Q. No. IT - 502 / 100

B. Tech./Odd
2016-17/Reg

2016-17

THEORY OF COMPUTATION

IT - 502

Full Marks : 70 Time : Three Hours

The figures in the margin indicate full marks.

Answer Question no. 1, 2 and any *six* from the rest.

1. Select the most correct alternative. Justify your answer wherever necessary.

1.1 The minimum length string generated by the regular expression $(a+b+c)(a+b)(a)$ over $\Sigma=\{a, b, c\}$ is

(i) 3

(ii) 6

(iii) 1

(iv) 0

1.2 Consider the following grammars over $\Sigma=\{(\,,\,)\}$ with balanced parenthesis.

Grammar 1 Grammar 2

$S \to SS$ $S \to (S)S$

P.T.O.

$S \rightarrow (S)$ $\qquad$ $S \rightarrow (S)$

$S \rightarrow \phi$ $\qquad$ $S \rightarrow (\ )S(\ )$

Which of the above grammar is ambiguous

(i) Only Grammar 1

(ii) Only Grammar 2

(iii) Both the grammar

(iv) None of the above

1.3 Which are not regular

(A) $L = \{a^n b^n \mid n > 0\}$

(B) $L = \{a^n b^m c^n \mid m, n > 0\}$

(C) $L = \{a^{m+n} \mid m, n > 0\}$

(i) Only A

(ii) Only B

(iii) Only C

(iv) Only A and C

1.4 Let aAbBc be a sentential form where $a, b, c \in \Sigma$ and $A, B \in V_N$. Consider the production rules

$aA \rightarrow aa$

$bB \rightarrow bb$

The immediate next sentential form using the LMD (Left Most Derivation) would be

(i) aAbbc

(ii) aabBc

(iii) aabbc

(iv) None of the above

1.5 The transition function of a Deterministic PDA is defined as

(i) $\delta : Q \times \Sigma \times \Gamma \rightarrow Q \times \Sigma$

(ii) $\delta : Q \times \Sigma \times \Gamma \rightarrow Q \times \Sigma^*$

(iii) $\delta : Q \times \{\Sigma \cup \phi\} \times \Gamma \rightarrow Q \times \Gamma^*$

(iv) $\delta : Q \times \{\Sigma \cup \phi\} \times \Gamma \rightarrow Q \times \Gamma$

1.6 The acceptance criteria of an empty stack PDA is

(q_0 initial state, w the input, Z initial STACK, q_i general state, q_f final state, $\alpha \in \Gamma^*$, $\beta \in \Sigma^*$)

P.T.O.

(i) $ID_0(q_0, w, Z) \rightarrow ID_F(q_i, \phi, \phi)$

(ii) $ID_0(q_0, w, Z) \rightarrow ID_F(q_f, \phi, \phi)$

(iii) $ID_0(q_0, w, Z) \rightarrow ID_F(q_f, \phi, \alpha)$

(iv) $ID_0(q_0, w, Z) \rightarrow ID_F(q_i, \beta, \phi)$

1.7 Consider the grammar G as below :

$S \rightarrow XSX \mid R$

$R \rightarrow aTb \mid bTa$

$T \rightarrow XTX \mid X \mid \phi$

$X \rightarrow a \mid b$

Which of the following is not in $L(G)$

(i) *abab*

(ii) *baba*

(iii) *bbbb*

(iv) *aabb*

1.8 *RE* be the set of recursively enumerable language, and *R* be the set of recursive language. Which of the following statement is correct.

(i) $RE \subset R$

(ii) $R \subset RE$

(iii) R and RE are disjoin

(iv) None of the above

1.9 Which of the following productions are in Chomsky Normal Form (CNF).

1. $A \rightarrow bC$

2. $A \rightarrow BC$

3. $A \rightarrow c$

(i) Only Production 1.

(ii) Production 1 and 2 both.

(iii) Production 2 and 3 both.

(iv) None of the above.

1.10 Let (10 + 01)1*(11 + 00) be the regular expression for the language L. Find the regular expression for the language L^R.

(i) (01 + 10) 1* (11 + 00)

(ii) (11 + 00) *1 (10 + 01)

(iii) (11 + 00) 1* (10 + 01)

(iv) None of the above.

1.11 The intersection of the {0*1} and {10*} would be

(i) {0*1*}

(ii) {1}

P.T.O.

(iii) $\{1^*\}$

(iv) None of the above

1.12 The maximum length string generated by the regular expression $(a+aa+aaa)b(c+cc+ccc)$ is

(i) 3

(ii) 6

(iii) 7

(iv) ∞

1.13 L_1 and L_2 are two regular languages. Consider the two statements :

Statement 1 : $L_1 \cap L_2$ is regular language.

