Total number of printed pages–8

2024

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 questions as directed :
$$1 \times 10 = 10$$

   (a) Which is true for the following CFG ?
   $S \rightarrow aA/\varepsilon$
   $A \rightarrow bA/a$

      (i) Null Production can be removed
      (ii) Null Production cannot be removed
      (iii) As A does not produce null so cannot be removed
      (iv) Both (ii) and (iii)
      (Choose the correct option)

(b) CFL is not closed under

    (i) Union

    (ii) Concatenation

    (iii) Complementation

    (iv) Star closure
            (Choose the correct option)

(c) PDA is the machine format of

    (i) Type 0 language

    (ii) Type 1 language

    (iii) Type 2 language

    (iv) Type 3 language
            (Choose the correct option)

(d) $(a+b)^*$ means _____.

    (i) Any combination of a,b including null

    (ii) Any combination of a,b excluding null

    (iii) Any combination of a,b with equal numbers of a's and b's

    (iv) None of the above
            (Choose the correct option)

(e) The difference between Finite Automata and PDA is

    (i) Reading Head

    (ii) Input Tape

    (iii) Finite Control

    (iv) Stack
            (Choose the correct option)

(f) In DFA null $(or\ \varepsilon)$ move is allowed.
            *(State True **or** False)*

(g) Regular language is closed under union.
            *(State True **or** False)*

(h) If R is a Regular Expression then
    $RR^* =$ _____.   *(Fill in the blank)*

(i) For the given grammar
    $G = (\{S\}, \{a,b\}, P, S)$ where the production rules Pare $S \rightarrow ab$. Find out any string that can be generated by the grammar.

(j) What is useless production ?

2. Answer the following questions : 2×5=10

(a) Define DFA.

(b) What NPDA ?

(c) Describe the RE in English language.

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

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

(d) Write the RE for the following language over $\{a,b\}$

    (i) Language consisting of all strings of a and b having 'bb' as substring

    (ii) Language consisting of all string of a and b with even number of a's

(e) Define Left Linear and Right Linear Grammar.

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

                5×4=20

(a) Convert the following grammar into GNF

$$S \to AB$$
$$A \to BSB/BB/b$$
$$B \to aAb/a$$

(b) Show that $L = \{O^P | \text{where } P \text{ is Prime}\}$ is not context Free.

(c) Prove the given grammar

$$G = (\{S, X, Y\}, \{0,1\}, P, S)$$ is ambiguous

where P is defined by

$$S \to 0Y/01$$
$$X \to 0XY/0$$
$$Y \to XY1/1$$

(d) Prove that complement of a Regular Expression (RE) is also RE.

(e) Construct the string '$aaabbabbba$' forms the grammar

$$S \to aB/bA$$
$$A \to a/aS/bAA$$
$$B \to b/bS/aBB \quad \text{by using}$$

    (i) Left most derivation

    (ii) Right most derivation

(f) Prove the given Regular Expressions $R_1 = (a+b)^*$ and $R_2 = (ab)^*$ are equivalent.

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

$$10 \times 4 = 40$$

(a) Answer the following :

(i) Construct a DFA without null equivalent to

$$M = (\{q_0, q_1, q_2, q_3\}, \{a, b\}, \delta, q_0, \{q_0\})$$

where δ is defined by the transition table given below : 7

Present State	Next State	
	Input = a	Input = b
$\rightarrow q_0$	---	q_1
q_1	q_0	q_2
q_2	q_0, q_1	q_3
(q_3)	q_3	q_0, q_1

(ii) Define NFA with null move with an example. 3

(b) What is useless symbol and unit Production ? Remove the useless symbol and unit Production from the given grammar 3+7=10

$S \rightarrow aX/Yb/Y$

$X \rightarrow S$

$Y \rightarrow Yb/b$

(c) State and proof the properties of CFL.

(d) Define Deterministic PDA. Construct a PDA to accept the language

$$L = \{WCW^R, \text{where } W \in (a, b)^+ \text{ and}$$

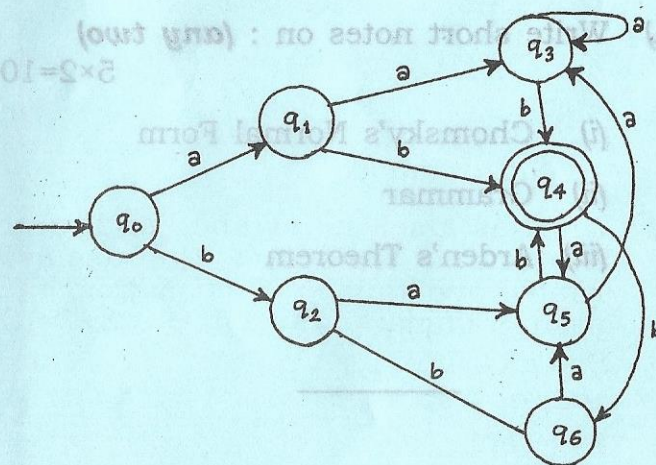W^R is the reverse of $W\}$ by empty stack and final state. 3+7=10

(e) Construct CFG for

$$\{a^n b^n c^m d^m \mid n, m \geq 1\}.$$

(f) Construct the minimum state automata equivalent of the DFA

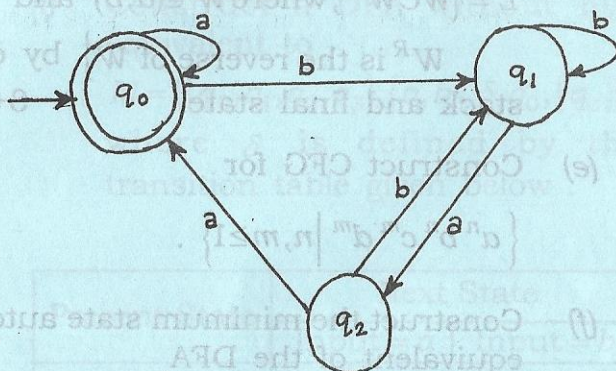$$M = (\{q_0, q_1, q_2\, q_3, q_4, q_5, q_6\}, \{a, b\}, \delta, q_0,$$

$\{q_4\})$ where δ is defined by

(g) Answer the following :

    (i) Construct a RE from the given FA by Algebric Method Using Arden's Theorem.   5

    (ii) Construct a FA equivalent of the given RE $L = (00+11)^* 11(0+1)^*$ 5

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

    (i) Chomsky's Normal Form

    (ii) Grammar

    (iii) Arden's Theorem

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