BYJU'S EXAM PREP

GATE 2021

Computer Science & Information Technology

Shift-2

Questions & Solutions

SECTION: GENERAL APTITUDE

1. Gauri said that she can play the keyboard _______ her sister.

A. as worse as B. as better as

C. as nicest as D. as well as

Ans. D

Sol. As well as, option A, B better/worse are comparative so they should be follow by than, C nicest is superlative degree which express the highest form of an adjective.

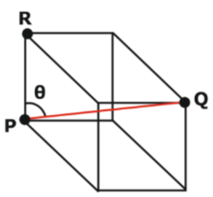
2. If θ is the angle, in degrees, between the longest diagonal of the cube and any one of the edges of the cube, then, cos θ =

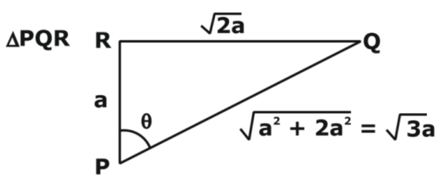
A. $\frac{1}{\sqrt{3}}$ B. $\frac{1}{2}$

C. $\frac{1}{\sqrt{2}}$ D. $\frac{\sqrt{3}}{2}$

Ans. A

Sol.





$$\cos\theta = \frac{a}{\sqrt{3}a} = \frac{1}{\sqrt{3}}$$

3. Six students P, Q, R, S, T and U, with distinct heights, compare their heights and make the following observations.

Observation I: S is taller than R.

Observation II: Q is the shortest of all.

Observation III: U is taller than only one student.

Observation IV: T is taller than S but is not the tallest.

The number of students that are taller than R is the same as the number of students shorter than _______ .

A. T B. P

C. S D. R

Ans. C

Sol. We will arrange the students in descending order here ,where the tallest will come at first and the shortest at last

Observation 1: S > R

Observation 2: Q will be at the last.

Observation 3: U > Q

Observation 4: T > S but not the tallest and hence cannot be at the first.

So the as per the given observation the only possible arrangement is P > T > S > R > U >Q The number of students that are taller than R is the same as the number of students shorter than S.

Hence the correct answer is S.

4. Pen : Write :: Knife : ______

Which one of the following options maintains a similar logical relation in the above?

A. Cut B. Vegetables

C. Sharp D. Blunt

Ans. A

Sol. Pen is used for writing as well as knife is used for cutting the things.

5. The number of students in three classes is in the ratio 3:13:6. If 18 students are added to each class, the ratio changes to 15:35:21.

The total number of students in all the three classes in the beginning was:

A. 88 B. 110

C. 22 D. 66

Ans. A

Sol. 3 : 13 : 6

Let $\quad 3k + 13k + 6k = n$

Now $\;+18 + \;18\; + 18$

$\quad 15 : 35 : 20$

15y + 35y + 21 y = 22 k + 54

71y = 22k + 54

Put value of k and satisfy

Here, k = 4

On putting k = 4 in equation (1)

n = 88 .

6. If $\left(x-\frac{1}{2}\right)^2-\left(x-\frac{3}{2}\right)^2=x+2$, then the value of x is :

A. 6   B. 4

C. 2   D. 8

Ans. B

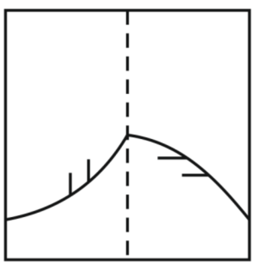
Sol. $\left(x^2+\frac{1}{4}-x\right)-\left(x^2+\frac{9}{4}-3x\right)=x+2$

$\Rightarrow x^2+\frac{1}{4}-x-x^2-\frac{9}{4}+3x=x+2$

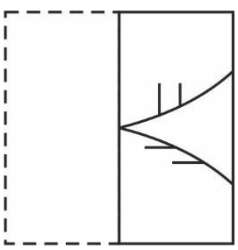
$\Rightarrow \frac{-8}{4}+2x=x+2$

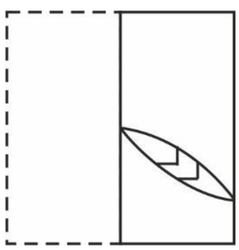
$\Rightarrow x = 4$

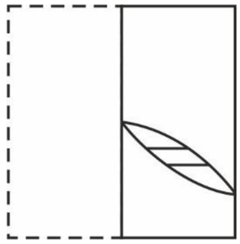
7.

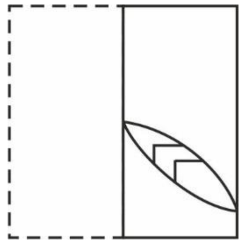


A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like ________ .

A. 

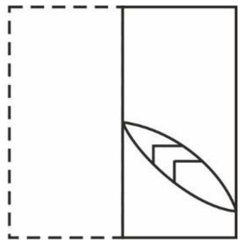
B. 

C. 

D. 

Ans. D

Sol.



Here we just need to fold the paper towards the dotted line on the right and join the figures to get the given solution.

8. Listening to music during exercise improves exercise performance and reduces discomfort. Scientists researched whether listening to music while studying can help students learn better and the results were inconclusive. Students who needed external stimulation for studying fared worse while students who did not need any external stimulation benefited from music.

Which one of the following statements is the CORRECT inference of the above passage?

A. Listening to music has a clear positive effect on physical exercise. Music has a positive effect on learning only in some students.

B. Listening to music has no effect on learning and a positive effect on physical exercise.

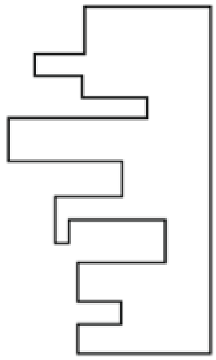
C. Listening to music has a clear positive effect both on physical exercise and on learning.

D. Listening to music has a clear positive effect on learning in all students. Music has a positive effect only in some students who exercise.

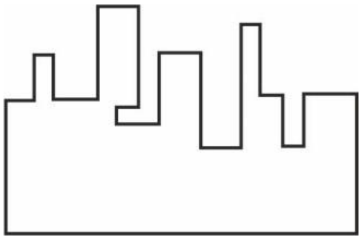
Ans. A

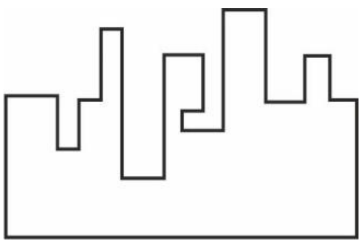
Sol. Listening to music Has a clear positive effect on physical exercise. Music has a positive effect on learning only in some students. Only this statement can be concluded.

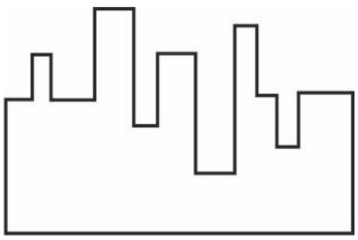
9.

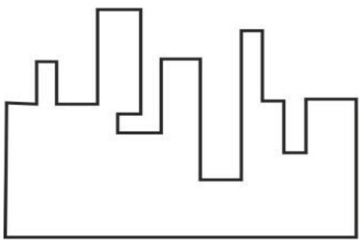


A jigsaw puzzle has 2 pieces. One of the pieces is shown above. Which one of the given options for the missing piece when assembled will form a rectangle? The piece can be moved, rotated or flipped to assemble with the above piece.

A. 

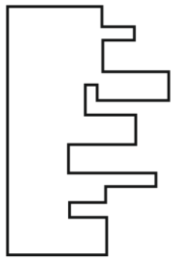
B. 

C. 

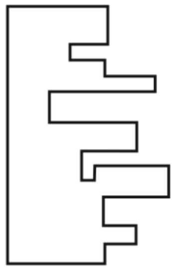
D. 

Ans. A

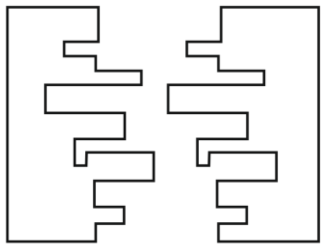
Sol.