Statement 2 : If $L_2 \subset L_1$ then $L_1 - L_2$ is always regular.

(i) Only Statement 1 is correct

(ii) Both Statement 1 and 2 are correct

(iii) None of the Statement is correct

(iv) Only Statement 2 is correct

1.14 The regular expression of the language over $\Sigma = \{1, 0\}$ where the 3rd alphabet from right is 0. (Assume the strings are at least of length 3)

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

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

(iii) $(0(1+0)(1+0))^+$

(iv) $(1+0)^*000$

1.15 The Turing Machine has the following states of Acceptance

(i) Accept with Halt and Reject with Halt

(ii) Accept with Halt, Reject with Halt and Loop for ever

(iii) Accept with Halt

(iv) Accept with Halt and Loop for ever

1.16 Consider the following Problem Definition

Problem 1: *Weather a given number n is Prime.*

Problem 2: *G_1 and G_2 are two grammars of same type. Whether $L(G_1) = L(G_2)$.*

(i) Problem 1 is recursively enumerable

(ii) Problem 2 is recursive

(iii) Problem 2 is recursively enumerable

(iv) Problem 1 is recursive

P.T.O.

1.17 L_1 is a context free language and L_2 is a regular language. Which of the following is FALSE ?

(i) $L_1 \times L_1$ is context free

(ii) $L_1 \cap L_2$ is regular

(iii) $\Sigma - L_1$ is context free

(iv) L_1^* is context free

1.18 Consider the NDFSM as in the following matrix :

	a	b
p_0	p_0, p_2	p_0, p_1
p_1	p_1	p_0, p_1
p_2	p_2, p_1	p_2

How many final states would be there for the DFSM of the given NDFSM ?

(i) 1

(ii) 2

(iii) 3

(iv) 4

1.19 Consider the NDFSM in Question 1.18. Which of the following regular expression represents the FSM.

(i) b^*

(ii) a^*

(iii) ab^*

(iv) ϕ

1.20 Consider the DFSM given below

The number of states in the minimized FSM of M is

(i) 1

(ii) 2

(iii) 3

(iv) 4 $1 \times 20 = 20$

2. Select the most correct alternative. Give your justification.

2.1 Consider the PDA as follow :

$$\delta(q_0, a, Z) \rightarrow (q_0, AZ) \quad \delta(q_0, b, Z) \rightarrow (q_0, BZ)$$

$$\delta(q_0, a, A) \rightarrow (q_0, AA), (q_0, \phi)$$

$$\delta(q_0, b, B) \rightarrow (q_0, BB), (q_0, \phi)$$

$$\delta(q_0, a, B) \rightarrow (q_0, AB) \quad \delta(q_0, b, A) \rightarrow (q_0, BA)$$

$$\delta(q_0, \phi, Z) \rightarrow (p_f, \phi)$$

Let we input the strings

A abba

B abbaab

P.T.O.

The PDA will accept

(i) Only A

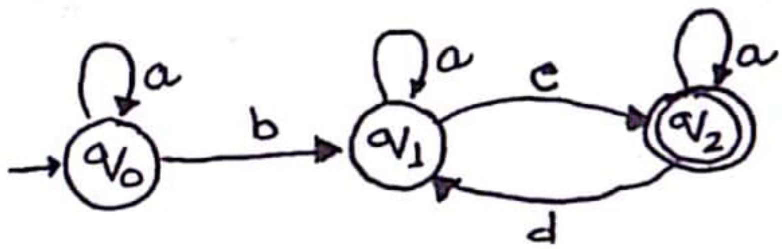
(ii) Only B

(iii) Both A and B

(iv) Rejects both A and B

2.2 Consider the following DFSM

The regular expression of the FSM is



(i) $a^*\left(ba^*(c+d)\right)^*a^*$

(ii) $(a+b)a^*(c+d)^*a$

(iii) $a^*ba(c+d)^*a^*$

(iv) $a^*ba^*c(a+da^*c)^*$

2.3 Consider the following DFSM that recognizes the language L :

How many Final States are there for the DFSM that recognizes the language $\Sigma^* - L$.

