Software Engineering

Degrees Offered
• Masters of Science, Software Engineering (M.S.S.E.)

Program Description
The Lane Department of Computer Science and Electrical Engineering offers the professionally oriented and applied Masters of Science in Software Engineering (M.S.S.E.) degree program, as well as a graduate Certificate in Software Engineering. The M.S.S.E. provides graduate educational opportunities to working professionals. The M.S.S.E. degree is a unique fully-online program which provides graduate level software engineering expertise to individuals who are currently working in the software engineering and information technology industry. The program aspires to serve both the full-time software engineer from any industry and the computer science or similar graduate seeking an applied masters program with the flexibility of taking courses online from where they are located. Typical M.S.S.E. students are full time software engineering professionals who wish to augment their work experience with additional academic background.

Program Educational Objectives & Outcomes
The objective of the program is to produce graduates who have the knowledge, skills, and attitudes that will ensure success in professional positions in business, industry, research, or governmental service.

More specifically, after completing five core courses, students will achieve the following outcomes:
• Proficiency in Software Project Management.
• Proficiency in Software Analysis and Design.
• Proficiency in Object-Oriented Design of software.
• Proficiency in Software Verification and Validation.
• Proficiency in Software Evolution.

Students will complete their degree requirements with six advanced elective courses with the course work only option that will deepen their understanding of aspects of software engineering relevant to their careers. Problem Report and Thesis Options are also available.

Admissions
Students seeking admission to the M.S.S.E. program must meet requirements under one of the following two ways to be considered.

PROSPECTIVE STUDENTS WITH RELATED SOFTWARE ENGINEERING UNDERGRADUATE DEGREE
Students who have recently completed a Bachelor’s degree in Computer Science, Computer Engineering, Software Engineering, or a closely related field from an accredited University will be considered for admission as regular graduate students if they satisfy the following requirements:
• Have a minimum cumulative grade point average of 3.00 (on a 4-point scale) or better within the major. Official transcripts showing degree completion must be provided in all cases.
• Submit satisfactory scores in quantitative reasoning for the GRE General Test or Revised General Test.
• International students must demonstrate proficiency in communicating in English (a minimum TOEFL Score of 550, or iBT Score of 79, or IELTS Score of 6.5). Students who have completed a recent four-year bachelor’s degree in the USA need not submit these scores.

PROSPECTIVE STUDENTS WITH AN UNDERGRADUATE DEGREE AND AT LEAST ONE YEAR OF SOFTWARE EXPERIENCE
Students who have at least one year of work experience related to software development will be considered for admission as provisional graduate students if they meet the following requirements:
• Hold a four-year Bachelor’s degree in any field from an accredited University, with a GPA of at least 3.00 (on a 4-point scale). Official transcripts showing degree completion must be provided in all cases.
• Submit a resume documenting at least one year of software development experience within any industry.
• Submit three letters of reference from persons familiar with the student’s professional software development work.
• The GRE is not required.
• International students must demonstrate proficiency in communicating in English (a minimum TOEFL Score of 550, or iBT Score of 79, or IELTS Score of 6.5). Students who have completed a recent four-year bachelor’s degree in the USA need not submit these scores.
Students must request a transfer to Regular Status from the program coordinator prior to completing 18 credit hours in the M.S.S.E. program. At the time of the request to transfer to Regular Status, they must:

- Complete any requirements specified in their admission letter.
- Earn a grade of at least a B in each of the first four core courses taken (any of the five core).
- Submit a resume documenting at least two years of software development experience if not already done so during admissions.

**Admission to Certificate in Software Engineering**

Students seeking admission to the Certificate in Software Engineering program must meet requirements to be admitted as a non-degree student:

- Hold a Bachelor's degree in Computer Science, Computer Engineering, Software Engineering, or a closely related field from an accredited University.
- Have a minimum cumulative grade point average of 3.00 (on a 4-point scale) or better within the major. Official transcripts showing degree completion must be provided in all cases.
- Submit three professional/academic letters of recommendation.
- International students must demonstrate proficiency in communicating in English (a minimum TOEFL Score of 550, or iBT Score of 79, or IELTS Score of 6.5). Students who have completed a recent four-year bachelor's degree in the USA need not submit these scores.
- The GRE is not required.
- Students may enroll in core courses in the M.S.S.E. program to complete the certificate. They may apply to the M.S.S.E. program; WVU policies on residency and credit sharing by programs should be considered for planning multiple programs.

**REGULAR, PROVISIONAL, AND NON-DEGREE ADMISSION**

Students admitted into a program in the Lane Department are designated as regular status or provisional. Students admitted into the Certificate in Software Engineering are designated as non-degree students. The department also admits students to non-degree status in the College of Engineering and Mineral Resources, but these students are not admitted to any specific program. Regular status is given to students who are qualified for unconditional admission to a specific program. Provisional status is given to students who have deficiencies to make up such as incomplete credentials or other reasons as identified by the graduate coordinator. In all cases, the student's letter of admission will state what must be done to attain regular status.

