Question of the Day
By GATE And Tech

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Monday 13th January, 2025

Question of the Day

Quantitative Aptitude: Concepts of divisibility

November 12, 2024

Question

1. Consider the following positive integers:

$$A = 1234679580, B = 1234789560$$

Which of the following statements is/are true?

(A) Both A and B are divisible by 36.

(B) Both A and B are divisible by 72.

(C) Only B is divisible by 120.

(D) The number A is divisible by 80.

Source: M.Sc. Data Science Entrance Examination 2024

Explanation

We need to consider the divisibility by $4, 6, 8, 9, 10$. The number A is divisible by $2, 3, 4, 5, 6, 9$ and B is divisible by $2, 3, 4, 5, 6, 8, 9$.
Correct Answer: A; C

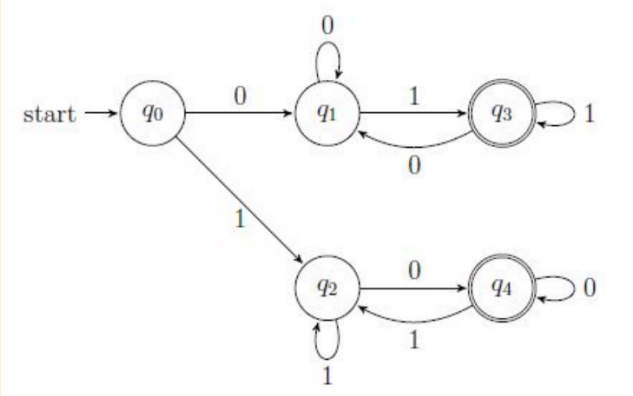
Question of the Day

Theory of computation: Deterministic finite automaton (DFA)

November 13, 2024

Question

2. This DFA accepts which strings from the given options?



(A) All the strings with same symbol

(B) All strings of even length

(C) All strings ending with different symbols

(D) None of the above

Source: NPTEL Assignment 3

Explanation

Correct Answer: C

Question of the Day

Theory of computation: DFA & NFA

November 14, 2024

Question

3. Given an arbitrary NFA with n states, the maximum number of states in an equivalent minimized DFA is _____.

(A) n

(B) 2^n

(C) n^2

(D) None of the above

Source: NPTEL Assignment 3

Explanation

The maximum number of states is 2^n. Conversion from NFA to DFA is done by [subset construction] and the number of states of the resulting DFA is in the worst case 2^n. Minimization of the resulting DFA in the worst case might not reduce the number of states.
An example of this is automaton that accepts strings over $\Sigma = \{0, 1\}$ which have 1 as the nth symbol from the end. Of course, n is a concrete number. A NFA has states $q_0 ... q_n$ and the following transition function:

$$(q_0, 0) \to \{q_0\} \quad (q_0, 1) \to \{q_0, q_1\}$$
$$(q_i, 0) \to \{q_{i+1}\} \quad (q_i, 1) \to \{q_{i+1}\} \quad 1 \leq i \leq n-1$$

Intuitively, the corresponding DFA needs to remember last n symbols since it does not know has it seen the end, which means there are 2^n states.

Ref: https://cs.stackexchange.com/questions/18278/maximum-number-of-states-in-minimized-dfa-from-nfa-with-n-states/

Correct Answer: B

Question of the Day

Theory of computation: Deterministic finite automaton (DFA)

November 15, 2024

Question

4. Given $L = \{ab, baa\}$ which of the following is not in L^*

(A) *ababaaab*

(B) *baaabbaa*

(C) *abbaaab*

(D) *ababbaaab*

Source: NPTEL Assignment 3

Explanation

Correct Answer: A

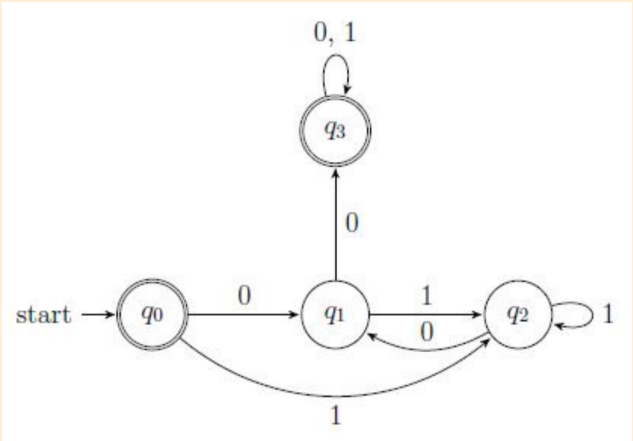
Question of the Day

Theory of computation: Deterministic finite automaton (DFA)

November 16, 2024

Question

5. Given NFA accepts strings of which of the given options.



(A) All strings ending with 00

(B) All strings ending with 00, including empty string

(C) All strings containing 00

(D) All strings containing 00, including empty string

Source: NPTEL Assignment 3

Explanation

Correct Answer: D

Question of the Day

Theory of computation: Deterministic finite automaton (DFA)

November 17, 2024

Question

6. The number of states in minimum DFA corresponding to the language $(0+1)^*(10)$ is _____.

(A) 2

(B) 3

(C) 4

(D) 5

Source: NPTEL Assignment 3

Explanation

Correct Answer: B

Question of the Day

Operating Systems: Paging

November 18, 2024

Question

7. One day famed student Joe Surfer had an inspiration while hanging ten at Mission Beach. He observes that most programs have most of their data at the beginning of the address space. For his homegrown SaltWater OS, he decides that he is going to implement his page tables similar to the way Unix implements inodes. He calls this page table design Inode Page Tables. Inode Page Tables are essentially two-level page tables with the following twist: The first half of the page table entries in the master page table directly map physical pages, and the second half of the entries map to secondary page tables as normal. Call the first half the entries fast, and the second half normal. For the following questions, assume that addresses are 32 bits, the page size is 4 KB, and that the master and secondary page tables fit into a single page.

How many virtual pages are fast pages and how many are normal respectively? (**Select all appropriate options**)

(A) $2^9, 2^{19}$

(B) $2^{10}, 2^{20}$

(C) $512, 524288$

(D) $2^8, 2^{18}$

Source: University of California San Diego

Explanation

4 KB/4 = 1024 PTEs
1024/2 = 512 PTEs $\Rightarrow$ 512 or (2^9) pages are fast

The remaining 512 PTEs refer to second-level page tables. Each second-level page table has 1024 PTEs, so:
$2^9 * 2^{10} = 2^{19}$ pages are normal

Correct Answer: A;C

Question of the Day

Operating Systems: User Mode and Kernel Mode

November 19, 2024

Question

8. Which of the following situations correctly describes instances of user mode transfer or kernel mode transfer? (Select all options that apply)

(A) The timer interrupt interrupts a user program.

(B) A user program attempts to access unmapped memory and triggers a page fault.

(C) A bug in the kernel's scheduler algorithm causes a segmentation fault.

(D) One process sends a signal to another process.

Source: University of California, Berkeley

Explanation

Safe control transfer involves switching from user mode to kernel mode or vice versa. User to kernel mode transfer include user-mode interrupts and exceptions (not errors that occur in kernel mode). Signals are handled by the kernel, so two-mode transfers are necessary.

Correct Answer: A;B;D

Question of the Day

Operating Systems: Process and Threads

November 20, 2024

Question

9. In the below program, several threads are created. Which of the following statements in foo always print the same memory address when evaluated by different threads in the same process? (Select all options that apply)

```c
int global;

void* foo(void* arg) {
    printf("%p\n", &foo);
    printf("%p\n", &global);
    printf("%p\n", &arg);
    printf("%p\n", arg);
    return NULL;
}
int main() {
    void* hmem = malloc(1);
    for (int i = 0; i < 3; i++) {
        pthread_t pid;
        pthread_create(&pid, NULL, foo, hmem);
    }
}
```

(A)

```c
    printf("%p\n", &foo)
```

(B)

```c
    printf("%p\n", &global)
```

(C)

```c
    printf("%p\n", &arg)
```

(D)

```c
    printf("%p\n", arg)
```

Source: University of California, Berkeley

Explanation

Threads in the same process share the same address space, so foo and global are the same across all threads. The same argument is given to each thread, so arg stays the same. Each thread has its own stack, so the location of the argument (&arg) is different.

Correct Answer: A;B;D

Question of the Day

Operating Systems: Process and Threads

November 21, 2024

Question

10. Let's assume that there are three threads, Threads A, B, and C, running in Process Z. For which of these synchronization scenarios would you utilize a single semaphore initialized with a value of 2 (as opposed to a semaphore initialized to some other value)? (Select all options that apply)

(A) Preventing more than 2 of the threads from running function f() simultaneously

(B) Ensuring that Thread A completes before Thread B

(C) Ensuring that Thread A runs after Thread B and Thread C have both completed

(D) Preventing Thread A or B from running function f() simultaneously

Source: University of California, Berkeley

Explanation

Semaphores, unlike locks, do not have a concept of ownership – any thread can up() or down() the semaphore. This means that we cannot enforce some strict ordering with a single semaphore. With a single semaphore initialized to 2, we can only sure that some resource (the function f()) has up to two concurrent usages.