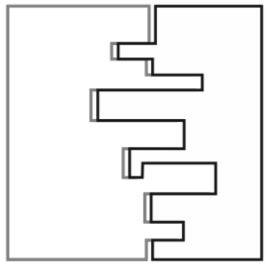
First we will rotates this figure to right at the angle of 90°



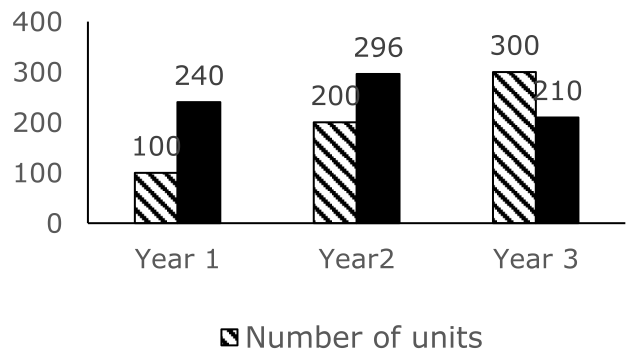
then, we need to flip the figure vertically.



After joining both it will look like this.



10.



The number of units of a product sold in three different years and the respective net profits are presented in the figure above. The cost/unit in Year 3 was ₹ 1, which was half the cost/unit in Year 2. The cost/unit in Year 3 was one-third of the cost/unit in Year 1. Taxes were paid on the selling price at 10%, 13% and 15% respectively for the three years. Net profit is calculated as the difference between the selling price and the sum of cost and taxes paid in that year.

The ratio of the selling price in Year 2 to the selling price in Year 3 is ________ .

A. 4 : 3 B. 1 : 1

C. 1 : 2 D. 3 : 4

Ans. A

Sol. Cost per unit of Year 3 = ₹ 1

Cost per unit of Year 2 = ₹ 2

Cost per unit of Year 1 = ₹ 3

Cost Price of 100 units in Year 1 is ₹ 300

Cost Price of 200 units in Year 2 is ₹ 400

Cost Price of 300 units in Year 3 is ₹ 300

Net Profit = Selling price – [Cost Price + (Tax%*Selling Price)]

Now we can calculate the selling price for Year 2 and Year 3.

Year 2:

296 = SP – [400 + 0.13 SP]

⇒ 296 = 0.87 SP – 400

⇒ 0.87 SP = 696

⇒ SP = ₹ 800

Year 3:

210 = SP – [300 + 0.15 SP]

⇒ 210 = 0.85 SP – 300

⇒ 0.85 SP = 510

⇒ SP = ₹ 600

Hence the ratio of SP of Year 2 and Year 3 = 800 : 600 = 8 : 6 = 4 : 3

TECHNICAL

1. Consider the following ANSI C program.

```
#include <stdio.h>
int main(){
int arr [4] [5] ;
  int i, j;
for (i=0; i<4; i++){
 for (j=0; j<5; j++){
arr[i][j] = 10*i + j;
 }
}
printf("%d", *(arr[1] + 9));
return 0;
}
```

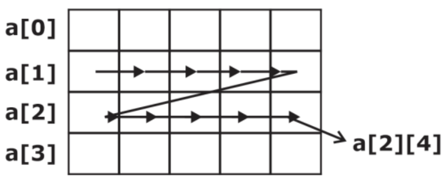
What is the output. of the above program?

A. 14 B. 24

C. 30 D. 20

Ans. B

Sol.



$*(a[1]+9) = a[2][4]$

$= 10 \times 2 + 4$

$= 24$

2. Which of the following statement(s) is/are correct in the context of CPU scheduling?

A. Turnaround time includes waiting time.

B. Round-robin policy can be used even when the CPU time required by each of the processes is not known apriori.

C. Implementing preemptive scheduling needs hardware support.

Ans. A, B, C

Sol. option A is Correct, turnaround time = burst time + waiting

option B is correct

option C is correct, preemptive scheduling needs hardware supports such as timer.

option D is incorrect, we have to maximize the throughput also.

3. Consider the following sets, where $n \geq 2$:

S_1: Set of all $n \times n$ matrices with entries from the set {a, b, c}

S_2: Set of all functions from the set $\{0, 1, 2, \ldots, n^2 - 1\}$ to the set {0,1,2}

Which of the following choice(s) is/are correct?

A. There exists a bijection from S_1 to S_2.

B. There exists a surjection from S_1 to S_2.

C. There does not exist an injection from S_1 to S_2.

D. There does not exist a bijection from S_1 to S_2.

Ans. A, B

Sol. S1 : There are n^2 element in the matrix, we have 3 choices for each element, so number of such matrices = 3^{n^2}

S2 : There are n^2 total elements with 3 choices for each element, so number of functions possible = 3^{n^2}

As the cardinality of both the sets are same, we can establish a bijection from one set to another, as bijection is possible, so surjection is also possible.

so, option A and B.

4. Consider the following ANSI C code segment:

```
z = x + 3 + y->f1 + y->f2;
  for (i = 0; i< 200; i = i + 2){
 if (2 >i) {
 p = p + x + 3:
q = q + y->f1;
} else {
 p = p + y->f2:
 q = q + x + 3:
}
}
```

Assume that the variable y points to a struct (allocated on the heap) containing two fields f1 and f2, and the local variables x, y, z, p, q, and i are allotted registers. Common sub-expression elimination (CSE) optimization is applied on the code. The number of addition and dereference operations (of the form y->f1 or y->f2) in the optimized code, respectively, are:

A. 303 and 102 B. 303 and 2

C. 403 and 102 D. 203 and 2

Ans. B

Sol. $t_1 = x + 3$ ‖ 1 addition

$t_2 = y \rightarrow f_1$; ‖ 1 dereference

$t_3 = y \rightarrow f_2$; ‖ 1 dereference

$z = t_1 + t_2 + t_3$‖ 2 additions

```
for (i = 0;  I< 200; i+ = 2) {
      if (z >i) {
            p = p + t1 ;‖  1 addition
q = q + t2 ;‖ 1 addtion
}else {
            p = p + t3;   ‖ 1 addition
            q = q + t1; ‖ 1 addition
     }
}
```

loop will run 100 times and both if and else are performing 2 addition operations, so from loop we get 2 × 100 = 200 additions and 100 times i is incrementing, so, 200 + 100 = 300 addition from the loop. Before loop, 3 additions and 2 dereference operations.

So, 303 addition, 2 dereference.

5. Consider a Boolean function f(w, x, y, z) such that

$f(w, 0, 0, z) = 1$

$f(1, x, 1, z) = x + z$

$f(w, 1, y, z) = wz + y$

The number of literals in the minimum sum-of-products expression of f is ______ .

Ans. 6

Sol.

W	x	Y	z	F
0	0	0	0	1
0	0	0	1	1
0	0	1	0	$\cancel{0}$
0	0	1	1	$\cancel{0}$
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

yz \ wx	00	01	11	10
00	1_{0}	$_{4}$	$_{12}$	1_{8}
01	1_{1}	$_{5}$	1_{13}	1_{9}
11	ϕ_{3}	1_{7}	1_{15}	1_{11}
10	ϕ_{2}	1_{6}	1_{14}	$_{10}$

$\Rightarrow \bar{x}\,\bar{y} + wz + xy$

⇒ 6 literals

6. Let S be the following schedule of operations of three transactions T_1, T_2 and T_3 in a relational database system:

$R_2(Y)$, $R_1(X)$, $R_3(Z)$, $R_1(Y)$, $W_1(X)$, $R_2(Z)$, $W_2(Y)$, $R_3(X)$, $W_3(Z)$

Consider the statements P and Q below:

P: S is conflict-serializable.

Q: If T_3 commits before T_1 finishes, then S is recoverable.

Which one of the following choices is correct?

A. Both P and Q are true.

B. P is false and Q is true.

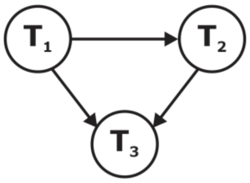
C. Both P and Q are false.

D. P is true and Q is false.

Ans. D

Sol.

