SYSTEMS ENGINEERING (SYSEN)

SYSEN 1900 - Systems Engineering Project for First-Years (1-4 Credits)
Project experience for students who want to pursue a particular analytical, computational, or experimental project experience outside of regular courses. An engineering report on the project is required of each student. Intended for first-year students on project teams and for project team members performing non-technical tasks.
Enrollment Information: Enrollment limted to: first-year students.
Course Fee: Course Fee, TBA. TBA.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 3900 - Systems Engineering Project of Undergraduate Students (1-4 Credits)
Independent project experience for students pursuing analytical, computational, or experimental work outside of regular courses. Students define their own goals, timelines, and deliverables, which must be approved by a faculty advisor. Regular meetings with the advisor ensure guidance and feedback throughout the project. Grades are based on project planning, execution, and the quality of deliverables—rather than solely on achieving a working solution. Projects often address real-world problems with real stakeholders, and students are expected to demonstrate how their work meets stakeholder needs. A final report is required, detailing the project's objectives, methods, design decisions, and recommendations for future work, written clearly enough for others to replicate and build upon.
Enrollment Information: Enrollment limited to: Undergraduate Sophomores/Juniors.
Last Four Terms Offered: Spring 2026, Fall 2025
Learning Outcomes:

- Decompose a problem into its functional requirements and prioritize a problem's set of use cases.
- Determine the functional and operational flow to inform system design, define subsystems and/or subteams necessary to work towards a problem, and identify, specify, and track interfaces between components, subsystems, subteams, etc. as a solution is developed.
- Justify design trade-offs by defining objective performance criteria and communicating the value and effectiveness of solutions to both teammates and external stakeholders.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 4050 - Systems Engineering Design Fundamentals (2 Credits)
Systems Engineering is one of the most rapidly growing, sought-after skills sets in industry. This course introduces students to fundamental ideas of Systems Engineering that can be applied to virtually any project, whether it be a traditionally engineering focus project or otherwise. This course gives students some of the most popular, versatile, and valued ready-to-use Systems Engineering tools along the Vee-diagram covering key aspects of initial problem definition and defining of system requirements, thru systems design & architecture, to integration, evaluation & setting design targets, and risk identification & mitigation.
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Students will be able to decompose problem statements into an objective, functional, and verifiable problem definition and proposed functional flow.
- Students will be able to identify objective means for evaluating the performance of any valid problem solution to perform effective trade studies and justifiable design decisions.
- Students will be able to access and evaluate project integration needs as well as project risk and mitigation strategies.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 4200 - Inventory, Operations, and Supply Chain Management: Models and Optimization (3 Credits)
Crosslisted with ORIE 4120
This course will provide a rigorous coverage of the (stochastic and deterministic) models commonly used in the study of inventory, operations, and supply chain management. This includes the multi-period newsvendor model and its many variants, as well as more sophisticated models which arise in supply chain management, logistics, and the study of operations more broadly. We will study tools for analyzing and optimizing such systems, as well as operational insights which can be extracted from such models. The course will in general have a fairly mathematical orientation, focusing on using tools from stochastic modeling, optimization, and dynamic programming/algorithms to formulate and analyze these models.
Prerequisites: introductory courses in probability and optimization (including linear programming and dynamic programming.) An introductory course in algorithms is helpful, but not strictly necessary.
Last Four Terms Offered: Spring 2022, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 4900 - Systems Engineering Project for Undergraduates (1-4 Credits)
Project experience for students who want to pursue a particular analytical, computational, or experimental project experience outside of regular courses, or for informal instruction supplementing that given in regular courses. An engineering report on the project is required of each student. Students are expected to spend 3-4 hours per week per credit hour working on the project. Intended for sophomores, juniors, and seniors on project teams performing technical tasks.
Course Fee: Course Fee, TBA. TBA.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5020 - Creating Solutions with Embedded Systems (1 Credit)
With the number of embedded systems in the world far exceeding the number of humans, nearly every major piece of technology involves one, if not several embedded systems. Students will understand the capabilities and challenges that come in creating embedded systems and the larger systems that rely upon them -- not becoming experts in embedded systems, but being able to work more effectively with those experts. This hands-on course will also not only introduce core embedded systems concepts, such as hardware peripherals, interrupt service routines, realtime programming, digital i/o, A2D converters, and interfacing with sensors, etc., but will also introduce related systems engineering principles to aid students in making smart and well-supported design choices, manage design interfaces, and provide justification on whole solution trade-offs.
Corequisites: SYSEN 5100.
Learning Outcomes:

