Daniel Felix Ritchie School
of Engineering & Computer Science
UNIVERSITY OF DENVER

PROPEL YOUR CAREER

Stackable Specialized Graduate Certificates and MS Degree Programs from the University of Denver exclusively for Lockheed Martin Employees

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What you need to know

Each certificate requires completion of 16 credit hours of coursework and may be taken in any order.

Each certificate requires completion of 16 credit hours of coursework and may be taken in any order. These certificates may be completed individually or combined to form a Master of Science in Systems Engineering.

Courses are traditionally taught weeknights after business hours at Lockheed Martin's Waterton campus.

We are honored to work with you and the Lockheed Martin organization.

Master of Science in SYSTEMS ENGINEERING

The Master of Science in Systems Engineering is a program available only to current Lockheed Martin employees.

This degree allows students to explore three specializations within systems engineering (fundamentals of space systems, systems design & architecture, and systems applications). These specialization areas have been selected to coincide with emerging technologies in the industry today. The purpose of this program is to serve the engineering profession and the Colorado community through advanced, multidisciplinary studies in mechanical, computer, and electrical engineering.

There are three paths to the MS in Systems Engineering:

01 Three Stackable Certificates

- 48 Credit Hours Total
- Each certificate is 4 courses (16 total credit hours)
- Combination of Core and Elective Classes

02 Non-Thesis Option*

- 45 Credit Hours Total
- Combination of Core, Concentration and Elective Classes

03 Thesis Option*

- 13-17 Credit Thesis
- 45 Credit Hours Total
- Combination of Core, Concentration and Elective Classes

**Detailed information regarding degree requirements can be found in the DU Graduate Bulletin.*

Fundamentals of Space Systems

Stackable Certificate #1

This Specialized Graduate Certificate requires completion of a minimum of four graduate-level courses, or 16 Quarter Hours (QHs). Completion of this certificate provides expertise in the fundamentals of space systems engineering, space system design and integration, and space project management.

Required Courses

ENMT 4000:
Space Systems Design I (4 QHs)

ENMT 4010:
Space Systems Design II (4 QHs)

ENMT 4100:
Systems Engineering (4 QHs)

ENGR 4810:
Project Management (4 QHs)

Objectives & Collective Outcomes

This certificate is recommended for entry-level space employees seeking a greater understanding of space systems and systems engineering.

This certificate will focus on the following skills:

- fundamentals of space and missile systems analysis, design and operation
- ability to design, model, analyze and evaluate space and missile systems
- understanding of hardware and software architectural layouts and different architectural configurations
- mastering understanding of component integration to meet performance project management

Courses associated with this certificate introduce students to an overview of space systems engineering, its major subsystems within a space system, appropriate design considerations, and project management.

Fundamentals of Space Systems Course Descriptions

ENMT 4000: Space Systems Design I (4 QHs)

This is the first of the two-course sequence to familiarize the student with the basic design of space systems, application of advanced theories and concepts as they relate to the development of spacecraft and missile subsystems, and how such subsystems are related under the umbrella of systems engineering.

Emphasis is given on the practical aspects of space system design and integration. This course is team-taught by faculty and functional experts in their respective fields of study.

Course Requirements: Assignments and Tests

ENMT 4010: Space Systems Design II (4 QHs)

This is the second of the two-course sequence and it is team-taught by faculty and functional experts in the respective fields of study.

Lecture topics include payload communications, guidance and control, spacecraft electric power, propulsion systems, radiation and avionics and sensor subsystems.

There is focus on existing space system architectures and the classical methods of designing them with emphasis in multi-attribute utility theory as a new design paradigm for space systems, when combined with integrated concurrent engineering and efficient searches of large architectural tradespaces. Designing for flexibility and uncertainty is considered, as are policy and product development issues.

Course Requirements: Assignments and Tests.

ENMT 4100: Systems Engineering (4 QHs)

This course provides a framework for understanding and acquiring the knowledge, tools, and systems engineering skills to successfully design, develop, produce, integrate, test, operate, and maintain complex systems.

