

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.TECH(CSE)/SEM-4/CS-401/2010  
2010**

**FORMAL LANGUAGE AND AUTOMATA THEORY**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP - A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for the following :

10 × 1 = 10

i) The production grammar {  $S \rightarrow aSbb$ ,  $S \rightarrow abb$  } is

- a) type-3 grammar      b) type-2 grammar
- c) type-1 grammar      d) type-0 grammar.

ii) The loop-free testing graph indicates that

- a) the machine has finite memory
- b) the machine has non-finite memory
- c) the machine has finite states
- d) the machine has non-finite states.

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iii) A shift register is a

- a) Mealy M/c                      b) Moore M/c  
c) Turing M/c                    d) All of these.

iv) Consider the following regular expression :

$$R = (ab + abb)^*bbab.$$

Which of the following is not in the set denoted by  $R$  ?

- a)  $ababab$                       b)  $ababbabbbab$   
c)  $abbbab$                       d)  $abbabbbab$ .

v) Which of the following is correct ?

- a) Language can be derived from the FA  
b) Regular expressions can be derived from the FA  
c) FA can be derived from the language  
d) Both (a) & (b).

vi) The reduced grammar of  $S \rightarrow AB \mid a, A \rightarrow a$  is

- a)  $S \rightarrow a$                       b)  $S \rightarrow a \mid A$   
     $A \rightarrow a$                        $A \rightarrow a$   
c)  $S \rightarrow a$                       d)  $S \rightarrow aa$ .

vii) Which of the following grammars generates strings with any number of 1's ?

- a)  $S \rightarrow 1A, A \rightarrow \epsilon$                       b)  $S \rightarrow 1S, S \rightarrow \epsilon$   
c)  $S \rightarrow S1, S \rightarrow \epsilon$                       d) (b) & (c).

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viii) Input sequence of an information lossless machine can be determined from the knowledge of

- a) only output sequence
- b) output sequence and initial state
- c) output sequence, initial state and final state
- d) initial state.

ix) Context Free Grammar can be recognized by

- a) finite state automata
- b) 2-way linear bounded automata
- c) push-down automata
- d) both (b) & (c).

x) Which of the following statements is wrong ?

- a) A turing machine cannot solve halting problem.
- b) Set of recursively enumerable languages is closed under union.
- c) A finite state machine with 3/stacks is more powerful than finite state machine with 2 stacks.
- d) Context sensitive grammar can be recognized by a linearly bounded memory machine.

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**GROUP - B****( Short Answer Type Questions )**Answer any *three* of the following.  $3 \times 5 = 15$ 

2. a) State the pumping lemma for regular language. 2
- b) Using pumping lemma prove that the set  $L = \{ 0^i 1^i \mid i \geq 1 \}$  is not regular. 3
3. Draw the transition diagram of a finite state automaton that accepts all strings over  $\{ 0, 1 \}$
- a) having odd number Of 0's
- b) having even number of 0's and even number of 1's.

$$2 \frac{1}{2} + 2 \frac{1}{2}$$

4. Convert the following context free grammar into an equivalent grammar in CNF :

$$S \rightarrow aAbB$$

$$A \rightarrow abAB / aAA / a$$

$$B \rightarrow bBaA / bBB / b.$$

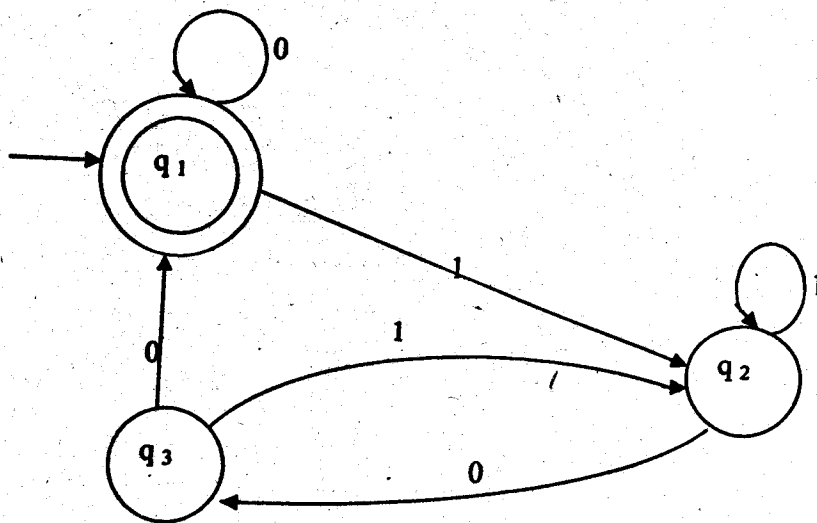
5. State and discuss Myhill-Nerode's theorem.
6. Construct a regular grammar  $G$  generating the regular set represented by

$$P = a^*b ( a + b )^*.$$

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**GROUP - C****( Long Answer Type Questions )**Answer any *three* of the following.  $3 \times 15 = 45$ 

