

Computer Science

Degrees Offered

• Master of Science in Computer Science (M.S.C.S)
• Doctor of Philosophy in Computer Science (Ph.D.)

Program Description

The Masters of Science in Computer Science (M.S.C.S.) degree program qualifies a student to assume a professional role in industry or government, teach in a junior or senior college, or undertake advanced training toward a doctorate in computer science. The following sections describe the general procedures to be followed in completing the M.S.C.S. degree. Note that steps are intended to be carried out in a specific order.

Program Educational Objectives & Outcomes

The objective of the Masters of Science in Computer Science (M.S.C.S.) degree program is to produce graduates who have the knowledge, skills, and attitudes that will ensure success in professional positions in business, industry, research, government service, or in further graduate or professional study.

Specific outcomes that will be achieved by graduates of the program are:

• Achieve a depth of proficiency in a specific field of Computer Science by completing major courses in one of three areas: computer systems, software and knowledge engineering, or the theory of computation.
• Achieve a breadth of understanding of Computer Science by completing minor coursework requirements in other areas, and by participation in graduate seminar requirements.
• Demonstrate professionalism and communication skills through completion of coursework, project, or thesis defense.

Admissions

Students who satisfy the departmental graduate admission requirements given on the main departmental section will be considered for admission. Additional criteria may be considered in making a final decision. All applicants must submit three letters of reference and complete an Applicant Information Form.

REMOVING DEFICIENCIES

The minimum background expected of any student entering the M.S.C.S. program is coursework equivalent to the following:

• One year of calculus (MATH 155 and MATH 156).
• One course in probability and statistics (STAT 215).
• Knowledge of introductory programming in a high-level programming language (STAT 215).

Students not meeting these minimum requirements will be required to take the equivalent coursework before applying to the M.S.C.S. program.

Students entering without a four-year Bachelors degree in Computer Science may have additional deficiencies in their coursework which must be addressed before beginning the regular M.S.C.S. program. These students will be initially admitted with provisional status and required to remove these deficiencies during their first eighteen hours of coursework.

Possible deficiency areas for students having a Bachelors degree in other disciplines represent the following core areas required of all undergraduate CS students:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 111</td>
<td>Introduction to Data Structures</td>
<td>4</td>
</tr>
<tr>
<td>CS 220</td>
<td>Discrete Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>CS 221</td>
<td>Analysis of Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>CS 230</td>
<td>Introduction to Software Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CS 310</td>
<td>Principles of Programming Languages</td>
<td>3</td>
</tr>
<tr>
<td>CS 350</td>
<td>Computer System Concepts</td>
<td>3</td>
</tr>
</tbody>
</table>

As demand justifies and resources permit, the department will offer accelerated courses to assist graduate students in satisfying deficiencies.

Curriculum in Masters of Science in Computer Science

A candidate for the M.S. degree in computer science must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Lane Department of Computer Science and Electrical Engineering.
Program Requirements

All M.S. degree candidates are required to perform research and follow a planned program of study. The student's research advisor, in conjunction with the student's Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student's needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

Curriculum Requirements

A minimum cumulative GPA of 3.0 is required

Course Requirements

A minimum of 60% of courses must be from 500 level of above

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 796</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

Area of Concentration

Complete one Area of Concentration as follows:

- One Core course: 9
- Two Elective courses: 6

Complete the remaining Areas of Concentration as follows:

- One Core course: 9
- Elective courses: 9

Choose three of the following:

- Any BIOM, CE, CHEM, CPE, CS, EE, IENG, IH&S, MAE, MATH, MINE, PNGE, PHYS, SAFM, SENG, or STAT courses 400-799

Complete 1 of the following options: 7-8

Thesis Option - 7 hours

- CS 796 Graduate Seminar (1 hour)
- CS 697 Research (6 hours)
- Written Research Proposal
- Thesis
- Final Oral or Written Examination

Problem Report Option - 8 hours

- Complete 5 additional hours of coursework
- CS 697 Research (3 hours)
- Written Research Proposal
- Formal written report or professional report/paper
- Final Oral or Written Examination

Coursework Option - 8 hours

- Complete 8 additional hours of coursework
- Final Oral or Written Examination

Total Hours: 32-33

* Students who do not hold a baccalaureate degree in computer science are required to take a set of undergraduate computer science courses above and beyond the minimum coursework requirements.

