SYSTEMS ENGINEERING GRADUATE CERTIFICATE (ECE)

Banner Code: VS-CERG-SYST

Architecture-Based Systems Integration
2100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1670
Email: seor@gmu.edu

C4I & Cyber
2100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1670
Email: seor@gmu.edu

Communications and Networking
3100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1569
Email: ece@gmu.edu

Engineering Resilient Enterprise Systems
2100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1670
Email: seor@gmu.edu

Financial Systems Engineering
2100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1670
Email: seor@gmu.edu

Tactical Computer Operations
3100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1569
Email: ece@gmu.edu

Admissions & Policies

Admissions

Architecture-Based Systems Integration Concentration
A bachelor's degree is required for admission to a certificate program.

C4I & Cyber Concentration
The certificate with this concentration is available to students who hold bachelor's degrees in engineering and scientific disciplines or are in graduate status in such programs. Admission requirements are identical to those for the Systems Engineering, MS.

Communications and Networking Concentration
The certificate with this concentration in communications and networking is open to all students who hold BS degrees in scientific and engineering disciplines from accredited universities.

Engineering Resilient Enterprise Systems Concentration
The certificate with this concentration is available to any student who holds a bachelor's degree in an engineering or scientific discipline or has graduate status in such a program. Admission requirements are identical to those for the Systems Engineering, MS, except that the math requirements include only MATH 113 Analytic Geometry and Calculus I (Mason Core), MATH 114 Analytic Geometry and Calculus II, and a probability and statistics course.

Financial Systems Concentration
The certificate with this concentration will be open to all students who hold a BS degree in scientific and engineering disciplines from an accredited university program, with a GPA minimum established by VSE for all MS programs. Students who are already enrolled in a master's program must submit an application form to enroll in this certificate with concentration program; all others must apply for graduate admission to this certificate with concentration program.

Tactical Computer Operations Concentration
Students applying to the certificate with this concentration must hold a bachelor's degree in either computer science or computer engineering. Prospective students without these specific degrees will need to have a technical bachelor's degree and show academic competence in the areas of: C (C++, C#, Objective C), Assembler, discrete mathematics, and computer networking. An undergraduate grade point average (GPA) of 3.0 or better (4.0 scale) is required. The Graduate Record Exam (GRE) is not required.

Policies
The Systems Engineering Graduate Certificate may be pursued on a part-time basis only.

For policies governing all graduate certificates, see AP.6.8 Requirements for Graduate Certificates.

Requirements

Total credits: 12-15

This certificate may be pursued on a part-time basis only.

Concentration in Architecture-Based Systems Integration (ABSI)
Administered by the Department of Systems Engineering and Operations Research (https://seor.gmu.edu)

Coursework
The following four courses must be completed with a grade of B or better:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 520</td>
<td>System Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>SYST 618</td>
<td>Model-based Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SYST 620</td>
<td>Discrete Event Systems</td>
<td>3</td>
</tr>
<tr>
<td>SYST 621</td>
<td>Systems Architecture Design</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credits: 12

Certificate coursework within the Systems Engineering MS
In addition to the ABSI concentration courses, students must take the following six courses within the Systems Engineering, MS:
# Systems Engineering Graduate Certificate (ECE)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 505</td>
<td>Systems Engineering Principles ¹</td>
<td>3</td>
</tr>
<tr>
<td>SYST 510</td>
<td>Systems Definition and Cost Modeling</td>
<td>3</td>
</tr>
<tr>
<td>SYST 530</td>
<td>Systems Engineering Management I</td>
<td>3</td>
</tr>
<tr>
<td>SYST 611</td>
<td>System Methodology and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>SYST 699</td>
<td>Masters Project</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Select one approved elective from the ABSI concentration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>18</td>
</tr>
</tbody>
</table>

¹ Students who have work experience in systems engineering should consult with their advisor on replacing SYST 505 Systems Engineering Principles with a higher-level SYST course.

## Concentration in C4I & Cyber (C4IC)

Administered by the Department of Systems Engineering and Operations Research (https://seor.gmu.edu)

This certificate with concentration may be pursued on a part-time basis only.

The certificate with concentration requires 12 credits (4 courses). Students must complete the following with an average grade of B or better:

<table>
<thead>
<tr>
<th>Coursework Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 680</td>
<td>Principles of Command, Control, Communications, Computing, and Intelligence (C4I)</td>
<td>3</td>
</tr>
<tr>
<td>or ECE 670</td>
<td>Principles of Command, Control, Communications, Computing, and Intelligence (C4I)</td>
<td></td>
</tr>
<tr>
<td>OR 542</td>
<td>Operations Research: Stochastic Models</td>
<td>3</td>
</tr>
<tr>
<td>or ECE 528</td>
<td>Introduction to Random Processes in Electrical and Computer Engineering</td>
<td></td>
</tr>
<tr>
<td>Select two from the following:</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>ECE 542</td>
<td>Computer Network Architectures and Protocols</td>
<td></td>
</tr>
<tr>
<td>ECE 630</td>
<td>Statistical Communication Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 642</td>
<td>Design and Analysis of Computer Communication Networks</td>
<td></td>
</tr>
<tr>
<td>OR 635</td>
<td>Discrete System Simulation</td>
<td></td>
</tr>
<tr>
<td>SYST 584</td>
<td>Heterogeneous Data Fusion</td>
<td></td>
</tr>
<tr>
<td>SYST 664</td>
<td>Bayesian Inference and Decision Theory</td>
<td></td>
</tr>
<tr>
<td>SYST 683</td>
<td>Modeling, Simulation, and Gaming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>12</td>
</tr>
</tbody>
</table>

