



GATE WALLAH

EXAM HELD ON

4th FEBRUARY 2023

COMPUTER SCIENCE
& INFORMATION TECHNOLOGY

DETAILED
SOLUTIONS
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[NAT]

A particular number is 132 in radix 4 representation what will be the representation the same number in radix 5?

Sol. (110)

Given $(132)_4$

- Now to find the radix 5 representation we first convert $(132)_4$ to decimal (radix 10)

The decimal representation of $(132)_4$ is:

$$\Rightarrow 1 \times 4^2 + 3 \times 4^1 + 2 \times 4^0$$

$$\Rightarrow 16 + 12 + 2$$

$$\Rightarrow (30)_{10}.$$

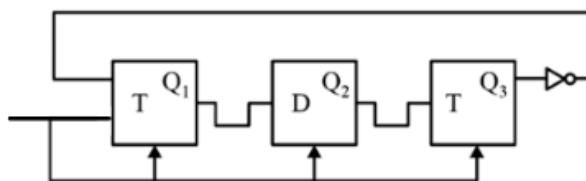
- Now converting $(30)_{10}$ to radix 5 representation.

5	30		
5	6	0	↑
	1	1	
	$(30)_{10}$	$=$	$(110)_5$

Hence 110 is the answer.

[MCQ]

Consider the below circuit with Q_1, Q_2, Q_3 initialized to 011, after implementing the circuit what value of Q_1, Q_2, Q_3 can never be achieved?



(a) 001

(b) 101

(c) 100

(d) 110

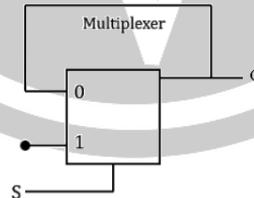
Sol. (a)

Clock	$T = \bar{Q}_3$	$D = Q_1$	$T = Q_2$	Q_1	Q_2	Q_3
0	-	-	-	0	1	1
1	0	0	1	0	0	0
2	1	0	0	1	0	0
3	1	1	0	0	1	0
4	1	0	1	1	0	1
5	0	1	0	1	1	1
6	0	1	1	1	1	0
7	1	1	1	0	1	1

States involved 011, 000, 100, 010, 101, 111, 110. The only state 001 can never be achieved.

[MCQ]

The given circuit is equivalent to?



- (a) D – flip flop (b) D – Latch (c) Demultiplexer (d) Half Adder

Sol. (b)

$$Q^+ = \bar{S} Q + S Q$$

$$Q^+ = S Q$$

$$Q^+ = Q$$

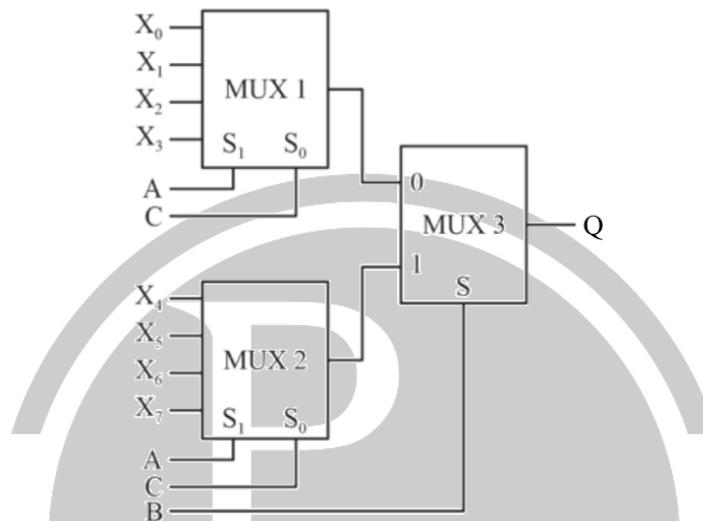
Q^+ is generated after delay



Now in a flip flop we always consider edge but in the circuit, it is level sensitive, therefore the circuit is equivalent to a D-latch.

[MCQ]

Given two 2×4 multiplexers and one 1×2 multiplexer implemented to generate the output $\bar{A} + \bar{AC} + A\bar{B} C$ as shown below:



To generate the output Q, what will be the value of $X_0, X_1, X_2, X_3, X_4, X_5, X_6, X_7$ respectively?

- (a) 10110111 (b) 01001100 (c) 11011100 (d) 01111100

Sol. (c)

Given function $f(ABC) = \bar{A} + \bar{AC} + A\bar{B} C$

- First, we minimize the given function

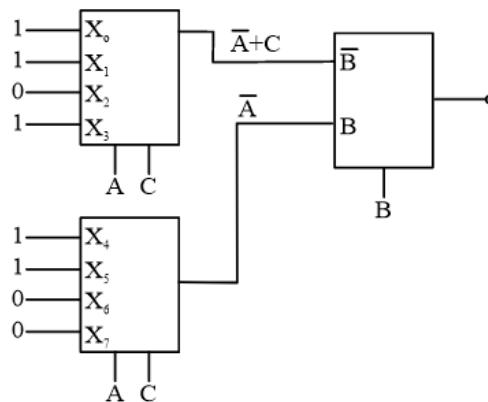
$$\Rightarrow \bar{A}(1 + \bar{C}) + A\bar{B} C$$

$$\Rightarrow \bar{A} + A\bar{B} C$$

$$\Rightarrow \bar{A} + \bar{B} C \text{ (using absorption)}$$

$$\Rightarrow \bar{A} + \bar{B} C = \Sigma m(0, 1, 2, 3, 5)$$
- Now implementing on 2×1 mux.

	\bar{B}	B
$\bar{A}\bar{C}$	0	2
$\bar{A}C$	1	3
$A\bar{C}$	4	6
AC	5	7
	$\bar{A} + C$	\bar{A}



$$\therefore (X_0 X_1 X_2 X_3 X_4 X_5 X_6 X_7) = (11011100)$$

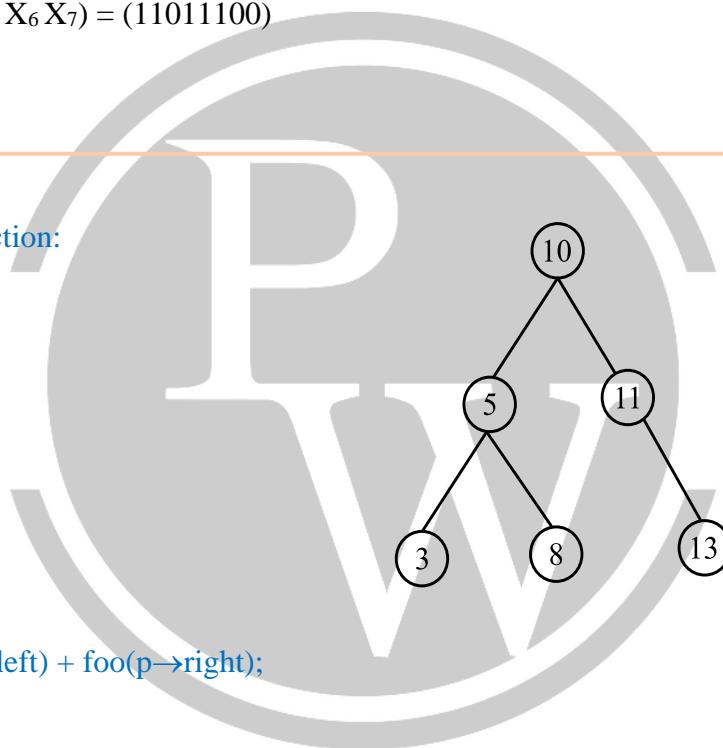
[MCQ]

Consider the following function:

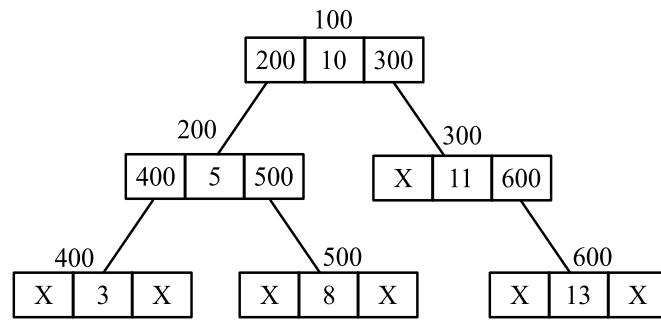
```
struct node {
    struct node * left
    int data;
    struct node * right;
} node;
int foo (struct node * p){
    int retval;
    if (p == Null) return 0,
    else {
        retval = p->val + foo (p->left) + foo(p->right);
        printf ("%d", retval);
        return retval;
    }
}
```

The output printed by the above program-

- (a) 3 8 24 13 16 50
- (b) 3 8 16 13 24 50
- (c) 3 13 16 8 50 24
- (d) 3 8 24 16 13 50

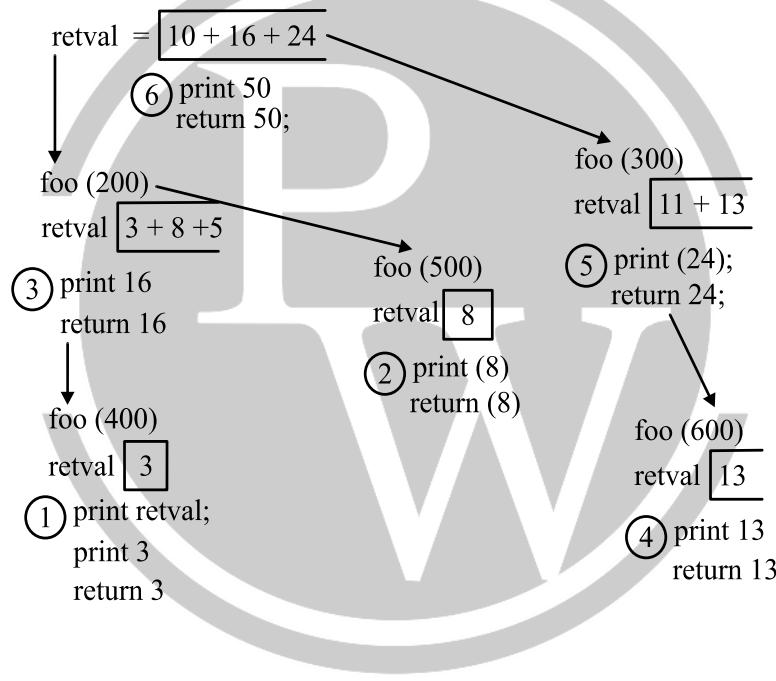


Sol. (b)