Correct Answer: A

Question of the Day

Operating Systems: Memory Managements

November 22, 2024

Question

11. Which of the following statements is/are True?

(A) Two processes reading from the same virtual address will access the same contents.

(B) Two processes reading from the same physical address will access the same contents.

(C) The size of a virtual page is identical to the size of a physical page.

(D) The OS provides the illusion to each thread that it has its own address space.

Source: University of California, Berkeley

Explanation

False - Each process has its own address space.
True - they must have a mapping so share a page so potentially different virtual addresses in each of their address spaces point to the same physical address.
True - The size of a virtual page is identical to the size of a physical page.
False - Each process has its own address space, but threads in the same address space share that address space (e.g., they use the same code and heap).
Correct Answer: B; C

Question of the Day

Operating Systems: Process and Threads

November 23, 2024

Question

12. Which of the following statements is/are incorrect?

(A) Kernel-level threads are handled by the operating system directly.

(B) Kernel level threads are faster to create and manage than user level threads.

(C) Multiple threads of the same process can be scheduled on different processors in kernel-level threads.

(D) If a kernel-level thread is blocked, all threads of the same process also gets blocked.

Source: University of California, Berkeley

Explanation

A mode switch to kernel mode is required to transfer control from one thread to another in a process. So, a kernel-level thread is slower to create and manage than a user level thread. So option B is false.
Also, since kernel is managing the threads if a kernel level thread gets blocked, the kernel can schedule another thread of the same process which is not the case for user level threads.
Correct Answer: B; D

Question of the Day

Operating Systems: Fork System Call

November 24, 2024

Question

13. Consider the following program fragment:

```
main() {
    printf("I'm here!\n");
    fork();
    printf("I'm there!\n");
    if (fork() == 0)
        printf("I'm everywhere!\n");
    else
        printf("No you're not!\n");
    printf("Goodbye.\n");
}
```

Including the original process, this program results in the creation of how many processes?

(A) 6

(B) 4

(C) 5

(D) 3

Source: Lehigh University

Explanation

This program results in the creation of four processes.

Correct Answer: B

Question of the Day

Operating Systems: Locks, Semaphores

November 25, 2024

Question

14. Which of the following is/are incorrect? (Select all options that apply)

(A) Locks and binary semaphores are equivalent.

(B) The scheduler runs on every context switch.

(C) A context switch can occur in the middle of an instruction.

(D) Shortest-time-to-completion-first is the fairest scheduling algorithm.

Source: Harvard John A. Paulson School Of Engineering And Applied Sciences

Explanation

Correct Answer: A; B; D

Question of the Day

Operating Systems: Semaphores

November 26, 2024

Question

15. Assume that you have a semaphore associated with each item (and on the head structure) on a doubly linked list. Using no other synchronization primitives, what is the fewest number of semaphores that you must acquire for any operation (lookup, insert, delete)?

(A) 1

(B) 3

(C) N, where N is the number of items on the list

(D) None of the above

Source: Harvard John A. Paulson School Of Engineering And Applied Sciences

Explanation

Always lock the head of the list.

Correct Answer: A

Question of the Day

Operating Systems: CPU Scheduling Algorithms

November 27, 2024

Question

16. Which of the following scheduling algorithms will tend to schedule I/O bound jobs before CPU-bound jobs? (Select all options that apply)

(A) Shortest-time-to-completion-first

(B) Multilevel Feedback Queues

(C) Lottery Scheduling

(D) Round Robin

Source: Harvard John A. Paulson School Of Engineering And Applied Sciences

Explanation

Correct Answer: B;C

Question of the Day

Algorithms: Asymptotic Notations

November 28, 2024

Question

17. Which of the following expressions surely supports the statement $f(n) = \Omega(g(n))$?

(A) $f(n) \leq 4g(n)$ for all $n \geq 1$

(B) $f(n) \geq 4g(n)$ for all $n \geq 136$

(C) $\lim_{n \to \infty} \frac{f(n)}{g(n)} = 0$

(D) None of the above

Source: California State University, Long Beach

Explanation

Correct Answer: B

Question of the Day

Algorithms: Asymptotic Notations

November 29, 2024

Question

18. Let k denote the degree of polynomial $p(n)$, and l the degree of polynomial $q(n)$. If $p(n) = o(q(n))$, then necessarily

(A) $k = l$

(B) $k < l$

(C) $k > l$

(D) None of the above

Source: California State University, Long Beach

Explanation

Correct Answer: B

Question of the Day

Algorithms: Time Complexity

November 30, 2024

Question

19. An algorithm takes as input an $n \times n$ Boolean matrix A. If the running time of the algorithm is $T(n) = \mathrm{O}(n \log n)$ when n is used as the input size parameter, then which of the following expressions describes the big-O growth of $T(m)$, the running time of the algorithm when $m = n^2$ is used as the size parameter?

(A) $\mathrm{O}(\sqrt{m} \log m)$

(B) $\mathrm{O}(m^2 \log m)$

(C) $\mathrm{O}(m \log m)$

(D) $\mathrm{O}(m^2 \log^2 m)$

Source: California State University, Long Beach

Explanation

Correct Answer: A

Question of the Day

Data Structures: Binary Search Tree

December 1, 2024

Question

20. If numbers from the set $\{1, \ldots, n\}$ are selected at random (without replacement) and inserted into an initially-empty binary search tree, then the big-O expression that best describes the average (taken over all possible resulting trees) height of the resulting tree is _____.

(A) $O(n)$

(B) $O(\log n)$

(C) $O(\sqrt{n})$

(D) $O(n)$

Source: California State University, Long Beach

Explanation

Correct Answer: B

Question of the Day

Algorithms: Time Complexity

December 2, 2024

Question

21. If $T(n)$ satisfies $T(n) = 2T(n/3) + \sqrt{n}$, then

(A) $T(n) = \Theta(\sqrt{n})$.

(B) $T(n) = \Theta(n^2)$.

(C) $T(n) = \Theta(n^{\log_3 2})$.

(D) $T(n) = \Theta(n^{\log 3})$.

Source: California State University, Long Beach

Explanation

Correct Answer: C

Question of the Day

Algorithms: Dynamic Programming

December 3, 2024

Question

22. The Floyd-Warshall dynamic programming algorithm defines the matrix of numbers d_{ij}^k, where i and j are graph vertices satisfying $1 \leq i, j \leq n$, and $k \in \{0, 1, \ldots, n\}$. Moreover, d_{ij}^k represents

(A) the distance from i to j when restricted to paths that traverse at most k edges.

(B) the distance from i to j when restricted to paths that traverse at least k edges.

(C) the distance from i to j when restricted to paths whose intermediate vertices must lie within the set $\{1, \ldots, k\}$.

(D) the distance from i to j when restricted to paths whose intermediate vertices must lie within the set $\{k+1, \ldots, n\}$.

Source: California State University, Long Beach

Explanation

Correct Answer: C

Question of the Day

Algorithms: Time Complexity

December 4, 2024

Question

23. Suppose $T_1(n) = O(F(n))$ and $T_2(n) = O(F(n))$. Which of the following is/are true?

(A) $T_1(n) + T_2(n) = O(F(n))$

(B) $T_1(n) * T_2(n) = O(F(n))$

(C) $T_1(n)/T_2(n) = O(1)$

(D) $T_1(n) = O\left(T_2(n)\right)$

Source: FIU School of Computing and Information Sciences

Explanation

Correct Answer: A

Question of the Day

Algorithms: Time Complexity & Asymptotic Notations

December 5, 2024

Question

24. The solution to $T(n) = T(\lfloor 3n/4 \rfloor) + 10$ with $T(0) = 0$ is most accurately given by

(A) $O(\log n)$

(B) $O(n)$

(C) $O(n \log n)$

(D) $O\left(n^2\right)$

Source: FIU School of Computing and Information Sciences

Explanation

Correct Answer: A

Question of the Day

Algorithms: Time Complexity

December 6, 2024

Question

25. What is the running time of the following routine?

```
// Check if N is prime
function Is_Prime( N : Integer ) return Boolean is
    I : Integer := 3;
begin
    if N = 2 or else N = 3 then
        return TRUE;
    end if;
    if N MOD 2 = 0 then
        return FALSE;
    end if;
    while i * i <= N loop
        if N MOD i = 0 then

            return FALSE;
        else
            I := I + 2;
        end if;
    end loop;
    return TRUE;
end Is_Prime;
```

(A) constant time

(B) $O(\log N)$

(C) $O(N)$

(D) $O(\sqrt{N})$

Source: FIU School of Computing and Information Sciences

Explanation

Correct Answer: D

Question of the Day

Data Structures: Binary Tree, Recurrence Relation

December 7, 2024

Question

26. Let $C(X)$ be the number of leaves in a binary tree rooted at T. Assume that IsLeaf(T) returns 1 if T is a leaf. Which of the following observations leads to a recursive implementation?

