The total number of graduate course credits required is 48 plus a 30-credit
Bachelor’s to Ph.D. Programs
Bachelor’s to Master’s programs

Graduate Certificate Programs
- The interdisciplinary Advanced Engineering Certificate Program
  offers the following tracks,
  - Biomedical Engineering
  - Cyber Systems Security
  - Energy Systems
  - Engineering Management
  - Naval Architecture and Marine Engineering
- Graduate Certificate in Coastal Engineering
- Graduate Certificate in Entrepreneurship and Innovation in Engineering
- Graduate Certificate in Homeland Security
- Graduate Certificate in Modeling and Simulation Engineering
- Graduate Certificate in Project Management

Collaborative Programs
Commonwealth Graduate Engineering Program (CGEP)

Master’s Programs
The Batten College of Engineering and Technology grants the following
Master’s degrees: Master of Science in Engineering, Master of Engineering,
and Master of Engineering Management. The programs of study leading to
the master’s degree are listed in Table 1. Interested students should refer to
the individual program section of this catalog for admission information and
degree requirements.

Linked Bachelor’s to Master’s Degree Programs
These programs are designed to allow qualified students to secure a space
in a Master’s program available in the Frank Batten College of Engineering
and Technology while they are still pursuing their undergraduate degrees.
An eligible student can choose a Master’s program in the same discipline
as his/her Bachelor’s program or in a complementary discipline. Subject to
the approval of the undergraduate and graduate program directors, a student
enrolled in a linked program can count up to six credit hours of course work
towards both the undergraduate and the graduate degrees. Full-time students
can complete the requirements for the Bachelor’s degree in four years and
for the Master’s degree in one additional year.

Students who are matriculated in an undergraduate major in the Frank
Batten College of Engineering and Technology with a GPA of at least
3.00 overall and 3.00 in the major are eligible to apply for admission to
a linked Bachelor’s/Master’s program. Transfer students who desire to be
admitted to a linked program at the time they join an undergraduate major
at Old Dominion University are eligible to apply if their overall GPA at
their previous institution is 3.25 or higher. Pre-requisite courses may be
required for engineering technology majors to pursue a Master’s degree in
engineering.

Continuance in a linked Bachelor’s/Master’s program requires maintenance
of a GPA of 3.00 or higher overall and in the major.

Doctor of Philosophy (Ph.D.) Programs
The Batten College of Engineering and Technology grants the Doctor
of Philosophy degree in Engineering. The programs of study leading
to the Ph.D. degree are listed in Table 1. Interested students should refer to
the individual program section of this catalog for admission information and
degree requirements.

Bachelor’s to Ph.D. Programs
A select number of exceptionally well-qualified students may be admitted
directly into the Ph.D. program upon completion of the baccalaureate degree.
The total number of graduate course credits required is 48 plus a 30-credit
dissertation. The credit hour requirement is the sum total of the minimum requirements for the Master’s and Ph.D. degree programs.

A select number of exceptionally well-qualified students at Old Dominion University may be admitted to the Linked Bachelor/Ph.D. program while they are pursuing their junior year in one of the undergraduate programs. This program encourages admitted students to work closely with individual faculty members during the remainder of their undergraduate program. Just as in the linked Bachelor’s/Master’s program, six credit hours of graduate course work may again be counted toward the undergraduate degree and doctoral course work. Therefore, the total graduate credit hours after obtaining the bachelor’s degree at Old Dominion can be 42 credit hours of graduate courses plus a 30-credit dissertation. That is 6 credits shorter than the regular path. Students in these programs must maintain a GPA of 3.50 or better throughout their bachelor’s studies.

**Doctor of Engineering Program**

The College offers an interdisciplinary Doctor of Engineering (D.Eng.) program to provide the Commonwealth and the nation with exceptionally educated engineering practitioners. These individuals will have developed the highest possible capability to provide innovative solutions in specialized engineering endeavors. The graduates of the program will meet the highest standards for advanced level engineering and leadership positions in industry and government.