## Electives

After completing the foundation courses, students choose electives by taking three courses from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 535</td>
<td>Digital Signal Processing</td>
<td></td>
</tr>
<tr>
<td>ECE 565</td>
<td>Introduction to Optical Electronics</td>
<td></td>
</tr>
<tr>
<td>ECE 567</td>
<td>Optical Fiber Communications</td>
<td></td>
</tr>
<tr>
<td>ECE 630</td>
<td>Statistical Communication Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 633</td>
<td>Coding Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 635</td>
<td>Adaptive Signal Processing</td>
<td></td>
</tr>
<tr>
<td>ECE 642</td>
<td>Design and Analysis of Computer Communication Networks</td>
<td></td>
</tr>
<tr>
<td>ECE 643</td>
<td>Network Switching and Routing</td>
<td></td>
</tr>
<tr>
<td>ECE 646</td>
<td>Cryptography and Computer Network Security</td>
<td></td>
</tr>
<tr>
<td>ECE 731</td>
<td>Digital Communications</td>
<td></td>
</tr>
<tr>
<td>ECE 732</td>
<td>Mobile Communication Systems</td>
<td></td>
</tr>
<tr>
<td>ECE 734</td>
<td>Detection and Estimation Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 738</td>
<td>Advanced Digital Signal Processing</td>
<td></td>
</tr>
<tr>
<td>ECE 741</td>
<td>Wireless Networks</td>
<td></td>
</tr>
<tr>
<td>ECE 742</td>
<td>High-Speed Networks</td>
<td></td>
</tr>
<tr>
<td>OR 635</td>
<td>Discrete System Simulation</td>
<td></td>
</tr>
<tr>
<td>OR 643</td>
<td>Network Modeling</td>
<td></td>
</tr>
<tr>
<td>OR 647</td>
<td>Queuing Theory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>9</td>
</tr>
</tbody>
</table>

## Completing the certificate with the C4I concentration within the Systems Engineering Master's Program

In addition to the four courses above, students must complete the following six courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 505</td>
<td>Systems Engineering Principles</td>
<td>3</td>
</tr>
<tr>
<td>SYST 510</td>
<td>Systems Definition and Cost Modeling</td>
<td>3</td>
</tr>
<tr>
<td>SYST 520</td>
<td>System Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>SYST 530</td>
<td>Systems Engineering Management I</td>
<td>3</td>
</tr>
<tr>
<td>SYST 611</td>
<td>System Methodology and Modeling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>9</td>
</tr>
</tbody>
</table>

## Concentration in Communications and Networking (CON)E

Administered by the Department of Electrical and Computer Engineering (https://ece.gmu.edu/welcome-gmu-ece-department).

The certificate with a concentration in Communications and Networking is awarded on completion of five graduate courses (15 credits) in communications and networking. A cumulative GPA of 3.00 is required and one course with a grade of C at most may be applied toward the certificate. The certificate courses comprise two required foundation courses and three electives.

<table>
<thead>
<tr>
<th>Coursework Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 528</td>
<td>Introduction to Random Processes in Electrical and Computer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ECE 542</td>
<td>Computer Network Architectures and Protocols</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>6</td>
</tr>
</tbody>
</table>

## Electives

After completing the foundation courses, students choose electives by taking three courses from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 535</td>
<td>Digital Signal Processing</td>
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<tr>
<td>ECE 565</td>
<td>Introduction to Optical Electronics</td>
<td></td>
</tr>
<tr>
<td>ECE 567</td>
<td>Optical Fiber Communications</td>
<td></td>
</tr>
<tr>
<td>ECE 630</td>
<td>Statistical Communication Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 633</td>
<td>Coding Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 635</td>
<td>Adaptive Signal Processing</td>
<td></td>
</tr>
<tr>
<td>ECE 642</td>
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<td></td>
</tr>
<tr>
<td>ECE 643</td>
<td>Network Switching and Routing</td>
<td></td>
</tr>
<tr>
<td>ECE 646</td>
<td>Cryptography and Computer Network Security</td>
<td></td>
</tr>
<tr>
<td>ECE 731</td>
<td>Digital Communications</td>
<td></td>
</tr>
<tr>
<td>ECE 732</td>
<td>Mobile Communication Systems</td>
<td></td>
</tr>
<tr>
<td>ECE 734</td>
<td>Detection and Estimation Theory</td>
<td></td>
</tr>
<tr>
<td>ECE 738</td>
<td>Advanced Digital Signal Processing</td>
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</tr>
<tr>
<td>ECE 741</td>
<td>Wireless Networks</td>
<td></td>
</tr>
<tr>
<td>ECE 742</td>
<td>High-Speed Networks</td>
<td></td>
</tr>
<tr>
<td>OR 635</td>
<td>Discrete System Simulation</td>
<td></td>
</tr>
<tr>
<td>OR 643</td>
<td>Network Modeling</td>
<td></td>
</tr>
<tr>
<td>OR 647</td>
<td>Queuing Theory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>9</td>
</tr>
</tbody>
</table>

