GATE CS 2020 ANSWER KEY WITH DETAILED SOLUTIONS

Except for the Aptitude section, this paper is not easy at least..

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1. Select the word that fits the analogy
   Cook : Cook : : Fly :   [Mark 1]
   A. Flying
   B. Flyer [ANS]
   C. Flighter
   D. Flew

   Explanation:
   Cook (verb) : Cook (noun: a person who prepares and cooks food, especially as a job or in a specified way)
   Hence for Fly (verb) : Flyer (noun)

2. His knowledge of the subject was excellent but his classroom performance was _____.
                                                                       [Mark 1]

   A. good
   B. extremely poor [ANS]
   C. desirable
   D. Praiseworthy

   Explanation:
   Here we have to note that the conjunction used is **but.** The conjunction **but** is used to connect ideas that contrast. Hence the option which is suitable here is "extremely poor".

3. Raman is confident of speaking English _____ 6 months as he has been practicing regularly _____ the last 3 weeks.   [Mark 1]

   A. within, for [ANS]
   B. for, since
   C. for, in
   D. during, for

4. Goods and service tax (GST) is an indirect tax introduced in India in 2017 that is imposed on the supply of goods and services used, and it subsumes all indirect taxes except a few. It is a destination-based tax imposed on goods and services used, and it is not imposed at the point of origin from where goods come. GST also has few components specific to the state governments, central government and Union Territories (UTs).

   Which one of the following statements can be inferred from the given passage?

   [Mark 1]

   A. GST is imposed on the production of goods and services.
   B. GST does not have a component-specific to UT.
   C. GST includes all indirect taxes.
   D. GST is imposed at the point of usage of goods and services. [ANS]

5. There are multiple routes to reach from node 1 to node 2 as shown in the network.
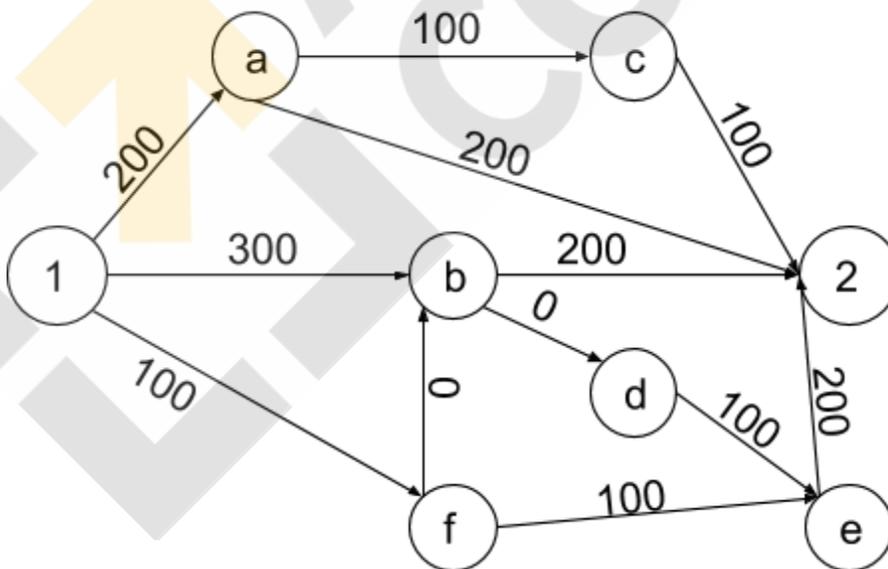
   The cost of travel on an edge between two nodes is given in rupees. Nodes 'a', 'b', 'c', 'd', 'e', and 'f' are toll booths. The toll price at toll booths

marked 'a' and 'e' is Rs. 200 and is Rs. 100 for the other toll booths. Which is the cheapest route from node 1 to node 2?

[Mark 1]

    A. 1-a-c-2
    B. 1-f-e-2
    C. 1-f-b-2 [ANS]
    D. 1-b-2

Explanation:
       1-a-c-2 = 200+200+100+100+100=700
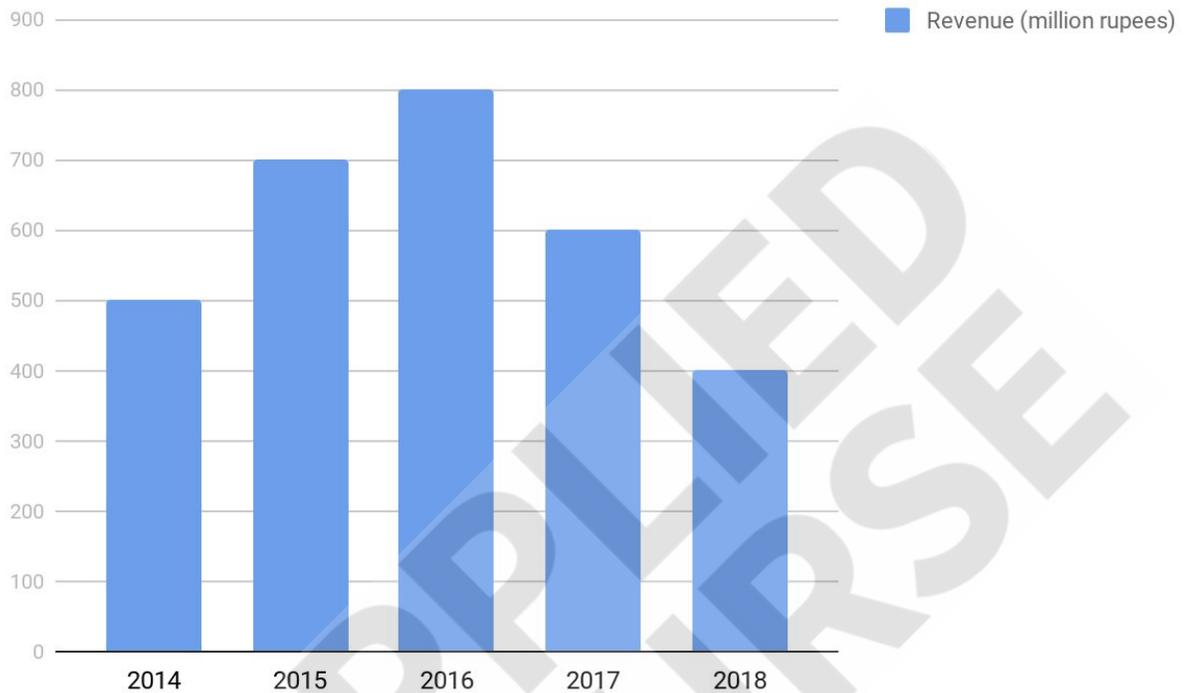   1-f-e-2 = 100+100+100+200+200=700
       1-f-b-2 = 100+100+0+100+200=500
       1-b-2 = 300+100+200=600

6. The total revenue of a company during 2014 - 2018 is shown in the bar graph. The total expenditure of the company each year is 500 million rupees. The aggregate profit/loss (in percentage) on the total expenditure of the company during 2014 - 2018 is _____.   [Marks 2]

A. 16.67% profit

B. 16.67% loss

C. 20% loss

D. 20% profit [ANS]

Explanation:

Total Expenditure = 500 * 5 = 2500

Total Revenue = 500+700+800+600+400 = 3000

Total Profit = 3000 - 2500 = 500

Profit (%) = (500/2500)*100 = 20%.