(A) $C(T) := C(T.Left) + C(T.Right)$

(B) $C(T) := C(T.Left) + C(T.\ \text{Right}) + 1$

(C) C(T) := C(T.Left) + C(T.Right) +IsLeaf(T)

(D) C(T) := C(T.Left) + C(T. Right) + IsLeaf(T) + 1

Source: FIU School of Computing and Information Sciences

Explanation

Correct Answer: C

Question of the Day

Algorithms: Hashing

December 8, 2024

Question

27. Suppose we are implementing quadratic probing with a hash function $Hash(X) = X \bmod 100$. If an element with key 4594 is inserted and the first three locations attempted are already occupied, then the next cell that will be tried is _____.

(A) 2

(B) 3

(C) 9

(D) 97

Source: FIU School of Computing and Information Sciences

Explanation

Correct Answer: B

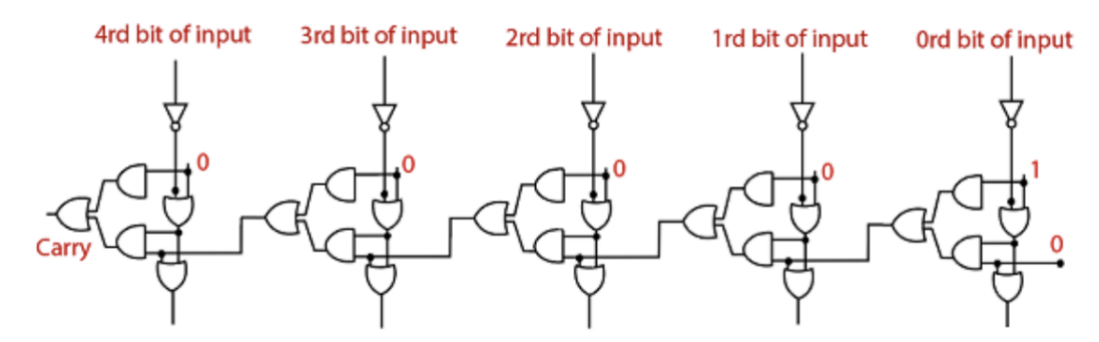
Question of the Day

Digital Logic: Number Representations

December 9, 2024

Question

28. This is the logic circuit for finding 2's complement of the 5-bit binary number.



If the input is 10000_2, what's the output in binary?

(A) 10000_2

(B) 00001_2

(C) 10001_2

(D) 00000_2

Source: Universitat Politècnica de Catalunya

Explanation

For 5 bits, this is the most negative number, so it is a special case. The two's complement of the most negative number representable is itself, 10000_2. You have to reverse the bits and add 1, ignoring the overflow.
Correct Answer: A

Question of the Day

Algorithms: Paging

December 10, 2024

Question

29. Which one of the following is true about page-based memory allocation:

(A) It requires the use of a best-fit strategy for memory allocation.

(B) It removes the possibility for external fragmentation.

(C) It removes the possibility for internal fragmentation.

(D) It removes the problems associated with "sparse" address spaces.

Source: UC Berkeley Electrical Engineering & Computer Sciences (EECS)

Explanation

Correct Answer: B

Question of the Day

Operating System: CPU Scheduling

December 11, 2024

Question

30. Consider the following scheduling policy implemented by an OS, in which a user can set numerical priorities for processes running in the system. The OS scheduler maintains all ready processes in a strict priority queue. When the CPU is free, it extracts the ready process with the highest priority (breaking ties arbitrarily), and runs it until the process blocks or terminates. Which of the following statements is/are true about this scheduling policy?

(A) This scheduler is an example of a non-preemptive scheduling policy.

(B) This scheduling policy can result in the starvation of low priority processes.

(C) This scheduling policy guarantees fairness across all active processes.

(D) This scheduling policy guarantees lowest average turnaround time for all processes.

Source: CSE at IIT Bombay

Explanation

Correct Answer: A; B

Question of the Day

Operating System: CPU Scheduling

December 12, 2024

Question

31. Consider the following scheduling policy implemented by an OS. Every time a process is scheduled, the OS runs the process for a maximum of 10 milliseconds or until the process blocks or terminates itself before 10 milliseconds. Subsequently, the OS moves on to the next ready process in the list of processes in a round-robin fashion. Which of the following statements is/are true about this scheduling policy?

(A) This policy cannot be efficiently implemented without hardware support for timer interrupts.

(B) This scheduler is an example of a non-preemptive scheduling policy.

(C) This scheduling policy can sometimes result in involuntary context switches.

(D) This scheduling policy prioritizes processes with shorter CPU burst times over processes that run for long durations.

Source: CSE at IIT Bombay

Explanation

Correct Answer: A; C

Question of the Day

Operating System: System Call

December 13, 2024

Question

32. Consider a process P that needs to save its CPU execution context (values of some CPU registers) on some stack when it makes a function call or system call. Which of the following statements is/are true?

(A) During a system call, when transitioning from user mode to kernel mode, the context of the process is saved on its kernel stack.

(B) During a function call in user mode, the context of the process is saved on its user stack.

(C) During a function call in kernel mode, the context of the process is saved on its user stack.

(D) During a function call in kernel mode, the context of the process is saved on its kernel stack.

Source: CSE at IIT Bombay

Explanation

Correct Answer: A; B; D

Question of the Day

Operating System: Context Switch

December 14, 2024

Question

33. Which of the following statements is/are true about a context switch?

(A) A context switch from one process to another will happen every time a process moves from user mode to kernel mode.

(B) For preemptive schedulers, a trap of any kind always leads to a context switch

(C) A context switch will always occur when a process has made a blocking system call, irrespective of whether the scheduler is preemptive or not

(D) For non-preemptive schedulers, a process that is ready/willing to run will not be context switched out.

Source: CSE at IIT Bombay

Explanation

Correct Answer: C; D

Question of the Day

Operating System: CPU Scheduling

December 15, 2024

Question

34. Consider the following three processes that arrive in a system at the specified times, along with the duration of their CPU bursts. Process P1 arrives at time t=0, and has a CPU burst of 10 time units. P2 arrives at t=2, and has a CPU burst of 2 units. P3 arrives at t=3, and has a CPU burst of 3 units. Assume that the processes execute only once for the duration of their CPU burst, and terminate immediately. For each policy, you must state the completion time of all three processes, P1, P2, and P3. Assume there are no other processes in the scheduler's queue. For the preemptive policies, assume that a running process can be immediately preempted as soon as the new process arrives (if the policy should decide to preempt).
Which of the following options is/are true to calculate the time of completion of the three processes under each of the following scheduling policies?

(A) First Come First Serve ⇒ (FCFS: P1 at 10, P2 at 12, P3 at 15)

(B) Shortest Job First (non-preemptive) ⇒ SJF: P1 at 10, P2 at 12, P3 at 15

(C) Shortest Remaining Time First (preemptive) ⇒ SRTF: P2 at 4, P3 at 7, P1 at 15

(D) Round robin (preemptive) with a time slice of (atmost) 5 units per process ⇒ RR: P2 at 7, P3 at 10, P1 at 15

Source: CSE at IIT Bombay

Explanation

Correct Answer: A; B; C; D

Question of the Day

Operating System: Page Replacement Algorithms

December 16, 2024

Question

35. Consider the following page reference string:

$$7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.$$

Assuming demand paging with 3 frames, page faults would occur for the following replacement algorithms. Which of the following options is/are correct?

(A) LRU replacement, 18-page faults

(B) FIFO replacement, 17-page faults

(C) Optimal replacement, 13-page faults

(D) None of the above

Source: Indian Institute of Technology, Kharagpur

Explanation

Correct Answer: A; B; C

Question of the Day

Operating System: File Systems

December 17, 2024

Question

36. In an i-node based file system implementation, the i-node typically stores 12 direct block pointers, one 1-indirect block pointer, one 2-indirect block pointer, and one 3-indirect block pointer. Recall that an indirect block is a disk block storing an array of disk block addresses (i.e. pointers). The pointers in a 1-indirect block point to disk blocks that store file data. The pointers in a 2-indirect (or 3-indirect) block point to other 1-indirect (or 2-indirect) blocks. Suppose the file system is configured to use a block size of 2^{10} bytes and each pointer takes up 4-byte. What is the maximum file size that can be supported in the file system?

(A) 6 GB

(B) 4 GB

(C) 16 GB

(D) 8 GB

Source: New York University

Explanation

Each 1-indirect block can address $2^{10}/4 = 2^8$ data blocks. Each 2-indirect block can address $2^8 * 2^8 = 2^{16}$ data blocks.

Each 3-indirect block can address $2^8 * 2^8 * 2^8 = 2^{24}$ data blocks.

In total, the biggest file can contain at most $12 + 2^8 + 2^{16} + 2^{24} \approx 2^{24}$ data blocks (i.e. $2^{24} * 2^{10} =$ 16 GB).
Correct Answer: C

Question of the Day

Digital Logic: Number Representations

December 18, 2024

Question

37. If we have seven (7) bits to represent integers, what is the largest unsigned number, and what is the largest 2s complement a signed number we can represent (in decimal and binary)?

