

# **GATE - 2021**

# **Questions Outions**

# COMPUTER SCIENCE & INFORMATION TECHNOLOGY

(Afternoon Session)

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# GATE - 2021

# Computer Science & Information Technology Question with Detailed Solutions

Afternoon Session

# SUBJECTWISE WEIGHTAGE

S. No.	NAME OF THE SUBJECT	Number of Questions
01	Discrete Mathematics	10
02	Theory Computation	7
03	Compiler Design	4
04	Database Management Systems	5
05	Computer Networks	4
06	Operating Systems	4
07	Algorithms	7
08	Data Structures	1
09	Programming Languages	4
10	Digital Logic	3
11	Computer Organization & Architecture	6
12	Verbal Ability	6
13	Numerical Ability	4
	Total No. of Questions	65

Engineering Publications	1	GATE_2021_Questions with Solutions
Section : General Aptitude		P > T > S > R > U > Q
<b>01.</b> If $\left(x - \frac{1}{2}\right)^2 - \left(x - \frac{3}{2}\right)^2 = x + 2$ , then the value of x i	s:	The number of students that are taller than R is the same as the number of students shorter than S
(a) 6 (b) 2 (c) 8 (d) 4 <b>01.</b> Ans: (d)	0	04. The number of students in three classes is in the ratio 3:13:6. If 18 students are added to each class,
Sol: $(a-b)^2 = a^2 + b^2 - 2ab$ = $\left[x^2 + \left(\frac{1}{2}\right)^2 - 2(x)\left(\frac{1}{2}\right)\right] - \left[x^2 + \frac{9}{4} - 2(x)\left(\frac{3}{2}\right)\right]$		the ratio changes to 15:35:21 The total number of students in all the three classes in the beginning was:
$= x^{2} + \frac{1}{4} - x - x^{2} - \frac{9}{4} + 3x$ = -2+2x		(a) 66 (b) 88 (c) 110 (d) 22
$\therefore -2+2x = x+2$ x =4		04. Ans: (b) Sol: The total number of students in three classes in the
02. Pen: write :: Knife : Which one of the following options maintains	a	beginning Let $3a + 13a + 6a = 22a = n$
similar logical relation in the above? (a) Cut (b) Blunt (c) Sharp (d) Vegetables		After addition of 18 student total number of students. 15b + 35b + 21b = 71b
02. Ans: (a) Sol: Pen is to write just as knife is to cut.		3a + 18 + 13a + 18 + 6a + 18 = 22a + 54 22a + 54 = 71b n + 54 = 71b
03. Six students P, Q, R, S, T and U with distinct heigh	ts	n = 71b - 54 = 88 : When $b = 2$ by verification
<ul> <li>os. Six students P, Q, R, S, F and O with distinct neight and make the following observations.</li> <li>Observation I: S is taller than R.</li> <li>Observation II: Q is the shortest of all</li> <li>Observation III: U is taller than only one student</li> </ul>		995
Observation IV: T is taller than S but is not the tallest		
The number of students that are taller than R is the same as the number of students shorter than		A transparent square sheet shown above is folded along the dotted line. The folded sheet will look
<b>03. Ans: (b)</b> <b>Sol:</b> I: S > R II: Q < P, R, S, T, U From III and IV observation		like (a)



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\* Lectures

Engineering Publications	2	Computer Science & Information Technology
(b)		<ul> <li>(a)Listening to music has a clear positive effect on physical exercise Music has a positive effect on learning only in some students.</li> <li>(b) Listening to music has no effect on learning and a positive effect on physical exercise.</li> </ul>
(c)		<ul><li>(c) Listening to music has a clear positive effect on learning in all students Music has a positive effect only in some students who exercise.</li><li>(d) Listening to music has a clear positive effect</li></ul>
(d)		<ul> <li>both on physical exercise and on learning</li> <li>7. Ans: (a)</li> <li>ol: Listening to music improves exercise performance</li> </ul>
05. Ans: (a) Sol:	0	<ul><li>and reduces discomfort. Music as positive effort only on few students during learning.</li><li>8.</li></ul>
06. Gauri said that she can play the keyboard		
	ce 19	A jigsaw puzzle has 2 pieces. One of the pieces is shown above. Which one of the given option for the missing piece when assembled will form
<ul><li>06. Ans: (c)</li><li>Sol: 'As well as' is used in positive degree.</li></ul>		a rectangle? The piece can be moved. rotated of flipped to assemble with the above piece.
07. Listening to music during exercise improve exercise performance and reduces discomform		

Scientists researched whether listening to music

while studying can help students learn better and the results were inconclusive. Students who needed external stimulation for studying fared worse while students who did not need any external stimulation

Which one of the following statements is the

CORRECT inference of the above passage?

benefited from music.

(b)

(c)

Engineering Publications	3	
		Sol: Giver ∴Co Cost ∴In Taxes Let th
08. Ans: (c) Sol:		$\therefore \text{ Ne}$ $296 =$ $296 =$ $x = -\frac{1}{0}$ $\therefore \text{ Sel}$ In ye Total
09. $\begin{bmatrix} 350 \\ 300 \\ 250 \\ 200 \\ 150 \\ 100 \\ 50 \\ 0 \\ Year 1 \\ Year 2 \\ Year 3 \\ SNumber of units \\ \blacksquare Net Profit (₹) \\ \end{bmatrix}$	ERI	Taxes Let th $\therefore 210$ 210 = $\therefore y =$ $\therefore$ Sel $\therefore \frac{x}{y}$

The number of units of a product sold in three different years and the respective net profits are presented in the figure above. The cost/unit in year 3 was Rs.  $\gtrless1$ , which was half the cost/unit in Year 2. The cost /unit in year 3 was one-third of the cost/ unit in Year 1. Taxes were paid on the selling price at 10%, 13% and 15% respectively for the three years. Net profit is calculated as the difference between the selling price and the sum of cost and taxes paid in that year.

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

price in real 5 is	
(a)1:1	(b) 3:4
(c)1:2	(d) 4:3

#### 09. Ans: (d)

15-33

GATE\_2021\_Questions with Solutions

en that cost/unit in year  $3 = \overline{\mathbf{x}} \mathbf{1}$ ost/ unit in year 2 = ₹2/ unit in year 1 = ₹3year 2, total cost =  $200 \times 2 = ₹400$ es paid = 13% of selling price. the selling price in year 2 be 'x' et profit = selling price  $-(\cos t + Taxes)$ = x - (400 + 0.13x) $= 0.87 \mathrm{x} - 400$  $\frac{696}{0.87} = 800$ elling price in year 2 = ₹800ear 3,  $1 \cos t = 300 \times 1 = 300$ es paid = 0.15% of selling price the selling price in year 3 be 'y' 0 = y - (300 + 0.15y)= 0.85 y - 300 $=\frac{510}{0.85}=600$ elling price in year 3 = 600 $=\frac{800}{600}=\frac{4}{3}$ 

10. If  $\theta$  is the angle in degrees, between the longest diagonal of the cube and any of the edges of the cube then  $\cos \theta =$ 