**Curriculum**

A minimum of 48 hours of graduate work beyond the master’s degree is required including:

- 18 credit hours of core courses
- At least 18 credit hours of graduate coursework in the student’s area of specialization
- At least 12 credit hours of applied doctoral project

At least three fifths of the course work must be at 800-level. The 18 credit hours of core courses are:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGA 604</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>ENGA 611</td>
<td>Financial Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENGA 612</td>
<td>Analysis of Organizational Systems</td>
<td>3</td>
</tr>
<tr>
<td>ENGA 811</td>
<td>Methodologies for Advanced Engineering Projects</td>
<td>3</td>
</tr>
<tr>
<td>ENGA 812</td>
<td>Engineering Leadership</td>
<td>3</td>
</tr>
<tr>
<td>ENGA 813</td>
<td>Engineering Ethics</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 18

Six specialization areas are available:

1. Aerospace Engineering
2. Civil and Environmental Engineering
3. Electrical and Computer Engineering
4. Engineering Management and Systems Engineering
5. Mechanical Engineering
6. Modeling and Simulation

**Admission Criteria**

Consideration for admission to the Doctor of Engineering program requires a formal application, undergraduate and graduate transcripts, and two letters of recommendation. Also required is an essay describing the applicant’s preparation for graduate work, personal and academic goals, and professional objectives. One of the letters of recommendation should be from an agency point of contact if a sponsoring agency is involved. Sponsorship does not necessarily imply financial support, but it rather focuses on the provision of a project and access to data, information, and means to apply and test a solution. A personal or telephone interview of the applicant with the graduate program director will be required.

The minimum eligibility requirements for regular admission to the Doctor of Engineering program are: engineering experience of at least two years within the last five years and a master’s degree with a grade point average of 3.50 out of 4.00 in an appropriate field from an accredited institution of higher education.

**Continuation and Graduation Requirements**

The continuation requirements are the same as the continuation requirements for the Doctor of Philosophy programs. The graduation requirements for the Doctor of Engineering degree are as follows:

1. Satisfactory completion of a minimum of 48 credit hours of approved graduate work beyond the master’s degree, including the doctoral project.
2. Satisfactory performance on a diagnostic examination at the completion of nine credit hours of coursework. The purpose of this examination is to determine if the student has adequate background to pursue a doctoral degree. The diagnostic examination may only be repeated once.
3. Satisfactory completion of a written and oral candidacy examination. The student will take the candidacy examination when he/she is within six credit hours of completing all the required coursework. The candidacy examination may only be repeated once.
4. Preparation and successful defense of a project concept proposal. The student will be required to prepare and present a concept proposal related to the work that will be undertaken for the doctoral project. The concept proposal will be defended before the doctoral committee.
5. Submission of progress reports as deemed necessary by the doctoral committee.
6. Written report of the project results. The doctoral project shall be documented in a manner consistent with advanced, professional work. The project report will follow the standard format for Old Dominion University dissertations and theses.
7. Comprehensive oral defense of the doctoral project before the student’s doctoral committee and a general audience.

The applied doctoral project must successfully demonstrate the student’s mastery of the subject area and his/her ability to apply advanced technical knowledge to identify, formulate, and solve novel and complex engineering problems. The project must address a complex but practical problem currently faced by the public, industry, or government, and it must provide a solution that satisfies all the technical, social, political, economic, safety, sustainability, and environmental requirements and/or constraints. The doctoral project committee will have at least three Old Dominion University faculty members certified for graduate instruction; two faculty members must be from the major department. The committee must also have at least one non-University person with special knowledge of the project subject area.

**Additional Graduate Degrees Policy**

Graduate students may pursue an additional graduate degree in any discipline at Old Dominion University. Such a degree may be sought subsequent to or concurrently with another degree. Students may request that up to six credit hours of graduate level course work used to fulfill requirements for one Master’s degree offered by the Batten College of Engineering and Technology be applied to another Master’s program offered by the College. Approval of the appropriate graduate program directors and college dean is required. Course work used to fulfill requirements for another graduate degree cannot be applied to a doctoral degree offered by the Batten College of Engineering and Technology.

**Interdisciplinary Graduate Certificate Programs**

The college has established several certificate programs that enable students to specialize in technical areas of current interest to industry, government and academia. Both non-degree and degree-seeking students can enroll in the certificate programs. The programs provide the opportunity for practicing engineers to further their knowledge and become more competent in their profession.

