Formal Specification and Verification
List of Topics

- **Propositional logic**
  - Syntax, semantics
  - Translation to CNF (also structure preserving translation; optimized translation)
  - Methods for checking validity, satisfiability, entailment:
    - Inference Systems and Proofs - Example: Hilberts Deductive System
    - The Resolution Procedure
    - Sequent calculi
    - The DPLL procedure
    - BDDs; OBDDs.
- **First-order logic**
  - Syntax, semantics
  - Logical theories (Link theories - models)
  - Herbrand models, Term algebras, free algebras
- **Specification**
  - Algebraic specification
  - Transition systems; Program graph representation; links
- **Verification**
  - Temporal logic
    - LTL (syntax, semantics)
    - CTL (syntax, semantics)
    - Comparison between LTL and CTL
    - Model checking
      - Problem description
      - Algorithm which computes the set of states at which a CTL formula holds
      - Implementation based on OBDDs
  - Propositional dynamic logic
    - Syntax, semantics
    - Axiom system for PDL:
      - Soundness and Completeness: definitions; proof idea;
      - Using a (given) axiom system for proving formulae in PDL.
    - Finite model property (Proof idea); decidability
    - Using a (given) sequent system for proving formulae in PDL.

- Deductive verification for infinite state systems: An introduction
  - Succinct representation of sets of states and of transitions between sets of states using formulae.
  - Verification problem: Program + Description of the bad states
    Succinct representation using formulae
    Initial state, error state, transition relation, computation,
    Checking safety: compute set of reachable states
    – post operator (idea); iterations; Forward reachability analysis
    – pre operator (idea); Backward reachability analysis (idea)
  - Invariant checking, Bounded model checking (definitions)