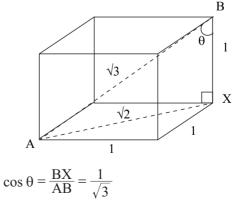
 $(b)\frac{1}{2}$ 

 $(d)\frac{1}{\sqrt{3}}$ 

$$(a) \frac{1}{\sqrt{2}}$$
$$(c) \frac{\sqrt{3}}{2}$$

10. Ans: (d)





Section : Computer Science & Infor- mation Technology	02. Consider the following augmented grammar wi $\{\#, @, <, >, a, b, c\}$ as the set of terminals. $S^1 \rightarrow S$
<ul> <li>D1. Consider the following multi-threaded code segment (in a mix of C and pseudo-code), invoked by two processes P1 and P2, and each of the processes spawns two threads T1 and T2: int x = 0; // global Lock L1: // global main() {     create a thread to execute foo (); // Thread T1 create a thread to execute foo (); // Thread T2 wait for the two threads to finish execution; print (x);} foo() {     int y = 0; Acquire L1; x = x + 1; y = y +1; Release L1; print (y); }</li> <li>Which of the following statement (s) is/are correct?     (a) Both T1 and T2 in both the processes, will print the value of y as 1.     (b) Both P1 and P2 will print the value of x as 2.     (c) At least one of P1 and P2 will print the value of x as 4.</li> </ul>	S $\rightarrow$ S# cS S $\rightarrow$ SS S $\rightarrow$ SS S $\rightarrow$ SS S $\rightarrow$ S S $\rightarrow$ S S $\rightarrow$ A S $\rightarrow$ b S $\rightarrow$ c Let I <sub>0</sub> = CLOSURE ({S' $\rightarrow$ · S} The number of iter in the set GOTO (GOTO (I <sub>0</sub> , <), <) is 02. Ans: 8 Sol: Closure (S <sup>1</sup> $\rightarrow$ .S)= $I_0$ $I_1$ $I_1$ $S^1 \rightarrow .S$ S $\rightarrow .S \# cS$ S $\rightarrow .S \# cS$ S $\rightarrow .S \%$ S
<ul> <li>01. Ans: (a), (b)</li> <li>Sol: 'y' is a local variable; 'x' is a global variable. Incrementing the value of x &amp; y are under lock control. So the final value of both will be 2 resp. but printing of y is done individually by both the threads. Whenever x is printed by after the termination of both.</li> </ul>	03. Consider a computer network using the distant vector routing algorithm in its network layer. The partial topology of the network is as shown below $x = \frac{x}{\sqrt{y}} + \frac{x}$

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Computer Science & Information Technology

ACE Engineering Publications



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\* All Subjects Launching Soon!

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ACE Engineering Publications

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

- (a) The next hop router for a packet from R to P is Y.
- (b) The distance from R to Q will be stored as 7
- (c) The distance from R to P will be stored as 10.
- (d) The next hop router for a packet from R to Q is Z

#### 03. Ans: (a) & (b)

Sol: Here, the path chosen to P would be from Y and distance cost is 8 Since And the path chosen to Q would be from X and

distance is 7

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

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

$$(b)\frac{r}{r+b}$$
$$(c)\frac{r}{r+b+3}$$
$$(d)\frac{r+3}{r+b+3}$$

#### 04. Ans: (b)

**Sol:** Assume that after i\_th iteration, we have r red balls and b black balls.

So, probability of choosing red ball in (i+1)th iteration will be :

= [r/(r+b)]

So, probability of choosing red ball in (i+2)th iteration will be :

(note that, in (i+1)th iteration, we could either pick black or red ball.)

[r/(r+b)][(r+1)/(r+b+1)] + [b/(r+b)][(r)/(r+b+1)]= [r/(r+b)]

So, in the beginning we have r red balls, and b green balls. So, in every iteration, the probability of choosing a red ball will be [r/(r+b)].

05. In an examination a student can choose the order in which two questions (Ques A and Ques B) must be attempted.

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

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

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

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

question	probability of answering correctly	marks
Ques A	0.8	10
Ques B	0.8	20

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

- (a) First QuesB and then QuesA. Expected marks 22.
- (b)First QuesA and then QuesB.Expected marks 16.
- (c)First QuesA and then QuesB. Expected marks 14.
- (d)First QuesB and then QuesA. Expected marks 14.

#### 05. Ans: (b)

- **Sol:** Let M = marks obtained by students
  - Case(i): Student answer and question A followed by question B

Μ	0	10	30
P(M)	0.2	0.8×0.5	0.8×0.5

 $E(M) = 10 \times 0.8 \times 0.5 + 30 \times 0.8 \times 0.5$ 

E(M) = 4 + 12 = 16

Case(ii): student answers question B followed by question A

Μ	0	20	30
P(M)	0.5	0.5×0.2	0.8×0.5
E(M) = 2 +	12 = 14		

- 06. Consider the following statements S1 and S2 about the relational data model:
  - S1: A relation scheme can have at most one foreign key
  - S2: A foreign key in a relation scheme R cannot be used to refer to tuples of R.

Which one of the following chooses is correct?

- (a)Both S1 and S2 are true.
- (b)S1 is false and S2 is true.
- (c)Both S1 and S2 are false
- (d) S1 is true and S2 is false

#### 06. Ans: (c)

- **Sol:** S1: A relation schema can have more than one. Foreign key references to more than one table.
  - S2: A foreign key in a relation schema R can be used to refer to tuples of R.
  - : Both statements S1 and S2 are false.
- 07. What is the worst-case number of arithmetic operations performed by recursive binary search on a sorted array of size n?

(a) 
$$\Theta(\sqrt{n})$$
 (b) $\Theta(n)$   
(c)  $\Theta(\log_2(n))$  (d) $\Theta(n^2)$ 

#### 07. Ans: (c)

- Sol: Time complexity of Binary search on a sorted input of size 'n' is  $\Theta(\log n)$
- 08. Let S be the following schedule of operations of three transactions  $T_1$ ,  $T_2$  and  $T_3$  in a relational database system:  $R_{2}(Y), R_{1}(X), R_{3}(Z), R_{1}(Y), W_{1}(X), R_{2}(Z), W_{2}$  $(Y), R_3(X), W_3(Z)$

Consider the statements P and Q below:

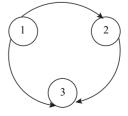
- P: S is conflict-serializable
- Since 1990: If  $T_3$  commits before  $T_1$  finishes, then S is recoverable.

Which one of the following choices is correct?

- (a) Both P and Q are false
- (b) P is false and O is true
- (c) P is true and Q is false
- (d) Both P and Q are true.

#### 08. Ans: (c)

**Sol:**  $\rightarrow$  Precedence graph for the given schedule is



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As the precedence graph do not have cycles then the schedule is said to be C.S.

- $\rightarrow$  Transaction T<sub>3</sub> performing dirty read of T<sub>1</sub> and  $T_3$  should commit after  $T_1$  to make the schedule recoverable.
- 09. For a string w, we define  $w^{R}$  to be the reverse of w. For example, if w = 01101 then  $w^{R} = 10110$ Which of the following languages is /are contextfree?
  - (a)  $\{w \ge x^R w^R \mid w, x \in \{0,1\}^*\}$
  - (b) {w x w<sup>R</sup> | w, x  $\in \{0,1\}^*$ }
  - (c) {w x w<sup>R</sup> x<sup>R</sup> | w, x  $\in$  {0,1}\*}
  - (d) {w  $w^{R} x x^{R} | w, x \in \{0,1\}^{*}$ }

#### 09. Ans: (a), (b) & (d)

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Sol: Option (a) and Option (d) are context tree languages we can build a push down automatic (Non deterministic) to recognize  $l = \{wxx^Rw^R | w, x \in \{0,1\}^*\},\$ also for  $l = \{ww^R xx^R | w, x \in \{0,1\}^*\}$ 

Option (b) is regular language because we can express  $l = \{wxw^R | w, x \in \{0,1\}^*\}$  as  $(0+1)^*$ . For Option (c) we cannot have Push down automata or context free it is context sensitive language.