Initially, $p = 100$;

foo (100)



Thus, the output sequence printed is: 3 8 16 13 24 50

[NAT]

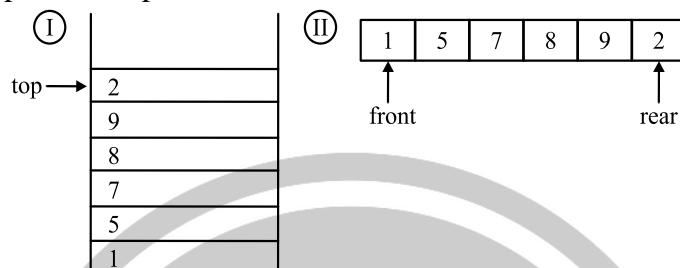
Consider the following elements $a_0 = 1, a_1 = 5, a_2 = 7, a_3 = 8, a_4 = 9$, and $a_5 = 2$. A Stack and Queue is used to store these elements and performed below operation:

- Push all the elements from a_0 to a_5 into the stack S in same order.
- Push all the elements from a_0 to a_5 into the queue Q in same order.
- Pop an element from Stack S
- Dequeue an element from Queue Q

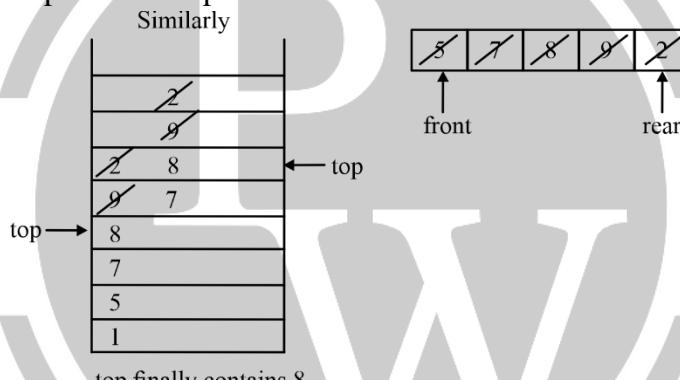
- V. Pop an element from Stack S
VI. Dequeue an element from Queue Q
VII. Dequeue (Q) and push the same element into S
VIII. Repeat VII three more times
IX. Pop an element from Stack S
X. Pop an element from Stack S
The element at the top of the stacks is

Sol. (8)

After completion of step I and Step II:



Now, after performing Step III and Step IV:



Similarly perform the Step on stack and queue accordingly

Thus, top will point to element 8 in the Stack.

[MCQ]

Let SLLDe be a function that deletes a node in single linked list.

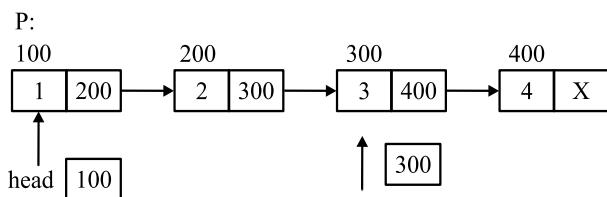
Let DLLDe be a function that deletes a node in double linked list.

Assume that the pointer to the node to be deleted as given and pointer to the head/start node is also given.

Then the time complexities are _____

- | | |
|------------------|-------------|
| (a) SLLDe = O(n) | DLLDe: O(1) |
| (b) SLLDe = O(1) | DLLDe: O(1) |
| (c) SLLDe = O(n) | DLLDe: O(n) |
| (d) SLLDe = O(1) | DLLDe: O(n) |

Sol. (a)



Suppose the pointer to the element 3 is given-

To delete the node having address '300' –

We need to connect the previous and successive nodes of the 3rd node.

We can get the address of the fourth node using the next pointer of p i.e. $p \rightarrow \text{next}$.

But, there is no way getting the previous node address of p, so, we have to traverse up to p and use a pointer q to store the address of the previous node.

$r = 100, q = \text{NULL}$

$r = 200, q = 100$

$r = 300 (\text{p}), q = 200$

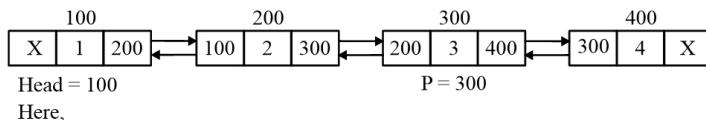
$q \rightarrow \text{next} = p \rightarrow \text{next};$

$200 \rightarrow \text{next} = 400;$

$\text{free}(p);$

If the second last element is to be deleted in a single linked list to n-nodes, we need to traverse up to $(n - 1)$ nodes. So, the time complexity is $O(n)$.

For a double linked list Q:



We can trace the previous and the next node address of p using $p \rightarrow \text{prev}$ and

$p \rightarrow \text{next}$.

So, $p \rightarrow \text{prev} \rightarrow \text{next} = p \rightarrow \text{next};$

$\text{free}(p)$

Hence, the time complexity is $O(1)$

**[NAT]**

Consider a computer system with 57 bits virtual address using multilevel page tables with L levels for virtual to Physical address translation. The page size is 4 KB and page table entry at any of the levels occupy 8 bytes. what is the value of L?

Sol. (5)

Given virtual address = 57 bit

Page size = 4KB

(P.T.E) Page Table Entry = 8 bytes

Page Table = Number of pages * P.T.E.

Ist level Page table:

$$\text{Number of pages} \Rightarrow \frac{2^{57}}{2^{12}} = 2^{45} \text{ pages}$$

Page Table size $\Rightarrow 2^{45} * 8 \text{ Bytes} = 2^{48} \text{ bytes.}$

IInd Level Page Table:

$$\text{Number of pages} \Rightarrow \frac{2^{48}}{2^{12}} = 2^{36} \text{ pages}$$

Page Table Size $\Rightarrow 2^{36} * 8 \text{ bytes} = 2^{39} \text{ bytes.}$

IIIrd Level Page Table:

$$\text{Number of pages} \Rightarrow \frac{2^{39}}{2^{12}} = 2^{27} \text{ pages}$$

Page Table size $\Rightarrow 2^{27} * 8 \text{ bytes} = 2^{30} \text{ bytes}$

IVth Level Page Table:

$$\text{Number of pages} = \frac{2^{30}}{2^{12}} = 2^{18} \text{ pages}$$

Page table size $= 2^{18} * 8 \text{ bytes} = 2^{21} \text{ bytes}$

Vth Level Page Table:

$$\text{Number of pages} = \frac{2^{21}}{2^{12}} = 2^9 \text{ pages}$$





Page table size = $2^9 * 8$ bytes = 2^{12} bytes

At level 5, Page table fits into 1 page

∴ Value of L = 5.

OR

V.A = 57 bits; VAS = 2^{57} Bytes;

P.S = 4KB; 2^{12} Bytes

P.T.E = 2^3 Bytes

Also,

V.A.S = 2^S Bytes (S = Virtual Address(bits))

P.S = 2^x Bytes

P.T.E = 2^c Bytes

Number of levels of Paging = 'l'

Formula: $2^x = 2^{S-l \cdot x + l \cdot c}$

$$2^{12} = 2^{57-l \cdot 12+l \cdot 3}$$

$$12 = 57 - 12 \cdot l + 3 \cdot l$$

$$1 = 5$$

[NAT]

Consider the given C program code:

```
int funcp()
{
    static int x = 1;
    x++;
    return x;
}
```

```
int main
```

```
{
    x = funcp();
    y = funcp() + x;
    printf("%d", (x + y));
}
```

What is the value printed by the above program?





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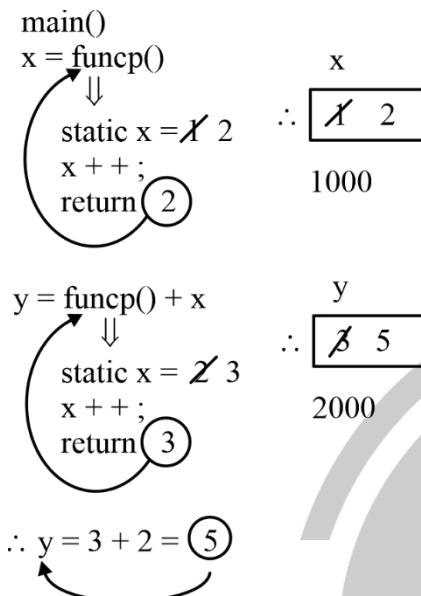
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Sol. (7)

When a local variable is declared with a static keyword, then it is known as a static local variable. The memory of a static local variable is valid throughout the program, but the scope of visibility of a variable is the same as the automatic local variables. However, when the function modifies the static local variable during the first function call, then this modified value will be available for the next function call also.



Now, inside main()

print(x + y) : 2 + 5 = 7

Hence, the above program will print 7.

[MSQ]

Which of the following algorithm causes starvation?

- (a) Round robin (b) FCFC (c) SJF (d) Priority Scheduling

Sol. (c, d)

Starvation: Starvation is the problem that occurs when high priority processes keep executing and low priority processes get blocked for indefinite time.

I: SJF: Shortest Job First scheduling algorithm favors shorter burst time job first thus, the process with larger burst time get starved.

II: Priority Scheduling: If higher priority process keeps on arriving then lower priority process gets starved.

