Reg. No. :

## Question Paper Code: U6H51S

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2024

Sixth Semester

Computer Science and Engineering

21UGT651 - Comprehensive Engineering Aptitude Test

(Common to Information Technology)

Duration: Three hours                                                                 Maximum: 100 Marks

Answer ALL Questions

PART A - (1 x 30 = 30 Marks)

MATHEMATICS

1. The general solution of the differential equation $\frac{dy}{dx} = \frac{1+\cos 2y}{1-\cos 2x}$ is

   (a) tany-cotx = c        (b) tanx-coty = c    (c) tany+cotx = c                    (d) tanx+coty = c

2. If two fair coins are flipped and at least one of the outcomes is known to be a head, what is the probability that both outcomes are heads?

   (a) $\frac{1}{3}$            (b) $\frac{1}{2}$            (c) $\frac{2}{3}$            (d) $\frac{1}{4}$

3. The solution of differential equation $\frac{dy}{dx} = ky$ and y(0) = c is

   (a) $x = ce^{ky}$        (b) $x = ke^{cy}$        (c) $y = ce^{kx}$            (d) $y = ce^{-kx}$

4. If a fair coin is tossed four times, what is the probability that two heads and two tails will result?

   (a) $\frac{5}{8}$            (b) $\frac{3}{8}$            (c) $\frac{3}{4}$            (d) $\frac{6}{8}$

5. For a Group $G = \{1, -1, -i, i\}$ under multiplication, which element(s) have self-reciprocal inverse(s)
   (a) 1,i                (b) $i, -i$            (c) 1, -1                        (d) $i, -1$

6. The truth value "If 91 is prime then 25 is odd", The truth value
   " $\sin 135° = 1$ and 3 is a positive integer "
   (a) T,F                (b) F,T                (c) T,T                        (d) F,F

7. For a Group $(Z, *)$ , * is defined by $a*b = a+b+2ab$ then identity element is
   (a) 0                  (b)2                   (c) -1                          (d) 0 and 1

8. Consider a 50 kbps satellite channel with a 500 milliseconds round trip propagation delay. If the sender wants to transmit 1000 bit frames, how much time will it take for the receiver to receive the frame?

(a) 250 milliseconds                       (b) 20 milliseconds

(c) 520 milliseconds                       (d) 270 milliseconds

9. Type checking is normally done during

(a) Lexical analysis                       (b) Syntax analysis

(c) Syntax directed translation           (d) Code optimization

10. Which one of the following statements is NOT correct about the B+ tree data structure used for creating an index of a relational database table?

(a) B+ Tree is a height-balanced tree

(b) Non-leaf nodes have pointers to data records

(c) Key values in each node are kept in sorted order

(d) Each leaf node has a pointer to the next leaf node

11. Which one of the following is NOT a part of the ACID properties of database transactions?

(a) Atomicity       (b) Consistency      (c) Isolation                (d) Deadlock-freedom

12. What is the optimized version of the relation algebra expression $\pi A1(\pi A2(\sigma F1(\sigma F2(r))))$, where A1, A2 are sets of attributes in r with $A1 \subset A2$ and F1, F2 are Boolean expressions based on the attributes in r?

(a) $\pi A1(\sigma(F1 \wedge F2)(r))$                   (b) $\pi A1(\sigma(F1 \vee F2)(r))$

(c) $\pi A2(\sigma(F1 \wedge F2)(r))$                   (d) $\pi A2(\sigma(F1 \vee F2)(r))$

13. In the following pairs of OSI protocol layer/sub-layer and its functionality, the INCORRECT pair is

(a) Network layer and Routing

(b) Data Link Layer and Bit synchronization

(c) Transport layer and End-to-end process communication

(d) Medium Access Control sub-layer and Channel sharing

14. If there are nn devices (nodes) in a network, what is the number of cable links required for a fully connected mesh and a star topology respectively

(a) $n(n-1)/2$ , $n-1$       (b)$n, n-1$       (c) $n-1, n$                      (d) $n-1,\ n(n-1)/2$

15. The essential content(s) in each entry of a page table is/are

(a) Virtual page number                                (b)Page frame number

(c) Both virtual page number and page frame number      (d) access right information

16. Let S and T be language over $=\{a,b\}$ represented by the regular expressions $(a+b*)*$ and $(a+b)*$, respectively. Which of the following is true?

(a) ScT (S is a subset of T)      (b)TcS (T is a subset of S      (c) S=T          (d) SnT=Ø

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17. Let P be a regular language and Q be context-free language such that Q ⊆ P. (For example, let P be the language represented by the regular expression p*q* and Q be {$p^n q^n$|n∈ N}). Then which of the following is ALWAYS regular?

