BYJU'S EXAM PREP

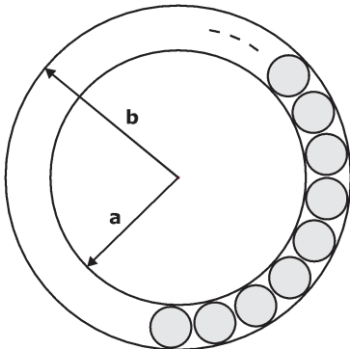
GATE 2020

Computer Science & Information Technology

Questions & Solutions

SECTION: GENERAL APTITUDE

1. The figure below shows an annular ring with outer and inner radii as b and a, respect. The annular space has been painted in the form of blue colour circles touching the and inner periphery of annular space. If maximum n number of circles can be painted, then the unpainted area available in annular space is _____.



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

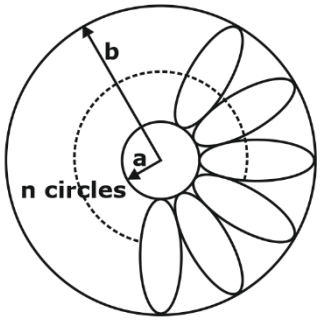
B. $\pi[(b^2-a^2)-\frac{n}{4}(b-a)^2]$

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

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

Ans. B

Sol.



Radius of inner circle = a

Radius of outer circle = b

Radius of small circle = $\frac{b-a}{2}$

area of donut shaped figure = $\pi(b^2 - a^2)$

Area of each small circle = $\pi\left(\frac{b-a}{2}\right)^2$

total area of all small circle $= n\pi\left(\frac{b-a}{2}\right)^2$

Area of remaining portion

$= \pi(b^2 - a^2) - n\pi\left(\frac{b-a}{2}\right)^2$

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

2. The dawn of the 21st century witnessed the melting glaciers oscillating between giving 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. Give situation of imminent global exodus of billions of people displaced by rising seas, nation-states need to rethink their cartoon footprint for political concerns, if not for environmental ones.

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

A. Nation-states do not have environmental concerns.

B. Billions of people are affected by melting glaciers.

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

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

Ans. B

Sol. Billions of people are affected by melting glaciers.

3. His knowledge of the subject was excellent, but his classroom performance was_____.

A. good

B. praiseworthy

C. desirable

D. extremely poor

Ans. D

Sol. His knowledge of the subject was excellent, but his classroom performance was extremely poor.

4. 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 α + β is _____ .

A. 180^0 B. 60^0

C. 120^0 D. 90^0

Ans. D

5. If P = 3, R = 27, T = 243, then Q + S = _____

A. 90 B. 80

C. 40 D. 110

Ans. A

Sol. $P = 3^1$

$Q = 3^2 = 9$

$R = 3^3 = 27$

$S = 3^4 = 81$

$T = 3^5 = 243$

So, Q + S = 9 + 81 = 90

6. Goods and Services Tax (GST) is an indirect tax introduced in India in 2017 imposed on the supply of goods and services, and it subsumes all indirect taxes except few. It is a destination-based tax imposed on goods and services used, and it is not imposed the point of origin from where goods come. GST also has a few components spec*** state governments, central government and Union Territories (UT's).

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

A. GST does not have a component specific to UT.

B. GST is imposed at the point of usage of goods and services.

C. GST is imposed on the production of goods and services.

D. GST includes all indirect taxes.

Ans. B

Sol. GST is imposed at the point of usage of goods and services.

7. Raman is confident of speaking English _____ six months as he has been practicing regularly _____ the last three weeks.

A. within, for B. during, for

C. for, in D. for, since

Ans. A

Sol. within, for

8. Select the words that fits the analogy:

Cook : Cook :: Fly : _____

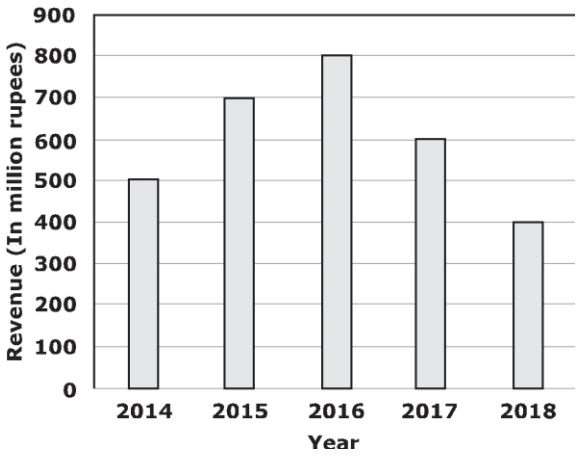
A. Flew B. Flighter

C. Flyer D. Flying

Ans. C

Sol. Flyer

9. The total revenue of a company during 2014-2018 is shown in the graph. If the expenditure of the company in each year is 500 million rupees, then the aggregate profit loss (in percentage) on the total expenditure of the company during 2014-2018 is _____



A. 20% profit

B. 16.67% loss

C. 16.67 profit

D. 20% loss

Ans. A

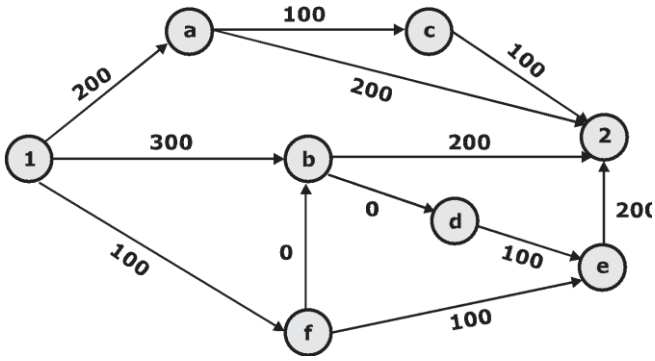
Sol. Total expenditure = 2500 million

Total revenue = 3000 million

profit % = $\frac{500}{2500} \times 100$

profit % = 20

10. There are multiple routes to reach from node 1 to node 2, as shown in the network.



The cost of the travel on an edge between 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, Rs. 100 for the other toll booths. Which is the cheapest route from node 1 to 2?

A. 1-b-2

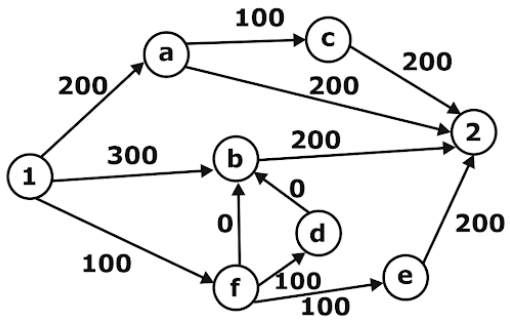
B. 1-f-e-2

C. 1-a-c-2

D. 1-f-b-2

Ans. D

Sol.



Source (1), Destination (2)

from Node (1) shortest is (1) → (f)

From (f) → (e) cost 100

(f) → (b) cos 0

So, (f) → (b) is selected.

Then (b) → (2) is selected

⇒ so, (1) → (f) → (b) → (2)

TECHNICAL

1. Consider the following C program.

```
#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, 9, 20}};
  printf("%d\n", *(*(a+**a+2)+3);
  return(0);
  }
```

The output program is _____ .