[MCQ]

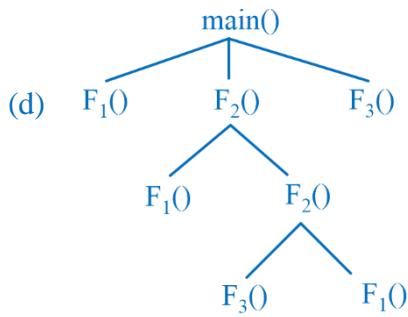
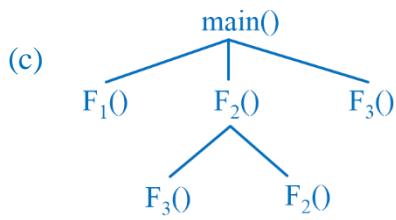
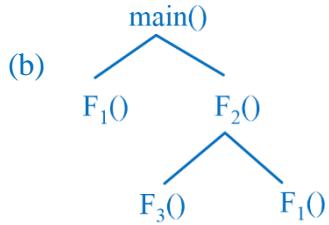
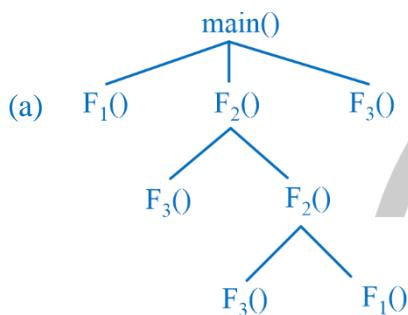
```
int main()
{
    f1();
    f2(2);
    f3();
    return 0;
}
```

```
int f1()
{
    return 1;
}
```

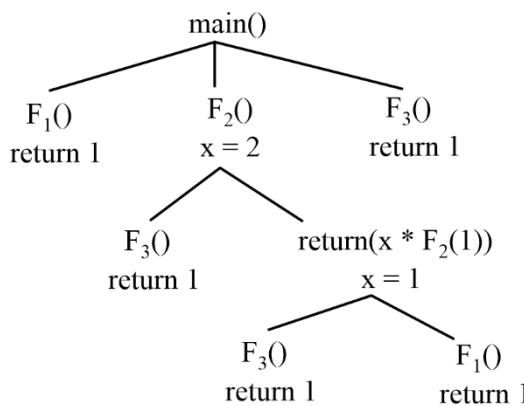
```
int f2(int x)
{
    f3();
    if (x == 1)
    {
        f1();
    }
    else return (x*f2(x-1));
}
```

```
int f3()
{
    return 1;
}
```

Which of the following is activation records of the given code?



Sol. (a)



Hence, option (a) is correct.

[MCQ]

Which of the following is correct regarding arity (or degree of a relation)?

- (a) Number of attributes of a relation.
- (b) Number of distinct domains of a relation schema.
- (c) Number of records of relation.
- (d) Number of tuples of a relation.

Sol. (a)

I: The number of fields/attributes of a relation are known as arity/degree.

II: The number of records / tuples of a relation is known as cardinality.

Roll No.	Marks	Grade
1	90	A
2	85	A
:	:	:
35	50	C

Number of rows
are records/tuples
of student relation
(Cardinality)

Number of columns
are fields/attributes
of relation student
(Arity or degree)





III: Student (Roll No., Marks, Grade) have 2 distinct domains but arity is 3.

So, option b is false.

Hence, the correct answer is option (a)

[NAT]

Consider a relation student as:

Student

Roll. No	Name	Marks	Gender
1	Namit	62	Male
2	Aliya	70	Female
3	Aliya	80	Female
4	Jatin	90	Male
5	Swati	65	Female

The following Query executed on above student table

SELECT*

FROM Student

WHERE Gender = 'Female'

AND Marks > 65

The number of tuples returned by the above query _____?

Sol. (2)

Given query:

SELECT*



FROM Student

WHERE Gender = 'Female'

AND marks > 65

On the, relation student

Roll No	Name	Marks	Gender
1	Namit	62	M
2	Aliya	70	F
3	Aliya	80	F
4	Jatin	90	M
5	Swati	65	F

will yield only two tuples i.e.,

Roll No	Name	Marks	Gender
2	Aliya	70	F
3	Aliya	80	F

[MSQ]

Which of the following is updated when a thread T1 of a process switches context to a thread T2 of the same process?

- (a) Program Counter
- (b) General Purpose Registers
- (c) Stack Pointer
- (d) Page Table Base Register

Sol. (a, b, c)

I: Program counter will be updated as it stores the address of instruction to be executed next from the memory.

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So, If T1 is currently executing the instruction at address 1000 then PC will have value 1001 (step size 1) that need to be saved.

II: General purpose registers and stack pointer also gets updated.

Hence, correct options are (a), (b) and (c).

[MCQ]

Which one of the following sequences when stored in an array at locations A[1] to A[10] result a max-heap?

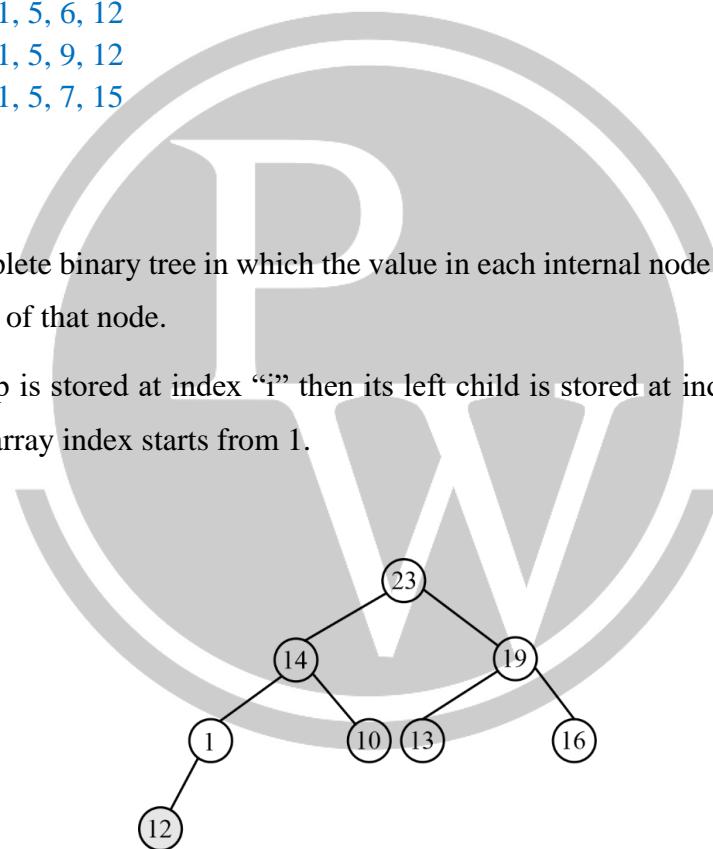
- (a) 23, 14, 19, 1, 10, 13, 16, 12, 7, 5
- (b) 23, 17, 14, 7, 13, 10, 1, 5, 6, 12
- (c) 23, 17, 10, 6, 13, 14, 1, 5, 9, 12
- (d) 23, 17, 14, 6, 13, 10, 1, 5, 7, 15

Sol. (b)

A max heap is a complete binary tree in which the value in each internal node is greater than or equal to the values in the children of that node.

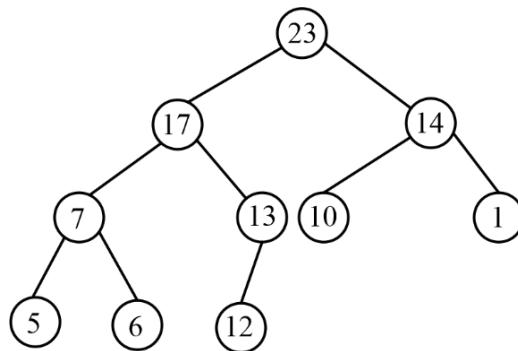
If a node in max heap is stored at index “i” then its left child is stored at index “2i” and its right child at index “2i + 1” if the array index starts from 1.

Option (a):



: 12 is larger than 1. So, it violates max-heap property.

Option (b):

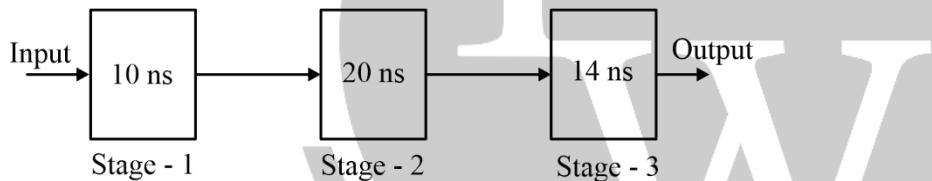


The above tree is satisfying the property if max-heap. Hence option (b) results in max-heap.

[NAT]

Consider a 3-stage pipelined processor having stage Delays of 10ns, 20ns and 14ns (Nano second) for the first, second and third stage respectively. Pipeline Register used between the stages has Negligible Time. The given pipeline has no hazards. Assume in every cycle 1 instruction is fetched then the Total time taken to execute 100 Instruction is (in nanosecond) _____

Sol. (2040)



Now, the cycle time of the pipeline will be = max (stage delays)

$$\therefore t_p = \max (10 \text{ ns}, 20 \text{ ns}, 14 \text{ ns})$$

$$t_p = 20 \text{ ns}$$

the pipeline has 100 instructions to execute. So, the execution time of pipeline with 3 – stage ($k = 3$) will be:

$$\begin{aligned} \text{Execution time}_{\text{Pipeline}} &= (k + n - 1) * t_p \\ &= (3 + 100 - 1) * 20 \text{ ns} \\ &= 102 * 20 \text{ ns} \\ &= 2040 \text{ ns}. \end{aligned}$$

[NAT]

A 8 – way set associative cache of bytes, 64 KB (1KB = 1024 Bytes) is used in a system with 32 bits address.

