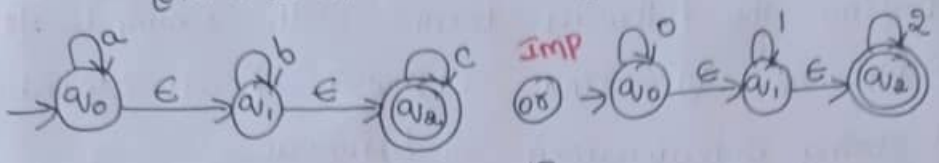
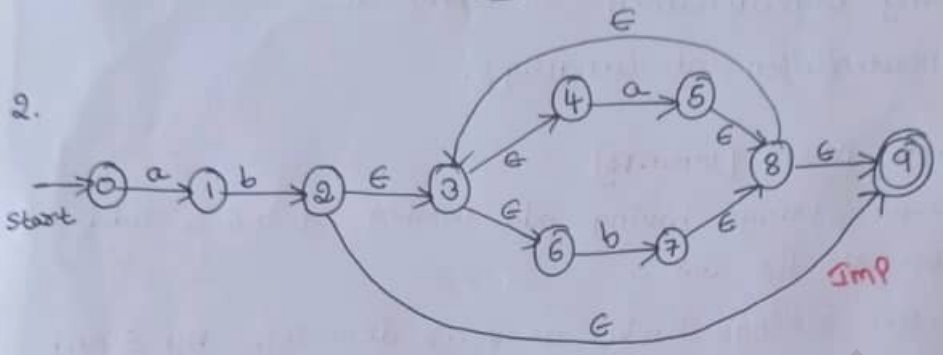
1) Define the following terms with Example : [8m]
   a) Alphabet. b) string. c) Power of an alphabet.
   d) String Concatenation. e) Language.
   f) Concatenation at Languages.

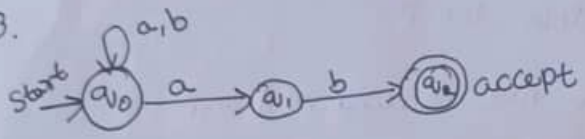
2) Design DFSM. [10marks]
   1. To accept strings having odd number of a's & odd number of b's. Imp
   2. To accept strings having no. of a's divisible by 5 and number of b's divisible by 3.
   3. $L = \{w \in \{0,1\}^* : w$ does not Ending of $1\}$ Imp
   4. $L = \{w \in \{a,b\}^* :$ Every a in w is immediately preceded & followed by $b\}$
   5. To accept $L = \{w(ab+ba) \mid w \in \{a,b\}^*\}$
   6. To accept $L = \{wbab \mid w \in \{a,b\}^*\}$
   7. To accept strings over $\{a,b\}$ such that Each block of 5 (length five) Consecutive symbols have atleast two a's Imp
   8. To accept strings having Even no of a's & Even no of b's.
   9. To accept binary numbers divisible by 5 Imp
   10. Obtain a DFA to accept the language $L = \{w : |w| \bmod 5 \neq 0\}$ on $\Sigma = \{a,b\}$.

Convert the following ε-NDFSm of DFSm

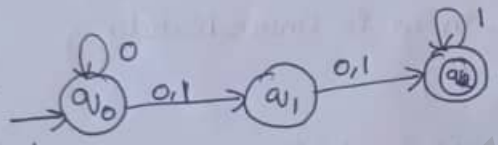
[ε NFA to DFA Conversion]

1. 

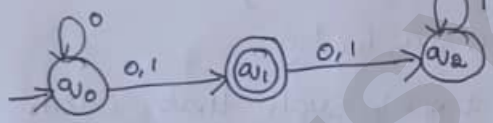
2. 

3. 

{NFA to DFA} 10 marks or 8 marks.

4. 

{NFA to DFA}

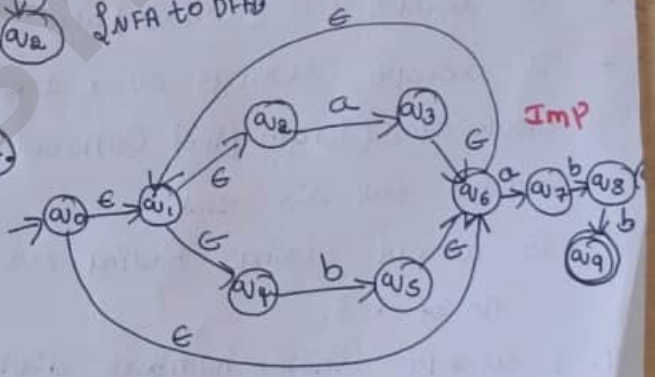
5. 