Key skills include: systems thinking, identifying stakeholder needs, requirements development, mission design and architecture definition, technical management, design integration, and product verification and validation.

The course emphasizes the execution of lifecycle models for systems engineering processes that reduce the risk inherent in each lifecycle stage. Lifecycle models to be discussed include: Waterfall, Spiral Development and Agile.

Course Requirements: Assignments, Projects, and Tests.

ENGR 4810: Project Management (4 QHs)

This course introduces the student to the key elements of a successful product delivery system, including a product delivery process, core skills, training, tools, and project leadership.

Core skills include: team leadership; project planning; budget, schedule, risk and opportunity management; product quality management; contract/subcontract management and utilization of modern Earned Value Management (EVM) and Enterprise Resource Planning (ERP) systems.

Course Requirements: Assignments and Tests.

Systems Design and Architecture

Stackable Certificate #2

This Specialized Graduate Certificate requires completion of a minimum of four graduate-level courses, or 16 QHs. Two courses (8 QHs) are required courses, and two courses (8 QHs) are elective courses. Completion of this certificate provides expertise in support for proposals, after contract award and through critical design reviews, as well as system design and integration.

Required Courses

ENMT 4285:
Complex System Architectures, Models and Tools (4 QHs)

ENGR 4790:
Systems Engineering Requirements (4 QHs)

Recommended Elective Courses (choose at least two):

- ENMT 4225: Systems Models, Simulations, and Tools (4 QHs)
- ENMT 4270: Fundamentals of System Electrical, Mechanical and Software Design (4 QHs)
- ENGR 4910: Conceptual Design (4 QHs)
- ENGR 4920: Aerospace Missions (4 QHs)

Objectives & Collective Outcomes

This certificate is targeted for System Architects and Systems Engineers working the front-end of programs and proposals.

This certificate will focus on the following skills:

- understanding the state-of-the-art in complex (e.g. space, missile) systems and how they are designed, modeled, controlled, and evaluated
- tackling challenges related to mission technical design and mission analysis
- interpreting mission-specific architectures, including modularity and reconfigurability
- completing requirements decomposition and resource allocation
- performing risk analysis, validation and verification, and fault management
- running integrated control and diagnostics
- analyzing networks for control and communication purposes
- utilizing software-based toolsets to achieve required objectives

Systems Design and Architecture Course Descriptions

ENMT 4225: Systems Models, Simulations, and Tools (4 QHs)

The course focuses on modeling and design of complex engineering systems that meet a-priori performance characteristics. The whole cycle from design and modeling, to implementation and testing is followed, along with computer architecture, hardware and software design techniques, real-time data flow diagrams, state-transition diagrams, and performance evaluation methods.

Model-based Systems Engineering techniques are used to leverage SML (Cameo MagicDraw tool) to develop concepts of operations and define requirements. A major design project is assigned.

Course Requirements: Assignments, Projects, and Tests.

ENMT 4285: Complex System Architectures, Models and Tools (4 QHs)

The course focuses on mission requirements and how a mission should function by examining different architecture configurations and tools for modeling purposes.

Example architecture models include: executable, networked, distributed, real-time, information assurance, framework, and reference.
Students learn about development and allocation of functional and non-functional requirements and how to analyze architecture issues.

Emphasis is on development of Service-Oriented Architecture (SOA) solutions and ability to model and analyze using Systems Modeling Language (SysML).
Course Requirements: Assignments and projects.

ENGR 4910: Conceptual Design (4 QHs)

Conceptual Design specifies the principal solution. Concept Design rarely starts at the same point; you might have an existing design that needs iterating or the requirement to create a conceptualized form. Problem solving consists of using generic or ad hoc methods in an orderly manner to find solutions to problems.