The physical address is sub-divided into TAG, INDEX and BLOCK OFFSET. The number of bits in TAG

_____?

Sol. (19)

I: Cache size is 64 KB

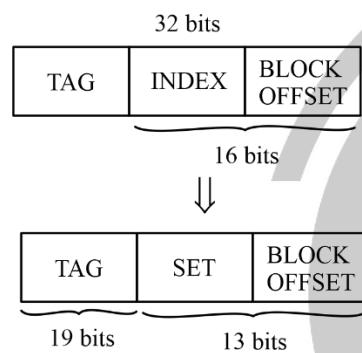
Block size is not given by default 1 byte

$$\text{So, number of lines} = \frac{\text{Cache Size}}{\text{Block Size}} = \frac{64\text{KB}}{1\text{B}}$$

II: Now, 8 – way set associativity given.

$$\text{So, number of sets} = \frac{\text{Number of line}}{\text{p-way}} = \frac{2^{16}}{8} = 2^{13} \text{ sets.}$$

III: Physical address is translated into:



$$\therefore \text{Tag bits} = 32 \text{ bits} - 13 \text{ bits} = 19 \text{ bits}$$

[MCQ]

A priority queue, implementation using max heap.

Extract-max (A) = Extract and delete the max elements, Insert (A, key) - Insert-key in A.

Then, which of the following is correct?

[Note: properties of heap should be maintained at end of each operation].

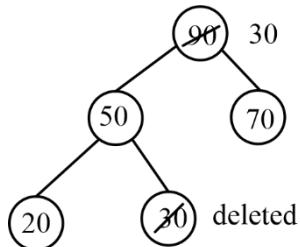
- (a) Extract Max O(logn) and Insert O(logn)
- (b) Extract Max O(1) and Insert O(logn)
- (c) Extract Max O(logn) and Insert O(1)
- (d) Extract Max O(1) and Insert O(1)

Sol. (a)

I: It is given that properties of heap should be maintained at the end of each operation.

II: Heap is a special case of balanced binary tree data structure hence; the height of tree is O(logn).

Extract – Max Operation: This will delete the root node data and replaced it by last level leaf data.



Therefore, to maintain the max-heap property, we have to perform Top-bottom max-heapify operation and it will take $O(\log n)$.

Insert – Key Operation: It will insert an element to the last level of max – heap.

If the inserted values is larger than root node then we have to perform bottom-top max-heapify and this will take $O(\log n)$.

Hence, option (a) is correct.

[MSQ]

$$f(n) = n, g(n) = n^2, \text{ for all natural numbers } n$$

- (a) $f(n) \in \Theta(g(n))$
- (b) $f(n) \in O(g(n))$
- (c) $f(n) \in \omega(g(n))$
- (d) $f(n) \in \Omega(g(n))$

Sol. (b, c)

the given functions are $f(n) = n, g(n) = n^2$

option (a): $f(n) \in \Theta(g(n))$

$$\begin{array}{ccc} \Downarrow & & \Downarrow \\ n & & \Theta(n^2) \\ \therefore n & \neq & n^2 \end{array}$$

Hence, option (a) is incorrect.

Option (b): $f(n) \in O(g(n))$

$$\begin{array}{ccc} \Downarrow & & \Downarrow \\ n & \in & O(n^2): \{n^2, n, \log n, 1, \dots\} \end{array}$$

Big – O means the time complexity of an algorithm can't go beyond n^2 .

Hence, option (b) is correct.

Option (c): $f(n) \in \omega(g(n))$

\Downarrow \Downarrow

$n \in \omega(n^2): \{n, \log n, 1, \dots\}$

Hence, option (c) is also correct.

Option (d): $f(n) \in \Omega(g(n))$

\Downarrow \Downarrow

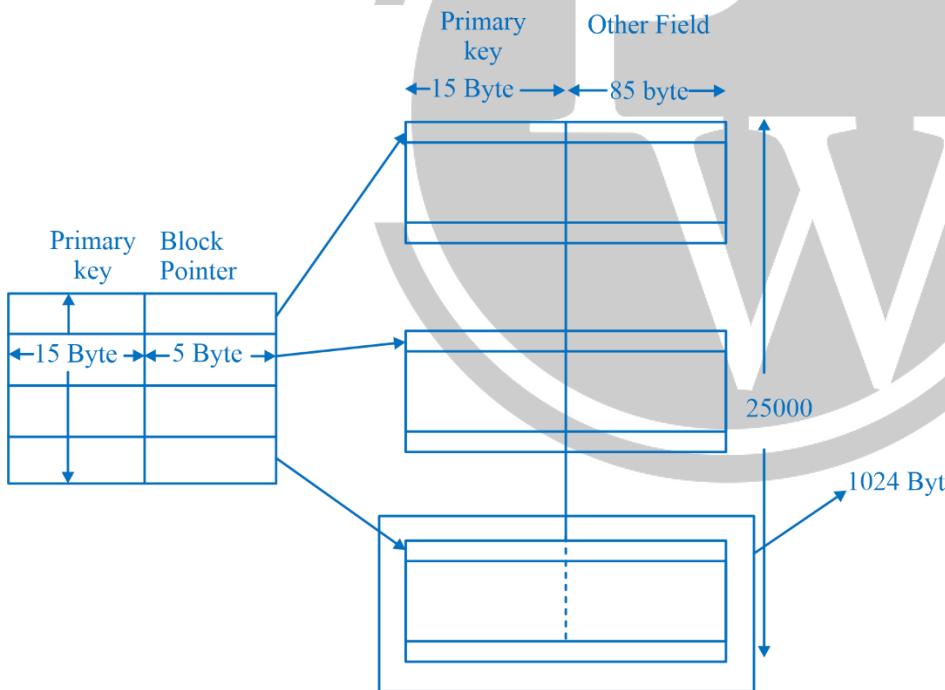
$n \notin \Omega(n^2): \{n^2, n^3, n^4, \dots\}$

Hence, option (d) is incorrect.

Thus, correct options are b and c.

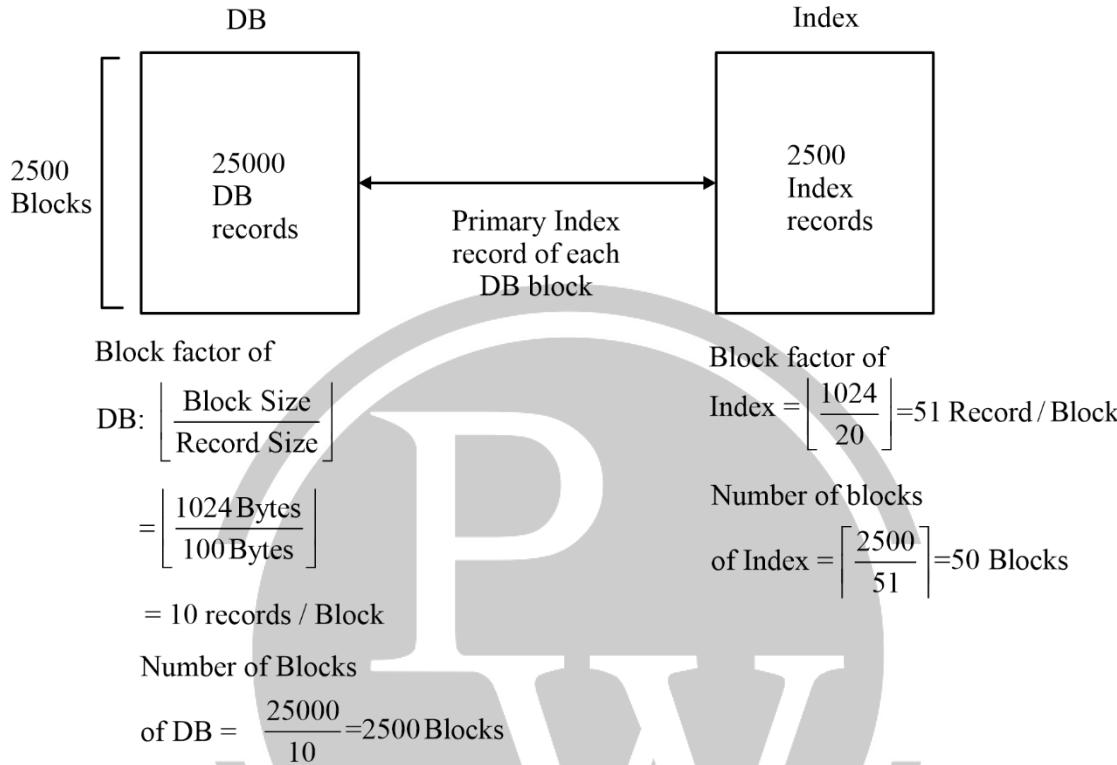
[NAT]

Consider a Database with 25000 records, all the records are of fixed length of size 100 bytes and unspammed organization is used. The primary key which is used for indexing is of 15 bytes. Block size is 1024 bytes.



A pointer is used to store the database block address is of 5 bytes. If we apply binary search on index, then in the worst case it taking $\lceil \log_2 b \rceil$, where b is number of blocks of Index file. What is the total numbers of block access required to search an element which is present in the database?

Sol. (7)



- I: Now, we have 50 blocks in Index file. If we apply binary search on Index file then worst case block access from index will be: $\lceil \log_2 50 \rceil = 6 \text{ Blocks.}$
- II: One more block access required to access the required data from database. Hence, total 7 block access required.

[MSQ]

Which of the following is/are false regarding OSPF protocol?

- (a) OSPF uses Dijkstra's algorithm.
- (b) OSPF uses Bellman Ford algorithm.
- (c) OSPF implemented using hierarchical structure.
- (d) OSPF is an inter domain routing protocol.

Sol. (b, d)

OSPF uses Dijkstra's algorithm not Bellman Ford algorithm. OSPF is an intra-domain routing protocol not inter domain. OSPF supports hierarchical network design (implemented using two layers).

[MCQ]

A link is point to point connected using stop and wait protocol, then certainly which of the following will yield lowest link utilization?

- Lower link length and higher transmission rate.
- Lower link length and lower transmission rate.
- Higher link length and higher transmission rate.
- Higher link length and lower transmission rate.