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

#### emp (empId, name, gender, salary, deptId)

Consider the following SQL query:

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

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

- (a) employees in the department
- (b) female employees in the department
- (c) female employees in the company
- (d) employees in the company

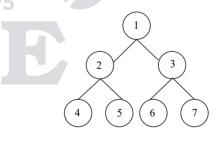
#### 10. Ans: (d)

- Sol: Inner query finds the average salary of all the employee. Therefore the query finds, "for each department in the company, the number of female employees whose salary is greater than the average salary of employees in the company".
- 11. Consider a complete binary tree with 7 nodes. Let A denote the set of first 3 elements obtained by performing Breadth-First search (BFS) starting from the root. Let B denote the set of first 3 elements obtained by performing Depth-First Search (DFS) starting from the root.

The value of |A - B| is

#### 11. Ans: 1

Sol: Let Binary tree be 1995



After BFS from root:  $A = \{1, 2, 3\}$  A = 3After DFS from root:  $B = \{1, 2, 4\}$  B = 4Cardinality of the set |A-B| = 1

	ACE Engineering Publications			8	<b>Computer Science &amp; Information Technology</b>
	followed dur	ring TCP conne	ndshake mechanism ection establishmen and Y be two random	t	value and the record pointer to the corresponding student record. is built and stored on the same disk. Assume that the records of data file and index file
		-	ers chosen by P and		are not split across disk blocks. The number of
			ds a TCP connection		blocks in the index file is
	~ .		TCP segment having		
	-	- ·	= X and ACK bi	-	13. Ans: 698
			connection request		<b>Sol:</b> Size of index record = $12 + 7 = 19$
-	Which one of	f the following c	hoices represents the	e	No. of index records = $1,50,000$
	information p	resent in the TCI	segment header tha	t	
	is sent by Q to (a) SYN bit =		= X+1, ACK bit $=$ 0,		Blocking factor = $\left[\frac{4096}{19}\right]$ = 215 records/block.
		ber = Y, FIN bit =			
	(b) SYN bit =		= Y, ACK bit $=$ 1.	EKI	No. of index blocks = $\left[\frac{1,50,000}{215}\right] = 698$
			= Y, ACK bit =1,		14. Consider the following ANSI C program:
		ber = $X$ , FIN bit			#include <stdio.h></stdio.h>
			= $X+1$ , ACK bit = 0,		#include <stdlib.h></stdlib.h>
		ber = Y, FIN bit =			struct Node{
12.	Ans: (b)				int value;
Sol:					<pre>struct Node * next;};</pre>
	TCP Transpor	rt Connection Establishm	ent		int main () {
T	1				struct Node * boxE, *head, *boxN; int index = 0;
conne	or sends ction request	SYN[X]	Responder receives the		boxE = head = (struct Node *) malloc (sizeof
with io Initiat	d =X		connection request with id = X and generates a connection confirmation with its own id = Y	ce 1	(struct Node $));1995head\rightarrow value = index;$
	mation of the ction with its own		while its own id = 1		for (index = 1; index $\leq$ = 3; index ++) {
id X a	and the responder's o identify the	SYN[Y,X+1]			boxN = (struct Node *) malloc (sizeof(struct
conne					Node)) :
			The Source and		$boxE \rightarrow next = boxN;$
	or sends ACK dentifier Y	ACK[Y+1]	Destination ports plus the sequence number		$boxN \rightarrow value = Index;$
			identify this connection		$boxE = boxN; $ }
					for (index = 0; index $\leq 3$ ; index $++$ )
13.	A data file cor	nsisting of 1, 50,0	000 student-records is	s	printf ("Value at index %d is %d\n", index, head
	stored on a ha	rd disk with bloc	ck size of 4096 bytes		$\rightarrow$ value);
1	The data file is sorted on the primary key <b>RollNo</b> .				head = head $\rightarrow$ next;
	The size of a	record pointer fo	or this disk is 7 bytes	.	printf ("Value at index %d is %d\n", index+1,
	Each student-	-record has a ca	ndidate key attribute	e	head $\rightarrow$ value); }}
	called ANum	of size 12 byte	s. Suppose an index	ĸ	Which one of the statements below is correct about
	file with reco	ords consisting o	f two fields. ANum	1	the program?
		8 -		1	





# **ACE SCHOLARSHIP TEST**

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LAST DATE FOR ONLINE REGISTRATION 5<sup>th</sup> MARCH 2021



Exam Date : **7<sup>th</sup> March 2021** Timing: **11:00 AM** 

No. of Questions: 50 25 Q: 1 Mark | 25 Q: 2 Mark Total : 75 Marks Duration : 90 Mins. Streams: EC | EE | ME | CE | CSIT | IN | PI





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Engineering Publications	9	GATE_2021_Questions with Solutions
<ul> <li>(a) It dereferences an uninitialized pointer that may result in a run-time error</li> <li>(b) It has a missing return which will be reported as an error by the compiler.</li> <li>(c) Upon execution, the program creates a linked-list of five nodes.</li> <li>(d) Upon execution, the program goes into an</li> </ul>		3) index =2 Head points to 2 Print (Indexhead→value)//2,2 head=head→next head points to 3 print(index+1, head→value)//3,3 4)
infinite loop. 14. Ans: (a) Sol: Linked list: $0 \ 1 \rightarrow 2 \rightarrow 3 \rightarrow$ Note that the next link of node with value 3 is not initialised in the second for-loop, /* for (index=0; index<=3; index++){ printf("%d %d\n", index, head $\rightarrow$ value); head = head $\rightarrow$ next; printf("%d %d\n", index+1, head $\rightarrow$ value); }		<pre>index=3 head points to 3 print (Index, head→value)//3,4 head=head→next #EXCEPTION print(index+1,headvalue) 15. Consider the following directed graph</pre>
<pre>/*/ Iterations: 1) index= <math>\theta</math> head points to <math>\theta</math> print(Index, head<math>\rightarrow</math>value)//<math>\theta</math>, <math>\theta</math> head = head<math>\rightarrow</math>next head points to 1 print (index+1, head<math>\rightarrow</math>value)//1,1 2) index = 1 head pionts to 1 print (Index, head<math>\rightarrow</math>value)//1,1 head=head<math>\rightarrow</math>next head points to 2 print(index+1, head<math>\rightarrow</math>valur)//2,2</pre>	:e 1	<ul> <li>Which of the following is/are correct about the graph?</li> <li>(a) The graph does not have a strongly connected component.</li> <li>(b) A depth-first traversal starting at vertex S classifies three directed edges as back edges.</li> <li>(c) For each pair of vertices u and v, there is a directed path from u to v.</li> <li>(d) The graph does not have a topological order.</li> </ul>

**Computer Science & Information Technology** 

# 

#### 15. Ans: (b) & (d)

- **Sol:** Because the graph is directed & when DFS is performed from 's' three back edges will result. Since the graph does not have a source vertex hence Topological order is not possible. Remaining options can be verified to be false.
- 16. In the context of compilers, which of the following is/are NOT an intermediate representation of the source program?
  - (a) Abstract Syntax Tree (AST)
  - (b) Three address code
  - (c) Control Flow Graph (CFG)
  - (d) Symbol table

#### 16. Ans: (c) & (d)

- Sol: Three major categories of intermediate representations called structural, linear and hybrid. DAG and AST are an example of structural intermediate representation. Three address code is an example of linear intermediate representation. Control flow graph is an example hybrid intermediate representation.
- 17. Choose the correct choice(s) regarding the following propositional logic assertions:

$$S:((P \land Q) \rightarrow R) \rightarrow ((P \land Q) \rightarrow (Q \rightarrow R))$$

- (a) S is a tautology
- (b) The antecedent of S is logically equivalent to the consequent of S
- (c) S is a contradiction.
- (d) S is neither a tautology nor a contradiction

#### 17. Ans: (a) & (b)

Sol: The antecedent of S is  $(P \land Q) \rightarrow R$ . Which can be written as P' v Q' + R

The consequent of S is  $(P \land Q) \rightarrow (Q \rightarrow R)$  Which can be written as P' v Q' + Q' + R which is P' v Q' + R

So, antecedent and consequent, both are equivalent.