- The interdisciplinary Advanced Engineering Certificate Program offers the following tracks,
• Biomedical Engineering
• Cyber Systems Security
• Energy Systems
• Engineering Management
• Naval Architecture and Marine Engineering
• Graduate Certificate in Coastal Engineering
• Graduate Certificate in Entrepreneurship and Innovation in Engineering
• Graduate Certificate in Homeland Security
• Graduate Certificate in Modeling and Simulation Engineering
• Graduate Certificate in Project Management

Advanced Engineering Certificate in Biomedical Engineering

The Graduate Certificate in Biomedical Engineering Program offers students and professionals the opportunity to further their knowledge with advanced study in the growing area of Biomedical Engineering. The program is designed to provide well-rounded instruction in several key facets of Biomedical Engineering. Those who complete the Program receive the Advanced Engineering Certificate in Biomedical Engineering from Old Dominion University and a letter of recognition from the Batten College of Engineering and Technology. Courses taken for the certificate program may later be applied to the Ph.D. degree in Biomedical Engineering.

Certificate Program Admission Requirements

• Bachelor of Science degree (or equivalent) in an engineering field or undergraduate degree in another relevant STEM field.
• Prerequisites for applicants from non-engineering fields include college-level mathematics, calculus-based physics, and chemistry or biology.
• Students enrolled in the Biomedical Engineering Ph.D. or Master of Engineering programs at ODU are not eligible for the certificate.

Certificate Program Curriculum Requirements

• Twelve credit hours of graduate course work
• A grade point average of 3.0 or better

<table>
<thead>
<tr>
<th>BME Fundamentals*</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 501 Biomedical Engineering I: Principles</td>
<td></td>
</tr>
<tr>
<td>BME 502 Biomedical Engineering II: Applications</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BME Electives (select two)**</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 554 Introduction to Bioelectric</td>
<td></td>
</tr>
<tr>
<td>BME 630 Advanced Bioelectric</td>
<td></td>
</tr>
<tr>
<td>BME 720 Modern Biomedical Instrumentation</td>
<td></td>
</tr>
<tr>
<td>BME 721 Mathematical Modeling in Physiology I</td>
<td></td>
</tr>
<tr>
<td>BME 724 Neural Engineering</td>
<td></td>
</tr>
<tr>
<td>ECE 562 Introduction to Medical Image Analysis (MIA)</td>
<td></td>
</tr>
<tr>
<td>ECE 564 Biomedical Applications of Low Temperature Plasmas</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours 12

* Students who have completed BME 401 or BME 402 as part of a previous degree, program, or minor may substitute these courses with graduate-level BME electives approved by the Graduate Program Director.

** Appropriate course substitutions may be considered with permission of the Graduate Program Director.

Advanced Engineering Certificate in Energy Systems

The certificate program aims to provide a thorough understanding of the cyber security threats faced by the stand-alone computer systems, networked systems, IT infrastructure, and cyber physical systems having embedded computer systems operated by individuals, small businesses and large enterprises along with the knowledge required to defend against these threats. The course will enable participants to learn state of the art techniques necessary for analyzing cyber security risks, preventing, detecting and recovering from cyber attacks through class room instructions and hands-on lab work. The program uniquely accommodates students from engineering, math and sciences as well as practicing engineers and managers. The course will make use of ODU’s multidisciplinary strengths in the fields of Cyber Systems, Computer Engineering, Software Engineering and Modeling and Simulation. This program is designed both as a complement for students working on graduate degrees and for those personnel working on information and cyber systems used in industry, small businesses, healthcare, government, military and home land security. It is anticipated that students will complete the program in 2 semesters (full time enrollment) or 2 years (part-time enrollment or working to complement an existing graduate program).

Certificate Program Admission Requirements

All applicants admitted to the certificate program must have earned a baccalaureate degree in engineering or a relevant STEM field from a regionally-accredited institution or an equivalent degree from a foreign institution. Prerequisites for applicants from non-engineering fields include college-level mathematics, calculus-based physics, and chemistry, health sciences and business. Those whose native language is not English must submit a minimum score of 230 on the computer-based TOEFL or 80 on the TOEFL iBT.

