BYJU'S EXAM PREP

# GATE 2023

## Computer Science & IT Engineering

## Questions & Solutions

**Memory Based**

## GATE 2023 CS & IT Engg. : Major Highlights

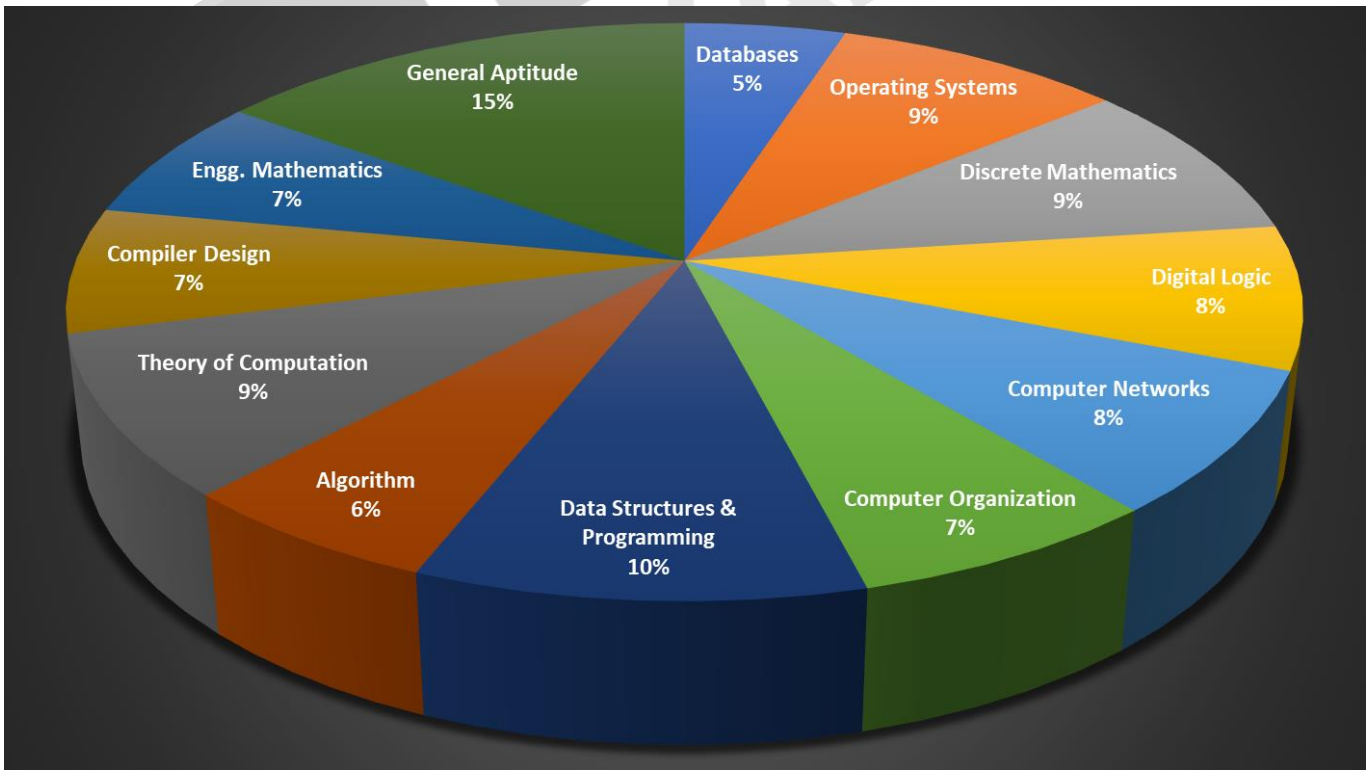
- Questions more difficult from Computer Network (Application Layer)
- Paper was Moderate to Tough
- Few questions were easy
- MCQ : 34Qs, MSQ : 15Qs and NAT 16Qs
- MCQ : 52 Marks, MSQ : 22 Marks and NAT 26 Marks
- More Descriptive questions

## GATE 2023 CS & IT Engg. : Comparison with last Years' Data

| S.No. | Subject Name | 2023 | 2022 | 2021 | |
|---|---|---|---|---|---|
| | | | | Set-1 | Set-2 |
| 1 | **Databases** | **5** | 7 | 8 | 8 |
| 2 | **Operating Systems** | **9** | 10 | 6 | 7 |
| 3 | **Discrete Mathematics** | **9** | 11 | 6 | 6 |
| 4 | **Digital Logic** | **8** | 3 | 6 | 5 |
| 5 | **Computer Networks** | **8** | 10 | 12 | 7 |
| 6 | **Computer Organization** | **7** | 9 | 5 | 8 |
| 7 | **Data Structures & Programming** | **10** | 10 | 8 | 9 |
| 8 | **Algorithm** | **6** | 7 | 13 | 9 |
| 9 | **Theory of Computation** | **9** | 8 | 8 | 11 |
| 10 | **Compiler Design** | **7** | 4 | 7 | 8 |
| 11 | **Engg. Mathematics** | **7** | 6 | 6 | 7 |
| 12 | **General Aptitude** | **5** | 15 | 15 | 15 |
| | **Total** | **100** | **100** | **100** | **100** |

## GATE 2023 CS & IT Engg. : Subject-Wise Marks Distribution

| Subjects | Questions | | Total Marks |
|---|---|---|---|
| | 1 Mark | 2 Marks | |
| Databases | 1 | 2 | 5 |
| Operating Systems | 3 | 3 | 9 |
| Discrete Mathematics | 1 | 4 | 9 |
| Digital Logic | 4 | 2 | 8 |
| Computer Networks | 2 | 3 | 8 |
| Computer Organization | 3 | 2 | 7 |
| Data Structures & Programming | 2 | 4 | 10 |
| Algorithm | 2 | 2 | 6 |
| Theory of Computation | 3 | 3 | 9 |
| Compiler Design | 1 | 3 | 7 |
| Engg. Mathematics | 3 | 2 | 7 |
| General Aptitude | 5 | 5 | 15 |
| Total | 30 | 35 | 100 |



## Section – A (General Aptitude)

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

A. Mostly B. Nearly

C. Utterly D. Near

**[MCQ - 1 Marks]**

**Ans.** B

**Sol.** Nearly is the answer for this question.

**2.** Two function of time (t) $f(t) = 0.01(t)^2$, $g(t) = 4t$ where $0 < t < ¥$

(i) For some $t > 0$, $g(t) > f(t)$

(ii) There exists a T, such that $f(t) > g(t)$.