Areas of Concentration

COMPUTER SYSTEMS

Core Courses

- CPE 670 Switching Circuit Theory 1
- CS 550 Theory of Operating Systems

Elective Courses

- CPE 435 Computer Incident Response
- CPE 520 Application of Neural Networks
- CPE 521 Applied Fuzzy Logic
- CPE 536 Computer Data Forensics
- CPE 538 Intro Computer Security Management
CS 533  Developing Portable Software
CS 453  Data and Computer Communications
CS 539  Computer Forensics and the Law
CS 555  Advanced Computer Systems Architecture
CS 556  Distributed and Pervasive Compt
CS 568  Computer Network Forensics
CS 570  Interactive Computer Graphics
CS 578  Medical Image Analysis
or CS 778  Medical Image Analysis

SOFTWARE/KNOWLEDGE ENGINEERING

Core Courses
CPE 684  Advanced Real-Time Systems
CS 573  Advanced Data Mining
CS 677  Pattern Recognition
CS 630  Empirical Methods in Software Engineering and Computer Science

Elective Courses
BIOM 693  ADTP: Advanced Biometrics
CS 533  Developing Portable Software
CS 558  Multimedia Systems
CS 572  Advanced Artificial Intelligence Techniques
CS 578  Medical Image Analysis
or CS 778  Medical Image Analysis
CS 665  Computer System Security
CS 736  Software Performance Engineering
CS 791H  Approximation Algorithms
CS 757  Distributed Systems and Algorithms
EE 565  Advanced Image Processing
SENG 530  Validation and Verification

THEORY OF COMPUTING

Core Courses
CS 510  Formal Specification of Language
CS 520  Advanced Analysis of Algorithms
CS 525  Computational Complexity

Elective Courses
CS 410  Compiler Construction
CS 420  Design of Algorithms
CS 422  Automata Theory
CS 426  Discrete Mathematics 2
CS 727  Information Dissemination
CS 591A  String Algorithms
CS 591B  Network Optimization
CS 591Q  Pattern Recognition
CS 691H  Fixed Parameter Algorithms
CS 791E  Algorithmic Graph Theory
CS 791G  Randomized Algorithms
CS 791H  Approximation Algorithms

Final Examination
M.S. students following the thesis or problem report option must prepare a written research proposal. The proposal must be approved by the student’s AEC at least one semester prior to the final oral examination.
All students, regardless of option, are required to pass a final oral or written examination, administered by their AEC, covering the thesis or problem report and/or related course material.

All master’s students must defend their thesis or problem report at an oral exam, attended by all members of the committee.

A student who fails the research defense may repeat the defense at most once, at a time determined by the AEC but not necessarily during the same semester.

**Suggested Plan of Study**

The plan below illustrates the Thesis Option. It is important for students to take courses in the order specified as much as possible; all prerequisites and concurrent requirements must be observed. A typical M.S.C.S degree program that completes degree requirements in one and half years is as follows. Those students who lack course prerequisites may require more than three semesters of full-time study to complete the degree. Students with research assistantships may also require more than three semesters to complete the degree.

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Concentration 1 Core Course</td>
<td>3</td>
<td>3 Area of Concentration 1 Elective Course</td>
<td>3</td>
</tr>
<tr>
<td>Area of Concentration 1 Elective Course</td>
<td>3</td>
<td>3 Area of Concentration 2 Core Course</td>
<td>3</td>
</tr>
<tr>
<td>Elective Course</td>
<td>3</td>
<td>3 Elective Course</td>
<td>3</td>
</tr>
<tr>
<td>CS 796</td>
<td></td>
<td>1 CS 796</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

**Second Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Concentration 3 Core Course</td>
<td>3</td>
</tr>
<tr>
<td>Elective Course</td>
<td>3</td>
</tr>
<tr>
<td>CS 697</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

Total credit hours: 32

**Curriculum in Doctor of Philosophy –Computer Science Requirements**

A candidate for the Ph.D. degree with a major in computer science must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Lane Department of Computer Science and Electrical Engineering.

**Program Requirements**

The doctor of philosophy degree with a major in computer science is administered through the college’s interdisciplinary Ph.D. program. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of computer science.

All Ph.D. degree candidates are required to perform research and follow a planned program of study. The student’s research advisor, in conjunction with the student’s Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student’s needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

Research work for the doctoral dissertation must represent a significant contribution to engineering or computer science. It may entail a fundamental investigation into a specialized area.

**Curriculum Requirements**

A minimum cumulative GPA of 3.0 is required

**Course Requirements**

* A minimum of six credit hours of 600 or higher level courses
* A maximum of six credit hours may be in directed study (CS 795)

<table>
<thead>
<tr>
<th>Research</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 797</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>24</td>
</tr>
</tbody>
</table>

Select from the following based on degree path:

* Any BIOM, CE, CHEM, CPE, CS, EE, IENG, IH&S, MAE, MATH, MINE, PNGE, PHYS, SAFM, SENG, or STAT courses 500-799

**Examinations**
Students who do not hold a baccalaureate degree in computer science are required to take a set of undergraduate computer science courses above and beyond the minimum coursework requirements. Doctoral students who do not have an M.S.C.S. degree must either earn this degree or complete coursework as required for the M.S.C.S. with thesis option. It is not necessary to actually write a thesis. A minimum of twenty-four hours of coursework is required. Up to twelve hours may be transferred from work done at another institution. A minimum of forty-two hours of coursework and thirty hours of independent research beyond a bachelor’s degree, or eighteen hours of coursework and twenty-four hours of independent research beyond an M.S. degree are required.