T_1	T_2	T_3
	R(Y)	
		R(Z)
R(X)		
R(Y)		
W(X)		
	R(Z)	
	W(Y)	
		R(X)
		W(Z)



because there is no cycle so it is conflict serializable. Hence statement 1 is true.

S2: If T_3 will commit first than T_1 and in T_3 we have dirty read ($W_1(X) \rightarrow R_3(X)$) so it will not be recoverable. Hence statement 2 is false.

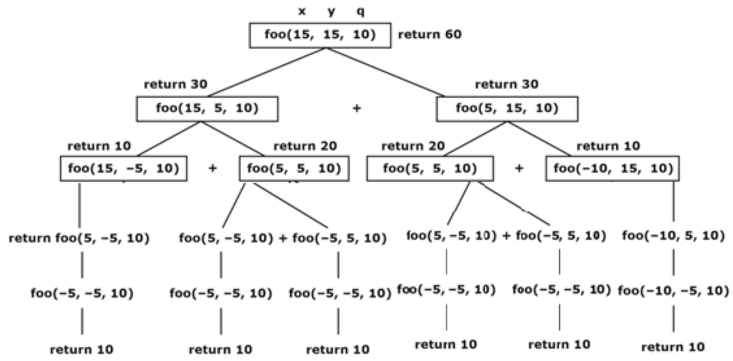
7. Consider the following ANSI C program.

```
#include <stdio.h>
int foo(int x, int y, int q)
{
  if ((x <= 0) && (y <= 0))
 return q;
  if (x <= 0)
 return foo(x, y-q, q);
 if (y <= 0)
 return foo(x-q, y, q);
 return foo(x, y–q, q) + foo(x-q, y, q);
}
int main()
{
  int r = foo(15,15,10);
printf("%d", r);
  return 0;
}
```

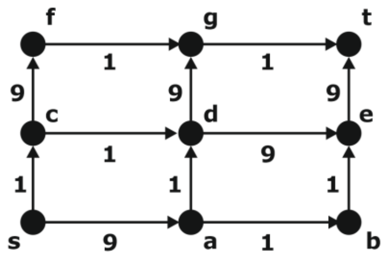
The output of the program upon execution is _______

Ans. 60

Sol.



8. In a directed acyclic graph with a source vertex s, the quality-score of a directed path is defined to be the product of the weights of the edges on the path. Further, for a vertex v other than s, the quality-score of v is defined to be the maximum among the quality-scores of all the paths from s to v. The quality-score of s is assumed to be 1.



The sum of the quality-scores of all the vertices in the graph shown above is ______ .

Ans. 929

Sol.

S = 1

S → a = 9

S → b = 9

S → c = 1

S → d = 9

S → e = 81

S → f = 9

S → g = 81

S → t = 729

929

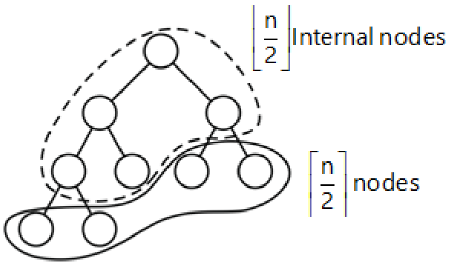
9. Let H be a binary min-heap consisting of n elements implemented as an array. What is the worst case time complexity of an optimal algorithm to find the maximum element in H ?

A. Θ(n) B. Θ(1)

C. Θ(log n) D. Θ(n log n)

Ans. A

Sol.



Maximum element present in the leaf node which is $\left\lceil \frac{n}{2} \right\rceil$ nodes.

Hence time complexity = θ(n).

10. Consider a network using the pure ALOHA medium access control protocol, where each frame is of length 1,000 bits. The channel transmission rate is 1 Mbps (= 10^6 bits per second). The aggregate number of transmissions across all the nodes (including new frame transmissions and retransmitted frames due to collisions) is modelled as a Poisson process with a rate of 1,000 frames per second. Throughput is defined as the average number of frames successfully transmitted per second. The throughput of the network (rounded to the nearest integer) is _______.

Ans. 135

Sol. L = 1000 bits

B = 10^6 bits/sec

1 frame transmission delay

$$= \frac{1000 \text{ bits}}{10^6 \text{ bits/sec}} = 1 \text{ m sec}$$

1000 frames transmission delay = 1000 × 1 m sec

= 1 sec

g_u 1 sec sending 1000 frames which is 1 milisec per frame

g_u one sec we are using the full load G = 1

$S = G * e^{-2G}$

S = 0.1353

Through put of pure aloha = 13.53

1 is 1 sec 1000 frames = 0.1353 × 100

= 135.3

= 135 (closest Integer).

11. Let S be a set consisting of 10 elements. The number of tuples of the form (A, B) such that A and B are subsets of S, and A ⊆ B is _______.

Ans. 59049

Sol. If |A| = 0 so |B| = 2^{10} (Total number of subsets)

Similarly if |A| = 1 so |B| = 2^{10-1}

If |A| = 2 so |B| = 2^{10-2} and so on then it will be

$2^{10} + {}^{10}C_1 + 2^9 + {}^{10}C_2 \times 2^8 + \ldots\ldots + {}^{10}C_1\, 2^{10-k}$

Therefore, we get: $(1 + 2)^{10} = (3)^{10}$

12. Consider the following ANSI C function:

```
int SomeFunction(int x, int y)
{
if ((x == 1) | | (y == 1)) return 1;
 if (x == y) return x;
 if (x > y) return SomeFunction(x – y, y);
if (y > x) return SomeFunction(x, y – x);
}
```

The value returned by SomeFunction(15, 255) is _______

Ans. 15

Sol.

x y

foo(15, 255)

↓ y > x

foo(15, 240)

↓ y > x

foo(15, 225)

↓ y > x

foo(15, 210) .

↓ .

foo(15, 195) .

↓

foo(15, 180)

↓

foo(15, 165)

↓

foo(15, 150)

↓

foo(15, 135)

↓

foo(15, 120)

↓

foo(15, 105)

↓

foo(15, 90)

↓

foo(15, 75)

↓

foo(15, 60)

↓

foo(15, 45)

↓

foo(15, 30)

↓

foo(15, 15)

↓ x == y

return x; (return 15)

Hence the final return value is 15.

13. Let G be a connected undirected weighted graph. Consider the following two statements.

S_1 : There exists a minimum weight edge in G which is present in every minimum spanning tree of G.

S_2 : If every edge in G has distinct weight, then G has a unique minimum spanning tree.

Which one of the following options is correct?

A. S_1 is true and S_2 is false.

B. S_1 is false and S_2 is true.

C. Both S_1 and S_2 are true.

D. Both S_1 and S_2 are false.

Ans. C

Sol. Both S_1 and S_2 are true. If there exists an edge with minimum weight then it will be included in every minimnum spanning tree. If every edge has distinct weights then the minimum spanning tree will be unique.

14. For constants a ≥ 1 and b > 1, consider the following recurrence defined on the non-negative integers:

$$T(n) = a \cdot T\left(\frac{n}{b}\right) + f(n)$$

Which one of the following options is correct about the recurrence T(n) ?

A. f(n) is $O\left(n^{\log_b(a)-\varepsilon}\right)$ for some ∈> 0, then T(n) is $\Theta\left(n^{\log_b(a)}\right)$.

B. If f(n) is $\dfrac{n}{\log_2(n)}$, then T(n) is $\Theta(\log_2(n))$.

C. If f(n) is $\Theta\left(n^{\log_b(a)}\right)$, then T(n) is $\Theta\left(n^{\log_b(a)}\right)$.

D. If f(n) is n $\log_2(n)$, then T(n) is $\Theta(n\log_2(n))$.

Ans. A

Sol. If we take a=2, b=2 apply extended master's theorem we get option B, C, D wrong. Option A is correct.

15. Choose the correct choice(s) regarding the following propositional logic assertion S:

S : ((P ∧ Q) → R) → ((P ∧ Q) → (Q → R))

A. S is neither a tautology nor a contradiction.

B. S is a tautology.

C. S is a contradiction.

D. The antecedent of S is logically equivalent to the consequent of S.

Ans. B, D

Sol. **Case I:**

((P ∧ Q) → R) is true then

1) (P ∧ Q) is true so (Q → R) if Q is false then always true & if Q is false then depends on R value & hence always true.

