(Old Course)

(Theoretical Foundation of Computer Science)

Full Marks : 80

Pass Marks : 32 (Backlog) / 24 (2014 onwards)

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* State True or False : 1

$\{a^n b^n \mid n \geq 1\}$ is context-free but not regular.

(b) If $L_1 = \{bc, bcc, cc\}$ and $L_2 = \{cc, ccc\}$, then find $L_1 \cdot L_2$. 2

(c) If a regular expression is 1*0, then find string set. 2

2. *(a)* State True or False : 1

If a grammar $G = (V_n, \Sigma, P, S)$, then V_n and Σ are finite but P can be infinite.

(b) State the difference between a Mealy machine and a Moore machine. 2

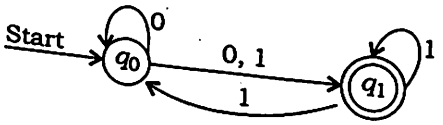
(c) Answer any *two* from the following : 6×2=12

(i) Construct a minimum state automata equivalent to an automata whose transition table is defined by

State	Input	
	a	*b*
$\rightarrow q_0$	q_1	q_2
q_1	q_1	q_3
q_2	q_3	q_4
q_3	q_1	q_5
q_4	q_4	q_2
(q_5)	q_6	q_6

(ii) Construct an NFA accepting the set of all strings over {0, 1} that have at least two consecutive 0's and 1's.

(iii) Convert the following NFA to its equivalent DFA :



(Continued)

(a) State True or False : 1

Every finite subset of Σ^* is a regular language.

(b) Consider the DFA given by the transition table below :

State	Input	
	a	*b*
$\rightarrow (q_0)$	q_2	q_1
q_1	q_3	q_0
q_2	q_0	q_3
q_3	q_1	q_2

Test whether the string 110101 is accepted by the DFA or not. 2

(c) What is the highest type number that can be applied to the following grammar? 2

$$S \rightarrow Aa,\ A \rightarrow C|Ba,\ B \rightarrow abc$$

(d) Show that the grammar

$$G = S \rightarrow aSbS|bSaS|\wedge$$

is recursive. 3

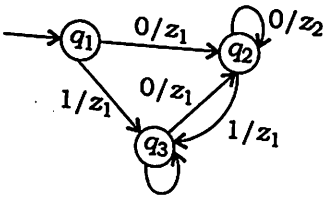
(e) Answer any *one* from the following : 7

(i) Construct a grammar that generates the language

$$L = \{a^j b^n c^n \,|\, n \geq 1,\ j \geq 0\}$$

(Turn Over)

(ii) Construct a Moore machine equivalent to the Mealy machine given below :



4. (a) State True or False :

$(P+Q)^* = (P^*Q^*)^*$, where P and Q are regular expressions.

(b) Prove that

$$\wedge + 1^*(011)^*(1^*(011)^*)^* = (1+011)^*$$ 5

(c) Represent the following set by regular expression :

$\{w \in \{a, b\}^* | w$ has only one $a\}$

$\{a^n | n$ is divisible by 2 or 3 or $n = 5\}$ 2

(d) Answer any *two* from the following : 6×2=12

(i) Construct an FA equivalent to the regular expression

$$(0+1)^*(00+11)(0+1)^*$$

(Continued)

(ii) Construct a grammar G to generate the set of all palindromes over $\{a, b\}$.

(iii) Show that $L = \{ww | w \in \{a, b\}^*\}$ is not regular.

5. (a) What is context-free grammar? 1

(b) Define parse tree for a CFG. 2

(c) Answer any *two* from the following : 6×2=12

(i) Convert the following CFG to Chomsky normal form :

$$S \to aB | bA$$
$$A \to a | aS | bAA$$
$$B \to b | bS | aBB$$

(ii) Reduce the following grammar to Greibach normal form :

$$S \to AA | a,\ S \to AA | b$$

(iii) Show that $L = \{a^n b^n c^n | n \geq 1\}$ is not context-free but context-sensitive.

6. (a) Define the formal definition of push-down automation. 3

(Turn Over)

(b) Construct a PDA accepting $L = \{wcw^R | w$ is in $(0|1)^*$ and w^R is the reverse of $w\}$.

(c) Show the moves by the PDA for the string ((( ))).

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