

CS222: Theory of Computation

(Deployment of the Course)

Faculty: Prof. K.R. Chowdhary

Course: CS222: TOC.

Week 1: 02 Jan-2016 to 06 Jan. 2017

- (1) 02-jan, 2017: (Monday) names of books, main area of computer sc. algorithmic processing, representation, storage, transmission. Is it science, maths, or philosophy? It is combination of maths, philosophy, natural science and deals with determinism, nondeterminism, theorems, proofs, truth, false, complexity, randomness, approximation, language, etc.

languages: Chomsky hierarchy type 3, 2, 1, 0, reg, cf, cs, unrest,fa, pda, lba, tm.

- (2) 05-Jan, 2017:(Thursday) Theory, meta theory, proofs, Contradiction, deduction, induction, functions & mapping.
- (3) 06-Jan, 2017: (Friday) Program for halting machine, functions, finite program and alphabets, countable algorithms and uncountable languages, computable functions, languages, non-computable algorithms.

Week 2: 09 Jan-2016 to 14 Jan. 2017

- (4) 09-Jan, 2017: (Monday) Counting, Diagonalization theorem, algebraic systems-homomorphism, isomorphism, reducibility, formal languages.
- (5) 12-Jan, 2017: (Thursday) Languages and their operations, language as set, syntactically defining a language, formally defining languages, kleene star or Σ and language L, regular expressions, and regular language, defining regex, examples of regular expressions and languages.
- (6) 13-01-2017: (Friday) uncountable number of languages and countable representations of reg lang., no bijection between an infinite countable set and its power set (proof), regular expressions, defining, regular languages, operations on regular languages.

Week 3: 16 Jan. 2017 to 21 Jan. 2017

- (7) 16-01-2017: (Monday) defining FA, FA as program, FA mathematical model, physical model of FA. extended transition function, moves, definition of language accepted by FA, example of FA, transition diagram, corresponding regex.
- (8) 19-01-2017: (Thursday) applications of regex- lexical analyzers, search, sequential ckts.
- (9) 20-01-2017(Friday): Introduction to NFA.

Week 4: 23 Jan. 2017 to 28 aug. 2017

- (10) 23-01-2017 (Monday): construction of NFA, equivalence of NFA and DFA.
- (11) 27-01-2017 (Friday): convert NFA to DFA, introduction to minimization of DFA.

Week 5: 30 Jan. 2017 to 04 Feb. 2017

- (12) 30-01-2017: (Monday) Minimization, examples, and theory.
- (13) 02-01-2017: (Thursday) Minimization, partition based method.
- (14) 03-01-2017: (Friday) Discussion on home work 1

Week 6: 06 Feb. 2017 to 11, feb. 2017

- () 06-02-2017: (Monday) Midsem #1 course up to FA, minimization, regex, NFA.
- (15) 09-02-2017: (Thursday) On regularity of languages, pumping lemma, exercises $anbn$, a^n -prime.
- (16) 10-02-2017: (Friday) Ardens theorem, GNFA for FA to regular expressions. Examples.

Week 7: 13 Feb. 2017 to 18, feb. 2017

- (17) 13-02-2017: (Monday) Myhill-Nerode theorem and its application for testing regularity of languages.
- (18) 16-02-2017: (Thursday) Proof of Myhill-Nerode theorem, finding equivalence classes for a given language.
- (19) 17-02-2017: (Friday) CFL and CFG introduction, $a^*(b^* + c^*)b$ derivation using cfg, def. $g=(c, \sigma, s, p)$, applications of cfg, cfl.

Week 8: 20 Feb. 2017 to 25, feb. 2017

- (20) 20-02-2017: (Monday) $s \rightarrow asb, s \rightarrow asa \rightarrow bsb$, closure on union, def reg gr., reg gr subset of CFG, and reg lang. subset of cfl,
- (21) 23-02-2017: (Thursday) reg gr subset of CFG, and reg lang. subset of cfl, type of grammars: 0, 1, 2, 3 and their properties, Closure properties of CFL,
- () 24-02-2017: (Friday) Holiday due to ignus and shivratri.