Certificate Program Curriculum Requirements

The Graduate Certificate in Cyber Security requires completion of 12 credit hours of graduate course work consisting of the following four courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 570</td>
<td>Foundations of Cyber Security</td>
</tr>
<tr>
<td>ENMA 670</td>
<td>Cyber Systems Engineering</td>
</tr>
<tr>
<td>MSIM 673</td>
<td>Threat Modeling and Risk Analysis</td>
</tr>
<tr>
<td>MSIM 773</td>
<td>Networked System Security</td>
</tr>
</tbody>
</table>

Total Hours 12

Advanced Engineering Certificate in Energy Systems

The Graduate Certificate in Energy Systems Engineering Program offers students and professionals the opportunity to further their knowledge with advanced study in the growing area of Energy Engineering. The program is aimed at providing understanding of energy engineering and the increasing role of energy engineers in addressing growing energy needs. The new skills and advanced understanding developed in class will prepare students for employment in rapidly growing energy industries.

Those who complete the Program receive the Advanced Engineering Certificate in Energy Systems Engineering from Old Dominion University and a letter of recognition from the Batten College of Engineering and Technology. Courses taken for the certificate program may also be applied to master’s level or doctoral graduate engineering programs at ODU, where they meet the program requirements.

Certificate Program Admission Requirements

• Baccalaureate degree in engineering—or a related field—from a regionally-accredited institution or an equivalent degree from a foreign institution.
• Those whose native language is not English must submit a minimum score of 230 on the computer-based TOEFL or 80 on the TOEFL iBT.

Certificate Program Curriculum Requirements

• Twelve credit hours of graduate course work
• A grade point average of 3.0 or better

Energy Engineering Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 671</td>
<td>Carbon-Free Clean Energy</td>
</tr>
</tbody>
</table>
Program consists of 12 credit hours of graduate level course work. The four courses comprising the certificate program are offered on a regular basis to enable the completion of the program in two years.

**Graduate Certificate Course Requirements**

The Graduate Certificate in Engineering Management requires the completion of 12 credit hours at the graduate level. The courses are offered via distance learning.

**Select 4 of the following:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENMA 600</td>
<td>Cost Estimating and Financial Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 601</td>
<td>Analysis of Organizational Systems</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 602</td>
<td>Systems Engineering Management</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 603</td>
<td>Operations Research</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 604</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 614</td>
<td>Quality Systems Design</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours** 12

* Appropriate course substitutions may be considered with permission of the Graduate Program Director.

A grade point average of 3.0 or better is required to earn the certificate.

**Advanced Engineering Certificate in Naval Architecture and Marine Engineering**

In order to provide the opportunity for practicing engineers to further their knowledge and to become more competent in the fields of Naval Architecture and Marine Engineering, the Department of Mechanical and Aerospace Engineering offers a non-degree graduate level certificate program in Naval Architecture and Marine Engineering. Admission to the program requires a Bachelor of Science degree (or equivalent) in Mechanical Engineering, Aerospace Engineering, Naval Architecture and Marine Engineering, or a related field. The students must complete four 3-credit graduate-level courses to earn a certificate. The certificate program credits will be transferable to the Master’s degree programs in Mechanical and Aerospace Engineering. The certificate program offers two tracks:  
1. Naval Architecture  
2. Marine Engineering

To meet the requirements of either track, students must complete a common required course, Engineering Mathematics or MAE 608, Applied Mathematics for Engineers and three 3-credit courses described below.

**Naval Architecture Track:**

**Required**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 550/888</td>
<td>Principles of Naval Architecture</td>
<td>3</td>
</tr>
</tbody>
</table>

**Select two of the following:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 788</td>
<td>Computational Intelligence for Engineering Design Optimization Problems</td>
<td>6</td>
</tr>
<tr>
<td>MAE 695</td>
<td>Topics in Mechanical and Aerospace Engineering (Numerical Marine Hydrodynamics)</td>
<td>3</td>
</tr>
<tr>
<td>MAE 695</td>
<td>Topics in Mechanical and Aerospace Engineering (Ship Resistance and Propulsion)</td>
<td>3</td>
</tr>
<tr>
<td>MAE 695</td>
<td>Topics in Mechanical and Aerospace Engineering (Dynamics of Marine Crafts)</td>
<td>3</td>
</tr>
<tr>
<td>MAE 695</td>
<td>Topics in Mechanical and Aerospace Engineering (Marine Structures)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours** 9