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

Input sequence: 00100011000011100

Output sequence: 00000001000001100

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

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

(a) 
$$t = s+b$$
  
 $y = sb$   
(b)  $t = b$   
 $y = s\overline{b}$   
(c)  $t = s+b$   
 $y = s\overline{b}$   
(d)  $t = b$   
 $y = sb$ 

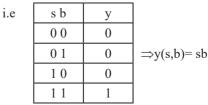
#### 18. Ans: (a)

**Sol:** Next state of the mealy machine depends on the current input and current state.

The machine is initial in state S and current input is b, then next state is t = 1. //Because not specified any condition when it switch to 1.

therefore t(s, t) = s+b

The output y is generated with condition that the first 1 in any sequence of consecutive 1's by a 0. It can be written as



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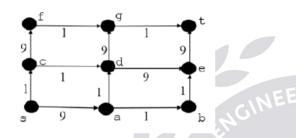
College Goe	rs Batch for (	GATE & ESE - 2022 / 2023	<b>0</b>	lyderabad	
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GATE + P	SUs – 2022	2 & 2023	(	@ VIZAG	
Weekend Batch	Saturday <b>2 pm to 8 pm</b> Sunday <b>9am to 6pm</b>	3 <sup>rd</sup> April 2021	6 to 7 Months	Vizag Classroom	
GATE + PS	Us – 2022 &	2023	@ V	IJAYAWADA	
Weekend Batch	Saturday <b>2 pm to 8 pm</b> Sunday <b>9am to 6pm</b>	3 <sup>rd</sup> April 2021	6 to 7 Months	Vijayawada Classroom	
GATE + PS	Us – 2022		@	TIRUPATI	
Weekend Batch	Saturday <b>2 pm to 8 pm</b> Sunday <b>9am to 6pm</b>	20 <sup>th</sup> March 2021	6 to 7 Months	Tirupati Classroom	
Sce	Rs	RLY BIRD OFFER <b>3,000/- OFF</b> on or before 31 <sup>st</sup> March 2	<del>b</del> 2		

	11	GATE_2021_Questions with Solutions
<ul> <li>19. Let H be a binary min-heap consisting of n elementary implemented as an array. What is the worst case time complexity of an optimal algorithm to find the maximum element in H?</li> <li>(a)Θ(log n) (b)Θ(n log n)</li> <li>(c)Θ(n) (d)Θ(1)</li> <li>19. Ans: (c)</li> </ul>	e	(b) $x' = 0$ 1 = 1 + 4x1 2 = Mux $1 = 3 + 5_0$ f = 1 y = 2 (c) $1 = 0$ 1 = 4x1 y = 2 f = 1 y = 2 f = 1 f =
Sol: Correct Minimum-Heap to Maximum-Heap with Heapify method at complexity of $\Theta(n)$	1	(c) $1 \xrightarrow{1} 4x1$ $2 \text{ Mux}$ $x' \xrightarrow{3} s_1 s_0$ $\uparrow \uparrow \uparrow$ $y z$ $1 \xrightarrow{0}$
20. If x and y are two decimal digits and $(0.1101)_2 = (0.8xy5)_{10}$ , the decimal value of x+y is		$\begin{pmatrix} d \\ 1 \\ x' \\ x' \\ x' \\ x' \\ y' \\ y' \\ z \\ \end{pmatrix} \xrightarrow{f} f$
20. Ans: 3		2
<b>Sol:</b> Given $[0.1101]_2 = [0.8xy5]_{10}$		21. Ans: (c)
Now convert $[0.1101]_2$ into decimal	S	<b>Sol:</b> Given $f(x,y,z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6$
$\begin{bmatrix} 0. & 1^{2^{-1}} & 1^{2^{-2}} & 0^{2^{-3}} & 1^{2^{-4}} \end{bmatrix}_2$		$f(x,y,z) = \Sigma m(0,1,3,4,5,6)$ verify using options
$1 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4}$		Option (a)
$\frac{1}{2} + \frac{1}{4} + 0 + \frac{1}{16}$		$f = (x)\overline{y}\overline{z} + (1)\overline{y}z + (\overline{x})\overline{y}\overline{z} + (1)\overline{y}z$
$0.5+0.25+0+0.0625 = [0.8125]_{10}$		$= x\overline{y}\overline{z} + (\overline{x} + x)\overline{y}z + (\overline{x} + x)yz$
$[0.8125]_{10} = [0.8xy5]_{10}$		$xy \overline{z} + \overline{x} \overline{y} \overline{z} + \overline{x} \overline{z} +$
$[0.8125]_{10} = [0.8xy5]_{10}$ Here x= 1 & y = 2	ce ry	100  0  0  1  0  1  0  1  1  1
hence $x+y=1+2=3$		$m_4 + m_1 + m_2 + m_3 + m_7$
		$= \Sigma m [1, 2, 3, 4, 5, 7]$
21. Which one of the following circuits implements the		So option (a) is wrong
Boolean function given below?		Option (b) verification
$f(x,y,z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6$ where m	i.	$f = (\overline{x}) \overline{y} \overline{z} + (1) \overline{y} z + xy\overline{z} + (1) y z$
is the i <sup>th</sup> minterm.		$f = \Sigma m [0, 1, 3, 5, 6, 7]$ so option (b) also wrong
		Option (c)
(a) $\begin{array}{c} x \\ 1 \\ \end{array} \begin{array}{c} 0 \\ 1 \\ \end{array} \begin{array}{c} 4x1 \\ x \\ 1 \end{array}$		$f = (1) \overline{y} \overline{z} + (1) \overline{y} z + xy\overline{z} + \overline{x} y z$
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		$= (\overline{x} + x) \overline{y} \overline{z} + (\overline{x} + x) \overline{y} z + xy\overline{z} + \overline{x} y z$
$1 - 3 s_1 s_0$		$= \overline{x} \overline{y} \overline{z} + x \overline{y} \overline{z} + \overline{x} \overline{y} z + x \overline{y} z + x \overline{y} z + x y \overline{z} + \overline{x} y z$
y z		$0 \ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 0$
		$m_0^+$ $m_4^+$ $m_1^+$ $m_5^+$ $m_6^+$ $m_3$
		$f = \Sigma m [0, 1, 3, 4, 5, 6]$ hence option (c) is correct

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



The sum of the quality-scores of all the vertices in the graph shown above is \_\_\_\_\_

#### 22. Ans: 929

**Sol:** This is simple question. Since it is directed acyclic graph and all the edge weights of all the edges are either 1 or 9, we can find quality-scores of each vertex as follows :

If we have incoming edge to vertex X from from Y,Z then quality score of X will be : Since

QS(X) = Max (QS(Y)\*W(YX), QS(Z)\*W(ZX))Where W(PQ) is weight of edge from P to Q.