Provisional students must complete the requirements for transfer to regular status by the end of the semester in which they complete eighteen credit hours. Usually provisional students are not considered for graduate assistantships or tuition waivers.

Non-degree status is granted upon request to students meeting the minimum admission requirements. A non-degree student is one who wishes to take courses without seeking a formal degree. Non-degree students require permission of the instructor to take courses that are restricted to specific majors. There is no guarantee of eventual acceptance into a degree program, and in no case may more than twelve hours be transferred to a degree program.

Non-degree students may not be offered graduate assistantships or tuition waivers.

**Curriculum in Master of Science in Software Engineering**

A candidate for the M.S. degree in software engineering 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 follow a planned program of study. The student’s faculty 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 student with the necessary support to complete their degree and prepare them for their career.

**Curriculum Requirements**

A minimum cumulative GPA of 3.0, based upon a 4.0 system is required for all applicants.

<table>
<thead>
<tr>
<th>Course Requirements</th>
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<tbody>
<tr>
<td><strong>Course Requirements</strong></td>
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<tr>
<td>The following five core courses are required.</td>
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<tr>
<td>SENG 510</td>
<td>Software Project Management</td>
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<td>SENG 520</td>
<td>Software Analysis and Design</td>
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<tr>
<td>SENG 530</td>
<td>Software Verification and Validation</td>
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<td>SENG 540</td>
<td>Software Evolution</td>
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<td>SENG 550</td>
<td>Object Oriented Design</td>
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<td>Advanced Elective Course</td>
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Select from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CPE 538</td>
<td>Intro Computer Security Management</td>
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<tr>
<td>CS 533</td>
<td>Developing Portable Software</td>
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<td>SENG 560</td>
<td>Software Reuse</td>
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<td>CYBR 535</td>
<td>Business Network Security</td>
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<td>CYBR 540</td>
<td>Information Ethics and Legal Procedures</td>
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<tr>
<td>SENG 561</td>
<td>Agile Software Development</td>
</tr>
<tr>
<td>SENG 564</td>
<td>Software Engineering of Mobile Applications</td>
</tr>
<tr>
<td>SENG 581</td>
<td>Quality Software Process Management</td>
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<tr>
<td>SENG 582</td>
<td>Enterprise Architecture Framework</td>
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<tr>
<td>SENG 670</td>
<td>Data Analytics with Applications in Software Engineering</td>
</tr>
<tr>
<td>SENG 695</td>
<td>Independent Study (Experiential Learning)</td>
</tr>
<tr>
<td>SENG 650</td>
<td>Cloud Computing for the Internet of Things</td>
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<tr>
<td>STAT 511</td>
<td>Statistical Methods 1</td>
</tr>
<tr>
<td>STAT 521</td>
<td>Statistical Analysis System Programming</td>
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<tr>
<td>STAT 522</td>
<td>Advanced Statistical Analysis System Programming (upon request to Advisor)</td>
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Any SENG Courses 510-699 may be taken as an advanced elective.

Complete 1 of the following options: 6-9

**Thesis Option - 6 hours**
- SENG 697 Research (6 hours)
- Written Research Proposal
- Thesis
- Final Oral or Written Examination

**Problem Report Option - 9 hours**
- Complete 6 additional hours of advanced elective coursework
- SENG 697 Research (3 hours)
- Written Research Proposal
- Formal written report or professional report/paper
- Final Oral or Written Examination

**Coursework Option - 9 hours**
- Complete 9 additional hours of advanced electives

**Total Hours** 30-33

* SENG 505 is only offered as a Preparatory Course, required only for specified Provisional Graduate Student and no credit can be earned toward the degree or certificate.

** A maximum of 12 semester credit hours taken elsewhere may be transferred into the program.

*** No more than 9 semester credit hours of 400-level (senior undergraduate) LCSEE department courses (or equivalent courses transferred from outside the university) may be included in your program if they were not counted for another degree.

**** All of these options noted require approval by the software engineering curriculum committee.

**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. These students are required to pass a final oral examination, administered by their AEC, covering the thesis or problem report.

**Suggested Plan of Study**

The plan below illustrates the Coursework 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.S.E degree program that completes degree requirements in two years is as follows.
Certificate in Software Engineering

CERTIFICATE CODE - CG10

The certificate in software engineering program provides further education to individuals who are currently working in the computer and information technology industry. This program is offered online at evening times convenient for the working professional.

Students may apply for admission as non-degree students to complete the certificate requirements. These students may then optionally apply for transfer to the M.S.S.E. program. In addition, students already admitted to the M.S.S.E. may elect to receive the certificate after completing the necessary requirements.