Ans. 19

Sol.

Given Array size ⇒ C [4] [4]
(4 rows, 5 columns)

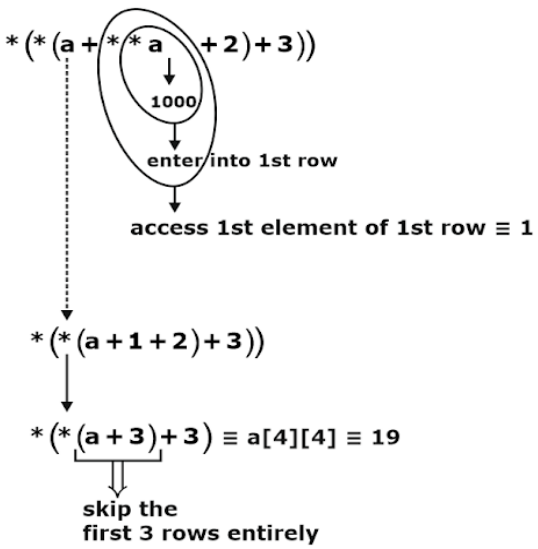
a[4] [5] ⇒

Column →	1	2	3	4	5
row → 1	1 (1000)	2 (1002)	3 (1004)	4 (1006)	5 (1008)
2	6 (1010)	7 (1012)	8 (1014)	9 (1016)	10 (1018)
3	11 (1020)	12 (1022)	13 (1024)	14 (1026)	15 (1028)
4	16 (1030)	17 (1032)	18 (1034)	19 (1036)	20 (1038)

base address of a = 1000

"*" → has higher precedence the "+"

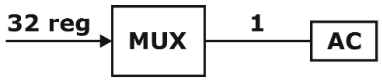
((a + ** a + 2) + 3)



2. A multiplexer is placed between a group of 32 register and an accumulator to regulate data movement such at that 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 _____ .

Ans. 5

Sol.



MUX: 2^n inputs, n selection lines, 1 o/p

$2^n = 32$ ⇒ $n = 5$

3. What is the worst case time complexity of inserting n^2 elements into an AVL Tree with n elements initially?

A. $\theta(n^2 \log n)$ B. $\theta(n^2)$

C. $\theta(n^3)$ D. $\theta(n^4)$

Ans. A

Sol. Insertion of an element into AVL requires O(log n) time.

To insert an element

1. Find the position, where to insert
2. After insertion, to satisfy AVL properly, we may need to perform rotation.

So, (1) take 'log n time' and (2) take 'log n' time.

Total time for inserting one element into AVL tree is log n + log n = 2 log n ⇒ O (log n).

Now, To insert n^2 elements ⇒ $n^2 \log n$

⇒ $O(n^2 \log n)$

4. Consider the following sentences.

I. If $L_1 \cup L_2$ is regular, then both L_1 and L_2 must be regular.

II. The class of regular languages is closed under infinite union.

Which of the above statements is/are TRUE?

A. Both I and II B. Neither I nor II

C. I only D. II only

Ans. B

Sol. Let $L_1 = a^n b^n \Rightarrow$ CFL

$L_2 = \Sigma^* \Rightarrow$ Regular

$L_1 \cup L_2 = (a^n b^n) \cup \Sigma^* = \Sigma^* \Rightarrow$ Regular

Since $L_1 \cup L_2$ is regular but L_1 is not regular, Hence statement I is false.

Regular language is not closed under infinite union. Hence, statement-II is also false.

$\therefore$ Neither I nor II is true.

5. 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 of the existing holes. Which one of the following statements is TRUE?

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

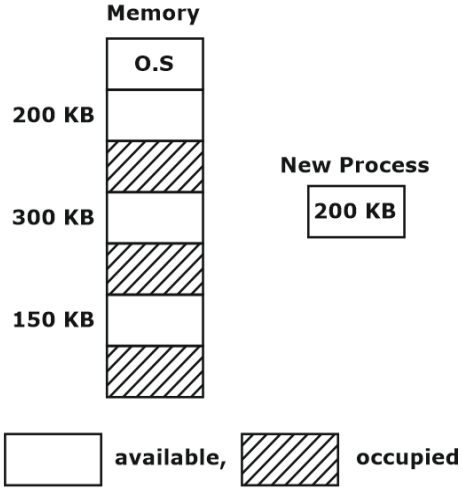
B. The hole created by the best fit is always larger than the hole created by next fit

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

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

Ans. A

Sol. Let us consider a new process required 120 kb memory and existing holes in the memory are 200, 300, 150 kb as shown in the diagram in the same order.



Now, when we allocate, this new process a memory using different algorithms, it would be like given below

Algorithm	Allocated partition	size of new tube
First Fit	200 KB	80 KB
Best Fit	150 KB	30 KB
Worst Fit	300 KB	180 KB
Next Fit	300 KB	180 KB

6. If there are m input lines and n output for a decoder that is used to unique address a byte addressable 1 KB RAM, then the minimum value of m + n is _____

Ans. 1034

Sol. Byte addressable 1 KB RAM

$\Rightarrow 2^{10}$ bytes

m = 10

$n = 2^m$

m = 10, n = 1024

so, m+n= 1024+ 10 = 1034

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

I. A router does not modify the 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 outing packet 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

C. I and III only D. I only

Ans. B

Sol. **Statement 1:** False, Because, Intermediate router may modify fields like TTL, offset checksum.

Statement 2: True, router may not implement routing protocol, for static routing.

Statement 3: False, It is not mandatory to reassemble.

8. Consider the following grammar.

$S \rightarrow aSB \mid d$
$B \rightarrow b$

The number of reduction steps taken by a bottom-up parser while accepting string aaadbbb is _____

Ans. (7)

Sol. $S \rightarrow aSB$

$\rightarrow aaSBB$ [$S \rightarrow aSB$]

$\rightarrow aaaSBBB$ [$S \rightarrow aSB$]

$\rightarrow aaadBBB$ [$S \rightarrow d$]

$\rightarrow aaadbBB$ [$B \rightarrow b$]

$\rightarrow aaadbbB$ [$B \rightarrow b$]

$\rightarrow aaadbbb$ [$B \rightarrow b$]

Total 7 steps required.