**Marine Engineering Track:**

**Required**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 511</td>
<td>Mechanical Engineering Power Systems Theory and Design</td>
<td>3</td>
</tr>
</tbody>
</table>

**Select two of the following:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 512</td>
<td>Environmental Control</td>
<td>3</td>
</tr>
<tr>
<td>MAE 517</td>
<td>Propulsion Systems</td>
<td>3</td>
</tr>
<tr>
<td>MAE 602</td>
<td>Fluid Dynamics and Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 722/822</td>
<td>Theory and Design of Turbomachines</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours** 9

**Graduate Certificate in Entrepreneurship and Innovation in Engineering**

Entrepreneurship and innovation are expected to be primary forces in the creation of new business ventures that drive growth and progress in the worldwide economy. Experienced engineering professionals pursuing this certificate may seek to implement their ideas in a multitude of organizational structures. Many may seek outlets outside their current work environments where they can bring their ideas to fruition.

This certificate program provides an integrated approach to teaching, mentoring and encouraging engineering professionals. It introduces engineering students and students from other disciplines with an engineering background to a wide range of entrepreneurial approaches. The certificate’s content addresses the formation of start-up ventures, the growth of existing ventures, and the continued viability of mature, technical enterprises.

**Graduate Certificate Admission Requirements**

All applicants admitted to the certificate program must have earned a baccalaureate degree from a regionally-accredited institution or an equivalent degree from a foreign institution. Those whose native language is not English must submit a minimum score of 230 on the computer-based TOEFL or 80 on the TOEFL iBT.

The Graduate Certificate in Entrepreneurship and Innovation in Engineering requires the completion of the courses listed below totaling 12 credit hours at the graduate level.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGN 620</td>
<td>The Entrepreneurial Engineer</td>
<td>2</td>
</tr>
</tbody>
</table>

Frank Batten College of Engineering and Technology
Graduate Certificate in Mission Analysis & Engineering

The graduate certificate in Mission Analysis and Engineering provides students and professionals with the necessary understanding to manage engineering and systems engineering activities such that mission supporting capabilities are achieved in even the most complex conditions. The program is designed to elevate understanding of the difficulties that are endemic to working with complex, socio-technical systems, or system of systems, in extremely transient and uncertain situations. It provides the student with the opportunity to hone planning, decision-making, and/or execution skills necessary to work transformational environments. It is recommended that students intending to take the certificate contact the certificate director to develop a plan of study that will most benefit the student’s goals.

Transferability of courses: The certificate is listed as a graduate certificate by the State Council for a higher Education in Virginia. The program offers “for-credit”, graduate-level, courses listed in the Old Dominion University Graduate Catalog. Courses taken for the certificate may be used towards graduate studies with approval of the student's Advisor or Graduate Program Director. Non-degree seeking students completing the certificate may later apply the credit hours earned towards graduate degrees in engineering and other disciplines with approval of the Graduate Program Director of the program to which the student has been admitted or is seeking admission.

The certificate may be customized to specific domains such as the U.S. Navy or Department of Defense when offered through the College of Continuing Education and Professional Development. Students or organizations should contact the College of Continuing Education and Professional Development for additional details.

Admission Requirements

All degree-seeking applicants admitted to the certificate program must meet ODU requirements for graduate admission: an earned baccalaureate degree from a regionally-accredited institution or an equivalent degree from a foreign institution. Those whose native language is not English must submit a minimum score of 230 on the computer-based TOEFL or 80 on the TOEFL iBT.

Non-degree seeking students are required to have these same credentials, though documentation is not required. Ultimately, students must apply to the program in order to obtain the certificate.

Curriculum Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENMA 650</td>
<td>Mission Analysis and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 702</td>
<td>Systemic Decision Making</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 750</td>
<td>System of Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 660</td>
<td>Systems Architecture and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 605</td>
<td>Program Capstone (Required) *</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Hours 13

* Instructor approval required. Pre- or co-requisite: ENMA 650.