(i) 1

(ii) 2

(iii) 3

(iv) 4

2.4 Consider the following context free grammar

$S \rightarrow aSa \mid bSb \mid c$

How many additional nonterminals would be required to form the grammar to Chomsky's Normal Form (CNF)

(i) 1

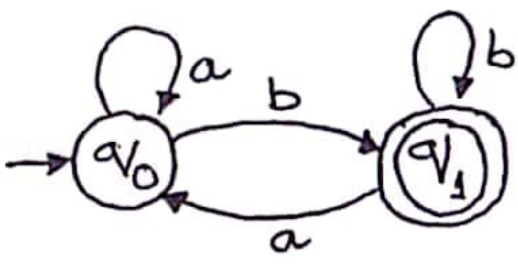
(ii) 2

(iii) 3

(iv) 4

2.5 Consider the DFSM as below :

The Arden's State Equation for q_0 is



(i) $q_0 = aq_0 + aq_1$

(ii) $q_0 = q_0a + q_1a$

(iii) $q_0 = \phi + aq_0 + aq_1$

(iv) $q_0 = \phi + q_0a + q_1a$

P.T.O.

2.6 Let T be a Turing machine with the transition as follows :

$$\delta(q_0, 0) \to (q_1, 0, R) \qquad \delta(q_0, 1) \to (q_2, 1, R)$$

$$\delta(q_1, 0) \to (q_0, 0, L) \qquad \delta(q_2, 1) \to (q_0, 1, L)$$

$$\delta(q_1, 1) \to (q_2, 1, R) \qquad \delta(q_2, 0) \to (q_1, 0, R)$$

$$\delta(q_1, \mathbb{B}) \to (q_1, \mathbb{B}, H) \qquad \delta(q_2, \mathbb{B}) \to (q_2, \mathbb{B}, H)$$

where q_h is the halt state. $\mathbb{B}$ is the blank symbol.

For what input the TM loops for ever. Let initially TM be at left of the input.

(i) 1010

(ii) 0101

(iii) 1100

(iv) None of the above

2.7 Consider the context free grammar $S \to aSb \mid c$. The Nondeterministic PDA that accepts the language is given as :

$$\delta_1(q, a, a) \to (q, \phi)$$

$$\delta_2(q, b, b) \to (q, \phi)$$

$$\delta_3(q, c, c) \to (q, \phi)$$

δ_4 and δ_5

Which of the following is the correct ?

(i) $\delta_4(q, S, \phi) \to (q, bSa)$

$\delta_5(q, S, \phi) \to (q, c)$

(ii) $\delta_4(q, \phi, S) \to (q, bSa)$

$\delta_5(q, \phi, S) \to (q, c)$

(iii) $\delta_4(q, S, \phi) \to (q, aSb)$

$\delta_5(q, S, \phi) \to (q, c)$

(iv) $\delta_4(q, \phi, S) \to (q, aSb)$

$\delta_5(q, \phi, S) \to (q, c)$

2.8 The regular expression $(11^*00+0)^*1^*$ defines the regular set

(i) All binary strings having at least one 0

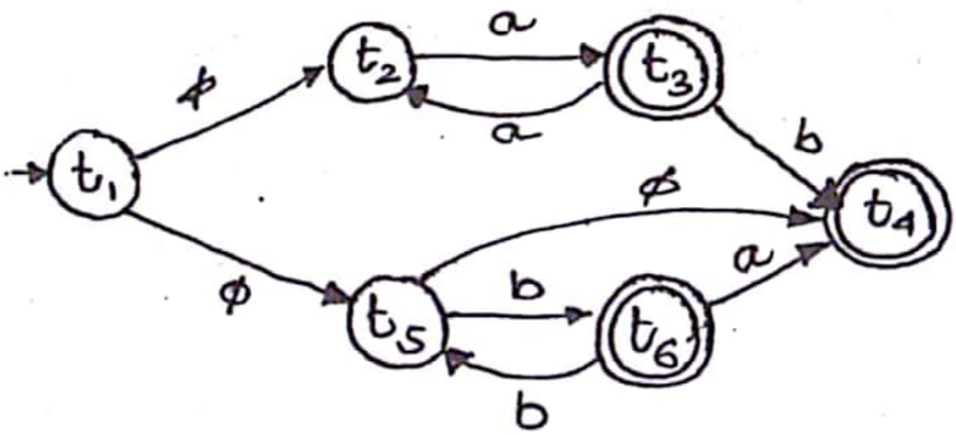
(ii) All binary strings having no consecutive 0

(iii) All binary strings having no substring as 101

(iv) All binary strings having no more 0s than 1s

2.9 Consider the NDFSM as below :

The $\phi-CLOSURE\{t_1\}$ is



(i) $\{t_1, t_2, t_5\}$

(ii) $\{t_1\}$

(iii) $\{t_1, t_2, t_4, t_5\}$

(iv) $\{t_4\}$

2.10 Consider the context free grammar

$S \rightarrow aSbS \mid bSaS \mid \phi$

The height of the derivation for the string abbaba would be

(i) 4

(ii) 5

(iii) 6

(iv) 7

2×10=20

3.1 Design the Grammar for the following (any *one*)

(A) All strings over $\{a, b\}$ those start and end with the same alphabet.