Sol. (c)

$$\text{Efficiency } (\eta) = \frac{1}{1 + 2(a)}$$

$$a = \frac{T_p}{T_t}$$

$$\text{Transmission Time } (T_t) = \frac{\text{Frame Size}}{\text{Bandwidth}}$$

$$\text{Propagation time } (T_p) = \frac{\text{Length}}{\text{Velocity}}$$

$$\eta = \frac{1}{1 + 2 \left(\frac{T_p}{T_t} \right)}$$

- T_p increases then overall efficiency will decrease (as denominator bigger than the numerator)
- Also, if bandwidth (Transmission Rate) is higher than T_t value will be small and hence T_p / T_t will be a large value.
- Therefore, to get overall η low, higher link length and higher transmission rate is required.

[NAT]

Consider the given routing table:

Subnet ID	Subnet Mask	Interface ID
200.150.0.0	255.255.0.0	1
200.150.64.0	255.255.224.0	2
200.150.68.0	255.255.255.0	3
200.150.68.64	255.255.255.224	4
Default		0

To Which interface, IP 200.150.68.118 will be forwarded?

Sol. (3)



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- We match with the longest subnet mask.
- Bitwise ANDing of given IP with subnet masks provided.

I:

200.150.68.118	$[118:01110110]$
<u>255.255.255.224</u>	<u>224:11100000</u>
<u>200.150.68.96</u>	<u>96: 01100000</u>

Not Matching

II:

200.150.68.118	$[118:01110110]$
<u>255.255.255.0</u>	<u>0: 00000000</u>
<u>200.150.68.0</u>	<u>0: 00000000</u>

Matching with given subnet ID i.e. 200.150.68.0, hence the IP will be forwarded to interface ID 3.

[MSQ]

Suppose there is a TCP connection with 100 Mbps and round trip time = 150 msec. The lifetime = 2 mins then which of the following is/are valid length of sequence number?

- 32 bits
- 30 bits
- 34 bits
- 36 bits

Sol. (a, c, d)

(a)

$$WAT = \frac{\text{Total Sequence Number}}{(\text{Bandwidth})\text{Byte}}$$

$$WAT = \frac{2^{32}}{12.5 * 10^6}$$

$$WAT = 343.59 \text{ sec}$$

$$LT = 120 \text{ sec}$$

[WAT > LT] No Problem. WAT must be larger than Lifetime.

(b)

$$WAT = \frac{\text{Total Sequence Number}}{(\text{Bandwidth})\text{Byte}}$$





$$WAT = \frac{2^{30}}{12.5 * 10^6}$$

$$WAT = 85.89 \text{ sec}$$

[WAT < LT]

(c)

$$WAT = \frac{\text{Total Sequence Number}}{(\text{Bandwidth})\text{Byte}}$$

$$WAT = \frac{2^{34}}{12.5 * 10^6}$$

$$WAT = 1374.38 \text{ sec}$$

[WAT > LT]

(d)

$$WAT = \frac{\text{Total Sequence Number}}{(\text{Bandwidth})\text{Byte}}$$

$$WAT = \frac{2^{36}}{12.5 * 10^6}$$

$$WAT = 5497.55 \text{ sec}$$

[WAT > LT]

OR

Lifetime span = 2 mins = 120 sec

Bandwidth \Rightarrow 100 Mbps

Data that can be sent in given lifespan $\Rightarrow 120 \times 100 \times 10^6$ bits

But since TCP is used and as it is a Byte stream protocol we convert given data transmitted in bytes.

$$\log_2 \left\lceil \frac{120 \times 100 \times 10^6}{8} \right\rceil$$

$$\Rightarrow \log_2 \left\lceil 15 \times 10^8 \right\rceil$$

$$\Rightarrow \log_2 \lceil 30.32 \rceil = 5$$

Sequence number will be 31 or above, so right choices will be 32, 34 and 36.

[MSQ]



Which of the following is/are correct?

- (a) Intersection of two CFL's is CFL
- (b) Intersection of two regular languages is regular
- (c) Intersection of two Recursive languages is Recursive
- (d) Intersection of two RE languages is RE

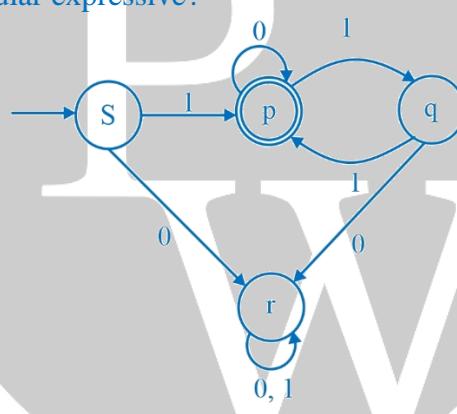
Sol. (b, c, d)

- (a) $\text{CFL} \cap \text{CFL} = \text{CSL}$ [False]
- (b) Regular \cap Regular = Regular [True]
- (c) Recursive \cap Recursive = Recursive [True]
- (d) RE \cap RE = RE [True]

Hence, option (b), (c) and (d) are correct.

[MCQ]

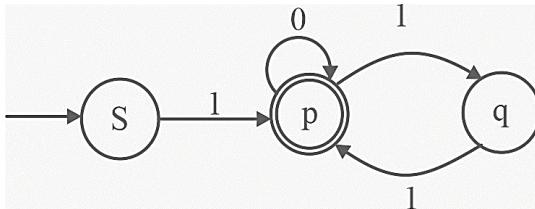
Which of the following is correct regular expressive?



- (a) $1(0 + 11)^*$
- (b) $1(0^* 11)^*$
- (c) $1(0 + 1)^*$
- (d) $0^*(0 + 11)^*$

Sol. (a)

I. To write regular expression from the machine, first remove any unreachable state or dead state.



Regular Expression = $1(0 + 11)^*$

[NAT]

Consider the following SDT:

$$N \rightarrow I\#F \quad \{N.val = I.val + F.val\}$$

$$I \rightarrow I_1B \quad \{I.val = 2 I_1.val + B.val\}$$

$$I \rightarrow B \quad \{I.val = B.val\}$$

$$F \rightarrow BF_1 \quad \{F.val = \frac{1}{2} (B.val + F_1.val)\}$$

$$F \rightarrow B \quad \{F.val = \frac{1}{2} (B.val)\}$$

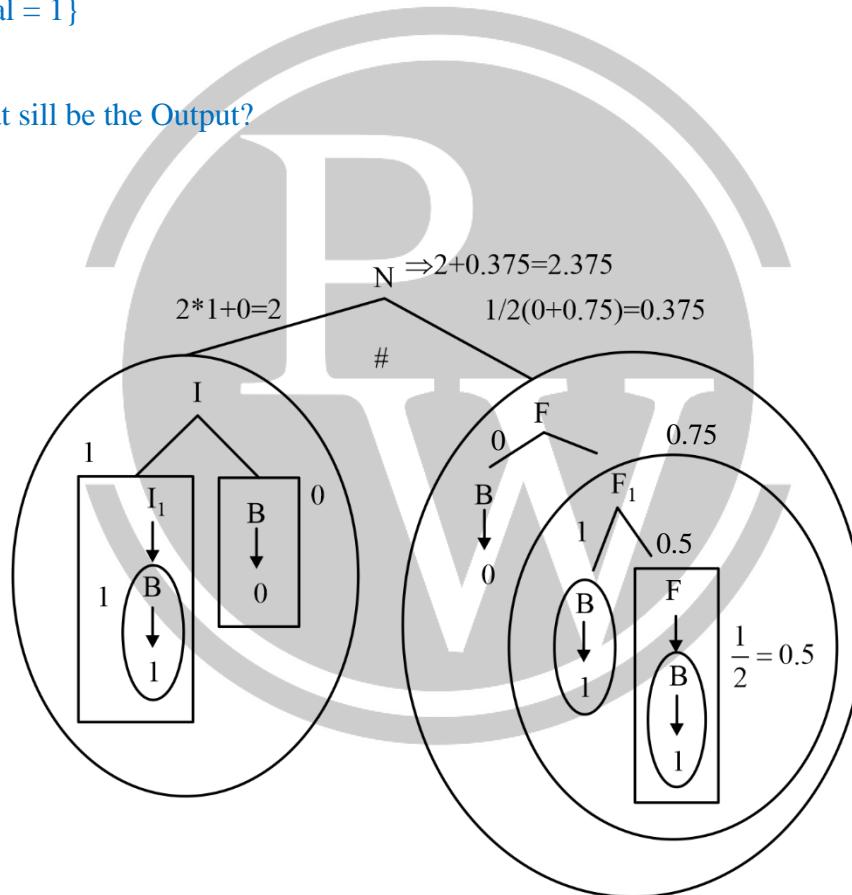
$$B \rightarrow 0 \quad \{B.val = 0\}$$

$$B \rightarrow 1 \quad \{B.val = 1\}$$

For input 10#011 what will be the Output?

Sol. (2.375)

Input 10#011



$$N = 2.375$$

[MCQ]

Consider the following statements

S1: Front-end of compiler is independent of target hardware

S2: Backend of compiler depends on target hardware



S3 : Backend of compiler depends on HLL

Which of the following is/are correct?