(A) Largest unsigned: 1111 111 (127)

(B) Most positive signed: 0111 111 (63)

(C) Most negative signed: 1000 000 (-64)

(D) All of the above

Source: Paul G. Allen School of Computer Science & Engineering University of Washington

Explanation

Correct Answer: D

Question of the Day

Computer Organization and Architecture: Cache Memory

December 19, 2024

Question

38. You are using a byte-addressed machine with 64 KiB of Physical address space. You have a 2-way associative L1 data cache of total size 256 bytes with a cache block size of 16 bytes. It uses LRU replacement and write-allocate and write-back policies.

If the x = Number of bits for the cache block offset, y = Number of bits for the cache tag, z = Number of cache sets. Then the value of $x - y + z$ =?

(A) 9

(B) 8

(C) 4

(D) 3

Source: Paul G. Allen School of Computer Science & Engineering University of Washington

Explanation

Cache Block Offset: 4
Cache Tag: 9
Cache sets: 8
$\therefore$ The value of $x - y + z = 4 - 9 + 8 = 3$.
Correct Answer: A

Question of the Day

Operating System: Translation Lookaside Buffer, Virtual Memory

December 20, 2024

Question

39. Assume we have a virtual memory detailed as follows:

- 8 KiB Virtual Address Space,
- 2 KiB Physical Address Space,
- a TLB (Translation Lookaside Buffer) with 16 entries that is 4-way set associative with LRU replacement
- 64 B page size

How many bits will be used for Page offset, Virtual Page Number (VPN), Physical Page Number(PPN), TLB index, and TLB tag respectively?

(A) 6, 7, 5, 2, 5

(B) 6, 5, 7, 2, 5

(C) 6, 7, 5, 5, 2

(D) 7, 6, 5, 2, 5

Source: Paul G. Allen School of Computer Science & Engineering University of Washington

Explanation

Correct Answer: A

Question of the Day

Operating System: Virtual Memory, Translation Lookaside Buffer

December 21, 2024

Question

40. Assume we have a virtual memory detailed as follows:

- 8 KiB Virtual Address Space,
- 2 KiB Physical Address Space,
- a TLB (Translation Lookaside Buffer) with 16 entries that is 4-way set associative with LRU replacement
- 64 B page size

How many TOTAL entries are in this page table? (Select all the options that apply)

(A) 256

(B) 2^7

(C) 128

(D) 2^8

Source: Paul G. Allen School of Computer Science & Engineering University of Washington

Explanation

Correct Answer: B; C

Question of the Day

Computer Organization and Architecture: Cache Memory

December 22, 2024

Question

41. Suppose we have a system with the following properties:

- Memory accesses are to 4-byte words
- Addresses are 12 bits wide
- The cache is two-way set associative, with a 8-byte block size and 4 sets
- A cache hit has 10ns latency and a cache miss has 100ns latency

What is the size of the cache in bytes?

(A) 64 bytes

(B) 16 bytes

(C) 128 bytes

(D) 32 bytes

Source: Paul G. Allen School of Computer Science & Engineering University of Washington

Explanation

Correct Answer: A

Question of the Day

Digital Logic: Multiplexer, Boolean Algebra, Number Representations

December 23, 2024

Question

42. Which of the following statements is/are incorrect?

(A) An 8-input multiplexer can select between any one of 8 inputs and requires 8/2=4 "select" or control lines.

(B) It is possible to have two different truth tables that describe the same Boolean function.

(C) 2^N is the largest unsigned binary number that can be represented in N bits.

(D) The minimum number of base-3 digits required to obtain at least as many combinations as can be done with 4 binary digits is three

Source: UNC Asheville Department of Computer Science

Explanation

Correct Answer: A;B;C

Question of the Day

Digital Logic: Combinational Circuits

December 24, 2024

Question

43. Which of the following statements is/are correct?

(A) An AND gate is the same as an OR gate with its inputs complemented.

(B) An AND gate can be built with fewer transistors than a NAND gate.

(C) A decoder is a combinational logic device that selects one of many inputs to pass through to the output.

(D) Any combinational logic circuit can be build solely with NAND or NOR gates.

Source: UNC Asheville Department of Computer Science

Explanation

Correct Answer: D

Question of the Day

Digital Logic: Number Representations, Decoder, Flip-Flop

December 25, 2024

Question

44. Which of the following statements is/are incorrect?

(A) Given that the ASCII code for the character "c" is 1000011, the ASCII code for "g" is 1000111.

(B) A 2's complement integer representation includes more negative numbers than it does positive ones.

(C) A decoder is a combinational logic device that selects one of many inputs to pass through to the output.

(D) The difference between an SR flip flop and an SR latch is that the SR flip flop's output updates whenever The clock signal is high.

Source: UNC Asheville Department of Computer Science

Explanation

Correct Answer: C; D

Question of the Day

Data Structures: Binary Search Tree, AVL Tree

December 26, 2024

Question

45. Which of the following statements about trees is/are incorrect?

(A) Given a set S of n real keys chosen at random from a uniform distribution over $[a, b)$, a binary search tree can be constructed on S in $O(n)$ expected time.

(B) In the AVL tree they never have a height imbalance greater than 2.

(C) Given a connected, weighted, undirected graph G in which the edge with minimum weight is unique, that edge belongs to every minimum spanning tree of G.

(D) Deleting a node from a binary search tree on n nodes takes $O(\lg n)$ time in the worst case.

Source: Massachusetts Institute of Technology

Explanation

Deletion on an ordinary binary search tree of height h takes $\Theta(h)$ time in the worst case, and h can be $\Omega(n)$ if the tree with n nodes is unbalanced.
Correct Answer: D

Question of the Day

Data Structures: Queue, Linked List

December 27, 2024

Question

46. Suppose that you implement a queue using a null-terminated singly-linked list, maintaining a reference to the item least recently added (the front of the list) but not maintaining a reference to the item most recently added (the end of the list). What are the worst-case running times for enqueue and dequeue?

(A) constant time for both enqueue and dequeue

(B) constant time for enqueue and linear time for dequeue

(C) linear time for enqueue and constant time for dequeue

(D) linear time for both enqueue and dequeue

Source: Princeton Computer Science

Explanation

Correct Answer: C

Question of the Day

Algorithms: Sorting, Dynamic Programming, Topological Sort

December 28, 2024

Question

47. Which of the following statements about trees is/are incorrect?

(A) The Bellman-Ford algorithm applies to instances of the single-source shortest path the problem which do not have a negative-weight directed cycle, but it does not detect the existence of a negative-weight directed cycle if there is one.

(B) The topological sort of an arbitrary directed acyclic graph G = (V, E) can be computed in linear time.

(C) Given an undirected graph, it can be tested to determine whether or not it is a tree in O(V + E) time. A tree is a connected graph without any cycles.

(D) Radix sort works in linear time only if the elements to sort are integers in the range $\{0, 1, \ldots, cn\}$ for some $c = O(1)$.

Source: Massachusetts Institute of Technology

Explanation

A. False. Bellman-Ford detects negative-weight-directed cycles in its input graph.
B. True. A topological sort can be obtained by listing the nodes in the reverse order of the exit times produced by a DFS traversal of the graph. The DFS can also be used to detect if there is a cycle in the graph (there is no valid topological sort in that case). The running time of DFS is O(V + E).
C. True. Using either DFS or BFS yields a running time of O(V + E).
D. False. Radix sort also works in linear time if the elements to sort are integers in the range $\{1, \ldots, n^d\}$ for any constant d.
Correct Answer: A; D

Question of the Day

Data Structures: AVL Tree, Linked List, Binary Tree

December 29, 2024

Question

48. Which of the following statements about trees is/are incorrect?

(A) The AVL invariant states that a tree's shortest and longest paths differ in length by at most 1.

(B) The rotate operation on AVL trees preserves inorder numbering.

(C) Binary search is as efficient on linked lists as on arrays, provided the list is doubly linked.

(D) In the worst case, search in an unbalanced binary tree is asymptotically the same complexity as search in a balanced binary tree.

Source: Cornell Computer Science

Explanation

Correct Answer: A;C;D

Question of the Day

Algorithms: Asymptotic Complexity

December 30, 2024

Question

49. Suppose we wish to compute x^n for integer values of n. We can do this recursively as follows:

- if $n = 0$, return 1
- if $n = 1$, return x
- if $n > 1$ and n is even, recursively compute $y = x^{n/2}$ and return $y \cdot y$
- if $n > 1$ and n is odd, recursively compute $y = x^{n-1}$ and return $x \cdot y$

Assuming addition and multiplication are $O(1)$ operations, what is the worst-case asymptotic complexity of computing x^n this way?

(A) $O(n^2)$

(B) $O(n)$

(C) $O(\log n)$

(D) $O(1)$

Source: Cornell Computer Science

Explanation

Correct Answer: C

Question of the Day

Data Structures: Binary Tree

December 31, 2024

Question

50. In a binary tree, a node may have 0,1 , or 2 children. In the following questions about binary trees, the height of a tree is the length (number of edges) of the longest path. A tree consisting of just one node has height 0.

