• Basic graph algorithms
  • directed and undirected graphs
  • DFS (depth-first search)
  • reachability
  • connectedness
• Strongly connected components of directed graphs
  • finding a topological sort of a dag
  • Tarjan’s algorithm
• Connected components of undirected graphs
  • union-find
  • optimizations
  • running time
• Matching and flow optimization
  • Flow networks
  • The Min-cut-max-flow theorem
  • How to compute optimal flows
  • Application to the marriage problem
• Stable marriage problem
  • Gale-Shapley algorithm
  • running-time
  • correctness
  • optimality (for boys!)
• String matching (will not appear on the exam)
  • Rabin-Karp
  • Knuth-Morris-Pratt
• Turing machines and complexity
  • Definition of Turing machines
  • Definitions of recursive, recursively enumerable (r.e.)
  • The existence of a universal TM and simulations
  • Undecidability of the halting problem
  • Time and space complexity (deterministic, non-deterministic)
  • Complement classes
  • The time-bounded halting problem and $\text{PTIME} \neq \text{EXPTIME}$
  • Configuration graphs for Turing machines

• Satisfiability problems for (propositional) logics
  • The problem SAT (in $\text{NPTIME}$)
  • The problem Horn-SAT (in $\text{PTIME}$)
  • Krom-SAT (i.e. 2-SAT) (in $\text{Co-NLOGSPACE}$)
  • QBF-SAT (in $\text{PSPACE}$)
• Reductions, completeness and hardness
  • Many-one polynomial-time/log-space reductions
  • Transitivity of many-one log-space reductions
  • SAT is $\text{NPTime}$-hard (Cook’s Theorem/Cook-Levin Theorem)
  • 3-SAT is $\text{NPTime}$-hard
  • ILP-feasibility is $\text{NPTime}$-hard.
    (You will not be required to show membership in $\text{NPTime}$)

• Hard graph-theoretic problems
  • 3-colourability is $\text{NPTime}$-hard
  • Hamiltonian-circuit is $\text{NPTime}$-hard
  • The travelling salesman problem
• Hardness results for other complexity classes
  • Krom-SAT is $\text{NLogSpace}$-hard
  • QBF-SAT is $\text{PSPACE}$-hard
• Two important theorems
  • Savitch’s Theorem (both forms)
  • The Immerman-Szelepcsényi Theorem (both forms)
• The standard complexity hierarchy
• Reading:
  http://studentnet.cs.manchester.ac.uk/ugt/2019/COMP36111/syllabus/

• Course texts, as directed in the overheads.

• Past exam papers:
  I recommend the years 2016-17 and 2017-18. Note that the syllabus may vary slightly from year to year. In particular, linear programming (the simplex algorithm) is not on the syllabus this year.