GATE SOLVED PAPER - CS

THEORY OF COMPUTATION

YEAR 2001

Q. 1 Consider the following two statements :

$S1 : \{0^{2n} | n \geq 1\}$ is a regular language

$S2 : \{0^m 1^n 0^{m+n} | m \geq 1 \text{ and } n \geq 1\}$ is a regular language

Which of the following statements is incorrect ?

(A) Only $S1$ is correct
(B) Only $S2$ is correct
(C) Both $S1$ and $S2$ are correct
(D) None of $S1$ and $S2$ is correct.

Q. 2 Which of the following statements true ?

(A) If a language is context free it can be always be accepted by a deterministic push-down automaton.
(B) The union of two context free language is context free.
(C) The intersection of two context free language is context free
(D) The complement of a context free language is context free

Q. 3 Given an arbitary non-deterministic finite automaton (NFA) with N states, the maximum number of states in an equivalent minimized DFA is at least.

(A) N^2
(B) 2^N
(C) $2N$
(D) $N!$

Q. 4 Consider a DFA over $\Sigma = \{a, b\}$ accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have ?

(A) 8
(B) 14
(C) 15
(D) 48

Q. 5 Consider the following languages :

$L1 = \{ww | w \in \{a, b\}*\}$

$L2 = \{ww^R | w \in \{a, b\}^* w^R \text{ is the reverse of w}\}$

$L3 = \{0^{2i} | i \text{ is an integer}\}$

$L4 = \{0^{i^2} | i \text{ is an integer}\}$

Which of the languages are regular ?

(A) Only $L1$ and $L2$
(B) Only $L2$, $L3$ and $L4$
(C) Only $L3$ and $L4$
(D) Only $L3$

Q. 6 Consider the following problem x.
Given a Turing machine M over the input alphabet Σ, any state q of M.
And a word $w \in \Sigma^*$ does the computation of M on w visit the state q ?
Which of the following statements about x is correct ?

(A) x is decidable
(B) x is undecidable but partially decidable

(C) x is undecidable and not even partially decidable

(D) x is not a decision problem

YEAR 2002

Q. 7 The smallest finite automaton which accepts the language $\{x \mid$ length of x is divisible by 3$\}$ has

(A) 2 states (B) 3 states

(C) 4 states (D) 5 states

Q. 8 Which of the following is true ?

(A) The complement of a recursive language is recursive.

(B) The complement of a recursively enumerable language is recursively enumerable.

(C) The complement of a recursive language is either recursive or recursively enumerable.

(D) The complement of a context-free language is context-free.

Q. 9 The C language is :

(A) A context free language (B) A context sensitive language

(C) A regular language (D) Parsable fully only by a Turing machine

Q. 10 The language accepted by a Pushdown Automaton in which the stack is limited to 10 items is best described as

(A) Context free (B) Regular

(C) Deterministic Context free (D) Recursive

YEAR 2003 ONE MARK

Q. 11 Ram and Shyam have been asked to show that a certain problem Π is NP-complete. Ram shows a polynomial time reduction from the 3-SAT problem to Π, and Shyam shows a polynomial time reduction from Π to 3-SAT. Which of the following can be inferred from these reduction?

(A) Π is NP-hard but not NP-complete

(b) Π is in NP, but is not NP-complete

(C) Π is NP-complete

(D) Π is neither Np-hard, nor in NP

Q. 12 Nobody knows yet if $P = NP$. Consider the language L defined as follows

$$L = \begin{cases} (0+1)^* & \text{if P = NP} \\ \phi & \text{othervise} \end{cases}$$

Which of the following statements is true?

(A) L is recursive

(B) L is recursively enumerable but not recu

(C) L is not recursively enumerable

(D) Whether L is recursive or not will be known after we find out if $P = NP$

Q. 13 The regular expression $0*(10)*$ denotes the same set as

(A) $(1*0)*1*$

(B) $0+(0+10)*$

(C) $(0+1)*10(0+1)*$

(D) None of the above

Q. 14 If the strings of a language L can be effectively enumerated in lexicographic (i.e. alphabetic) order, which of the following statements is true?

(A) L is necessarily finite

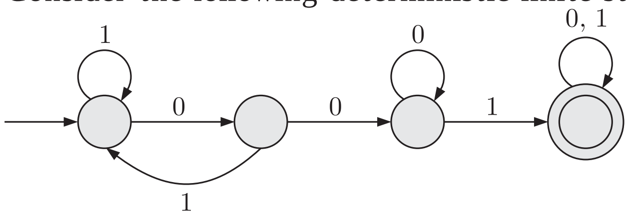
(B) L is regular but not necessarily finite

(C) L is context free but not necessarily regular

(D) L is recursive but not necessarily context free

YEAR 2003 TWO MARKS

Q. 15 Consider the following deterministic finite state automaton M.



Let S denote the set of seven bit binary strings in which the first, the fourth, and the last bits are 1. The number of strings in S that are accepted by M is

(A) 1 (B) 5

(C) 7 (D) 8

Q. 16 Let $G = (\{S\},\{a,b\}R,S$ be a context free grammar where the rule set R is

$S \to a\ S\ b \mid S\ S \mid \varepsilon$

Which of the following statements is true?