9. 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	Bangal
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 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);
```

The number of rows returned by the above SQL query is

A. 0 B. 4

C. 2 D. 5

Ans. B

Sol.

Catalog	
S.no	Cost
S_1	50
S_1	250
S_1	100
S_2	200
S_2	250
S_3	150
S_3	250
S_3	300
S_4	200

AVG.
225

S.no	pno	cost
S_2	P_4	200
S_4	P_4	250

Result

S.no	S name
S_1	M/s Royal Furniture
S_2	M/s Balaji Furniture
S_3	M/s Premium Furniture
S_3	M/s Premium Furniture

Therefore 4 rows returned by the above query.

10. Which one of the following is used to represent the supporting many-one relationships of a weak entity set in an entity-relationship diagram?

A. Ovals that contain underlined identifiers

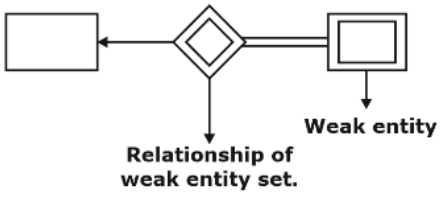
B. Diamonds with double/bold border

C. Ovals with double/bold border

D. Rectangles with double/bold border

Ans. B

Sol.



11. 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 _____.

Ans. (13.5)

Sol. Cache Memory = 1 MB

Word size = 64 bit = 8 B

Block size = 256 B

Hit rate, x = 0.94

miss rate= 1-x = 0.06

Cache access time, Tc = 3ns

Number of words / Block = 256/8 = 32

Using Hierarchical Approach,

Tavg= (x.Tc) + (1-x)[Tc + 1^{st} word access time + remaining word access time]

Tavg = (0.94 × 3) + (1 – 0.94) [3 + 20 + (31 × 5)]

Tavg = 13.5 ns

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

Ans. 0.125

Sol. No. of relation on A = 2^9

No. of reflexive relation on

A = 2^(n^2-n) = 2^(3^2-3)= 2^6

$$\therefore \text{Probability (reflexive)} = \frac{2^6}{2^9} = \frac{1}{8} = 0.125$$

13. Consider the following statements about 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

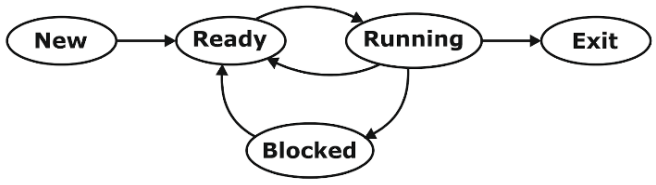
B. I, II, and IV only

C. I, II, and III only

D. II and III only

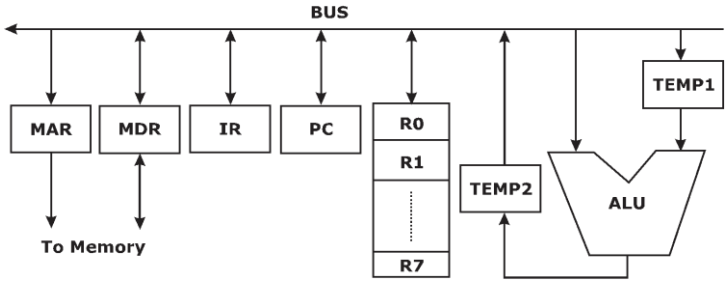
Ans. B

Sol.



1,2,4 are True

14. Consider the following data path diagram.



Consider an instruction: $R0 \leftarrow R1 + R2$. 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. $TEMP2_r$, $R0_w$
5. MDR_r, IR_w

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

A. 3, 5, 2, 1, 4 B. 2, 1, 4, 5, 3

C. 3, 5, 1, 2, 4 D. 1, 2, 4, 3, 5

Ans. A

Sol. Given steps:

1. $R2_r$, $TEMP^1_r$, ALU_{add}, $TEMP^2_W$
2. $R1_r$, $TEMP^1_W$
3. PC_r, MAR_W, MEM_r
4. $TEMP^2_r$, RO_W
5. MDR_r. IR_W

Instruction fetch is first step to be done which is indicated by step 3 and 5

$$\text{3 } Pc_r\ MAR_w,\ MEM_r \\ \text{5 } MDR_r,\ IR_w \Rightarrow \begin{cases} MAR \longleftarrow PC \\ IR \longleftarrow \text{Read (MAR)} \\ IR \longleftarrow MDR \end{cases}$$

Then instruction decoded by cu and then operand fetch should be performed. If is indicated with step 2 and operand fetch and perform operation by step 1

$$\text{2 } R1_r,\ TEMP^1{}_w \\ R_{2r},\ TEMP_{1r},\ ALUa_{ddr} \\ TEMP^2{}_w \Rightarrow \begin{cases} TEMP_1 \longleftarrow R_1 \\ TEMP_2 \longleftarrow R_2 \\ (add)ALU \longleftarrow TEMP_1, TEMP_2 \end{cases}$$

4. Now, write result operations should be performed. It is indicated by step 4 as result should be in R_0.

Step 4:

$$TEMP_{2w},\ RO_w \Rightarrow \begin{cases} TEMP_2 \longleftarrow \text{ALU (result)} \\ R_0 \longleftarrow TEMP_2 \end{cases}$$

Hence correct order of execution should be, 3, 5, 2, 1, 4

15. Let G be a group of 35 elements. Then the largest possible size of a subgroup of G other G itself is _____.

Ans. 7

Sol. According to Lagrange's theorem, state that for any finite group G, the order (number of element) of every subgroup t_1 of G divides the order of G. therefore, possible subgroup of group of 35 elements.

{1, 5, 7, 35}

16. For parameters a and b, both of which are ω(1), T(n) = $T(n^{1/a})$ + 1, and T(b)=1. Then T(n) is:

A. $\Theta(\log_{ab} n)$ B. $\Theta(\log_a \log_b n)$

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

Ans. B

Sol. $T(n) = T(n^{\frac{1}{a}}) + 1$ & $T(b) = 1$

$$T(n^{\frac{1}{a}}) = T\left((n^{\frac{1}{a}})^{\frac{1}{a}}\right) + 1 \quad \& \quad T(b) = 1$$

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

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

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

$$\vdots$$

$$\vdots$$

$$T\left(\frac{1}{n^{a^K}}\right) + K$$

$\Rightarrow \log_a \log_b n$

$\Rightarrow O(\log_a \log_b n)$

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 use' are detected during syntax analysis.

Which of the above statements is/are TRUE?

A. I only B. None of I, II, and III

C. I and III only D. II only

Ans. B

Sol. Statement I – False, symbol table can be accessed during any phase of compiler.

Statement II- False, For recursion support it is not necessarily be heap storage, as stack storage also supports recursion.

Statement III – False, "Variable must be declared before use" are detected during semantic analysis.

Hence, None of the statements is correct.

18. 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 very small images. The minimum number of TCP connections required to display the web page completely in your browser is _____.

Ans. 6

Sol. In non-persistent HTTP, each packet takes 2 RTT (Round trip Time): one for TCP connection, one or HTTP Text (Image file As, it is given text and 5 images that totals 6 objects.)

