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3 (Sem-5/CBCS) CSC HC 2

2023

**COMPUTER SCIENCE**

(Honours Core)

Paper : CSC-HC-5026

**(Theory of Computation)**

Full Marks : 80

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

1. Answer the following as directed :

1×10=10

(a) For the given grammar

$G = (\{S\}, \{a, b\}, P, S)$ , the production rules  $P$  are  $S \rightarrow aSb / SS / \epsilon$ . The string that will be generated by this grammar is

(i)  $ababab$

(ii)  $a^3b^3$

(iii)  $aababb$

(iv) All of the above

*(Choose the correct option)*

Contd.

(b) In the following CFG, which variable is useless ?

$S \rightarrow aAB, A \rightarrow aA/a, B \rightarrow bB/b, C \rightarrow d$

(i) A

(ii) S

(iii) C

(iv) B

*(Choose the correct option)*

(c) Which of the following statement is not true for PDA ?

(i) PDA contains stack

(ii) The head moves from left to right

(iii) Input string is surrounded by infinite number of blank in both sides

(iv) The head reads as well as writes

*(Choose the correct option)*

(d) Regular sets are closed number

(i) union

(ii) Kleene closure

(iii) concatenation

(iv) All of the above

*(Choose the correct option)*

(e) Which of the following is not a regular expression ?

(i)  $a + b$

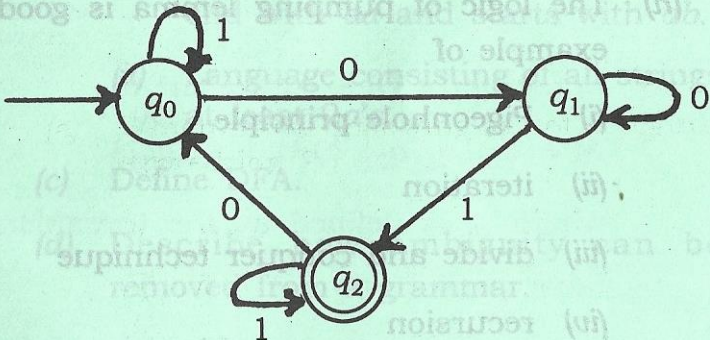
(ii)  $a$

(iii)  $ab$

(iv)  $a^n b^n$

(Choose the correct option)

(f) Consider the following transition diagram



Which of the following string is accepted by it ?

(i) 100111

(ii) 1110001

(iii) 01001

(iv) All of the above

(Choose the correct option)

(g) Which of the following is correct ?

(i)  $a^+ = a * a^*$

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

(iii)  $a^+ = a^+ a^+$

(iv)  $a^* = a^+ a^*$

(Choose the correct option)

(h) The logic of pumping lemma is good example of

(i) Pigeonhole principle

(ii) iteration

(iii) divide and conquer technique

(iv) recursion

(Choose the correct option)

(i) The grammar that produce more than one parse tree for the same string is

\_\_\_\_\_.

(Fill in the blank)

(j) According to Chomsky Hierarchy CFG is type \_\_\_\_\_ grammar.

\_\_\_\_\_.

(Fill in the blank)

2. Answer the following questions :  $2 \times 5 = 10$

(a) Describe the RE in English language.

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

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

(b) Write the RE for the following languages over  $[a, b]$

(i) Language consisting of all strings end with  $aa$  and starts with  $ab$ .

(ii) Language consisting of all strings at least  $2a$ 's.

(c) Define DFA.

(d) Describe how ambiguity can be removed from a grammar.

(e) Prove that two Res  $R_1$  and  $R_2$  over  $\Sigma$  is closed under intersection operation.

3. Answer **any four** of the following questions :

$5 \times 4 = 20$

(a) State Pumping lemma for regular language.

(b) Show that  $L = \{a^n b^n \mid n \geq 1\}$  is not regular.

(c) Convert the following grammar into CNF

$$S \rightarrow abAB$$

$$A \rightarrow bAB / \varepsilon$$

$$B \rightarrow Baa / \varepsilon$$

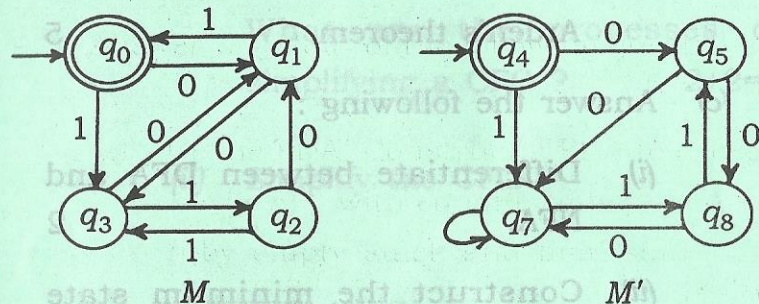
(d) Construct a DFA equivalent to

$$M = (\{q_0, q_1, q_2\}, \{0, 1\}, \delta, q_0, \{q_0\})$$

where  $\delta$  is defined by the transition table given below :