(A) G is not ambiguous

(B) There exist $x,y,\in L(G)$ such that $xy \notin L(G)$

(C) There is a deterministic pushdown automaton that accepts $L(G)$

(D) We can find a deterministic finite state automaton that accepts $L(G)$

Q. 17 Consider two languages L_1 and L_2 each on the alphabet $\sum$. Let $f{:}\sum \to \sum$ be a polynomial time computable bijection such that $(\forall x[x \in L_1\ iff\ f(x) \in L_2]$. Further, let f^1 be also polynomial time commutable.

Which of the following CANNOT be true?

(A) $L_1 \in P$ and L_2 finite

(B) $L_1 \in NP$ and $L_2 \in P$

(C) L_1 is undecidable and L_2 is decidable

(D) L_1 is recursively enumerable and L_2 is recursive

Q. 18 A single tape Turing Machine M has two states q^0 and q^1, of which q^0 is the starting state. The tape alphabet of M is {0,1,B} and its input alphabet is {0,1}. The symbol B is the blank symbol used to indicate end of an input string. The transition function of M is described in the following table

	0	1	B
q^0	$q^{1,1,R}$	$Q^{1,1,R}$	Halt
q^1	$q^{1,1,R}$	$q^{0,1,L}$	$qH0, B, L$

The table is interpreted as illustrated below.
The entry ($q^{1,1,R}$) in row q^0 and column 1 signifies that if M is in state q^0 and reads 1 on the current tape square, then it writes 1 on the same tape square, moves its tape head one position to the right and transitions to state q^1.
Which of the following statements is true about M?

(A) M does not halt on any string in $(0+1)^+$

(B) M dies not halt on any string in $(00+1)$*

(C) M halts on all string ending in a 0

(D) M halts on all string ending in a 1

Q. 19 Define languages L_0 and L_1 as follows
$L_0 = \{< M, w, 0 > | M$ halts on $w\}$
$L_0 = \{< M, w, 1 > | M$ does not halts on $w\}$
Here$< M, w, i >$ is a triplet, whose first component. M is an encoding of a Turing Machine, second component,w, is a string, and third component, t, is a bit.
Let $L = L_0 \cup L_1$. Which of the following is true?

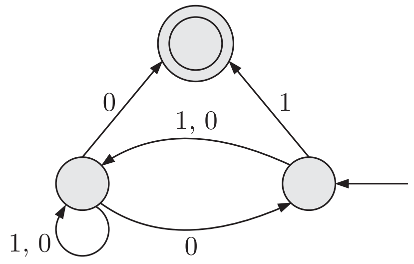
(A) L is recursively enumerable, but $\overline{L}$ is not

(B) $\overline{L}$ is recursively enumerable, but L is not

(C) Both L and $\overline{L}$ are recursive

(D) Neither L nor $\overline{L}$ is recursively enumerable

Q. 20 Consider the NFAM shown below.



Let the language accepted by M be L. Let L_1 be the language accepted by the $NFAM_1$, obtained by changing the accepting state of M to a non-accepting state and by changing the non-accepting state of M to accepting states. Which of the following statements is true?

(A) $L_1 = \{0,1\}^* - L$ (B) $L_1 = \{0,1\}^*$

(C) $L_1 \subseteq L$ (D) $L_1 = L$

YEAR 2004 ONE MARK

Q. 21 The problems 3-SAT and 2-SAT are

(A) both in P

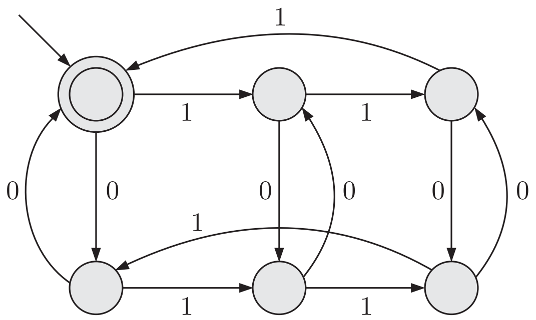
(B) both NP-complete

(C) NP-complete and in P respectively

(D) undecidable and NP-complete respectively

YEAR 2004 TWO MARKS

Q. 22 The following finite state machine accepts all those binary strings in which the number of 1's and 0's are respectively



(A) divisible by 3 and 2
(B) odd and even
(C) even and odd
(D) divisible by 2 and 3

Q. 23 The language $\{a^m b^{m+n} \mid m, n \le 1\}$ is
(A) regular
(B) context-free but not regular
(C) context sensitive but not context free
(D) type-0 but not context sensitive