## Concentration in Engineering Resilient Enterprise Systems (ERES)

Administered by the Department of Systems Engineering and Operations Research (https://seor.gmu.edu).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 505</td>
<td>Systems Engineering Principles</td>
<td>3</td>
</tr>
<tr>
<td>SYST 510</td>
<td>Systems Definition and Cost Modeling</td>
<td>3</td>
</tr>
<tr>
<td>SYST 520</td>
<td>System Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>SYST 530</td>
<td>Systems Engineering Management I</td>
<td>3</td>
</tr>
<tr>
<td>SYST 611</td>
<td>System Methodology and Modeling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Credits</td>
<td>9</td>
</tr>
</tbody>
</table>
To be eligible for a certificate with concentration in Engineering Resilient Enterprise Systems, students must complete two required courses (6 credits) plus two electives (6 credits) with an average grade of B or better.

### Coursework

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 523</td>
<td>Engineering Resilient and Agile Enterprise Systems</td>
<td>3</td>
</tr>
<tr>
<td>SYST 618</td>
<td>Model-based Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>

### Electives

The remaining two electives must be taken from the list below with the approval of the advisor. Courses designated as basic methods courses may also be used as an elective. Some certificate electives may require stronger math requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 514</td>
<td>Systems Thinking</td>
<td>3</td>
</tr>
<tr>
<td>INFS 622</td>
<td>Information Systems Analysis and Design</td>
<td></td>
</tr>
<tr>
<td>SWE 619</td>
<td>Object-Oriented Software Specification and Construction</td>
<td></td>
</tr>
<tr>
<td>SYST 542</td>
<td>Decision Support Systems Engineering</td>
<td></td>
</tr>
<tr>
<td>SYST 584</td>
<td>Heterogeneous Data Fusion</td>
<td></td>
</tr>
<tr>
<td>SYST 630</td>
<td>Systems Engineering Management II</td>
<td></td>
</tr>
</tbody>
</table>

Select at least one course from the following:

- SYST 514 Systems Thinking
- INFS 622 Information Systems Analysis and Design
- SWE 619 Object-Oriented Software Specification and Construction
- SYST 542 Decision Support Systems Engineering
- SYST 584 Heterogeneous Data Fusion
- SYST 630 Systems Engineering Management II

Select the second course from the courses listed above or from the following:

- CS 555 Computer Communications and Networking
- ECE 542 Computer Network Architectures and Protocols
- INFS 612 Principles and Practices of Communication Networks

**Total Credits** 6

### Concentration in Financial Systems (FNSY)

Administered by the Department of Systems Engineering and Operations Research (https://seor.gmu.edu).

To be eligible for the certificate with concentration in Financial Systems Engineering, students must complete three required courses (9 credits) plus one elective (3 credits) with an average grade of B or better.

### Coursework

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST/OR 538</td>
<td>Analytics for Financial Engineering and Econometrics</td>
<td>3</td>
</tr>
<tr>
<td>SYST/OR 588</td>
<td>Financial Systems Engineering I: Introduction to Options, Futures, and Derivatives</td>
<td>3</td>
</tr>
<tr>
<td>SYST/OR 688</td>
<td>Financial Systems Engineering II: Derivative Products and Risk Management</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits** 9

### Electives

Select one from the following:

- OR 645 Stochastic Processes
- OR 682 Computational Methods in Engineering and Statistics
- SYST 584 Heterogeneous Data Fusion
- SYST 671 Judgment and Choice Processing and Decision Making

**Total Credits** 3

### Concentration in Tactical Computer Operations (TCO)

Administered by the Department of Electrical and Computer Engineering (https://ece.gmu.edu/welcome-gmu-ece-department).

Students must meet prerequisites for courses by either taking the appropriate undergraduate courses or through instructor permission.

### Coursework

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 571</td>
<td>Operating Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECE 511</td>
<td>Microprocessors</td>
<td>3</td>
</tr>
<tr>
<td>CFRS 761</td>
<td>Malware Reverse Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits** 9

### Electives

Select two courses from the following:

- CFRS 767 Penetration Testing in Computer Forensics
- CFRS 769 Anti-Forensics
- CFRS 773 Mobile Application Forensics and Analysis
- CFRS 775 Kernel Forensics and Analysis
- ECE 646 Cryptography and Computer Network Security
- ISA 564 Security Laboratory
- ISA 656 Network Security
- ISA 681 Secure Software Design and Programming
- ISA 763 Security Protocol Analysis

**Total Credits** 6