalent?

I. $\Pi_{P,Q}(R \bowtie S)$

- II. $\Pi_p(R) \bowtie \Pi_p(S)$
- III. $\Pi_p(\Pi_{p,q}(R) \cap \Pi_{p,q}(S))$
- IV. $\Pi_p(\Pi_{p,q}(R) - (\Pi_{p,q}(R) - \Pi_{p,q}(S)))$

- (A) Only I and II
- (B) Only I and III
- (C) Only I, II and III
- (D) Only I, III and IV

Ans.) D

IV is equivalent to III because $(R - (R - S)) = R \cap S$

and $R \bowtie S$ contains only those (p,q) pairs that are there in both R and S

and all project the same column p

II is not equivalent to other ones as it only checks to see the presence of column values p in both R and S

69. Consider the following relational schemes for a library database:

Book (Title, Author, Catalog_no, Publisher, Year, Price)

Collection (Title, Author, Catalog_no)

with in the following functional dependencies:

- I. Title Author \rightarrow Catalog_no
- II. Catalog_no \rightarrow Title Author Publisher Year
- III. Publisher Title Year \rightarrow Price

Assume {Author, Title} is the key for both schemes. Which of the following statements is true?

- (A) Both Book and Collection are in BCNF
- (B) Both Book and Collection are in 3NF only
- (C) Book is in 2NF and Collection is in 3NF
- (D) Both Book and Collection are in 2NF only

Ans.) C

Collection is in BCNF and

Book is not in 3NF because transitive dependency exists on a non-prime attribute., but is in 2NF because

no partial dependency exists.
So the correct answer is C
***Be careful with the word only.

70. Consider a file of 16384 records. Each record is 32 bytes long and its key field is of size 6 bytes. The file is ordered on a non-key field, and the file organization is unspanned. The file is stored in a file system with block size 1024 bytes, and the size of a block pointer is 10 bytes. If the secondary index is built on the key field of the file, and a multi-level index scheme is used to store the secondary index, the number of first-level and second-level blocks in the multi-level index are respectively

- (A) 8 and 0
- (B) 128 and 6
- (C) 256 and 4
- (D) 512 and 5

Common Data for Questions: 71 72 and 73

Consider a machine with a 2-way set associative data cache of size 64Kbytes and block size 16bytes. The cache is managed using 32 bit virtual addresses and the page size is 4Kbytes. A program to be run on this machine begins as follows:

```
double ARR[1024][1024] ;  
  
int i, j ;  
  
/* Initialize array ARR to 0.0 */  
  
for (i=0; i <1024; i++)  
  
    for(j= 0; j <1024; j++)  
  
        ARR[i][j] = 0.0;
```

The size of double is 8Bytes. Array ARR is located in memory starting at the beginning of virtual page 0xFF000 and stored in row major order. The cache is initially empty and no pre-fetching is done. The only data memory references made by the program are those to array ARR

71. The total size of the tags in the cache directory is

- (A) 32Kbits
- (B) 34Kbits
- (C) 64Kbits
- (D) 68Kbits

Ans:(B) the number of bits needed to represent tag = 17

the number of tag entries(one for block) = cache size/ block size = 64KB/16B = 4K

the total size of the tags in the cache directory = 17*4Kbits = 68Kbits

72. Which of the following array elements has the same cache index as ARR [0] [0]?

- (A) ARR [0] [4]
- (B) ARR [4] [0]
- (C) ARR [0] [5]
- (D) ARR [5] [0]

Ans:(B)

hint:

The number of blocks in cache = the cache size/block size = 64kbytes/16bytes = 4k

in k-way set associative mapping each physical block i is mapped to cache block $i \% [(\text{cache size})/k]$ and each block can accommodate 2 elements as size of each element = 8Bytes

73. The cache hit ratio for this initialization loop is

- (A) 0% (B) 25% (C) 50% (D) 75%

Ans:(C)

since each block size is 2 elements ; each cache miss will bring one extra element into cache, saves us half of the time .

Common Data for Questions: 74 and 75

Consider the following C functions:

.

```
int f1(int n)
{
    if(n==0 || n==1)
        return n;
    else
        return( 2*f1( n-1) + 3*f1(n-2)) ;
}

int f2(int n)
{
    int i;
    int X[N] , Y[N] , Z[N] ;
    X[0] = Y[0] = Z[0] = 0;
    X[1] = 1; Y[1] = 2; Z[1] = 3;
    for(i=2; i<=n; i++) {
        X[i] = Y[i-1] + Z[i-2] ;
        Y[i] = 2 * X[i];
        Z[i] = 3 * X[i] ;
    }
    return X[n] ;
}
```

74. The running time of f1 (n) and f2 (n) are

- (A) $\Theta(n)$ and $\Theta(n)$
- (B) $\Theta(2^n)$ and $\Theta(n)$
- (C) $\Theta(n)$ and $\Theta(2^n)$
- (D) $\Theta(2^n)$ and $\Theta(2^n)$

Ans.) B

The recurrence relation of $f_1(n) = 2*f_1(n-1) + 3*f_1(n-2)$ is similar to

the recurrence relation of Fibonacci series $f(n) = f(n-1) + f(n-2)$

and the complexity is $\Theta(2^n)$

and the complexity of $f_2(n)$ is $\Theta(n)$

75. $f_1(8)$ and $f_2(8)$ return the values

- (A) 1661 and 1640
- (B) 59 and 59
- (C) 1640 and 1640
- (D) 1640 and 1661

Ans.) C

Linked Answer Questions: Q.76 to 85 Carry Two Marks Each

Statement for Linked Answer Questions: 76 & 77

Delayed branching can help in the handling of control hazards

76. For all delayed conditional branch instructions, irrespective of whether the condition evaluates to true or false

- (A) The instruction following the conditional branch instruction in memory is executed
- (B) The first instruction in the fall through path is executed

(C) The first instruction in the taken path is executed

(D) The branch takes longer to execute than any other instruction

Ans:(A)

77. The following code is to run on a pipelined processor with one branch delay slot:

I1: ADD R2 \leftarrow R7 R8

I2 : SUB R4 \leftarrow R5 R6

I3 : ADD R1 \leftarrow R2 R3

I4 : STORE Memory[R4] \leftarrow R1

BRANCH to Label if R1 == 0

Which of the instructions I1, I2, I3 or I4 can legitimately occupy the delay slot without any other program modification?