A. i-true B. ii-true

C. both true D. Both false

**[MCQ – 2 Marks]**

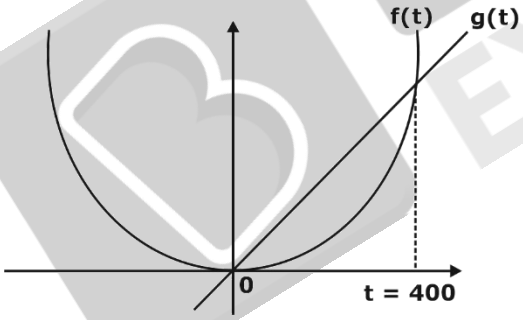
**Ans.** C

**Sol.** $f(t) = 0.01(t)^2$

$g(t) = 4(t)$

Intersection at $0.01(t)^2 = 4(t)$

$\Rightarrow$ $t = 0, 400$




(i) True, because for $0 < t < 400$

$g(t) > f(t)$

(ii) True, because for $t > 400$

$f(t) > g(t)$

**3.** Kind: _____ ; often : frequently.

A. Cruel

B. Mean

C. Type

D. Kindly

**[MCQ - 1 Marks]**

**Ans.** C

**Sol.** Often and frequently are synonym. So, answer be similar to the meaning of the word kind. Kind is an adjective. It has two meanings (i) Nice, (ii) Type. Kindly can be used as adjective also and adverb also. Kind is generally related an individual act. Whereas kindly refers to general character of a person.

**Ex.** The kindly woman helped the poor.

**4.** Given $f_{n+1} = f_n + f_{n-1}$. If $f_6 = 37$, $f_7 = 60$ then find $f_1$.

A. 4 B. 5

C. 8 D. 9

**[MCQ - 1 Marks]**

**Ans.** A

**Sol.** $f_{n+1} = f_n + f_{n-1}$

$f_{n-1} = f_{n+1} - f_n$

$n = 6$ $f_5 = f_7 - f_6 = 60 - 37 = 23$

$n = 5$ $f_4 = f_6 - f_5 = 37 - 23 = 14$

$n = 4$ $f_3 = f_5 - f_4 = 23 - 14 = 9$

$n = 3$ $f_2 = f_3 - f_3 = 14 - 9 = 5$

$n = 2$ $f_1 = f_3 - f_2 = 9 - 5 = 4$

## Section – B (Technical)

**5.** What does arity means?

A. Number of entries in the table

B. Number of samples in the table

C. Number of attribute in the table

D. Number of records in the table

**[MCQ - 1 Mark]**

**Ans.** C

**Sol.** Arity refers to the number of columns in a table.

For example, If a relation has 6 attributes say R(A, B, C, D, E, F) then the arity is 6.

**6.** Total number of tuples returned by below query:

Query: Select * from student where age > 65 and gender = 'F';

**Student Table:**

| Roll No. | Name | Gender | Marks |
|---|---|---|---|
| 1 | A | M | 65 |
| 2 | B | F | 70 |
| 3 | B | F | 80 |
| 4 | C | M | 82 |
| 5 | D | F | 65 |

**[NAT - 2 Marks]**

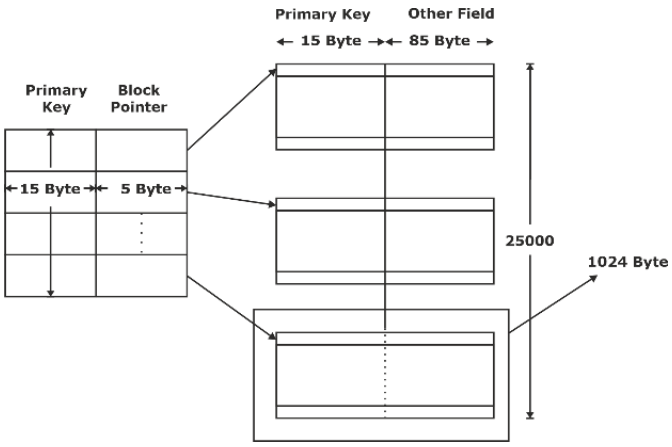
**Ans.** 2

**Sol.** The above query finds the total tuples (records)of female students who are elder than 65 in age.

| Roll No. | Name | Gender | Marks |
|---|---|---|---|
| 1 | A | M | 65 |
| 2 | B | F | 70 |
| 3 | B | F | 80 |
| 4 | C | M | 82 |
| 5 | D | F | 65 |

2 Tuples Selected

**7.** Total number of records are 25000,
Block size is 1024 Byte,
Key size = 15 Byte,
Block pointer Size = 5 Byte,
Total number of blocks required to access for a record using primary index?




**[NAT - 2 Marks]**

**Ans.** 7

**Sol.** Given,

Number of records = 25000

Block size = 1024 Byte

Key size = 15 Byte

Block pointer size = 5 Byte

Record size = 100 Byte

Index entry size = 15 + 5 = 20 Byte

$$\text{Number of records per block} = \left\lfloor \frac{1024}{100} \right\rfloor$$

$$\lfloor 10.24 \rfloor = 10$$

$$\text{Total data blocks required} = \left\lceil \frac{25000}{10} \right\rceil$$

$$= 2500$$

Number of index entries per block

$$= \left\lfloor \frac{1024}{20} \right\rfloor = \lfloor 51.2 \rfloor$$

$$= 51$$

Total index blocks required

$$= \left\lceil \frac{\text{Total data blocks}}{\text{Total index entries}} \right\rceil = \left\lceil \frac{2500}{51} \right\rceil = \lceil 49.01 \rceil$$

$$= 50$$

Total blocks required to access for searching a record using primary key

$$\lceil \log_2 50 \rceil + 1$$

(∴ Records are sequential so binary search is used)

$$= 6 + 1$$

$$= 7$$

**8.** Consider the following statements

$S_1$: Front end of the compiler is independent to hardware.