(B) All strings over $\{1, 0\}$ those are divisible by 3.

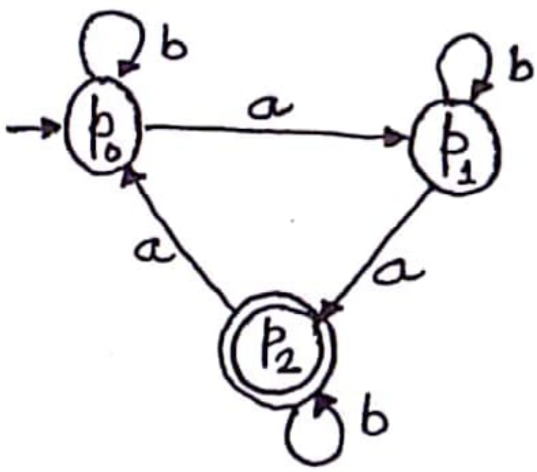
3.2 Design regular expression for the following (any *one*).

(A) All strings over $\{a, b\}$ having at most two as.

(B) All strings over $\{a, b\}$ where the length of the strings is divisible by 3. 2.5×2=5

4. Design the DFSM over $\Sigma = \{0, 1\}$ that accepts the strings of binary having even length and every 1 is followed by at least one 0. 5

5. Find the regular expression using Arden's Theorem of the given DFSM.



5

6. Design the Deterministic PDF (Empty Stack) for the following (any *one*).

(A) $L = \left\{a^n b^{2n} \middle| n > 0\right\}$

(B) All strings over $\{a, b\}$ with equal number of as and bs.

5

7. Using pumping lemma show that the following languages are not regular (any *one*).

(A) $L = \left\{a^{i^2} \middle| i > 0\right\}$. All strings over $\{a\}$ with length as perfect square.

(B) $L = \left\{a^n b^n \middle| n > 0\right\}$. 5

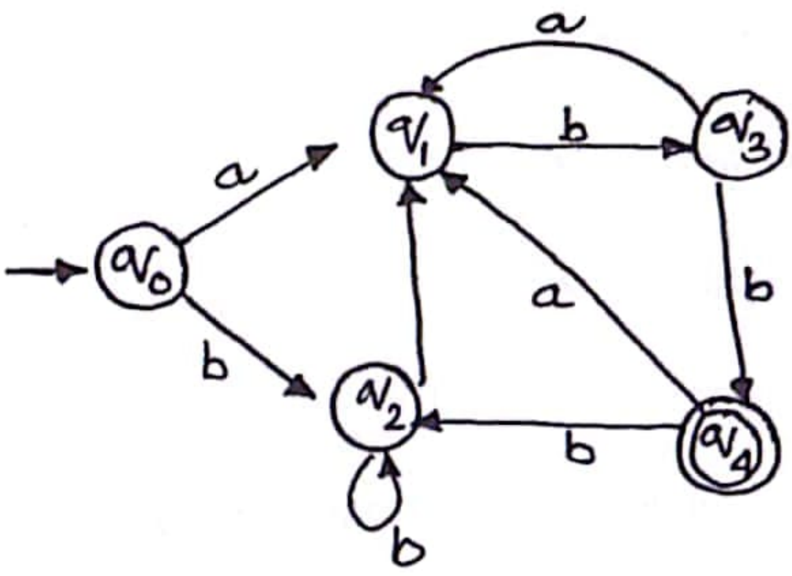
8. Design Turing Machine for the following (any *one*). Consider that the HEAD would be initially placed at the Left of the Input.

(A) L are the strings of palindrome over $\{a, b\}$.

(B) L are the binary strings with equal number of $1s$ and $0s$.

5

9. Minimize the following DFSM.



5

10. Let M_1 be a PDA that accepts the language L_1 and given below :

$$\delta(q_0, a, Z) \to (q_1, AZ)$$

$$\delta(q_1, a, A) \to (q_1, AA)$$

$$\delta(q_1, b, A) \to (q_1, \phi)$$

$$\delta(q_1, \phi, Z) \to (q_f, \phi)$$

(q_0 initial state, Z initial Stack, q_f final state)

And M_2 be the FSM that accepts the language L_2 and given below :

$$\delta(p_0, a) \rightarrow p_0$$

$$\delta(p_0, b) \rightarrow p_1$$

$$\delta(p_1, b) \rightarrow p_1$$

(p_0 initial state, p_1 final state)

Design the PDA that accepts the language $L_1 \cap L_2$. 5

2014 - 15

THEORY OF COMPUTATION

IT - 502

Time - Three Hours Full Marks - 70

The figures in the margin indicate full marks.