Q. 24 Consider the flowing grammar C

$$S \to bS \mid aA \mid b$$
$$A \to bA \mid aB$$
$$B \to bB \mid aS \mid a$$

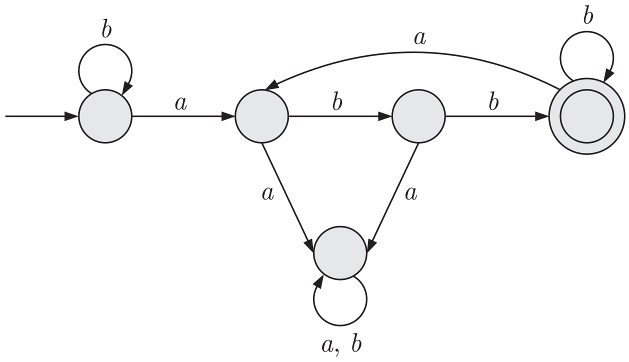
Let $N_a(W)$ and $N_b(W)$ denote the number of a's and b's in a string W respectively. The language $L(G) \subseteq \{a, b\}^+$ generated by G is
(A) $\{W \mid N_a(W) > 3N_b(W)\}$
(B) $\{W \mid N_b(W) > 3N_a(W)\}$
(C) $\{W \mid N_a(W) = 3k, k \in \{0,1,2,...\}\}$
(D) $\{W \mid N_b(W) = 3k, k \in \{0,1,2,...\}\}$

Q. 25 L_1 is a recursively enumerable language over Σ. An algorithm A effectively enumerates its words as $w_1, w_2, w_3, ...$ Define another language L_2 over $\Sigma \cup \{\#\}$ as $\{w_i \# w_j : w_i, w_j \in L_1, i < j\}$. Here # is a new symbol. Consider the following assertion.
$S_1 : L_1$ is recursive implies L_2 is recursive
$S_2 : L_2$ is recursive implies L_1 is recursive
Which of the following statements is true?
(A) Both S_1 and S_2 are true
(B) S_1 is true but S_2 is not necessarily true
(C) S_2 is true but S_1 ins necessarily true
(D) Neither is necessarily true

YEAR 2005 TWO MARKS

Q. 26 Consider three decision problem P_1, P_2 and P_3. It is known that P_1 is decidable and P_2 is undecidable. Which one of the following is TRUE?
(A) P_3 is decidable if P_1 is reducible to P_3
(B) P_3 is undecidable if P_3 is reducible to P_2
(C) $PL3$ is undecidable if P_2 is reducible to P_3
(D) P_3 is decidable if P_3 is reducible to P_2's complement

Q. 27 Consider the machine M



The language recognized by M is

(A) $\{W \in \{a,b\}^*/$ every a in w is followed by exactly two $b's\}$

(B) $\{W \in \{a,b\}^*/$ every a in w is followed by at least two $b's\}$

(C) $\{W \in \{a,b\}^*/$ w contains the substring 'abb'

(D) $\{W \in \{a,b\}^*/$ w does not contain 'aa' as a substring$\}$

Q. 28 Let N_f and N_p denote the classes of languages accepted by non-deterministic finite automata and non-deterministic push-down automata, respectively. let D_f and D_P denote the classes of languages accepted by deterministic finite automata and deterministic push-down automata, respectively. Which one of the following is TRUE?

(A) $D_f \subset N_f$ and $D_P \subset N_P$

(B) $D_f \subset N_f$ and $D_P = N_P$

(C) $D_f = N_f$ and $D_P = N_P$

(D) $D_f = N_f$ and $D_P \subset N_P$

Q. 29 Consider the languages

$L_1 + \{a^n b^n c^m \mid n, m > 0\}$ and $L_2 = \{a^n b^m c^m \mid n, m > 0\}$

(A) $L_1 \cap L_2$ is a context-free language

(B) $L_1 \cup L_2$ is a context-free language

(C) L_1 and L_2 are context-free language

(D) $L_1 \cap L_2$ is a context sensitive language

Q. 30 Let L_1 be a recursive language, and let L_2 be a recursively enumerable but not a recursive language. Which one of the following is TRUE?

(A) $\overline{L_1}$ is recursive and $\overline{L_2}$ is recursively enumerable

(B) $\overline{L_1}$ is recursive and $\overline{L_2}$ is not recursively enumerable

(C) $\overline{L_1}$ and $\overline{L_2}$ are recursively enumerable

(D) $\overline{L_1}$ is recursively enumerable and $\overline{L_2}$ is recursive

Q. 31 Consider the languages

$L_1 = \{WW^R \mid W \in \{0,1\}^*\}$

$L_2 = \{W \# W^R \mid W \in \{0,1\}^*\}$, where # is a special symbol

$L_3 = \{WW \mid W \in \{0,1\}^*\}$

Which one of the following is TRUE?

(A) L1 is a deterministic CFL

(B) L_2 is a deterministic CFL

(C) L_3 is a CFL, but not a deterministic CFL

(D) L_3 is a deterministic CFL

Q. 32 Consider the following two problems on undirected graphs

α: Given $G(V,E)$, does G have an independent set of size $|V|-4$?

β: Given $G(V,E)$, does G have an independent set of size 5?

Which one of the following is TRUE?

(A) α is in the P and β is NP-complete

(B) α is NP-complete and β is P

(C) Both α and β are NP-complete

(D) Both α and β are in P

YEAR 2006 ONE MARK

Q. 33 Let S be an NP-complete problem Q and R be two other problems not known to be in NP. Q is polynomial-time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true?