2) (P ∧ Q) is false so right side is always true so it is always true.

Case 2:

If ((P ∧ Q) → R) is false then the complete expression is true.

So it is a Tautology.

$(PQ \to R)' + (PQ)' + (Q' + R)$

$= ((PQ)' + R)' + (PQ)' + Q' + R$

$= ((PQ)' + R)' + P' + Q' + Q' + R$

$= \underbrace{PQR'}_{x'} + \underbrace{P' + Q' + R}_{x}$

$(PQR')' = P' + Q + R$

So, $x + x' = 1$

Hence it is tautology.

Option D is also correct-

Antecedent of S:

$(P \wedge Q) \to R$

$= \sim(P \wedge Q) \vee R$

$= \sim P \vee \sim Q \vee R$

Consequent of S :

$(P \wedge Q) \to (Q \to R)$

$= (P \wedge Q) \to (\sim Q \vee R)$

$= \sim(P \wedge Q) \vee (\sim Q \vee R)$

$= \sim P \vee \sim Q \vee (\sim Q \vee R)$

$= \sim P \vee \sim Q \vee R$

16. Consider a computer system with DMA support. The DMA module is transferring one 8-bit character in one CPU cycle from a device to memory through cycle stealing at regular intervals. Consider a 2 MHZ processor. If 0.5% processor cycles are used for DMA, the data transfer rate of the device is ________ bits per second.

Ans. 80,000

Sol. 1 cycle time = $\frac{1}{2 \times 10^6}$ sec = 0.5 μsec [Micro-seconds]

In 1 cycle, it can transfer 8 bits

So, In 0.5 micro-sec = 8 bits

1 micro-sec = 16 bits

1 sec = 16×10^6 bits

But it could use only 0.5% of processor cycles,

so the data rate is $\frac{0.5}{100} \times 16 \times 10^6$ bits = 80000 bits per sec.

17. Consider the following augmented grammar with {#, @, <, >, a, b, c} as the set of terminals.

$S' \to S$

$S \to S\#cS$

$S \to SS$

$S \to S@$

$S \to < S >$

$S \to a$

$S \to b$

$S \to c$

Let I_0 = CLOSURE({$S' \to \bullet S$}). The number items in the set GOTO(GOTO(I_0,<), <) is _________ .

Ans. 8

Sol. Then find no. of items in goto (goto (I_o, <), <)

Input: (I_o)

$S' \to .S$
$S \to .\ S\ \#\ cS\ \vert\ .<S>\ \vert\ .a\ \vert\ .b\ \vert\ .S\ S\ \vert\ .S\ @\ \vert\ .c$

$\downarrow <$

Input: (I_1)

$S \to <.\ S >$
$S \to .\ S\ \#\ cS\ \vert\ .<S>\ \vert\ .a\ \vert\ .b\ \vert\ .S\ S\ \vert\ .S\ @\ \vert\ .c$

<

goto (I_o, <) = I_1

goto (goto (I_o, <), <) = goto (I_1, <) = I_1

No. of item in I_1 is 8.

18. Suppose the following functional dependencies hold on a relation U with attributes P, Q R, S, and T:

$P \to QR$

$RS \to T$

Which of the following functional dependencies can be inferred from the above functional dependencies?

A. $PS \to T$ B. $PS \to Q$

C. $P \to R$ D. $R \to T$

Ans. A, B, C

Sol. In option (D) $R \to T$, we find $(R)^+$. $R^+ = \{R\}$ so in R^+ we do not have T so can't be inferred. Hence false.

In option (C) $P \to R$, $(P)^+ = \{PQR\}$ and we find R so can be inferred. Hence True.

In option (B) $PS \to Q$, $(PS)^+ = \{PSQRT\}$ so can be inferred. Hence True.

In option (A) PS → T, $(PS)^+$ = {PSQRT} so can be inferred. Hence True.

19. Consider the cyclic redundancy check (CRC) based error detecting scheme having the generator polynomial $X^3 + X + 1$. Suppose the message $m_4m_3m_2m_1m_0$ = 11000 is to be transmitted. Check bits $c_2c_1c_0$ are appended at the end of the message by the transmitter using the above CRC scheme. The transmitted bit string is denoted by $m_4m_3m_2m_1m_0c_2c_1c_0$. The value of the checkbit sequence $c_2c_1c_0$is

A. 111 B. 100

C. 101 D. 110

Ans. B

Sol. Generator = $1\cdot x^3 + 0.x^2 + 1\cdot x^1 + 1\cdot x^0$

1011

CRC generator = $x^3 + x + 1$

$1.x^3 + 0.x^2 + 1.x^1 + 1.x^0$

1011

Message = 11000

$$\begin{array}{r|l} 1011 & \overline{11000\ \ \underline{000}} \\ & \underline{\ \ 10\,11\ \ \ \ \ \ \ } \\ & 0\,111\,0000 \\ & \underline{\ \ 1011\ \ \ \ \ } \\ & 0101000 \\ & \underline{\ \ 1011\ \ \ } \\ & 000\ \boxed{100} \end{array}$$

CRC = 100

20. If x and y are two decimal digits and $(0.1101)_2 = (0.8xy5)_{10}$, the decimal value of x + y is ________.

Ans. 3

Sol. $\underbrace{(0.1101)_2}_{\frac{13}{16}=(0.8125)_{10}}$

x = 1, y = 2

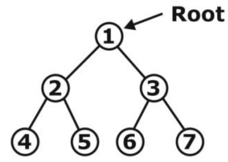
x + y = 3

21. Consider a complete binary tree with 7 nodes. Let A denote the set of first 3 elements obtained by performing Breadth-First Search (BFS) starting from the root. Let B denote the set of first 3 elements obtained by performing Depth-First Search (DFS) starting from the root.

The value of |A – B| is __________.

Ans. 1

Sol.



A ⇒ {1, 2, 3}

B ⇒ {1, 2, 4} {1, 2, 5}

{1, 3, 6} {1, 3, 7}

|A – B| (Set of elements which are present in A but not in B) = 1

22. Let L_1 be a regular language and L_2 be a context-free language. Which of the following languages is/are context-free?

A. $L_1 \cup (L_2 \cup \overline{L_2})$

B. $\overline{\overline{L_1} \cup \overline{L_2}}$

C. $(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2)$

D. $L_1 \cap \overline{L_2}$

Ans. A, B, C

Sol. L_1→ Regular

L_2→ CFL

$L_1U (L_2U\overline{L_2})$ = Reg U Σ* = Σ* ➔ Regular ➔ CFL

$\overline{\overline{L_1} U \overline{L_2}} = L_1 \cap L_2 = \text{Reg} \cap \text{CFL} \Rightarrow \text{CFL}$

$(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2) = \text{CFL} \cup \text{CFL} \Rightarrow \text{CFL}$

$L_1 \cap \overline{L_2} \Rightarrow \text{Reg} \cap \overline{\text{CFL}} \Rightarrow \text{Need not be CFL}$

23. Consider the following ANSI C program:

```
int main() {
 Integer x;
 return 0;
}
```

Which one of the following phases in a seven-phase C compiler will throw an error?

A. Lexical analyzer

B. Machine dependent optimizer

C. Semantic analyzer

D. Syntax analyzer

Ans. D

Sol. integer x; has no lexical error

id_1, id_2 has syntax error as Integer does not match with keyword integer.

24. Consider the following two statements about regular languages:

S_1: Every infinite regular language contains an undecidable language as a subset.

S_2: Every finite language is regular.

Which one of the following choices is correct?

A. Only S_2 is true. B. Both S_1 and S_2 are true.

C. Neither S_1 nor S_2 is true. D. Only S_1 is true.

Ans. B

Sol. Both S_1 and S_2 are TRUE

S_1 is TRUE

Every infinite regular language has all possible subsets.

S_2 is TRUE

Every finite language is regular

25. Suppose that f : R → R is a continuous function on the interval [-3, 3] and a differentiable function in the interval (-3, 3) such that for every x in the interval, $f'(x) \leq 2$. If f(-3) = 7, then f(3) is at most ________ .