So, using this, quality scores of the vertices are as follows :

QS(S) = 1 (Given) QS(C) = 1; QS(A) = 9 QS(D) = 9; QS(B) = 9; QS(E) = 9\*9 = 81 QS(F) = 9; QS(G) = 81; QS(T) = 81\*9 = 729Total is 929.

23. For a statement S in a program, in the context of liveness analysis, the following sets are defined.USE (S): the set of variables used in S IN (S): the set of variables that are live at the entry

of S

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

Consider a basic block that consists of two statements  $S_1$  followed by  $S_2$ .

Which one of the following statements is correct?

(a) OUT  $(S_1) = IN (S_1) \cup USE (S_1)$ 

(b) OUT  $(S_1) = IN (S_2)$ 

(c) OUT 
$$(S_1) = USE (S_1) \cup IN (S_2)$$

(d) OUT 
$$(S_1) = IN (S_2) \cup OUT (S_2)$$

#### 23. Ans: (b)

Sol: The set of variables that are live at the exit of

- S1 = the set of variables that are live at the entry of 'S'; where 'S' is all Successors for S1.
- 24. Consider a pipelined processor with 5 stages, instruction Fetch (IF) Instruction Decode (ID), Execute (EX) Memory Access (MEM), and Write Back (WB), Each stage of the pipeline, except the Ex stage, takes one cycle. Assume that the ID stage merely decodes the instruction and the register read is performed in the Ex stage. The Ex stage takes one cycle for ADD instruction and two cycles for MUL instruction. Ignore pipeline register latencies.

Consider the following sequence of 8 instructions: ADD, MUL, ADD, MUL, ADD, MUL, ADD, MUL Assume that every MUL instruction is datadependent on the ADD instruction just before it and every ADD instruction (except the first ADD) is data-dependent on the MUL instruction just before it. The speedup is defined as follows.

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

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

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	Engineering Publications	13		GATE_2021_Questions with Solution
24.	Ans: 1.87		26.	Ans: (a)
Sol:	Without operand forwarding, execution time $= 30$	)   ;	Sol:	Integer X; is not matching the syntax of 'C'
	cycles.			program.
	With operand forwarding, execution time = $16$	5		
	cycles.		27.	Consider a computer system with DMA support
	So, answer 1.87.			The DMA module is transferring one 8-bit charact in one CPU cycle from a device to memory through
5	Let G be a connected undirected weighted graph			cycle stealing at regular intervals. Consider
	Consider the following two statements.	•		2 MHz processor. If 0.5% processor cycles a
	consider the following two statements.			used for DMA the data transfer rate of the devi
	$S_1$ : There exists a minimum weight edge in $C$			is bits per second.
	which is present in every minimum spanning	5	27	Ans: 80000
	tree of G	: KU /		
	S <sub>2</sub> : If every edge in G has distinct weight, then C has a unique minimum spanning tree.	ř	501:	Type of Data transfer is cycle steal i.e. one 8 characters / one request
	has a unique minimum spanning tree.			$f = 2MHz;$ $T = 0.5\mu$ sec
	Which one of the following options is correct?			$\therefore$ Clock cycle time= 0.5 µsec
	(a)Both S <sub>1</sub> and S <sub>2</sub> are true			Hence DMA transfers 8 bits in 0.5 µsec
	(b) $S_1$ is true and $S_2$ is false			
	(c) $S_1$ is false and $S_2$ is true			i.e 16 bits in 1 µsec
	(d) Both $S_1$ and $S_2$ are false.			i.e. in one second, it can transfer 160.000
25.	Ans: (c)			bits, but only 0.5% processor clocks are us
	$S_2$ : is by Basic property of graph with distinct edge		_	for DMA transfer, Hence the Data transfer ra
	weights.			$= 16000000 \times \frac{0.5}{10000000}$
	$S_1$ : It may not be possible for a least cost edge to be	e 1	99	$= 16000000 \times \frac{0.5}{100}$ = 80000 bits/ sec
	present in MCST since it may from a cycle.			= 80000 bits/ sec
06	Consider the following ANSI C program			
26.	Consider the following ANSI C program			
	int main () {			
	Integer x;			
	return 0;			
	}			
	Which one of the following phase in a seven-phase			
	C compiler will throw an error?			
	(a) Syntax analyzer			
	(b) Lexical analyzer			
	(c) Semantic analyzer			
	(d) Machine dependent optimizer			

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

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

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

Which of the following statement is correct?

- (a)  $S_1$  is false and  $S_2$  is true
- (b)  $S_1$  is true and  $S_2$  is true
- (c)  $S_1$  is false and  $S_2$  is false
- (d)  $S_1$  true and  $S_2$  is false

#### 28. Ans: (d)

**Sol:** S1 is true and S2 is false.

#### Statement 1 :

Write Through - the information is written to both the block in the cache and to the block in the lowerlevel memory.

#### Advantage:

- read miss never results in writes to main memory
- easy to implement
- main memory always has the most current copy of the data (consistent)

#### **Disadvantage:**

- write is slower
- every write needs a main memory access
- as a result uses more memory bandwidth

Write back - the information is written only to the block in the cache. The modified cache block is written to main memory only when it is replaced. To reduce the frequency of writing back blocks on replacement, a dirty bit is commonly used. This status bit indicates whether the block is dirty (modified while in the cache) or clean (not modified). If it is clean the block is not written on a miss.

#### Advantage:

- writes occur at the speed of the cache memory

- multiple writes within a block require only one write to main memory
- as a result uses less memory bandwidth

#### **Disadvantage:**

- harder to implement
- main memory is not always consistent with cache
- reads that result in replacement may cause writes of dirty blocks to main memory

#### Statement 2 :

There are two common options on a write miss:

Write Allocate - the block is loaded on a write miss, followed by the write-hit action.

No Write Allocate - the block is modified in the main memory and not loaded into the cache.

Although either write-miss policy could be used with write through or write back, write-back caches generally use write allocate (hoping that subsequent writes to that block will be captured by the cache) and

write-through caches often use no-write allocate (since subsequent writes to that block will still have to go to memory).

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

- (a) (0\* (1(1\*0)\*1)\*)\*
- (b) (0+11+11 (1+00)\*00)\*
- (c) (0+1 (01\*0)\*1)\*
- (d) (0+11+10 (1+00)\*01)\*

#### 29. Ans: (a), (c) and (d)

**Sol:** All possible binary strings whose decimal values is divisible by 3 can be listed as follow.

 $l = \{\epsilon, 0, 00, 000, 11, 110, 1001, 1100, \dots\}$ 

We can generate all above strings using option (b) (c) and (d).

Option (b) will generate string 11100 = 57 not divisible by 3 and also it cannot generate string 1001 = 9.

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GENCO / TRANSCO / DISCOMs

Starts from: 22<sup>nd</sup> Feb, 2021

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Starts from: 5<sup>th</sup> April, 2021

**KPSC / KPWD** 

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ACE Engineering Publications

- 30. Consider the following two statements about regular languages:
  - S<sub>1</sub>: Every infinite regular language contains an undecidable language as a subset
  - S<sub>2</sub>: Every finite language is regular
  - Which one of the following choices is correct?
  - (a) Both  $S_1$  and  $S_2$  are true
  - (b) Neither  $S_1$  nor  $S_2$  is true
  - (c) Only  $S_2$  is true
  - (d) Only  $S_1$  is true

#### 30. Ans: (a)

Sol: Cantor's theorem says that If S is any set then  $|S| \le |P(S)|$  where P(S) is power set of S.

