Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS / B. TECH (IT) / SEM-5 / CS-512 / 2010-11

2010-11

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) What is the language of the grammar with the following production rules?

$$S \rightarrow ASb \mid c$$
$$A \rightarrow a$$

   a) $\{a^n cb^n \mid n \in \text{IN}\}$ b) $\{xcb \mid x \in \{a\}^*\}$

   c) $\{acy \mid y \in \{b\}^*\}$ d) None of these.

ii) A grammar has the following production :

$S \rightarrow aSSb \mid a \mid bSa$

Which of the following sentences are in the language that is generated by this grammar ?

a) aaaaabb b) aabbaabb

c) bbbaabbaa d) All of these.

iii) The following grammar generates a small part of the statements in Java :

$S \rightarrow S; S \mid$ if Bool then S else $S \mid$ Identifier : = IN $\mid$

You may assume that an Identifier is represented by a string. What is the most precise statement about this grammar ?

a) This grammar is unambiguous

b) This grammar is left recursive

c) This grammar is LL (1)

d) All three statements are correct.

iv) Take a look at the following grammar :

$S \rightarrow AaC \mid Bd$

$A \rightarrow BC$

$B \rightarrow bB \mid C$

$C \rightarrow accS \mid$

For which non-terminals N is symbol a part of the collection follow N ? Give the best answer.

a) $\{A\}$

b) $\{A, C\}$

c) $\{A, B, C\}$

d) $\{A, B, C, S\}$

v) Which of the following grammars is a (right) regular grammar with the same language as the

regular expression $a*+b*+ab$?

a) $S \rightarrow AB$
$A \rightarrow aA \mid$
$B \rightarrow bB \mid$

b) $S \rightarrow ab \mid A \mid B$
$A \rightarrow Aa \mid$
$B \rightarrow Bb \mid$

c) $S \rightarrow A \mid B$
$A \rightarrow aA \mid b$
$B \rightarrow Bb \mid a$

d) $S \rightarrow ab \mid A \mid B$
$A \rightarrow aA \mid$
$B \rightarrow bB \mid$

vi) 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.

vii) The logic pumping lemma is a good example of

a) the pigeon-hole principle

b) the divide & conquer technique

c) recursion

d) iteration.

viii) If S is the number of states in NDFA then equivalent DFA can have maximum of

a) S states

b) S –1 states

c) 2^S states

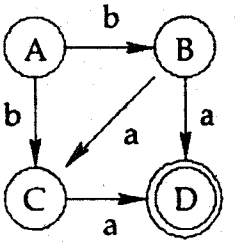
d) $2^S - 1$ states.

ix) The regular sets are closed under

a) Union b) Concatenation

c) Kleene closer d) all of these.

x) Look at the following non-deterministic finite-state automation (NFA),with *A* as the start state, and *D* as the only accepting state.



With deterministic finite-state automation (DFA) with *d* as its state transition function accepts the same language ?

a) Start state *A*, accepting state *C* and *D*.

d A b = B

d B a = C

d C a = D

b) Start state *A*, accepting state *C*.

d A b = B

d B a = C

d C a = C

c) Start state A, accepting state D.

d A b = B

d B a = D

d B b = C

d C a = D

d) All of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Find a grammar generating $L = \{a^n, b^n, c^f \mid n >= 1, f >= 0\}$.

3. Construct a PDA equivalent to the grammar $S \rightarrow aAAA \rightarrow aS/b$.

4. State and prove pumping lemma for CFL's.

5. The language defined as $L = \{a^n b^n c^n / n >= 1\}$ is context free or not. Prove it.

6. Draw state diagram of a sequence detector which detects the sequence 01101 (Overlapping sequence acceptable).

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Design a Moore Machine to determine the residue mode 4 for each binary string treated as integer.

   b) Design a Mealy machine that uses its state to remember the last symbol read and emits output '*y*' whenever current input matches to previous one, and emits *n* otherwise. 7 + 8

8. a) Find the equivalence partition of the machine shown below :

PS	NS, z	
	$x = 0$	$x = 1$
A	B, 1	H, 1
B	F, 1	D, 1
C	D, 0	E, 1
D	C, 0	F, 1
E	D, 1	C, 1
F	C, 1	C, 1
G	C, 1	D, 1
H	C, 0	A, 1

b) Show a standard form of the corresponding reduced machine.

c) Find a minimum length input sequence that distinguishes state *A* from *B*. 5 + 5 + 5

9. a) Develop a procedure to determine the shortest input sequence that distinguishes a state S_i from another state S_j of a given machine.

b) Use the procedure to determine the shortest input sequence that distinguishes state *A* from state *G* in the machine given below :

PS	*NS*, *z*	
	$x = 0$	$x = 1$
A	*A*, 0	*B*, 0
B	*C*, 0	*D*, 1
C	*E*, 0	*D*, 0
D	*F*, 0	*E*, 1
E	*G*, 0	*A*, 0
F	*G*, 0	*B*, 1
G	*C*, 0	*F*, 1

c) Draw merger graph for the following incompletely specified machine.

PS	*NS*, *z*			
	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

5 + 5 + 5

10. a) Define Pushdown Automata. Discuss with an example.

b) Find if the string *aaa bbb ccc* can be derived from the productions.

$S \rightarrow ABSc, S \rightarrow Abc, BA \rightarrow AB, Bb \rightarrow bb, Ab \rightarrow ab, AA \rightarrow aa$

c) Draw derivation tree for the sentential form *baabaab* for the productions

$S \rightarrow AB, A \rightarrow Aa, A \rightarrow bB, B \rightarrow a, B \rightarrow Sb$ 5 + 5 + 5

11. a) Define Turing Machine.

b) Design a Turing machine M to recognize the language $\{1^n 2^n 3^n \mid n \geq 1\}$

c) Construct an FA equivalent to the regular expression $(0+1)^*(00+11)(0+1)^*$. 2 + 8 + 5

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