Ans. 19

Sol. by LMVT (Lagrange's Mean value Theorem),

There is $x \in (-3, 3)$ such that

$$f'(x) = \frac{f(3) - f(-3)}{3 - (-3)}$$

$$f'(x) = \frac{f(3) - 7}{6}$$

Now, $f'(x) \leq 2$

$$\frac{f(3) - 7}{6} \leq 2$$

$f(3) \leq 19$

So, $[f(3)]_{max} = 19$

26. Consider the following statements S1 and S2 about the relational data model:

S1: A relation scheme can have at most one foreign key.

S2: A foreign key in a relation scheme R cannot be used to refer to tuples of R.

Which one of the following choices is correct?

A. S1 is false and S2 is true.

B. S1 is true and S2 is false.

C. Both S1 and S2 are false.

D. Both S1 and S2 are true.

Ans. C

Sol. **S1:** False

Because it is not necessary that we should always have a foreign key. More than one FK are also possible in a relation.

S2: False

Foreign Key of a relation can refer to tuples of other relation as well as tuples of the same relation R.

27. For a string w, we define w^R to be reverse of w. For example, if w = 01101 then w^R = 10110. Which of the following languages is/are context-free?

A. $\{ww^Rxx^R \mid w, x \in \{0, 1\}^*\}$

B. $\{wxw^Rx^R \mid w, x \in \{0, 1\}^*\}$

C. $\{wxw^R \mid w, x \in \{0, 1\}^*\}$

D. $\{wxx^Rw^R \mid w, x \in \{0, 1\}^*\}$

Ans. A, C, D

Sol. $(ww^Rxx^R \mid w, x, \in \{0, 1\}^*)$ is CFL

$(wxw^Rx^R \mid w, x, \in \{0, 1\}^*)$ is not CFL

$(wxw^R \mid w, x, \in \{0, 1\}^*)$ is regular so, CFL

$(wxx^Rw^R \mid w, x, \in \{0, 1\}^*)$ is CFL

28. Consider a three-level page table to translate a 39-bit virtual address to a physical address as shown below.

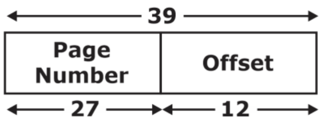
←------ **39-bit virtual address** ------→

Level 1 offset	**Level 2 offset**	**Level 3 offset**	**Page offset**
9 bits	**9 bits**	**9 bits**	**12 bits**

The page size is 4K8 (1KB = 2^{10} bytes) and page table entry size at every level is 8 bytes. A process P is currently using 2GB (1GB = 2^{30} bytes) virtual memory which is mapped to 2GB of physical memory. The minimum amount of memory required for the page table of P across all levels is ________ KB.

Ans. 4108

Sol. **Lavel-1 Page Table**



Page Table Size = $2^{27} \times 8$ Bytes = 2^{30} Bytes.

Level-2 Page Table

Number of pages $= \dfrac{2^{30}B}{2^{12}} = 2^{18}$

Page Table size = $2^{18} \times 8B = 2^{21}$ = Bytes.

Level-3 Page Table

Number of Pages $= \dfrac{2^{21}}{2^{12}} = 2^{9}$

Size of Page Table = $2^{9} \times 8 = 2^{12}$ Bytes = 4 K Bytes

So in total we need 1 table for 1st level page table, 2 tables for 2nd level page table and 2^{10} tables for 3rd level page table so total size=(1+2+1024) x 4KB = 1027 x 4KB= 4108

29. Consider the three-way handshake mechanism followed during TCP connection establishment between hosts P and Q. Let X and Y be two random 32-bit starting sequence numbers chosen by P and Q respectively. Suppose P sends a TCP connection request message to Q with a TCP segment having SYN bit = 1, SEQ number = X, and ACK bit = 0. Suppose Q accepts the connection request. Which one of the following choices represents the information present in the TCP segment header that is sent by Q to P?

A. SYN bit = 1, SEQ number = Y, ACK bit = 1, ACK number = X+1, FIN bit = 0

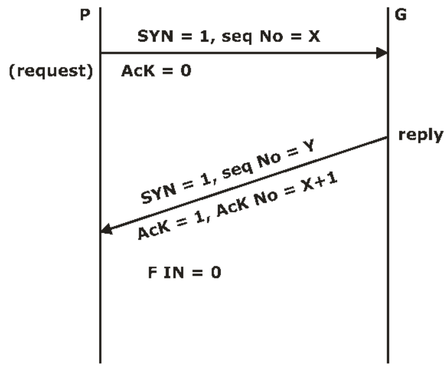
B. SYN bit = 0, SEQ number = X+1, ACK bit = 0, ACK number = Y, FIN bit = 1

C. SYN bit = 1, SEQ number = X+1, ACK bit = 0, ACK number = Y, FIN bit = 0

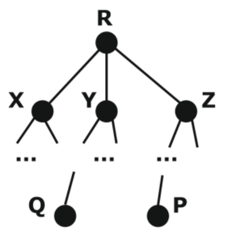
D. SYN bit = 1, SEQ number = Y, ACK bit = 1, ACK number = X, FIN bit = 0

Ans. A

Sol.



30. Consider a computer network using the distance vector routing algorithm in its network layer. The partial topology of the network is as shown below.



The objective is to find the shortest-cost path from the router R to routers P and Q. Assume that R does not initially know the shortest routes to P and Q. Assume that R has three neighbouring routers denoted as X, Y, and Z. During one iteration, R measures its distance to its neighbours X, Y, and Z as 3, 2, and 5, respectively. Router R gets routing vectors from its neighbours that indicate that the distance to router P from routers X, Y, and Z are 7, 6, and 5, respectively. The routing vector also indicates that the distance to router Q from routers X, Y, and Z are 4, 6, and 8, respectively. Which of the following statement(s) is/are correct with respect to the new routing table of R, after updation during this iteration?

A. The distance from R to P will be stored as 10.

B. The next hop router for a packet from R to P is Y.

C. The next hop router for a packet from R to Q is Z.

D. The distance from R to Q will be stored as 7.

Ans. B, D

Sol.

R to X = 3

R to Y = 2

R to Z = 5

X to P = 7

Y to P = 6

Z to P = 5

Distance from R to P using X, Y, Z is

3 + 7, 2 + 6, 5 + 5

min (10, 8, 10)

min = 8

S: R to P = 8 [using Y]

X to Q = 4

Y to Q = 6

Z to Q = 8

Distance R to Q using X, Y, Z is

min (3 + 4, 2 + 5, 5 + 8)

min = 7

So choose R to Q is 7 (using X)

31. For two n-dimensional real vectors P and Q, the operation s(P, Q) is defined as follows:

$$s(P,Q) = \sum_{i=1}^{n} \left(P[i] \cdot Q[i]\right)$$

Let $\mathcal{L}$ be a set of 10-dimensional non-zero real vectors such that for every pair of distinct vectors P, Q $\in\mathcal{L}$, s(P, Q) = 0. What is the maximum cardinality possible for the set $\mathcal{L}$?

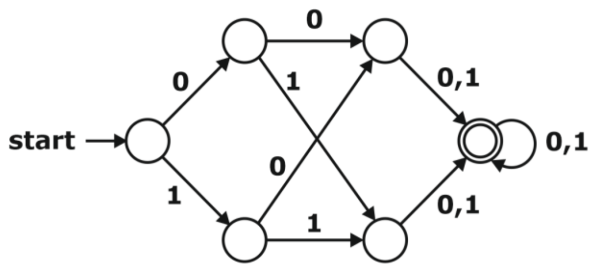
A. 11 B. 9

C. 10 D. 100

Ans. C

Sol. S(P, Q) is nothing but the dot product of two vectors. The dot product of two vectors is zero when they are perpendicular, as we are dealing with 10 dimensional vectors the maximum number of mutually perpendicular vectors can be 10.

32. Consider the following deterministic finite automaton (DFA).



The number of strings of length 8 accepted by the above automaton is _______ .

Ans. 256

Sol. All length 3 strings it reaches to final state, After reaching final state, it will accept all the strings so it would be, $8 \times 2^5 = 256$.

Minimum length accepted by given DFA is 3.

