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1 SEM TDC CSC G 1

2013

(November)

COMPUTER SCIENCE

(General)

Course : 101

(Theoretical Foundation of Computer Science)

Full Marks : 80
Pass Marks : 32

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. *(a)* "NFA is more powerful than a DFA." State True or False. 1

(b) Write the regular expression to represent the set of all strings over a and b starting with a and ending with ab. 1

(c) What is a derivation tree? 1

(d) If $G = (\{s\}, \{0, 1\}, \{s \to 0Ss, s \to \Lambda\}, s)$, find $L(G)$. 2

(Turn Over)

2. *(a)* "A final state is called an accepting state." State True or False. 1

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

States	Input	
	a	*b*
→ 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) State the difference between a Mealy machine and a Moore machine. 2

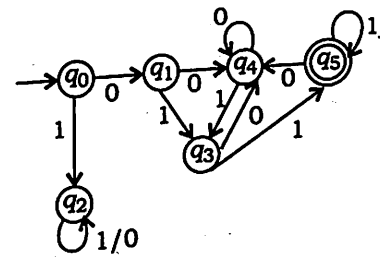
(d) Answer any *two* from the following : 5×2=10

(i) Construct a DFA equivalent to the NFA given below :

States/Σ	*a*	*b*
→ q_0	q_0, q_1	q_0
q_1	q_2	q_1
q_2	q_3	q_3
(q_3)		q_2

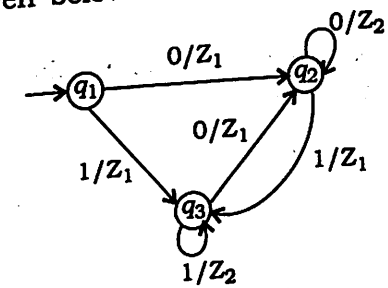
(Continued)

(ii) Consider the DFA given below :



Construct an equivalent DFA with reduced states.

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



3. *(a)* "A set X is recursive if we have an algorithm to determine whether a given element belongs to X or not." State True or False. 1

(b) Construct a grammar G to generate the set of all palindromes over $\{a, b\}$. 2

(c) Give the formal definition of a grammar. 2

(Turn Over)

(d) Answer any *two* from the following : 5×2=10

(i) Explain Chomsky hierarchy.

(ii) Consider the grammar G given by $S \to 0SA_1 2$, $S \to 012$, $2A_1 \to A_1 2$, $1A_1 \to 11$.

Test whether $001122 \in L(G)$. Also draw the finite automata to accept all strings over a and b containing even numbers of a's and b's.

(iii) Construct a grammar G generating $\{a^n b^n c^n \mid n \geq 1\}$

4. (a) "Λ is a regular expression." State True or False. 1

(b) Prove that 2

$$\Lambda + 1^*(011)^*(1^*(011)^*)^* = (1 + 011)^*$$

(c) Represent the following sets by regular expressions : 2

(i) $\{a^{2n} \mid n \geq 1\}$

(ii) $\{a^{2n+1} \mid n \geq 1\}$

(d) Answer any *two* from the following : 5×2=10

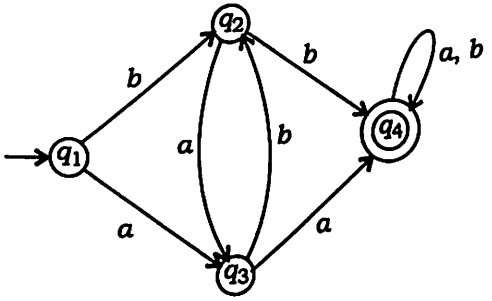
(i) Prove that $L = \{0^n \mid n \text{ is prime}\}$ is not regular.

(Continued)

(ii) Construct a transition system equivalent to the regular expression given below :

$$(ab + a)^*(aa + b)$$

(iii) Find the regular expression corresponding to the automata given below :



5. (a) "Every context-free language is recursive." State True or False. 1

(b) Show that the grammar 2

$$G = S \to aSbS \mid bSaS \mid \Lambda$$

is recursive.

(c) Write a CFG to generate 2

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

(Turn Over)

(d) Answer any *two* from the following : 5×2=10

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

$S \to aB \mid bA$

$A \to a \mid aS \mid bAA$

$B \to b \mid bS \mid aBB$

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

$S \to A0,\ A \to 0B,\ B \to A0,\ B \to 1$

(iii) Show that the language

$\{a^{n^2} \mid n \geq 1\}$

is not context-free.

6. (a) "Every regular expression may not be recognised by a transition system." State True or False. 1

(b) Describe in English language, the sets represented by the following regular expressions : 2

(i) $(aa + bbb)^*$

(ii) $a^*b + b^*a$

(c) Define pumping lemma. 2

(d) Answer any *two* from the following : 5×2=10

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

(ii) Construct a PDA accepting $L = \{a^{2n}cb^n \mid n \geq 1\}$

(iii) Construct a PDA equivalent to the following grammar :

$S \to aSa \mid bSb \mid a$

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