    (a) P ∩ Q       (b)P − Q       (c) $\sum$* − P       (d) $\sum$* − Q

18. A computer has a 256 KB, 4-way set associative, write back data cache with block size of 32 bytes. The processor sends 32 bit addresses to the cache controller. Each cache tag directory entry contains in addition to address tag, 2 valid bits, 1 modified bit and 1 replacement bit. The number of bits in the tag field of an address is-

    (a) 11       (b)14       (c) 16       (d) 27

19. The amount of ROM needed to implement a 4 bit multiplier is

    (a) 64 bits       (b) 128 bits       (c) 1 Kbits       (d) 2 Kbits

20. The smallest integer than can be represented by an 8-bit number in 2's complement form is

    (a) -256       (b) -128       (c) -127       (d) 0

21. The result evaluating the postfix expression 105+60 6/*8− is

    (a) 284       (b) 213       (c) 142       (d) 71

22. A function f defined on stacks of integers satisfies the following properties. f(φ) = 0 and f (push (S, i)) = max (f(S), 0) + i for all stacks S and integers i. If a stack S contains the integers 2, -3, 2, -1, 2 in order from bottom to top, what is f(S)?

    (a) 6       (b) 4       (c) 3       (d) 2

23. The output Y of a 2-bit comparator is logic 1 whenever the 2-bit input A is greater than the 2-bit input B. The number of combinations for which the output is logic 1, is

    (a) 4       (b) 6       (c) 8       (d) 10

24. To implement Dijkstra's shortest path algorithm on unweighted graphs so that it runs in linear time, the data structure to be used is:

    (a) Queue.       (b) Stack.       (c) Heap.       (d) B-Tree.

25. The Floyd-Warshall algorithm for all-pair shortest paths computation is based on
    (a) Greedy paradigm.
    (b) Divide- and- conquer paradigm.
    (c) Dynamic programming paradigm.

    (d) Neither Greedy nor Divide- and- conquer nor Dynamic programming paradigm.

## GENERAL APTITUDE

26. Find the number of triangles in the given figure.
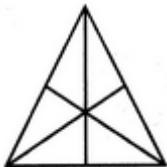
    

    (a)16       (b) 13       (c) 9       (d) 7

27. The price of an item is increased by 20% and then decreased by 20%. The final price as compared to original price is:

    (a) 20% less       (b) 20% more       (c) 4% more       (d) 4% less

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28. The Last day of Century cannot be
    (a) Monday      (b) Tuesday      (c) Wednesday      (d) Friday

29. What is the probability that a leap year selected at random will contain 53 Sundays?

    (a) 2/7      (b) 3/7      (c) 4/7      (d) 5/7

30 If a person walks at 14 km/hr instead of 10 km/hr, he would have walked 20 km more. The actual distance travelled by him is:
    (a) 50 km      (b) 56 km      (c)70 km      (d)80 km

## PART B - (35 x 2 = 70 Marks)
## MATHEMATICS

31 For the matrix $\begin{bmatrix} 4 & 1 \\ 1 & 4 \end{bmatrix}$, the eigen values are

   (a) 3 and -3      (b) -3 and -5      (c)3 and 5      (d)5 and 0

32 The inverse of $\begin{pmatrix} 1 & 2 \\ 5 & 7 \end{pmatrix}$ is

   (a) $\dfrac{1}{3}\begin{pmatrix} -7 & 2 \\ 5 & -1 \end{pmatrix}$     (b) $\dfrac{1}{3}\begin{pmatrix} 7 & 2 \\ 5 & 1 \end{pmatrix}$     (c) $\dfrac{1}{3}\begin{pmatrix} 7 & -2 \\ -5 & 1 \end{pmatrix}$     (d) $\dfrac{1}{3}\begin{pmatrix} 7 & -2 \\ -5 & -1 \end{pmatrix}$

33 Find the value of $\int_{0}^{3} \sqrt{(3+x)(3-x)}\,\mathbf{dx}$

   (a) $\dfrac{9\boldsymbol{\pi}}{4}$      (b) $\dfrac{9\boldsymbol{\pi}}{8}$      (c ) $9\boldsymbol{\pi}$      (d)0

