Propel Your Career

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

UNIVERSITY of DENVER

DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

FIRST

THANK YOU
FOR CONSIDERING DU!

In Fall 2019 we modernized our ongoing relationship with Lockheed Martin by launching three new graduate-level, specialized certificates. These certificates were created to give LMCO employees valuable knowledge and skills tailored for their career growth within the organization. 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. All course work will be online until the COVID-19 pandemic has been safely contained.

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

Dr. Haluk Ogmen
Interim Dean

CONTENT

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The Master of Science in Systems Engineering is a program available only to current Lockheed Martin employees and is designed to advance the student's knowledge in several areas of engineering. This degree provides breadth while permitting the student to achieve depth in a specialization area. This specialization area, with thematic sequences of courses, has been selected to coincide with those of high current interest as well as those emerging technologies that hold promise of increasing importance for the future. The purpose of this program is to serve the profession of engineering and the Colorado community through advanced study in computer engineering, electrical engineering, and other related fields. This program prepares the student for academic and industrial advancement.

There are three paths to the MS in Systems Engineering

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

Non-Thesis Option*
- Total 45 Credit Hours
- Combination of Core, Breadth, and Depth (Elective) Classes

Thesis Option*
- 13-17 Credit Thesis
- Total 45 Credit Hours
- Combination of Core, Breadth, and Depth (Elective) Classes

* Detailed information regarding degree requirements can be found in the [DU Graduate Bulletin](#)

FUNDAMENTALS OF SPACE SYSTEMS CERTIFICATE

This Specialized Graduate Certificate requires completion of a minimum of four graduate level courses, or 16 QHs. Completion of this certificate provides expertise in fundamentals of space systems engineering, space system design and integration, and space project management. Space systems include, at minimum, spacecraft and missiles.

Objectives and Collective Outcomes

This certificate is recommended for those new to the space industry and early career space employees seeking a greater understanding of space systems and systems engineering. Courses associated with this certificate introduce the student to an overview of space systems engineering, its major subsystems within a space system, appropriate design considerations, and project management. Courses focus on: 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.

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)

FUNDAMENTALS OF SPACE COURSE DESCRIPTIONS

ENMT 4000: Space Systems Design I (4QHs)
This is the first of the two-course sequence to familiarize the student with basic design of Space Systems. Application of advanced theory 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 practical aspects of space systems design and integration. Course is team-taught by faculty and functional experts in the respective fields of study. Lecture topics include aerospace materials, mechanics, thermal control, embedded systems, distributed sensor networks, aerospace probability and statistics. In addition, fundamentals of satellite systems are discussed, including history of space flight and satellite systems, orbital mechanics, the space and earth segment, satellite link fundamentals, satellite reliability, and overview of satellite applications. Course Requirements: Assignments and Tests.

ENMT 4010: Space Systems Design II (4QHs)
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. In addition, 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. Prerequisite: Space Systems Design I, or permission by the Instructor. 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, stakeholder needs identification, requirements development, mission design and architecture definition, technical management, design integration, and product verification and validation. Emphasis is on the execution of life-cycle models for systems engineering processes that reduce the risk inherent in each life-cycle 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 will introduce the student to the key elements of a successful product delivery system. The product delivery system consists of five components: a product delivery process, core skills, training, tools, and project leadership. The process is the means by which projects are consistently and efficiently planned, executed, monitored and completed in compliance with customer requirements and within budget and schedule. 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. The system is aligned with the principles of a total quality improvement program, namely client focus, project manager commitment, evaluation and measurement, corporate support and, continuous improvement. Course Requirements: Assignments and Tests.

SYSTEMS DESIGN AND ARCHITECTURE CERTIFICATE

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 with emphasis on support for proposals, after contract award and through critical design reviews, as well as system design and integration.

Objectives and Collective Outcomes

This certificate is targeted for System Architects and Systems Engineers working the frontend of programs and proposals. It centers on: understanding the state-of-the-art in complex (e.g. space and missile, etc.) systems, how they are designed, modeled, controlled and evaluated; ability to tackle challenges related to mission technical design and mission analysis; mission specific architectures, including modularity and re- configurability; requirements decomposition and resource allocation; risk analysis, validation and verification and fault management; integrated control and diagnostics; network analysis for control and communication purposes; and software-based toolsets to achieve required objectives.