From this we can say that if S is countably infinite set then P(S) is uncountable.

We know Every language is countable.

If we have any infinite language L, then it means that we have uncountable many subsets of L But we know that set of RE languages is countable So, due to this we have a subset of L which is Not RE, So, all statements are true.

For regular languages, we can prove statement 1,2 using pumping lemma as well. Using the pumping lemma, we find x,y,z such that  $xy^nz$  is in language L for every n, and then consider the subset

 $S=\{xy^nz \mid n \in A\}$ , where A is your favorite undecidable set of natural numbers. So, S is Not decidable.

Note that from the above given logic and proof, following all statements are correct :

- a. Every infinite regular language L has a subset S which is undecidable.
- b. Every infinite regular language L has a subset S which is unrecognizable.
- c. Every infinite language L has a subset S which is undecidable.
- d. Every infinite language L has a subset S which is unrecognizable.
- e. Every infinite regular language L has a subset S

which is non-regular.

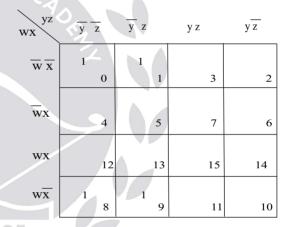
- f. Every infinite regular language L has a subset S which is non-CFL.
- g. Every infinite regular language L has a subset S which is non-CSL.
- 31. Consider a Boolean function f(w, x, y, z) such that
  f(w, 0, 0, z) =1
  f(1, x, 1, z) = x+z

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

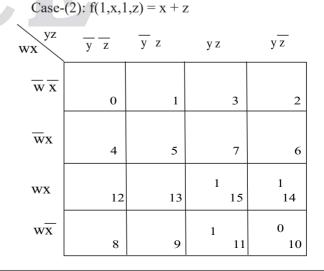
The number of literals in the minimal sum-ofproducts expression of f is

#### 31. Ans: 6

Sol: Case-(1):  $f(w,0,0,z) = 1 \Rightarrow given x = 0, y = 0$ 



x = 0 means  $\overline{x}$  1<sup>st</sup> & 4<sup>th</sup> rows are belongs to  $\overline{x}$  and y = 0 means  $\overline{y}$  1<sup>st</sup> & 2<sup>nd</sup> columns x = 0 & y = 0 common cells are =  $\Sigma m$  [0,1,8,9]...(1)

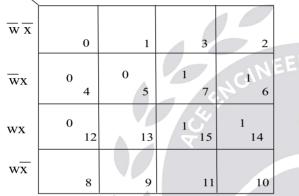




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**Computer Science & Information Technology** 

f(w,x,y,z) = f(1, x, 1, z)given w = 1 & y = 1 w = 1  $\Rightarrow$  3<sup>rd</sup> & 4<sup>th</sup> rows y = 1  $\Rightarrow$  3<sup>rd</sup> & 4<sup>th</sup> columns To get f(1,x,1,z) = x + z minterms should be  $\Sigma m(11,14,15)....(2)$ Case-(3): f(w,1,y,z)= w z + y wx yz yz yz yz yz



 $f(w,1,y,z) \Rightarrow given x = 1$ 

x = 1 are  $2^{nd}$  &  $3^{rd}$  rows

f(w,1,y,z) = wz + y satisfying minterms are

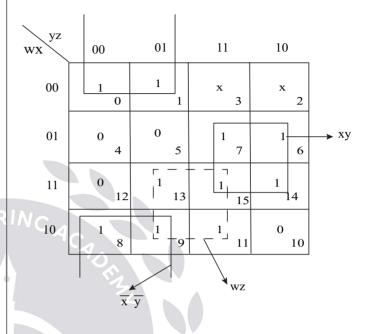
 $\Sigma$ m [6,7,13,14,15] .....(3)

From case(1), case(2) & case(3) about 2<sup>nd</sup>, 3<sup>rd</sup> cells Information not provided hence consider as don't cares

d [2,3] .....(4)

From equation 1, 2, 3 & 4

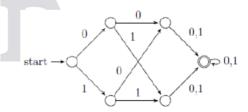
$$f(w,x,y,z) = \Sigma m = [0,1,6,7,8,9,11,13,14,15] + d[2,3]$$



 $f(w,x,y,z) = \overline{x} \overline{y} + xy + wz$ Here number of literals are six.

 $\therefore$  In simplified sop expression, number of literals are Six.

32. Consider the following deterministic finite 199 automaton (DFA)



The number of strings of length 8 accepted by the above automaton is \_\_\_\_\_

#### 32. Ans: 256

**Sol:** The given DFA can accept all strings over {0,1} of length three or more.

i.e., language of the DFA = {0000, 001, 010,.....} it can be written as  $(0 + 1) (0 + 1) (0 + 1) (0 + 1)^*$ 



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As per the given condition in the string length it should be exactly 8.

We can write the expression for length 8 strings as: (0+1)(0+1)(0+1)(0+1)(0+1)(0+1)(0+1)

- $=(0+1)^{8}$
- = All possible combinations
- $= 2^8 = 256.$
- Let L<sub>1</sub> be a regular language and L<sub>2</sub> be a context-fee language. Which of the following language is /are contex-free
  - (a)  $\overline{\overline{L_1} \cup \overline{L_2}}$
  - $(\mathbf{b})(\mathbf{L}_1 \cap \mathbf{L}_2) \cup (\overline{\mathbf{L}_1} \cap \mathbf{L}_2)$
  - (c)  $L_1 \cap \overline{L_2}$
  - (d)  $L_1 \cup \left(L_2 \cup \overline{L_2}\right)$

#### 33. Ans: (a) (b) and (d)

**Sol:** We know that Regular set closed under complementation, but context free language not closed under complementation.

All context tree languages intersected with regular languages. i.e., if  $l_1$  is regular and  $l_2$  is context tree then  $l_1 \cap l_2$  is CFL.

Option (a)  $\overline{\overline{L_1 \cup \overline{L_2}}}$  can be written as  $L_1 \cap L_2$  so it can context free language.

Option (b)  $(L_1 \cap L_2) \cap (\overline{L_1} \cap L_2)$  also context free because  $L_1 \cap L_2$  is CFL,  $\overline{L_1}$  is also regular,

 $\therefore \overline{L}_1 \cap L_2$  is also CFL.

As context free language closed under union the language obtained with  $(L_1 \cap L_2) \cap (\overline{L}_1 \cap L_2)$  is also CFL.

Option (c)  $L_1 \cap \overline{L}_2$  not necessary be CFL because  $\overline{L}_2$  is no need to be CFL.

In Option (d)  $(L_1 \cup \overline{L}_2) = \sum^*$ , it is regular therefore  $L_1 \cap \Sigma^* = \Sigma^*$  it is also regular. Every regular is CFL.

