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 : $10 \times 1 = 10$

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.

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) $S \rightarrow a$, $A \rightarrow a$ b) $S \rightarrow a \mid A$, $A \rightarrow a$

c) $S \rightarrow a$ d) $S \rightarrow aa$.

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

a) $S \rightarrow 1A, A \rightarrow \varepsilon$ b) $S \rightarrow 1S, S \rightarrow \varepsilon$

c) $S \rightarrow S1, S \rightarrow \varepsilon$ d) (b) & (c).

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.

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 0f 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 :

   $S \rightarrow aAbB$

   $A \rightarrow abAB \mid aAA \mid a$

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

5. State and discuss Myhill-Nerode's theorem.

6. Construct a regular grammar G generating the regular set represented by

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

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

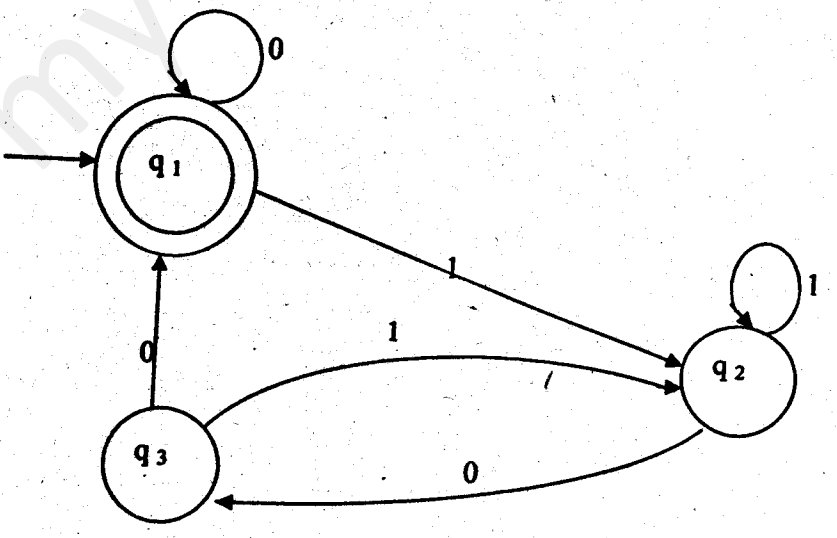
d) Find Regular expressions over $\Sigma = \{ a, b \}$ for the languages defined as follows :

i) $L1 = \{ a^m b^m : m > 0 \}$

ii) $L2 = \{ a^{2n} b^{2m+1} \mid n \geq 0, m\, n \geq 0 \}$

iii) $L3 = \{ b^m ab^n : m > 0, n > 0 \}$ 1 + 1 + 1

e) Find the Regular expression for the following transition graph : 5



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

i) leftmost derivation

ii) rightmost derivation

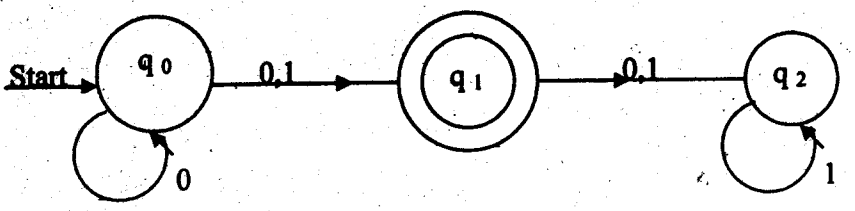
iii) derivation tree. 2 + 2 + 2

9. a) Construct the minimum state automata equivalent to given automata M defined below :

states \ Σ	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) 6

b) Convert the following NFA to DFA. 5



c) Prove that CFLs are not closed under intersection and complement operation. 4

10. a) What is information lossless machine ? 3

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 μ. 5

c) Design a 2-input 2-output Mealy machine, which takes as input a binary stream and generates on output of 1 only when a sequence of the pattern 01011 is found in the input stream. Design should be clearly justified. 7

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		
	$X = 0$	$X = 1$	Z
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 π-lattice for it. 6