7. If P = 3, R = 27 and T = 243, then find Q+S ?   [Marks 2]

   A. 90 [ANS]

   B. 110

   C. 80

   D. 40

Explanation:

P	Q	R	S	T
3		27		243

Here we can see that $3^1 = 3$

Then, $3^2 = 9$

Then, $3^3 = 27$

Then, $3^4 = 81$
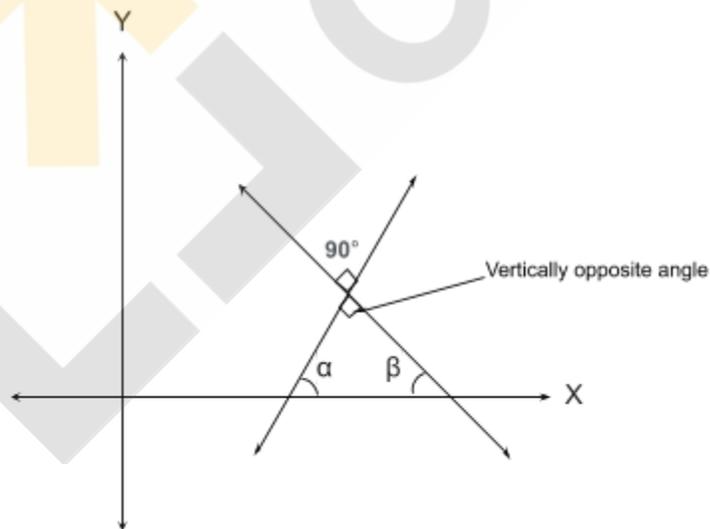
And $3^5 = 243$

Hence, $Q + S = 9 + 81 = 90$

8. Two straight lines are drawn perpendicular to each other in X - Y Plane. If α and β are the acute angles the straight lines make with the X-axis, then $\alpha + \beta$ is _____.   [Marks 2]

   A. $180°$
   B. $120°$
   C. $60°$
   D. $90°$ [ANS]

Explanation:

Since α & β are acute angles hence it will form the interior angles of the straight lines.

$$\alpha + \beta = 180° - 90° = 90°$$

9. The figure below shows an annular ring with outer and inner radii b and a, respectively. The annular space has been painted in the form of blue color circle touching the outer and inner periphery of annular space. If maximum n number of circles can be painted, then the unpainted area available in annular space is _____.　　　　　　　　　　　　　　　　[Marks 2]
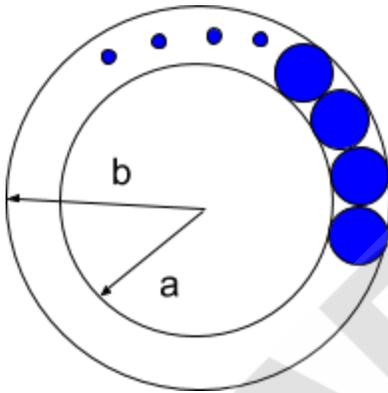
A. $\pi[(b^2 - a^2) - \frac{n}{4}(b-a)^2]$ **[ANS]**

B. $\pi[(b^2 - a^2) + n(b-a)^2]$

C. $\pi[(b^2 - a^2) + \frac{n}{4}(b-a)^2]$

D. $\pi[(b^2 - a^2) - n(b-a)^2]$

Explanation:

Area of the space between the outer and inner circle $= \pi b^2 - \pi a^2$

$\Rightarrow \pi(b^2 - a^2)$

Area of the painted circle $= n * \pi(\frac{b-a}{2})^2$

$\Rightarrow \frac{n\pi}{4}(b-a)^2$

Therefore, the area of the non painted portion $=$

$\pi(b^2 - a^2) - \frac{n\pi}{4}(b-a)^2$

$\Rightarrow \pi[(b^2 - a^2) - \frac{n}{4}(b-a)^2]$

10. The dawn of the 21st century witnessed the melting glaciers oscillating between giving too much and too little to billions of people who depend on them for fresh water. The UN climate report estimates that without deep cuts to man-made emissions, at least 30% of the northern hemisphere's surface permafrost could melt by the end of the century. Given this situation of imminent global exodus of billions of people displaced by rising seas, nation-states need to rethink carbon footprint for political concerns, if not for environmental ones.

Which one of the following statements can be inferred from the given passage? [Marks 2]

    A. Nation-states do not have environmental concerns.

    B. Nation-states are responsible for providing fresh water to billions of people.

    C. Billions of people are affected by melting glaciers. [ANS]

    D. Billions of people are responsible for man-made emissions.

Please note that questions 1-25 carries 1 mark each and the questions 26-55 carries 2 marks each

1. Consider the following grammar   [Mark 1]
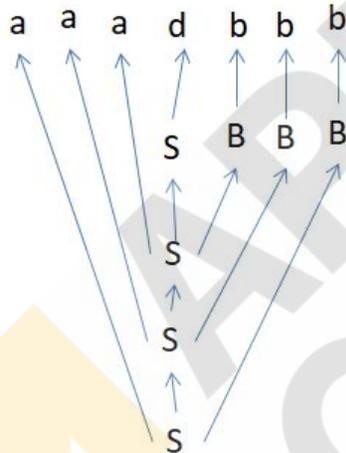
   S→ aSB | d

   B→ b

   The number of reduction steps taken by a bottom-up parser while accepting the string **aaadbbb** is_____.

   Answer: 7

   Explanation:

   Given input string is aaadbbb

   Total number of steps/reductions in the derivation is 7

2. Consider a relational database containing the following schemas.

Catalogue

sno	pno	cost
S1	P1	150
S1	P2	50
S1	P3	100
S2	P4	200
S2	P5	250
S3	P1	250
S3	P2	150
S3	P5	300
S3	P4	250

Suppliers

sno	sname	location
S1	M/s Royal furniture	Delhi
S2	M/s Balaji furniture	Bangalore
S3	M/s Premium furniture	Chennai

Parts

pno	pname	part_spec
P1	Table	Wood
P2	Chair	Wood
P3	Table	Steel
P4	Almirah	Steel
P5	Almirah	Wood

The primary key of each table is indicated by the underlining the constituent fields.

```
SELECT S.sno, S.sname
FROM Suppliers S, Catalogue C
WHERE S.sno==C.sno AND cost >(SELECT avg(cost)FROM
Catalogue WHERE Pno='p4' GROUP BY Pno);
```

A. 0

B. 4

C. 5

D. 2

Explanation:

The inner query will make 5 groups of pno out of which pno 4 is returned by it. The average cost return by the inner query will (200+250)/2= 225.

Now, the outer query will return Sno and Sname of suppliers having cost > 225. Thus, the total number of tuples returned by the query is 4.

3. Consider a Double Hashing scheme in which the primary hash function is
   h1(K) = K mod 23, and the secondary hash function is h2(K) = 1 +
   Kmod19. Assume that the table size is 23. Then the address returned by the
   probe 1 in the probe sequence(Assume that the probe sequence begins at 0)
   for key value k = 90 is _____

Answer: 13

Explanation:

      h1(K) = 90 mod 23 = 21

      h2(K)= 1 + Kmod19. = 1 +90 mod 19 = 15

      For double hashing =(h1(K) + i * h2(K)) % Table size

      For probe 1 the value of i=1

      = (21 +15) mod 23 = 13

4. Consider the following functions   **[1 Mark]**

    I. e^{-x}

    II. $x^2 - sinx$

    III. $\sqrt{x^3 + 1}$

Which of the above functions is/are increasing everywhere in [0,1]?

    A. II only
    B. III only [ANS]
    C. I and III only
    D. II and III only

Explanation:

In order to determine the functions which are increasing in a given interval we can check for their slope/derivative of the curve is positive.

A. If $f(x)=e^{-x}$, $f'(x)=-e^{-x}$ it is -ve in the interval $[0,1]$

B. If $f(x)=x^2-sinx$, $f'(x)=2x$-cosx in the interval $[0,1]$ 2x-cosx is -ve at x=0 therefore the it is not increasing at x=0.

C. If $f(x)=\sqrt{x^3+1}$ $f'(x)=\frac{1}{3(x^3+1)^{\frac{2}{3}}}*(3x^2)$. Here for all points in $[0,1]$

here the function is >=0 for all points therefore only III is the increasing function.

5. Consider the following statements about the process state transitions for a system using preemptive scheduling.
   - I. A running process can move to ready state.
   - II. A ready process can move to running state.
   - III. A blocked process can move to running state.
   - IV. A blocked process can move to ready state.

Which of the above statements are TRUE?
   A. I, II, III and IV
   B. II and III only
   C. I, II and III only
   D. I, II and IV only [ANS]

Explanation:
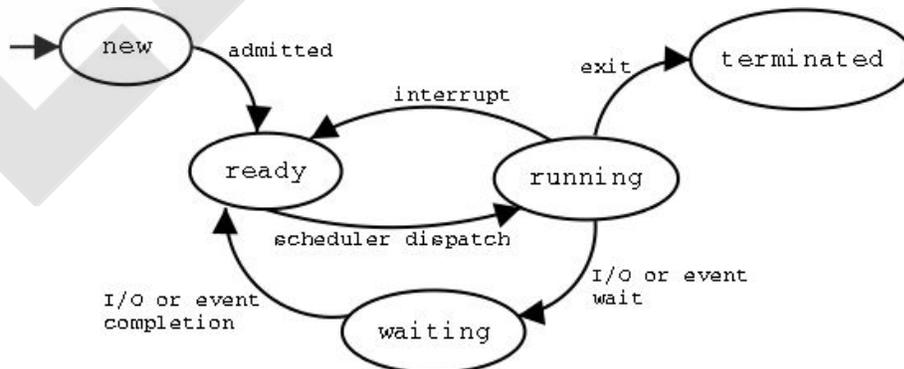
From the process state diagram, we can see that there can't be a transition from the waiting/blocked state to the running state. The other options are correct.