(A) R is NP-complete

(B) R is NP-hard

(C) Q is NP-complete

(D) Q is NP-hard

Q. 34 Let $L_1 = \{0^{n+m}1^n 0^m \mid n,m \le 0\}, L_2 = \{0^{n+m}1^{n+m}0^m \mid n,m \le 0\}$, and $L_3 = \{0^{n+m}1^{n+m}0^{n+m} \mid n,m \le 0\}$. Which of these languages are NOT context free?

(A) L_1 only

(B) L_3 only

(C) L_1 and L_2

(D) L_2 and L_3

YEAR 2006 TWO MARKS

Q. 35 If s is a string over $(0+1)^*$, then let $n_0(s)$ denote the number of 0's in s and $n_1(s)$ the number of 1's in s. Which one of the following languages is not regular?

(A) $L = \{s \in (0+1)^* \mid n_0(s)$ is a 3-digit prime$\}$

(B) $L = \{s \in (0+1)^* \mid$ for every prefixes' of $s, | n_0(s') - n_1(s')| \le 2\}$

(C) $L = \{s \in (0+1)^* || n_0(s) - n_1(s) \le 4$

(D) $L = \{s \in (0+1)^* \mid n_0(s) \bmod 7 = n_1(s) \bmod 5 = 0\}$

Q. 36 For $s \in (0+1)^*$ let $d(s)$ denote the decimal value of $s (e.g. d(101) = 5)$

Let $L = \{s \in (0+1)^* \mid d(s) \bmod 5 = 2$ and $d(s) \bmod 7 \ne 4\}$

Which one of the following statements is true?

(A) L is recursively enumerable, but not recursive

(B) L is recursive, but not context-free

(C) L is context_free, but not regular

(D) L is regular

Q. 37 Let SHAM, be the problem of finding a Hamiltonian cycle in a graph $G+(V,E)$ with $[V]$ divisible by 3 and DHAM' be the problem of determining if a Hamltonian cycle exists in such graphs. Which one of the following is true?

(A) Both DHAM, and SHAM, are NP-hard

(B) SHAM, is NP-hard, but DHAM, is not

(C) DHAM, is NP-hard, but SHAM, is not

(D) Neither DHAM,nor SHAM, is NP-hard

Q. 38 Consider the following statements about the context-free grammar,
$G = \{S \to SS, S \to ab, S \to ba, S \to \in\}$

1. G is ambiguous.
2. G produces all strings with equal number of a's and b's.
3. G can be accepted by a deterministic PDA.

Which combination below expresses all the true statements about G?

(A) 1 only (B) 1 and 3 only

(C) 2 and 3 only (D) 1, 2 and 3

Q. 39 Let L_1 be regular language, L_2 be a deterministic context-free language and L_3 a recursively enumerable, but not recursive, language. Which one of the following statements is false?

(A) $L_1 \cap L_2$ is a deterministic CFL (B) $L_3 \cap L_1$ is recursive

(C) $L_1 \cup L_2$ is context free (D) $L_1 \cap L_2 \cap L_3$ is recursively enumerable

Q. 40 Consider the regular language $L = (111 + 111111)^*$. The minimum number of states in any DFA accepting this languages is

(A) 3 (B) 5

(C) 8 (D) 9

YEAR 2007 ONE MARK

Q. 41 Which of the following problems is undecidable?

(A) Membership problem for $CFGs$

(B) Ambiguity problem for $CFGs$

(C) Finiteness problem for $FSAs$

(D) Equivalence problem for $FSAs$

Q. 42 Which of the following is TRUE?

(A) Every subset of a regular set is regular

(B) Every finite subset of a non-regular set is regular

(C) The union of two non-regular sets is not regular

(D) Infinite union of finite sets is regular

YEAR 2007 TWO MARKS

Q. 43 A minimum state deterministic finite automation accepting the language $L = \{w \mid w \in (0,1)^*$, number of 0$s$ &1s in w are divisible by 3 and 5, respectively$\}$ has

(A) 15 states (B) 11 states

(C) 10 states (D) 9 states

Q. 44 The language $L = \{0^T 21^i \mid i \leq 0\}$ over the alphabet $\{0,1,2)$ is

(A) not recursive

(B) is recursive and is a deterministic CFL

(C) us a regular language

(D) is not a deterministic CFI but a CFL

Q. 45 Which of the following languages is regular?

(A) $\{WW^R \mid W \in \{0,1\}^+\}$

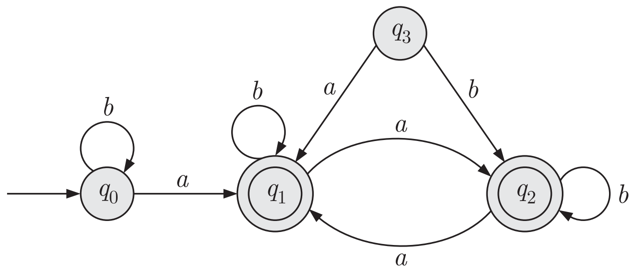
(B) $\{WW^R X \mid X, W \in \{0,1\}^+\}$