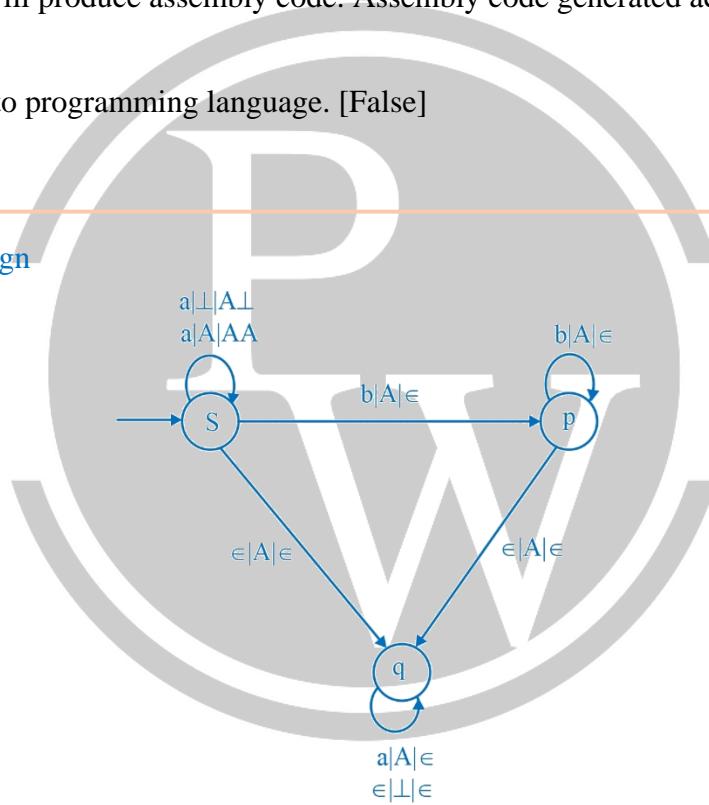
- (a) Only S1
- (b) Only S2
- (c) Only S2 and S3
- (d) Only S1 and S2

Sol. (d)

- S1: Frontend of the compiler is independent of target hardware as the result of frontend is a portable code.
Hence, the given statement S1 is True
- S2: Code generator will produce assembly code. Assembly code generated according to target machine.
[True]
- S3: Frontend is near to programming language. [False]

[MCQ]

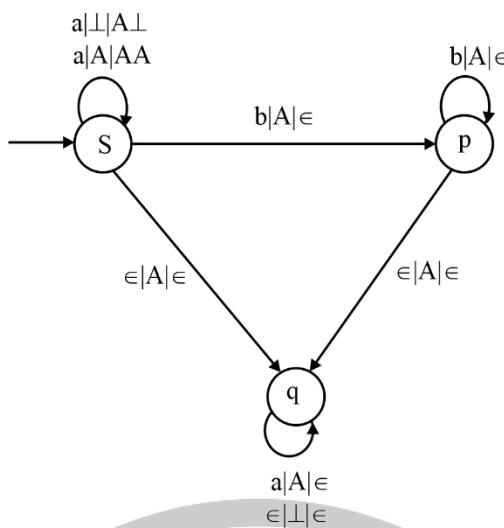
Consider the following design



For empty stack accepting mechanism which of the following is correct?

- (a) $\{a^n b^m \mid n, m \geq 0\}$
- (b) $\{a^n b^m \mid n \geq 1, m \geq n\}$
- (c) $\{a^n b^m \mid m \geq n \geq 0\}$
- (d) $\{a^*\} \cup \{b^*\}$

Sol. (b)



$$L = \{a^n b^m \mid m \geq n, n \geq 1\}$$

[MCQ]

Consider the following grammar

$$S \rightarrow a S b \mid X$$

$$X \rightarrow a X \mid X b \mid a \mid b$$

Which of the following is correct?

- (a) The Language generated by above grammar is not Regular.
- (b) The language generated by above grammar is $(a + b)^*$
- (c) The language generated by above grammar is $a^*(a + b)b^*$
- (d) The language generated by above grammar is $(a + b)^+$

Sol. (c)

$$S \rightarrow a S b \mid X$$

$$X \rightarrow a X \mid X b \mid a \mid b = a^* b^+ + b^* a^+$$

$$= a^* (a + b) b^*$$

$$S = a^n a^* (a + b) b^* b^n = a^* (a + b) b^*$$

Hence, Regular expression = $a^* (a + b) b^*$

[MCQ]

An ϵ -NFA is used during Token finding for Identifier.

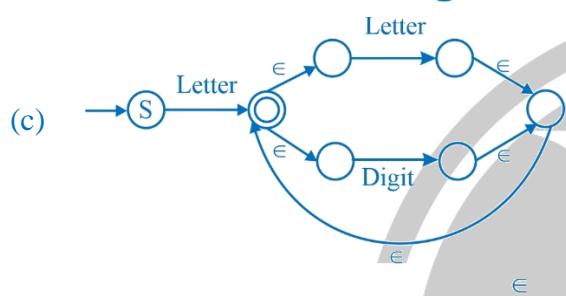
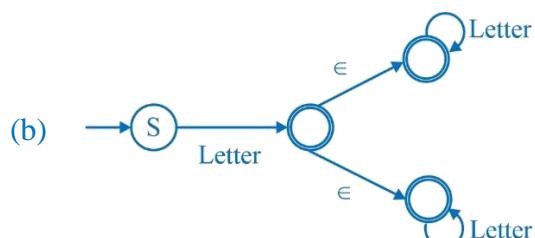
$$\text{Letter} \rightarrow \{A - Z, a - z\}$$

$$\text{Digit} \rightarrow \{0 - 9\}$$



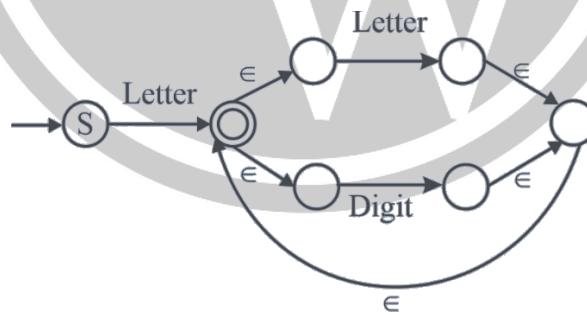
$\text{id} \rightarrow \text{Letter}(\text{Letter}/\text{Digit})^*$

What will be ϵ -NFA for above Identifier?



Sol. (c)

Draw an ϵ -NFA for identifier which is represented by $\text{Letter}(\text{Letter} + \text{Digit})^*$



[NAT]

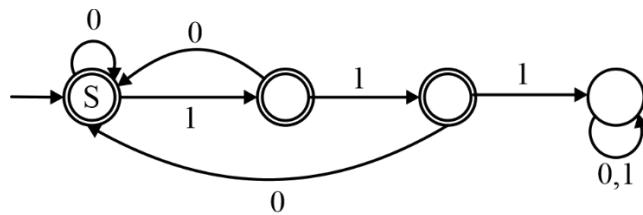
For $L = \{w \in \{0,1\}^* | w \text{ does not contain three or more consecutive } 1's\}$

How many states required in minimal DFA?

Sol. (4)

$L = \{\omega \mid \omega \text{ does not accept three consecutive } 1's \text{ or more consecutive}\}$

DFA:



\therefore Number of minimum states = 4

[MCQ]

Consider the two functions `Incr()` and `Decr()`

<code>Incr()</code>	<code>Decr()</code>
<code>wait(s)</code>	<code>wait(s)</code>
<code>x = x + 1</code>	<code>x = x - 1</code>
<code>signal (s)</code>	<code>signal (s)</code>

Five threads are executing `Incr()` and three threads are executing `Decr()`

`x` is a shared variable initialized to 10.

I_1 : `s` value is 1 (Binary semaphore)

I_2 : `s` value is 2 (Counting semaphore)

Let V_1 and V_2 be the minimum possible values of implementation I_1 and I_2 , then choose the values of `x` for V_1 and V_2 .

- (a) 12, 7
- (b) 7, 7
- (c) 15, 7
- (d) 12, 8

Sol. (a)

Case I: Let's find the minimum possible value of `x` for V_1 , when semaphore "`s`" is binary semaphore initialized to 1.

<code>P4P8</code> \Rightarrow <code>Incr()</code>	<code>Decr()</code> \Rightarrow P1, P2, P3
1. <code>Wait(s);</code>	1. <code>Wait(s);</code>
2. <code>x = x + 1;</code>	2. <code>x = x - 1;</code>
3. <code>signal (s);</code>	3. <code>Signal (s);</code>

Semaphore `s` = \emptyset 1

`P1 : Decr ()`

1. `wait(s); s = 0`



2. Read x: $x = 10$

Now, if you pre-empt P1, before performing decrement operation then other process would not be able to execute on 'x' as semaphore value is $s = 0$.

$$\therefore x - 1 : 10 - 1 : 9$$

$x = 9$: update x by 9.

3. signal(s); $s = 1$

P₂: Decr()

1, 2, 3: Final value of $x = 8$

P₃: Decr()

1, 2, 3: Final value of $x = 7$

P₄...P₈: Incr()

1, 2, 3: Increment x 5 times: $x = 12$

Hence, minimum possible value is 12 for V₁.

Case II: Let's find the minimum possible value of x for V₂, when semaphore S is counting semaphore initialized to 2.

P₁: Decr ()

1. wait (s): $s = \not 1$

2. read (x): $x = 10$

Preempt Process P₁.

Now, execute Incr()

P₄: ...P₈: Incr()

1, 2, 3: Final x value will be, $x = 15$

Now, revoke the process P₁ from pre-emption

2. Perform $x - 1 : 10 - 1 = 9$

Update x : $x = 9$

P₂: Decr()

1, 2, 3: $x = 8$

P₃: Decr()

1, 2, 3: $x = 7$

Hence, find value of V₂ is 7 for counting semaphore.

[MSQ]



Which of the following will guarantee the computer system transitions from user mode to kernel mode?

- (a) malloc call
- (b) System call
- (c) Page Fault
- (d) Function call

Sol. (b, c)

System calls and page faults are privileged instructions, hence, executed in kernel mode.

[MCQ]

We reached the station late, and _____ missed the train.

- (a) utterly
- (b) near
- (c) mostly
- (d) nearly

Sol. (a)

[MCQ]

$f(x)$ and $g(y)$ are functions of x and y , respectively, and $f(x) = g(y)$ for all real values of x and y .

Which one is true for all x and y ?