Answer **PART-A** and *any five*(5) from **PART-B.**

Part - A

1. Select the correct alternative. Answer *any 20* questions.

(1.1) The grammar $S \rightarrow aSb \mid ab$ generates all strings

(i) $\{a^n b^n \mid n > 1\}$

(ii) $\{a^n b^n \mid n \geq 0\}$

(iii) $\{a^n b^n \mid n \geq 1\}$

(iv) equal number of a's and b's.

(1.2) Which of the following are not recognized by a FSM (the $\Sigma = \{a, b\}$)

a At least one a at the end.

b Equal number of as and bs.

c Even number of as and bs.

(i) Only a and b.

(ii) Only b and c.

(iii) Only c and a.

(iv) All the above.

(1.3) The acceptance criterions of TM is:

(i) {Accept, Reject}

(ii) {Accept with Halt, Reject}

(iii) {Accept with Halt, Reject with Halt, loop for ever}

(iv) {Accept with empty TAPE, Reject with halt, Reject with symbols in TAPE}

(1.4) If Right-Most-Derivation is used on the sentential form $aABb$ where the productions are

$$A \to aA$$

$$B \to Bb$$

The immediately next sentential form would be

(i) $aaABb$

(ii) $aABbb$

(iii) $aaABbb$

(iv) None of the above

(1.5) The production $aA \to aa$ is a

(i) type 0 production

(ii) type 1 production

(iii) type 2 production

(iv) type 3 production

(1.6) The acceptance criteria of an empty STACK PDA is defined as:

(Consider q_0 is the initial state, Z_0 initial Stack Symbol, $q_i \in Q$ is the set of states and $w \in \Sigma^*$)

(i) $(q_0, w, Z_0) \overset{*}{\to} (q_i, \phi, \phi)$

(ii) $(q_0, w, Z_0) \overset{*}{\to} (q_i, \phi, \beta)$

(iii) None of the above

(1.7) The minimum number of states require to recognize the language

$$1 = \{a^{2k} \mid k \geq 1\}$$

(i) 1

(ii) 2

(iii) 3

(1.8) In Chomsky's normal form, all the productions are

(i) $A \rightarrow BC|a$

(ii) $A \rightarrow aA|a$

(iii) $A \rightarrow \alpha$

(NOTE: $A, B, C \in V_N$, $a \in \Sigma$ and $\alpha \in (V_N \cup \Sigma)^*$)

(1.9) Consider the following grammars over $\Sigma = \{a, b\}$

$S \rightarrow aSb \mid aA \mid Bb$

$A \rightarrow aA$

$B \rightarrow Bb$

(i) $L = \{a^n b^m \mid n < m\}$

(ii) $L = \{a^n b^m \mid n > m\}$

(iii) $L = \{a^n b^m \mid n \neq m\}$

(iv) $L = \{a^n b^m \mid n = m\}$

(1.10) Let the regular expression of a language L over $\Sigma = \{0, 1\}$ be $(11 + 00)^*$. The regular expression of L^R (reverse of L) is

(i) $(00 + 11)^*$

(ii) $(01 + 01)^*$

(iii) $(00)^* + (11)^*$

(iv) None of the above

(1.11) The regular expression of the language over $\Sigma = \{1, 0\}$ where the first and last alphabet are same.

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

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

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

(iv) None of the above

(1.12) Let a PDA move from $ID\ (\phi, q_i, AAZ_0) \vdash (\phi, q_j, AZ_0)$. The corresponding transition function of the PDA is

(i) $(q_i, \phi, A) \rightarrow (q_j, \phi)$

(ii) $(q_i, \phi, A) \rightarrow (q_j, AB)$

(iii) $(q_i, \phi, A) \rightarrow (q_j, BA)$

(1.13) Let L_1 and L_2 are two context-free languages, which of the following is correct:

(i) $L_1 \cap L_2$ is context-free

(ii) $L_1 \cup L_2$ is context-free

(iii) $\Sigma^* - L_1$ (complement of L_1) is always context-free

(1.14) Chomsky normal form all productions are (consider $a \in \Sigma$, $A, B, C \in V_N$ and $\alpha \in (\Sigma \cup V_N)^*$

(i) $A \rightarrow aB|a$

(ii) $A \rightarrow aB|BC$

(iii) $A \rightarrow a\alpha$

(1.15) Let L be a regular language over Σ. Then, there exists a constant n such that for every $w \in L$ with $|w| \geq n$ we have x, y, z substrings of w (i.e. $w = xyz$) such that