(C) $\{WXW^R X \mid X, W \in \{0,1\}^+\}$

(D) $\{XWW^R X \mid X, W \in \{0,1\}^+\}$

Common Data For Q. 46 & 47

Solve the problems and choose the correct answers.
Consider the following Finite State Automation



Q. 46 The language accepted by this automaton is given by the regular expression

(A) $b^* ab^* ab^* ab^*$ (B) $(a+b)^*$

(C) $b^* a(a+b)^*$ (D) $b^* ab^* ab^*$

Q. 47 The minimum state automaton equivalent to the above FSA has the following number of states

(A) 1 (B) 2

(C) 3 (D) 4

YEAR 2008 ONE MARK

Q. 48 Which of the following in true for the language$\{a^P \mid P$ is a prime$\}$?

(A) It is not accepted by a Turning Machine

(B) It is regular but not context-free

(C) It is context-free but not regular

(D) It is neither regular nor context-free, but accepted by a Turing machine

Q. 49 Which of the following are decidable?

1. Whether the intersection of two regular languages is infinite
2. Whether a given context-free language is regular
3. Whether two push-down automata accept the same language
4. Whether a given grammar is context-free

(A) 1 and 2 (B) 1 and 4

(C) 2 and 3 (D) 2 and 4

Q. 50 If L and $\overline{L}$ are recursively enumerable then L is

(A) regular (B) context-free

(C) context-sensitive (D) recursive

YEAR 2008 TWO MARKS

Q. 51 Which of the following statements is false?

(A) Every NFA can be converted to an equivalent DFA

(B) Every non-deterministic Turing machine can be converted to an equivalent deterministic Turing machine

(C) Every regular language is also a context-free language

(D) Every subset of a recursively enumerable set is recursive

Q. 52 Given below are two finite state automata(→indicates the start and F indicates a final state)

Y:

	a	b
→	1	2
2F	2	1

Z :

	a	b
→	2	2
2F	1	1

(A)

	a	b
-P	S	R
Q	R	S
R(F)	Q	P
S	Q	P

(B)

	a	b
-P	S	Q
Q	R	S
R(F)	Q	P
S	Q	P

(C)

	a	b
-P	Q	S
Q	R	S
R(F)	Q	P
S	Q	P

(D)

	a	b
-P	S	Q
Q	S	R
R(F)	Q	P
S	Q	P

Q. 53 Which of the following statements are true ?

1. Every left-recursive grammar can be converted to a right-recursive grammar and vice-versa
2. All ε-productions can be removed from any context-free grammar by suitable transformations
3. The language generated by a context-free grammar all of whose production are of the form $X \to w$ or $X \to wY$ (where, w is a staring of terminals and Y is a non-terminal), is always regular
4. The derivation trees of strings generated by a context-free grammar in Chomsky Normal Form are always binary trees.

(A) 1, 2, 3 and 4

(B) 2, 3 and 4 only

(C) 1, 3 and 4 only

(D) 1, 2 and 4 only

Q. 54 Match List-I with List-II and select the correct answer using the codes given below the lists:

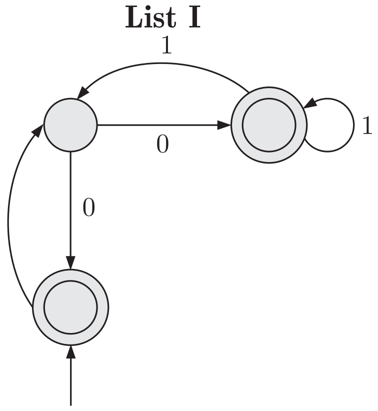
	List-I		List-II
P.	Checking that identifiers are declared before their use	1.	$L = \{a^{"}b^{"}c^{"}d^{"} \mid n \leq 1, m \leq 1\}$
Q.	Number of formal parameters in the declaration to a function agress with the number of actual parameters in a use of that function	2.	$X \to XbX \mid XcX \mid dXf \mid g$
R.	Arithmetic expressions with matched pairs of parentheses	3.	$L = \{wcw \mid w \in (a \mid b)^*\}$
S.	Palindromes	4.	$X \to bXb \mid cXc \mid \varepsilon$

Codes:

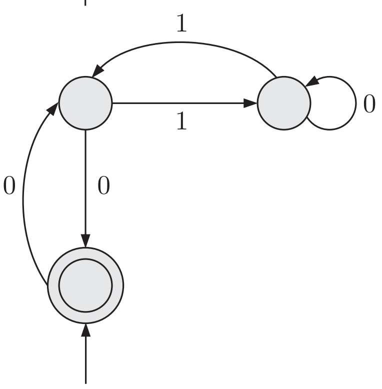
	P	Q	R	S
(A)	1	3	2	4
(B)	3	1	4	2
(C)	3	1	2	4
(D)	1	3	4	2

Q. 55 Match List I with List II and select the correct answer using the codes given below the lists:

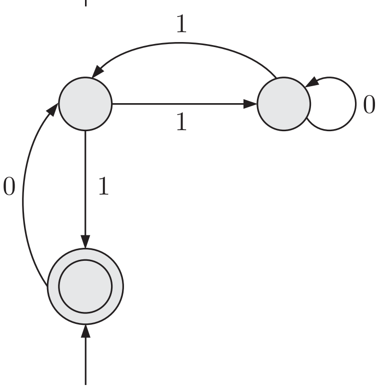
List I **List II**

a.