Week 9: 27 Feb. 2017 to 04, Mar. 2017

- (22) 27-02-2017: (Monday) every lang is regular iff generated by reg grammar, parsing, ambiguity in CFL, removal of it,
- (23) 02-03-2017: (Thursday) pumping lemma for CFL, simplification and normalization of CFG.
- (24) 03-03-2017: (Friday) $anbncn$ not in cfl, simplification of cfg: null, useless prod, unit prod, PDA.

Week 10: 06 Mar. 2017 to 11, Mar. 2017

- (25) 06-03-2017: (Monday) Language acceptability of PDAs, nondeterministic PDA, for a PDA accepting by empty stack,

II Midsem Syllabus: Pumping lemma for regular languages, Ardens theorem and its applications. CFL and CFG, derivation using CFG, Closure properties of CFLs. Type of grammars: 0, 1, 2, 3. Parsing, ambiguity in CFL, removal of ambiguity, Pumping lemma for CFL, simplification and normalization of CFG, Chomsky Normal Form. Push Down Automata.

Week 11: 20 Mar. 2017 to 25, Mar. 2017

- (26) 20-03-2017: (Monday) TM definition, formal definition, examples: erase, anbn
- (27) 23-03-2017: (Thursday) Configurations, Turing decidable, Turing recognizable, transition table, anbncn,
- (28) 24-03-2017: (Friday) even odd palindromes, arithmetic functions: succ, adding numbers, with unary representation, nesting functions. delete a character, TM as function computer.

Week 12: 27 Mar. 2017 to 01, Apr. 2017

- (29) 27-03-2017: (Monday) Primitive recursive (PR) functions: Z, S, Succ, Pred, composition, projection, variants of TM, K-tape TM, for $k=2$ implemented $a^n b^n, ww^r, w = w^r$.
- (30) 30-03-2017: (Thursday) lect+10mt Qz, $L = \{a^{i^2}\}$ defn 3-tape, multi-track tm, multi-track simulation using std TM, 3-tape simulation on std TM, $\{w\}$ has equal number of as and bs. Complexities of single and other are P.
- (31) 31-03-2017: (Friday) Universal TM, its simulation on 3-tape TM,

Week 13: 03 Apr. 2017 to 08, Apr. 2017

- (32) 03-04-2017: (Monday) Non-deterministic TM, defn, its simulation on 3-tape TM, generation sequences, solution of Q6.
- (33) 06-04-2017: (Thursday) Turing machine enumerators, union of recursive languages, enumerator can recognize RE language, church-Turing thesis.
- (34) 07-04-2017: (Friday) Intersection of recursive languages, church-Turing thesis.

Week 14: 10 Apr. 2017 to 15, Apr. 2017

- (35) 10-04-2017(Monday) : decidability, of FA, reg. exr, cfg, cfl.
- (36) 13-04-2017(Thursday) : Undecidability, Halting Problem.
- 14-04-2017(Friday) : Ambedkar jyanti holiday.

Week 15: 17 Apr. 2017 to 22, Apr. 2017

- (37) 20-04-2015(Thursday): complexity, why, $T(n)$, N , $S(n)$, P , NP , $DTIME$, $NTIME$.
- (38) 21-04-2015(Friday): $EXPTIME$, $DSPACE$, $PSPACE$, NP -complete, SAT, Reduction, $\leq_m$, $\leq_T$, $\leq_P$, some theorems on reduction.
- (39) 24-04-2015(Monday): Godels incomplete theorem, and its consequence, David Hilbert, Greek axioms, and their failure.

End sem Syllabus: CFL: Closure properties, CF Pumping Lemma

Computability: Turing Machines, Church-Turing Thesis, Variants of Turing machines, non-determinism, enumerators, Decidability, Halting problem, Reducibility, Rice's theorem, Undecidability, Godel's incompleteness theorem.

Marks distribution: HW 10, Quizes 15 (best 4 out of 8), midsem1 15, midsem2 15, endsem 45

Week 16: 27 Apr. 2017 to 27, Apr. 2017

- (40) 27-04-2015(Thursday): Computational Complexity: The classes P and NP , Boolean circuits, NP Completeness (example problems: SAT)