So, it takes 12 RTT in total. But,

12 RTT includes 6 HTTP connections + 6TCP connections.

So, the minimum number of TCP connections required is 6.

19. Consider the language $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$ 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. III only B. I and III only

C. I only D. II only

Ans. B

Sol. Statement I-- $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$

↓ ↓

Linear power, well know DCFL

∴ it is regular

∴ L = Regular ∪ DCFL {use the closure properties}

L = DCFL

Statement--III As we cannot write LL(k) grammar, for any value of k, Hence statement III is correct.

20. Which one of the following regular expressions represents the set of all binary strings with an odd number of 1's?

A. 10*(0*10*10*)*

B. (0*10*10*)*10*

C. (0*10*10*)*0*1

D. ((0 + 1)*1(0 + 1)*1)*10*

Ans. MTA

Sol. Regular expression in option A cannot generate 001

Regular expression in option B cannot generate 100

Regular expression in option C cannot generate 001

Regular expression in option D cannot generate 001

Hence, mark was given to everyone in GATE for this question.

21. Consider a double hashing scheme in which the primary hash function $h_1(k) = k \bmod 23$, and the secondary hash function is $h_2(k) = 1 + (k \bmod 19)$ Assume that the table size is 23. Then the address returned by probe 1 in the probe sequence (assume that the probe sequence begins at probe 0) for key value k =90 is _____.

Ans. (13)

Sol. Given Hash Function ⇒ $h_1(k) = k \bmod 23$

$h_2(k) = 1 + (k \bmod 19)$

Table size = 23

Key = 90

h1 (k) = 90 mod 23 ≡ 21

h2 (k) = 1 + 90 mod 19 ≡ 1 + 14 = 15

Double hashing, (h1 (k) + i.h2(k)) mod 23

Asked for probe 1, put i = 1

(21 + 1. (15) mod 23

36 mod 23 = 13

22. Consider the functions

I. e^{-x}

II. $x^2 - \sin x$

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

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

A. II and III only B. I and III only

C. II only D. III only

Ans. D

Sol. (i) e^{-x} is decreasing

(ii) $f(x) = x^2 - \sin x$

$f'(x) = 2x - \cos x$

Now check $f'(x)$ at $[0, 1]$

$f'(0) = -1$

$f'(1) = 2 - \cos 1 = 1.4596$

$\therefore$ f(x) is not increasing everywhere

(iii) $f(x) = \sqrt{x^3 + 1}$

$$f'(1) = \frac{1}{2\sqrt{x^3+1}} \times 3x^2$$

$f'(x) \geq 0$ for all x.

$\therefore$ f(x) is an increasing function.

23. 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. $\Theta(n^2)$ B. $\Theta(1)$

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

Ans. A

Sol. Here we have to do insertion to the linked list one element at a time, the only way to ensure sorted order for the linked list is to follow insertion sort mechanism. This will take $\Theta(n^2)$ time in the worst case.

24. The preorder traversal of a binary search tree is 15, 10, 12, 11, 20, 18, 16, 19. Which one of the following is the post order traversal of the tree?

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

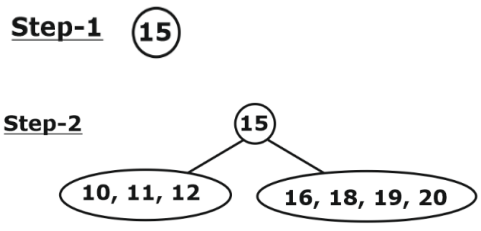
B. 20, 19, 18, 16, 15, 12, 11, 10

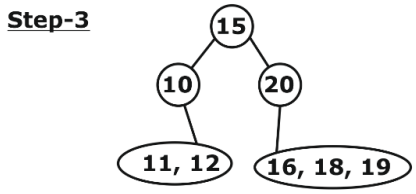
C. 10, 11, 12, 15, 16, 18, 19, 20

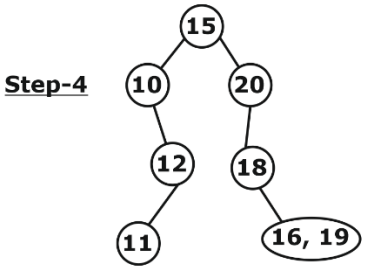
D. 19, 16, 18, 20, 11, 12, 10, 15

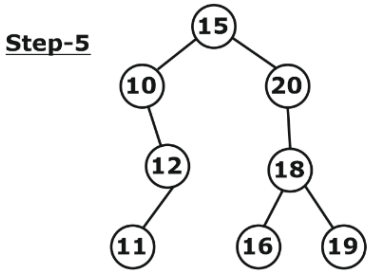
Ans. A

Sol.









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

25. 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 the 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 IV only

C. I and III only D. I and II only

Ans. C

Sol. **Statement 1:** True, Daisy chaining assign non-uniform priorities in attending interrupts.

Statement 2: False, A vectored interrupt means, CPU knows the source of the interrupt.

Statement 3: True, polling technique makes CPU to periodically verity states bits and service for need

Statement 4: False: During DMA also, CPU will have master control over the bus. (OR) IOP (I/O processor) and CPU can be mastered but not at the same time.

Hence, I and III are true

26. Which of the following languages are undecidable? Note that $\langle M \rangle$ indicates encoding of the Turing machine M.

$L_1 = \{\langle M \rangle | L(M) = \varnothing\}$

$L_2 = \{\langle M, w, q \rangle | M$ on input w reaches state q in exactly 100 steps$\}$

$L_3 = \{\langle M \rangle | L(M)$ is not recursive$\}$

$L_4 = \{\langle M \rangle | L(M)$ contains at least 21 members$\}$

A. L_2 and L_3 only

B. L_1 and L_3 only

C. L_1, L_3, and L_4 only

D. L_2, L_3, and L_4 only

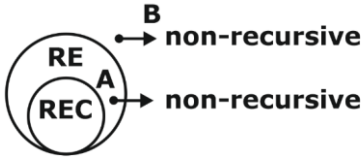
Ans. C

Sol. L_1 $L(m) = \varphi \Rightarrow$ emptiness problem of TM.

TM is undecidable under emptiness.

L_2 = where a TM visits a particular state in finite steps in decidable, as we can do this with UTM.

$L_3 = L(m)$ is non-Recursive,



Clearly from the diagram

L(A) $\Rightarrow$ non recursive language accepted by TM

L(B) $\Rightarrow$ non-recursive language not accepted by TM.

$\therefore$ it is a non-trivial property, hence undecidable.

L_4 = Undecidable problem using rice-theorem.

Hence, L_1, L_3, and L_4 are undecidable.

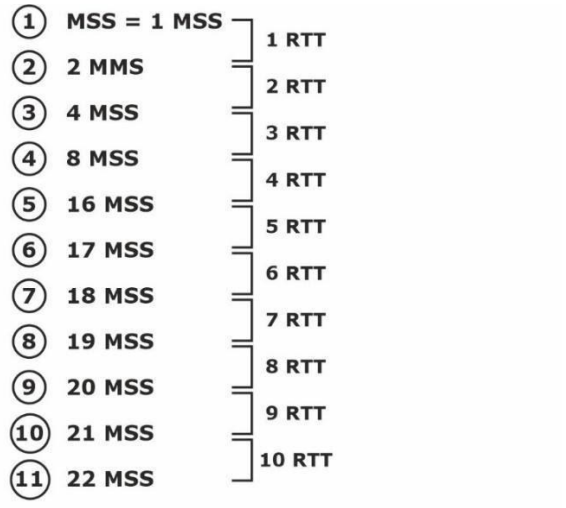