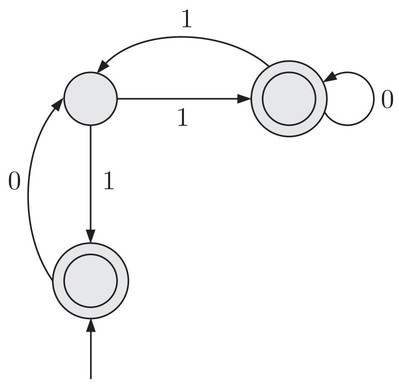
1. $\varepsilon+0(01^*1+00)^*01^*$

b.


2. $\varepsilon+0(10^*1+00)^*0$

c.


3. $\varepsilon+0(10^*1+10)^*1$

d. 

4. $\varepsilon+0(10^*1+10)^*10^*$

Code:

	a	b	c	d
(A)	2	1	3	4
(B)	1	3	3	4
(C)	1	2	3	4
(D)	3	2	1	4

Q. 56 Which of the following are regular sets?

1. $\{a^n b^{2m} \mid n \leq 0, m \leq 0\}$
2. $\{a^n b^m \mid n = 2m\}$
3. $\{a^n b^m \mid n \neq m\}$
4. $\{xcy \mid x, y \in \{a,b\}^*\}$

(A) 1 and 4 only (B) 1 and 3 only

(C) 1 only (D) 4 only

YEAR 2009 ONE MARK

Q. 57 $S \to aSa \mid bSb \mid a \mid b$

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

Q. 58 Which one of the following languages over the alphabet {0, 1} is described by the regular expression :

$(0+1)^*0(0+1)^*0(0+1)^*$?

(A) The set of all strings containing the substring 00

(B) The set of all strings containing at most two 0's

(C) The set of all strings containing at least two 0's

(D) The set of all strings that being and end with either 0 or 1

Q. 59 Which one of the following is FALSE ?

(A) There is a unique minimal DFA for every regular language

(B) Every NFA can be converted to an equivalent PDA

(C) Complement of every context-free language is recursive

(D) Every nondeterministic PDA can be converted to an equivalent deterministic PDA

Q. 60 Match all items in Group I 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.	Data flow 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

YEAR 2009 TWO MARKS

Q. 61 Given the following state table of an FSM with two states A and B, one input and one output :

Present State A	Present State B	Input	Next State A	Next State B	Output
0	0	0	0	0	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	1	0	0
0	0	1	0	1	0
0	1	1	0	0	1
1	0	1	0	1	1
1	1	1	0	0	1

If the initial state is $A = 0, B = 0$, what is the minimum length of an input string which will take the machine to the state $A = 0, B = 1$ with Output$= 1$?

(A) 3
(B) 4
(C) 5
(D) 6

Q. 62 Let $L = L_1 \cap L_2$ where L_1 and L_2 are language as defined below :

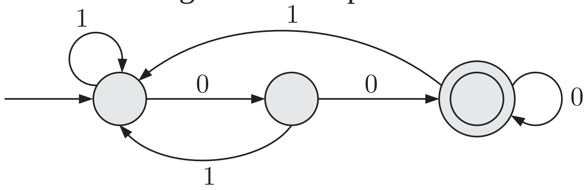
$L_1 = \{a^m b^m c a^n b^n \mid m, n \geq 0\}$

$L_2 = \{a^i b^j c^k \mid i, j, k \geq 0\}$

Then L is

(A) Not recursive
(B) Regular
(C) Context-free but not regular
(D) Recursively enumerable nut not context-free

Q. 63 The following DFA accept the set of all string over {0, 1} that



(A) Begin either with 0 or 1
(B) End with 0
(C) End with 00
(D) Contain the substring 00

YEAR 2010 ONE MARK

Q. 64 Let $L1$ be a recursive language. Let $L2$ and $L3$ be language that are recursively enumerable but not recursive. What of the following statements is not necessarily true ?

(A) $L1 - L1$ is recursively enumerable

(B) $L1 - L3$ is recursively enumerable

(C) $L2 \cap L3$ is recursively enumerable

(D) $L2 \cap L3$ is recursively enumerable

YEAR 2010 TWO MARKS

Q. 65 Let $L = \{\omega \in (0+1)^* | \omega$ has even number of 1s$\}$, i.e., L is the set of all bit strings with even number of 1s. Which one of the regular expressions below represents L ?

(A) $(0^*10^*1)^*$

(B) $0^*(10^*10^*)^*$

(C) $0^*(10^*1)^*0^*$

(D) $0^*1(10^*1)^*10^*$

Q. 66 Consider the language $L1 = \{0^i1^j | i \neq j\}$, $L2 = \{0^i1^j | i = j\}$, $L3 = \{0^i1^j | i = 2j+1\}$ $L4 = \{0^i1^j | i \neq 2j\}$.Which one of the following statements is true ?