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

#### 34. Ans: 2

Sol: Tye of Map set Associative Map Cache size =  $2KB = 2^{11}Bytes$ Block size  $2^6$  Bytes Cache is Byte Addressable physical Address size= 32 bits Given tag field size = 22 bits the Associativity of cache is

Tag 📿	Set offset	Byte offset
	32 bits	

For direct Map, the no. of bits in Tag field = PA - CA = 32-11=21For 'N' way set Associative map, the Tag size= (PA - CA) +  $\log_2 N$ (PA - CA) +  $\log_2 N = 22$   $\log_2 N = 1$ 100  $\therefore$  N = 2,

35. Consider the following ANSI C program.
# include <stdio. h>
int foo (int x, int y, int q)
{
 If ((x <=0) && (y <=0))</pre>

return q; if (x <=0) return foo (x, y-q, q); if (y <= 0) return foo (x-q, y, q); return foo (x, y-q, q) + foo (x-q, y, q);



Engineering Publications	18         Computer Science & Information Technology
int main ()	36. Ans: (c)
{	Sol: Option (c) is the first case of master theorem
int $r = foo (15, 15, 10);$	Remaining all options are incorrect.
printf ("%d", r);	
return 0;	37. If the numerical value of a 2-byte unsigned integer
}	on a little endian computer is 255 more than that
The output of the program upon execution is	_ on a big endian computer. which of the following
	choices represent (s) the unsigned integer on a little
35. Ans: 60	endian computer?
Sol: Output:60	(a)0x0001 (b) 0x6665
Reason:	(c) $0x0100$ (d) $0x4243$
foo(15,15,10)	
= foo(15,5,10) + foo(5,15,10)	ER 37. Ans: (b) & (c)
= 30+30	<b>Sol:</b> Take 0x6665 :
= 60	He is saying that 0x6665 is the representation of
	integer on a little endian computer, so, it means that
foo(15,15,10)	the original number must have been 0x6566.
=foo(15,-5,10)+foo(5,5,10)	So, for the number 0x6566 :
=30	On little endian(LE) : 0x6665
foo(15,-5,10)	On Big endian(BE) : 0x6566
=foo(5,-5,10)	Clearly, $LE = 255 + BE$
=foo(-5,-5,10)	
=10	Similarly, for 0x0100.
foo(5,5,10)	Take 0x0100 :
=foo(5,-5,10)+foo(-5,5,10) Sin(	ce 199 He is saying that 0x0100 is the representation of
=10+10=20	integer on a little endian computer, so, it means that
	the original number must have been 0x0001.
36. For constants $a \ge 1$ and $b > 1$ , consider the following	
recurrence defined on the non -negative integers	So, for the number 0x0001.
$T(n) = a T\left(\frac{n}{b}\right) + f(n)$	On little endian(LE) : $0x0100$
Which one of the following options is correct about	On Big endian(BE) : 0x0001
the recurrence T(n)?	Clearly, $LE = 255 + BE$
(a) If $f(n)$ is $\frac{n}{\log_2(n)}$ , then $T(n)$ is $\Theta(\log_2(n))$ .	
$\log_2(n)$ , $\log_2(n)$ , $\log_2(n)$ .	38. Suppose that f: $R \rightarrow R$ is a continuous function or
(b) If $f(n)$ is $\Theta(n^{\log_b(a)})$ , then $T(n)$ is $\Theta(n^{\log_b(a)})$	the interval $[-3, 3]$ and a differentiable function
	in the interval $(-3, 3)$ such that for every x in the interval $\beta(x) < 2$ . If $\beta(x) = 7$ then $\beta(2)$ is a
(c) If $f(n)$ is $O(n^{\log_b(a)-\varepsilon})$ for some $\varepsilon > 0$ ,	the interval $f'(x) \le 2$ . If $f(-3) = 7$ then $f(3)$ is a
then $T(n)$ is $\Theta(n^{\log_b(a)})$	most
(d) If $f(n)$ is $n \log_2(n)$ , then $T(n)$ is $\Theta(n \log_2(n))$	
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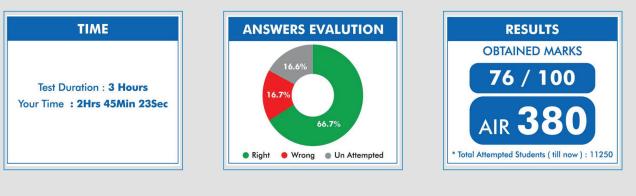
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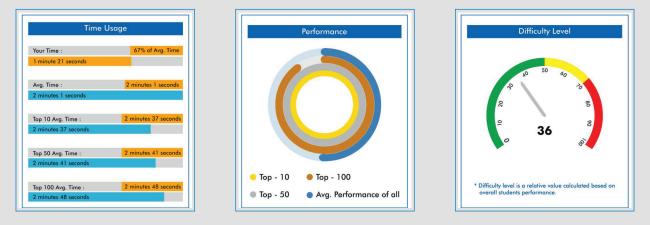
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Engineering Publications	19	GATE_2021_Questions with Solution
8. Ans: 19		orthogonal vectors is zero. Conversely, the only wa
<b>Sol:</b> Given; $f(x)$ is continuous in $[-3,3]$		the dot product can be zero is if the angle betwee
f(x) is differentiable in $[-3,3]$		the two vectors is 90 degrees (or trivially if one of
By mean value theorem, we have		both of the vectors is the zero vector). Thus, tw
$f'(c) = \frac{f(3) - f(-3)}{3 - (-3)}$		non-zero vectors have dot product zero if and onl if they are orthogonal.
- ( - )		Example
$f^{t}(c) = \frac{f(3) - 7}{6}$		<1,-1,3> and $<3,3,0>$ are orthogonal since the doproduct is $1(3) + (-1)(3) + 3(0) = 0$ .
More over $f^{1}(x) \leq 2$		So, The dot product of two vectors is zero whe
$f^{1}(c) \le 2, c \in (-3, 3)$		they are perpendicular/orthogonal, as we are dealin with 10 dimensional vectors the maximum number
$\frac{f(3)-7}{6} \le 2$	RIA	of mutually-perpendicular vectors can be 10. So option D.
$f(3) - 7 \le 12$		
$f(3) \le 19$	4	0. Which of the following statements (s) is/are correct
$\therefore$ f(3) is atmost 19.		in the context of CPU scheduling?
		(a) The goal is to only maximize CPU utilization
		and minimize throughput
		(b)Turnaround time includes waiting time
9. For two n-dimensional real vectors P and Q, the		(c) Implementing preemptive scheduling needs
operation s(P,Q) is defined as follows:		hardware support
$s(P,Q) = \sum_{t=1}^{n} (P[i],Q[i])$		(d) Round-robin policy can be used even when th CPU time required by each of the processes is
Let L be a set of 10-dimensional non-zero real	e 19	oo5 not known apriori knowledge as it is
vectors such that for every pair of distinct vectors		
P,Q $\in$ L, s(P, Q) =0. What is the maximum	4	0. Ans: (b), (c) & (d)
cardinality possible for the set L?	S	<b>Sol:</b> Goals is to maximize CPU utilization, which wi
(a) 100 (b) 11		automatically result in man of throughout.
(c) 9 (d) 10		TAT always is inclusive of W.T.
		Timer can be used for preemption.
). Ans: (d)		R.R does not need apriors knowledge as it is base
<b>l:</b> s(P,Q) represents Dot product of two vectors.		on TQ.
The dot product of $a=<1,3,-2>$ and $b=<-2,4,-1>$ is		
$\vec{a} \vec{b} = 1(-2) + 3(4) + (-2)(-1) = 12$		1. Let S be a set consisting of 10 elements. The number
An important use of the dot product is to test whether		of tuples of the form (A,B) such that A and B and
or not two vectors are orthogonal. Two vectors are		subsets of S, and $A \subseteq B$ is
orthogonal if the angle between them is 90 degrees.		
Thus, using (**) we see that the dot product of two		

