CS/B.TECH (CSE/OLD)/SEM-4/CS-401/2013

2013

FORMAL LANGUAGE & 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 any *ten* of the following :

$$10 \times 1 = 10$$

    i)   The following grammar

$$G = (N, T, P, S)$$
$$N = \{ S, A, B \}$$
$$T = \{ a, b, c)$$
$$P : S \rightarrow aSa$$
$$S \rightarrow aAa$$
$$A \rightarrow bB$$
$$B \rightarrow bB$$
$$B \rightarrow c$$

    a)   is type 3

    b)   is type 2 but not type 3

    c)   is type 1 but not type 2

    d)   is type 0 but not type 1.

ii) Consider the following language :

$$L = \left\{ a^n b^n c^n d^n \mid n \geq 1 \right\}$$

L is

a) CFL but not regular

b) CSL but not CFL

c) regular

d) type 0 language but not type 1.

iii) Can a DFSA simulate a NFSA ?

a) No   b) Yes

c) Sometimes   d) Depends on NFA.

iv) The following grammar

$G = (N, T, P, S)$

$N = \{ S, A, B, C, D, E \}$

$T = \{ a, b, c \}$

$P : S \rightarrow aAB$

$AB \rightarrow CD$

$G = (N, T, P, S)$

$CD \rightarrow CE$

$C \rightarrow aC$

$C \rightarrow b$

$bE \rightarrow bc$

a) is type 3

b) is type 2 but not type 3

c) is type 1 but not type 2

d) is type 0 but not type 1.

v) The following grammar

$G = (N, T, P, S)$

$N = \{ S, A, B, C \}$

$T = \{ a, b, c \}$

$P : S \rightarrow aS$

$A \rightarrow bB$

$B \rightarrow cC$

$C \rightarrow a$

a) is type 3

b) is type 2 but not type 3

c) is type 1 but not type 2

d) is type 0 but not type 1.

vi) Consider the following language :

$L = \left\{ a^n b^n \mid n \geq 1 \right\}$

L is

a) CFL but not regular

b) CSL but not CFL

c) regular

d) type 0 language but no type 1.

vii) The following CFG is in

$S \rightarrow AB$

$B \rightarrow CD$

$B \rightarrow AD$

$B \rightarrow b$

$D \rightarrow AD$

$D \rightarrow d$

$A \rightarrow a$

$C \rightarrow a$

a) Chomsky normal form but not strong Chomsky normal form

b) Weak Chomsky normal form but not Chomsky normal form

c) Strong Chomsky normal form

d) Greibach normal form.

viii) Which of the following CF languages is inherently ambiguous ?

a) $\left\{ a^n b^n c^m d^m \mid n, \ m \geq 1 \right\}$

b) $\left\{ a^n b^m c^p d^q \mid n = p \ \text{or} \ m = q, n, m, p, q \geq 1 \right\}$

c) $\left\{ a^n b^m c^p d^q \mid n \neq m \ \wedge \ p \neq q \right\}$

d) $\left\{ a^n b^m c^p d^q \mid n \neq m \ \vee \ p \neq q \right\}$.

ix) The concept of FSA is much used in which part of the compiler ?

    a) Lexical analysis

    b) Parser

    c) Code generation

    d) code optimization.

x) The set of all strings over the alphabet

    $\sum = \{ a, b \}$ (including ε) is denoted by

    a) $(a + b)^{*}$ b) $(a + b)^{+}$

    c) $a^{+} b^{+}$ d) $a^{*} b^{*}$

xi) Which one of the following statements is *False* ?

    a) Context-free languages are closed under union.

    b) Context-free languages are closed under concatenation.

    c) Conext-free languages are closed under intersection.

    d) Context-free languages are closed under Kleene closure.

xii) Which of the following conversions is not possible (algorithmically) ?

    a) Regular grammar to context-free grammar

    b) Non-deterministic FSA to deterministic FSA

    c) Non-deterministic PDA to deterministic PDA

    d) Non-deterministic M to deterministic TM.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. a) Give an NFA that accepts the language

   $L((a + b)^* b (a + bb)^*)$. 2

   b) Design a Moore machine for 1's complement of a given binary number. 3

3. a) Write the regular expression of the language on (0, 1) such that it contains at least one double letter. 2

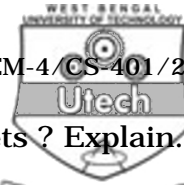   b) Show the left-most derivation tree for the string *aabbbb* with the grammar

   $S \rightarrow AB \mid \lambda$

   $A \rightarrow aB$

   $B \rightarrow Sb$. 3

4. Test the following machine for definiteness using contracted tables :

PS	NS	
	x = 0	x = 1
A	A	B
B	E	B
C	E	F
D	E	F
E	A	D
F	E	B

5. What are the closure properties of Regular sets ? Explain.

6. Write a short note on context sensitive language with suitable example.

7. Write about Linear Bounded Automata.

GROUP – C

(Long Answer Type Questions)

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

8. a) Design a Mealy machine which is equivalent to the Moore machine given in the table below : 5

PS	NS		Output
	$i = 0$	$i = 1$	
$\rightarrow$ q1	q1	q2	0
q2	q1	q3	0
q3	q1	q3	1

b) Construct a PDA for the language

$$L = \left\{ a^3 b^n c^n : n \geq 0 \right\}.$$ 8

c) Define linear grammar and regular grammar. 1 + 1

9. a) Construct a Turing machine for the language

$$L = \left\{ a^n b^n c^n : n \geq 1 \right\}.$$ 12

b) Show that the language $L = \left\{ a^n : n \geq 0, n \neq 4 \right\}$ is regular. 3
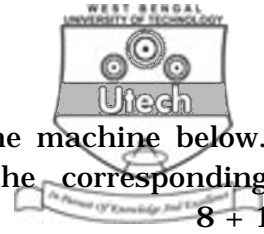
10. a) Find the equivalence partitions for the machine below. Also find the standard form of the corresponding reduced machine. 8 + 1

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

b) Remove all unit productions, all useless productions and all λ-productions from the following grammar : 6

$S \rightarrow aA \mid aBB$
$A \rightarrow aaA \mid \lambda$
$B \rightarrow bB \mid bbC$
$C \rightarrow B.$

11. a) Find a Greibach normal form equivalent to the following CFG : 8

$S \rightarrow AB/a, A \rightarrow BS/b, B \rightarrow SA/c$

b) Remove all unit productions, all useless productions and all e-productions for the following grammar : 7

$S \rightarrow aA/aBB, A \rightarrow aaA/e, B \rightarrow bB/bbC, C \rightarrow B.$

12. a) Construct a PDA equivalent to the grammar $S \rightarrow aAA$, $A \rightarrow aS/b$. 7

b) Show that $L = \{ WW/W \in \{ a, b \}^* \}$ is not regular. 8

13. Write notes on any *three* of the following : 3 × 5

a) Myhill-Nreode theorem

b) Chomsky Normal form

c) Recursively enumerable sets

d) DFA and NFA.

═══════════