7. a) State the difference between DFA and NFA. 2
- b) Design an NFA which accepts set of all binary strings containing 1100 or 1010 as substrings. 3
- c) What is Regular language ? 2
- d) Find Regular expressions over  $\Sigma = \{ a, b \}$  for the languages defined as follows :  $1 + 1 + 1$
- i)  $L1 = \{ a^m b^m : m > 0 \}$
- ii)  $L2 = \{ a^{2n} b^{2m+1} \mid n \geq 0, m, n \geq 0 \}$
- iii)  $L3 = \{ b^m ab^n : m > 0, n > 0 \}$
- e) Find the Regular expression for the following transition graph : 5



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8. a) Define pushdown automata. 2
- b) Construct a PDA accepting the set of all strings over  $\{a, b\}$  with equal number of  $a$ 's and  $b$ 's. 5
- c) What are the nonempty transitions in an NPDA? 2
- d) Let  $G$  be a grammar  $s \rightarrow 0B \mid 1A$ ,  $A \rightarrow 0 \mid 0S \mid 1AA$ ,  $B \rightarrow 1 \mid 1S \mid 0BB$ . For the string 00110101, find
- leftmost derivation
  - rightmost derivation
  - derivation tree. 2 + 2 + 2
9. a) Construct the minimum state automata equivalent to given automata  $M$  defined below :

$\Sigma$ states	$a$	$b$
$\rightarrow q_0$	$q_5$	$q_1$
$q_1$	$q_2$	$q_6$
$*q_2$	$q_2$	$q_0$
$q_4$	$q_5$	$q_7$
$q_5$	$q_6$	$q_2$
$q_6$	$q_4$	$q_6$
$q_7$	$q_2$	$q_6$

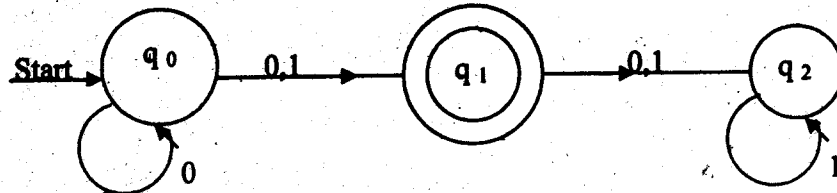
( \*  $q_2$  indicates that  $q_2$  is the final state )

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b) Convert the following NFA to DFA.

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c) Prove that CFLs are not closed under intersection and complement operation.

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10. a) What is information lossless machine ?

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b) Consider the machine shown in the following table :

Present State	Next State	
	X = 0	X = 1
A	A, 1	C, 1
B	E, 0	B, 1
C	D, 0	A, 0
D	C, 0	B, 0
E	B, 1	A, 0

Is this machine information lossless of finite order ? If yes, find the order  $\mu$ .

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c) Design a 2-input 2-output Mealy machine, which takes as input a binary stream and generates an output of 1 only when a sequence of the pattern 01011 is found in the input stream. Design should be clearly justified.

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11. a) Consider the following machine :

PS	NS			
	$I_1$	$I_2$	$I_3$	$I_4$
A	-	-	E, 1	-
B	C, 0	A, 1	B, 0	-
C	C, 0	D, 1	-	A, 0
D	-	E, 1	B, -	-
E	B, 0	-	C, -	B, 0

- i) Draw the merger graph. 2
- ii) Draw the merger table. 2
- iii) Draw the compatibility graph. 2
- iv) Find the minimal closed covering with justification. 3

b) Consider the machine given below :

PS	NS		Z
	X = 0	X = 1	
A	D	G	0
B	C	E	0
C	H	F	0
D	F	F	0
E	B	B	0
F	G	D	0
G	A	B	0
H	E	C	1

Derive the closed partitions. Construct a  $\pi$ -lattice for it.

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