27. Consider a TCP connection between a client and a server with the following specifications: the round trip time is 6 ms, the size of the receiver advert window is 50 KB, slow-start threshold at the client is 32 KB, and the maximum segment size is 2 KB. The connection is established at time t = 0. 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 acknowledgements processed is _____.

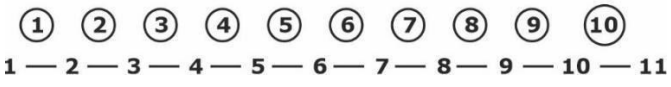
Ans. 44

Sol. TCP connections at t = 0

1MSS = 2KB Threshold = 32KB (slow start)

RTT = 6ms. Then how big packet it (packet size) may deliver after t + 60 ms





1 RTT = 6 ms

$\Rightarrow$ 10 RTT = 60 ms

t + 60 = 0 + 60 = 60 ms

At 60 ms, CWND = 22 MSS

1 MSS = 2KB

$\Rightarrow$ 22 MSS = 22 × 22 = 44 KB

28. 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 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. II and III only B. I and II only

C. III and IV only D. I and IV only

Ans. A

Sol. No. of host = 1500

No. of host bits = $[\log_2 1500] = 11$ bits

$\therefore$ Total possible hosts = $2^{11} = 2^3 \times 2^8$

n is the netmask bits,

Range of addresses is = 2^{32-n}

$$2^{11} = 2^{32-n}$$

Available IP address $\Rightarrow$ 202.61.0.0/17

$$\left.\begin{matrix}0000\ 0000.0000\ 0000\\ 0000\ 0111.1111\ 1111\end{matrix}\right\} 0.0 - 7.255$$

$$\left.\begin{matrix}0000\ 1000.0000\ 0000\\ 0000\ 1111.1111\ 1111\end{matrix}\right\} 8.0 \text{ to } 15.255$$

So the IP address follow the pattern

0.0 to 7.255
8.0 to 15.255
16.0 to 23.255
⋮
64.0 to ...
⋮
104.0 to ...

$\therefore$ The possible IP addresses are 202.61.64.0/21 & 202.61.104.0/21

29. Consider a relational table R that is in 3NF, but not in BCNF. Which one following statements is TRUE?

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

B. R has a nontrivial functional dependency $X \rightarrow A$, where X is not a super key and A is a prime attribute.

C. R has a nontrivial functional dependency $X \rightarrow A$, where X is not a super key and A is a non-prime attribute and X is a proper subset of some key.

D. R has a nontrivial functional dependency $X \rightarrow A$, where X is not a super key and A is a non-prime attribute and X is not a proper subset of any key.

Ans. B

Sol. R has a nontrivial functional dependency $X \rightarrow A$, where X is not a sup and A is a prime attribute.

30. 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 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

D.

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

Ans. D

Sol. $R_2(B)$ is conflicting with $W_1(B)$ so, $W_1(B)$ should always come after $R_2(B)$
$W_2(B)$ is conflicting with $W_1(B)$ similarly, $W_1(B)$ should always come after $W_2(B)$
$R_2(D)$ is conflicting with $W_1(D)$, so, $W_1(D)$ should always come after $R_2(D)$
$R_1(C)$ is conflicting with $W_2(C)$ so, $W_2(C)$ should always come after $R_1(C)$
Therefore the transaction will be:

T1	T2
	R(B)
	W(B)
	R(D)
R(A)	
R(C)	
W(D)	
W(B)	
	W(C)
Commit	
	Commit

31. Consider a database implemented using B+ tree for file indexing and installed a disk drive with block size of 4 KB. The size of the search key is 12 bytes and 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 _____.

Ans. 4

Sol. No. of records = 10^6

Block size = 8 KB

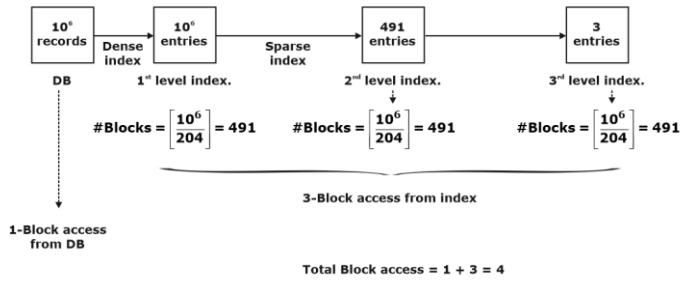
Search key = 13 bytes

Block pointer size = 8 bytes

$$\text{Balancing factor og index file} = \left[\frac{\text{Block size}}{\text{search key} + \text{Blcok pointer}}\right]$$

$$= \left[\frac{4\text{ KB}}{12+8}\right] = \left[\frac{2^{12}}{20}\right]$$

Balancing Factor of index file =204



32. 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) 0×42200000 and 0×C1200000, respectively.

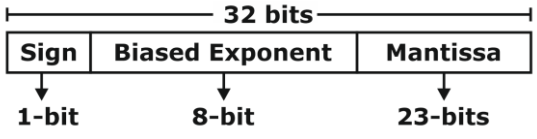
If $R3 = \frac{R1}{R2}$, What is the value stored in R3?

A. 0×83400000 B. 0×C0800000

C. 0×40800000 D. 0×C8500000

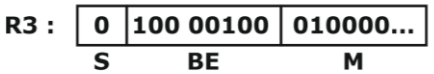
Ans. B

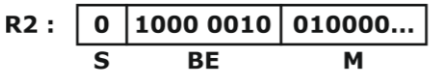
Sol. IEEE-754 single precision floating point format



R1 : 0 × 42200000 ⇒ 01000 0010 0010 0000 0000 0000 …

R1 : 0 × C1200000 ⇒ 1100 0001 0010 0000 0000 …





Need to perform $R3 = \frac{R1}{R2}$

1. Actual exponent = R1 exponent – R2 exponent

$$\begin{array}{r} 1000\ 0100 \\ 1000\ 0010 \\ \hline \text{AE}: 0000\ 0010 \end{array}$$

In IEEE-754, Bias = $\underline{2^{n-1}} - 1 = 2^{8-1} - 1 = 127$

Bias = 01111111

BE = AE + Bias

AE:0000 0010

Bias:0111 1111

BE :1000 0001

2. Divide the Mantissa of R1 by R2.

M_{R1} : 1.0100...

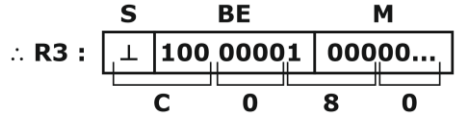
M_{R2} : 1.0100...

: 1.00000

Mantissa of result is all zero

3. Sign of divisor and dividend is opposite,

∴ Result sign = –ve. (1)



∴ R3 = C0800000

33. 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 P_1, P_2, P_3, P_4.

Processes	P_1	P_2	P_3	P_4
Burst time (in ms)	8	7	2	4

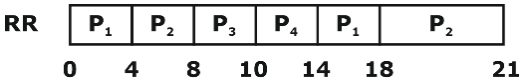
If the time quantum for RR is 4 ms, then the absolute value of the difference between the average turnaround times (in ms) of SJF and RR (round off to 2 decimal places) is ……..

Ans. 5.25

Sol. Average turnaround time

P_1 = 21, P_2 = 13, P_3 = 2, P_4 = 6

$$\text{Avg.} = \frac{21+13+2+6}{4} = \frac{42}{4} = 10.5$$



Average turnaround time

P_1 = 18, P_2 = 21, P_3 = 10, P_4 = 14

$$\text{Avg.} = \frac{18+21+10+14}{4} = \frac{64}{4} = 15.75$$

Difference = 15.75 – 10.5 = 5.25

34. 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
        (fun2 (n–1));
              }
return (i);
}
```