(A) Only $L2$ is context free

(B) Only $L2$ and $L3$ are context free

(C) Only $L1$ and $L2$ are context free

(D) All are context free

Q. 67 Let ω by any string of length n in$\{0,1\}^*$. Let L be the set of all substring so ω. What is the minimum number of states in a non-deterministic finite automation that accepts L ?

(A) $n-1$

(B) n

(C) $n+1$

(D) 2^{n+1}

YEAR 2011 ONE MARK

Q. 68 Which of the following pairs have DIFFERENT expressive power?

(A) Deterministic finite automata (DFA) and Non-deterministic finite automata (NFA)

(B) Deterministic push down automata (DPDA) and Non-deterministic push down automata (NPDA)

(C) Deterministic single-tape Turing machine and Non-deterministic single-tape Turing machine

(D) Single-tape Turing machine and multi-tape Turing machine

Q. 69 The lexical analysis for a modern computer language such as Java needs the power of which one of the following machine models in a necessary and sufficient sense?

(A) Finite state automata

(B) Deterministic pushdown automata

(C) Non-deterministic pushdown automata

(D) Turing machine

Q. 70 Let P be a regular language and Q be a context-free language such that $Q \subseteq P$. (For example, let P be the language represented by the regular expression p^*q^* and Q be $\{p^n q^n \mid n \in N\}$. Then which of the following is ALWAYS regular?

(A) $P \cap Q$ (B) $P - Q$

(C) $\Sigma^* - P$ (D) $\Sigma^* - Q$

YEAR 2011 TWO MARKS

Q. 71 Consider the languages L1, L2 and L3 are given below:

L1 $\{0^p 1^q \mid p, q \in N\}$, L2 $\{0^p 1^q \mid p, q \in N \text{ and } p = q\}$ and

L3 $\{0^p 1^q 0^r \mid p, q, r \in N \text{ and } p = q = r\}$

Which of the following statements is NOT TRUE?

(A) Push Down Automata (PDA) can be used to recognize L1 and L2

(B) L1 is a regular language

(C) All the three languages are context free

(D) Turing machines can be used to recognize all the languages

Q. 72 Definition of a language L with alphabet $\{a\}$ is given as follows:

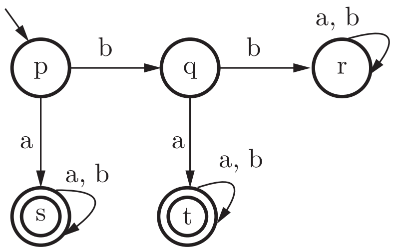
$L = \{a^{nk} \mid k > 0\}$, and n is a positive integer constant}

What is the minimum number of states needed in a dfa to recognize L?

(A) $k+1$ (B) $n+1$

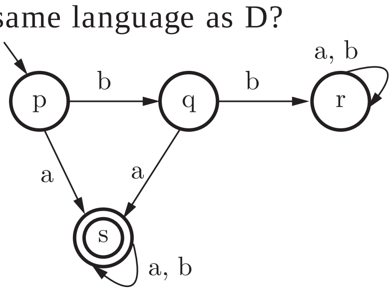
(C) 2^{n+1} (D) 2^{k+1}

Q. 73 A deterministic finite automaton (DFA) D with alphabet $\Sigma = \{a, b\}$ is given below:

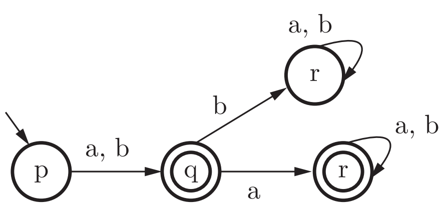


Which of the following finite state machines is a valid minimal DFA which accepts the same language as D?

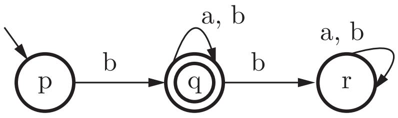
(A)



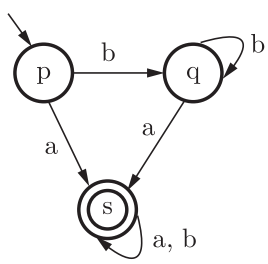
(B)



(C)



(D)



YEAR 2012 ONE MARK

Q. 74 assuming $P \neq NP$, which of the following is TRUE?

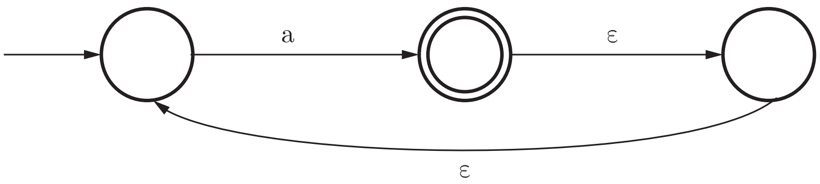
(A) NP-complete $= NP$

(B) NP-complete $\cap P = \varnothing$

(C) NP-hard $= NP$

(D) $P = NP$-complete

Q. 75 What is the complement of the language accepted by the NFA shown below? Assume $\Sigma = \{a\}$ and ε is the empty string.