6. Which one of the following is the Regular expression represents the set of all binary strings with an odd number of 1's?
   A. **(0*10*10*)*10* [ANS]**
   B. 10*(0*10*10*)*
   C. ((0+1)*1(0+1)*1)*10*
   D. (0*10*10*)*0*1

Explanation:
   A. **(0*10*10*)*10*** Most suitable answer for the given problem according to the given options.
   B. 1*0(0*10*10*)* Every string Starts with 1 and contains an odd number of 1's.
   C. ((0+1)*1(0+1)*1)*0*1It contains an even number of 1's also.
   D. (0*10*10*)*0*1 Every string ends with 1 and the number of 1's in the string is odd

7. What is the worst-case time complexity of inserting n^2 elements into an AVL tree with n elements initially?
   A. $\Theta(n^2)$
   B. $\Theta(n^4)$
   C. $\Theta(n^2 log n)$ **[ANS]**
   D. $\Theta(n^3)$

Explanation:
   Insertion into the AVL tree takes a time of logn
   Therefore 1st insertion takes logn,
   2nd insertion takes log(n+1),
   3rd insertion takes log(n+2),

.

.

n^2 insertions takes $\log(n+n^2)$.

Total time can be $\log n + \log(n+1) + \log(n+2) + ... + \log(n+n^2)$

$\Rightarrow \log(n*(n+1)*(n+2).....*(n+n^2))$

$\Rightarrow$ We can assume the upper bound function $O(\log(n)^{n^2})$

$\Rightarrow n^2 * \log n$

8. Which of the following is used to represent the supporting Many-One relationships of a weak entity set in an E-R diagram

   A. Ovals with double/bold borders

   B. Diamond with double/bold borders [ANS]

   C. Ovals that contain underlined identifiers.

   D. Rectangles with double bold/borders

   Explanation:

   In the ER diagram, the identification relationship is represented by a double-lined diamond box. Thus, the correct option is B.

9. Consider the language L= $\{a^n \mid n \geq 0\}$ U $\{a^n b^n \mid n \geq 0\}$ and the following statements

   I.   L is deterministic context-free.
   II. L is context-free but not deterministic context-free.
   III. L is not LL(k) for any k.

   Which of the above statements is/are TRUE?

   A. I only

   B. I and III Only [ANS]

   C. II only

   D. III Only

Explanation:

L= {aⁿ | n≥0} U {aⁿbⁿ | n≥0}

$\Rightarrow L = \{ \varepsilon ,a, aa, aaa, b, bb, ab, aabb,..............\}$

We can construct a deterministic context free grammar and DPDA for the language.

The grammar for the given language is

S→ aSb | A

A→ aA | ε

Which is not LL(1) as it contains First(S) ={ a} U First (A) ≠ Φ

10. A direct mapped cache memory of 1 MB has a block size of 256 bytes. The cache has an access time of 3 ns and a hit rate of 94%. During a cache miss, it takes 20 ns to bring the first word of a block from the main memory, while each subsequent word takes 5 ns. The word size is 64 bits. The average memory access time in ns (round off to 1 decimal place) is _____.

Answer: 13.32

Explanation:

Given that Hit ratio = 94%

Word length = 64bits =8B

Block size = 256B

Number of words in the cache block = 256B/8B = 32

For a cache miss we need to transfer block into the cache and for the transfer of the first word 20ns and the remaining 31 words will take 5ns each.

AMAT = 0.94*3 + 0.06(1*20ns + 31*5ns) = 2.88 + 0.06(175) = 2.88 + 10.5 = 13.32

11. If there are M input lines and N output lines for a decoder that is to be used to uniquely address a byte addressable 1KB RAM, then the minimum value of M+N is_____

Answer: 1034

Explanation:

For 1KB RAM which is byte addressable, we need at least 10 input
lines
Also we need 1024 output lines
Therefore, M+N is 1034

12. Consider the following statements [Mark 1]
I. If L_1 U L_2 is Regular, then L_1, and L_2 are also regular languages
II. Infinite union of regular languages are also regular
Which of the above statements is/are True?
A. I only
B. II only
C. Both I and II
D. Neither I nor II

Answer:D

Explanation:

If L_1 U L_2 is Regular, then L_1, and L_2 are also regular languages: False
Suppose consider {ab}, {aabb}, {aaabbb}, {aaaabbbb},....
Each one of them is regular individually but their union cannot make
that language regular.

13. What is the worst case time complexity of inserting n elements into an
empty linked list, if the linked list needs to be maintained in sorted order?
A. Θ (n log n)[ANS]
B. Θ (n^2)
C. Θ (1)
D. Θ (n)

Explanation:

Given that it's an empty linked list, we have to insert the n elements in sorted order. We can sort the given n elements in $\Theta(n \log n)$ and then insert them into the list which is $\Theta(n)$

$$\Rightarrow \Theta(n \log n) + \Theta(n) = \Theta(n \log n)$$

14. A multiplexer is placed between a group of 32 registers and an accumulator to regulate data movement such that at any given point in time the content of only one register will move to the accumulator. The minimum number of select lines needed for the multiplexer is _____.

Answer: 5

Explanation:

It's a 32 x 1 MUX with 32 input lines.

Thus, $32 = 2^5$

2^n inputs require n select lines, therefore, 5 select lines are required.

15. Consider the following statements.

   I.   Daisy chaining is used to assign priorities in attending interrupts.
   II. When a device raises a vectored interrupt, the CPU does polling to identify the source of interrupt.
   III. In polling, the CPU periodically checks the status bits to know if any device needs its attention.
   IV. During DMA, both the CPU and DMA controller can be bus masters at the same time.

   Which of the above statements is/are TRUE?
   A. III only
   B. I and III only [ANS]
   C. I and IV only
   D. I and II only

Explanation:

I. True: The daisy-chaining method involves connecting all the devices that can request an interrupt in a serial manner. This configuration is governed by the priority of the devices. The device with the highest priority is placed first followed by the second highest priority device and so on.

III. True, Polling also refers to the situation where a device is repeatedly checked for readiness, and if it is not, the computer returns to a different task.

16. Consider the following C program   **[1 Mark]**

```c
#include<stdio.h>
int main () {
        int a[4][5]={{1, 2, 3, 4, 5},
                     {6, 7, 8, 9, 10},
                     {11, 12, 13, 14, 15},
                     {16, 17, 18, 19, 20}};
        printf("%d\n", *(*(a+**a+2)+3));
        return(0);
}
```

The output of the program is _____

Answer 19

Explanation: https://onlinegdb.com/rJd_IP2fL

17. Consider the following statements.

I. Symbol table is accessed only during lexical analysis and syntax analysis.

II. Compilers for programming languages that support recursion necessarily need heap storage for memory allocation in the run-time environment.

III. Errors violating the condition any variable must be declared before its use' are detected during syntax analysis.

Which of the above statements is/are TRUE?
- A. I only
- B. II only
- C. I and III only
- **D. None of I, II, and III [ANS]**

Explanation:

Symbol table can be accessed only in Lexical analysis and Syntax analysis

False: We can access the symbol table throughout all the phases of compilation.

Programming languages which support recursion need to have heap data structures in Runtime environment

False

The errors like "variables must be declared before its use" will be recognized in syntax analysis.

False: Will be identified in the semantic analysis phase of the compiler

18. For parameters a and b, both of which are $\omega(1)$, $T(n) = T(n^{1/a}) + 1$, and $T(b) = 1$.

Then $T(n)$ is
- **A.** $\Theta(log_a log_b n)$ **[ANS]**
- B. $\Theta(log_b log_a n)$

C. $\Theta(log_{ab}n)$

D. $\Theta(log_2 log_2 n)$

Explanation:

This can be solved by using the method of substitution.

$T(n) = T(n^{\frac{1}{a}}) + 1$

$= T(n^{\frac{1}{a}}) + 1$

$= T(n^{\frac{1}{a^2}}) + 2$

$= T(n^{\frac{1}{a^3}}) + 3$

..