There are many types of intellectual property such as patents, and some countries recognize more than others. Designers assess the many different directions a design could take at this stage will allow you to identify what you like and don't like from each one. The preferred concept will then be further developed using engineering drawings, schematics and possibly 3D models which will show how the design will look and operate.

ENMT 4270: Fundamentals of System Electrical, Mechanical and Software Design (4QHs)

Design of individual electrical and mechanical components comprises a system. Comprehensive integrated approach makes the transition from design of individual electrical/mechanical components into a complete electrical-mechanical system design.

Topics include systems engineering of complex electronics (FPGAs, ASICs, Hybrids), electromagnetic compatibility and analysis, electromagnetic interference, system power modeling and energy efficiency, electrical systems integration and test methodologies, mechanical system modeling, system thermal/stress analysis methods and tools, mass management, mechanical systems integration and test methodologies.

Course Requirements: Assignments and projects.

ENGR 4790: Systems Engineering Requirements (4 QHs)

The course covers fundamentals of design and requirements analysis of complex systems to meet overall mission requirements.

It spans the whole requirements engineering phase that includes requirements analysis, decomposition, derivation, allocation, verification and validation planning. Students acquire expertise in creating UML and SYML case diagrams and implementing verification/validation plans. Requirement management methods and tools, associated vernacular, and requirements configuration control are also covered.

Course Requirements: Assignments, tests, and a major project.

ENGR 4920: Aerospace Missions (4 QHs)

The design "problem" in Advanced Aerospace Systems describes the complications in the conceptual design of various types of aircraft, spacecraft, and complex vehicles.
It covers the following topics: design of orbital spacecraft, design for Moon missions (such as landers), design for Mars missions (including rovers), design of an unmanned drone for surveillance (high-altitudes), CubeSats (having large constellations), and rockets and missiles (including hypersonic).

This class stands as a reference of interest to engineers and scientists working in aerospace engineering and related topics.

Systems Application

Stackable Certificate #3

This Specialized Graduate Certificate requires completion of a minimum of four graduate level courses, or 16 QHs. Two courses (8 QHs) are required, and two courses (8 QHs) are elective.

Completion of this certificate provides hands-on expertise in system design, integration, implementation and testing.

Required Courses

ENMT 4275:
Applied System Electrical, Mechanical and Software Design (4 QHs)

ENGR 4680:
Fault Diagnosis and Prognosis for Engineering Systems (4 QHs)

Recommended Elective Courses (choose at least two; 4 QHs):

- ENGR 4620: Systems Optimization
- ENMT 4280: Design for Feasibility and Resilience
- ENGR 4940: Mission Operations Controls

Objectives & Collective Outcomes

This certificate is targeted towards system applications with an emphasis on implementation and testing.

This certificate will focus on the following skills:

- system analysis, synthesis and models for decision making
- electromechanical integration
- component- and system-level validation and verification
- fault- tolerance, reliability and feasibility analysis and design for resilience as attributes for developing trusted systems
- designing systems with performance guarantees in the presence of faults and failures

Projects will be related to the professional student's domain of expertise.

Systems Applications Course Descriptions

ENMT 4275: Applied System Electrical, Mechanical and Software Design (4 QHs)

This is a practice-centered course that will allow students to assess case studies of design, implementation, testing, validation, and verification of complete complex systems to meet mission requirements with performance guarantees.

Course Requirements: Projects.

ENGR 4680: Systems Optimization (4 QHs)

Reliability engineering is a sub-discipline of systems engineering that emphasizes dependability in the lifecycle management of a product. Reliability, describes the ability of a system or component to function under stated conditions for a specified period of time. Reliability is closely related to availability, which is typically described as the ability of a component or system to function at a specified moment or interval of time. Normally, quality focuses on the prevention of defects during the warranty phase whereas reliability looks at preventing failures during the useful lifetime of the product or system from commissioning to decommissioning. Diagnosis is used, with variations in the use of logic, analytics, and experience, to determine "cause and effect". In systems engineering, it is typically used to determine the causes of symptoms, mitigations, and solutions. Prognostics is an engineering discipline focused on predicting the time at which a system or a component will no longer perform its intended function. This lack of performance is most often a failure beyond which the system can no longer be used to meet desired performance. The predicted time then becomes the remaining useful life (RUL), which is an important concept in decision making for contingency mitigation. Success in this course requires knowledge of probability theory and statistics, and familiarity with MATLAB/Simulink.