$S_2$: Back end is specific to target hardware.

$S_3$: Back end is specific to programming language.

A. $S_1$ only B. $S_2$ & $S_3$
C. $S_3$ only D. $S_1$ & $S_2$ only

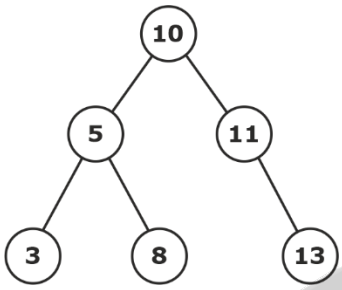
**[MCQ - 1 Marks]**

**Ans.** D

**Sol.** Front end of the compiler means the phases of the compiler completely depends on source language and independent on target machine.

Backend of the compiler means the phases of the compiler completely depends on the target machine and independent on source language.

**9.**




```
typedef struct mode {
int val;
struct node* left, *right;
} node

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

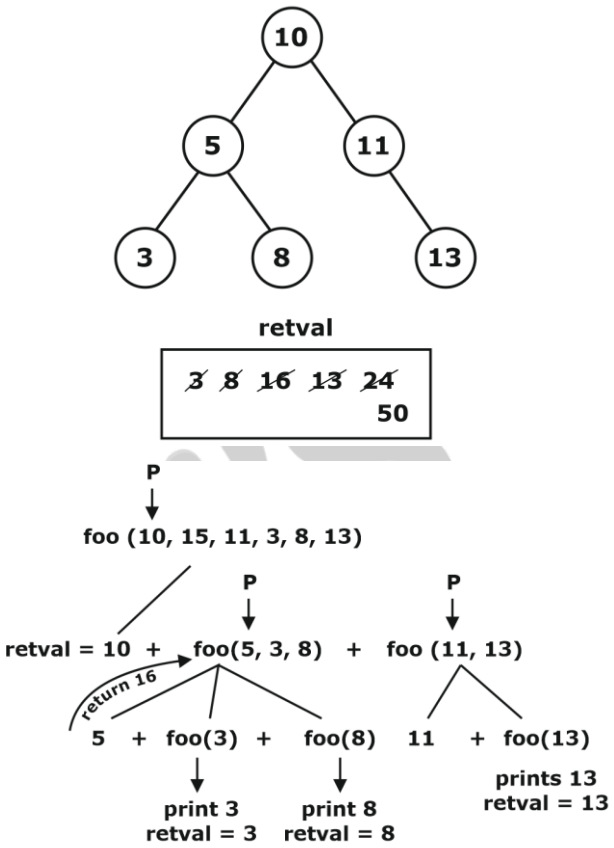
What is the output printed ?

A. 3, 8, 13, 16, 24, 50
B. 3, 8, 16, 13, 24, 50
C. 3, 8, 16, 24, 13, 50
D. 3, 8, 16, 13, 24, 50

**[MCQ - 2 Marks]**

**Ans.** B

**Sol.**




foo(5, 3, 8) prints 16 retval = 16

foo (11, 13) prints 24 retval = 24

finally foo(10, 5, 11, 3, 8, 13) prints 10 + 16 + 24 = 60, retval = 50

**Output:** 3, 8, 16, 13, 24, 50

**10.** Which one of the following sequences when store in an array at locations A[1] to A[10] forms a max-heap?

A. 23, 14, 19, 1, 10, 13, 16, 12, 7, 5
B. 23, 17, 14, 7, 13, 10, 1, 5, 6, 12
C. 23, 17, 10, 6, 13, 14, 1, 5, 9, 12
D. 23, 17, 14, 6, 13, 10, 1, 5, 7, 15

**[MCQ - 1 Mark]**

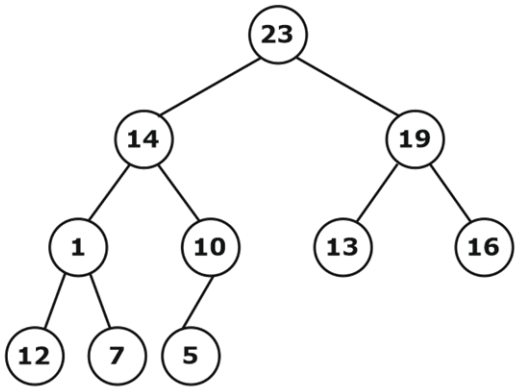
**Ans.** B

**Sol.** A max-heap must satisfy 2 properties

1. **Structuring property:** It must be a complete Binary Tree

2. **Ordering property:** Parent value must be greater than all children values at each level.

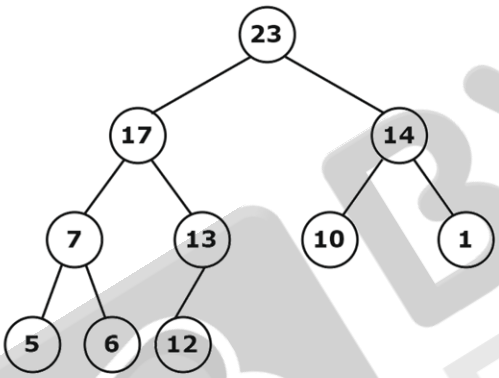
**Option A:**




Parent value 1 < children values 12, 7.

It's not max-heap.

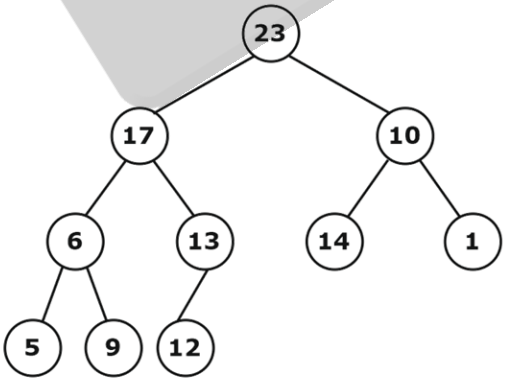
**Option B :**




It satisfy both properties.

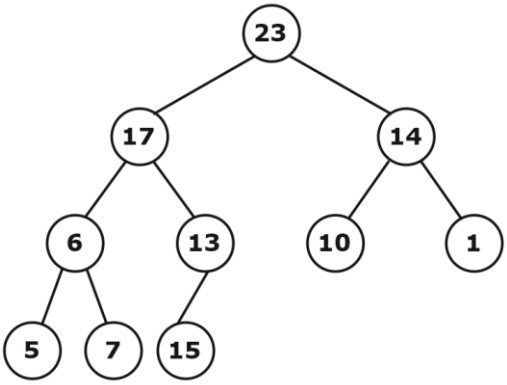
Hence, It is max-heap.

**Option C:**




6 < 9, Hence it is not max-heap.

**Option D:**




6 < 7 and 13 < 15.

Hence it's Not max-heap.

**11.**

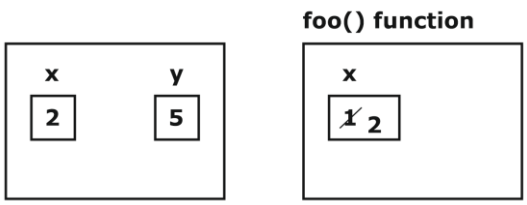
```
int foo ()
{
static int x = 1;
x++;
return (x);
}

