Formal Languages and Automata Theory - Video course

NPTEL

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Mathematics

Coordinators:

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COURSE OUTLINE

Unit 1: (D. Goswami)
Introduction to the course. Texts and References are given.
Unit 2: (D. Goswami)
Alphabet, Strings, Languages, Finite Representation of languages, Regular Expressions.
Unit 3: (K. V. Krishna)
Context-free Grammars (CFGs) -Formal definition, sentential forms, leftmost and rightmost derivations,, the language of a CFG. Derivation tree or Parse tree - Definition, Relationship between parse trees and derivations. Parsing and ambiguity, Ambiguity in grammars and Languages. Regular grammars.
Unit 4: (D. Goswami)
Finite automata (FA) -its behavior; DFA -Formal definition, simplified notations (state transition diagram, transition table), Language of a DFA. NFA -Formal definition, Language of an NFA, Removing, epsilon-transitions. Equivalence of DFAs and NFAs.
Unit 5: (K. V. Krishna)
Myhill-Nerode Theorem and minimization of finite automata
Unit 6: (D. Goswami)
Establishing the equivalence between regular languages, regular grammars and finite automata.
Unit 7: (K. V. Krishna)
2DFA, Moore and Mealy automata.
Unit 8: (K. V. Krishna)
Some closure properties of Regular languages -Closure under Boolean operations, reversal, homomorphism, inverse homomorphism, etc. Pumping lemma, proving languages to be non regular.

Unit 9: (D. Goswami)
Simplification of CFGs -Removing useless symbols, epsilon- Productions, and unit productions, Normal forms -CNF and GNF

Unit 10: (K. V. Krishna)
Some closure properties of CFLs -Closure under union, concatenation, Kleene closure, substitution, homomorphism, reversal, intersection with regular set, etc. Pumping lemma.

Unit 11: (K. V. Krishna)
Pushdown automata and showing the equivalence between PDA and CFG.

Unit 12: (K. V. Krishna)
Turing Machines TM -Formal definition and behavior, Transition diagrams, Language of a TM, TM as accepters and deciders. TM as a computer of integer functions. Variants of Turing machines.

Unit 13: (K. V. Krishna)
Grammars and grammatically computable functions.

Unit 14: (D. Goswami)
Recursive languages, Some properties of recursive and recursively enumerable languages, Codes for TMs. A language that is not recursively enumerable (the diagonalization language). The universal language, Undecidability of the universal

language, The Halting problem, Undecidable problems about TMs.

Unit 15: (K. V. Krishna)
Time bounded TMs, The classes P, NP and NP-complete, Cook's Theorem, Some NP-complete problems.

Unit 16: (D. Goswami)

Context-sensitive languages, linear bounded automata and Chomsky Hierarchy.

COURSE DETAIL

Module No. & Module Name	Topic	No. of Hours
0. Introduction	**Lecture 1: Introduction**	**01**
1. Languages and finite representation	**Lecture 1: Alphabet, Strings, Languages** **Lecture 2: Finite Representation**	02
2. Grammars	**Lecture 1: Grammars (CFG)** **Lecture 2: Derivation Trees** **Lecture 3: Regular Grammars**	03
3. Finite automata	**Lecture 1: Finite Automata** **Lecture 2: Nondeterministic Finite Automata** **Lecture 3: NFA <=> DFA**	03
4. Minimization of finite automata	**Lecture 1: Myhill-Nerode Theorem** **Lecture 2: Minimization**	02
5. RL ↔ RG ↔ FA	**Lecture 1: RE => FA** **Lecture 2: FA => RE** **Lecture 3: FA <=> RG**	03
6. Variants of finite automata	**Lecture 1: Variants of FA**	01
7. Properties of regular languages	**Lecture 1: Closure Properties of RL** **Lecture 2: Homomorphism** **Lecture 3: Pumping Lemma**	03
8. Simplification of CFGs	**Lecture 1: Simplification of CFG** **Lecture 2: Normal Forms of CFG**	02

9. Properties of CFLs	**Lecture 1: Properties of CFLs**	01
10. Pushdown automata	**Lecture 1: Pushdown Automata** **Lecture 2: PDA <=> CFG**	02
11. Turing machines	**Lecture 1: Turing Machines** **Lecture 2: Turing Computable Functions** **Lecture 3: Combining Turing Machines** **Lecture 4: Multi Input** **Lecture 5: Turing Decidable Languages** **Lecture 6: Variants of Turing Machines**	06
12. Structured grammars	**Lecture 1: Structured Grammars**	01
13. Decidability and undecidability	**Lecture 1: Decidability** **Lecture 2: Undecidability** **Lecture 3: Undecidability** **Lecture 4: Undecidability**	04
14. Introduction to complexity theory	**Lecture 1: Time Bounded Turing Machines** **Lecture 2: P and NP** **Lecture 3: NP-Completeness** **Lecture 4: NP-Complete Problems** **Lecture 5: NP-Complete Problems** **Lecture 6: NP-Complete Problems**	06
15. Chomsky Hierarchy	**Lecture 1: Chomsky Hierarchy**	01
	Total	**41**

References:

1. J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson, 2001.
2. H. R. Lewis and C. H. Papadimitriou, Elements of the Theory of Computation, Prentice Hall, 1997/Pearson 1998.
3. J. E. Hopcroft and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, Narosa, 1979.
4. M. Sipser, Introduction to the Theory of Computation, Thomson Asia, 1997.
5. D. C. Kozen, Automata and Computability, Springer-Verlag, 1997.