ENGR 4680: Fault Diagnosis and Prognosis for Engineering Systems (4 QHs)

The course provides the fundamentals of fault diagnosis and failure prognosis with a focus on intelligent fault diagnosis and failure prognosis technologies for condition-based maintenance.

It includes interdisciplinary methods required to understand the physics of failure mechanisms in materials, structures, and rotating equipment; strategies to detect faults or incipient failures and predicts the remaining useful life of failing components.

Case studies are used throughout to illustrate enabling technologies in a holistic and integrated approach that addresses the various interdisciplinary components of the field, from engineering to business management.

Course Requirements: Assignments and projects.

ENGR 4280: Design for Feasibility and Resilience (4 QHs)

In this course, students will explore methodologies and techniques to architect systems for reliability, maintainability and sustainability. They will also explore probabilistic and deterministic methods of improving reliability and resilience of complex systems.
Additional topics for the course include, probabilistic risk assessment; reliability analysis; error analysis; uncertainty analysis, quantification and handling; random, common cause, external events and systematic uncertainty; comparison of models and case studies.

Course Requirements: Assignments and projects

ENGR 4940: Mission Operations Controls (4 QHs)

Space operations is based at a centralized control center, a facility used for command & control (C2), and related communication equipment (antennas, etc.). The human operators conduct the day-to-day operations for controlling the spacecraft. They control the spacecraft and its payloads, and carry out all activities related to mission planning and scheduling.
For example, normal orbital operations are interrupted every six months to conduct orbital maneuvers. Launch operations begin with spacecraft integration and checked-out for launch. Once safely placed in orbit, command and control goes back and forth between the ground control station and the spacecraft or satellite.

A key aspect of spacecraft operations is the transferring of data from the onboard instruments collected by its payload to the ground, eventually disseminating the data to concerned users and analysts through a ground data network. This requires an on-orbit communication architecture.

Course Schedule

Summer 2023-Spring 2026

Summer 2023

TBD Elective Course
ENGR 4504: Graduate Capstone Design IV

Fall 2023

ENMT 4000: Space Systems Design I
ENGR 4790: Systems Engineering Requirements
ENGR 4810: Project Management
ENGR 4501: Graduate Capstone Design I

Winter 2024

ENMT 4010: Space Systems Design II
ENMT 4270: Fundamentals of System Electrical, Mechanical and Software Design
ENGR 4910: Conceptual Design
ENGR 4502: Graduate Capstone Design II

Spring 2024

ENMT 4010: Space Systems Design II
ENGR 4920: Aerospace Missions
ENMT 4280: Design for Feasibility and Resilience

Summer 2024

ENGR 4910: Conceptual Design

Fall 2024

ENMT 4000: Space Systems Design I
ENMT 4275: Applied System Electrical, Mechanical and Software Design
ENGR 4810: Project Management

Winter 2025

ENMT 4010: Space Systems Design II
ENMT 4225: Systems Models, Simulations, and Tools
ENGR 4940: Mission Operations Controls

Spring 2025

ENMT 4100: Space Systems Design II
ENMT 4285: Complex System Architectures, Models and Tools
ENGR 4620: Systems Optimization

Summer 2025

TBD

Fall 2025

ENMT 4000: Space Systems Design I
ENGR 4790: Systems Engineering Requirements
ENGR 4810: Project Management

Winter 2026

ENMT 4010: Space Systems Design II
ENGR 4920: Aerospace Missions
ENGR 4680: Fault Diagnosis and Prognosis for Engineering Systems

Spring 2026

ENMT 4100: Space Systems Design II
ENMT 4270: Fundamentals of System Electrical, Mechanical and Software Design
ENMT 4280: Design for Feasibility and Resilience

- Fundamentals of Space Systems
- Systems Design and Architecture
- Systems Application
- Electives & Other

Tuition, Fees, & Reimbursement

As a Lockheed Martin employee, your tuition reimbursement and billing processes are unique.