(i) $|xy| \leq n$, $|y| \geq n$ and $xy^iz \in L$ for $i = 0, 1, \ldots$

(ii) $|xy| \leq n$, $|y| \geq 1$ and $xy^iz \in L$ for $i = 0, 1, \ldots$

(iii) $|xy| \leq n$, $|y| \geq 1$ and $xy^iz \in L$ for $i = 1, 2, \ldots$

(iv) $|xy| \leq n$, $|y| \geq n$ and $xy^iz \in L$ for $i = 1, 2, \ldots$

(1.16) Let L_1 and L_2 be two regular language. Which of the following is false

(i) $L_1 \cap L_2$ is regular

(ii) $L_1 \times L_2$ is regular

(iii) $\Sigma^* - L_1$ is nor regular (complement of L_1)

(iv) All the above are true

(1.17) Let L_1 be a regular language and L_2 be a context free language. Which of the following is false

(i) $L_1 \cap L_2$ is always CFL

(ii) $L_1 \times L_2$ is always CLF

(iii) $\Sigma^* - L_2$ is always CLF (complement of L_2)

(iv) All the above are true

(1.18) The set R is called *recursive* if

(i) For which there exists at least one TM that halts on every input $r \in R$

(ii) For which there exists at least one TM that runs on every input $r \in R$ and either halts or ioops for ever.

(iii) For which there exists an universal TM which always halts on every input $r \in R$.

(iv) All the above are true

(1.19) Let L be a regular language recognized by DFSM $M = (Q, \Sigma, q_0, \delta, F)$. For all $q_i \in Q$, $\mathbb{Q}_i$ represents the equivalence class corresponds to stare q_i. Let there exists a transition $\delta(q_i, x) \rightarrow q_j$ where $q_j \in Q$ then

(i) $\forall wx \in \mathbb{Q}_i$ where $w \in \mathbb{Q}_i$

(ii) $\forall wx \in \mathbb{Q}_j$ where $w \in \mathbb{Q}_i$

(iii) $\forall wx \in L$ where $w \in \mathbb{Q}_i$

(iv) None of the above

(1.20) Which of the following would be recognized by a FSM

(i) All palindromes over $\Sigma = \{a, b\}$

(ii) All strings ww where $w \in \{a, b\}^*$

(iii) All strings w where $w \in \{a, b\}^*$ and having even number of as.

(iv) None of the above

(1.21) Let $\Sigma = \{a, b, c, d\}$, and L be the regular set described by the regular expression

$$a(a + b)(a + b + c)(a + b + c + d)$$

The minimum length string in L is of length

(i) 1

(ii) 2

(iii) 3

(iv) 4

2. Select the correct alternatives with justification. Answer *any ten* questions.

(2.1) Which of the following grammar is ambiguous

GRAMMAR 1: $S \to aSbS \mid bSaS \mid \phi$

GRAMMAR 2: $S \to aB \mid bA\phi$

$A \to a \mid aS \mid bAA$

$B \to b \mid bS \mid aBB$

(i) Only GRAMMAR 1

(ii) Only GRAMMAR 2

(iii) Both GRAMMAR 1 & GRAMMAR 2

(iv) None of the above

(2.2) The transition functions of a PDA is as follows:

$(q_0, a, Z) \rightarrow (q_1, AZ)$

$(q_0, b, Z) \rightarrow (q_1, BZ)$

$(q_1, a, A) \rightarrow (q_1, AA)$

$(q_1, a, B) \rightarrow (q_1, \phi)$

$(q_1, b, B) \rightarrow (q_1, BB)$

$(q_1, b, A) \rightarrow (q_1, \phi)$

$(q_1, \phi, Z) \rightarrow (q_f, \phi)$

Which of the following string are accepted by the PDA.

q_0 is the initial state, Z initial Stack Symbol, q_f final state.

(i) (FIRST) equal number of *a*s and *b*s

(ii) (SECOND) even number of *a*s and *b*s

(iii) both FIRST and SECOND

(2.3) Consider the CFG G_1 with the productions as

$$S \rightarrow aSa \mid bSb \mid c$$

Let G_2 be the Chomsky Normal Form of G_1. The additional number of nonterminals (minimum) and the number of productions in the grammar G_2 would be

(i) Additional nonterminals: 4, Number of productions: 7

(ii) Additional nonterminals: 5, Number of productions: 8

(iii) Additional nonterminals: 3, Number of productions: 7

(2.4) Consider the following DFSM in Figure 1:

