gradeup

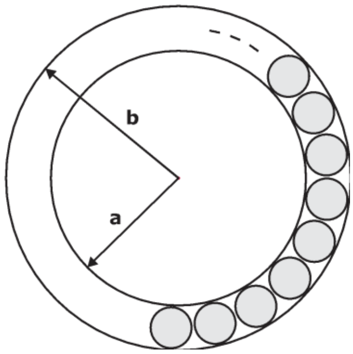
GATE 2020

Computer Science & Information Technology

Questions

GENERAL APTITUDE

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



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

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

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

A. Nation-states do not have environmental concerns.

B. Billions of people are affected by melting glaciers.

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

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

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

A. good

B. praiseworthy

C. desirable

D. extremely poor

4. Two straight lines are drawn perpendicular to each other in X–Y plane. If α and β are the acute angles the straight lines make with the X-axis then α + β is _____ .

A. 180^0
B. 60^0
C. 120^0
D. 90^0

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

A. 90 B. 80

C. 40 D. 110

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

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

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

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

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

D. GST includes all indirect taxes.

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

A. within, for B. during, for

C. for, in D. for, since

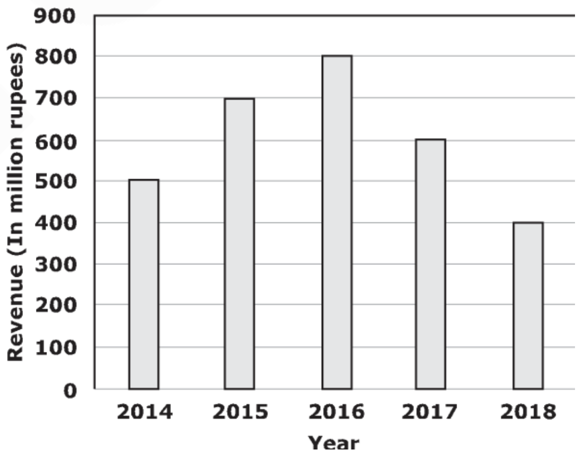
8. Select the words that fits the analogy:

Cook : Cook :: Fly : ______

A. Flew B. Flighter

C. Flyer D. Flying

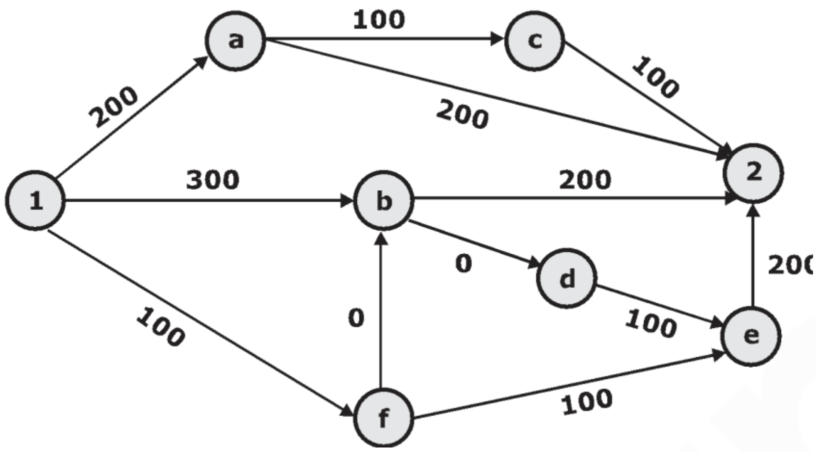
9. The total revenue of a company during 2014-2018 is shown in the graph. If the expenditure of the company in each year is 500 million rupees, then the aggregate profit loss (in percentage) on the total expenditure of the company during 2014-2018 is _______



A. 20% profit B. 16.67% loss

C. 16.67 profit D. 20% loss

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



The cost of the travel on an edge between nodes is given in rupees. Nodes 'a', 'b', 'c', 'd', 'e' and 'f' are toll booths. The toll price at toll booths marked 'a' and 'e' is Rs. 200, Rs. 100 for the other toll booths. Which is the cheapest route from node 1 to 2?

A. 1-b-2

B. 1-f-e-2

C. 1-a-c-2

D. 1-f-b-2

TECHNICAL

1. Consider the following C program.

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

The output program is _______ .

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

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

A. $\theta(n^2 \log n)$ B. $\theta(n^2)$
C. $\theta(n^3)$ D. $\theta(n^4)$

4. Consider the following sentences.

I. If $L_1 \cup L_2$ is regular, then both L_1 and L_2 must be regular.
II. The class of regular languages is closed under infinite union.
Which of the above statements is/are TRUE?