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 course)
- 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)

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, 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 leveraging SML (Cameo Magic Draw tool) to develop concept of operations and define requirements. A major design project is assigned. Prerequisites: Knowledge of feedback control systems, knowledge of fundamentals of computer organization and logic design, familiarity with MATLAB/Simulink, or permission by the Instructor. Course Requirements: Assignments, Projects and Tests.

ENMT 4270: Fundamentals of System Electrical, Mechanical and Software Design (4QHs)
Design of individual electrical and mechanical components comprising a system. Comprehensive integrated approach making 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, electromagnetic interference, electrical compatibility analysis, 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. Prerequisites: ENMT 4000, ENMT 4010, or permission by the Instructor. Course Requirements: Assignments and projects.

ENMT 4285: Complex System Architectures, Models and Tools (4 QHs)
The course focuses on mission requirements and how an overall 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 modeling and analysis using Systems Modeling Language (SysML). Prerequisites: ENMT 4100, or permission by the Instructor. 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 in defining and implementing verification and validation plans. Requirement management methods and tools, associated vernacular, and requirements configuration control are also covered. Perquisites: ENMT 4100, or permission by the Instructor. Course Requirements: Assignments, tests, and a major project.

ENGR 4910: Conceptual Design (4 QHs)
Conceptual design is the part of the design process where—by identifying the essential problems through abstraction, establishing function structures, searching for appropriate working principles and combining these into a working structure— the basic solution path is laid down through the elaboration of a solution principle. Conceptual design specifies the principle 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. George Polya (mathematician) presented two important decision-making principles, understanding the problem and devising a plan. To understand what is new, students are asked to look at intellectual property, a category of property that includes intangible creations of the human intellect. 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.

ENGR 4920: Aerospace Missions (4 QHs)
The design "problem" in Advanced Aerospace Systems describes the problems 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). Problem statements are concise descriptions of design problems. Design teams use them to define the current and ideal states, to freely find user-centered solutions. This class stands as a reference of interest to engineers and scientists working in aerospace engineering and related topics.

SYSTEMS APPLICATION CERTIFICATE

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 hands-on expertise in system design, integration, implementation and testing.

Objectives and Collective Outcomes

This certificate is targeted towards system applications with emphasis on implementation and testing. The courses focus on: 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; and designing systems with performance guarantees in the presence of faults and failures. Projects will be related to the professional student's domain of expertise.

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 course)
- ENGR 4620: Systems Optimization (4 QHs)
- ENMT 4280: Design for Feasibility and Resilience (4 QHs)
- ENGR 4940: Mission Operations Controls (4 QHs)

SYSTEMS APPLICATION COURSE DESCRIPTIONS

ENMT 4275: Applied System Electrical, Mechanical and Software Design (4 QHs)
This is a practice-centered course. Assess case studies of design, implementation and testing, validation and verification of complete complex (e.g. spacecraft) systems to meet mission requirements with performance guarantees. Prerequisites: It is recommended that the elective course ENMT 4270 is taken first, or permission by the Instructor. Course Requirements: Projects.

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 electrical, electronic, mechanical, industrial, and computer engineering to business management. Prerequisites: Knowledge of probability theory and statistics, familiarity with MATLAB/Simulink, or permission by the instructor. Course Requirements: Assignments and projects.

ENMT 4280: Design for Feasibility and Resilience (4 QHs)
Methodologies and techniques to architect systems for reliability, maintainability and sustainability. Probabilistic and deterministic methods of improving reliability and resilience of complex systems. Topics include: Probabilistic risk assessment (e.g. fault trees, event trees and importance ranking); reliability analysis; error analysis; uncertainty analysis, quantification and handling; random, common cause, external events (e.g., Space weather) and systematic uncertainty; comparison of models and case studies. Prerequisites: Knowledge of probability and statistics, familiarity with MATLAB/Simulink, or permission by the Instructor. Course Requirements: Assignments and projects

ENGR 4620: Systems Optimization (4 QHs)
Engineering problems will be formulated as different programming problems to show the wide applicability and generality of optimization methods. The development, application, and computational aspects of various optimization techniques will be discussed with engineering examples. The application of nonlinear programming techniques will be emphasized. A design project will be assigned. Prerequisite: ENGR 3621, or permission by the Instructor. Course Requirements: Assignments, tests 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 carries 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.