{NFA to DFA}

6. Imp

δ_D	0	1
→ P	{P, Q}	{P}
Q	{R}	{R}
R	{S}	ϕ
*S	{S}	{S}

{NFA to DFA}



minimization Problems [Distinguishable & Indistinguishable] (2)

1.

δ	a	b
→A	B	E
B	C	F
*C	D	H
D	E	H
E	F	I
*F	G	B
G	H	B
H	I	C
*I	A	E

8 marks or 10 marks

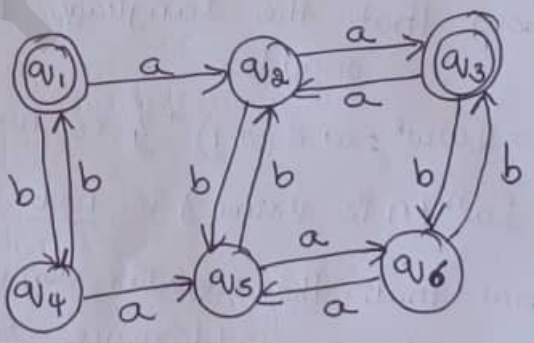
2. Imp

δ	0	1
→A	B	F
B	G	C
*C	A	C
D	C	G
E	H	F
F	C	G
G	G	F
H	G	C

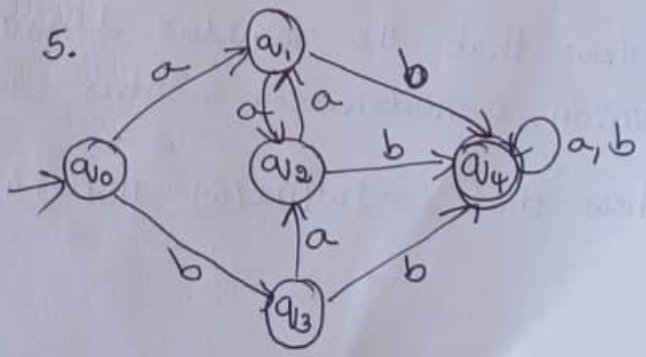
3.

δ	0	1
→A	B	A
B	A	C
C	D	B
*D	D	A
E	D	F
F	G	E
G	F	G
H	G	D

4. Imp



5.



module - 2

1. State & prove pumping lemma theorem for regular languages. Show that [10marks]
$L = \{ a^n b^n \mid n \geq 0 \}$ is not Regular. Imp

2. Show that regular languages are closed under Complement and intersection. 5m/7m

3. Using Kleen's theorem. prove that for any regular Expression R, their exits a finite automata $M = \{ Q, \Sigma, \delta, q_0, F \}$ which accepts L(R). [10marks]

OR

4. Prove Kleen's theorem. Any language that can be defined with a regular expression can be accepted by some FSM & so is regular.

5. Show that the language $L = \{ a^i b^j \mid i > j \}$ is not regular.

6. $L = \{ ww^R : w \in (0,1)^* \}$ is not regular. 3m

7. $L = \{ a^n \mid n \text{ is prime} \}$ is not regular 3m

8. Show that the regular languages are closed under homomorphism, difference & complementation 5m

9. Show that the regular languages are closed under union, concatenation & star closure. 5m

10. Show that $L = \{ w \mid n_a(w) = n_b(w) \}$ is not regular. 3m

Obtain Regular Expression for the following languages. (3)

1. $L = \{a^n b^m c^p \mid n \leq 4,\ m \geq 2,\ p \leq 2\}$ Imp
2. $L = \{w : |w| \bmod 3 = 0 \ \& \ w \in \{a,b\}^*\}$ (8m)
3. $L = \{a^n b^m \mid m+n \text{ is Even}\}$
4. $L = \{w : n_a(w) \bmod 3 = 0 \text{ where } w \in (a,b)^*\}$ Imp
5. $L = \{a^{2n} b^{2m} \mid n \geq 0,\ m \geq 0\}$
6. $L = \{w : \text{strings ends with ab (or) ba where } w \in \{a,b\}^*\}$
7. $L = \{a^n b^m \mid n \geq 4, m \leq 3\}$
8. $L = \{0^n 1^m \mid m \geq 1, n \geq 1 \quad mn \geq 3\}$
9. $L = \{w \in \{a,b\}^* : \text{string with atmost one pair of consecutive as}\}$ Imp
10. $L = \{a^n b^m \mid m \geq 1,\ n \geq 1,\ nm \geq 3\}$

Obtain an NFA for the Regular Expression (8m)

1) $a^* + b^* + c^*$ Imp
2) $(a+b)^* aa (a+b)^*$ Imp
3) $(0+1)^* 01 (0+1)^*$
4) $0^* 1^* + (0+1)^* 01$

{ ϵ-NFA Constrⁿ }

module 4

Push Down Automata. [PDA]

1. What is NPDA? Design NPDA for language $L = \{a^n b^n \mid n \geq 1\}$. Draw transition diagram. write sequence of moves made by NPDA to accept the string aaabbb. Imp

2. Design a PDA for the language. Imp
$L = \{wcw^R \mid w \in (a,b)^*$ where w^R is reverse of $w\}$ and show the moves made by PDA for the string "aabcbaa" & "abacbba".