A. Both I and II B. Neither I nor II
C. I only D. II only

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

A. The hole created by the best fit is never larger than the hole created by first fit
B. The hole created by the best fit is always larger than the hole created by next fit
C. The hole created by the next fit is never larger than the hole created by best fit
D. The hole created by worst fit is always larger than the hole created by first fit

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

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

I. A router does not modify the packets during forwarding.

II. It is not necessary for a router to implement any routing protocol.

III. A router should reassemble IP fragments if the MTU of the outing packet is larger than the size of the incoming IP packet.

Which of the above statements is/are TRUE?

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

8. Consider the following grammar.

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

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

9. Consider a relational database containing the following schemas.

Catalogue

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

Suppliers

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

Parts

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

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

```
SELECT          s.sno, s.sname
FROM            Suppliers s, Catalogue c
WHERE           s.sno = c.sno AND
Cost > (SELECT AVG (cost)
FROM Catalogue
WHERE pno = 'P4'
GROUP BY pno);
```

The number of rows returned by the above SQL query is

A. 0
B. 4
C. 2
D. 5

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

A. Ovals that contain underlined identifiers

B. Diamonds with double/bold border

C. Ovals with double/bold border

D. Rectangles with double/bold border

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

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

13. Consider the following statements about process state transitions for a system using preemptive scheduling.

I. A running process can move to ready state.

II. A ready process can move to running state.

III. A blocked process can move to running state.

IV. A blocked process can move to ready state.

Which of the above statements are TRUE?

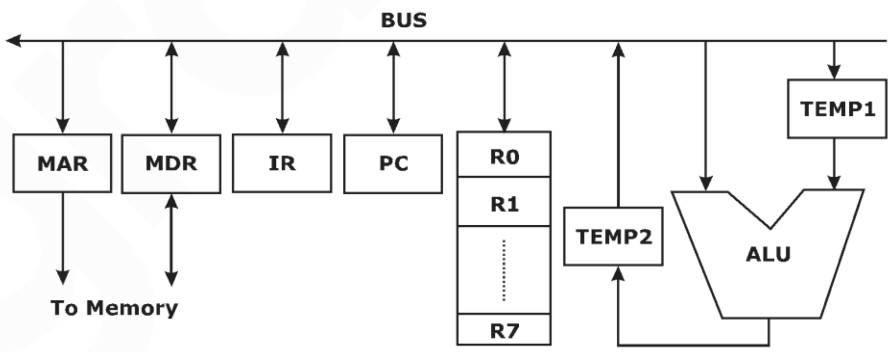
A. I, II, III, and IV

B. I, II, and IV only

C. I, II, and III only

D. II and III only

14. Consider the following data path diagram.



Consider an instruction: $R0 \leftarrow R1 + R2$. The following steps are used to execute it over the given data path. Assume that PC is incremented appropriately. The Subscripts r and w indicate read and write operations, respectively.

1. $R2_r$, $TEMP1_r$, ALU_{add}, $TEMP2_w$

2. $R1_r$, $TEMP1_w$

3. PC_r, MAR_w, MEM_r

4. $TEMP2_r$, $R0_w$

5. MDR_r, IR_w

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

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

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

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

A. $\Theta(\log_{ab} n)$
B. $\Theta(\log_a \log_b n)$
C. $\Theta(\log_2 \log_2 n)$
D. $\Theta(\log_b \log_a n)$

17. Consider the following statements.

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

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

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

Which of the above statements is/are TRUE?

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

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

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

I. L is deterministic context-free.

II. L is context-free but not deterministic context-free.

III. L is not LL(k) for any k.

Which of the above statements is/are TRUE?

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

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

A. 10*(0*10*10*)*
B. (0*10*10*)*10*
C. (0*10*10*)*0*1
D. ((0 + 1)*1(0 + 1)*1)*10*

21. Consider a double hashing scheme in which the primary hash function $h_1(k)$ = k mod 23, and the secondary hash function is $h_2(k)$ = 1 + (k mod19) Assume that the table size is 23. Then the address returned by probe 1 in the probe sequence (assume that the probe sequence begins at probe 0) for key value k =90 is ________.

22. Consider the functions

I. e^{-x}

II. $x^2 - \sin x$

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

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

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

23. What is the worst case time complexity of inserting n elements into an empty linked list, if the linked list needs to be maintained in sorted order?

