Code No: R1622055 **R16** SET - 1

II B. Tech II Semester Regular/ Supplementary Examinations, April/May - 2019
FORMAL LANGUAGES AND AUTOMATA THEORY
(Computer science and Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Why it is important to study Automata Theory for Computer science? (2M)

   b) What is a Regular expression in the theory of Automata? (2M)

   c) Eliminate Useless symbols from the given grammar (3M)
   A→ xyz |Xyzz
   X → Xz |xYz
   Y →yYy|Xz
   Z → Zy | z

   d) Define Push Down Automata. (2M)

   e) What do you mean by Instantaneous Description of Turing Machine? (3M)

   f) What is Post correspondence problem in Theory of Computation? (2M)

PART -B

2. Let Σ = {a, b}, (14M)
   a) Give DFA that accepts any string with *aababb* as a substring.
   b) Minimize the DFA obtained for the answer of question 2(a) using MyhillNerode theorem.

3. a) Convert the regular expression (((00)*(11)) + 01)* into an NFA. (7M)

   b) Prove that the following language L is not regular using pumping lemma (7M)
   L = { w belongs to {a,b}* | $w = w^R$}

4. a) Consider the CFG with {S,A,B} as the non-terminal alphabet, {a, b} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   S → ASA | aB | b
   A → B
   B → b | ∈
   Find a reduced grammar equivalent to the above grammar.

   b) State and prove the Ogden's Lemma. (7M)

5. a) Explain the various ways of determining the acceptability of Pushdown Automata. (6M)

   b) Construct a PDA that accepts L = {$0^n 1^n$ | n ≥ 0} (8M)

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6. a) Construct a Turing Machine for language $L = \{ww^R \mid w \in \{0, 1\}\}$. (7M)

   b) Why a Turing machine is called Linear Bounded Automata? Discuss the advantages of Linear Bounded Automata. (7M)

7. Explain in detail about P, NP, NP-complete and NP-hard problems with real time examples for each. (14M)

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) What is Automata and Language theory in computer science? (2M)

   b) Write regular expressions for the following language over the alphabet ' (3M)
   $\Sigma = \{0, 1\}$
   i) Strings with three consecutive 1's
   ii) Strings with three 1's

   c) Remove Null production from the following grammar (3M)
   $S \rightarrow ASA \mid aB \mid b$
   $A \rightarrow B$
   $B \rightarrow b \mid \in$

   d) Does push down automata have memory? Give explanation. (2M)

   e) What is the Turing test and why is it important? (2M)

   f) Is Halting problem recursively enumerable? Give explanation. (2M)

PART –B

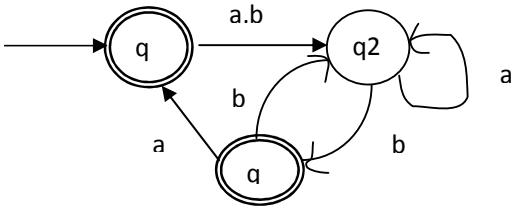
2. a) How finite automata is useful for Natural language processing? Explain. (4M)

   b) Give a DFA for $\Sigma = \{a, b\}$ that accepts any string with *aababb* as a substring. (5M)

   c) Design a Moore machine for 2's complement of binary number. (5M)

3. a) State and Explain the pumping lemma for Regular languages. (7M)

   b) Convert the following DFA to a regular expression. (7M)



4. a) Define Context Free Grammar. State and Explain the closure properties of CFG. (7M)

   b) Consider the CFG with {S,A,B} as the non-terminal alphabet, {a,b, ε} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   $S \rightarrow ASA \mid aB$
   $A \rightarrow B|S$
   $B \rightarrow b|\varepsilon$
   Convert the given grammar into CNF

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5. a) Define Push Down Automata. Explain the basic structure of PDA with a neat graphical representation. (7M)
   b) Show that $\{ a^m b^n c^p \mid m < n \text{ or } n < p\}$ is not deterministically context-free. (7M)

6. a) Construct Turing machine for $L = \{a^n b^m a^{(n+m)} \mid n,m \geq 1\}$ (7M)
   b) Discuss the variants of Turing machines. (7M)

7. a) Explain the halting problem and demonstrate that it is undecidable. (7M)
   b) What is meant by Reducibility in NP-problems and why it is required? Explain. (7M)

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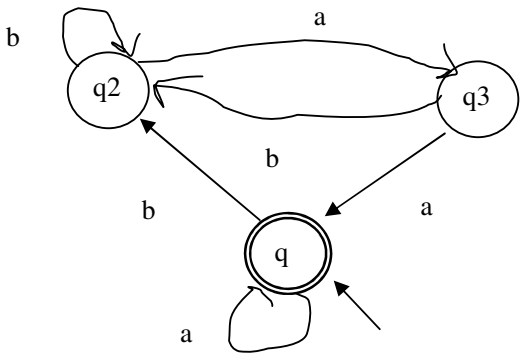
PART –A