The return value of fun2(5) is _____.

Ans. 55

Sol.

fun2(5)

Step – I: $0 + \text{fun1}(5) = 0 + 5 = 5$ (returns $0 + 5$)

fun2(4)

Step – 2: $5 + \text{fun1}(4) = 5 + (5 + 4) = 14$ (returns $5 + 4$)

fun2(3)

Step – 3: $14 + \text{fun1}(3) = 5 + (5 + 4) + (5 + 4 + 3) = 5 + 9 + 12 = 26$ (returns 12)

fun2(2)

Step – 4: $26 + \text{fun2}(2) = 5 + (5 + 4) + (5 + 4 + 3) + (5 + 4 + 3 + 2) = 5 + 9 + 12 + 14 = 40$ (returns 14)

fun2(1)

Step – 5: $40 + \text{fun2}(1) = 5 + (5 + 4) + (5 + 4 + 3) + (5 + 4 + 3 + 2) + (5 + 4 + 3 + 2 + 1) = 5 + 9 + 12 + 14 = 55$ (returns 15)

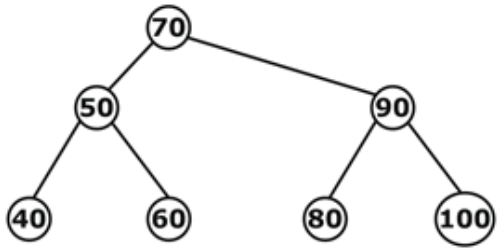
35. In a balanced binary search tree with n elements, what is the worst case time complexity of reporting all elements in range [a, b]? Assume that the number of reported elements is k.

A. $\Theta(\log n + k)$ B. $\Theta(n \log k)$

C. $\Theta(\log n)$ D. $\Theta(k \log n)$

Ans. A

Sol.



To find a number between range [x, y] requires log n comparisons.

As, K numbers are to be found, K + log n would be time complexity.

36. Let A and B be two n × n matrices over real numbers. Let rank(M) and det(M) denote the rank and determinant 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) $\leq$ rank(A) + rank(B)

IV. det(A + B) $\leq$ det(A) + det(B)

Which of the above statements are TRUE?

A. I and IV only B. I and II only

C. III and IV only D. II and III only

Ans. D

Sol. d(AB) = d(A) × d(B)

d(A + B) ≥ d(A) + d(B)

r(A + B) ≤ r(A) + r(B)

r(AB) ≠ r(A) r(B)

