Unit 1:
Introduction to Automata, Computability and Complexity theory, Automaton as a model of
computation, Central Concepts of Automata Theory: Alphabets, Strings, Languages. Decision
Problems Vs Languages. Finite Automata, Structural Representations, Deterministic Finite Automata
(DFA)-Formal Definition, Simplified notation: State transition graph, transition table, Language of
DFA, construction of DFAs for Languages and proving correctness, Product construction,
Nondeterministic finite Automata (NFA), NFA with epsilon transition, Language of NFA, Conversion of NFA with epsilon transitions to DFA, Applications and Limitation of Finite Automata.

Unit 2 :
Regular expression (RE), Definition, Operators of regular expression and their precedence, Algebraic
laws for Regular expressions, Kleene's Theorem: Equivalence Regular expressions and DFAs
(without proof), Closure properties of Regular Languages (union, intersection, complementation,
concatenation, Kleene closure), Decision properties of Regular Languages, Applications of Regular
expressions. Myhill-Nerode theorem and applications: proving non-regularity, lower bound on
number of states of DFA, State Minimization algorithm, Equivalence testing of DFAs. Non-Regular
Languages, Revisiting Pigeon-Hole principle, Pumping Lemma for regular Languages.

Unit 3 :

Context Free Grammars: Definition, Examples, Derivation, Languages of CFG, Constructing CFG,
correctness proof using induction. Closure properties of CFLs (Union, Concatenation,

Kleene
closure, reversal). Derivation trees, Ambiguity in CFGs, Removing ambiguity, Inherent ambiguity.
Normal forms for CFGs: CNF and GNF (without proof). Decision Properties of CFLs (Emptiness,
Finiteness and Membership). Applications of CFG.

Unit 4 :
Description and definition, Language of PDA, Acceptance by Final state, Acceptance by empty
stack, Deterministic, Non-deterministic PDAs, CFG to PDA construction (with proof). Equivalence
of PDA and CFG (without proof). Intersection of CFLs and Regular language. Pumping lemma for
CFLs, non-Context Free Languages, Chomsky hierarchy.

Unit 5 :
Basic model, definition, and representation, Instantaneous Description, Language acceptance by TM.
Robustness of Turing Machine model and equivalence with various variants: Two-way/One-way
infinite tape TM, multi-tape TM, non-deterministic TM, Universal Turing Machines. TM as enumerator. Recursive and Recursively Enumerable languages and their closure properties.

Unit 6:
Church-Turing Thesis and intuitive notion of Algorithm, Encoding for Turing machines and
countability of set of all Turing machines. Existence of Turing unrecognizable languages via Cantor's

diagonalization. Undecidability of Halting problem. Examples of undecidable problems: Post
Correspondence Problem, Hilbert's 10th Problem, Tiling problem (without proof). Example of
Turing unrecognizable language. Decision properties of R, RE languages.