Graduate Certificate in Modeling and Simulation Engineering

The Graduate Certificate in Modeling and Simulation Engineering is designed for those who meet the admission requirements of the modeling and simulation master's program and wish to broaden their knowledge of modeling and simulation related principles and practices without pursuing a graduate degree. This is a 12 credit hour non-degree program offered by the Department of Modeling, Simulation and Visualization Engineering. The certificate program is open to both degree-seeking and non-degree-seeking graduate students. Certain courses taken for the certificate program may later be applied to the master’s degree in modeling and simulation.

Graduate Certificate Admission Requirements

Students should have either an undergraduate degree from a regionally accredited institution and should have a mathematical background through calculus, along with a calculus based probability and statistics course. Students should submit a graduate non-degree application through the Office of Admissions, and then submit a departmental application with copies of unofficial transcripts from all previous coursework to the MSVE Department. Departmental applications are available online on the MSVE Department’s website – http://eng.odu.edu/msve - and should be sent to:

Academic Advisor and Program Manager
MSVE Department
Old Dominion University
1300 Engineering and Computational Sciences Building
Norfolk, VA 23529

Graduate Certificate Course Requirements

The Graduate Certificate in Modeling and Simulation Engineering requires the completion of 12 credit hours at the graduate level. The course requirements are:

<table>
<thead>
<tr>
<th>Select three courses from the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 601 Introduction to Modeling and Simulation</td>
</tr>
<tr>
<td>MSIM 602 Simulation Fundamentals</td>
</tr>
<tr>
<td>MSIM 510 Model Engineering</td>
</tr>
<tr>
<td>MSIM 603 Simulation Design</td>
</tr>
<tr>
<td>MSIM 541 Computer Graphics and Visualization</td>
</tr>
<tr>
<td>MSIM 551 Analysis for Modeling and Simulation</td>
</tr>
</tbody>
</table>

Total Hours 12

* A graduate level elective approved by the Graduate Program Director. This elective may be an MSIM course or from another discipline outside of modeling and simulation. It is possible that this course may be outside of the discipline of modeling and simulation, but approved because it complements the field of modeling and simulation and the student's interests.

An overall GPA of 3.0 or better is required to earn the graduate certificate in modeling and simulation engineering.

Graduate Certificate in Project Management

The project management graduate certificate program is designed to facilitate learning essential and contemporary concepts, tools, and processes to manage projects in modern organizations. Courses in the program cover a mix of technical and human topics that are needed for successful project management. Students looking to enroll in the certificate program must meet the admission requirements of Old Dominion University at the graduate level to obtain the Graduate Certificate in Project Management. Certain courses taken for the certificate program may later be applied to the master’s degree in Engineering Management for students that get formally admitted to the program. The graduate certificate in Project Management consists of 12 credit hours of graduate level course work. The four courses comprising the certificate program are offered on a regular basis to enable the completion of the program in two years.
Graduate Certificate Admission Requirements
Admission to the program requires a Bachelor of Science degree in engineering (or equivalent). The certificate consists of four pre-approved graduate level courses contributing to an emphasis area that can be interdisciplinary. A grade point average of 3.0 or better is required to earn the certificate.

Graduate Certificate Course Requirements
The Graduate Certificate in Engineering Management requires the completion of 12 credit hours at the graduate level. The courses are offered via distance learning. The four required courses are listed below:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENMA 604</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 780</td>
<td>Leadership for Engineering Managers</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 410/510</td>
<td>Agile Project Management</td>
<td>3</td>
</tr>
<tr>
<td>ENMA 700/800</td>
<td>Economic Analysis of Capital Projects</td>
<td>3</td>
</tr>
</tbody>
</table>

Optional

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENMA 601</td>
<td>Analysis of Organizational Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 12

An overall GPA of 3.00 or better is required to earn the graduate certificate in project management.

ENGINEERING Courses

ENGN 554. Introduction to Bioelectrics. 3 Credits.
The course is designed to provide engineers and engineering technologists with the knowledge, skills and experience needed to create products and services that will be attractive to consumer markets and to bring those products and services to market in new commercial ventures. Topics covered include: How to evaluate entrepreneurial opportunities in the engineering field; elements of a viable business plan; governance models; management succession planning; use of social media; and creating an ethical engineering enterprise in the global economy.

