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**Fifth Semester B.E. Degree Examination, May/June 2010**  
**Formal Languages and Automata Theory**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions, selecting at least TWO questions from each part.**

**PART - A**

- 1 a. Define the following terms, with an example for each:
  - i) String
  - ii) Alphabet
  - iii) Powerset
  - iv) Language. (08 Marks)
- b. Mention the differences between DFA, NFA and  $\epsilon$ -NFA. (04 Marks)
- c. Convert the following  $\epsilon$ -NFA to DFA. [Refer Fig.Q1(c)]. (08 Marks)

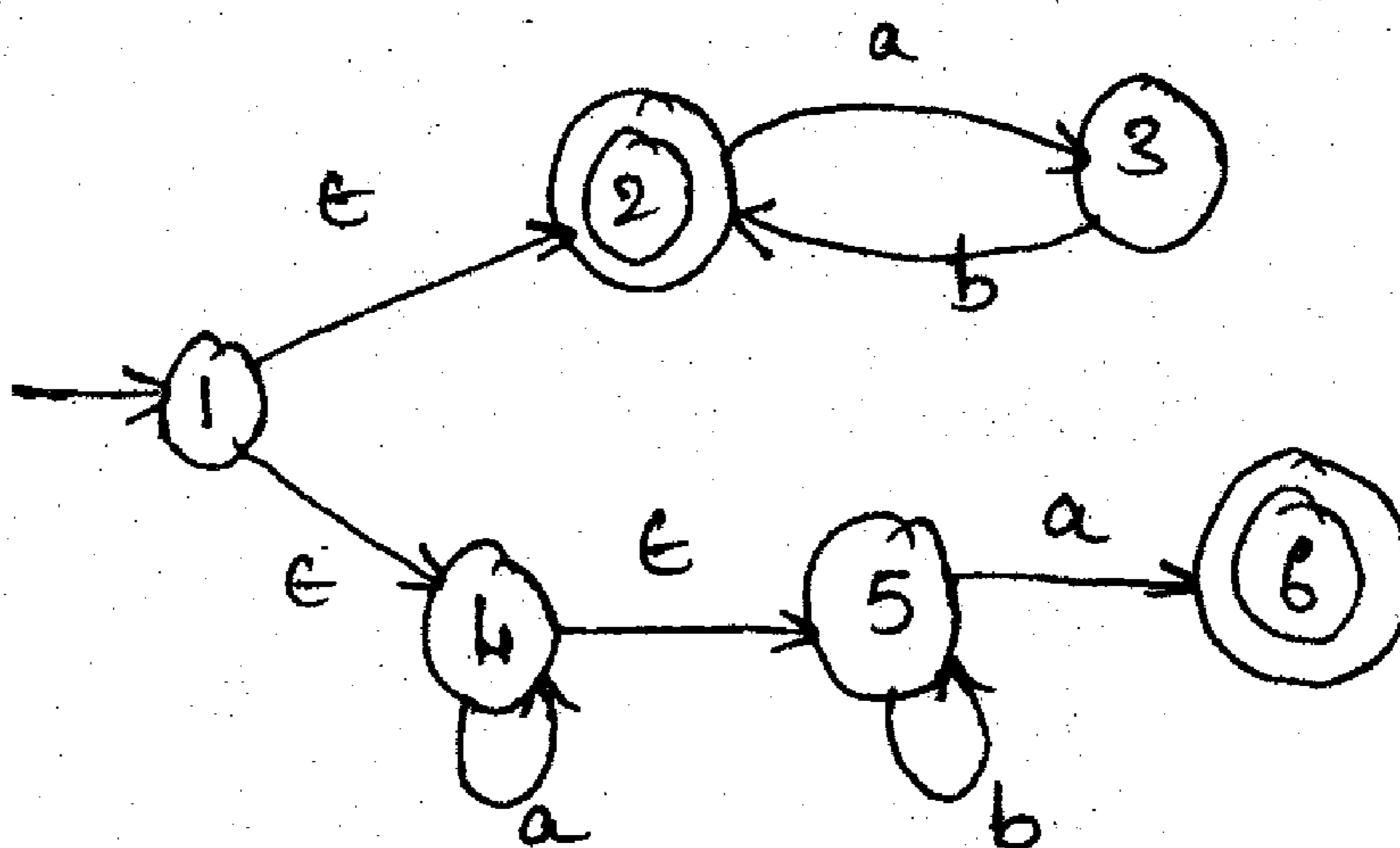


Fig.Q1(c)

- 2 a. Define a regular expression. Find regular expression for the following languages on  $\{a, b\}$ :
  - i)  $L = \{ a^{2n} b^{2m} : n \geq 0, m \geq 0 \}$
  - ii)  $L = \{ -w : |w| \bmod 3 = 0 \}, w \in \{a, b\}^*$  (08 Marks)
- b. Prove that if L and M are regular languages, then so is  $L \cap M$ . (06 Marks)
- c. Convert the regular expression  $(01 + 1)^*$  to an  $\epsilon$ -NFA. (06 Marks)
- 3 a. State pumping lemma for regular languages. Prove that the language  $\{a^n b^n \mid n \geq 1\}$  is non-regular. (10 Marks)
- b. Define distinguishable and indistinguishable states. Minimize the following DFA using table filling algorithm.

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

(10 Marks)

- 4 a. Define CFG. Obtain CFG for the following languages:
  - i)  $L = \{ ww^R \mid w \in \{a, b\}^* \}$ ,  $w^R$  is the reversal of  $w$
  - ii)  $L = \{ w : w \text{ has a substring } ab \}$  (10 Marks)
- b. What is an ambiguous grammar? Show that the following grammar is ambiguous.
 

$E \rightarrow E + E \mid E - E \mid E * E \mid E / E \mid (E) \mid a$

 where E is the start symbol. Find the unambiguous grammar. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and/or equations written eg,  $42+8=50$ , will be treated as malpractice.

PART - B

- 5 a. Define PDA. Design PDA to accept the following language by final state.  
 $L = \{ w \mid w \in \{a, b\}^*, N_a(w) = N_b(w) \}$   
 Draw the graphical representation of PDA. Also, show the moves made by the PDA for the string abbaba. (12 Marks)
- b. Convert the following CFG to PDA.  
 $S \rightarrow aABB \mid aAA$   
 $A \rightarrow aBB \mid a$   
 $B \rightarrow bBB \mid A$   
 $C \rightarrow a$  (08 Marks)
- 6 a. What are useless symbols? Eliminate  $\epsilon$ , unit and useless productions from the following grammar:  
 $S \rightarrow AaA \mid CA \mid BaB$   
 $A \rightarrow aaBa \mid CDA \mid aa \mid DC$   
 $B \rightarrow bB \mid bAB \mid bb \mid aS$   
 $C \rightarrow Ca \mid bC \mid D$   
 $D \rightarrow bD \mid \epsilon$  (10 Marks)
- b. What is CNF and GNF? Obtain the following grammar in CNF:  
 $S \rightarrow aBa \mid abba$   
 $A \rightarrow ab \mid AA$   
 $B \rightarrow aB \mid a$  (10 Marks)
- 7 a. Prove that the context free languages are closed under union, concatenation and reversal. (10 Marks)
- b. Design a turning machine that performs the following function:  
 $q_0 w \vdash^* q_f ww$  for any  $w \in \{1\}^*$  (10 Marks)
- 8 Write short notes on:  
 a. Multitape TM  
 b. Post correspondence problem  
 c. Chomsky hierarchy  
 d. Applications of regular expressions. (20 Marks)

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