$= T(n^{\frac{1}{a^k}}) + k$ (k times we have repeated each time it is doing a constant amount of work).

This will repeat until $n^{\frac{1}{a^k}} = b$

$n^{\frac{1}{a^k}} = b$

On taking log base b on both the sides

$\frac{1}{a^k} log_b n = 1$

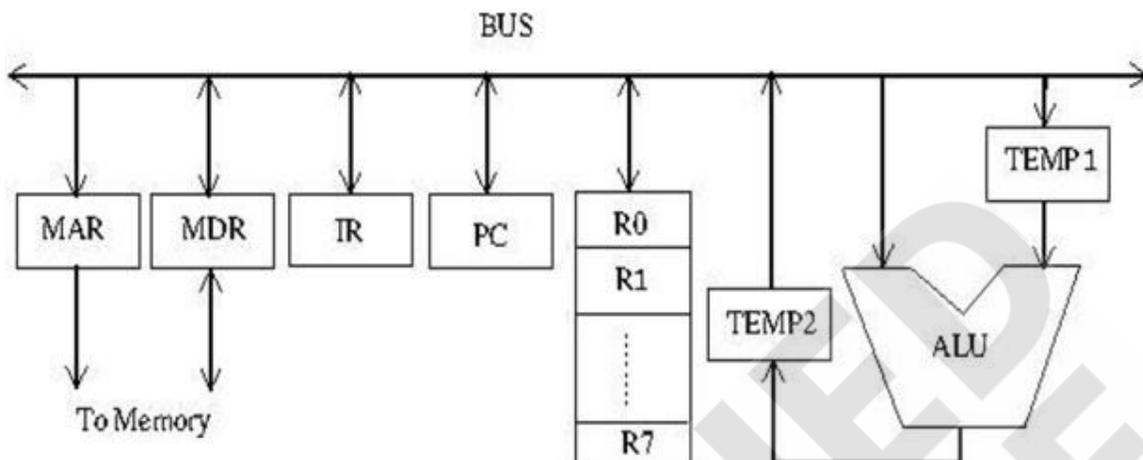$log_b n = a^k$

On taking log base a on both the sides

$log_a log_b n = k$

Therefore the time complexity is O($log_a log_b n$).

19. Consider the following data path diagram.

BUS

Consider an instruction: RO R1 + R2. The following steps are used to execute it over the given data path. Assume that PC is incremented appropriately. The subscripts r and w indicate read and write operations, respectively.

1. $R2_r$, $TEMP1_r$, ALU_{add}, $TEMP2_w$
2. $R1_r$, $TEMP1_w$
3. PC_r, MAR_w, MEM_r
4. $TEMP2_r$, RO_w
5. MDR_r, IR_w

Which one of the following is the correct order of execution of the above steps?

A. 2, 1, 4, 5, 3
B. 3, 5, 1, 2, 4
C. 1, 2, 4, 3, 5
D. 3, 5, 2, 1, 4 [ANS]

Explanation:

The correct order is as follows:

Step 1: PC_r, MAR_w, MEM_r

Step 2: MDR_r, IR_w

Step 3: $R1_r$, $TEMP1_w$

Step 4: R2$_r$, TEMP1$_r$, ALU$_{add}$, TEMP2$_w$

Step 5: TEMP2$_r$, RO$_w$

20. Consider allocation of memory to a new process. Assume that none of the existing holes in the memory will exactly fit the process's memory requirement. Hence, a new hole of smaller size will be created if allocation is made in any of the existing holes. Which one of the following statements is TRUE?

A. The hole created by best fit is never larger than the hole created by first fit. [ANS]

B. The hole created by worst fit is always larger than the hole created by first fit.

C. The hole created by next fit is never larger than the hole created by best fit.

D. The hole created by first fit is always larger than the hole created by next fit.

Explanation:

Let's consider the following examples where the grey spaces are occupied spaces while the white space represents the free holes and P1 means partition 1, P2 means partition 2 and so on.

A. The hole created by best fit is never larger than the hole created by first fit.

Best Fit always allocates the request that provided minimum hole sizes. Thus, best fit will never produce holes that are greater than the holes created by First Fit. This option is true.

B. The hole created by worst fit is always larger than the hole created by first fit.

Consider the following example:

P1(8 KB)		P2(4 KB)		P3(2 KB)		P4(1 KB)

For the first process of the requirement of 1 KB, using Worst Fit, partition P1 allocated to the process. Thus hole created will be (8-1) = 7 KB

And, using First Fit, partition P1 is also allocated to the process. Thus hole created will be (8-1) = 7 KB

Therefore, this option is false, as "always larger" is incorrect. and we need not check further.

C. The hole created by next fit is never larger than the hole created by best fit.

Next Fit starts as First Fit.

P1(8 KB)		P2(4 KB)		P3(2 KB)		P4(1 KB)

If the requirements of the three processes are 1 KB, 2 KB, 3KB
For the first process of requirement 1 KB, using Next Fit, partition P1 allocated to the process. Thus hole created will be (8-1) = 7 KB
And, using Best Fit, partition P4 is also allocated to the same process. Thus hole created will be (1-1) = 0 KB
Since we have proved 'never be greater' is incorrect, we need not check further.
Therefore, this option is false.

D. The hole created by first fit is always larger than the hole created by next fit.

P1(8 KB)		P2(4 KB)		P3(2 KB)		P4(1 KB)

If the requirements of the three processes are 1 KB, 2 KB, 3KB

Next Fit starts as First Fit.

The requirement of the first process is 1 KB, using Next Fit, partition P1 allocated to the process. Thus hole created will be (8-1) = 7 KB

And, using First Fit, partition P1 is also allocated to the process. Thus hole created will be (8-1) = 7 KB

The requirement of the second process is 2 KB, using Next Fit, partition P2 will be allocated to the process. Thus hole created will be (4-2) = 2 KB

And, using First Fit, partition P1 is also allocated to the process. Thus hole created will be (7-2) = 5 KB

The requirement of the third process is 3 KB, using Next Fit, partition P1 will be allocated to the process. Thus hole created will be (7-3) = 4 KB

And, using First Fit, partition P1 is also allocated to the process. Thus hole created will be (5-3) = 2 KB

Therefore First Fit does not always produce holes of size greater than that of Next Fit. Thus this option is false.

21. Consider the following statements about the functionality of an IP based router.

   I.   A router does not modify the IP packets during forwarding.
   II.   It is not necessary for a router to implement any routing protocol.
   III.   A router should reassemble IP fragments if the MTU of the outgoing link is larger than the size of the incoming IP packet.

Which of the above statements is/are TRUE?
   A. I and II only
   B. II only [ANS]
   C. II and III only
   D. I only

Explanation:

Statement 1: The packet contains header and data. The router modifies the header details like TTL.

Statement 2: Routers are configured with routing algorithms so it is not necessarily required to implement routing algorithms for the router.

Statement 3: The reassembly of the packets is not necessarily done at the router.

22. The preorder traversal of a binary search tree is 15, 10, 12, 11, 20, 18, 16, 19.

Which one of the following is the postorder traversal of the tree?

A. 10, 11, 12, 15, 16, 18, 19, 20
B. 19, 16, 18, 20, 11, 12, 10, 15
C. 11, 12, 10, 16, 19, 18, 20, 15 [ANS]
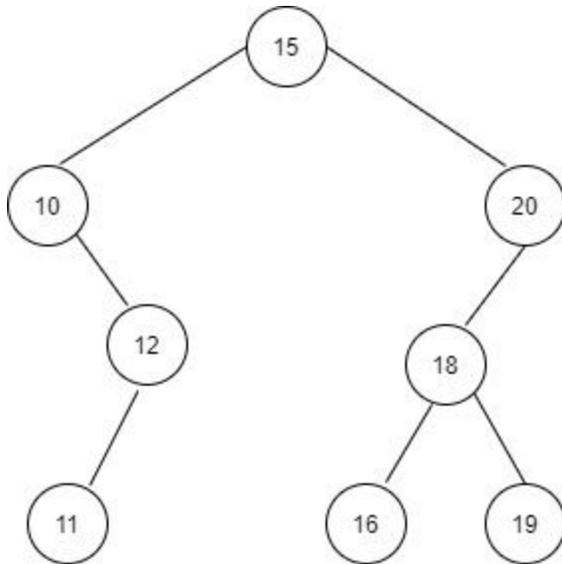D. 20, 19, 18, 16, 15, 12, 11, 10

Explanation:

Pre order: 15, 10, 12, 11, 20, 18, 16, 19

The inorder of the binary search tree is always increasing order

10, 11, 12 , 15 , 16, 18, 19, 20

The BST we can make using preorder and inorder:

The post order of given tree is 11, 12, 10, 16, 19, 18, 20, 15

23. Let G be a group of 35 elements. Then the largest possible size of a subgroup of G other than G itself is _____.
Answer: 7

Explanation:
Order of a Subgroup always divides the order of Group. The Subgroup of Group having order 35 would have order 1,5,7,35. So, the largest subgroup of G other than G itself would be 7.