1. a) List any four important applications of Finite Automata. (2M)
   b) Define pumping lemma for regular languages. (3M)
   c) Define Context Free Grammar. (2M)
   d) How is a two stack PDA equivalent to a Turing machine? (2M)
   e) What is the name of the test that is used to evaluate whether a machine is intelligent human? (2M)
   f) Why is the halting problem undecidable? (3M)

PART –B

2. a) Give an ∈-NFA for strings of the form 01*0*1 over the alphabet Σ = {0, 1} (7M)
   b) Explain the sequence of steps in converting the ∈-NFA obtained in previous question 2(a) to an equivalent DFA. (7M)

3. a) Prove that the following language L is not regular using pumping lemma (7M)
   $L = \{ a^{2n} b^{3n} a^{n} \mid n \geq 0 \}$
   b) Construct a Regular expression corresponding to the following finite automata. (7M)



4. a) Consider the CFG with {S,A,B} as the non-terminal alphabet, {0,1} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   S → A1B
   A → 0A / ∈
   B → 0B / 1B / ∈
   For the string w = 00101, find the Leftmost derivation, Rightmost derivation, and Parse Tree.
   b) Show that language $L=\{a^n b^n c^n \mid n \geq 0\}$ is not a Context Free. (7M)

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5. a) Construct a pushdown automaton which accepts the language of words over the alphabet {a,b} containing more a's than b's. (7M)
   b) Consider the CFG with {S,A,X} as the non-terminal alphabet, {a,b} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   $S \rightarrow XS \mid \varepsilon$,
   $A \rightarrow aXb \mid Ab \mid ab$
   Construct a PDA for the given CFG.

6. a) Construct a Turing Machine for language $L = \{0^n1^n2^n \mid n \geq 1\}$. (7M)
   b) Explain the differences between Halt, Accept, and Decidable in the context of Turing machines. (7M)

7. a) Show that the Post Correspondence Problem is decidable over unary alphabet. (7M)
   b) How to determine a problem L is NP-complete? Explain with an example. (7M)

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) Define NFA with ∈- moves. (2M)
   b) How do you prove a language is regular? (2M)
   c) What is Chomsky Normal Form (CNF) and why we convert a CFG to CNF? (2M)
   d) Is a Push Down Automata with two stacks equivalent to Turing Machine? Give justification to your answer. (3M)
   e) What is the Turing test and how does it work? (2M)
   f) What is NP-hard and NP-complete problem? (3M)

PART -B

2. a) Draw a deterministic and non-deterministic finite automata for Σ = {A-Z} which accept a string containing "CSE" at the end of a string of {A-Z}. (6M)
   b) Design Moore machine for 2's complement of binary number. (4M)
   c) Mention the limitations of Finite automata (4M)

3. a) Consider the following statements, (7M)
   Statement 1: All finite languages are Regular
   Statement 2: All regular languages finite
   Which of the above statements are TRUE? Give a detailed explanation to your answer.
   b) Give a regular expression that generates the language L over the alphabet Σ ={a, b} where each b in the string is followed by exactly one or three a's. (7M)

4. a) Consider the CFG with {S,A,B} as the non-terminal alphabet, {a,b} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   S → aB|bA
   S → aS|bAA| a
   B → bS| aBB| b
   Is this grammar ambiguous or unambiguous? Give justification to your answer.
   b) Consider the CFG with {S,X,Y} as the non-terminal alphabet, {m,n,o} as the terminal alphabet, S as the start symbol and the following set of production rules (7M)
   S → XY | Xn | p
   X → mX | m
   Y → Xn | o
   Convert the given CFG into Geibach Normal Form

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5.	a)	Construct a PDA that accepts language L = { ww^R | w = (a+b)* }.	(5M)
	b)	Differentiate between Deterministic PDA and Non-deterministic PDA.	(5M)
	c)	Mention the applications of Push Down Automata.	(4M)
6.	a)	Construct a Turing machine for L = {$a^ib^jc^k$ | i*j = k; i, j, k ≥ 1}.	(7M)
	b)	Explain the differences between Turing Machine and Universal Turing Machine.	(7M)
7.	a)	Show that the Post correspondence problem is undecidable over the binary alphabet.	(7M)
	b)	Explain about recursive and recursively enumerable language.	(4M)
	c)	Write about Boolean Satisfiability Problem.	(3M)

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