If $x =$ the maximum number of nodes in a binary tree of height $d, y =$ the minimum number of nodes in a binary tree of height $d, z =$ the maximum height of a binary tree containing n nodes, $w =$ the minimum height of a binary tree containing n nodes, then what is the value of x, y, z, w respectively?

(A) $x = 2^d - 1, y = d + 1, z = n - 1, w = \lfloor \log n \rfloor$

(B) $x = 2^{d+1} - 1, y = d + 1, z = n - 1, w = \lfloor \log n \rfloor$

(C) $x = 2^{d+1} - 1, y = d, z = n - 1, w = \lfloor \log n \rfloor$

(D) $x = 2^{d+1} - 1, y = d + 1, z = n, w = \lfloor \log n \rfloor$

Source: Cornell Computer Science

Explanation

The maximum number of nodes in a binary tree of height d is $2^{d+1} - 1$.

The minimum number of nodes in a binary tree of height d is $d + 1$.

The maximum height of a binary tree containing n nodes is $n - 1$.

The minimum height of a binary tree containing n nodes is $\lfloor \log n \rfloor$.

Correct Answer: B

Question of the Day

Databases: SQL

January 1, 2025

Question

51. Consider the following schema for a courses database:

- department(<u>did</u>, dname, location)
- student(<u>sid</u>, sname, did, age)
- course(<u>cid</u>, cname, time, room)
- enrolled(<u>sid</u>, <u>cid</u>)

Which of the following SQL queries will count the number of departments with no students taking the course 'Databases'. (Mark all the appropriate choices)

(A)

```
SELECT COUNT(d.did)
FROM department d
WHERE d.did NOT IN (
    SELECT s.did
    FROM student s
    WHERE s.sid IN (
        SELECT e.sid
        FROM enrolled e, course c
        WHERE e.cid = c.cid
          AND c.cname = 'Databases'
    )
);
```

(B)

```
SELECT COUNT(DISTINCT s.did)
FROM student s
WHERE s.sid NOT IN (
    SELECT e.sid
    FROM enrolled e, course c
    WHERE e.cid = c.cid
      AND c.cname = 'Databases'
);
```

(C)

```
SELECT COUNT(DISTINCT d.did)
FROM department d
WHERE d.did NOT IN (
    SELECT s.did
    FROM enrolled e, course c, student s
    WHERE e.cid = c.cid
      AND c.cname = 'Databases'
      AND e.sid = s.sid
);
```

(D)

```
SELECT COUNT(d.did)
FROM department d, student s, course c, enrolled e
WHERE e.cid = c.cid
  AND c.cname = 'Database'
  AND e.sid != s.sid
  AND d.did = s.did;
```

Source: Massachusetts Institute of Technology

Explanation

A and C. B is incorrect because it counts the number of departments with students not taking the course 'Databases'.
Correct Answer: A;C

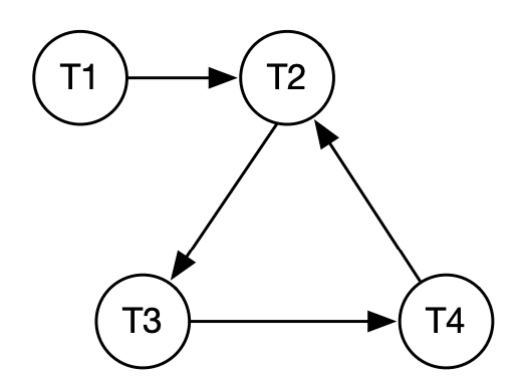
Question of the Day

Databases: Transactions and concurrency control

January 2, 2025

Question

52. Consider the following waits for graphs indicating transactions waiting for locks held by other transactions; here, an arrow from T1 to T2 indicates T1 is waiting for a lock T2 holds. For each graph, indicate which are possible serial equivalent schedules for the transactions, assuming the use of strict two-phase locking, and, in the case of deadlock, a random transaction is aborted to break the deadlock.



Which are possible serial equivalent schedules? Assume transactions not listed were aborted because of deadlock and that aborted transactions don't restart. (Mark all the appropriate choices)

(A) T1, T2, T4

(B) T3, T2, T1

(C) T4, T1, T2

(D) T4, T2, T1

Source: Massachusetts Institute of Technology

Explanation

Because of two-phase locking, if Ti waited for Tj, then there is either a deadlock or Tj acquired all of its locks before Ti. One of T2, T3, or T4 must have aborted abort because of deadlock. The remaining transactions will serialize in reverse order. Disconnected transactions could serialize at any point. Of the options listed, the only possible choice is T3, T2, T1.
Correct Answer: B

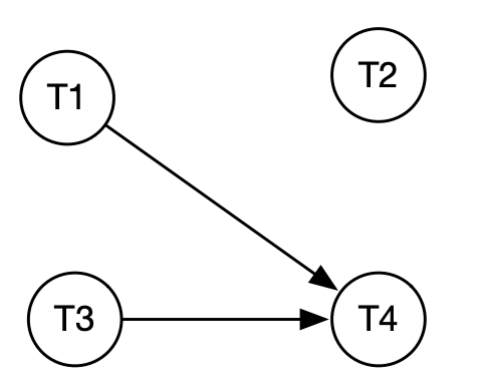
Question of the Day

Databases: Transactions and concurrency control

January 3, 2025

Question

53. Consider the following waits for graphs indicating transactions waiting for locks held by other transactions; here, an arrow from T1 to T2 indicates T1 is waiting for a lock T2 holds. For each graph, indicate which are possible serial equivalent schedules for the transactions, assuming the use of strict two-phase locking, and, in the case of deadlock, a random transaction is aborted to break the deadlock.



Which are possible serial equivalent schedules? (Mark all the appropriate choices)

(A) T2, T4, T1, T3

(B) T1, T4, T3, T2

(C) T4, T3, T1, T2

(D) T4, T1, T3, T2

Source: Massachusetts Institute of Technology

Explanation

T2, T4, T1, T3 ;
T4, T3, T1, T2 ;
T4, T1, T3, T2.
Correct Answer: A;C;D

Question of the Day

Databases: Relational Algebra

January 4, 2025

Question

54. Which of the following statements is/are incorrect? (Mark all the appropriate choices)

(A) Given relations $R(A, B)$ and $S(A, C)$, the natural join $R \bowtie S$ is equal to $R \cap S$.

(B) Given relations $R(A, B, C)$ and $S(D, E)$, the natural join $R \bowtie S$ is equal to $R \times S$.

(C) The following two relational algebra expressions are equivalent (that is, they return the same answer when evaluated on any instance of the database).

- $\pi_{\text{title,year,name}}\ (\sigma_{\text{year}\ \geq 2001}(\ \text{Movie}\ ) \bowtie (\ \text{Performs} \bowtie \text{Actor}\ ))$
- $\pi_{\text{title,year,name}}\ (\sigma_{\text{year}\ \geq 2001}(\ \text{Movie} \bowtie (\ \text{Actor} \bowtie \text{Performs}\ )))$

(D) The following two relational algebra expressions are equivalent (that is, they return the same answer when evaluated on any instance of the database).

$$\sigma_{\text{age}\ >50\ \vee\ \text{salary}\ <100k}(\text{Emp})$$
$$\sigma_{\text{age}\ >50}\ (\sigma_{\text{salary}\ <100k}(\text{Emp}))$$

Source: Department of Computer Science at Colgate University

Explanation

Correct Answer: A;D

Question of the Day

Databases: Transactions and concurrency control

January 5, 2025

Question

55. Which of the following statements is/are incorrect? (Mark all the appropriate choices)

(A) In Strict 2PL, we can give up locks after aborting but before rollback is complete.

(B) Some conflict serializable schedules cannot be produced when using 2PL.

(C) Schedules that are conflict serializable will not produce a cyclic dependency graph.

(D) Both Strict 2PL and 2PL enforce conflict serializability.

(E) All schedules that are conflict serializable are view serializable.

Source: University of California, Berkeley

Explanation

Only A is false. For A, you must wait until rollback is complete before giving up locks.

For B, 2PL enforces conflict serializability but may not allow all conflict serializable schedules (e.g. W1(X), R2(X), W1(Y), R2(Y) is impossible under 2PL).

For C, a schedule is conflict serializable if and only if the dependency graph is acyclic, so conflict serializable implies an acyclic dependency graph.

For D, because you cannot get any new locks after releasing a lock in both strict and non-strict 2PL, the dependency graph for the resulting schedule can never be cyclic.