First, you will fill out the 2022-2023 Lockheed Martin Tuition Deferment form and send it to Kaitlyn Jones (kaitlyn.jones@du.edu) in the Bursar's Office or complete the form through your Applicant Status Portal. This form states that your tuition bill will be deferred until final grades are posted for the quarter so that you can submit said final grades to Lockheed Martin's internal tuition reimbursement company (Bright Horizons/EdAssist) to receive your tuition reimbursement.

You will then fill out the internal Lockheed Martin tuition reimbursement application. In order to receive instructions on filling out this application, please contact Zach Yinger (Zachary.g.yinger@lmco.com). Lockheed Martin does not pay the University of Denver directly for your tuition costs. Students are responsible for ensuring that their tuition bill is paid on time (the deferred due date is listed on the deferred tuition bill you will receive at the end of the quarter) regardless of reimbursement from Lockheed Martin.

DU bills students directly and the student is financially responsible for paying their tuition bill. You will receive your tuition bill through your DU-assigned student email address.

For the 2022 - 2023 academic year, the tuition cost is $1,539 per credit hour. As a MS or PhD student, you may take up to three four-credit-hour courses or twelve credit hours and as a Certificate or Non-Degree Seeking student, you may take up to two four-credit-hour courses or eight credit hours and remain underneath your Lockheed Martin annual cap.

The quarter you take your twelfth (MS & PhD students) or eighth (Certificate & Non-Degree Seeking students) credit hour, you will receive a payment from the Electrical Engineering Department at DU on your tuition bill once final grades are posted that covers the remaining tuition amount that Lockheed Martin's internal tuition reimbursement program (Bright Horizons/EdAssist) does not cover in their $12,500 (MS & PhD students) or $7,500 (Certificate & Non-Degree Seeking students) annual tuition reimbursement cap.

More information on tuition caps

DU bills LMCO students directly and it is the student, not LMCO, who is financially responsible for coursework. LMCO students are responsible for following LMCO policy to receive tuition reimbursement and paying DU according to billing deadlines.

LMCO students must sign DU's Billing Agreement every academic year in MyDU (comparable to all graduate students at DU). You will receive notice through your DU-assigned email address to complete this task along with instructions.

Tuition, Fees, Reimbursement & Leave of Absence Policy

More information on tuition caps and Leave of Absence

The below is more relevant for non-ELDP LMCO students who have stricter caps on tuition reimbursement than ELDP students. That said, we have adjusted our tuition/billing to fit within LMCO's annual cap for MS and PhD students ($12,500 for three courses in a calendar year) and graduate certificate and non-degree-seeking students ($7,500 for two courses in a calendar year):

- When enrolled in single courses as a non-degree seeking student, LMCO Employees will be allowed to take up to 8 credit hours within a calendar year at a maximum tuition charge of $7,500.
- LMCO employees who have taken the maximum number of single course credit hours and are subsequently admitted to the graduate school as degree-seeking students in the same calendar year will be allowed to take an additional 4 credit hours at a maximum tuition of $5,000. Total credit and tuition limit for the calendar year will be 12 credit hours and $12,500.
- When enrolled in courses as a degree-seeking student, LMCO employees will be allowed to take up to 12 credit hours within a calendar year at maximum tuition charge of $12,500.
- Certificates: the annual cap is $7,500 for graduate certificates. If LMCO employees are interested in pursuing this as an option, LMCO employees will split courses across more than one calendar year or enroll as degree-seeking students and complete their certificates as part of taking the corresponding courses in their progress toward their master's degrees.
- If LMCO employees enroll in dual programs in sequence or concurrently during the year, the higher cap will always apply. For example, if LMCO employees complete a certificate and then enroll as master's students, their annual cap will be $12,500.
- LMCO employees taking more credits in a calendar year than the LMCO reimbursement annual cap, they will pay out of pocket for these credits. Coursework will cost the same per credit hour but may not be reimbursable by LMCO depending on the students' circumstances. If you have questions on how to request for an increase in your annual tuition reimbursement through Lockheed Martin, please contact Zach Yinger (Zachary.g.yinger@lmco.com)