All 3 length strings are accepted.

All 4, 5, 6, 7, 8 length strings are accepted

the no. of strings of length 8 accepted by given DFA $= 2^8 = 256$

33. Consider the following multi-threaded code segment (in a mix of C and pseudocode), invoked by two processes P1 and P2, and each of the processes spawns two threads T1 and T2:

```
int x = 0;   // global
Lock L1;     // global
main() {
  create a thread to execute foo();  // Thread T1
  create a thread to execute foo();  // Thread T2
  wait for the two threads to finish execution;
  print (x);}
foo() {
  int y = 0;
  Acquire L1;
  x = x + 1;
  y = y + 1;
  Release L1;
  print (y);}
```

Which of the following statement(s) is / are correct?

A. At least one of P1 and P2 will print the value of x as 4.

B. At least one of the threads will print the value of y as 2.

C. Both T1 and T2, in both the processes, will print the value of y as 1.

D. Both P1 and P2 will print the value of x as 2.

Ans. C,D

Sol. option C: correct

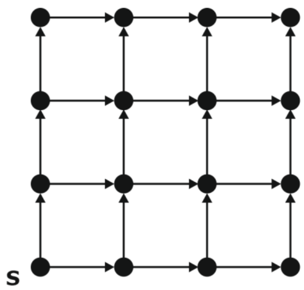
Threads don't share the stack. y is AUTO variable, stored in stack. So, each process spawns two threads, each locks and unlocks L1 as they increment x and y. Y is incremented from 0 to 1 by each thread of a process.

If P1 completely executes and then P2 completely executes without any preemption, then, x is incremented twice (once by each thread). Global variable x is stored in the data segment. Threads share data segments.

option D: Correct

If P1 and P2 executes in any order, x will be 2 printed by each process.

34. Consider the following directed graph:



Which of the following is/are correct about the graph?

A. The graph does not have a strongly connected component.

B. The graph does not have a topological order.

C. A depth-first traversal starting at vertex S classifies three directed edges as back edges.

D. For each pair of vertices u and v, there is a directed path from u to v.

Ans. B,C

Sol. B → The graph does not have a topological order, because there's a cycle in the bottom left corner of the graph.

C → Yes, there are only 3 back edges, if started from S.

A → The graph does have a strongly connected component, it has cycle.

D → You can observe and find that not all rectangular/square components forms a cycle.

35. For a given biased coin, the probability that the outcome of a toss is a head is 0.4. This coin is tossed 1,000 times. Let X denote the random variable whose value is the number of times that head appeared in these 1,000 tosses. The standard deviation of X (rounded to 2 decimal places) is _________ .

Ans. 15.49

Sol. p = 0.4 so q = 0.6

Variance = n × p × q

= 1000 × 0.6 × 0.4 = 240

So, Standard deviation = $\sqrt{npq}$ = $\sqrt{240}$ = 15.49

36. Suppose that P is a 4 × 5 matrix such that every solution of the equation Px = 0 is a scalar multiple of $[2\ 5\ 4\ 3\ 1]^T$. The rank of P is ________ .

Ans. 4

Sol. MX = 0 → homogenous system

M → 4 × 5

$M \Rightarrow \underset{\text{no. of equations}}{4} \times \underset{\text{no. of variables}}{5}$

Given that all solutions are scalar multiplications of $[1, 2, 3, 4]^T$

i.e. only 1 independent solution

No. of independent vectors is given as = no. of variable – rank(A)

So, 1 = 5 – r(A)

R(A) = 4.

37. A bag has r red balls and b black balls. All balls are identical except for their colours. In a trial, a ball is randomly drawn from the bag, its colour is noted and the ball is placed back into the bag along with another ball of the same colour. Note that the number of balls in the bag will increase by one, after the trial. A sequence of four such trials is conducted. Which one of the following choices gives the probability of drawing a red ball in the fourth trial?

A. $\frac{r+3}{r+b+3}$ B. $\frac{r}{r+b}$

C. $\left(\frac{r}{r+b}\right)\left(\frac{r+1}{r+b+1}\right)\left(\frac{r+2}{r+b+2}\right)\left(\frac{r+3}{r+b+3}\right)$

D. $\frac{r}{r+b+3}$

Ans. B

Sol. Various possibilities of getting red on the 4th trial,

R RR

R R B

R B R

R B B

B R R

B R B

B B R

B BB

After all these will need to get Red

The point to focus that all the 8 cases are not equiprobable hence we will also need to get their individual probabilities and multiply with probability of getting a red ball given either of them happened

P(1) = R / R+B. R+1 / R+B+1. R+2 / R+B+2.

P(R/1) = R+3 / R+B+3. P(R ∩ 1) = P(1). P(R / 1)

The expression for P (R on 4th trail) is

$P(R_4)$ = [(R)(R+1)(R+2)(R+3) + (R)(R+1)(B)(R+2) + (R)(B)(R+1)(R+2) + (R)(B)(B+1(R+1) + (B)(R)(R+1)(R+2) + (B)(R)(B+1)(R+1) + (B)(B+1)(R+1)(R+2) + (B)(B+1)(B+2)(R)]/[(R+B)(R+B+1)(R+B+2)(R+B+3)]

38. What is the worst-case number of arithmetic operations performed by recursive binary search on a sorted array of size n?

A. $\Theta(n^2)$ B. $\Theta(\sqrt{n})$

C. $\Theta(n)$ D. $\Theta(\log_2(n))$

Ans. D

Sol.

```
while (l ≤ h)
{
      m = (l + h)/2
}
```

Arithmetic operations is as many times as loop runs. Our loop runs for log n times, so, It is logn times.

39. Suppose we want to design a synchronous circuit that processes a string of 0's and 1's. Given a string, it produces another string by replacing the first 1 in any subsequence of consecutive 1's by a 0. Consider the following example.

Input sequence: 00100011000011100

Output sequence: 00000001000001100

A Mealy Machine is a state machine where both the next state and the output are functions of the present state and the current input.

The above mentioned circuit can be designed as a two-state Mealy machine. The states in the Mealy machine can be represented using Boolean values 0 and 1. We denote the current state, the next state, the next incoming bit, and the output bit of the Mealy machine by the variables s, t, b and y respectively.

Assume the initial state of the Mealy machine is 0.

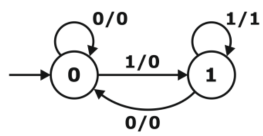
What are the Boolean expressions corresponding to t and y in terms of s and b?

A. $t = b$, $y = s\,b$ B. $t = s + b$, $y = s\bar{b}$

C. $t = b$, $y = s\,\bar{b}$ D $t = s + b$, $y = sb$

Ans. A

Sol.



PS (S)	NS (t)	Next bit (b)	o/p bit (y)
0	0	0	0
0	1	1	0
1	0	0	0
1	1	1	1

t = b

y = Sb

40. If the numerical value of a 2-byte unsigned integer on a little endian computer is 255 more than that on a big endian computer, which of the following choices represent(s) the unsigned integer on a little endian computer?

A. 0×4243 B. 0×6665

C. 0×0100 D. 0×0001

Ans. A, B, D

Sol.

Little Endian	**Big Endian**
LB	HB
HB	LB

(a) $0\times\underbrace{00}_{HB}\underbrace{01}_{LB} \longrightarrow (0100)_H\ (>255)$

(b) $0\times0100 \longrightarrow (0001)_H\ (>255)$

(c) $0\times6665 \longrightarrow 6566)_H\ (>255)$

(d) $0\times4243 \longrightarrow (4342)_H\ (>255)$

41. Consider a pipelined processor with 5 stages, Instruction Fetch (IF), Instruction Decode (ID), Execute (EX), Memory Access (MEM), and Write Back (WB). Each stage of the pipeline, except the EX stage, takes one cycle. Assume that the ID stage merely decodes the instruction and the register read is performed in the EX stage. The EX stage takes one cycle for ADD instruction and two cycles for MUL instruction. Ignore pipeline register latencies.