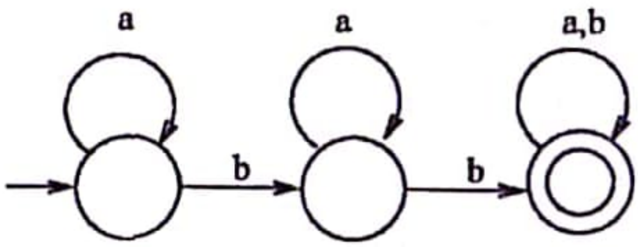


Figure 1: Figure for question 2.4

The number of length-3 strings which are not accepted by the FSM is

(i) 6

(ii) 7

(iii) 4

(2.5) Let T be a Turing machine with the transition as follows:

$\delta(q_0,0) \rightarrow (q_1,0,R)$ $\delta(q_0,1) \rightarrow (q_2,1,R)$

$\delta(q_1,0) \rightarrow (q_0,0,R)$ $\delta(q_2,1) \rightarrow (q_0,1,L)$

$\delta(q_1,1) \rightarrow (q_2,1,R)$ $\delta(q_2,0) \rightarrow (q_1,0,R)$

$\delta(q_1,\mathrm{B}) \rightarrow (q_f, \mathrm{B}, H)$ $\delta(q_2,\mathrm{B}) \rightarrow (q_2, \mathrm{B}, H)$

where q_h is the halt state. B is the blank symbol.

For what input the TM loops for ever. Let initially TM be at left of the input.

(i) 1010

(ii) 0101

(iii) 1100

(iv) None of the above

(2.6) The regular expression of the following DFSM in Figure 2 is

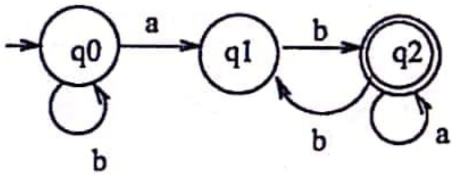


Figure 2: Figure for question 2.6

(i) $b^*(ab)\,(b+a)^*b$

(ii) $b^*(ab)\,(bb+a)^*$

(iii) $b^*(ab+a)^*bb$

(2.7) The regular expression of the following FSM in figure 3 is

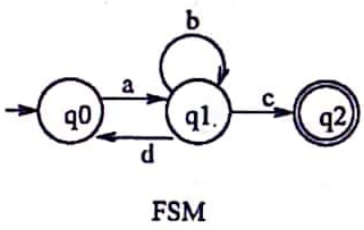


Figure 3: Figure for question 1.14

(i) $(ab^*d)^*ab^*c$

(ii) $(ab^*d)ab^*c$

(iii) $(ab^*d)(ab^*c)^*$

(2.8) Consider the NDFSM in Figure 4 The ϕ CLOSURE {6, 7}

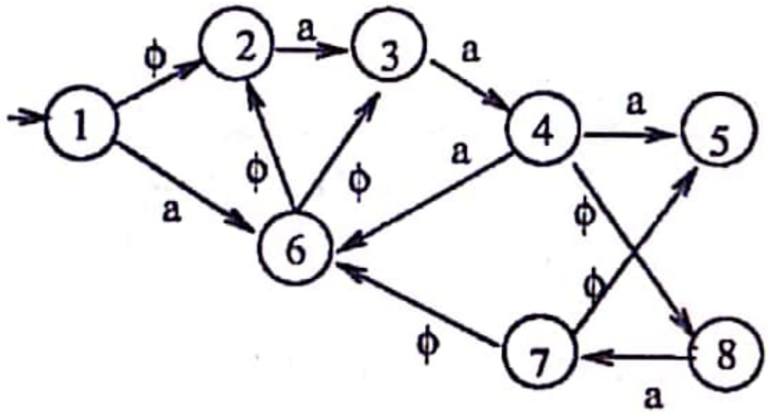


Figure 4: Figure for question 2.8

(i) {6, 2, 3, 7}

(ii) {2, 3, 5}

(iii) {6, 2, 3, 7, 5}

(2.9) Let M is a DFSM as in Figure 5. Let M be the complement of M.

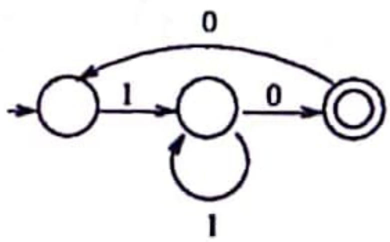


Figure 5: Figure for question 2.9

The number of final states in M would be

(i) 1

(ii) 2

(iii) 3

(2.10) The NDFSM is as follows

	a	b
q_0	q_0, q_1	q_2
q_1	q_1, q_2	q_2
q_2		q_2

q_0 be the initial state and q_2 be the final state.

The number of state and the number of final states in the DFSM is

(i) Number of states: 5, Number of final states: 2

(ii) Number of states: 4, Number of final states: 1

(iii) Number of states: 4, Number of final states: 2

(2.11) The regular expression $(0+\phi)(1+10)^*$ describes

(i) Binary strings with every 1 is followed by at lease one 0

(ii) Binary strings with no consecutive 0s

(iii) Binary strings with twice number of 1s then 0s.