ENGN 621. The Entrepreneurial Engineer. 2 Credits.
This course is designed to provide engineers and engineering technologists with the knowledge, skills and experience needed to create products and services that will be attractive to consumer markets and to bring those products and services to market in new commercial ventures. Topics covered include: How to evaluate entrepreneurial opportunities in the engineering field; elements of a viable business plan; governance models; management succession planning; use of social media; and creating an ethical engineering enterprise in the global economy.

ENGN 622. Remote Sensing. 3 Credits.
The course will cover electromagnetic passive and active sensing systems, earth resource satellite systems, digital image formats, image enhancement, interpretations and applications of computer assisted interpretation in mapping, geology, water quality and urban and regional planning. It also covers image rectification, registration and image data merger with GIS.

ENGN 623. Leadership and Human Dynamics for the Entrepreneurial Engineer. 2 Credits.
This course covers the concepts, skills, and characteristics of effective and successful entrepreneurial leaders in the 21st century. The course covers leadership for entrepreneurial engineers through case studies and literature review in areas such as the fundamentals of leadership, ethical leadership, social capital, emotional intelligence, and three-dimensional leadership.

ENGN 625. Business Planning for Entrepreneurial Engineers. 2 Credits.
This course is the capstone of the Entrepreneurship and Innovation graduate certificate for engineers. With data and expertise through prior certificate coursework, students develop and present a comprehensive and viable entrepreneurial business plan in engineering. Topics covered include: Product lifecycle management, marketing and strategic planning, entrepreneurial finance, and effective presentation techniques. The final presentation is delivered to a panel of ODU faculty and engineering practitioners who provide sound feedback to the student.

ENGN 630. Advanced Bioelectrics. 3 Credits.
The course will cover advanced application of pulsed power and plasma in the medical, biological and environmental fields. (Cross-listed with ECE 630). Prerequisites: bachelor’s degree in physics, engineering or biology.

ENGN 671. Carbon-Free Clean Energy. 3 Credits.
Nuclear power and nuclear energy; solar energy; wind energy; geothermal energy; hydroelectric power; hydrogen as energy resource; hydrogen fuel cells; hybrid technologies; global economics and environmental impacts of carbon-free energy.

ENGN 672. Energy Systems Management. 3 Credits.
System management principles; energy systems safety and security; automation and control; environmental effects and comparative risk assessment; energy storage; carbon sequestration; energy systems scale up issues; energy systems integration; hybrid systems; energy systems optimization; effects of public policies on energy systems management.

ENGN 673. Fossil Energy. 3 Credits.
Fossil fuel; global supply and demand; techniques for fossil fuel recovery; technologies for fossil fuel conversion; crude oil characterization and classification, oil refineries, heavy oil shale, tar sand, bitumen; coal characterization, recovery, conversion; natural gas, shale gas, landfill gas, gas hydrates; organic and polymeric wastes; environmental impacts.

ENGN 695. Multidisciplinary Topics in Engineering. 1-3 Credits.
Special interdisciplinary or multidisciplinary topics of interest with emphasis on emerging areas in engineering.

ENGN 697. Independent Study in Energy Engineering. 3 Credits.
Individual analytical, experimental, computational and/or design study selected by the student and supervised by the course instructor.

ENGN 811. Methodologies for Advanced Engineering Projects. 3 Credits.
Critical evaluation of published literature; experimental design and analysis; optimization methods; pre-project planning; definition of scope, projects risks, technical, economical, social, and political constraints; execution strategies; effective proposal development. Prerequisite: Graduate standing.
ENGN 812. Engineering Leadership. 3 Credits.
Effective communication techniques, strategic planning, building collaborative relationships, conflict management, building high-performance teams, risk management, managing innovations. Prerequisites: Graduate standing.

ENGN 813. Engineering Ethics. 3 Credits.
Scope of engineering ethics, moral reasoning and ethical theories, the engineer’s responsibility for safety, responsibilities to the employer, responsibilities to the public, rights of engineers, global issues, professional codes of ethics, case studies. Prerequisites: Graduate standing.

ENGN 998. Master’s Graduate Credit. 1 Credit.
This course is a pass/fail course for master's students in their final semester. It may be taken to fulfill the registration requirement necessary for graduation. All master's students are required to be registered for at least one graduate credit hour in the semester of their graduation.