(A) I1

(B) I2

(C) I3

(D) I4

Ans:(B)

branch delay+ slot can be filled with any instruction of the program such that the execution of that instruction should not violate the meaning of the program.

Statement for Linked Answer Questions: 78 & 79

Let X_n denote the number of binary strings of length n that contain no consecutive 0s.

78. Which of the following recurrences does X_n satisfy?

(A) $X_n = 2X_{n-1}$

(B) $X_n = X_{n/2} + 1$

(C) $X_n = X_{n/2} + n$

(D) $X_n = X_{n-1} + X_{n-2}$

Ans.) D

X_n = The # strings that end with 1

+

The # strings that end with 0

= X_{n-1}

+

X_{n-2} (since n-1th position must be a 1)

79. The value of X_5 is

(A) 5

(B) 7

(C) 8

(D) 16

Ans.)

$X_1 = 2, X_2 = 3$

$X_3 = 2 + 3, X_4 = 5 + 3, X_5 = 8 + 5 = 13$

Statement for Linked Answer Questions: 80 & 81

The subset-sum problem is defined as follows. Given a set of n positive integers,

$S = \{a_1, a_2, a_3, \dots, a_n\}$ and positive integer W , is there a subset of S whose elements sum to W ? A dynamic program for solving this problem uses a 2-dimensional Boolean array, X , with n rows and $W+1$ columns.

$X[i, j]$, $1 \leq i \leq n$, $0 \leq j \leq W$, is TRUE if and only if there is a subset of $\{a_1, a_2, a_3, \dots, a_i\}$ whose elements sum to j .

80. Which of the following is valid for $2 \leq i \leq n$ and $a_i \leq j \leq W$?

(A) $X[i,j] = X[i-1,j] \vee X[i,j-a_i]$

(B) $X[i,j] = X[i-1,j] \vee X[i-1,j-a_i]$

(C) $X[i,j] = X[i-1,j] \wedge X[i,j-a_i]$

(D) $X[i,j] = X[i-1,j] \wedge X[i-1,j-a_i]$

Ans.) B

The equality can be explained as it checks to see whether there is a subset of $\{a_1, a_2, a_3, \dots, a_{i-1}\}$ that sums up to j

or whether there is a subset of $\{a_1, a_2, a_3, \dots, a_{i-1}\}$ that sums up to $j-a_i$ (as adding weight a_i will sum up to j)

81. Which entry of the array X, if TRUE, implies that there is a subset whose elements sum to W?

(A) $X[i,W]$

(B) $X[n,0]$

(C) $X[n,W]$

(D) $X[n-1,n]$

Ans.) C

This follows by the definition of the procedure of the Subset-sum problem above.

Statement for Linked Answer Questions: 82 & 83

Consider the following ER diagram

82. The minimum number of tables needed to represent M, N, P, R1, R2 is

(A) 2

(B) 3

(C) 4

(D) 5

Ans.) A

Since R1 is many to one and participation of M is total, M and R1 can be combined to form the table {M1,M2,M3,P1}

and since N weakly participates in R2, P and N should be combined to form the table {P1,P2,N1,N2}

83. Which of the following is a correct attribute set for one of the tables for the correct answer to the above question?

(A) {M1,M2,M3,P1}

(B) {M1,P1,N1,N2}

(C) {M1,P1,N1}

(D) {M1,P1}

Ans.) A

Statement for Linked Answer Questions: 84 & 85

Consider the following C program that attempts to locate an element x in an array Y[] using binary search. The program is erroneous.

```
1. f(int Y[10] , int x ){  
2.     int u, j, k;  
3.     i = 0; j = 9;  
4.     do {  
5.         k = (i + j) /2;  
6.         if (Y[k] < x) i = k;else j = k;
```

```
7. } while ((Y[k] != x) && (i < j)) ;  
8. if (Y[k] == x) printf( "x is in the array " ) ;  
9. else printf(" x is not in the array " ) ;  
10. }
```

84. On which of the following contents of Y and x does the program fail?

- (A) Y is [1 2 3 4 5 6 7 8 9 10] and $x < 10$
- (B) Y is [1 3 5 7 9 11 13 15 17 19] and $x < 1$
- (C) Y is [2 2 2 2 2 2 2 2 2 2] and $x > 2$
- (D) Y is [2 4 6 8 10 12 14 16 18 20] and $2 < x < 20$ and x is even

Ans (C)

85. The correction needed in the program to make it work properly is

- (A) Change line 6 to: if (Y[k] < x) i = k + 1; else j = k - 1;
- (B) Change line 6 to: if (Y[k] < x) i = k - 1; else j = k + 1;
- (C) Change line 6 to: if (Y[k] <= x) i = k; else j = k;
- (D) Change line 7 to: } while((Y[k] == x) && (i < j));

ANS (A)

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