3. Is the PDA to accept the language $L = \{ww^R \mid w \in (a+b)^*\}$ is deterministic?

4. Is the PDA to accept the language $L = \{a^n b^{2n} \mid n \geq 1\}$ is deterministic? or nondeterministic?

PDA Problem Imp

8m | 10m

- DPDA [deterministic PDA]
- NPDA [non-deterministic PDA]

1. Define Context free grammar. Design CFG for the following language.

i) $L = \{0^i 1^j \mid i \neq j \geq 0, j \geq 0\}$ Imp

ii) $L = \{a^n b^m \mid n \geq 0, m > n\}$

iii) $L = \{0^m 1^m 2^n \mid m \geq 1 \text{ and } n \geq 0\}$ Imp

iv) $L = \{ww^R \mid w \in (a,b)^*\}$ 8m/6m

v) $L = \{a^n b^m c^k \mid n+2m = k \text{ for } m \geq 0 \text{ \& } n \geq 0\}$

vi) $L = \{w : |w| \bmod 3 = 0\}$ over $\Sigma = \{a\}$ Imp

vii) $L = \{a^n b^m c^k : m = n+k\}$ over $\Sigma = \{a,b,c\}$

viii) $L = \{w : w \text{ has a substring } ab\}$

2. Define Ambiguity. Consider the grammar Imp.

$E \to E+E \mid E*E \mid (E) \mid id$

Find LMD & RMD derivations & Parse tree for the string $id + id * id$. Show that the grammar is ambiguous. 10/8 marks

3. Define Leftmost derivation. Rightmost derivation and Parse tree. Consider the grammar.

$S \to AbB$ $\quad A \to aA \mid \epsilon$

$B \to aB \mid bB \mid \epsilon$ $\quad D \to a \mid \epsilon$

Obtain LMD, RMD & Parse tree for the string "aaabab".

4. Define Ambiguity. Consider the grammar $E \Rightarrow E+E \mid E-E \mid E*E \mid E/E \mid a/b$ Find LMD & RmD Parse tree for the string a+b*a+b. Show that the grammar is ambiguous. Imp

5. Is the following grammar ambiguous?

1) $S \Rightarrow aB \mid bA$
$A \Rightarrow aS \mid bAA \mid a$
$B \Rightarrow bS \mid aBB \mid b$
String "aabbab"

2) $S \Rightarrow iCtS \mid iCtSeS \mid a$
$C \Rightarrow b$
String "ibtibtaea"

3) $S \Rightarrow OS1S \mid 1SOS \mid \epsilon$
String "o1o1"

6. Eliminate left recursion from the following grammar

1. $E \Rightarrow E+T \mid T$ Imp
$T \Rightarrow T*F \mid F$
$F \Rightarrow (E) \mid id$

2) $S \Rightarrow Ab \mid a$
$A \Rightarrow Ab \mid Sa$

* Define left recursion?

7. Explain Chomsky Normal form? (CNF)

8. Define left factoring. Consider the following grammar Imp

1. $S \Rightarrow iEtS / iEtSeS / a$ $E \Rightarrow b$
2. $S \Rightarrow aSSbs / aSasb / abb / b$
3. $S \Rightarrow a / ab / abc / abcd$
4. $S \Rightarrow aAd / aB$
$A \Rightarrow a / ab$ $B \Rightarrow ccd / ddc$

module - 5

1. Define Turing machine (TM)? Explain the Turing machine model Imp

2. Design the turing machine to accept the language $L = \{a^n b^n c^n \mid n \geq 1\}$. Draw the transition diagram & Shown the moves made by turing machine for the string "aabbcc". 10/12m

3. Explain various techniave used for Construction of turning machine. 7m/8m

4. Explain the following: Imp
   a) multitape Turing machine.
   b) Non-deterministic TM
   c) Linear bounded Automata (LBA)
   d) Post correspondence problem
   e) quantum Computers
   f) Church-Turing Thesis
   g) Decidable & Undecidable language.
   h) halting Problem.
   i) P and NP classes.
   j) Recursively Enumerable languages.

Short note questions for 2 marks

Design of TM Problems

1. To accept the language $L = \{0^n 1^n 2^n \mid n >= 0\}$. Draw the transition diagram. write the seqvence of moves made by TM for string "001122" Imp

2. $L = \{0^n 1^n \mid n \geq 1\}$ string 0011 & 00111. [10 marks]

3. $L = \{w w^R \mid w \in (a+b)^*\}$