ţ,	Engineering Publications	20	<b>Computer Science &amp; Information Technology</b>
41.	Ans: 59049		Let the Addresses of Array Elements:
Sol:	If we make a pair (A,B) such that A has in it then B for we have $2^{(10-k)}$ possible of So answer will be : $2^{10}$ (when A is empty set ) + 10C1 * 2 <sup>9</sup> 1) + 10C2 * 2 <sup>8</sup> (when  A  = 2) + And = (1+2)^{10} = 59049	choices. (when  A  =	$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$
42.	Consider the following ANSI C program #include <stdio.h> int main() { int arr [4] [5] ; int i, j; for (i=0; i&lt;4; i++) { for (j =0; j&lt;5; j++) { arr[i] [j] = 10*i + j ; } printf("%d", *(arr[1])+9)) return 0; } What is the output of the above program (a) 24 (b) 30 (c) 20 (d)</stdio.h>	A AGINEER/A	<ul> <li>a[1]+9=1010+9(2)=1028</li> <li>*(a[1]+9)=*1028=24</li> <li>43. Consider the string abbccddeee. Each letter in the string must be assigned a binary code satisfying the following properties: <ol> <li>For any two letters, the code assigned to one letter must not be a prefix of the code assigned to the other letter.</li> </ol> </li> <li>2. For any two letters of the same frequency, the letter which occurs earlier in the dictionary order is assigned a code whose length is at most the length of the code assigned to the other letter.</li> <li>Among the set of all binary code assignments which satisfy the above two properties, what is the</li> </ul>
	Ans: (a) int a[4] [5]; for (i=0;1<4;i++) { for(j=0;j<5;j++) { a[i] [j]=10*i+j; } printf("%d", *(a[1]+9)) Given Array: 0 1 2 3 4 10 11 12 13 14 20 21 22 23 24 30 31 32 33 34		minimum length of the encoded string? (a) 25 (b) 23 (c) 21 (d) 30 (c) 3 (c) 21 (d) 30 (c) 4 (c) 4

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<ul> <li>44. Consider a computer system with multiple shared resource type, with one instance per resource type. Each instance and be owned by only one process at a time. Owning and freeing of resources are done by holding a global lock (L). The following sheme is used to own a resource instance: function OWN RESOURCE(Resource R) <ul> <li>Acquire lock L // a global lock</li> <li>if R is available then</li> <li>Acquire R</li> <li>Release lock L</li> <li>else</li> <li>if R is owned by another process P then</li> <li>Terminate P, after releasing all resources</li> <li>owned by P.</li> <li>Acquire R</li> <li>Restart P</li> <li>Release lock L</li> <li>end if</li> <li>end if</li> <li>end function</li> </ul> </li> </ul>	<ul> <li>S<sub>1</sub>: Set of all n × n matrices with entries from the set {a,b,c}</li> <li>S<sub>2</sub>: Set of all functions from the set {0,1,2,,n<sup>2</sup> - 1} to the set {0, 1, 2}</li> <li>Which of the following choice(s) is/are correct?</li> <li>(a) There exists a surjection from S<sub>1</sub> to S<sub>2</sub></li> <li>(b) There does not exist an injection from S<sub>1</sub> to S<sub>2</sub></li> <li>(c) There does not exist a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(d) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(e) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(f) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(g) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> <li>(h) There exists a bijection from S<sub>1</sub> to S<sub>2</sub></li> </ul>
<ul> <li>(a) The scheme ensures that deadlocks will not occurs</li> <li>(b) The scheme violates the mutual exclusion property</li> <li>(c) The scheme may lead to live-lock</li> <li>(d) The scheme may lead to starvation</li> <li>44. Ans: (a), (c) &amp; (d)</li> <li>Sol: Since it is lock based, deadlock is not possible &amp; moreover killing process would make deadlock freedom. Mutual inclusion is always generated. Because of inverse dependency of process it may cause give-lock. If a process is repeatedly killed then starvation</li> </ul>	<b>47.</b> Ans: 4 Sol: Given: P is a $4 \times 5$ matrix, every solution of PX = 0 [2]

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```
\begin{bmatrix} 2\\5\\4\\1\\3 \end{bmatrix} is only the linearly independent solution
Number of independent solutions = 1
n - r = 1
```

```
5-r=1
r=4
```

```
Rank of P = 4
```

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

#### 48. Ans: 135

Sol: For pure aloha, the value of number of successful is  $g * e^{(-2g)}$ , as we are transferring 1 frame per sec, so g = 1 which we can keep So, with g=1, we get 0.13536.

Now we need to transmit 1000 frames, which gives 1000 \* 0.13536, so 135.36 is the throughput For rounded to nearest integer, we get 135

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

sign	exponent	mantissa

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

#### 49. Ans: (d)

Sol: Question asked the smallest normalized positive number

 $\rightarrow$  option1: is used for representing the special value  $\pm 0$ 

 $\rightarrow$  option 3: is used for Denormalized number since exponent value is '0'

 $\rightarrow$  options 2 and 4 are used for implicant number representation but in these, option (d) is used to represent the smallest positive number correct option is (d)

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

< 39-bit virtual address						->		
   			Level 2 offset		Level 3 offset	   	Page offset	   
	9 bits		9 bits		9 bits		12 bits	_

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

#### 50. Ans: 4108

**Sol:** One O.P.T and 2 level 2 P.Ts and 1k level 3 P.Ts are needed each of size 4kb



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51. Consider the following ANSI C code segment:

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

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

(a) 403 and 102(c) 203 and 2

(b) 303 and 102 (d) 303 and 2

#### 51. Ans: (b)

Sol: Before the loop executes: Addition 3 times Difference 2 times Inside For loop: Addition 300(3\*100) times Difference 100(1\*100) times 303, 102

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

#### 52. Ans: 15.49

**Sol:** n = 1000, p = 0.4, q = 0.6. If number of trials are large and neither 'p' nor 'q' is small then variable of normal distribution can be approximated as variance of binomial distribution

$$\sigma^{2} = npq$$

$$\sigma = \sqrt{npq}$$

$$= \sqrt{1000 \times 0.4 \times 0.6}$$

$$= \sqrt{240}$$

$$= 15.49$$

53. Consider the cyclic redundancy check (CRC) based error detecting scheme having the generator polynomial  $X^3 + X + 1$ . Suppose the message  $m_4m_3m_2m_4m_0 = 11000$  is to be transmitted. Check bits  $c_2c_1c_0$  are appended at the end of the message by the transmitter using the above CRC scheme. The transmitted bit string is denoted by  $m_4m_3m_2m_1m_0c_2c_1c_0$ . The value of the checkbit sequence  $c_2c_1c_0$  is

(a) 101	(b) 111
(c) 100	(d) 110

#### 53. Ans: (c)

Since

**Sol:** By doing the simple CRC based calculation, where the generator polynomial is 1011.

54. Consider the following ANSI C function: int SomeFunction (int x, int y)

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

The value returned by SomeFunction (15,255) is\_\_\_\_\_

	Engineering Publications		24	Computer Science & Information Technology
54. Sol:	fun(15,255) =fun(15,240) =fun(15,225) =fun(15,210) =fun(15,15) =15			
55.	hold on a relation and T: $P \rightarrow QF$ $RS \rightarrow T$ Which of the follow	wing functional dependencies car e above functional dependencies	, 1	NG ACAOFIA
		(b) $PS \rightarrow T$ (d) $R \rightarrow T$ $\therefore P \rightarrow R$ possible $\therefore PS \rightarrow T$ possible $\therefore PS \rightarrow Q$ possible $\therefore R \rightarrow T$ is not possible	ce 1	995 E





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