main()
{
int x, y
x = foo();
y = foo() + x;
printf (x + y);
}
```

What is the output of above code ?

**[NAT - 2 Marks]**

**Ans.** 7

**Sol.** Program Execution starts from main() function.



x = foo() call foo function, initialise static variable x as 7. then x++ increments 'x' to 2 and return 2. Hence main() function's x = 2

y = foo() + x calls foo function again, Increment x to 3 and return 3.

y = 3 + 2 (main function x value) ⇒ y = 5

print (x + y) prints 7.

Answer is 7

**12.**

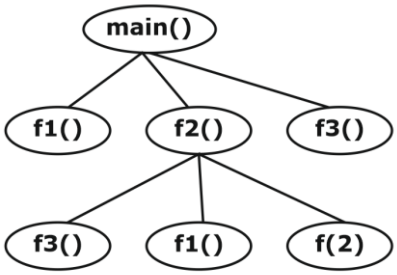
```
int main()
{
f1();
f2(2);
f3();
return 0;
}

int f1(){
x = 1;
return x;
}

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

**Activation tree of the function is _____.**

**[MCQ - 2 Marks]**

**Ans.** *

**Sol.** Activation Tree of given code is :




Activation Tree root must be main() function, as Execution gets initiated from main() function. then all other function calls made in it will be represented as child nodes.

The functions, in which recursion is not happening, they are represented as Leaf nodes.

**13.** Which of the following will guarantee the computer system transition from user modes to kernel modes?

A. Page fault B. Malloc call

C. function call D. System call

**[MSQ - 1 Mark]**

**Ans.** A, D

**Sol.** **a) Page fault :** When a page fault occurs, required page must be loaded from secondary to main memory. means, RAM should be written. It will be done in privileged mode.

**b) Malloc () call:** It may be done in both user and kernel modes. Hence, It cannot guarantee switching.

**c) function call:** As the functions may be user defined, It also does not guarantee mode switching.

**d) System call :** System calls are executed (or) processed in kernel mode only. Hence, It guarantees mode switching.

**14.** Which of the following scheduling policies cause starvation ?

A. FIFO B. SJF

C. Priority D. RR

**[MSQ - 1 Mark]**

**Ans.** B, C

**Sol.** a) In FIFO policy, process may under go waiting but it is due to convoy effect.

b) In SJF, when short jobs keep arriving, then a longer job might need to wait for longer time. Hence, It could cause starvation.

c) Priority policy also may cause low priority processes to wait. So, starvation possible.

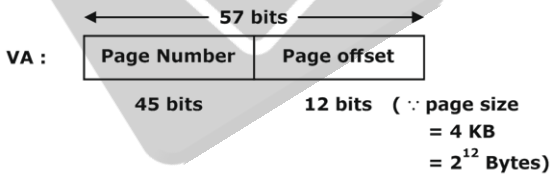
d) In round robin, as CPU time is shared to all processes, no process starve.

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

**[NAT - 2 Marks]**

**Ans.** 5

**Sol.**




- Page table size
  = No. of PTE's * PTE size
  = $2^{45}$ * 8 bytes = $2^{48}$ bytes …(1)
- To store $2^{48}$ bytes page table, No. of pages required = $\frac{2^{48}B}{2^{12}B} = 2^{36}$
  $2^{36}$ pages, page table size
  = $2^{36}$ PTE's * 8 bytes
  = $2^{39}$ bytes …(2)
- To store $2^{39}$ bytes table, page required
  = $\frac{2^{39}\text{bytes}}{2^{12}\text{bytes}} = 2^{27}$
  $2^{27}$ pages, page table size
  = 227 PTE's * 8 bytes
  = 230 bytes …(3)
- $2^{30}$ bytes table is divided into
  $\frac{2^{30}}{2^{12}} = 2^{18}$Pages.
- $2^{18}$ pages, page table size = $2^{18}$ PTE's * 8 bytes = $2^{21}$ bytes …(4)
- $2^{21}$ bytes table is divided into
  $\frac{2^{21}}{2^{12}} = 2^{9}$ pages.
  $2^{9}$ pages, page table size = 29 * 8 bytes = $2^{12}$ bytes …(5)

Hence, It can be stored in one frame of main memory.