Leave of Absence Policy

If you take all three courses before the Fall quarters, you are able to take "Personal Leave of Absence" from the University so that you remain an active student in the DU system and be able to register for the next quarter. Personal Leaves of Absences are not penalized and can be used for a multitude of reasons (maternity/paternity leave, maximizing your annual tuition cap, major life changes, etc.).

Admissions Requirements

Lockheed Martin Employee Certificate & Masters Application Requirements

LMCO-Specific Application Link

The application available to the general public does not have the LMCO-specific programs and you will not receive the LM/DU benefits if you do not apply through this link. Please use your LMCO e-mail address to verify employment.

(https://gradadmissions.du.edu/apply/?sr=1ed854af-1103-419b-a411-7f0c9e4287fe)

$65.00 Application Fee

Paid by employee, but potentially reimbursable through Lockheed Martin depending on employee's individual circumstances.

University Minimum Degree and GPA Requirements

The University of Denver offers admission to graduate applicants who demonstrate the highest potential for successful graduate study. The minimum baccalaureate GPA for graduate admission consideration at the University of Denver is a cumulative 2.5 on a 4.0 scale, or a 2.5 on a 4.0 scale for the last 60 semester credits or 90 quarter credits (approximately two years of work). For more details, please visit the Graduate Bulletin.

Transcripts

One official transcript from each post-secondary institution is required.

Employment Verification Letter Signed by Supervisor

Applicants will be asked to provide their supervisor's email address through the application system so that the letter may be signed through the email they receive.

If you are looking to begin a PhD program at the Ritchie School of Engineering and Computer Science, please contact Carson Koinzan, carson.koinzan@du.edu to discuss additional steps you will need to take in order to apply for your intended program.

Admissions Requirements

Lockheed Martin Employee Certificate & Masters Application Requirements

Additional Standards for Non-Native English Speakers

Official scores from the Test of English as a Foreign Language (TOEFL), International English Language Testing System (IELTS) or Cambridge English: Advanced (CAE) are required of all graduate applicants, regardless of citizenship status, whose native language is not English or who have been educated in countries where English is not the native language.

The minimum TOEFL/IELTS/CAE test score requirements for the degree program are:

- Minimum TOEFL Score (paper-based test): 550
- Minimum TOEFL Score (internet-based test): 80
- Minimum IELTS Score: 6.5
- Minimum CAE Score: 169

2023 - 2024 Application Deadlines

Term	Start Month	Final Submission Deadline
Fall 2023	September	August 15, 2023
Winter 2024	January	November 15, 2023
Spring 2024	March	February 15, 2024
Summer 2024	June	May 15, 2024

Contact Us

Carson Koinzan | Program Coordinator

303.871.6173
carson.koinzan@du.edu

For questions regarding admissions, applications, course registrations, tuition reimbursement, billing and accessing the LMCO-specific application link.

Wendell Chun | Faculty Director

303.871.6890
wendell.chun@du.edu

For questions regarding advising and curriculum.

Kaitlyn Jones | Tuition Reimbursement & Billing

303.871.2449
kaitlyn.jones@du.edu

For questions regarding tuition reimbursement processes, tuition billing, financial holds, and tuition deferment processes.

Zach Yinger | Lockheed Martin Point of Contact

zachary.g.yinger@lmco.com

For questions regarding EdAssist/Bright Horizons tuition reimbursement through Lockheed Martin.