Consider the following sequence of 8 instructions:

ADD, MUL, ADD, MUL, ADD, MUL, ADD, MUL

Assume that every MUL instruction is data-dependent on the ADD instruction just before it and every ADD instruction (except the first ADD) is data-dependent on the MUL instruction just before it. The Speedup is defined as follows:

$$\text{Speedup} = \frac{\text{Execution time without operand forwarding}}{\text{Execution time with operand forwarding}}$$

The Speedup achieved in executing the given instruction sequence on the pipelined processor (rounded to 2 decimal places) is _________.

Ans. 1.87 to 1.88

Sol. **Case I :-** Number of cycle without operand forwarding are

For the first ADD instruction, it will take 5 cycles, for every MUL it needs 4 additional, and for every ADD, it needs 3 additional

So, total cycles without operand forwarding is 5 + (4 + 3 + 4 + 3 + 4 + 3 + 4)

= 30 cycles.

Case II :- Number of cycles with the operand forwarding are

For the first ADD instruction, it will take 5 cycles, for every MUL it needs 2 Extra, and for every ADD, it would need 1 Extra cycle,

Total = 5 + (2 + 1 + 2 + 1 + 2 + 1 + 2) = 16 cycles

$$\text{Speed up} = \frac{30}{16} = 1.875\ .$$

42. Assume a two-level inclusive cache hierarchy, L1 and L2, where L2 is the larger of the two. Consider the following statements.

S_1 : Read misses in a write through L1 cache do not result in writebacks of dirty lines to the L2.

S_2 : Write allocate policy must be used in conjunction with write through caches and no-write allocate policy is used with writeback caches.

Which of the following statements is correct?

A. S_1 is true and S_2 is false

B. S_1 is false and S_2 is false

C. S_1 is false and S_2 is true

D. S_1 is true and S_2 is true

Ans. A

Sol. A cache with a write-through policy (and write allocate) reads an entire block (cache line) from memory on a cache miss and writes only the updated item to memory for a store. Evictions do not need to write to memory.

A cache with a write-back policy (and write-allocate) reads an entire block (cache line) from memory on a cache miss, and may need to write a dirty cache line first. Any writes to memory need to be the entire cache line since there is no way to distinguish which word was dirty with only a single dirty bit. Evictions of a dirty cache line cause a write to memory

S2: False

Write-allocate policy is also used with write-back cache.

43. Which of the following regular expressions represent(s) the set of all binary numbers that are divisible by three? Assume that the string ϵ is divisible by three.

A. (0*(1(01*0)*1)*)*

B. (0 + 1(01*0)*1)*

C. (0 + 11 + 11(1 + 00)*00)*

D. (0 + 11 + 10(1 + 00)*01)*

43. A, B, D

Sol. L = set of all binary number that are divisible by 3

$$[0^*(1(01^*0)^*1)^*]^*$$

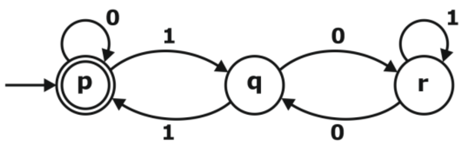
$$=$$

$$[0+1(01^*0)^*1]^*$$

$$=$$

$$=[0+11+10(1+00)^*01]^*$$

The below DFA depicts the set of all binary strings divisible by three.



44. Consider a computer system with multiple shared resource types, with one instance per resource type. Each instance can be owned by only one process at a time. Owning and freeing of resources are done by holding a global lock (L). The following scheme is used to own a resource instance :

function OWNRESOURCE(Resource R)
  Acquire lock L // a global lock
  if R is available **then**
    Acquire R
    Release lock L
  else
    if R is owned by another process P **then**
      Terminate P, after releasing all resources owned by P
      Acquire R
      Restart P
      Release lock L
      end if
    end if
  end if
end function

Which of the following choice(s) about the above scheme is/are correct?

A. The scheme violates the mutual exclusion property.

B. The scheme ensures that deadlocks will not occur.

C. The scheme may lead to starvation.

D. The scheme may lead to live-lock.

Ans. B, C, D

Sol. The lock ensures that mutual exclusion is enforced

Since forceful preemption of resources by termination of the other processes is allowed, deadlock will never occur.

Say when process P is holding the single instance resource of type R1, after some time, process Q requests for resource type R1. Using the OWNRESOURCE algorithm, process Q will be able to terminate process P and thus releasing all the resources held by process P. Now Q acquires (holds) resource type R1 while process P gets restarted. And then process Q releases lock L.

It may lead to a live lock, where each process continues to preempt each other, thus none of them can make any progress but neither are in a blocked state.

Livelock occurs when two or more processes continually repeat the same interaction in response to changes in the other processes without doing any useful work. These processes are not in the waiting state, and they are running concurrently. This is different from a deadlock because in a deadlock all processes are in the waiting state.

45. Consider the following ANSI C program:

```
#include <stdio.h>
#include <stdlib.h>
struct Node{
      int value;
      struct Node *next;};
int main(){
   struct Node *boxE, *head, *boxN; int index = 0;
boxE = head = (struct Node *) malloc(sizeof(struct
Node));
   head->value = index;
   for (index = 1; index <= 3; index++){
boxN = (struct Node *) malloc(sizeof(struct Node));
boxE->next = boxN;
boxN->va1ue = index;
boxE = boxN: }
   for (index = 0; index <= 3; index++) {
printf("Value at index %d is %d\n", index, head-
>value);
        head = head->next;
printf("Value at index %d is %d\n", index+1, head-
>value); } }
```

Which one of the statements below is correct about the program?

A. It dereferences an uninitialized pointer that may result in a run-time error.

B. It has a missing return which will be reported as an error by the compiler.

C. Upon execution, the program creates a linked-list of five nodes.

D. Upon execution, the program goes into an infinite loop.

Ans. A

Sol. The linked list of four nodes will be created.

First node : value = 0

Second node: value = 1

Third node: value = 2

Fourth node: value = 3

The last for loop will print the index number and the values.

In the last iteration when index = 3

head= head->next // Trying to access the unknown memory location because the fifth node is not there.

Hence the segmentation fault/run time error will come here.

46. The format of the single-precision floating-point representation of a real number as per the IEEE 754 standard is as follows:

sign	exp onent	mantissa

Which one of the following choices is correct with respect to the smallest normalized positive number represented using the standard?

A. exponent = 00000000 and mantissa : 00000000000000000000000

B. exponent : 00000001 and mantissa : 00000000000000000000000

C. exponent : 00000001 and mantissa : 00000000000000000000001

D. exponent : 00000000 and mantissa : 00000000000000000000001

Ans. B

Sol. $\left.\begin{array}{l} E \neq 0.....0 \\ E \neq 11....1 \end{array}\right\}$ For normalized value

$E_{Min.} = 1 = 00000001$

$M_{Min.} = 00..........0$

$S = 0$

Value = $+ 1.0 \times 2^{E\text{-bias}}$

Value = $+ 1.0 \times 2^{1-127}$

$= 2^{-126}$

47. Let $L \subseteq \{0, 1)^*$be an arbitrary regular language accepted by a minimal DFA with k states. Which one of the following languages must necessarily be accepted by a minimal DFA with k states?

A. $L \cdot L$ B. $\{0, 1\}^* - L$

C. $L - \{01\}$ D. $L \cup \{01\}$

Ans. B

Sol. L and complement of L have same no. of states in DFA.

$\{0, 1\}^* - L$ = complement of L

L has k states in min DFA

$\downarrow$

$\bar{L}$ has k states in min DFA

$\boxed{\bar{L} = \Sigma^* - L}$

48. For a statement S in a program, in the context of liveness analysis, the following sets are defined:

USE (S) : the set of variables used in S

IN (S) : the set of variables that are live at the entry of S

OUT(S) : the set of variables that are live at the exit of S

Consider a basic block that consists of two statements, S_1 followed by S_2. Which one of the following statements is correct?

A. $OUT(S_1) = IN(S_1) \cup USE(S_1)$

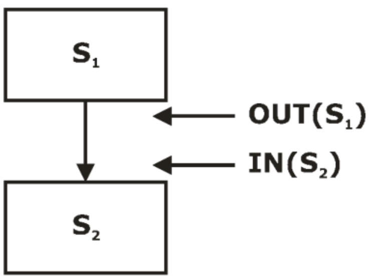
B. $OUT(S_1) = IN(S_2) \cup OUT(S_2)$

C. $OUT(S_1) = IN(S_2)$

D. $OUT(S_1) = USE(S_1) \cup IN(S_2)$

Ans. C

Sol. The following diagram represents the relationship between Out S1 and In S2.