- (a) $f(x) = g(y) = \text{Constant}$
- (b) $f(x) = 0$ and $g(y) = 0$
- (c) $f(x) \neq \text{constant}$ and $g(y) \neq \text{constant}$
- (d) $f(x) + g(y) = f(x) - g(y)$

Sol. (a)

[MCQ]

Select the correct option two complete the following analogy.

Kind : _____ :: Often : Frequently

- (a) Mean
- (b) Cruel
- (c) Type
- (d) Kindly

Sol. (c)

[MCQ]

Which one of the following sentence sequences creates a coherent narrative?

- (i) Once on the terrace, on her way to her small room in the corner, she notices the man right away.
- (ii) She begins to pant by the time she has climbed all the stairs.
- (iii) Mina has bought vegetables and rice at the market, so her bags are heavy.

- (iv) He was leaning against the parapet, watching the traffic below.
(a) (iv), (ii), (i), (iii) (b) (i), (ii), (iv), (iii) (c) (ii), (iii), (i), (iv) (d) (iii), (ii), (i), (iv)

Sol. (d)

[MCQ]

A series of natural number $F_1, F_2, F_3, F_4, F_5, F_6, F \dots$ obeys $F_{n+1} = F_n + F_{n-1}$ for all integers $n \geq 2$. If $F_6 = 37$, and $F_7 = 60$, then what is F_1 ?

- (a) 9 (b) 8 (c) 5 (d) 4

Sol. (d)

[MCQ]

Consider two functions of time (t)

$$f(t) = 0.01t^2, g(t) = 4t$$

Where $0 < t < \infty$

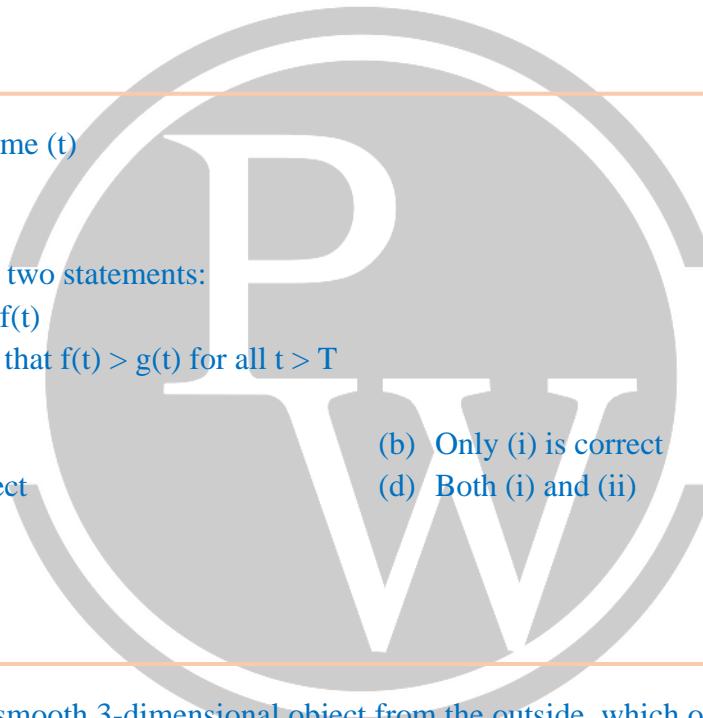
Now consider the following two statements:

- (i) For some $t > 0$, $g(t) > f(t)$
(ii) There exists a T , such that $f(t) > g(t)$ for all $t > T$

Which are is TRUE?

- (a) Only (ii) is correct
(c) Neither (i) nor is correct
(b) Only (i) is correct
(d) Both (i) and (ii)

Sol. (d)



[MCQ]

Looking at the surface of a smooth 3-dimensional object from the outside, which one of the following options is TRUE?

- (a) The object can have edges, but no corners.
(b) The surface of object must be concave everywhere
(c) The surface of object must be convex everywhere
(d) The surface of the object may be concave in some places and convex in other places

Sol. (a)

[MCQ]

A survey of certain year found that 90% of pregnant women received medical care at least one before giving birth. Of these women, 60% received care from doctors, while 40% received from other healthcare

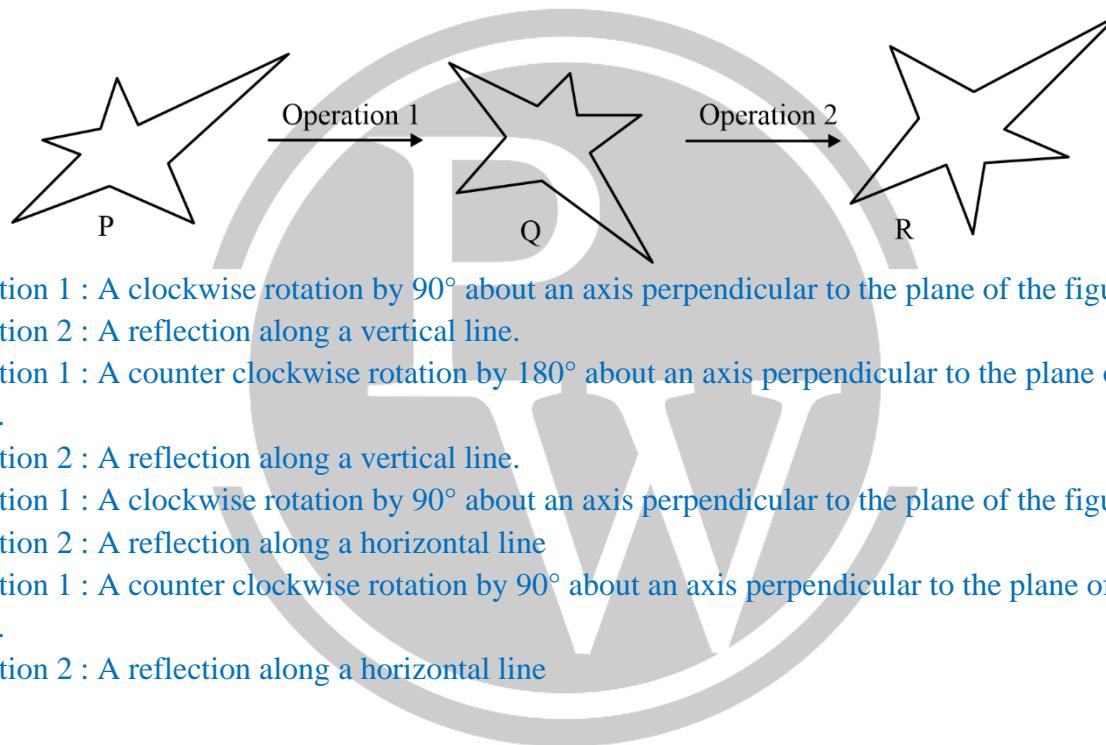
providers. Given this information, which one of the following statements can be inferred with certainty?

- (a) More than half of pregnant women received medical care at most once from a doctor.
- (b) More than half of pregnant women received medical care at least once from a doctor.
- (c) Less than half of pregnant women received medical care at most once from a doctor.
- (d) Less than half of pregnant women received medical care at least once from a doctor.

Sol. (b)

[MCQ]

Which one of the options best describes the transformation of the 2-dimensional figure P to Q, and then to R ?



- (a) Operation 1 : A clockwise rotation by 90° about an axis perpendicular to the plane of the figure.
Operation 2 : A reflection along a vertical line.
- (b) Operation 1 : A counter clockwise rotation by 180° about an axis perpendicular to the plane of the figure.
Operation 2 : A reflection along a vertical line.
- (c) Operation 1 : A clockwise rotation by 90° about an axis perpendicular to the plane of the figure
Operation 2 : A reflection along a horizontal line
- (d) Operation 1 : A counter clockwise rotation by 90° about an axis perpendicular to the plane of the figure.
Operation 2 : A reflection along a horizontal line

Sol. (c)

[NAT]

The value of then definite integral

$$\int_{-3}^3 \int_{-2}^2 \int_1^1 (4x^2y - z^3) dz dy dx$$

Sol. (0)

$$\int_{-3}^3 \int_{-2}^2 \int_1^1 (4x^2y - z^3) dz dy dx$$



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$$\int_{-3}^3 \int_{-2}^2 \int_1^1 (4x^2 y dz dy dx) - \int_{-3}^3 \int_{-2}^2 \int_1^1 (z^3 dz) dy dx$$

$$\int_{-3}^3 \int_{-2}^2 4x^2 y (z)_{-1}^1 dy dx - 0$$

$$\int_{-3}^3 \int_{-2}^2 8x^2 y dy dx$$

$$\int_{-3}^3 8x^2 \left(\int_{-2}^2 dy \right) dx$$

$$\int_{-3}^3 8x^2 (0) dx$$

$$= 0$$

[MSQ]

Let $f(x) = x^3 + 15x^2 - 33x - 36$ be a real valued function. Which statement is/are TRUE?

- (a) $f(x)$ does not have a local maximum.
- (b) $f(x)$ has a local maximum
- (c) $f(x)$ does not have a local minimum
- (d) $f(x)$ has a local minimum.

Sol. (b, d)

$$f(x) = x^3 + 15x^2 - 33x - 36$$

$$f'(x) = 3x^2 + 30x - 33$$

$$f''(x) = 6x + 30$$

$$f'(x) = 0$$

$$3x^2 + 30x - 33 = 0$$

$$x^2 + 10x - 11 = 0$$

$$(x + 11)(x - 1) = 0$$



$x = -11, x = 1$

$$f''(x) = 6x + 30$$

at $x = -11$

$$f''(-11) = -66 + 30$$

$$= 36 > 0$$

Local minima

$\Rightarrow f(x)$ has local maxima.

$\Rightarrow f(x)$ has local maxima.