37. 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);
}
```

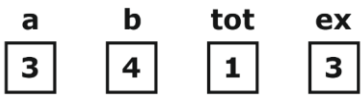
```
int pp(int a, int b) {
    int arr[20];
    int i, tob = 1, ex, 1;
    ex = a;
    len = tob(b, arr);
    for (i=0; i<len; i++) {
        if (arr[i]==1)
            tob = tob * ex;
        ex = ex * ex;
    }
    return (tot)
}
```

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

Ans. 81

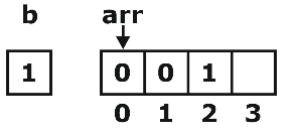
Sol. PP(3, 4) = _____

PP function:



Len = tob(b, arr)

tob functions:



i = 0 4 > 0, (with b = 4)

if (4 % 2) False, so else gets executed

So, arr[0] = 0,

if t b = b/2

i = 1

2 > 0 (with b = 2)

if (2 % 2) false

So, else gets executed ⇒ arr [1] = 0, i = i + t b = b/2

i = 2 1 > 0 (with b = 1)

if (1 % 2) True arr [2] = 1 i + 1, b = b/2

i = 3 0 > 0 (with b = 0) false

return I, returns '3' to len, in PP function.

In PP function: len = 3

For loop.

i = 0 ex = 3 × 3 = 9	i = 1 ex = 9 × 3 = 81	i = 2 tot = t * t * ex = 1 * 81 = 81

38. 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. T is serviced before P.

B. The head reverses its direction of movement between servicing of Q and P

C. R is serviced before P.

D. Q is serviced after S, but before T.

Ans. D

Sol. Given P : 155

Q : 85

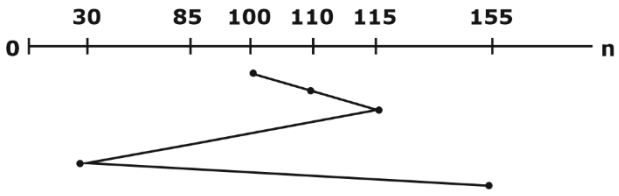
R : 110

S : 30

T : 115

Current head position = 100

SSTF = algorithm



From the above sequence, we can say that option D is correct.

39. 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 regular and L_2 is context-free.

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

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

D. Neither L_1 nor L_2 is context-free.

Ans. A

Sol. L_1: $\{\omega\, xyx \mid \omega, x, y \in (0 + 1)^*\}$

We can write the regular expression for this,

Let, x = 0

$L_{11} = \omega\ 0\ Y\ 0 \Rightarrow (0 + 1)^+\ 0(0 + 1)^+0$

x = 1

$L_{12} = \omega\ 1\ Y\ 1 \Rightarrow$ we can generate all the strings and since a regular expression can be written for 4, we can say 4 is regular.

L_2 is CFL:

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

L_2 generates strings of even length, which can be done by PDA, therefore L_2 is CFL.

40. 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 pipeline processor at 2 GHz. In a given program, assume that 30% are memory instructions, 60% are ALU instructions and the rest are branch instruction. 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-pipeline processor (round off to 2 decimal places) is _____.

Ans. 2.16

Sol. Non-pipeline

Clock frequency = 2.5 GHz.

$$\text{Cycle time} = \frac{1}{2.5\text{GHz}} = 0.4\text{ns}$$

Given, CPI = 5

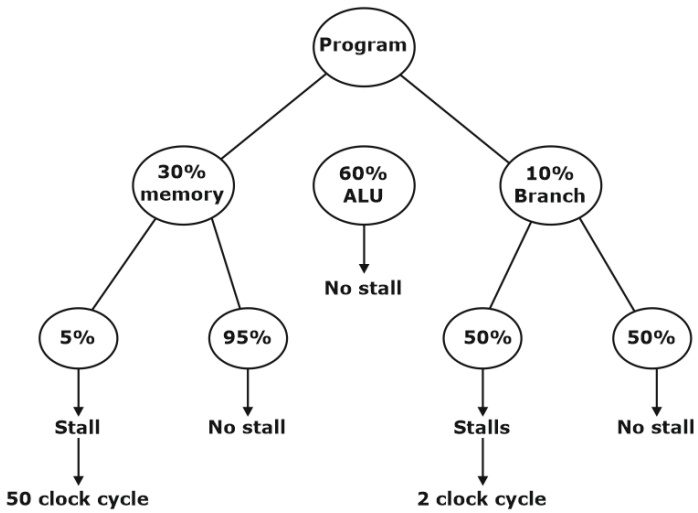
So, $ET_{non\text{-}pipe}$ = CPI × Cycle time

= 5 × 0.4 ns = 2 ns

Pipeline:

Clock frequency = 24 GHz

$$\text{Cycle time} = \frac{1}{2\text{GHz}} = 0.5\text{ ns}$$



∴ Number of stalls/instruction = 0.3 × 0.05 × 50 + 0.1 * 0.5 × 2

= 0.85

Avg. instruction ET_{pipe} = (1 + No. of stall instruction) * cycle time

= (1 + 0.85) × 0.5 ns = 0.925 ns

$$S = \frac{ET_{non-pipe}}{ET_{pipe}} = \frac{2}{0.925} = 2.16$$

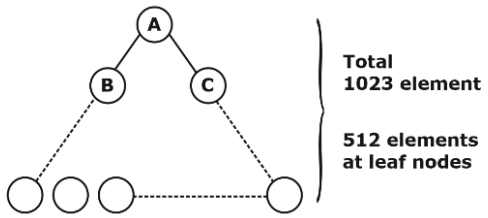
41. Consider the array representation of a binary min-heap containing 1023 element. The minimum number of comparisons required to find the maximum in the heap is _____.

Ans. 511

Sol. Min-heap contains 1023 elements.

Min-heap means, parent should be minimum or equal to it's children so, max children could be either left or right one.

Following this logic, maximum can be definitely at leaf nodes.



$$\text{No. of elements in leaf} = \left\lceil \frac{n}{2} \right\rceil = \left\lceil \frac{1023}{2} \right\rceil = 512$$

To find maximum among 512 elements, no. of comparisons needed is 511.

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

Ans. 0.5

Sol. Let n = 3

$0 \epsilon < 0,1]^3$

$$\text{Let } a = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$$

x = 0 or 1

$\sum_{i=1}^{3} a_i x_i = a_1x_1 + a_2x_2 + a_3x_3$

$= x_1 = x_3$

($\because a_1 = 1, a_2 = 0, a_3 = 1$)

= 0 or 1 or 1 or 2.

$\text{Let } a = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

$\sum_{i=1}^{3} a_i x_i = a_1x_1 + a_2x_2 + a_3x_3$

$= x_3$

($\because a_1 = a_2 = 0$)

= 0 or 1

$\text{Let } a = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$

$\text{again for } a = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, \sum_{i=1}^{3} a_i x_i = 0 \text{ or } 1$

$\text{Let } a = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}$

$\sum_{i=1}^{3} a_i x_i = x_1 + x_2 = 0, 0, 1, \text{or } 2$

$\text{Similarly for } a = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$

$\sum_{i=1}^{3} a_i x_i = 0, 1, 1 \text{ or } 2$

Total number of cases = 2 × 3 + 4 × 3 = 18

Now odd number of cases = 9

$P = \frac{9}{18} = 0.5$

43. Consider a graph G = (V, E), where V = {v_1, v_2, …, v_{100}}, E = {(v_i, v_j)|$1 \le i \le j \le 100$}, and weight of the edge (v_i, v_j) is |i – j|. The weight of the minimum spanning tree of G is _____.

Ans. 99

Sol. If we consider a small graph with 5 vertices, then the minimum spanning tree will have a weight 4.

So, for n-vertices, MST weight would be (n – 1)

As n = 100 (no. of vertices), So, minimum spanning tree weight = (100 – 1) = 99

44. 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. 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 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 _____.

Ans. 154.5

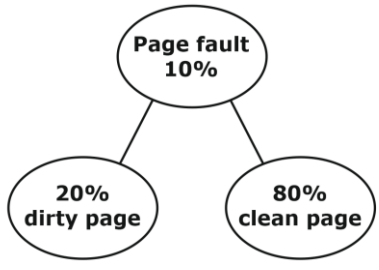
Sol. Main memory access time, T_m = 100 ns

TLB lookup, T_{TLB} = 20ns

Page transfer time, T_{PT} = 5000 ns

TLB hit ratio, x = 0.95 (95%)

page fault rate, p = 0.10 (10%)



We know,

EMAT for multilevel paging,

EMAT = x (T_c + T_m) + (1 – x) (T_c + (n + 1) T_m)

EMAT, when there is a page fault, S → is service time

EMAT = (1 – P) T_m + Ps

Here, we are using TLB, and page fault occurs whenever there is a miss in TLB, So the required EMAT is ,

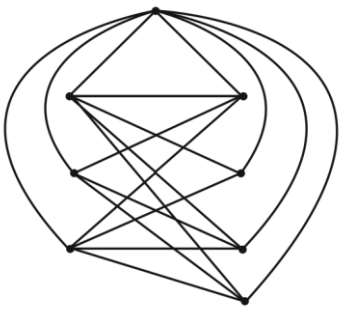
EMAT = x(T_{tlb} + T_m) + (1 – x) [(1 – P) (T_{tlb} + T_m + T_m) + p(% dirty (T_{tlb} + T_m + 2T_{PT}) + % clean (T_{tlb} + T_m + T_{PT})

$\therefore$ EMAT = 0.95 (20 + 100) + 0.05 (0.9 (20 + 100 + 100) + 0.1 (0.2 (20 + 100 + 2(5000)) + 0.8 (20 + 100 + 5000))

= 154.5 ns

45. 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 is G_____ .

Sol. 7



Minimum number = 3 + 4

Of edge-colors required = 7

46. 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) $\in$ V × V is added to G. The worst case time complexity determining if T is still an MST of the resultant graph is

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