ADMISSION REQUIREMENTS

Applicants for the certificate in software engineering must meet the following requirements:

• Hold a bachelor's degree in any field from an accredited University.
• Submit a resume documenting at least one year of software development experience.
• By the semester in which the certificate is to be awarded, students must meet the following additional requirements:
  a. Submit a resume documenting at least three years of software development experience.
  b. Submit three letters of reference from persons familiar with the student’s professional work.

Students working toward the certificate in software engineering are not degree candidates and are admitted as non-degree students. However, they may apply for admission to the M.S.S.E. program (see below) after satisfactory completion of most of the certificate requirements.

Students initially admitted to the M.S.S.E. program may elect to receive the certificate after satisfactory completion of the five core courses and the certificate paper (see below). In this case the resume and letters of reference are not required.

PROGRAM REQUIREMENTS

The certificate program consists of completing five approved courses and a certificate term paper. Students who achieve a B- or higher in each of the first four courses of the certificate program may qualify to enter the M.S.S.E. program, as described below.

Major Learning Outcomes

SOFTWARE ENGINEERING

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

1. Achieve success and proficiency in the Software Engineering profession.
2. Be recognized as leaders.
3. Contribute to the well-being of society.

COURSES

SENG 505. Programming Applications with Java. 3 Hours.
PR: Consent. This course serves as an introduction to developing application software. It covers solving problems using the Java programming language. Topics include problem-solving, fundamentals of programming, basic algorithms and data structures, data organization, defensive programming, relational databases and creating database applications.

SENG 510. Software Project Management. 3 Hours.
Techniques and tools for managing the software development process for large development projects.
SENG 520. Software Analysis and Design. 3 Hours.
Defining software requirements and an introduction to the principles and concepts relevant to the design of large programs and software systems.

SENG 530. Software Verification and Validation. 3 Hours.
PR: SENG 510 or consent. Tools and techniques for applied verification and validation of computer software including requirements, design, and code relevant to several development lifecycle models.

SENG 540. Software Evolution. 3 Hours.
Software process and the Capability Maturity Model (CMM), software maintenance and evolution, program understanding, reengineering, software configuration management, and software tools related to these issues.

SENG 550. Object Oriented Design. 3 Hours.
Highlights contemporary design and analysis techniques with a strong emphasis on the Unified Modeling Language (UML). The class focuses on problem space analysis utilizing object oriented techniques to produce real world design solutions in UML.

SENG 560. Software Reuse. 3 Hours.
PR: SENG 550 or consent. A detailed study of the business, organizational, and technical implications of large-scale software reuse in modern environments. Architecture, design for reuse, domain engineering, model-driven development, frameworks, library design, reuse tools, and design patterns.

SENG 561. Agile Software Development. 3 Hours.
PR: SENG 550 or consent. Techniques and methodologies of agile software engineering; development team roles, product backlog, sprint planning, sprint execution, test-driven development, sprint retrospective, development tools and environments. Emphasis on successfully managing agile projects in geographically dispersed work environments.

SENG 564. Software Engineering of Mobile Applications. 3 Hours.

SENG 581. Quality Software Process Management. 3 Hours.
PR: SENG 510 or consent. Evaluate quality theories and practices; research quality history, principles and techniques; and apply software engineering quality management methods and standards to develop software quality model artifacts in an enterprise environment.

SENG 582. Enterprise Architecture Framework. 3 Hours.
PR: SENG 520 or Consent. Study of architecture frameworks used in government and business to design holistic advanced computer systems. Application of frameworks to the enterprise processes, technologies, and people to achieve the enterprise mission and objectives.

SENG 591A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

SENG 610. Advanced Software Project Management. 3 Hours.

SENG 611. Strategies for Software Development. 3 Hours.
PR: SENG 510 or Consent. This course investigates the forces which drive a software organization's business strategy; alignment of a project to the business needs (product line or platform); and the importance of various project management, development and business models.

SENG 630. Requirements Engineering. 3 Hours.
PR: SENG 520 or consent. Study of the requirements engineering phase of the software development process. Techniques for building strong requirements, including management, analysis, risk mitigation, validation, customer signoff, and change control.

SENG 650. Cloud Computing for the Internet of Things. 3 Hours.
PR: SENG 550. Investigation of cloud computing techniques and architectures for the Internet of Things (IoT). Basic concepts and current practices of cloud computing and IoT. Topics include cloud computing models, technologies, security, and privacy. Exploration of example applications and patterns of IoT.

SENG 660. Data Analytics with Applications in Software Engineering. 3 Hours.
PR: SENG 520 and STAT 215 or consent. Foundation of data science, with focus on applications in software engineering. Different empirical methods such as surveys, case studies, and experiments. Threats to validity. Methods for data preparation. Statistics for data understanding and assessment. Commonly used supervised and unsupervised machine learning algorithms.

SENG 691A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

SENG 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.
SENG 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.).