(A) $\varnothing$

(B) $\{\varepsilon\}$

(C) $a*$

(D) $\{a, \varepsilon\}$

Q. 76 Which of the following problems are decidable?

1. Does a given program ever produce an output?
2. If L is a context-free language, then, is $\overline{L}$ also context-free?
3. If L is a regular language, then, is $\overline{L}$ also regular
4. If L is a recursive language, then, is $\overline{L}$ also recursive?

(A) 1, 2, 3, 4

(B) 1, 2

(C) 2, 3, 4

(D) 3, 4

Q. 77 Given the language $L = \{ab, aa, baa\}$, which of the following strings are in $L*$?

1. *abaabaaabaa*
2. *aaaabaaaa*
3. *baaaaabaaaab*
4. *baaaabaa*

(A) 1, 2 and 3

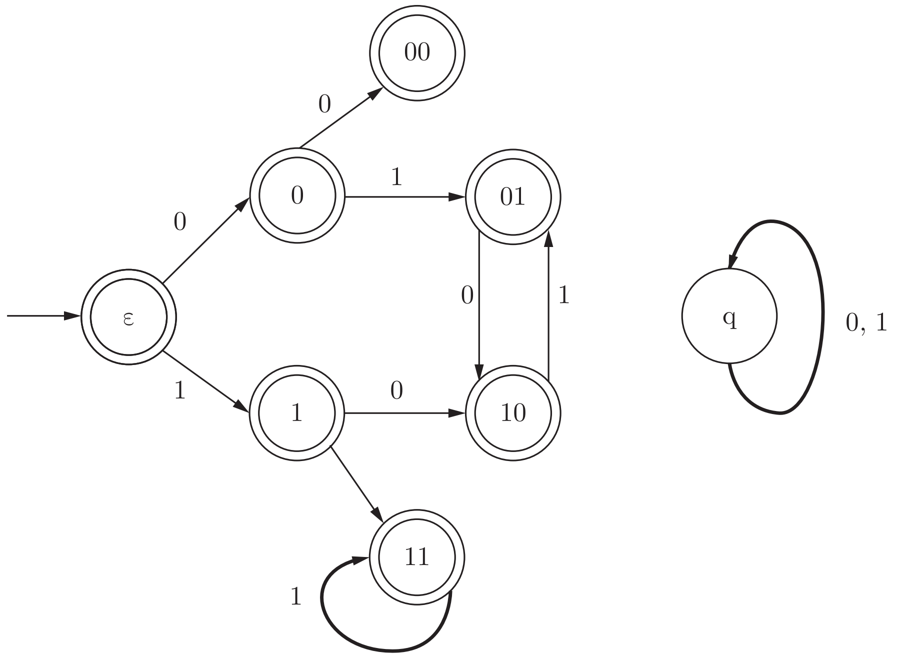
(B) 2, 3 and 4

(C) 1, 2 and 4

(D) 1, 3 and 4

YEAR 2012 TWO MARKS

Q. 78 Consider the set of strings on $\{0,1\}$ in which, every substring of 3 symbols has at most two zeros. For example, 001110 and 011001 are in the language, but 100010 is not. All strings of length less than 3 are also in the language. A partially complete DFA that accepts this language is shown below.
The missing arcs in the DFA are



(A)

	00	01	10	11	q
00	1	0			
01				1	
10	0				
11			0		

(B)

	00	01	10	11	q
00		0			1
01		1			
10				0	
11		0			

(C)

	00	01	10	11	q
00		1			0
01		1			
10			0		
11		0			

(D)

	00	01	10	11	q
00		1			0
01				1	
10	0				
11			0		

****

ANSWER KEY

Theory of Computation									
1	2	3	4	5	6	7	8	9	10
(A)	(B)	(C)	(C)	(C)	(A)	(B)	(A)	(A)	(B)
11	12	13	14	15	16	17	18	19	20
(C)	(A)	(?)	(D)	(C)	(C)	(C)	(A)	(B)	(C)
21	22	23	24	25	26	27	28	29	30
(C)	(A)	(B)	(C)	(B)	(C)	(B)	(D)	(A)	(B)
31	32	33	34	35	36	37	38	39	40
(B)	(?)	(B)	(D)	(C)	(D)	(?)	(B)	(B)	(D)
41	42	43	44	45	46	47	48	49	50
(B)	(B)	(A)	(B)	(C)	(C)	(B)	(D)	(B)	(D)
51	52	53	54	55	56	57	58	59	60
(D)	(A)	(C)	(C)	(C)	(A)	(B)	(C)	(D)	(B)
61	62	63	64	65	66	67	68	69	70
(A)	(C)	(A)	(B)	(B)	(D)	(C)	(B)	(A)	(C)
71	72	73	74	75	76	77	78		
(C)	(B)	(A)	(B)	(B)	(D)	(C)	(D)		