Present State	Next State	
	Input=0	Input=1
$\rightarrow q_0$	$q_1, q_2$	—
$q_1$	$q_2$	$q_1$
$q_2$	$q_0$	$q_1, q_2$

(e) Check whether the two DFA's  $M$  and  $M'$  are equivalent or not :



(f) Check whether the given grammar

$$G = (\{S\}, \{id, +, *\}, P), S \text{ is ambiguous or not where } P \text{ is defined by } S \rightarrow S + S / S * S / id.$$

4. Answer **any four** of the following questions :  $10 \times 4 = 40$

(a) Define PDA. Construct a PDA to accept  $L = (a, b)^*$  with equal number of  $a$  and  $b$  by empty stack and final state.

$2 + 8 = 10$

(b) Answer the following :

(i) State and prove Arden's theorem.

5

(ii) Construct the DFA that accept the RE  $L = ab + (aa + bb)(a + b)^*$  using Arden's theorem. 5

(c) Answer the following :

(i) Differentiate between DFA and NFA. 2

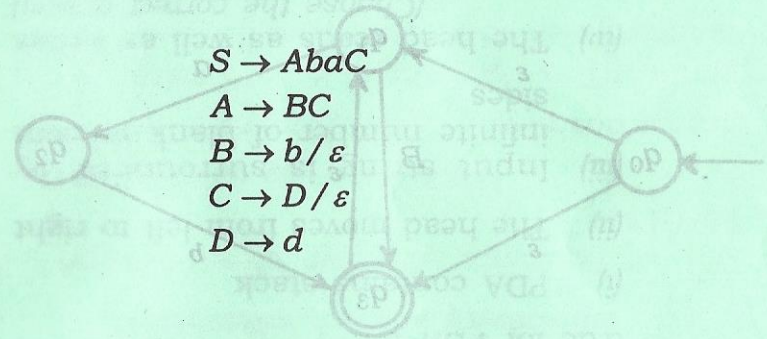
(ii) Construct the minimum state automation equivalent to the DFA given below : 8

Present State	Next State	
	Input = 0	Input = 1
$\rightarrow q_0$	$q_1$	$q_2$
$q_1$	$q_5$	$q_4$
$q_2$	$q_3$	$q_4$
$q_3$	$q_5$	$q_0$
$q_4$	$q_3$	$q_2$
$q_5$	$q_2$	$q_2$
$q_6$	$q_2$	$q_3$
$q_7$	$q_2$	$q_1$

(d) Answer the following :

(i) Why CFG is needed to simplify ? What are the processes of simplifying a CFG ? 2+2=4

(ii) Simplify the CFG 6



(e) Answer the following :

(i) Define RE with example. 2

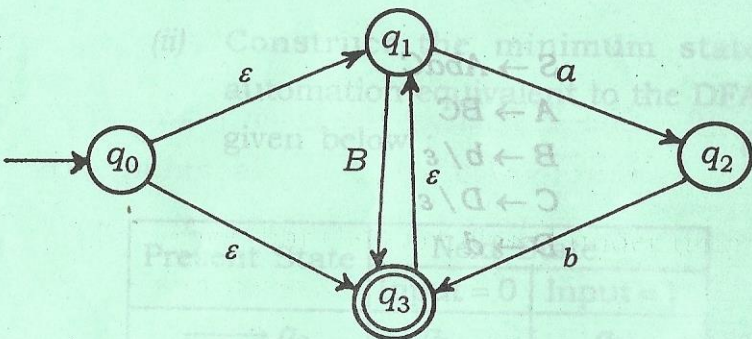
(ii) Prove the following using identities : 8

$$(a + abb^*) + (a + abb^*)(ab + abaa^*)(ab + abaa^*) = ab^*(aba^*)^*$$

(f) Prove that CFG are closed under union and concatenation.

(g) Answer the following:

(i) Convert the following NFA with  $\epsilon$  move to an equivalent DFA. 5



(ii) Prove that  $L = \{a^n b^n c^n \mid i \geq 1\}$  is not context free. 5

(h) Write short notes on : (any two) 5×2=10

(i) Chomsky's classification of grammar

- (ii) GNF
  - (iii) Parse tree
  - (iv) Pumping lemma for context free language
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