So, number of levels of paging, L = 5

**16.** What need to be stored during context switch of threads ($T_1$) to ($T_2$)

A. PC

B. Stack register

C. General purpose register

D. Base address of table

**[MSQ - 1 Mark]**

**Ans.** A,B,C

**Sol.** While switching from one thread to another, program counter value, stack register value and GPR values for local variables are stored in memory. Base address will not stored in memory.

**17.** 8-way set associative cache of bytes, 64 KB (1 KB = 1024 bytes) is used in a system with 32 bit address. the address is sub divided into TAG, INDEX and BLOCK OFFSET. No. of bits in TAG is _____ ?

**[NAT - 1 Mark]**

**Ans.** 19 bits

**Sol.** Cache size = 64 KB = $2^{16}$ bytes

8-way set associative memory contains eight blocks per set.

Let us assume direct mapping is considered then,


Number of bits of TAG is set-associative mapping is more than direct mapping. For $2^n$-way set associative, it is n-bits more. So for 8-way set associative, it is 3-bits more.

Total = 16 + 3 = 19 bits

**18.** 3 Stage pipelined processor having a delay of 10 ns, 20 ns, 14 ns, for the 1st, 2nd and 3rd stages respectively. No other delay and no other hazards. Assume 1 instruction is fetched in every cycle. The total execution time for 100 instruction is _____ ns.

**[NAT - 2 Marks]**

**Ans.** 2040 ns

**Sol.** Each cycle has max(10, 20, 14) ns which is 20 n.s.

Total cycles = (k + n – 1) × 1 cycle

Here K = 3 [Number of stages]

n = Number of instruction

Here n = 100, 1 cycle = 20 ns

Total cycles = (3 + 100 – 1) × 20 ns

= 102 × 20

= 2040 ns

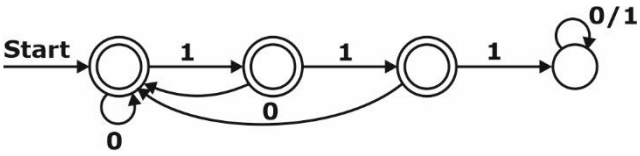
**19.** Minimum number of states in DFA which do not accept 111 sequence.

**[NAT - 2 Marks]**

**Ans.** 4

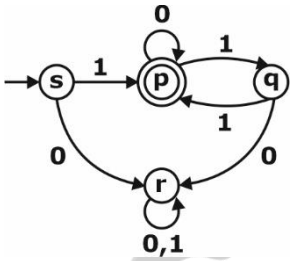
**Sol.** Assume S = {0, 1}

String do not contain 111 sequence,




Total states = 4 maximum

**20.** Consider the DFA below.




A. 1(0*11)*  B. 1(0 + 11)*

C. 0(0 + 1)*  D. 1(110*)*

**[MCQ - 2 Marks]**

**Ans.** B

**Sol.** **Option A:** 1(0*11)*, In this expression strings link "1110" not possible.

**Option C:** It generates strings link, 0, 01, 010, 0110, …., which are not accepted by DFA.

**Option D:** 1(110*)*, Here we don't get strings like 1011 …….

**21.** Which is true?

A. Recursive language ∩ Recursive language = Recursive language

B. Regular ∩ Regular = Regular

C. REL ∩ REL = REL

D. CFL ∩ CFL = CFL

**[MSQ - 1 Mark]**

**Ans.** A, B, C

**Sol.**
- Recursive languages are closed under complementation.
- Regular languages are closed under intersection and every regular is also recursive.
- R.E languages are also closed under complementation.
- CFL's are NOT closed under intersection.

So, A, B and C are true.

**22.** Regular expression: Letter (Letter|Digit)* What will be the NFA?

**[MCQ - 1 Marks]**

**Ans.** ?

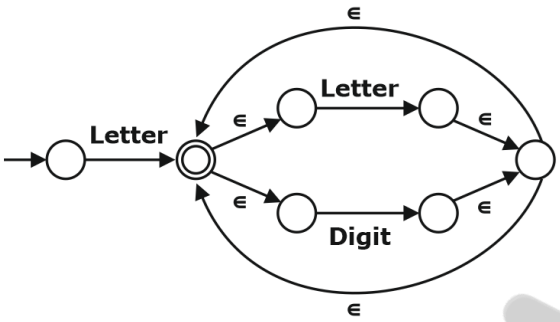
**Sol.** This expression covers all the strings starts with letter and followed by any combinations of letters and digits.

L(L + D)*

L : Letters

D = Digits

**NFA**




**23.** What is the language of grammar?

$$\begin{pmatrix} S \to aSb \mid X \\ X \to aX \mid bX \mid a \mid b \end{pmatrix}$$

**Ans.** ?

**Sol.** $S \to aSb|X$

$X \to aX|Xb|a|b$

Starting from X, we can generate any combination of a's and b's.

$S \to aSb$ gives strings like aSb, aaSbb, …, etc. If S is replaced with X then it generates $\{a^n \times b^n | n \geq 1\}$

$$\underbrace{a^n(a+b)+b^n+(a+b)^+}$$

$$\downarrow$$

It is equivalent to $(a + b)^+$

**24.** The utilization of stop and wait protocol will be low if

A. If link length is high and transmission rate is low

B. If link length is low and transmission rate is low

C. If link length is high and transmission rate is high

D. If link length is low and transmission rate is high

**[MCQ - 1 Marks]**

**Ans.** C

**Sol.**

- If link length is more, then the propagation time will be more, so that there will be more idle time for the sender, which can reduce the utilization as the utilization of stop and wait protocol is as follows.
- If transmission rate is high then the time for transmission is less and hence the sender sits idle after the fast transmission.

$$\text{Utilization} = h = \frac{T_t}{T_t + 2 \times T_p}$$

**25.** Which of the following is false about OSPF

A. It uses Dijkstra algorithm

B. It uses Bellman ford algorithm

C. It is hierarchical protocol

D. Inter domain routing

**[MCQ - 2 Marks]**

**Ans.** B, D

**Sol.**

- Dijkstra algorithm is used to create a shortest path tree.
- Bellmen ford is not used in shortest path identification.
- OSPF supports hierarchical
- OSPF is an intra-domain routing, not inter-domain.