2.5×10

Part - B

(3.1) Design grammar for the language over the alphabet $\Sigma = \{a, b, \#\}$ where $L = \{w\#x \mid w^R$ is a substring of x, $w \in \{a, b\}^*\}$

Find the regular expression over $\Sigma=\{a, b\}$ having at most two as.

Or,

(3.2) Design grammar for the language over $\Sigma = \{1, 0\}$ where the binary strings are divisible by 3.

Find regular expression over $\Sigma = \{1, 0\}$ where 10 does not appear as a substring.

2.5×2

4. Using Pumping Lemma show that $L = \{a^{2^i} \mid i \geq 1\}$ is not regular.

Or,

Using Pumping Lemma show that $L = \{a^n b^n \mid n \geq 1\}$ is not regular.

5

P.T.O

5. Let $L1$, $L2$ be two regular languages recognized by $M1$ and $M2$ respectively over the alphabet set $\Sigma = \{a, b\}$ as in the Figure 6. Find the DFSM for $L1 \cap L2$. 5

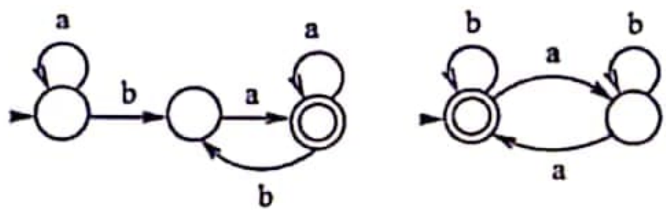


Figure 6: Figure for question 5

6. Find the minimum state DFSM for the FSM in Figure 7. 5

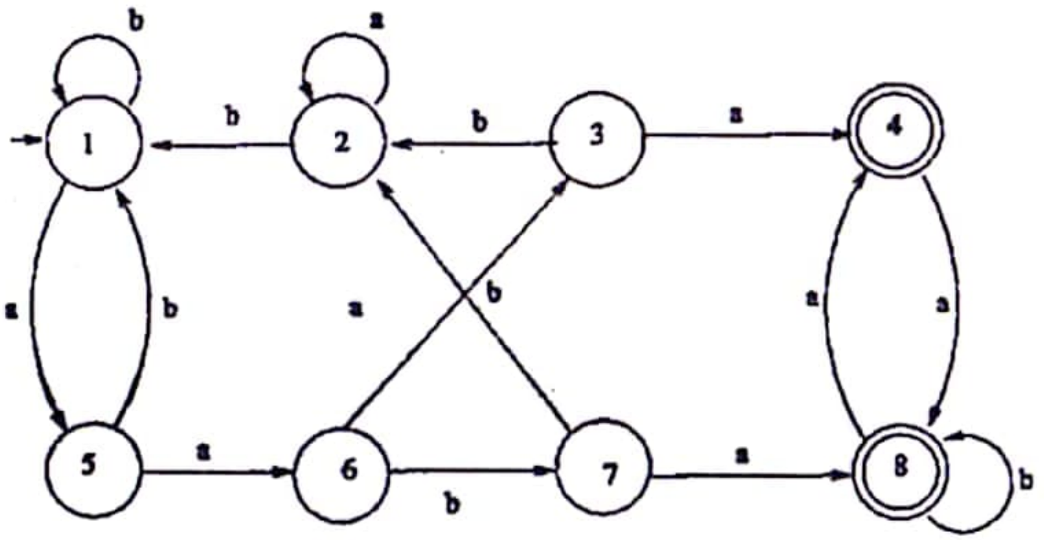


Figure 7: Figure for question 6

7. Design Push Down Automata to recognize all balanced parenthesis over $\Sigma = \{(,)\}$.

Or,

Design Push Down Automata to recognize all strings over $\Sigma = \{a, b\}$ where the number of as is twice the number of bs.

8. The context free grammar G having the productions as follows:

$$S \rightarrow aYbbX$$

$$X \rightarrow aXbb \mid abb$$

$$Y \rightarrow cYdd \mid cdd$$

Design a nondeterministic PDA for the language $L(G)$.

Show the PDA's IDs during the processing of string *aabbbbcdd*. 5

9. Design TM for the following (*any one*)

(a) $L = \{w \mid w \in \{a, b\}^*$ and w is a palindrom$\}$

(b) $L = \{w \mid w \in \{0, 1, 2\}^*$ the sum of the symbols is divisible by 3$\}$ for example $1221222 \in L$ as $1+2+2+1+2+2+2= 12$ 5