24. Let R be the set of all binary relations on the set {1,2,3}. Suppose a relation is chosen from R at random. The probability that the chosen relation is reflexive (round off to 3 decimal places) is _____.
Answer: 0.125

Explanation:
The total number of relations possible is 2^{n^2}.
The number of relations which are reflexive is 2^{n^2-n}

If the relation is selected randomly then the probability that it is reflexive is $= \dfrac{2^{(n^2-n)}}{2^{n^2}} = \dfrac{1}{2^n} = \dfrac{1}{8} = 0.125$.

25. Assume that you have made a request for a web page through your web browser to a web server. Initially the browser cache is empty. Further, the browser is configured to send HTTP requests in non-persistent mode. The web page contains text and five small images. The minimum number of TCP connections required to display the web page completely in your browser is _____.

Answer: 6

Explanation:

Text + 5 images = 6 objects.
In the non-persistent HTTP connection for every object separate TCP connection is established.
Like that we have 6 objects, six TCP connections required.

26. A computer system with a word length of 32 bits has a 16 MB byte-addressable main memory and a 64 KB, 4-way set associative cache memory with a block size of 256 bytes. Consider the following four physical addresses represented in hexadecimal notation.

A1 = 0x42C8A4, A2 = 0x546888, A3 = 0x6A289C, A4 = 0x5E4880

Which one of the following is TRUE?
  A. A1 and A4 are mapped to different cache sets.
  B. A1 and A3 are mapped to the same cache sets.
  C. A3 and A4 are mapped to the same cache sets.
  D. A2 and A3 are mapped to the same cache sets. [ANS]

Explanation:

Cache Size= 64KB/ 256B = $2^{16}/2^8 = 2^8$ =256 Blocks

4-way set associative cache ⇒ Set Index = 256/4 = 64 ⇒ 6bits

TAG	Set Index	Offset
18	6	8

A1 = 0x42C8A4 ⇒ 0100 0010 11(00 1000) (1010 0100) = 8th set
A2 = 0x546888 ⇒ 0101 0100 01 (10 1000) (1000 1000) =40th set
A3 = 0x6A289C ⇒ 0110 1010 00 (10 1000) (1001 1100) = 40th Set
A4 = 0x5E4880 ⇒ 0101 1110 01 (00 1000) (1000 0000) =8th set
A2 and A3 will represent the same set.

27. Consider three registers R1, R2 and R3 that store numbers in IEEE-754 single precision floating point format. Assume that R1 and R2 contain the values (in hexadecimal notation) 0x42200000 and 0xC1200000, respectively.

If R3 = R1/R2, what is the value stored in R3?

   A. 0xC0800000 [ANS]

   B. 0x40800000

   C. 0x83400000

   D. 0xC8500000

Explanation:

   R1 is 40 and R2 is -10.

   Option A is -4

   Option B is 4

   Option C is -3.76E-37

   Option D is -229376

28. Consider the following five disk access requests of the form (request id, cylinder number) that are present in the disk scheduler queue at a given time.

(P, 155), (Q, 85), (R, 110), (S, 30), (T, 115)

Assume the head is positioned at cylinder 100. The scheduler follows Shortest Seek Time First scheduling to service the requests.

Which one of the following statements is FALSE?

   A. The head reverses its direction of movement between servicing of Q and P.
   B. T is serviced before P.
   C. R is serviced before P.
   D. Q is serviced after S, but before T.[ANS]

Explanation:
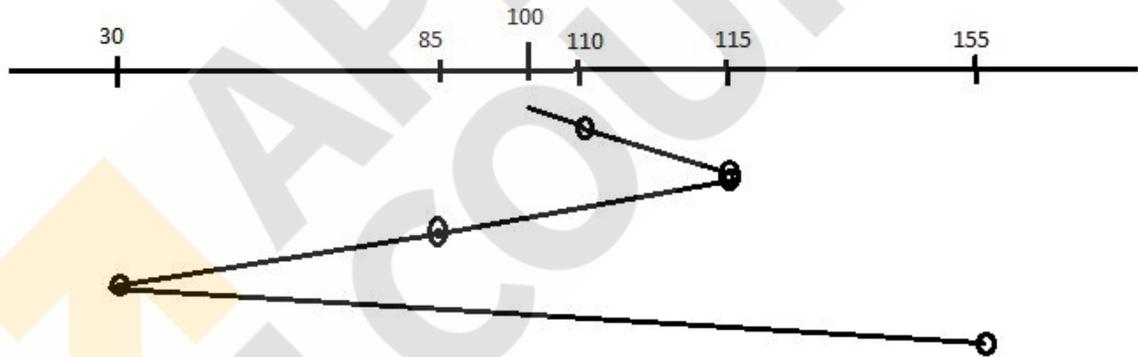
   Shortest Seek Time First: This algorithm services that request next which requires the least number of head movements from its current position regardless of the direction.
   S Q R T P
   30 85 110 115 155
   Option 4 is False because Q is serviced after T but before S.

29. Consider the array representation of a binary min-heap containing 1023

elements. The minimum number of comparisons required to find the maximum in the heap_____.

Answer: 511

Explanation:

Max element can only be found in Leaf nodes, as per the question number of leaf nodes are 512. To get the maximum value of these leaf nodes we need 511 nodes.

30. In a balanced binary search tree with n elements, what is the worst case time complexity of reporting all elements in range [a, b]? Assume that the number of reported elements is k.

    A. Θ (log n)

    B. Θ (n log k)

    C. Θ (log n+ k)[ANS]

    D. Θ (k log n)

Explanation:

We need first find the indices of a & b, which takes time of log n+log n(since its given balanced binary search tree). Once we find the indices, we can directly print the k elements (As k can be significantly larger than log n).

$\Rightarrow$ **log n + k**

31. Consider a database implemented using B+ tree for file indexing and installed on a disk drive with block size of 4 KB. The size of the search key is 12 bytes and the size of tree/disk pointer is 8 bytes. Assume that the database has one million records. Also assume that no node of the B+ tree and no records are present initially in main memory. Consider that each record fits into one disk block. The minimum number of disk accesses required to retrieve any record in the database is_____.

Answer: 4

Explanation:

The ordering key field of file is = 12B

Block pointer size = 8B

The size of each index entry Ri in primary key index will be = 12+8= 20B.

We are given with total number or records, r (total number of blocks of data file) = 1million = 10,00,000 records

The block size, B = 4KB = 4096B

The blocking factor (bfr) of index will be floor(B/Ri)= floor(4096/20)=204 entries per block.

Hence, the number of index blocks at first level is = ceil(r/bfr) = ceil(10,00,000/204)= 4902 blocks.

The number of block at second level = ceil(4092/bfr) = ceil(4092/204) = 20 blocks.

The number of block at third level = ceil(20/bfr) = ceil(20/204) = 1 block.

Thus, total block access for a search is 3+1=4 block access.

32. Consider a relation table R that is in 3NF, but not in BCNF. which one of the following statements is TRUE?

   A. R has a nontrivial Functional Dependency X→A, where X is not a superkey and A is a prime attribute. [ANS]

   B. R has a no trivial Functional Dependency X→A, where X is not a superkey and A is a non-prime attribute and X is a proper subset of some key.

   C. R has a nontrivial Functional Dependency X→A, where X is not a superkey and A is a non-prime attribute and X is not a proper subset of any key.

D. A cell in R holds a set instead of an atomic value.

Explanation:

For the given FD X-> A, the condition of 3NF are:

(i) X should be a super key, or

(ii) Y should be a prime attribute

While for a relationship to be in BCNF only (i) condition should be satisfied.

Thus, for a non- trivial dependency X-> A, X should not be a superkey and A is a prime attribute in order to satisfy 3NF and not BCNF.

