

## COURSE DESCRIPTION

**Department and Course Number:** CSCI 550

**Course Title:** Program Semantics and Derivation

**Current Catalog Description:** A study of formal methods for the specification, derivation, and verification of computer programs. Predicate logic; notations for specification of programs; programming language semantics; calculational techniques for the derivation of programs.

**Total Credits:** 3 hours

**Coordinator:** H. Conrad Cunningham, Associate Professor of Computer and Information Science

**Textbook:** Edward Cohen. *Programming in the 1990's*, Springer-Verlag, 1990.

**Other Required Materials:** H. Conrad Cunningham. *A Programmer's Introduction to Predicate Logic*. UMCIS-1994-02, revised January 1996. *Feijen's Table of Cubes Problem*, UMCIS-1994-05, revised August 1996.

**References:** <http://www.cs.olemiss.edu/~hcc/csci550.html>

**Course Goals:** Upon completion of the course, the student will be able to formally specify simple programs and prove them correct. The student will understand predicate logic and guarded command semantics. The student should also be able to apply basic program derivation techniques.

### Prerequisites by Topic:

1. Basic discrete mathematics (MATH 301)
2. Fundamental programming concepts and skills (CSCI 111, 112, 211)
3. Basic data structures and algorithms (CSCI 112, 211)

### Major Topics Covered in the Course:

1. Introductory example (1 hour).
2. Predicate logic (9 hours).
3. Program specification techniques (3 hours).
4. Guarded Commands notation and its semantics (6 hours).
5. Program correctness verification (4 hours).
6. Program derivation techniques (1 hour)
7. Loopless programs (2 hours)
8. Loop heuristic "deleting a conjunct" (3 hours)
9. Loop heuristic "replace a constant by a variable" (9 hours)
10. Tail recursion (3 hours)
11. Exams (3 hours)

**Laboratory Projects:** There are no laboratory projects, but there are approximately eight homework assignments that involve predicate logic proofs, program specifications, program verifications, or program derivations. Students have 1 to 1.5 weeks to complete each assignment.

**Estimate of ABET/CAC Category Content:** (in hours)

	CORE	ADVANCED		CORE	ADVANCED
Data Structures	_____	_____	Computer Organization and Architecture	_____	_____
Algorithms	_____	_____	Concepts of Programming Languages	_____	_____ 1
Software Design	_____	_____ 1	Theoretical	_____	_____ 1

**Theoretical Content (Foundations):** Approximately one-third of the content of this course involves theoretical content such as predicate calculus, programming language semantics, and formal methods.

**Problem Analysis:** A goal of this course is for all students to understand formal specifications of programs and to be able to develop formal specifications for simple programs. In the classroom, the instructor and students examine sample specification problems and various solutions. In the homework exercises, the students must analyze problems and construct formal specifications and manipulate formal specifications developed by others. About one-third of the course is devoted to this.

**Solution Design:** Approximately one-third of the course is devoted to deriving solutions to programming problems that have been formally specified. This involves use of program derivation heuristics and “calculations” based in formal logic.