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

Ans. D

Sol. G = (V, E) T = MST

Weighted edge (μ, v) is added to T.

To verify it is still a MST or not, we need to compare with all the vertices. So, it would be O(V).

47. 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 at most n–1 processes are in CODE SECTION P at any time.

C. It ensures that no process executes CODE SECTION Q before every process has finished CODE SECTION P.

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

Ans. C

Sol. Subject Operating Systems

a = 1 b = 0 count = 0

Code section P: For process 1

Wait (a) ⇒ a = 0

Count ++ ⇒ count = 1

If (count = = n) ⇒ false

signal (a) ⇒ a = 0

wait (b) process blocked

As shown above, all processes execute wait (b) before, signal (b) in if condition.

Because, 'if' condition becomes True only for process P_n(n^{th} process) [$\because$ if (count = = n)]

So, before Pn process finishes the code section, P, no other process executes code section Q.

Hence, no process executes code section Q before every process has finished code section P.

48. The number of permutations of the characters in LILAC so that no characters appears in its original position, if the two L's are indistinguishable, is _____.

Ans. 12

Sol. LILAC

IAC

3! + LLAC

$3+\frac{4}{2}+3+\frac{4}{2}+\frac{4}{2}$

3 + 2 + 3 + 2 + 2 = 12

49. Consider the production $A \rightarrow PQ$ and $A \rightarrow XY$. Each of the five non-terminal A, P, Q, X, and Y has two attributes: s is a synthesized attribute, and i is an inherited attribute. Consider the following rules.

Rule 1: P.i = A.i + 2, Q.i = P.i + A.i, and A.s = P.s + Q.s

Rule 2: X.i = A.i + Y.s and Y.i = X.s + A.i

Which one of the following is TRUE?

A. Both Rule 1 and Rule 2 are L-attributed.

B. Neither Rule 1 nor Rule 2 is L-attributed.

C. Only Rule 1 is L-attributed.

D. Only Rule 2 is L-attributed.

Ans. C

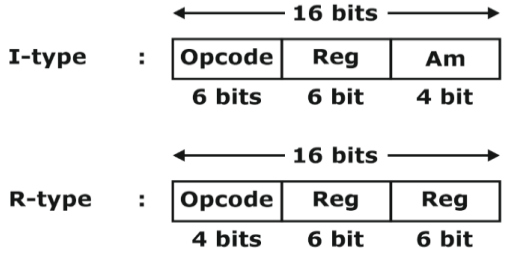
Sol. Rule 1: It is L-attributed as a child is inheriting either from parent or left sibling.

Rule 2: In expression (X.i = A.i + Y. s), child is inheriting from its right sibling, which is not allowed in L-attributed. Hence, Rule 2 is not L-attributed.

50. A processor has 64 registers and uses 16-bit instruction format. It has two type instruction: 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 _____.

Ans. 14

Sol.



⇒ # of instruction possible = 2^4 = 16

∴ No. of free opcodes = 16 – x

Let x is number of R-type instruction existed.

∴ No. of I-type instruction possible = (16 – x) * 2^2

8 = 64 – 4x

4x = 64 – 8 = 56

x = 14

51. 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 represent hexadecimal notation.

A1 = 0×42C8A4, A2 = 0×546888,

A3 = 0×6A289C, A4 = 0×5E4880

Which one of the following is TRUE?

A. A1 and A3 are mapped to the same cache set.

B. A3 and A4 are mapped to the same cache set.

C. A2 and A3 are mapped to the same cache set.

D. A1 and A4 are mapped to different cache sets.

Ans. C

Sol. 1 word = 4 bytes

Main memory = 16 MB

Bytes – Addressable

Cache size = 64 KB

4-way SAM

Block size = 256 bytes

$A_1 = (42C8A4)_{16}$ $A_2 = (546888)_{16}$ $A_3 = (6A289C)_{16}$ $A_4 = (5E4880)_{16}$

Which two map to the same cache set?

TAG	SET	WORD

SAM:

$$\text{Address length} = \frac{\text{Main memory size}}{\text{Byte}} = 16 \times 2^{20}\text{Bytes}$$

$$= 2^{24} \text{ Bytes}$$

$$= 24 \text{ bits.}$$

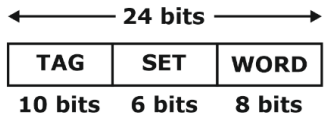
Word ⇒ Block size = 256 bytes ⇒ 8 bits for word

$$\text{No. of sets} = \frac{\text{Total Block}}{\text{Blokes Per set}} = \frac{2^8}{2^2} = 2^6 \text{sets}$$

$$\text{No. of block in cache} = \frac{\text{cache size}}{\text{Blcok size}} = \frac{64\text{KB}}{256\text{B}} = \frac{2^{16}}{2^8} = 2^8$$

So, SET field 6 bits

Remaining bits for TAG = 24 – (8 + 6) = 10 bits

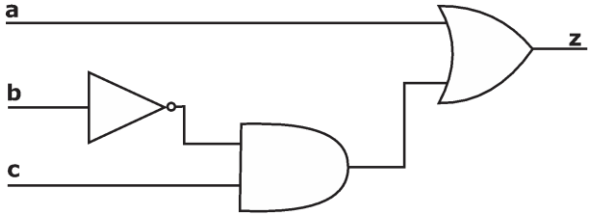


A_1 :	0100 0010 11	00 1000	1010 0100	SET : 8
A_2 :	0101 0100 01	10 1000	1000 1000	SET : 40
A_3 :	0110 1010 01	10 1000	1001 1100	SET : 40
A_4 :	0101 1110 01	00 1000	1000 0000	SET : 8

Hence, A_1 and A_4 maps to same set

A_2 and A_3 maps to same set

52. Consider the Boolean function z(a, b, c).



Which one of the following minterm lists represents the circuit given above?

A. $Z = \sum(2,3,5)$ B. $Z = \sum(2,4,5,6,7)$

C. $Z = \sum(1,4,5,6,7)$ D. $Z = \sum(0,1,3,7)$

Ans. C

Sol. $Z = a + \overline{bc}$

solving it with K-map

$Z = a + \bar{b}c = a$

bc /	00	01	11	10
0	0	1 1	3	2
1	1 4	1 5	1 7	1 6

∴ Minterms will be

= Σm(1, 4, 5, 6, 7)

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

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

A. $\forall x(p(x) \vee W) \equiv \forall x p(x) \vee W$

B. $\forall x(p(x) \rightarrow W) \equiv \forall x p(x) \rightarrow W$

C. $\exists x(p(x) \wedge W) \equiv \exists x p(x) \wedge W$

D. $\exists x(p(x) \rightarrow W) \equiv \forall x p(x) \rightarrow W$

Ans. B

Sol. $\forall \times (P(x) \rightarrow \omega) \equiv \forall x\ p(x) \rightarrow \omega$ is worng

since $\forall \times [(px) \rightarrow \omega] \equiv \forall x[\sim P(x) v \omega]$

$\equiv \forall x[\sim P(x) v \omega]$

$\equiv \sim[\exists \times P(x)] v \omega$

$\equiv \exists \times P(x) \rightarrow \omega$

54. Consider the following language.

$L = \{x \in (a,b)^* |$ 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 _____.

Ans. 6

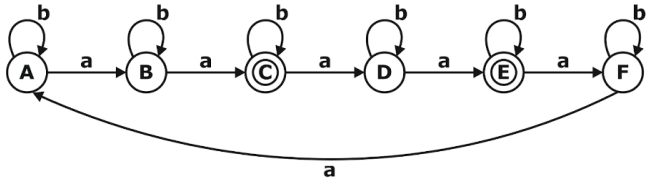
Sol. L = w ϵ (a, b)* $|n_a(w)$ = multiple of 2 but not 3.

$L_1 = \{n_a \bmod 2 = 0\} \Rightarrow$ need 2 states

$L_2 = \{n_a \bmod 3 \neq 0\} \Rightarrow$ need 3 states

$|L_1 \times L_2| = (2 \times 3) = 6$ states.

Minimal DFA design ⇒



∴ No. of states in min. DFA = 6 states.

55. Let G = (V, E) be a directed, weighted graph with weight function w: E → R. For some function f : V → R. for each edge $(u, v) \in E$, define w'(u, v) as w(u, v) + f(u) – f(v).

Which one of the options completes the following sentence so that it is TRUE?

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

A. if and only if f(u) is the distance from s to u in the graph obtained by adding new vertex s to G

and edges of zero weight from s to every vertex of G.

B. for every f: V → R

C. if and only if $\forall u \in V$, f(u) is positive

D. if and only if $\forall u \in V$, f(u) is negative

Ans. B

Sol. For any mapping of vertices to real values, the shortest paths won't change. All intermediate nodes values get canceled on any path you take and what you're left with is only the source and destination node values which would add up to cost on any path. Hence, the shortest paths would still be the same.

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