For E, view serializability is a generalization of conflict serializability, hence all conflict serializable schedules are view serializable.
Correct Answer: A

Question of the Day

Databases: SQL

January 6, 2025

Question

56. Consider a table Friend representing a social network. Each record of the Friend table consists of two integers corresponding to a friendship relationship between two users (identified by the id number). Assume that no person is friends with themselves.

```
CREATE TABLE Friend (
    id1 INTEGER,
    id2 INTEGER,
    PRIMARY KEY (id1, id2)
);
```

Some of the friendship relationships in this table are not reciprocated, i.e., (id1=a, id2=b) exists in the table but (id1=b, id2=a) does not exist. Which of the following SQL queries identifies all tuples where the reciprocal relationship does not exist in the table? (Mark all that apply)

(A)

```
SELECT *
FROM Friend f1
WHERE NOT EXISTS (
    SELECT *
    FROM Friend f2
    WHERE f1.id1 = f2.id2
      AND f1.id2 = f2.id1
);
```

(B)

```
SELECT t.id1, t.id2
FROM (
    (SELECT id1, id2
     FROM Friend f1)
    UNION ALL
    (SELECT f2.id2 AS id1, f2.id1 AS id2
     FROM Friend f2)
) AS t
GROUP BY t.id1, t.id2
HAVING count(*) < 2;
```

(C)

```
SELECT t.id1, t.id2
FROM (
    SELECT f2.id2 AS id1, f2.id1 AS id2
    FROM Friend f2
) AS t
FULL OUTER JOIN Friend
    ON t.id1 = Friend.id1
    AND t.id2 = Friend.id2
    AND Friend.id1 IS NOT NULL;
```

(D) None of the above

Source: University of California, Berkeley

Explanation

Answer A correctly uses a subquery to determine whether for each friendship tuple there exists at least one inverse relationship.

Answer B takes a union all of friends table and a friends table where the attributes are in reverse order. It counts the number of elements in each group. This relies on the fact that (id1,id2) is a primary key.

Answer C is incorrect because the statement Friend.id1 IS NOT NULL should not be applied in the join condition.

Correct Answer: A; B

Question of the Day

Databases: B and B+ Trees

January 7, 2025

Question

57. Which of the following statements is/are incorrect? (Mark all the appropriate choices)

(A) The first and second levels of a secondary index are dense.

(B) Each primary key lookup in a B+tree containing N records and P pointers per node will require $\log_P(N)$ node traversals.

(C) Each primary key lookup in a B-tree (not B+tree) containing N records and P pointers per node will require $\log_P(N)$ node traversals.

(D) LRU is a good replacement policy for caching B+tree nodes.

Source: Stanford University

Explanation

A. FALSE. Building a dense second level on top of a dense first level is redundant.
B. TRUE. B+tree record pointers are stored in leaf nodes, so we will need to traverse down to the leaf.
C. FALSE. Unlike a B+tree, a B-tree stores some record pointers in non-leaf nodes, so lookups can be faster.
D. FALSE. LRU will cache leaf and non-leaf nodes equally, despite the fact that non-leaf nodes are much more likely to be accessed. A better caching scheme is to cache the root and upper non-leaf nodes of the tree.
Correct Answer: A; C; D

Question of the Day

Databases: Transactions and concurrency control

January 8, 2025

Question

58. Which of the following statements is/are incorrect? (Mark all the appropriate choices)

(A) Two-phase locking is guaranteed to produce a schedule whose precedence graph is acyclic.

(B) Two-phase locking ensures recoverability.

(C) Strict two-phase locking is guaranteed to produce a conflict serializable schedule.

(D) A system providing exclusive access on each object (locking before accessing and unlocking afterwards) guarantees serializability.

Source: Stanford University

Explanation

Correct Answer: B; D

Question of the Day

Discrete Mathematics: Functions

January 9, 2025

Question

59. Suppose $f : X \to Y$ is a function. Which of the following are possible?

(A) f is injective but not surjective.

(B) f is surjective but not injective.

(C) f is surjective and injective.

(D) f is neither surjective nor injective.

Source: Oscar Levin Book

Explanation

Correct Answer: A;B;C;D

Question of the Day

Operating System: Disk Scheduling Algorithms

January 10, 2025

Question

60. At a particular point in time, the buffer cache has dirty data that needs to be flushed to disk. Suppose that the identities of these blocks can be listed in [track : sector] form as follows:

$$[10 : 5], [22 : 9], [11 : 6], [2 : 10], [20 : 5], [32 : 4], [32 : 5], [6 : 7]$$

Assume that the disk head is currently positioned over track 20.

Which of the following disk scheduling algorithms does not yield the following sequence of writes:

$$[20 : 5], [22 : 9], [32 : 4], [32 : 5], [11 : 6], [10 : 5], [6 : 7], [2 : 10]$$

(Mark all the appropriate choices)

(A) C-SCAN (initially moving upwards)

(B) Look (initially moving upwards)

(C) Shortest Seek Time First

(D) Scan (initially moving upwards)

Source: University of California, Berkeley

Explanation

Correct Answer: A

Question of the Day

Theory of Computation: Finite Automata

January 11, 2025

Question

61. Which of the following are true statements about the sizes of various kinds of representations of regular languages? (Mark all the appropriate choices)

(A) Every language recognizable by a DFA with n states is recognizable by some NFA with n states.

(B) Every language recognizable by an NFA with n states is recognizable by some DFA with n states.

(C) Every language describable by a length n regular expression is recognizable by an $O(n)$-state NFA.

(D) If two languages A, B are recognized by two (potentially different) DFAs with n states, then the language $A \cup B$ can be recognized by a DFA with at most $2n + 1$ states.

Source: Massachusetts Institute of Technology

Explanation

- **(A)** Every language recognizable by a DFA with n states is recognizable by some NFA with n states.

  (True): A DFA is a special case of an NFA, so it can be treated as an NFA with the same number of states.

- **(B)** Every language recognizable by an NFA with n states is recognizable by some DFA with n states.

  (False): Converting an NFA to a DFA can lead to up to 2^n states due to the subset construction.

- **(C)** Every language describable by a length n regular expression is recognizable by an $O(n)$-state NFA.

  (True): A regular expression of length n can be converted to an NFA with $O(n)$ states using methods like Thompson's construction.

- **(D)** If two languages A, B are recognized by DFAs with n states, then $A \cup B$ can be recognized by a DFA with at most $2n + 1$ states.

  (False): Constructing a DFA for $A \cup B$ can require n^2 states, not $2n + 1$.

Correct Answer: A;C

Question of the Day

Theory of Computation: Turing machines

January 12, 2025

Question

62. Which of the following languages are Turing-recognizable? (Mark all the appropriate choices)

(A) $\{\langle M \rangle \mid M$ is a (deterministic) Turing machine and M accepts $010\}$.

(B) $\{\langle M \rangle \mid M$ is a nondeterministic Turing machine and M accepts $010\}$.

(C) $\{\langle M \rangle \mid M$ is a Turing machine and M does not accept $101\}$.

(D) $\{\langle M \rangle \mid M$ is a Turing machine and $L(M) = \Sigma^*\}$.

Source: Massachusetts Institute of Technology

Explanation

(A) Turing-recognizable: Simulate the deterministic Turing machine M on 010. If M accepts, accept the input.

(B) Turing-recognizable: Enumerate all computation branches of the nondeterministic Turing machine M on 010. Accept if any branch accepts.

(C) Not Turing-recognizable: Verifying that M does not accept 101 requires solving the halting problem for rejection.

(D) Not Turing-recognizable: Checking if $L(M) = \Sigma^*$ involves verifying acceptance for all strings, which is undecidable.

Correct Answer: A; B

Question of the Day

Theory of Computation: Decidability and Rice's theorem

January 13, 2025

Question

63. Which of the following languages can be shown to be undecidable by a direct application of Rice's theorem? (Mark all the appropriate choices)

(A) $\{\langle M \rangle \mid M$ is a DFA and M accepts 010$\}$.

(B) $\{\langle M \rangle \mid M$ is a Turing machine and M accepts 010$\}$.

(C) $\{\langle M \rangle \mid M$ is a Turing machine and M accepts 010 and does not accept 101$\}$.

(D) $\{\langle M \rangle \mid M$ is a minimal Turing machine, that is, no Turing machine with a smaller representation recognizes the same language $\}$.

Source: Massachusetts Institute of Technology

Explanation

- **(A)**: This is a property of a DFA. Determining if a DFA accepts a specific string (e.g., "010") is decidable. Rice's theorem does not apply.
- **(B)**: This is a non-trivial property of the language recognized by a Turing machine. By Rice's theorem, this is undecidable.
- **(C)**: This is a non-trivial property of the language recognized by a Turing machine (whether it includes "010" but not "101"). By Rice's theorem, this is undecidable.
- **(D)**: This concerns the minimality of the Turing machine representation, not the language it recognizes. Rice's theorem does not apply.

Correct Answer: B;C

Question of the Day

Theory of Computation: Regular languages and Pumping lemma

January 14, 2025

Question

64. Consider the language L over $\{a, b\}$ consisting of strings with twice as many a 's as b 's. You are using the pumping lemma to show that L is not regular. You begin by supposing L were accepted by a DFA with k states. What would be a good choice of a string xyz that would allow you to obtain a contradiction?

(A) $aaaabb$

(B) $aaabbb$

(C) $a^k b^{2k}$

(D) $a^{2k} b^k$

Source: The University of Edinburgh

Explanation

We want a string depending on k that belongs to L. An obvious choice would be $a^{2k} b^k$.
Correct Answer: D

Question of the Day

Theory of Computation: Pushdown automata (PDA) and context-free languages (CFLs)

January 15, 2025

Question

65. Which one of the following statements concerning pushdown automata is false?
(Here we use 'accept' to mean 'accept on the empty stack'.) (Mark all the appropriate choices)

(A) Every context-free language is accepted by some deterministic PDA.