## COMPUTER SCIENCE ENGINEERING /INFORMATION TECHNOLOGY

34 Which of the following statements are TRUE?

   I. There exist parsing algorithms for some programming languages whose complexities are less than $\theta(n3)$.

   II. A programming language which allows recursion can be implemented with static storage allocation.

   III. No L-attributed definition can be evaluated in the framework of bottom-up parsing.

   IV. Code improving transformations can be performed at both source language and intermediate code level.

   (a) I and II      (b) I and IV      (c ) III and IV      (d) I, III and IV

35 An LALR(1) parser for a grammar G can have shift-reduce (S-R) conflicts if and only if
   (a) the SLR(1) parser for G has S-R conflicts
   (b) the LR(1) parser for G has S-R conflicts
   (c ) the LR(0) parser for G has S-R conflicts
   (d) the LALR(1) parser for G has reduce-reduce conflicts

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36 Given the following relation instance.

x y z
1 4 2
1 5 3
1 6 3
3 2 2

Which of the following functional dependencies are satisfied by the instance?
(a) XY -> Z and Z -> Y　　　　　　　　(b) YZ -> X and Y -> Z
(c) YZ -> X and X -> Z　　　　　　　　(d) XZ -> Y and Y -> X

37 In SQL, relations can contain null values, and comparisons with null values are treated as unknown. Suppose all comparisons with a null value are treated as false. Which of the following pairs is not equivalent?
(a) x = 5, not (not (x = 5)　　　(b) x = 5, x > 4 and x < 6, where x is an integer
(c) x < 5, not(x = 5)　　　　　　(d) None of the above

38 The protocol data unit(PDU) for the application layer in the Internet stack is
(a)Segment　　　　(b)Datagram　　　　(c)Message　　　　　　　　(d) Frame

39 In the IPv4 addressing format, the number of networks allowed under Class C addresses is
(a)2^14　　　　　(b)2^7　　　　　(c)2^21　　　　　　　　(d) 2^24

40 A virtual memory system uses First In First Out (FIFO) page replacement policy and allocates a fixed number of frames to a process. Consider the following statements:
P: Increasing the number of page frames allocated to a
process sometimes increases the page fault rate.
Q: Some programs do not exhibit locality of reference.
Which one of the following is TRUE?
(a) Both P and Q are true, and Q is the reason for P　　　(b) P is false, but Q is true
(c) Both P and Q are true, but Q is not the reason for P　　(d) Both P and Q are false

41 Match all items in Group 1 with correct options from those given in Group 2.

|  Group 1 | Group 2 |
| --- | --- |
| P. Regular expression | 1. Syntax analysis |
| Q. Pushdown automata | 2. Code generation |
| R. Dataflow analysis | 3. Lexical analysis |
| S. Register allocation | 4. Code optimization |

(a)P-4. Q-1, R-2, S-3　　　　　　　(b)P-3, Q-1, R-4, S-2
(c)P-3, Q-4, R-1, S-2　　　　　　　(d)P-2, Q-1, R-4, S-3

42 Which of the following languages is/are regular?

$L_1 : \{ wxw^R \,|\, w, x \in \{a, b\}^* \text{ and } |w|, |x| > 0 \}$, $w^R$ is the reverse of string w

$L_2 : \{ a^n b^m \,|\, m \neq n \text{ and } m, n \geq 0 \}$

$L_3 : \{ a^p b^q c^r \,|\, p, q, r \geq 0 \}$

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(a) L1 and L3 only            (b) L1 only

(c) L2 and L3only            (d) L3 only

43. What is the minimum number of states in deterministic finite automata (DFA) for string starting with ba$^2$ and ending with 'a' over alphabet {a, b}?

(a)Ten          (b)Nine          (c)Eight          (d) Six

44. Identify the language generated by the following grammar, where S is the start variable.

S→XY

X→aX|a

Y → aYb|ε

(a)$\{a^m b^n \mid m \geq n, n > 0\}$          (b)$\{a^m b^n \mid m > n, n > 0\}$

(c)$\{a^m b^n \mid m > n, n \geq 0\}$          (d)$\{a^m b^n \mid m \geq n, n \geq 0\}$

45. The protocol data unit(PDU) for the application layer in the Internet stack is

(a) Segment      (b) Datagram      (c) Message          (d) Frame

46. The output Y in the circuit below is always '1' when



(a)two or more of the inputs P, Q, R are '0'      (b)two or more of the inputs P, Q, R are '1'

(c)any odd number of the inputs P, Q, R is 0'      (d)any odd number of the inputs P, Q, R is 1'

47. Consider a hash table with 9 slots. The hash function is h(k) = k mod 9. The collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17, 10. The maximum, minimum, and average chain lengths in the hash table, respectively, are

(a)3, 0, and 1.      (b) 3, 3, and 3.      (c) 4, 0, and 1.          (d) 3, 0, and 2.