Certificate and MS Course Schedule Fall 2020 - Summer 2022

Fall 2020

ENMT 4000 Space Systems Design Design I

ENMT 4280 Design for Feasibility & Resilience

ENGR 4810 Project Management

ENGR 4501 Graduate Capstone Design (ELDP Only)

Winter 2021

ENMT 4010 Space Systems Design II

ENMT 4225 Systems Models, Simulation, and Tools

ENMT 4275 Applied System Electrical, Mechanical, and Software Design

ENGR 4502 Graduate Capstone Design (ELDP Only)

Spring 2021

ENMT 4100 Systems Engineering

ENGR 4920 Aerospace Missions

ENGR 4620 Optimization

ENGR 4503 Graduate Capstone Design (ELDP Only)

Summer 2021

ENGR 4504 Graduate Capstone Design (ELDP Only)

■ Fundamentals of Space Systems   ■ Systems Design & Architecture

Fall 2021

ENMT 4000 Spacecraft Design I

ENGR 4810 Project Management

ENGR 4790 System Engineering Requirements

ENGR 4501 Graduate Capstone Design (ELDP Only)

Winter 2022

ENMT 4010 Space Systems Design II

ENMT 4285 Complex System, Architectures, Models, and Tools

ENMT 4940 Mission Operations

ENGR 4502 Graduate Capstone Design (ELDP Only)

Spring 2022

ENMT 4100 Systems Engineering

ENMT 4270 Fundamentals of Systems Electrical, Mechanical, and Software Design

ENMT 4680 Fault Diagnosis & Prognosis for Systems Engineering

ENGR 4503 Graduate Capstone Design (ELDP Only)

Summer 2022

ENGR 4504 Graduate Capstone Design (ELDP Only)

Systems Applications

Electives and Capstone

ADMISSIONS REQUIREMENTS

Lockheed Martin Employee Certificate & Masters Application Requirements
- Lockheed Martin specific online admission application
- $65.00 Application Fee (Paid by Employee)
- University Minimum Degree and GPA Requirements
- Transcripts: One official transcript from each post-secondary institution
- Employment Verification Letter Signed by Supervisor

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

TUITION, FEES, & REIMBURSEMENT
- Certificate and Non-Degree Seeking students will be reimbursed by Lockheed Martin for 8 credit hours taken in a calendar year. Masters and PhD students will be reimbursed by Lockheed Martin for 12 credit hours taken in a calendar year.
- Lockheed Martin students must earn a B+ to be eligible for reimbursement per Lockheed's tuition reimbursement policy.
- Lockheed Martin students must submit to the DU Bursar's Office a signed tuition deferral form every academic year to have their tuition bill deferred until after their final grades are released.
- Lockheed Martin students will be required to meet all course registration, add/drop deadlines published by DU's Registrar's Office as well as follow tuition appeal processes as laid out in DU's Graduate Bulletin.

CONTACT US

Program Coordinator
Carson Koinzan | Phone: 303.871.6173 | Email: carson.koinzan@du.edu
For questions regarding admissions, applications, course registrations, tuition reimbursement and billing and to request the LMCO-specific application link.

Faculty Director
Wendell Chun | Phone: 303.871.6890 | Email: wendell.chun@du.edu
For questions regarding advising and curriculum.

DU STUDENT BENEFITS

While the Lockheed Martin employee courses may be at the Waterton Campus (or online) you still have access to the benefits of being a DU student. DU Graduate students have access to the Anderson Academic Commons, Career and Professional Development programs, Alumni networking events, complimentary subscriptions to online media, and other exclusive opportunities.

With your DU Student Card you get discounts and special student pricing at:
- Coors Fitness Center
- The Newman Center for Performing Arts
- Ritchie Center and Magness Arena Sporting Events
- Restaurants and businesses around town

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