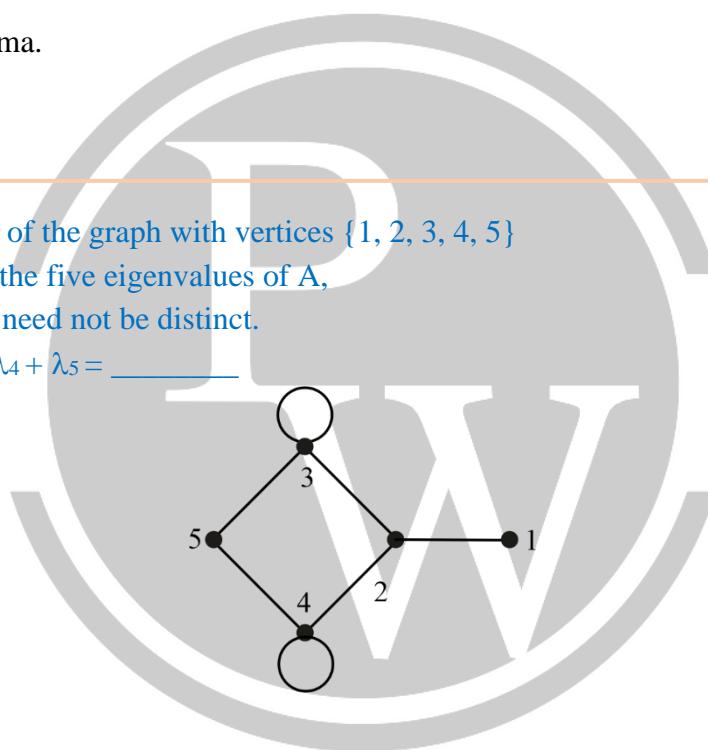
[NAT]

Let A be the adjacent matrix of the graph with vertices $\{1, 2, 3, 4, 5\}$

Let $\lambda_1, \lambda_2, \lambda_3, \lambda_4$, and λ_5 be the five eigenvalues of A ,

Note that these eigenvalues need not be distinct.

The value of $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 =$ _____



Sol. (2)

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

Sum of Eigen values

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 = \text{Tr}(A)$$





$$= 0 + 0 + 1 + 1 + 0 = 2$$

[MCQ]

Let

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix}$$

and

$$B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$$

Let $\det(A)$ and $\det(B)$ denote the determinants of the matrices A and B, respectively

- (a) $\det B = -\det A$
- (b) $\det A = \det B$
- (c) $\det(A) = 0$
- (d) $\det AB = (\det A)(\det B) A \times B$

Sol. (a)

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix}$$

$$B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$$

 $R_1 \leftrightarrow R_3$

$$\det B = -\det A$$

[MSQ]

Consider a random experiment where two fair coins are tossed. Let A be the event that denotes HEAD on both the throws, B be the event that denotes HEAD on 1st throw and C denotes HEAD on the 2nd throw, which statements is/are TRUE?

- (a) B and C are independent
- (b) A and B are independent





- (c) $P(B/C) = P(B)$
(d) A and C are independent

Sol. (a, c)

A: Head on both HH

B: Head on 1st

HT

HH

C: Head on second

HH TH

$$P(A) = \frac{1}{4}$$

$$P(B \cap C) = \frac{1}{4}$$

$$P(B) \cdot P(C) = \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$$

$$P(B \cap C) = P(B) \cdot P(C)$$

(∴ B and C are independent)

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

$$P(A \cap B) = \frac{1}{4}$$

$$P(A) \cdot P(B) = \frac{1}{4} \cdot \frac{1}{2} = \frac{1}{8}$$

$$P(A \cap B) \neq P(A) \cdot P(B)$$

(∴ A and B are not independent)

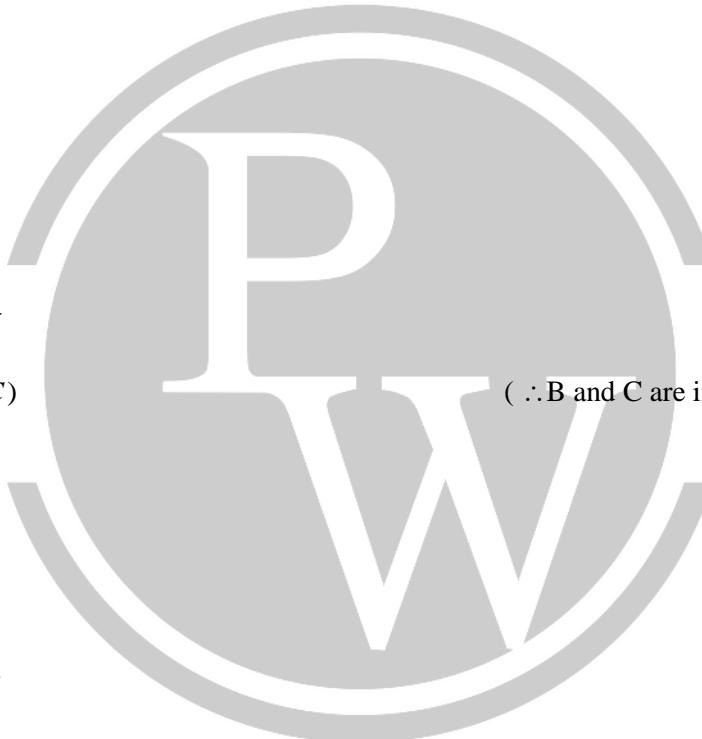
$$P(C) = \frac{1}{2}$$

$$P(A \cap C) = \frac{1}{4}$$

$$P(A) \cdot P(C) = \frac{1}{4} \cdot \frac{1}{2} = \frac{1}{8}$$

$$P(A \cap C) \neq P(A) \cdot P(C)$$

(∴ A and C are not independent)





$$P\left(\frac{B}{C}\right) = \frac{P(B \cap C)}{P(C)} = \frac{1/4}{1/2} = \frac{1}{2} = P(B)$$

[MCQ]

The Lunar sequence L_n is defined by the recurrence relation:

$$L_n = L_{n-1} + L_{n-2}, \text{ for } n \geq 3 \text{ with } L_1 = 1 \text{ and } L_2 = 3$$

Which one of the option given is TRUE?

(a) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n$

(c) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n + \left(\frac{1-\sqrt{5}}{2}\right)^n$

(b) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n + \left(\frac{1-\sqrt{5}}{3}\right)^n$

(d) $L_n = \left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n$

Sol. (c)

Lunar sequence

Put $n = 1$ in option we will get

$$l_1 = \frac{1+\sqrt{5}}{2} + \frac{1-\sqrt{5}}{2} = \frac{2}{2} = 1$$

given that $l_1 = 1$

put $n = 2$ in option we will get

$$l_2 = \left(\frac{1+\sqrt{5}}{2}\right)^2 + \left(\frac{1-\sqrt{5}}{2}\right)^2 = 2\left(\frac{1}{4} + \frac{5}{4}\right) = 2\left(\frac{6}{4}\right) = 3$$

Given that $l_2 = 3$

$$l_n = \left(\frac{1+\sqrt{5}}{2}\right)^n + \left(\frac{1-\sqrt{5}}{2}\right)^n$$

Both the boundary conditions are satisfied by the option c.



[MCQ]

How many permutations of U separate A from B?

- (a) $\binom{n}{2k}(n-2k)!(k!)^2$ (b) $\binom{n}{2k}(n-2k)!$ (c) $2\binom{n}{2k}(n-2k)!(!)^2$ (d) $n!$

Sol. (a)

$$U = \{1, 2, \dots, n\}$$

$$k < n < 1000$$

$$|A|=k$$

$$|B|=k$$

$$A \cap B = \emptyset$$

Permutation of U separates of A from B

$$\binom{n}{2k}(n-2k)!(k!)^2$$

[MSQ]

Let x be a set, 2^x = power $2k$ set of X . define A binary operation Δ on 2^x as $A \Delta B = (A-B) \cup (B-A)$,

Let $H = (2^x, \Delta)$, then

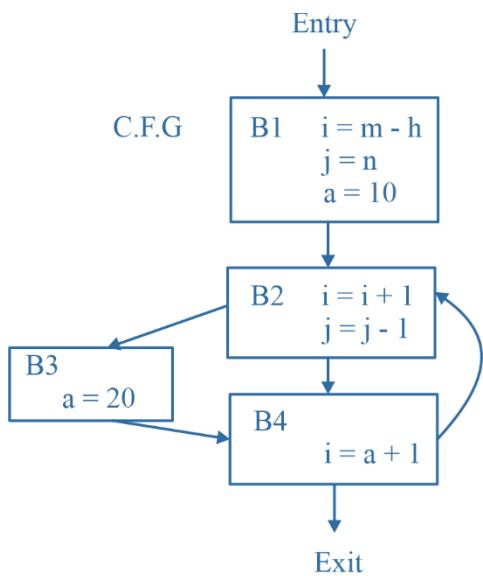
- (a) H is a group
(b) H satisfies inverse prop, but not a group
(c) for every $A \in 2^x$; inverse of A is A .
(d) for every $A \in 2^x$; inverse of A is not A .

Sol. (a, c)

[MSQ]

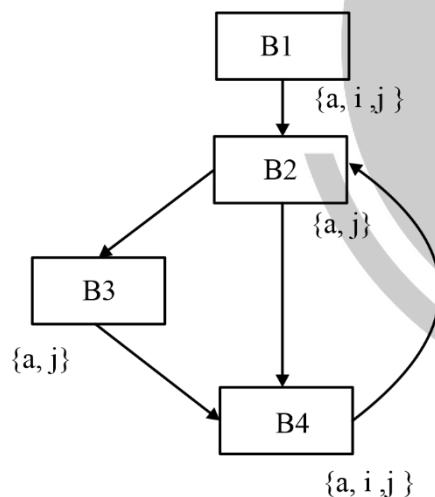
What are the live variables at the end of each block B1, B2, B3 and B4 respectively?





- (a) {a, i, j}, {a, j}, {a, j}, {a, i, j}
- (b) {a, i, j}, {a, i, j}, {a, j}, {a, j}
- (c) {a, j}, {a, i, j}, {a, j}, {a, i, j}
- (d) {a, j}, {a, i, j}, {a, j}, {a, i, j}

Sol. (a)





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