33. For n > 2, let a ϵ {0,1}^{n} be a non-zero vector. Suppose that x is chosen uniformly at random from {0,1}^{n}. Then, the probability that $\sum_{i=1}^{n} a_i x_i$ is an odd number is _____.

Answer 0.5

Explanation:

Given that a is a non zero vector then in order to have the result $\sum_{i=1}^{n} a_i x_i$ as an odd number there are two cases

Case 1: if there are odd numbers of ones in vector a, then if we have odd number of ones form these ones then we have an odd result. Probability, in this case, is 0.5.

Case 2: if there are even number of ones in vector a, then if we have odd number of ones form these ones then we have an odd result. Probability, in this case, is 0.5.

Over all the probability that the result is odd=0.5.

34. A processor has 64 registers and uses a 16-bit instruction format. It has two types of instructions: I-type and R-type. Each I-type instruction contains an opcode, a register name, and a 4-bit immediate value. Each R-type instruction contains an opcode and two register names. If there are 8 distinct I-type opcodes, then the maximum number of distinct R-type opcodes is___.
Answer: 14

Explanation:

Given that we have 64 registers.

Requires 6 bits to represent the register.

R-type instructions contains opcode, Register name1, Register name2

Opcode	R1	R2
4	6	6

I-type instructions contains opcode, Register name1, 4-bit immediate data

Opcode	R1	Immediate
6	6	4

From the given problem I-type instructions are =8

Opcode of both R-type and I-type shares the common addresses

Opcode	
4	2

$(2^4 - R) * 2^2 = 8$

$16 - R = 2$

$R = 14$

Possible R-type instructions are 14

35. Consider the following language.

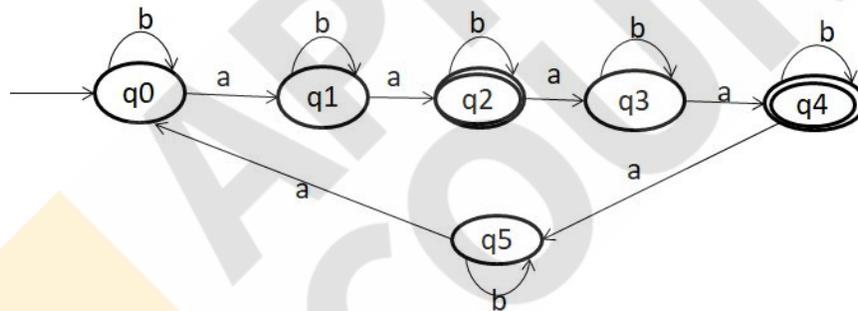L = {x € {a,b}*| number of a's in x is divisible by 2 but not divisible by 3}

The minimum number of states in a DFA that accepts L is_____.

Answer: 6

Explanation:

Numbers that are divisible by 2 but not by 3 = {2,4,8,10,14, 16,.......}

={ aa, aaaa, aaaaaaaa,.......................}

36. Consider the following set of processes, assumed to have arrived at time 0. Consider the CPU scheduling algorithms Shortest Job First (SJF) and Round Robin (RR). For RR, assume that the processes are scheduled in the order P1, P2, P3, P4

Processes	P1	P2	P3	P4
Burst time (in ms)	8	7	2	4

If the time quantum for RR is 4 ms, then the absolute value of the difference between the average turnaround times (in ms) of SJF and RR (round off to 2 decimal places) is_____.

Answer: 5.25 units

Explanation:
SJF

P3	P4	P2	P1

0   2   6   13   21

Avg TAT = 42 / 4 = 10.5

RR(TQ = 4)

P1	P2	P3	P4	P1	P2

0   4   8   10   14   18   21

Average TAT = (18 + 21 + 10 + 14)/4 = 15.75
Absolute difference = 15.75 - 10.5 = 5.25 units

37. Consider the productions A→PQ and A→ XY. Each of the five non-terminals A, P, Q, X and Y has two attributes: s is a synthesized attribute and i is an inherited attribute. Consider the following Rules
Rule1: P.i = A.i + 2, Q.i = P.i + A.i and A.s = P.s + Q.s
Rule2: X.i = A.i + Y.s and Y.i= X.s + A.i
Which of the following is/are True?
   A. Only Rule1 is L-attributed [ANS]
   B. Both Rule1 and Rule2 are L-attributed
   C. Neither Rule1 nor Rule 2 is L-attributed

D. Only Rule 2 is L-attributed

Explanation:

Rule1: P.i = A.i+2, Q.i = P.i+A.i, A.s = P.s+Q.s True

Rule2: X.i = X.i+Y.s and Y.i= X.s+A.i

X.i is an inherited attribute needed to get the data from its parents or left siblings.

38. Consider a graph G = (V,E), where V = {V_1, V_2, ..., V_{100}}, E = {(V_i, V_j;)|1 ≤ i < j ≤ 100), and weight of the edge (V_i, V_j;) is |i – j|. The weight of the minimum spanning tree of G is_____.
Answer: 99

Explanation

Let us consider a small graph with 3 edges then its minimal spanning tree is given as 2*(1)=2.

Each edge is connecting the vertices (i,i+1) for this the edges are of weight 1. The number of edges of the MST is |V|-1, in case of the given question |V|=100, now the cost for this is |V|-1=99.

Cost of the MST=99*1=99.

39. Consider a non-pipelined processor operating at 2.5 GHz. It takes 5 clock cycles to complete an instruction. You are going to make a 5-stage pipeline out of this processor. Overheads associated with pipelining force you to operate the pipelined processor at 2 GHz. In a given program, assume that 30% are memory instructions, 60% are ALU instructions and the rest are branch instructions. 5% of the memory instructions cause stalls of 50 clock cycles each due to cache misses and 50% of the branch instructions cause stalls of 2 cycles each. Assume that there are no stalls associated with the execution of ALU instructions. For this program, the speedup achieved by the pipelined processor over the non-pipelined processor (round off to 2 decimal places) is_____
Answer:2.16

Explanation:

Time for the non-pipelined processor = 5*(1/(2.5)) ns = 2ns

Pipelined processor speed = 2GHZ

Ideal CPI + Stall cycles per instr =1+Stall cycles per instr

Stall cycles = 0.3(0.05*50) + 0.1(0.5*2)

$\qquad$ = 0.3(2.5)+ 0.1(1)

$\qquad$ = 0.75+0.1 = 0.85

Time for the pipelined processor is = (1+0.85)*(0.5) = 0.925

Speedup = 2/ 0.925 = 2.16

40. Consider a schedule of transactions T_1 and T_2:

T_1	RA			RC		WD		WB	Commit		
T_2		RB	WB		RD		WC				Commit

Here, RX stands for "Read(X)" and WX stands for "Write(X)". Which one of the following schedules is conflict equivalent to the above schedule?

A.

T_1	RA	RC	WD	WB					Commit	
T_2					RB	WB	RD	WC		Commit

B.

T_1	RA	RC	WD				WB		Commit	
T_2				RB	WB	RD		WC		Commit

C.

T_1				RA	RC	WD	WB		Commit	
T_2	RB	WB	RD					WC		Commit

[ANS]

D.

T_1					RA	RC	WD	WB	Commit	
T_2	RB	WB	RD	WC						Commit

Answer: C

Explanation:

Conflicting operations are $R_1(C) \rightarrow W_2(C)$, $R_2(B) \rightarrow W_1(B)$, $W_2(B) \rightarrow W_1(B)$, $R_2(D) \rightarrow W_1(D)$

Now let us check the given options A, B, C, and D

	A	**B**	**C**	**D**
$R_1(C) \rightarrow W_2(C)$	✓	✓	✓	χ
$R_2(B) \rightarrow W_1(B)$	χ	✓	✓	
$W_2(B) \rightarrow W_1(B)$		✓	✓	
$R_2(D) \rightarrow W_1(D)$		χ	✓	

Therefore, option (C) had equivalent conflicting options.

41. Which one of the following predicate formulae is NOT logically valid?

    Note that W is a predicate formula without any free occurence of x.

    A. $\exists x(P(x) \wedge W) \equiv \exists xP(x) \wedge W$
    B. $\forall x(P(x) \vee W) \equiv \forall xP(x) \vee W$
    C. $\forall x(P(x) \rightarrow W) \equiv \forall x\, P(x) \rightarrow W$ [ANS]
    D. $\exists x(P(x) \rightarrow W) \equiv \forall x\, P(x) \rightarrow W$

Answer: C

Explanation:

Note that, W can have x unbounded or free. Which means, this x is not bound to the quantifier.