**26.** $F(x) = x^3 + 15x^2 - 33x - 36$

**[MSQ - 1 Mark]**

A. F(x) has local minima

B. F(x) does not have local minima

C. F(x) has local maxima

D. F(x) does not have local maxima

**Ans.** A, C

**Sol.** $F(x) = x^3 + 15x^2 - 33x - 36$

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

$F'(x) = 0 \Rightarrow x^2 + 10x - 11 = 0 \Rightarrow x = 1, -11.$

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

At $x = 1$: $F''(1) = 36 > 0 \Rightarrow$ f has local minimum

At $x = -11$: $F''(-11) = -36 < 0 \Rightarrow$ has local maximum

$\therefore$ So, option A and C are true.

**27.** $\int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1}\left(4x^2y - z^3\right)dzdydx$

**[NAT – 1 Mark]**

**Sol.** $I = \int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1}\left(4x^2y - z^3\right)dzdydx$

$=$

$\int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1} 4x^2y \; dzdydx - \int_{-3}^{3}\int_{-2}^{2}\int_{-1}^{1} 2^3 \; dzdydx$

$\downarrow$ y is odd function; $\downarrow$ odd function

So, integral is 0

So, integral is 0

$= 0 - 0 = 0$

**28.** $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$

A. $|A| = |B|$

B. $|AB| = |A| + |B|$

C. $|B| = -|A|$

D. $|A| = 0$

**[MCQ – 1 Mark]**

**Ans.** C

**Sol.** $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \end{bmatrix}$

Clearly $\boxed{A}$ $R_1 \leftrightarrow R_3$ $\boxed{B}$

By determinant properties, $|A| = -|B|$ and $|B| = -|A|$

**29.** In an experiment, two fair coins are tossed. Let A be the event that denotes HEAD on both throw, B event denotes HEAD on first throw and C event denotes HEAD on second throw. Which of the following is/are true?

A. A and C are independent

B. B and C are independent

C. A and B are independent

D. P(B/C) = P(B)

**[MCQ - 2 Marks]**

**Ans.** B, D

**Sol.** Sample space, $\Omega$ = {HH, HT, TH, TT}

A = HH $p(A) = \frac{1}{4}$

B = H_ = HT or HH $p(B) = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$

C = _H = TH or HH $p(c) = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$

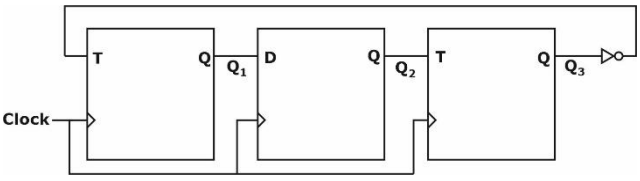
A & B $\Rightarrow$ HH

A & C $\Rightarrow$ HH

B & C $\Rightarrow$ HH

**30.** Consider the sequential circuit

Initially $Q_1, Q_2, Q_3 = 0, 1, 1$




Which state does not occur

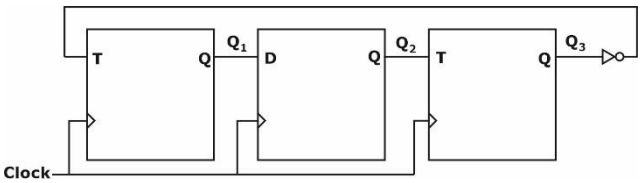
A. 1, 1, 1 B. 1, 0, 0

C. 1, 0, 1 D. 0, 0, 1

**[MCQ - 2 Marks]**

**Ans.** D

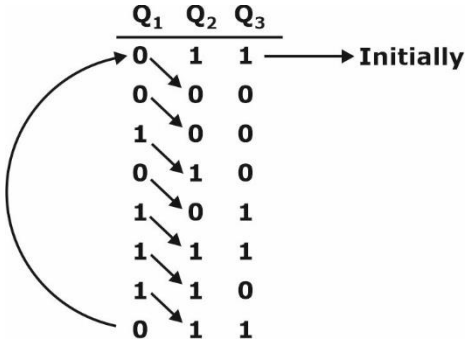
**Sol.** (0,0,1)




Note $Q_2^+ = D = Q_1$

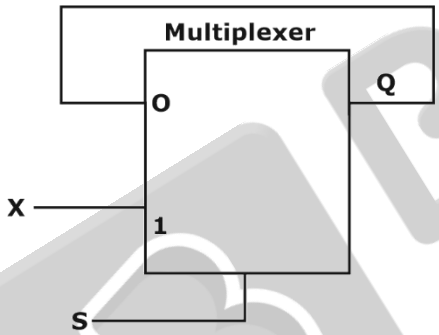
If $Q_3 = 0$ Toggle $Q_1$

If $Q_2 = 1$ Toggle $Q_3$




So, (0, 0, 1) does not occur

**31.** Find the function




A. D flip flop
B. D latch
C. Half adder
D. Demultiplexer

**[MCQ - 1 Marks]**

**Ans.** B

**Sol.** For S = O, $Q^+ = I_0 = Q_2$

For S = 1, $Q^+ = I_1 = X$

Let S = Clock and X = D

So, If clock = 1, $Q^+ = D$

If clock = 0, $Q^+ = Q$

So, it is a level triggered circuit, So it is D latch.