**Examinations**

**QUALIFYING EXAM**

All students must take and pass a written qualifying examination. Normally, the qualifying examination is given no later than one semester after completion of eighteen credit hours toward the doctoral degree. This examination is designed to assess the basic competency of students in the computer science field to determine whether or not they have sufficient knowledge to undertake independent research.

The Lane Department of Computer Science and Electrical Engineering is organized in the following five Areas of Concentration. All Ph.D. degree programs use these Areas to provide organizational structure to the educational process as delineated under specific Ph.D. requirements. The significance of these Areas will be of particular importance in preparation for the Qualifying Exam as each area has designated Ph.D. Qualifier Core Courses as follows:

1. **Electronics and Photonics Area**
   - EE 550 Advanced Semiconductor Electronics
   - EE 551 Linear Integrated Circuits
   - EE 650 Optoelectronics

2. **Signals and Systems Area**
   - EE 513 Stochastic Systems Theory
   - EE 515 Linear Control Systems
   - EE 533 Computer Applications in Power System Analysis

3. **Computer Systems**
   - CPE 670 Switching Circuit Theory 1
   - CS 550 Theory of Operating Systems

4. **Software/Knowledge Engineering**
   - CPE 684 Advanced Real-Time Systems
   - CS 573 Advanced Data Mining
   - CS 591Q Pattern Recognition

5. **Theory of Computing**
   - CS 510 Formal Specification of Language
   - CS 520 Advanced Analysis of Algorithms
   - CS 525 Computational Complexity

Ph.D. students must make the first attempt to pass the qualifying exam within fourteen months of their enrollment if they already have a M.S. degree from the Lane Department of CSEE or within twenty-six months otherwise. The Ph.D. qualifying process consists of completion of a research project and oral examination. The project is intended to demonstrate the student's ability to assemble and analyze the relevant literature for a given research problem and to make preliminary steps towards his/her own contribution.

The oral exam will include:

1. Presentation by the student of his/her research project
2. Questions about the work, its context, and relevant literature
3. Questions about course work, focusing specifically on the three core courses for which the student has earned credit

The possible outcomes of the first year exam are: "Pass" which means the student is qualified to begin work towards the candidacy exam; "Pass with Recommended Coursework" which means the student is qualified to begin work towards a candidacy exam but certain courses must be taken; or
"Fail". Any student failing the qualifying exam on the initial attempt will have one additional attempt within six months. Failure of the exam on the second attempt will disqualify the student from further doctoral studies in the LCSEE program.

**CANDIDACY EXAMINATION**

In order to be admitted to candidacy, the student must pass a candidacy exam, which is designed to evaluate the student's overall ability to engage in high-level research.

When all requirements are completed, the qualifying and candidacy examinations are passed, and the research proposal is successfully defended, the student is formally admitted to candidacy for the Ph.D. degree. For full-time students, admission to candidacy must normally occur within three years of entering the Ph.D. program.

**FINAL EXAMINATION**

At the completion of the dissertation research, candidates must prepare a dissertation and pass the final oral examination (defense) administered by their AEC.

In order to complete the Ph.D. requirements, a student must pass a final oral examination on the results embodied in the dissertation. This examination is open to the public and, in order to evaluate critically the student's competency, may include testing on material in related fields, as deemed necessary by the AEC. All requirements for the degree must be completed within five years after the student has been admitted to candidacy.

**Suggested Plan of Study**

It is important for students to take courses in the order specified as much as possible; all prerequisites and concurrent requirements must be observed. A typical doctoral degree program that completes degree requirements in three years is as follows. A typical Ph.D. program requires four to five years beyond the Baccalaureate degree, although scholarly achievements are more important than length of program

<table>
<thead>
<tr>
<th>First Year</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>3</td>
<td>Course</td>
<td>3</td>
</tr>
<tr>
<td>Course</td>
<td>3</td>
<td>Course</td>
<td>3</td>
</tr>
<tr>
<td>CS 797</td>
<td>3</td>
<td>CS 797</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS 797</td>
<td>6</td>
<td>CS 797</td>
<td>6</td>
</tr>
<tr>
<td>Course</td>
<td>3</td>
<td>Course</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third Year</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS 797</td>
<td>9</td>
<td>CS 797</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

Total credit hours: 54

**Major Learning Goals**

**COMPUTER SCIENCE**

It is our goal that in the first five years after graduation our students will:

1. achieve success and proficiency in the Computer Science profession,
2. be recognized as leaders,
3. and contribute to the well-being of society.