A. $\exists x(P(x) \wedge W) \equiv \exists x(P(x)) \wedge W \equiv \exists xP(x) \wedge W$
   Therefore, valid.

B. $\forall x(P(x) \vee W) \equiv \forall x(P(x)) \vee W \equiv \forall xP(x) \vee W$

Therefore, valid.

C. $\forall x(P(x) \rightarrow W)$
$\equiv \forall x(\sim P(x) \vee W)$
$\equiv \forall x(\sim P(x)) \vee W$
$\equiv [\sim P(x1) \wedge \sim P(x2) \wedge \sim P(x3) \wedge \ldots] \vee W$
$\equiv \sim \sim [\sim P(x1) \wedge \sim P(x2) \wedge \sim P(x3) \wedge \ldots] \vee W$
$\equiv \sim [P(x1) \vee P(x2) \vee P(x3) \vee \ldots] \vee W$
$\equiv \sim [\exists x P(x)] \vee W$
$\equiv \sim \exists x P(x) \vee W$
$\equiv \exists x P(x) \rightarrow W$

Therefore, LHS and RHS are not equivalent. Therefore, not valid.

D. $\exists x (P(x) \rightarrow W)$
$\equiv \exists x (\sim P(x) \vee W)$
$\equiv \exists x (\sim P(x)) \vee W$
$\equiv [\sim P(x1) \vee \sim P(x2) \vee \sim P(x3) \vee \ldots] \vee W$
$\equiv \sim \sim [\sim P(x1) \vee \sim P(x2) \vee \sim P(x3) \vee \ldots] \vee W$
$\equiv \sim [P(x1) \wedge P(x2) \wedge P(x3) \wedge \ldots] \vee W$
$\equiv \sim [P(x1) \wedge P(x2) \wedge P(x3) \wedge \ldots] \vee W$
$\equiv \sim [\forall x P(x)] \vee W$
$\equiv \forall x P(x) \rightarrow W$
Therefore, valid.

42. Consider the following languages.

$L_1 = \{wxyx \mid w,x,y \in \{0+1\}^+\}$

$L_2 = \{xy \mid x,y \in \{a+b\}^*, |x| = |y|, x \neq y\}$

Which one of the following is TRUE?

A. L_1 is context-free but L_2 is not context-free.

B. L_1 is regular and L_2 is context-free. [ANS]

C. Neither L_1 nor L_2 is context-free.

D. L_1 is context-free but not regular and L_2 is context-free.

Explanation:

L = {wxyx | w,x,y $\in$ {0+1}$^+$ } Regular and CFL

Let x=0, w0y0 (0+1)$^+$0(0+1)$^+$0

x=00, w00y00 (0+1)$^+$0(0+1)$^+$0

x=10 w10y10 (0+1)$^+$0(0+1)$^+$0

RE is (0+1)$^+$0(0+1)$^+$0 + (0+1)$^+$1(0+1)$^+$1

L = {xy | x,y $\in$ {0+1}* and |x| = |y| and x $\neq$ y}CFL

We observe that a string is in C if and only if it can be written as xy with |x| = |y| such that for some i, the ith character of x is different from the ith character of y. To obtain such a string, we start generating the corresponding ith characters and fill up the remaining characters. Based on the above idea, we define the CFG for C is as follows:

S → AB | BA

A → XAX | 0

B → XBX | 1

X → 0 | 1

43. An organization requires a range of IP addresses to assign one to each of its 1500 computers. The organization has approached an Internet Service Provider (ISP) for this task. The ISP uses CIDR and serves the requests from the available IP address space 202.61.0.0/17. The ISP wants to assign an address space to the organization which will minimize the number of routing entries in the ISP's router using route aggregation. Which of the following address spaces are potential candidates from which the ISP can allot any one to the organization?

    I.   202.61.84.0/21

    II.   202.61.104.0/21

    III.   202.61.64.0/21

    IV.   202.61.144.0/21

A. III and IV

B. I and IV

C. I and II

D. II and III [ANS]

Explanation:

We have given the four address space in four statement

Analyze the third octet:

Total of 17 net bits, 4 subnet bits, 11 host bits

84 -> 0 **1010** 100 -> This is incorrect because the host bit contains 1 .

104 -> 0 **1101** 000

64-> 0 **1000** 000

144 -> 1 **0010** 000 -> This does not belong to address space because starting net bit is 1 as it should be zero as per space 202.61.0.0/17

ISP can aggregate II and III for minimizing the routing table.

44. Let G = (V, E) be a weighted undirected graph and let T be a Minimum Spanning Tree (MST) of G maintained using adjacency lists. Suppose a new weighted edge (u,v) ε V x V is added to G. The worst case time complexity of determining if T is still an MST of the resultant graph is

   A. $\Theta(|V|)$ **[Ans]**

   B. $\Theta(|E| \ log|V|)$

   C. $\Theta(|E| + |V|)$

   D. $\Theta(|E||V|)$

Explanation

If the new edge connecting vertices (u,v) is considered then we need to first check if the path from u to v.

If the weight of the maximum edge on this path is less that the maximum weight edge on this path then we need to delete the maximum weight edge and add the new edge to the MST, otherwise the current MST remains unchanged.

Determining the path will take O(V) time as there are a maximum of |V|-1 edges and determining maximum will also take O(|V|) time.

Remaining other operations will take constant time, correct answer is $\Theta(|V|)$.

45. Let A and B be two n x n matrices over real numbers. Let rank(M) and det(M) denote the rank and determine of a matrix M, respectively. consider the following statements

  I. rank(AB) = rank(A)*rank(B)
  II. det(AB) = det(A)*det(B)
  III.rank(A+B) ≤ rank(A) + rank(B)
  IV.   det(A+B) = det(A) + det(B)

Which of the above statements are TRUE?

  A. I & II ONLY
  B. **II & III ONLY [ANS]**
  C. III & IV ONLY
  D. I & IV ONLY

   Explanation:
   I.   Consider any two matrices 3*3 matrices which are nonsingular then the rank of such matrices are 3 for both of them and the rank of AB is also 3 as the product is also non-singular rank(AB)=3. Options A and C can be eliminated.
   II. We know that from the properties of the determinant
          |AB|=|A||B|
   From this, we can conclude that option C is correct.

Consider the Boolean function $z(a, b, c)$.
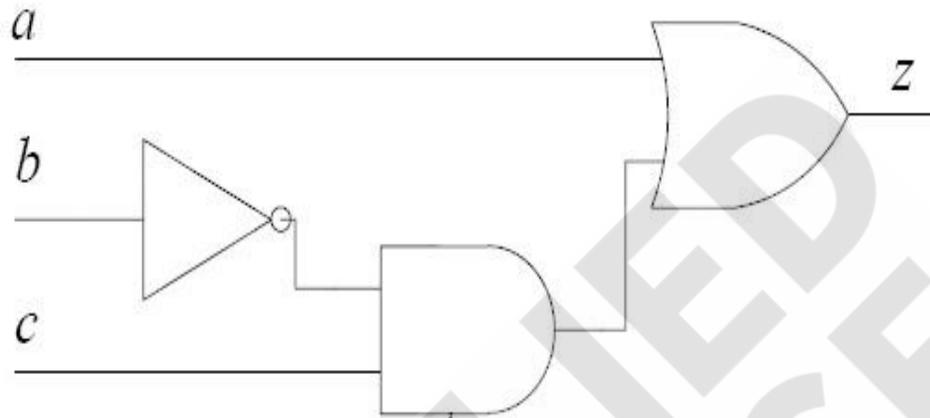
46. Which one of the following minterm lists represents the circuit given above?

    A. $z = \Sigma(0,1,3,7)$
    B. $z = \Sigma(2,4,5,6,7)$
    C. $z = \Sigma(2,3,5)$
    D. **$z = \Sigma(1,4,5,6,7)$ [ANS]**

Explanation :

    The given function is $z = a + (b'. c)$

Decimal	a	b	c	z
0	0	0	0	0
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1

5	1	0	1	1
6	1	1	0	1
7	1	1	1	1

Therefore, the minterm $\Sigma(1,4,5,6,7)$ represents the function $z = a + (b'. c)$

47. The number of permutations of the characters "LILAC" so that no character appears in its original position, if the two L's are indistinguishable is_____.
Answer: 12

Explanation :

Here we have 5 blanks

_ _ _ _ _

L I L A C

the 2 L's we can place in the remaining positions in C(3,2) ways and the remaining 3 letters can be placed in 2 ways and they can be shuffled in 2! ways, therefore the total number of arrangements is C(3,2)*2*2!=12.