**32.** $(132)_4 = (?)_5$ then find the value in radix 5 _____.

**[NAT - 1 Marks]**

**Ans.** 110

**Sol.** $(132)_4 = (?)_5$

$(132)_4 = (?)_{10} = (?)_5$

$(132)_4 = 1 \times 4^2 + 3 \times 4^1 + 2 \times 4^0$

$= (30)_{10}$

$(30)_{10} = (?)_5$

| | Q | R |
|---|---|---|
| 30 / 5 | 6 | 0 |
| 6 / 5 | 1 | 1 |
| 1 / 5 | 0 | 1 |

Ans: $(110)_5$

**33.** $L_n = L_{n-1} + L_{n-2}$, $L_1 = 1$, $L_2 = 3$

**[MCQ - 1 Mark]**

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

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

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

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

**Ans.** A

**Sol.** $L_n - L_{n-1} - L_{n-2} = 0$

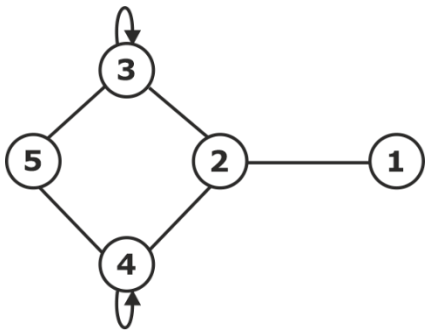
$t^2 - t - 1 = 0$

$t = \frac{1 \pm \sqrt{1+4}}{2} = \frac{1 \pm \sqrt{5}}{2}$ → option C and D are wrong.

Option A: $L_1 = \frac{1+\sqrt{5}}{2} + \frac{1-\sqrt{5}}{2} = 1$

Option B: $L_1 = \frac{1+\sqrt{5}}{2} - \frac{1+\sqrt{5}}{2} = \sqrt{5} \neq 1$

**34.** Consider this graph and it is represented by adjacency matrix. Let $\lambda_1$, $\lambda_2 \ldots \lambda_5$ are eigen values of A. Then $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 =$




**[NAT - 1 Mark]**

**Ans.** 2

**Sol.** Adjacency matrix

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

Sum of eigen value $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 = 2$

**35.** f: A - B is onto define equivalence relation $a_1 \sim a_2 \Leftrightarrow f(a_1) = f(a_2)$. Let E = {[x] x$\epsilon$A} be the set of all equivalence classes. Define a new mapping F[[x]] = f(x). Then

A. F is bijection

B. F is onto

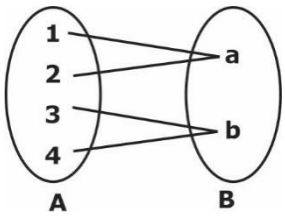
C. F is not well defined

D. F is injective

**[MSQ - 2 marks]**

**Ans.** A, B and D

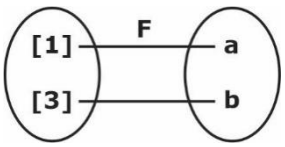
**Sol.** For example, Take A = {1, 2, 3, 4} B = {a, b}




So equivalence

Closer one {[1], [3]}

According, definition of F, F is as below




Clearly F is one-one, onto and hence bijection.

So, options A, B and D are true.

**36.** Let x be a set, $2^x$ = power 2k set of X. Define A binary operation $\Delta$ on $2^x$ as $A\Delta B = (A - B) \cup (B - A)$. Let $H = (2^x, \Delta)$, then

A. H satisfies inverse property but not a group

B. For every A $\epsilon$ $2^x$, inverse of $\bar{A}$ is A

C. For every A $\epsilon$ $2^x$, inverse of A is $\bar{A}$

D. H is a group

**[MSQ - 2 marks]**

**Ans.** B and D

**Sol.** x-set $2^x$ - power set of x

$(2x - \Delta)$ Algebraic structure

1. Identity property

   $\varphi$ is identity element since

   $A\Delta\varphi = A = \varphi\Delta A$

2. Inverse property

   Clearly for each A,

   $A\Delta A = \varphi = A\Delta A$

   So, A is inverse of A

Hence, $(2^x - \Delta)$ is a group

$\therefore$ Option B and D are true

**37.** G is simple finite undirected graph with $\{V_1, V_2, \ldots V_n\}$ N = {1, 2,....n} where $\Delta(G)$ is the minimum degree. Consider the greedy strategy for i = 1, 2……n color (Vi) = min{j $\in$ N/no neighbour of Vi is colored j}

A. Number of colors used is chromatic number

B. Number of colors used is atmost Δ(G) + 1

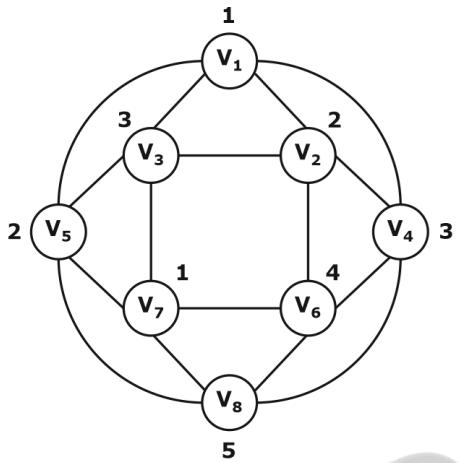
C. Number of colors used is atmost Δ(G)

D. This procedure is result in proper vertex coloring

**[MSQ – 2 Marks]**

**Ans.** B and D

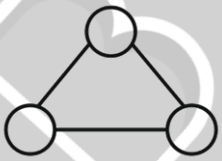
**Sol.**




but 5 not chromatic No

(a) false

(b) No. of colors used 4 max degree – 1 (true)



(c) false

(d) procedure results in proper vertex coloring

⇒ True

(It will not give optimum solution)

**38.** Let f & g is function of natural number f(n) = n and $g(n) = n^2$ then which statement is true

A. $f \in \Omega(g)$ B. $f \in O(g)$

C. $f \in \theta(g)$ D. $f \in o(g)$

**[MCQ – 1 Mark]**

**Ans.** B and D

**Sol.** A. $\Omega(g(n)) = \Omega(n^2)$ set of all functions which are asymptotically $\geq n^2$

B. $O(g(n)) = O(n^2)$ set of all functions which are asymptotically $\leq n^2$

f = O(g(n)) is true

C. $\theta(g(n)) = \theta(n^2)$ set of all functions which are asymptotically $\approx n^2$

D. $o(g(n)) = o(n^2)$ set of all functions which are asymptotically $< n^2$

f = o(g(n)) is true

**39.** Geetha has a conjecture about integers which is of the form $\forall x [P(x) \Rightarrow \exists y Q(x, y)]$, where P is a statement about integers and Q is a statement about pairs of integers. Which of the following (one or more) option would imply Geetha's conjecture.