(B) The language accepted by any non-deterministic PDA is a context-free language.

(C) For any non-deterministic PDA, there is a non-deterministic PDA with just one state that accepts the same language.

(D) Every LL(1) parse table gives rise to a deterministic PDA.

Source: The University of Edinburgh

Explanation

- **(A):** *Every context-free language is accepted by some deterministic PDA.*

  False. Some CFLs, such as $L = \{a^n b^n c^n \mid n \geq 1\}$, cannot be accepted by any deterministic PDA (DPDA). This is a known limitation of DPDAs.

- **(B):** *The language accepted by any non-deterministic PDA is a context-free language.*

  True. NPDAs accept exactly the class of context-free languages (CFLs). This is a fundamental property of PDAs.

- **(C):** *For any non-deterministic PDA, there is a non-deterministic PDA with just one state that accepts the same language.*

  True. Any NPDA can be converted into an equivalent NPDA with a single state by combining transitions into one state and encoding the original states into the stack symbols.

- **(D):** *Every LL(1) parse table gives rise to a deterministic PDA.*

  True. LL(1) grammars are deterministic by definition, and their parse tables can be directly translated into deterministic PDAs.

Correct Answer: A

Question of the Day

Theory of Computation: Properties of Formal Languages

January 16, 2025

Question

66. Which one of the following statements is false? (Mark all the appropriate choices)

(A) The union and complement of regular languages are also regular.

(B) The union of two context-free languages is context-free.

(C) The intersection of two recursively enumerable languages is recursively enumerable.

(D) The complement of a recursively enumerable language is recursively enumerable.

Source: The University of Edinburgh

Explanation

- **(A):** *The union and complement of regular languages are also regular.*

  True. Regular languages are closed under union and complement, meaning the union and complement of regular languages are regular.

- **(B):** *The union of two context-free languages is context-free.*

  True. Context-free languages are closed under union, so the union of two CFLs is also a CFL.

- **(C):** *The intersection of two recursively enumerable languages is recursively enumerable.*

  True. Recursively enumerable languages are closed under intersection, so the intersection of two RE languages is also RE.

- **(D):** *The complement of a recursively enumerable language is recursively enumerable.*

  False. Recursively enumerable languages are not closed under complement. The complement of an RE language may not be RE, as we cannot always construct a Turing machine for the complement unless the language is decidable.

Correct Answer: D

Question of the Day

Discrete Mathematics: First Order Logic

January 17, 2025

Question

67. What is the correct meaning representation for the sentence "Every female dentist extracted a rotten tooth"?

(A) $\forall x.\text{dentist}\ (x) \wedge \text{female}\ (x) \wedge \exists y \cdot \text{tooth}(y) \wedge \text{rotten}(y) \wedge \text{extracted}(\text{x}, \text{y})$

(B) $\forall x\ \text{dentist}\ (x) \wedge \text{female}\ (x) \Rightarrow \exists y \cdot \text{tooth}(y) \Rightarrow \text{rotten}(y) \wedge \text{extracted}(\text{x}, \text{y})$

(C) $\forall x.\text{dentist}\ (x) \wedge \text{female}\ (x) \Rightarrow \exists y \cdot \text{tooth}(y) \wedge \text{rotten}(y) \wedge \text{extracted}(x, y)$

(D) $\exists x.\text{dentist}\ (x) \wedge \text{female}\ (x) \Rightarrow \forall y \cdot \text{tooth}(y) \wedge \text{rotten}(y) \wedge \text{extracted}(x, y)$

Source: The University of Edinburgh

Explanation

Correct Answer: C

Question of the Day

Compiler Design: First and Follow

January 18, 2025

Question

68. Consider the following context-free grammar (where terminals are in lowercase, nonterminals are in uppercase, and the start symbol is A).

$$A \to CAB \mid a \mid \epsilon$$
$$B \to bA$$
$$C \to cA \mid \epsilon$$

Which of the following sets is First(A)?

(A) $\{a, \epsilon\}$

(B) $\{a, c, \epsilon\}$

(C) $\{a, b, c\}$

(D) $\{a, b, c, \epsilon\}$

Source: The University of Edinburgh

Explanation

Correct Answer: D

Question of the Day

Theory of Computation: Turing Machines and Decidability

January 19, 2025

Question

69. Which of the following statements about Turing machines is false?

(A) For every context-sensitive language L, there is a Turing machine that accepts precisely the strings of L.

(B) For any grammar G with set of terminals Σ, there is a Turing machine that accepts precisely the strings in Σ^* that cannot be derived from G.

(C) There is a Turing machine which, given encodings of two DFAs over the same alphabet Σ, can tell whether or not they define the same language.

(D) There is a Turing machine A which can simulate the behaviour of any given Turing machine B on any given finite input.

Source: The University of Edinburgh

Explanation

Every recursively enumerable set, including the halting set, can be generated by some grammar.
Correct Answer: B

Question of the Day

Discrete Mathematics: First Order Logic

January 20, 2025

Question

70. What is a correct first-order logic representation of the sentence: "Every student likes some course that he or she is taking".

(A) $\forall X.\exists Y.\ \text{student}\ (X) \wedge \text{course}(Y) \wedge \text{takes}(X, Y) \Rightarrow \text{likes}(X, Y)$

(B) $\forall X.\forall Y.\text{student}\ (X) \wedge \text{course}(Y) \wedge \text{takes}(X, Y) \Rightarrow \text{likes}(X, Y)$

(C) $\exists Y.\forall X.\ \text{student}\ (X) \wedge \text{course}(Y) \wedge \text{takes}(X, Y) \Rightarrow \text{likes}(X, Y)$

(D) $\forall X \cdot \text{student}(X) \Rightarrow \exists Y.\ \text{course}\ (Y) \wedge \text{takes}(X, Y) \wedge \text{likes}(X, Y)$

Source: The University of Edinburgh

Explanation

Correct Answer: D

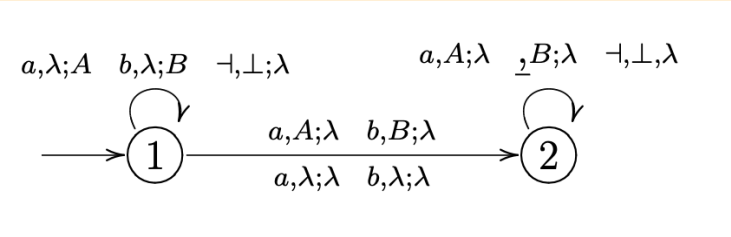
Question of the Day

Theory of Computation: Pushdown Automata (PDA)

January 21, 2025

Question

71. What is the langage recognised by the following pushdown automaton? The machine accepts with an empty stack and the initial symbol on the stack is $\perp$. In addition, we are using λ for the empty string of stack symbols and $\dashv$ is the end of the input symbol.



(A) $\emptyset$

(B) $\{w \dashv \mid w \in \{a,b\}^*, w = w^R\}$ where w_R is the reverse of the string w.

(C) $\{w \dashv \mid \#_a(w) = \#_b(w)\}$

(D) $\{a^n b^n \dashv \mid n \geq 0\}$

Source: The University of Edinburgh

Explanation

State 1 copies the initial portion of the string onto the stack and state 2 checks the remaining symbols match the initial portion.
Correct Answer: B

Question of the Day

Theory of Computation: Context Free Language

January 22, 2025

Question

72. Consider the following context-free language: $L_1 = \{a^m b^n c^n \mid n, m \geq 0\}$. Which of the following choices of language L_2 is context-free and ensures that $L_1 \cap L_2$ is not a context-free language?

(A) $L_2 = \{a^k b^{2k} c^m \mid k \geq 0 \text{ and } m \geq 0\}$

(B) $L_2 = \{(abc)^k \mid k \geq 0\}$

(C) $L_2 = \{a^k b^m c^k \mid k \geq 0 \text{ and } m \geq 0\}$

(D) $L_2 = \{a^k b^{2k} c^{2k} \mid k \geq 0\}$

Source: The University of Edinburgh

Explanation

The results in $L_1 \cap L_2 = \{a^n b^n c^n \mid n \geq 0\}$
Correct Answer: C

Question of the Day

Computer Organization and Architecture: Cache Memory

January 23, 2025

Question

73. Suppose that the level 1 data cache has a hit rate of 40% on your application, an access time of a single cycle, and a miss penalty to memory of forty cycles. What is the average memory access time (cycles)?