$\boxed{OUT(S_1) = IN(S_2)}$

49. A data file consisting of 1,50,000 student-records is stored on a hard disk with block size of 4096 bytes. The data file is sorted on the primary key RollNo. The size of a record pointer for this disk is 7 bytes. Each student-record has a candidate key attribute called **ANum** of size 12 bytes. Suppose an index file with records consisting of two fields, **ANum** value and the record pointer to the corresponding student record, is built and stored on the same disk. Assume that the records of data file and index file are not split across disk blocks. The number of blocks in the index file is _______ .

Ans. 698

Sol. index file

records = 150000, block size = 4096 B

key = 12 B, pointer = 7B

No. of index entry/block = $\dfrac{4096\text{ B}}{(12+7)\text{B}}$

$\left\lfloor \dfrac{4096\text{ B}}{19\text{ B}} \right\rfloor = 215$

No. of blocks needed for indexing =

$\left\lceil \dfrac{150000}{215} \right\rceil = 698$.

50. In an examination, a student can choose the order in which two questions (QuesA and QuesB) must be attempted.

- If the first question is answered wrong, the student gets zero marks.

- If the first question is answered correctly and the second question is not answered correctly, the student gets the marks only for the first question.

- If both the questions are answered correctly, the student gets the sum of the marks of the two questions.

The following table shows the probability of correctly answering a question and the marks of the question respectively.

question	probability of answering correctly	marks
QuesA	0.8	10
QuesB	0.5	20

Assuming that the student always wants to maximize her expected marks in the examination, in which order should she attempt the questions and what is the expected marks for that order (assume that the questions are independent)?

A. First QuesB and then QuesA. Expected marks 14.

B. First QuesB and then QuesA. Expected marks 22.

C. First QuesA and then QuesB. Expected marks 16.

D. First QuesA and then QuesB. Expected marks 14.

Ans. C

Sol. If first we answer A, then B :

Expected marks = prob. that A is wrong * 0 + prob. that A is correct * probability that B is wrong * 10 + prob. that A is correct * prob. that B is correct * 30

$\Rightarrow$ 0.2 * 0 + 1.8 * 0.5 * 10 + 0.8 * 0.5 * 30

$\Rightarrow$ 0 + 4 + 12 = 16

If first we answer B, then A :

Expected marks = prob. that B is wrong * 0 + prob. that B is correct * prob. that A is wrong * 20 + prob. that B is correct * prob. that A is correct * 30

= 0.5 * 0 + 0.5 * 0.2 * 20 + 0.5 * 0.8 * 30

= 0 + 2 + 12 = 14

51. In the context of compilers, which of the following is/are NOT an intermediate representation of the source program?

A. Three address code

B. Control Flow Graph (CFG)

C. Abstract Syntax Tree (AST)

D. Symbol table

Ans. D

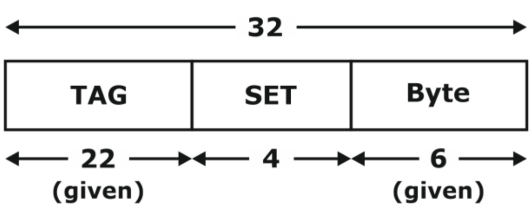
Sol. Symbol Table is not an intermediate representation of the Source program.

52. Consider a set-associative cache of size 2KB (1KB = 2^{10} bytes) with cache block size of 64 bytes. Assume that the cache is byte-addressable and a 32-bit address is used for accessing the cache. If the width of the tag field is 22 bits, the associativity of the cache is _________ .

Ans. 2

Sol. Number of blocks = $\frac{2\text{ KB}}{64\text{ B}} = \frac{2^{11}}{2^6} = 2^5$

Main memory will be divided is follows [32 bit address]



Set [Number of bits] = 32 – [22 + 6] = 4 bits (i.e. 16 sets)

No. of sets = $\frac{\text{No. of Blocks}}{n}$ [for n-way]

$16 = \frac{2^5}{n}$, n = 2, [It is 2-way Associative]

53. The relation scheme given below is used to store information about the employees of a company, where empId is the key and deptId indicates the department to which the employee is assigned. Each employee is assigned to exactly one department.

emp (<u>empId</u>, name, gender, salary, deptId)

Consider the following SQL query:

```
select deptId, count(*)
from emp
where gender = "female" and salary > (select avg(salary) from emp)
group by deptId;
```

The above query gives, for each department in the company, the number of female employees whose salary is greater than the average salary of

A. employees in the company.

B. female employees in the department.

C. employees in the department.

D. female employees in the company.

Ans. A

Sol. As the sub-query runs on emp table which contains both male and female employees from the company. Therefore it projects female employees with salary greater than average salary of all the employees.

54. Consider the string abbccddeee. Each letter in the string must be assigned a binary code satisfying the following properties:

1. For any two letters, the code assigned to one letter must not be a prefix of the code assigned to the other letter.

2. For any two letters of the same frequency, the letter which occurs earlier in the dictionary order is assigned a code whose length is at most the length of the code assigned to the other letter.

Among the set of all binary code assignments which satisfy the above two properties, what is the minimum length of the encoded string?

A. 30 B. 25

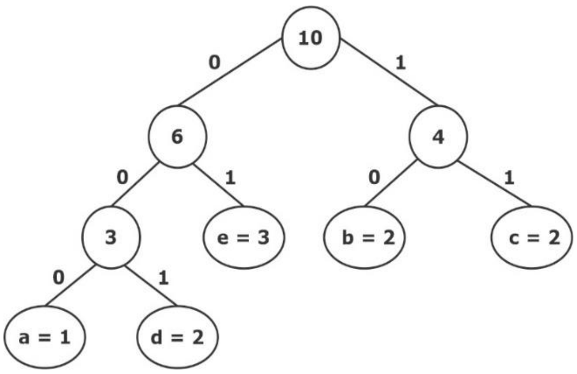
C. 21 D. 23

Ans. D

Sol.

Character	Frequency	Encoded bits
a	1	100
b	2	101
c	2	00
d	2	01
e	3	11

Arrange in ascending order of frequency and follow optional merge sequence. The Huffman tree would be



Total no. of bits = Σ frequency * Encoded bits

(1 × 3) + (2 × 3) + (2 × 2) + (2 × 2) + (3 × 2)

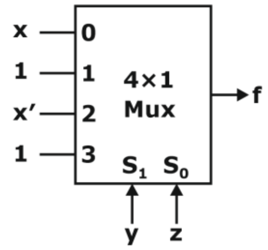
= 3 + 6 + 4 + 4 + 6

= 23 bits.

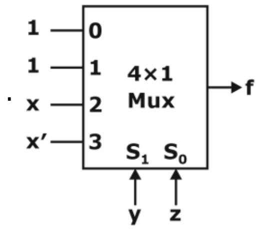
55. Which one of the following circuits implements the Boolean function given below?

$f(x, y, z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6$, where m_i is the i^{th} min term.

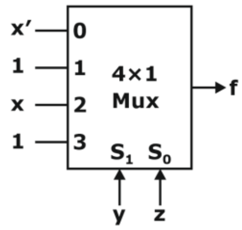
A.



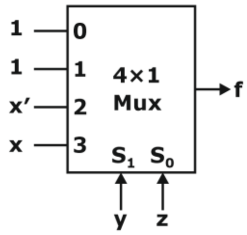
B



C.



D.



Ans. B

Sol. $f(x, y, z) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}yz + x\bar{y}\bar{z} + x\bar{y}z + xy\bar{z}$

$= (\bar{x} + x)\bar{y}\bar{z} + (\bar{x} + x)(\bar{y}z) + xy\bar{z} + \bar{x}yz$

$= \bar{y}\bar{z} + \bar{y}z + xy\bar{z} + \bar{x}yz$

This equation is equivalent to the multiplexer given in option B

so option B is correct.

****