

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**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.

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ii) Consider the following language :

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

$L$  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 :

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

$L$  is

- a) CFL but not regular
- b) CSL but not CFL
- c) regular
- d) type 0 language but no type 1.

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vii) The following CFG is in

$$S \rightarrow AB$$

$$B \rightarrow CD$$

$$B \rightarrow AD$$

$$B \rightarrow b$$

$$D \rightarrow AD$$

$$D \rightarrow d$$

$$A \rightarrow a$$

$$C \rightarrow a$$

- Chomsky normal form but not strong Chomsky normal form
  - Weak Chomsky normal form but not Chomsky normal form
  - Strong Chomsky normal form
  - Greibach normal form.
- viii) Which of the following CF languages is inherently ambiguous ?

- $\{ a^n b^n c^m d^m \mid n, m \geq 1 \}$
- $\{ a^n b^m c^p d^q \mid n = p \text{ or } m = q, n, m, p, q \geq 1 \}$
- $\{ a^n b^m c^p d^q \mid n \neq m \wedge p \neq q \}$
- $\{ a^n b^m c^p d^q \mid n \neq m \vee p \neq q \}.$



- ix) The concept of FSA is much used in which part of the compiler ?
- Lexical analysis
  - Parser
  - Code generation
  - code optimization.
- x) The set of all strings over the alphabet  $\Sigma = \{ a, b \}$  ( including  $\epsilon$  ) is denoted by
- $( a + b )^*$
  - $( a + b )^+$
  - $a^+ b^+$
  - $a^* b^*$
- xi) Which one of the following statements is *False* ?
- Context-free languages are closed under union.
  - Context-free languages are closed under concatenation.
  - Context-free languages are closed under intersection.
  - Context-free languages are closed under Kleene closure.
- xii) Which of the following conversions is not possible ( algorithmically ) ?
- Regular grammar to context-free grammar
  - Non-deterministic FSA to deterministic FSA
  - Non-deterministic PDA to deterministic PDA
  - Non-deterministic M to deterministic TM.

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

2. a) Give an NFA that accepts the language

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

- 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

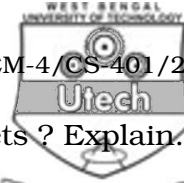
$$S \rightarrow AB \mid \lambda$$

$$A \rightarrow aB$$

$$B \rightarrow Sb. \quad 3$$

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

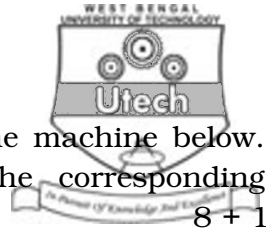
PS	NS		Output
	$i = 0$	$i = 1$	
$\rightarrow q1$	q1	q2	0
q2	q1	q3	0
q3	q1	q3	1

- b) Construct a PDA for the language  

$$L = \{ a^3 b^n c^n : n \geq 0 \} .$$
 8
- c) Define linear grammar and regular grammar. 1 + 1
9. a) Construct a Turing machine for the language  

$$L = \{ a^n b^n c^n : n \geq 1 \} .$$
 12
- b) Show that the language  $L = \{ a^n : n \geq 0, n \neq 4 \}$  is regular. 3

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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  $\lambda$ -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  $L = \{ WW \mid W \in \{ a, b \}^* \}$  is not regular. 8
13. Write notes on any *three* of the following : 3 × 5
- Myhill-Nreode theorem
  - Chomsky Normal form
  - Recursively enumerable sets
  - DFA and NFA.