NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - THEORY EXAMINATION (2022-2023)

Subject: Theory of Automata and Formal Languages

Time: 3 Hours   **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* **three Sections -A, B, & C.** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

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SECTION A   **20**

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1. Attempt all parts:-

1-a.   Can a DFA simulate NFA?   (CO1)   1

        (a) NO

        (b) YES

        (c) Sometimes

        (d) Depends on NFA

1-b.   Finite State Machine can recognize ………………   (CO1)   1

        (a) Any Grammar

        (b) Only CFG

        (c) Any unambiguous Grammar

        (d) Only Regular Grammar

1-c.   Consider the following regular expression :   (CO2)   1

    R = (ab + abb)* bbab

which of the following is not in R.

        (a) ababab

(b) abbabbbbab

(c) ababbbbab

(d) abbabbbab

1-d. The regular expression (a + b)* denotes all strings .... (CO2)   1

     (a) with zero or more instances of a and b both simultaneously

     (b) with one or more instances of a and b

     (c) any combination of a's and b's including null string.

     (d) None of these

1-e. Every CFG can be transfered into equivalent : (CO3)   1

     (a) Greiback Normal Form

     (b) CNF

     (c) Either GNF or CNF

     (d) All of mention

1-f. CFG is not closed under : (CO3)   1

     (a) Union

     (b) Kleene Star

     (c) Complementation

     (d) Product

1-g. A push down automata can represented using: (CO4)   1

     (a) Transition graph

     (b) Transition table

     (c) ID

     (d) All of the mentioned

1-h. The transition a Push down automaton makes is additionally dependent upon the: (CO4)   1

     (a) State

     (b) Unconsumed input

     (c) Stack content

     (d) All of the mentioned

1-i. Turing Machine consist of : (CO5)   1

     (a) Input Tape

     (b) Blank Symbol

     (c) Tape head

(d) All of these

1-j.   A turing machine that is able to simulate other turing machines: (CO5)   1

(a) Nested Turing Machine

(b) Universal Turing Machine

(c) Counter Turing Machine

(d) None of the mention

2. Attempt all parts:-

2.a.   Explain the term Alphabets, Strings, Language in Finite Automata.   (CO1)   2

2.b.   Describe the definition of Regular Expression.   (CO2)   2

2.c.   Explain the Mathematical description of Context Free Grammar.   (CO3)   2

2.d.   Describe the explanation for the Moves of Pushdown Automata.   (CO4)   2

2.e.   Explain Church's Thesis.   (CO5)   2

SECTION B   **30**

3. Answer any <u>five</u> of the following:-

3-a.   Design Finite Automata that accepts set of strings containing exactly four 1's in every string over alphabet {0,1}.   (CO1)   6

3-b.   Convert the given Moore machine into its equivalent Mealy machine.   (CO1)   6
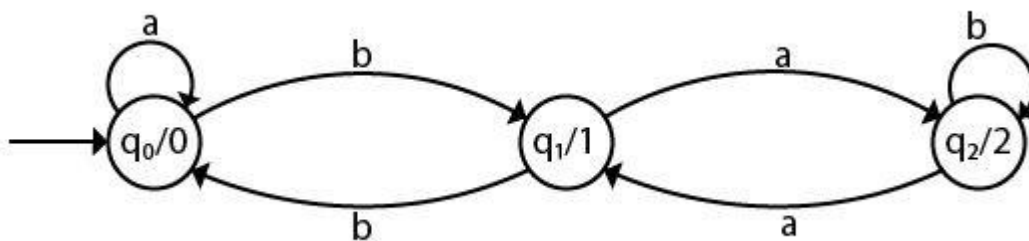
3-c.   Write the regular expression for the language L $= \{ a^n b^m : (n+m)$ is even $\}$ 6
(CO2)

3-d.   Prove that L $= \{ a^n b^n ab^{n+1}$ for n = 1,2,3, ...$\}$ is not regular.   (CO2)   6

3.e.   If CFG (G) is S ----> SbS / a , Show that G is ambigous.   (CO3)   6

3.f.   Design a PDA for the language L=$\{ 0^n 1^{2n} , n >0\}$ (CO4)   6

3.g.   Design a Turing Machine which recognize the language of Regular Expression (0 1* 0) .   (CO5)   6

SECTION C   **50**

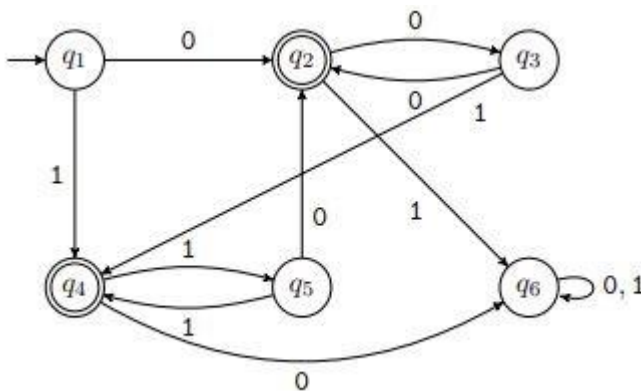## 4. Answer any <u>one</u> of the following:-