A. $\Theta(n^2)$
B. $\Theta(1)$
C. $\Theta(n\log n)$
D. $\Theta(n)$

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

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

25. Consider the following statements.

I. Daisy chaining is used to assign priorities in attending interrupts.

II. When a device raises a vectored interrupt, the CPU does polling to identify the source of the interrupt.

III. In polling, the CPU periodically checks the status bits to know if any device needs its attention.

IV. During DMA, both the CPU and DMA controller can be bus masters at the same time.

Which of the above statements is/are TRUE?

A. III only
B. I and IV only
C. I and III only
D. I and II only

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

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

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

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

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

A. L_2 and L_3 only
B. L_1 and L_3 only
C. L_1, L_3, and L_4 only
D. L_2, L_3, and L_4 only

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

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

I. 202.61.84.0/21
II. 202.61.104.0/21
III. 202.61.64.0/21
IV. 202.61.144.0/21

A. II and III only
B. I and II only
C. III and IV only
D. I and IV only

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

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

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

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

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

30. Consider a schedule of transactions T_1 and T_2:

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

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

A.

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

B.

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

C.

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

D.

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

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

32. Consider three registers R1, R2, and R3 that store numbers in IEEE-754 single precision floating point format. Assume that R1 and R2 contain the values (in hexadecimal notation) 0×42200000 and 0×C1200000, respectively.

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

A. 0×83400000

B. 0×C0800000

C. 0×40800000

D. 0×C8500000

33. Consider the following set of processes, assumed to have arrived at time 0. Consider the CPU scheduling algorithms Shortest Job First (SJF) and Round Robin (RR). For RR, assume that the processes are scheduled in the order P_1, P_2, P_3, P_4.

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

If the time quantum for RR is 4 ms, then the absolute value of the difference between the average turnaround times (in ms) of SJF and RR (round off t0 2 decimal places) is ……………..

34. Consider the following C functions.

```
int fun1 (int n)
{

 static int i = 0;
 if (n > 0) {

          ++i;
          fun1 (n−1);
         }

  return (i);

 }
```

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

The return value of fun2(5) is ________.

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

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

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

36. Let A and B be two n × n matrices over real numbers. Let rank(M) and det(M) denote the rank and determinant of a matrix M, respectively. Consider the following statements.

I. rank(AB) = rank(A) rank(B)

II. det(AB) = det(A) det(B)

III. rank(A + B) $\leq$ rank(A) + rank(B)

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

Which of the above statements are TRUE?

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

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

37. Consider the following C functions.

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

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

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

39. Consider the following languages.

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

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

Which one of the following is TRUE?

A. L_1 is regular and L_2 is context-free.

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

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

D. Neither L_1 nor L_2 is context-free.

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

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

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

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

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

45. Graph G is obtained by adding vertex s to $K_{3,4}$ and making s adjacent to every vertex of $K_{3,4}$. The minimum number of colours required to edge-colour is *G*_______ .

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

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

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

```
CODE SECTION P
  wait (a); count=count+1;
  If (count==n) signal (b);
  signal (a); wait (b); signal (b);
CODE SECTION Q
```

What does the code achieve?

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

B. It ensures that at most n−1 processes are in CODE SECTION P at any time.

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

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

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

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

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

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

Which one of the following is TRUE?

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

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

C. Only Rule 1 is L-attributed.

D. Only Rule 2 is L-attributed.

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

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

A1 = 0×42C8A4, A2 = 0×546888,

A3 = 0×6A289C, A4 = 0×5E4880

Which one of the following is TRUE?

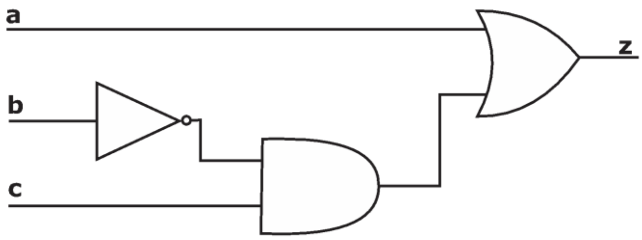
A. A1 and A3 are mapped to the same cache set.

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

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

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

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



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

A. $Z = \sum(2,3,5)$

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

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

D. $Z = \sum(0,1,3,7)$

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

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

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

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

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

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

54. Consider the following language.

$L = \{x \in (a,b)^* |$ number of a’s in x is divisible by 2 but not divisible by 3

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

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

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

“The shortest paths in G under w are shortest paths under w’ too, ______.

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

B. for every f: V →R

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

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

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