They are

1. CLILA
2. ILCLA
3. ALCIL
4. CLAIL
5. ILACL
6. ALICL
7. CAILL
8. ACILL

9. ICALL
10. IACLL
11. ALCLI
12. CLALI

48. Let G(V, E) be a directed, weighted graph with weight function w:E→**R.**
For some function f:V→**R**, for each edge (u,v)∈E, define w'(u,v) as w(u, v)+f(u)-f(v). Which of the following options completes the following statements so that it is true.

"Shortest paths in G under w are shortest paths in G under w' too,_____."

A. If and only if f(u) is the distance from s to u in the graph obtained by adding a new vertex s to G and edges of zero weight for s to every vertex of G.

B. For every f:V→R

C. If and only if ∀u∈V, f(u) is positive.

D. If and only if ∀u∈V, f(u) is negative.

49. Consider a TCP connection between a client and a server with the following specifications: the round trip time is 6 ms, the size of the receiver advertised window is 50 KB, slow-start threshold at the client is 32 KB, and the maximum segment size is 2 KB. The connection is established at time t = 0. Assume that there are no timeouts and errors during transmission. Then the size of the congestion window (in KB) at time t + 60 ms after all acknowledgments are processed is _____.

Answer: 44

Explanation:

First transmission: 2 KB → 6ms
Second transmission: 4 KB → 6ms

Third transmission: 8 KB→ 6ms
Fourth transmission: 16 KB→ 6ms
Fifth transmission: 32 KB [Th reached] → 6ms
Sixth transmission: 34 KB→ 6ms
Seventh transmission: 36 KB→ 6ms
Eighth transmission: 38 KB→ 6ms
Ninth transmission: 40 KB→ 6ms
Tenth transmission: 42 KB→ 6ms

After completion of 6 x10 = 60 ms
For the eleventh transmission, the congestion window size is 44 KB

50. Graph G is obtained by adding vertex s to $K_{3,4}$ and making s adjacent to every vertex of $K_{3,4}$. The minimum number of colours required to edge-colour G is _____.
Answer: 7

Explanation :

Edge coloring is a problem in graph theory where all the edges in a given graph must be assigned a color. Furthermore, all edges that are adjacent to each other must be given different colors. In other words, all the edges incident to any specific vertex must contain no repeated colors.
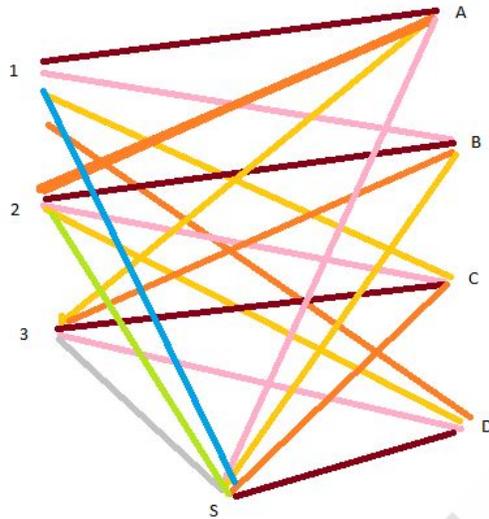
Therefore, 4 colors(for the K3,4) + 3 new colors from vertex S to vertices 1, 2 and 3.

51. Consider the following C functions

```
int fun1(int n) {
    static int i = 0;
    if (n > 0) {
        ++i;
        fun1(n-1);
    }
    return(i);
}
```

```
int fun2(int n) {
    static int i = 0;
    if (n > 0) {
        i = i + fun1(n);
        fun2(n-1);
    }
    return(i);
}
```

The return value of fun2 (5) is ___

Answer: 55

Explanation:

https://onlinegdb.com/B1Cwqv2M8

52.

Each of a set of *n* processes executes the following code using two semaphores a and b initialized to 1 and 0, respectively. Assume that count is a shared variable initialized to 0 and not used in CODE SECTION P.

```
CODE SECTION P
```

```
wait(a); count=count+1;
if (count==n) signal(b);
signal(a); wait(b); signal(b);
```

```
CODE SECTION Q
```

What does the code achieve?

A. It ensures that all processes execute CODE SECTION P mutually exclusively

B. It ensures that no processes execute CODE SECTION Q before every process has finished CODE SECTION P [ANS]

C. It ensures that at most two processes are in CODE SECTION Q at any time

D. It ensures that at most n-1 processes are in CODE SECTION p at any time

Explanation:

1. Incorrect because there is no synchronization mechanism given to ensure Mutual Exclusion in Section P.

2. Correct. As when the nth process executes wait(a), increases count by 1 and makes count = n, then signal(b) makes b = 1. Then wait(b) will unblock the first blocked process, thus the remaining (n-1) processes remain blocked. Thus, this way it ensures no process executes CODE SECTION Q before every process has finished CODE SECTION P.

3. As explained in Option 2, this option is also incorrect.
4. Incorrect because all the n processes can execute their CODE SECTION P simultaneously.

53. Consider a paging system that uses a 1-level page table residing in main memory and a TLB for address translation. Each main memory access takes 100 ns and TLB lookup takes 20 ns. Each page transfer to/from the disk takes 5000 ns. Assume that the TLB hit ratio is 95%, page fault rate is 10%. Assume that for 20% of the total page faults, a dirty page has to be written back to disk before the required page is read in from disk. TLB update time is negligible. The average memory access time in ns (round off to 1 decimal places) is_____

Answer: 725 ns

Explanation:

    Effective Access Time with page fault =
Page fault rate * { dirty page ratio * {Effective Access Time without page fault + Page fault service time for dirty page}
                    + clean page ratio * {Effective Access Time without page fault + Page fault service time for clean page}
            }
+ (1 - Page fault rate) * {Effective Access time without page fault}

Where,
Effective Access Time without page fault =
Hit ratio of TLB * {Access time of TLB + Access time of main memory}
+ Miss ratio of TLB * {Access time of TLB + (L + 1)* Access time of main memory}
and,
L = Number of levels of page table

Effective Access Time without page fault = 0.95(20 + 100) + 0.05(20 + 2 * 100)

$$= 114 + 11 = 125 \text{ ns}$$

Effective Access Time with page fault = 0.1 [0.2 { 125 + 10000}

$$+ 0.8 \ \{125 + 5000\}]$$

$$+ 0.9 \ (125)$$

$$= 612.5 + 112.5$$

$$= 725 \text{ ns}$$

NOTE: Please note that, in the GATE perspective, *PFST* is so large that *the memory access time* is ignored.

54. Which of the following languages are Undecidable? Note that <M> indicates encoding of the Turing Machine M.

L1 = { <M> | L(M) = ∅ }
L2 = { <M,w,q> | M on input w reaches state q in exactly 100 steps}
L3 = { <M> | L(M) is not recursive}
L4 = { <M> | L(M) contains at least 21 members}

        A. L2, L3, and L4 only
        B. L1, L3, and L4 only [ANS]
        C. L2 and L3 only
        D. L1 and L3 only

Explanation:

{ <M> | M is a TM with L(M) = ∅ } Emptiness of recognizable languages are undecidable

{ <M,w,q> | M will take for the string q exactly 100 steps}Decidable After 100 steps ™ will halt for both the valid and invalid inputs.

{ <M> | M is not recursive}Undecidable

{ <M> | M contains at least 21 members}Membership problems of recognizable language are undecidable.

55.
Consider the following C functions.

```
int tob(int b, int* arr){
    int i;
    for(i=0; b>0; i++){
        if(b%2)  arr[i]=1;
        else     arr[i]=0;
        b = b/2;
    }
    return(i);

}
```

```
int pp(int a,int b) {
    int arr[20];
    int i, tot = 1, ex, len;
    ex = a;
    len = tob(b,arr);
    for(i=0; i<len; i++){
        if(arr[i]==1)
            tot = tot * ex;
        ex = ex * ex;
    }
    return(tot);

}
```

The value returned by pp(3,4) is _____?

Answer: 81

Explanation:

https://onlinegdb.com/HJQnCK2GI