4-a.   Convert epsilon-NFA to NFA without epsilon .   (CO1)   10
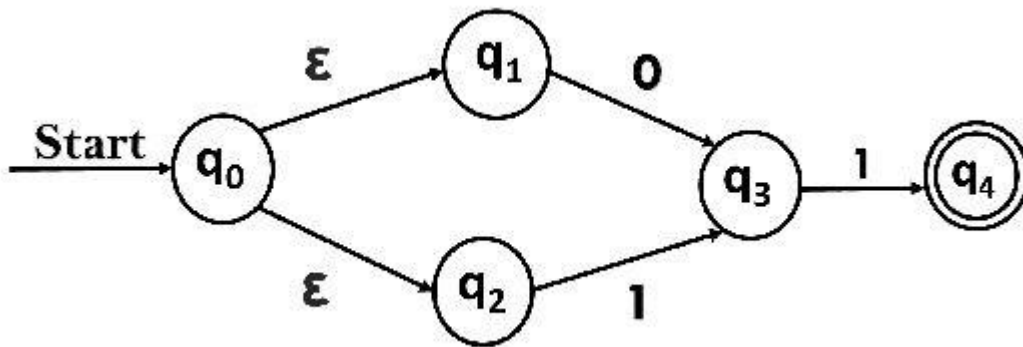
4-b. For the following DFA, determine the classes of equivalent states, and use them to provide the equivalent minimum-state DFA. (CO1)   10

5. Answer any <u>one</u> of the following:-

5-a. Write down the statement of Pumping Lemma for Regular Languages. also Describe the Closure Properties of Regular Languages. (CO2)   10

5-b. Prove Ardens's Theorem. Find the regular expression corresponding to Fig. (CO2)   10
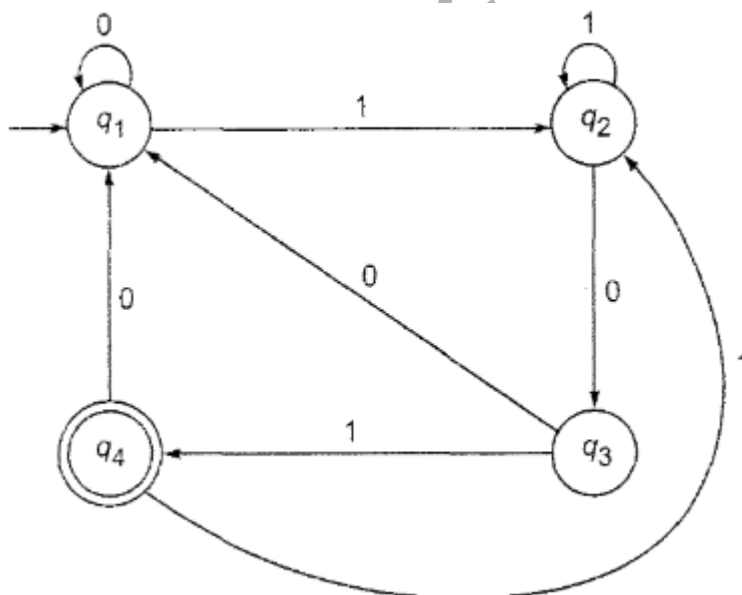
6. Answer any <u>one</u> of the following:-

6-a. Consider the grammar   (CO3)   10

    S ---> aB / bA

A ----> aS / bAA / a

B ---> bS / aBB / b

For the string aaabbabbba , find

(i) The left most derivation and left most derivation tree

(ii) The right most derivation and right most derivation tree

6-b. Describe the following : (CO3) 10

(i) Eliminating the Use Less Symbols in CFG

(ii) Removal of Unit Production in CFG

(iii) Removal of Null - Production in CFG

Find the Reduced Grammar that is equivalent to the CFG given below :

S ---> AB

A ---> a

B ---> C / b

C ---> D

D ----> E

E -----> a

7. Answer any <u>one</u> of the following:-

7-a. Describe the Definition of Pushdown Automata. Is PDA more powerful than Finite Automata? if Yes than why? also Design PDA for Language $L = \{ a^{m+n}b^m c^n$ / m, n > 1\}$ (CO4) 10

7-b. Design a PDA for the following CFG : (CO4) 10

S ----> ε

S ----> SS

S ----> (S)

Show the transition relation on string ( ) ( ) for constructed PDA.

8. Answer any <u>one</u> of the following:-

8-a. Explain Instantaneous description of Turing Machine. Design the Turing Machine for : (CO5) 10

(i) 1's Complement of any string

(ii) 2's Complement of any string

8-b. Explain any two of the following : (CO5) 10

(i) Universal Turing Machine

(ii) Recursively Enumerable Language

(iii) Halting Problem

(iv) Post's Correspondence Problem