(A) 50

(B) 25

(C) 40

(D) 64

Source: Massachusetts Institute of Technology

Explanation

AMAT = hit time + miss rate * miss penalty = 1 + (1 - 0.4) * 40 = 25 cycles
Or, equivalently:
AMAT = hit rate * hit time + miss rate * miss time = 0.4 * 1 + 0.6 * (1 + 40) = 25 cycles
Correct Answer: C

Question of the Day

Digital Logic: Flip Flop

January 24, 2025

Question

74. We would like to use a T flip-flop and design a circuit that works like a J-K flip-flop. The simplified input to the T flip-flop should be:

(A) $T = J = K$

(B) $T = JQ' + K'Q$

(C) $T = JQ' + KQ$

(D) $T = JQ + KQ'$

Source: Massachusetts Institute of Technology

Explanation

Correct Answer: C

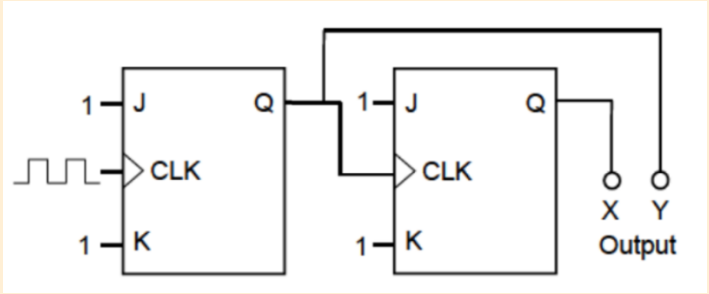
Question of the Day

Digital Logic: Counters

January 25, 2025

Question

75. The circuit shown in the figure below uses ideal positive edge-triggered synchronous J – K flip flops with outputs X and Y. If the initial state of the output is X = 0 and Y = 0 just before the arrival of the first clock pulse, the state of the output just before the arrival of the second clock pulse is _____.



(A) X = 0, Y = 0

(B) X = 0, Y = 1

(C) X = 1, Y = 0

(D) X = 1, Y = 1

Source: Massachusetts Institute of Technology

Explanation

The given counter is asynchronous. When the first clock pulse arrives, X goes from 0 to 1; So, Y goes from 0 to 1.
The given counter goes through states as follows:

$$XY = 00 \rightarrow 11 \rightarrow 10 \rightarrow 01 \rightarrow 00$$

Hence, the given counter is an Asynchronous 2-bit Binary Down Counter.
Correct Answer: D

Question of the Day

Discrete Mathematics: Combinatorics

January 26, 2025

Question

76. Hilary and Jocelyn are throwing a dinner party at their house and have invited four other couples. After the guests arrive, people greet each other by shaking hands. As you would expect, a couple do not shake hands with each other and no two people shake each other's hands more than once. At some point during the handshaking process, Jocelyn gets up on a table and tells everyone to stop shaking hands. She also asks each person how many hands they've shaken and learns that no two people on the floor have shaken the same number of hands. How many hands has Hilary shaken?

(A) 4

(B) 8

(C) 1

(D) 7

Source: Prof. Jacob R. Lorch

Explanation

She's shaken four hands, by the following reasoning. The fewest hands anyone can shake is zero, and the most is eight. So, there are only nine different possible handshake counts. We're told there are nine people on the floor with distinct handshake counts, so among them they must have all the handshake counts ranging from zero to eight. Denote by P_i the person on the floor with handshake count i. P_0 hasn't shaken anyone's hand, so in particular she hasn't shaken hands with P_8. But, P_8 has shaken eight people's hands, so she must have shaken everyone's hands but P_0. P_8 didn't shake hands with her partner, and P_0 is the only one she hasn't shaken hands with, so P_0 and P_8 must be partners. P_1 has only shaken one person's hand, and we know she's shaken P_8 's hand, so she hasn't shaken anyone else's hand. In particular, she hasn't shaken hands with P_7. So, P_7 hasn't shaken hands with P_0 or P_1. To have shaken hands with seven people, then, she must have shaken hands with everyone else besides those two. Now, P_7 hasn't shaken hands with her partner, so one of P_0 and P_1 must be her partner. But, we already know P_0 's partner is P_8. So, P_1 and P_7 must be partners. P_2 has only shaken two people's hands, and we know she's shaken P_7 's and P_8 's hands. So, she hasn't shaken anyone else's hand. In particular, she hasn't shaken P_6 's hand. So, P_6 hasn't shaken hands with P_0, P_1, or P_2. To have shaken hands with six people, she must have shaken hands with everyone else besides those three. Now, P_6 hasn't shaken hands with her partner, so one of P_0, P_1, and P_2 must be her partner. We already know the partners for P_0 and P_1 and they aren't P_6. So, P_2 and P_6 must be partners. P_3 has only shaken three people's hands, and we know she's shaken P_6 's, P_7 's, and P_8 's hands. So, she hasn't shaken anyone else's hand. In particular, she hasn't shaken P_5 's hand. So, P_5 hasn't shaken hands with P_0, P_1, P_2, or P_3. To have shaken hands with five people, she must have shaken hands with everyone else besides those four. Now, P_5 hasn't shaken hands with her partner, so one of P_0, P_1, P_2, and P_3 must be her partner. We already know the partners for P_0, P_1, and P_2 and they aren't P_5. So, P_3 and P_5 must be partners. We've paired up everyone besides Jocelyn and P_4, so those two must be partners. We can conclude that Hilary is P_4 and thus we know she's shaken four hands.
Correct Answer: A

Question of the Day

Calculus: Mathematical Series

January 27, 2025

Question

77. The value of the sum

$$\sum_{n=1}^{2024} \frac{1}{\sqrt{n+1}+\sqrt{n}}$$

is _____.

(A) 24

(B) 45

(C) 20

(D) 44

Source: IIT Delhi - Abu Dhabi

Explanation

Correct Answer: D

Question of the Day

Quantitative Aptitude: Profit and Loss

January 28, 2025

Question

78. A salesman sold two pipes at INR 12 each. His profit on one was 20% and the loss on the other was 20%. Then, on the whole, he

(A) Lost INR 1;

(B) Gained INR 1;

(C) Neither gained nor lost;

(D) Lost INR 2.

Source: Indian Institute of Technology, Kanpur

Explanation

Correct Answer: A

Question of the Day

Quantitative Aptitude: Percentage

January 29, 2025

Question

79. In an election, 10% of the voters on the voters' list did not cast their votes and 60 voters cast their ballot papers blank. There were only two candidates. The winner was supported by 47% of all voters in the list and he got 308 votes more than his rival. The number of voters on the lost was _____.

(A) 3600

(B) 6200

(C) 4575

(D) 6028

Source: Indian Institute of Technology, Kanpur

Explanation

Correct Answer: B

Question of the Day

Quantitative Aptitude:: Modular Arithmetic

January 30, 2025

Question

80. The remainder of $26^{1818181}$ divided by 297 is _____. [Hint: $1818181 = (180 \cdot 10101) + 1$].

(A) 31

(B) 29

(C) 26

(D) 27

Source: Indian Institute of Technology, Guwahati

Explanation

$$\phi(297) = \phi\left(3^3 \cdot 11\right) = \left(3^3 - 3^2\right) \cdot 10 = 180$$

since $\phi\left(p^k\right) = p^k - p^{k-1}$ if p is prime and $\phi(ab) = \phi(a)\phi(b)$ when a and b are relatively prime.
Since $1818181 = (180 \cdot 10101) + 1 = \phi(297) \cdot 10101 + 1$, we have

$$\text{rem}\left(26^{1818181}, 297\right) = \text{rem}\left(\left(26^{\phi(297)}\right)^{10101} \cdot 26, 297\right) = \mathbf{26}$$

since $26^{\phi(297)} \equiv 1 (\text{mod} 297)$ by Euler's theorem since 26 and 297 are relatively prime.
Correct Answer: C

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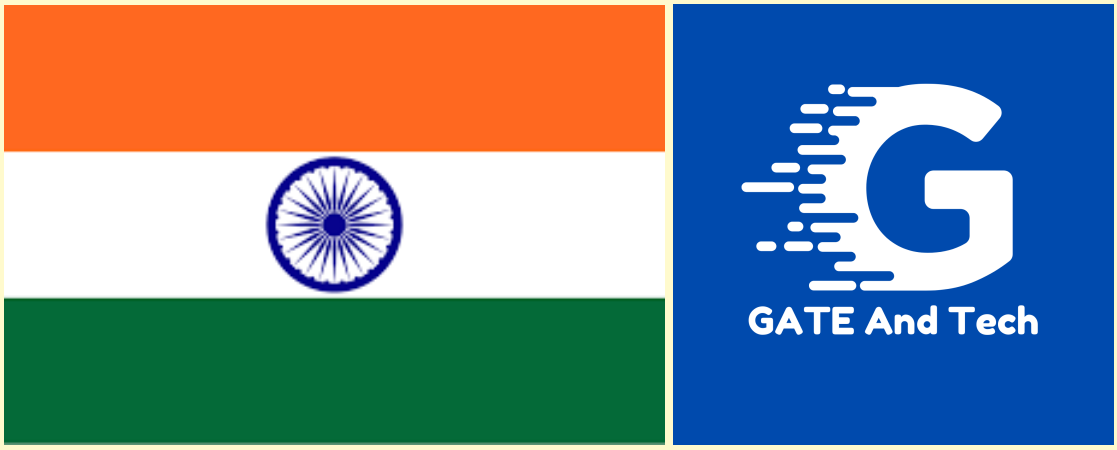

– Love From Lakshman Patel –