- Introduction Complexity classes
  - P, NP, NP-Hard, NP-Complete
  - Cook's theorem, SAT is NP-Hard
  - NP-Hard reductions
  - NP: Polynomial time certification
- Directions for solving NP-Hard problems
  - Approximation Algorithms
  - Randomized Algorithms
  - Heuristics
  - Polynomial time algorithms for restricted inputs
  - Parameterized algorithms
  - Exact exponential algorithms
- Text Books:

  Book-1: Parameterized Algorithms: Marek Cygan, Fedor V. Fomin, Lukasz Kowalik, Daniel Lokshtanov, Dániel Marx, Marcin Pilipczuk, Michael Pilipczuk and Saket Saurabh

  Book-2: Advanced Graph Algorithms: T. Kloks

- Vertex Cover problem is NP-Hard
  - Vertex cover, Minimum vertex cover, decision version of the problem
  - NP: A certification algorithms
  - NP-Hard: reduction from 3-SAT

  http://cgm.cs.mcgill.ca/~athens/cs507/Projects/2001/CW/npproof.html
- Graph Representations:
  - Adjacency matrix
  - Incidence matrix
  - Adjacency list
  - Edge list
  - Forward/Reverse star
- Approximation Algorithms:
  - α-approximation
  - 2-approximation for vertex cover

  http://tandy.cs.illinois.edu/dartmouth-cs-approx.pdf
- Randomized Algorithms
  - Las Vegas, Monte Carlo
  - Karger's min-cut algorithms

  https://www.cs.princeton.edu/courses/archive/fall13/cos521/lecnotes/lec2final.pdf
- Review of basic graph traversals
  - DFS, BFS, post order, pre-order traversals

- Linear time algorithms for trees – Dynamic programming on trees
    - Maximum independent set
    - Minimum dominating set

  https://people.eecs.berkeley.edu/~vazirani/s99cs170/notes/dynamic2.pdf
- Parameterized Algorithms
    - FPT, XP algorithms
    - FPT algorithms for maximum clique, vertex cover
    - Independent set problem not FPT
    - Bounded search tree technique
    - Kernelization techniques
    - Iterative compression
    - Crown decomposition

  References:
    - **Chapter- 2,3,4, Book-1**
    - **Chapter-3, Book-2**
- Tree decomposition
    - Nice tree decomposition
    - Dynamic programming on nice tree decomposition
    - Maximum independent set, minimum dominating set

  References:
    - **Chapter-7, Book-1**
    - **Chapter-4, Book-2**
- Graph classes
    - Chordal graphs, cographs, perfect graphs, series parallel graphs, interval graphs, circular arc graphs, split graphs, threshold graphs, distance hereditary graphs, line graphs and grid graphs
    - Algorithms for Chordal graphs
        - Perfect elimination ordering
        - Maximum clique, coloring problems on chordal graphs

  Reference: Chapter 2, Book-2
- Exact Algorithms
    - Travelling salesman problem
    - Maximum independent set
    - Graph coloring
    - Dominating set problem
    - Set cover problem

  Reference: Chapter-1, Book-2