48. Which of the following is/are valid statement(s) of the spanning tree of a connected undirected graph G (V,E)?

(a) Spanning Tree of G(V,E) must contain (V–1) number of edges.

(b) Spanning Tree of G(V,E) is minimally connected.

(c) Spanning Tree of G(V,E) is maximally cyclic.

(d) Spanning Tree of G(V,E) must contain (E–1) number of edges.

49. A CFG G is given with the following productions where S is the start symbol, A is a non-terminal and a and b are terminals. S→aS|AA→aAb|bAa|ε Which of the following strings is generated by the grammar above?

(a) aabbaba      (b) aabaaba      (c) abababb          (d) aabbaab.

50  Which of the following languages are undecidable? Note that ⟨M⟩ indicates encoding of the Turing machine M.

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

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

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

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

(a)L2 and L3 only     (b) L1 and L3 only     (c) L2,L3 and L4 only    (d) L1,L3 and L4 only

51  Consider the following statements.

> I. The complement of every Turing decidable language is Turing decidable
>
> II. There exists some language which is in NPNP but is not Turing decidable
>
> III. If LL is a language in NP,NP, LL is Turing decidable
>
> Which of the above statements is/are true?

(a) Only I and II     (b) Only I and III    (c) Only II            (d) Only III

52  Let N be an NFA with nn states. Let k be the number of states of a minimal DFAwhich is equivalent to N. Which one of the following is necessarily true?

(a)$K<2^n$            (b) $k<n^2$            (c) $K>2^n$            (d) $K>2^n$

53  Let L1 be a recursive language. Let L2 and L3 be languages that are recursively enumerable but not recursive. Which of the following statements is not necessarily true?

(a)L2-L1 is recursively enumerable          (b)L2∩L3 is recursively enumerable

(c)L1 –L3  is Recursively enumerable      (d)L2∪L3is recursively enumerable

54  S → aSa|bSb|a|b

The language generated by the above grammar over the alphabet {a,b} is the set of

(a)All Palindromes                        (b)All odd length Palindromes

(c)strings that begin and end with the same symbol     (d)all even length palindromes.

55  All the routers use the distance vector based routing algorithm to update their routing tables. Each starts with its routing table initialized to contain an entry for each neighbour with the weight of the respective connecting link. After all the routing tables stabilize, how many links in the network will never be used for carrying any data?

(a) 4            (b) 3            (c) 2               (d)  1

56  Which of the following is decidable?

(a) A Turing machine prints specific letter

(b) A Turing machine computes product of two numbers.

(c) An arbitrary Turing machine halts after fifty steps

(d) none of the above.

57  In which of the cases stated below is the following statement true?

"For every non-deterministic machine M1M1 there exists an equivalent deterministic machine M2M2 recognizing the same language".

(a) M1 is nondeterministic finite automation

(b) M1 is a nondeterministic PDA

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(c) M1 is a nondeterministic Turing machine

(d) For no machine M1 use the above statement true

58 Context free languages and regular languages are both closed under the operation(s) of :

(a) Union                                    (b) Intersection

(c) Concatenation                            (d) Complementation

59 Which of the following regular expression identities are false?

(a) (r+s)* =r* + s*      (b) r*s* =r* + s*      (c) r*=r*+s          (d) (r*s*)*=(r+s)*

60 Page fault occurs when

(a) the page is corrupted by application Software

(b) the page is in main memory

(c) the page is not in main memory

(d) the process requesting the page does not have privilege to access the page

GENERAL APTITUDE

61 What was the day of the week on 28th May, 2006?

(a) Sunday          (b) Tuesday          (c) Wednesday          (d) Friday

62 From the group of 5 men and 5 women. Two persons are chosen at random. The probability that one of them is man and the other woman is

(a) 2/5              (b) 3/5              (c) 5/9              (d) 4/9

63 A man is facing North-West. He turns $90^o$ in the clockwise direction, then $180^o$ in the anticlockwise direction and then another $90^o$ in the same direction. Which direction is he facing now?

(a) South              (b) South - West    (c) South - East          (d) East

64 In a certain code, '247' means 'spread red carpet'; '256' means 'dust one carpet' and '234' means 'one red carpet'. Which digit in that code means 'dust'?

(a) 2                (b) 3                (c) 5                (d) 6

65 60. 25 : 37 :: 49 : ?

(a) 65                (b) 69                (c) 79                (d) 81