A. $\exists x[P(x) \wedge \forall y\ Q(x, y)$

B. $\exists x[P(x) \wedge \exists y\ Q(x, y)$

C. $\exists y\ \forall x[P(x) \Rightarrow Q(x, y)$

D. $\forall x\ \forall y\ Q(x, y)$

**[MSQ, 2 Marks]**

**Ans.** C and D

**Sol.** Option C: $\exists y\ \forall x[P(x) \Rightarrow Q(x, y)]$

Use the rule $\exists y\ \forall x\ A(x, y) \Rightarrow \forall x\ \exists y\ A(x, y)$

So, option C implied $\forall x[P(x) \Rightarrow \exists y\ Q(x, y)]$

Option D: $\forall x\ \forall y\ Q(x, y)$

$\forall x\ \forall y\ Q(x, y)$ is true

$\Rightarrow \forall x\ \forall y\ P(x) \Rightarrow Q(x, y)$ is true

$\Rightarrow \forall x\ [P(x) \Rightarrow \exists y\ 2(x, y)]$ is true

**40.** Consider the following Pseudo code.

| Fun. 1 | Fun. 2 |
|---|---|
| While n > 1 do | for i = 1 to 100n do |
| for i = 1 to n | x = x + 1 |
| x = x + 1 | end for |

end for

$n = \left\lfloor \frac{n}{2} \right\rfloor$

end while

A. $f_1 \in O(f_2)$ B. $f_1 \in \theta(f_2)$

C. $f_1 \in \omega(f_2)$ D. $f_1 \in o(f_2)$

**[MSQ – 2 Marks]**

**Ans.** A, B

**Sol.** while (n>1)

for (1 = 1 to $\overset{\downarrow}{n}$)

x = x + 1

end for

$n = \left\lfloor \frac{n}{2} \right\rfloor$

and while Let $\frac{n}{2^k} = 1$

$f1 \quad n + \frac{n}{2} + \frac{n}{2^2} + \ldots + \frac{n}{2^k} - 1$

$= n\left(1 + \frac{1}{2} + \frac{1}{2^2} + \ldots + \frac{1}{2^{K-1}}\right)$

$= n\frac{\left(1 - \frac{1}{2K}\right)}{1 - \frac{1}{2}} = 2n\left(1 - \frac{1}{n}\right) = 2n - 2$

f1 = O(n)

f2 = O(n)

(A) f1 = 0(f2) true

(B) f2 = Θ(f2) true

(C) f1 = w(f2) false

(D) f1 = 0(f2) false

**41.** A priority queue, implementation using max heap. Extract-max (A) = Extract and delete the max elements, Insert (A, key) - Insert-key in A. Then, [Note: properties of heap should be maintained at end of each operation].

A. O(logn), O(logn)

B. O(1), O(n)

C. O(1), O(logn)

D. O(1), O(1)

**[MCQ – 1 Mark]**

**Ans.** A

**Sol.** Extract-max (A): swap root element with last element and max heapify (root) → O(logn)

Insert (A, key): Insert and Heaping taken → O(logn)

****

## GATE 2023 CS & IT Engg. : Expected Topper's Marks

- 80+/100 Marks Expected for AIR under 10
- 75+/100 Marks Expected for AIR under 100

## GATE 2023 CS Expected Cut-Off

| Category | 2021 | 2022 | Expected 2023 |
|---|---|---|---|
| General | 26.1 | 25 | 25 to 26 |
| OBC | 23.4 | 22.5 | 23 |
| SC/ST | 17.4 | 16.6 | 18 |

# Our Outstanding GATE Results

## 100+ Students under AIR-100 2021

**Rank 02**
Poojasree (EC)

**Rank 03**
Manoj (EC)

**Rank 03**
Munish (ME)

**Rank 06**
Parag (EC)

**Rank 07**
Vatsal (ME)

**Rank 08**
Rahul (CE)

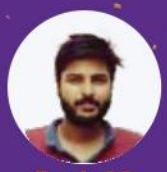
**Rank 08**
Hemant (EE)

**Rank 08**
Rajat (ME)

**Rank 09**
Vamsi (EC)

**Rank 13**
Shashwat (CE)

## 50+ Students under AIR-100 2020



**Rank 06**
Ghanendra (EC)

**Rank 09**
Avinash (ME)

**Rank 09**
Himanshu (EE)

**Rank 26**
Kartikay (CE)

**Rank 30**
Raja (EC)

**Rank 39**
Akash Singh (CS)

**Rank 39**
Navneet (CS)

**Rank 54**
Rishi (EE)

**Rank 56**
Apurv Mittal (ME)

**Rank 56**
Nikhil (ME)

# Our Success Stories

## Our Outstanding GATE Results

**80+**
Students under
AIR-100
**2022**


**Rank 01**
Ram (EC)


**Rank 02**
Amit (CE)

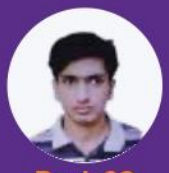

**Rank 02**
Vandit (EE)


**Rank 03**
Parvinder (ME)


**Rank 06**
Abhishek (ME)


**Rank 06**
Vivek (CE)


**Rank 08**
Kiran (CS)


**Rank 09**
Shivam (EC)


**Rank 09**
Tushar (EE)


**Rank 10**
Mitesh (CS)


**Rank 11**
Kaustav (ME)


**Rank 11**
Souvik (ME)


**Rank 12**
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**Rank 15**
Surya (CS)


**Rank 18**
Swastik (CE)


**Rank 20**
Lakshay (ME)


**Rank 21**
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**Rank 22**
Ayush (CE)


**Rank 29**
Piyush (EE)


**Rank 38**
Rajat (EE)