- Develop and implement a basic systems architecture for an embedded system that includes digital and analog sensors utilizing interrupts.
- Demonstrate various digital communication protocols and develop associated interface identification and specification design documentation.
- Identify embedded system solution requirements and means of verification.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5050 - Systems Engineering Design Fundamentals (2 Credits)
Systems Engineering is one of the most rapidly growing, sought-after skills sets in industry. This course introduces students to fundamental ideas of Systems Engineering that can be applied to virtually any project, whether it be a traditionally engineering focus project or otherwise. This course gives students some of the most popular, versatile, and valued ready-to-use Systems Engineering tools along the Vee-diagram covering key aspects of initial problem definition and defining of system requirements, thru systems design & architecture, to integration, evaluation & setting design targets, and risk identification & mitigation.
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Students will be able to decompose problem statements into an objective, functional, and verifiable problem definition and proposed functional flow.
- Students will be able to identify objective means for evaluating the performance of any valid problem solution to perform effective trade studies and justifiable design decisions.
- Students will be able to access and evaluate project integration needs as well as project risk and mitigation strategies.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5100 - Model Based Systems Engineering (4 Credits)
Crosslisted with CEE 5240, ECE 5120, ORIE 5140, MAE 5910
Fundamental ideas of systems engineering, and their application to design and development of various types of engineered systems. Defining system requirements, creating effective project teams, mathematical tools for system analysis and control, testing and evaluation, economic considerations, and the system life cycle.Content utilizes model-based systems engineering, which is the integration of systems modeling tools, such as SysML, with tools for systems analysis, such as Matlab and Modelica. The vision for this integration is the ability to create and analyze complete parametric representations of complex products and systems. These systems make it possible to investigate the impact of changing one aspect of a design on all other aspects of design and performance. This course will familiarize students with these modeling languages. Off-campus students must provide their own Windows 7, internet-connected, computer with administrator access in order to install the commercial software used in this course.
Prerequisites: Prerequisite or corequisite: enrollment in group-based project with strong system design component approved by course instructor.
Enrollment Information: Enrollment limited to: seniors or graduate students in an engineering field.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5120 - Energy and Climate Scenario Analysis (3 Credits)
This course examines quantitative methods to develop energy and climate-change mitigation policies. Students will learn about widely used software tools in the filed, such as LEAP and OSeMOSYS, to assess these policies. The course covers the analysis of energy demand and supply for different economic sectors. Mathematical models will be utilized to identify optimal policies and energy scenarios. Finally, students will learn how to perform a cost-benefit analysis to quantify the effects of the identified scenarios.
Last Four Terms Offered: Fall 2025, Spring 2025
Learning Outcomes:

- Develop mathematical models of different energy systems.
- Use the Low Emissions Analysis Platform (LEAP) and the Open Source Energy Modeling System (OSeMOSYS) software.
- Measure energy consumption, production, and resource extraction in different sectors of an economy.
- Quantify the effects of energy and climate change policy interventions.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5130 - Service System Modeling and Design (4 Credits)
Crosslisted with ORIE 5130
Service systems arise primarily from the service sector of the economy. Examples are contact centers (also known as call centers), airlines, insurance and healthcare. This course describes techniques that are useful in the analysis and design of such systems. The class is structured around a number of cases. The emphasis is on modeling, solving the models, and interpreting the results. Both operational and strategic decisions are covered through appropriate examples.
Corequisites: ORIE 3310, ORIE 3510.
Last Four Terms Offered: Fall 2025, Spring 2025, Fall 2023, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5140 - Economic and Financial Decisions for Engineers (3 Credits)
This course aims at empowering engineers with training in accounting, finance and engineering economics needed to make financial decisions concerning capital investments that have prolonged monetary impacts. These methods are suitable for problems involving capital allocations and investments as well as evaluation and selection of engineering projects. Students learn how to define and select appropriate economic criteria for the evaluation of alternatives as well as how to use proper methods for evaluating alternatives under deterministic conditions.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Be able to read and prepare major financial statements (in an easier context for the latter); perform financial ratio analyses.
- Be able to perform cost estimation and cost-driven design optimization to prepare income statements and cash flow statements for further economic analysis.
- Apply concepts of time value of money and equivalence factors to compute, by hand and/or by spreadsheets, economic criteria for a given set of cash flows and use them to evaluate economic viability of projects or to choose the best option from among mutually exclusive projects, including the use of benefit-cost ratios to evaluate public sector projects.
- Prepare after-tax cash flows for economic analysis taking into consideration the effects of depreciation, taxes, and inflation on project cash flows.
- Compute cost of capital and perform capital budgeting/allocation to determine an appropriate minimum attractive rate of return (MARR) for use in economic analysis.
- Use decision trees to help make complicated sequential decisions and to estimate value of additional information, as well as to understand the general approach for dealing with multiple criteria such as risk-return tradeoffs.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5150 - Management Science to Complex Problems (3 Credits)
In today's rapidly changing environment, management personnel, whether in companies, in non-profit organizations or within governmental departments, rely on analysis using quantitative models from the discipline of management science to make the right decisions. Management science tools, techniques and concepts (e.g., data, models, simulation, regression, linear programming, and optimization) have dramatically changed the way businesses operate in manufacturing, service operations, marketing, transportation, and finance. When used wisely, management science models and tools have tremendous value to support managers and systems engineers making right decisions to solve complex problems. In particular, we will focus on various ways of modeling, or thinking structurally about, decision problems in order to enhance decision-making skills in complex settings.
Prerequisites: CS 1110, CS 2110, MATH 2940, ORIE 3500.
Last Four Terms Offered: Summer 2021
Learning Outcomes:

- Formulate a problem/business opportunity as a mathematical model and solve it.
- Produce insights from solving mathematical models.
- Demonstrate deep understanding of management science techniques to solve various problems and the shortcoming of each technique.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5151 - Foundations of Systems Engineering (4 Credits)
Systems Engineering is a rapidly growing transdisciplinary field, and the range of areas systems engineers can specialize in is expanding. Traditionally, students have come from engineering or science backgrounds. However, emerging needs now require students with undergraduate knowledge in quantitative fields like mathematics, statistics, finance, economics, and data science. These skills are essential for applying systems methods to consumer products, service-oriented offerings, supply chains, and large data set analytics. Gaining expertise in these areas creates a strong foundation for a career in the analytical side of Systems Engineering. This course is designed to build core systems analytical skills on an existing mathematical background while offering a introduction to the fundamental systems engineering tools essential for all systems engineers, especially those with limited prior engineering experience.
Distribution Requirements: (CE-EN)
Last Four Terms Offered: Fall 2025
Learning Outcomes:

- Apply modern systems engineering tools throughout the entire vee-diagram design process.
- Identify where various modern systems analysis tools can be used throughout the vee-diagram process and which are most applicable for given situations and parts of the process.
- Demonstrate how modern systems analysis tools can both be used well in aiding in the systems engineering design process.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5160 - Managing and Modeling Complex Systems for Organizational Leaders (3 Credits)
This course introduces methods and tools from Systems Thinking and Engineering to prospective organizational leaders committed to shaping successful companies in a competitive landscape. The course is structured into biweekly modules covering various decision-making problems that organizational leaders will face in different roles and stages in their careers. We will cover problems from engineering, product development, marketing, sales, operations, finance, and customer behavior. The class will be hands-on and project-based, relying on real world case studies. Where possible, the modules in this course are facilitated by Jupyter notebooks, hence the programming language of choice is Python. The students will apply the learning from module and homeworks within a final group project of their choice.
Prerequisites: undergraduate linear algebra, statistics, and knowledge of python.
Last Four Terms Offered: Spring 2022
Learning Outcomes:

- Students demonstrate their ability to frame, implement, and solve various decision-making problems in Python.
- Students will identify and apply a subset of quantitative methods to facilitate a decision-making problem of their choice.
- Students will demonstrate their ability to understand the system before identifying or solving the problem.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5161 - Spacecraft Technology and Systems Architecture (4 Credits)
Crosslisted with MAE 5160
This course is a survey of contemporary space technology from subsystems through launch and mission operations, all in the context of spacecraft and mission design. It focuses on the classical subsystems of robotic and human-rated spacecraft, planetary rovers, and other space vehicles, as well as on contemporary engineering practice. This course includes an in-depth design activity suitable for MEng students. Topics covered include subsystem technologies and the systems-engineering principles that tie them together into a spacecraft architecture. Subsystem technologies discussed include communications, thermal subsystems, structure, spacecraft power, payloads (remote sensing, in-situ sensing, human life support), entry/descent/landing, surface mobility, and flight-computer hardware and software. The final project consists of architecting a complete spacecraft system with appropriate subsystems, with designs supported by parametric analysis and simulation.
Prerequisites: MAE 3260 and MAE 4060.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Students will be able to understand, at a higher systems level, space missions and systems, and how the space environment and mission requirements drive spacecraft design.
- Students will be able to understand the basic fundamentals of spacecraft subsystems, including propulsion, attitude determination and control, power, structures, thermal, communications, and command and data handling.
- Students will be able to understand typical practices for designing space systems in a contemporary context of US commercial space and government agencies.
- Students will be able to simulate a spacecraft in operation at the level of a Preliminary Design Review (PDR) using state of the art tools, and identify and characterize subsystems for a preliminary spacecraft design.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5170 - Energy Policies for Systems Transition (3 Credits)
How are policies defined and implemented? What role do policies play in the systems transition? Where and how to seize opportunities and foster sustainable solutions? How do technology developers, markets, companies and households respond to policy incentives? This course provides an understanding about the strategic role of policies, strategies and planning processes in international and national contexts with a strong focus on the world-critical topic of energy as the course's primary application area.Students will explore synergies between various sectors and learn how energy policies can help address broader environmental and socio-economic agendas. The course provides a solid basis for professionals from different backgrounds to understand energy policy either as planners, analysts or implementers of energy strategies with different stakeholder perspectives.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Understand the role of policies in addressing barriers and promoting a sustainable energy system transition.
- Analyze and compare energy systems and policy profiles at country level.
- Assess planning processes, policy goals and strategies, implementation and outcomes.
- Evaluate synergies between energy and other sectors, and the role of sectoral policies to address the energy transition while promoting renewables, resource efficiency and emissions reduction.
- Explain the perspective and roles of different stakeholders in energy policy formulation, implementation and system transformation.
- Propose policies and actions for system transformation, and critically evaluate ways to implement them and promote sustainable development.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5180 - Sociotechnical Systems and Policy (3 Credits)
This transdisciplinary course provides an in-depth learning experience on the fundamentals of sociotechnical systems, and welcomes students from all academic disciplines. Sociotechnical systems increase system complexity of engineered systems/technology, and this course teaches how to embrace them as part of systems engineering practice. An important dimension of sociotechnical systems is technology policy, and this course brings theory from social science disciplines and systems science together to evaluate how technical products interact with policy systems using systems engineering tools/analysis. Policy development, implementation and analysis in an engineering and technology context and its relationship with life cycle management, risk and quality are important themes in this course. There will be an application component to this class to illustrate the relevance for students from all backgrounds.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022
Learning Outcomes:

- Analyze engineered systems/technical products as embedded sociotechnical systems and their relationship to policy.
- Apply systems science to social science concepts and apply them in systems engineering tools and methods, including but not limited to: perception and identity; society and culture; and rural and urban spaces.
- Understand stakeholder engagement and how to practice inclusive, stakeholder-centric systems engineering and technology policy analysis.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5190 - Project Management of Complex Systems (4 Credits)
This course examines fundamental modern techniques of project management from a systems perspective, including project planning, organization, and control. Project management identifies, plans and coordinates activities required in order to deliver a satisfactory system, product, or service of appropriate quality, within the constraints of schedule, budget, resources, infrastructure, available staffing and technology. Topics include the management process, risk management, scheduling methodologies, management of project activities, and project control mechanisms. Complex systems are addressed at larger scales including combinations of novel, evolving, and legacy systems, implementing adaptive strategies and approaches. Case studies are used to examine application of principles. Complex system management, risk analysis and mitigation, integrated product and process development, quality management, and contracting are addressed. Complex system management also includes consideration of multiple disciplines, varying scales, uncertainty, and nonlinearity. Covers application of fundamental project management processes from traditional systems to more complex systems.
Last Four Terms Offered: Fall 2022
Learning Outcomes:

- Develop project management plans, processes and approaches and use appropriate tools for traditional and complex systems to control and monitor project management-related tasks.
- Explain project management organizations tailored to appropriate levels applying different types of approaches.
- Construct project breakdown structures, programmatic reviews, and milestones that translate system scope and requirements into an organized list of deliverables and tasks as part of a project plan.
- Analyze project uncertainty for cost, schedule and risk by applying mathematical techniques.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5200 - Systems Analysis Behavior and Optimization (3 Credits)
Crosslisted with CEE 5252, MAE 5920, ORIE 5142, ECE 5130
This is an advanced course in the application of analytical methodologies and tools to the analysis and optimization of complex systems. On completion of this course, students should be able to use probability and statistics as a modeling and analysis tool for systems exhibiting uncertainty; be able to use algorithms and dynamic programming to model and optimize systems with a recursive structure; be able to use optimization tools to optimize complex systems and tune parameters.
Prerequisites: ENGRD 2700, calculus skills, and familiarity with basic programming in a language such as python, C++, java, matlab, etc.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5210 - Economics of the Energy Transition (3 Credits)
Crosslisted with ENMGT 5200, CEE 5200
In response to the risks posed by global climate change, many states and countries have set emissions reductions goals necessitating a rapid transition toward zero-carbon energy resources. Achieving these goals entails unprecedented investment in civil infrastructure systems combined with large-scale consumer and industry adoption of clean energy solutions. This course will explore the economic challenges and opportunities associated with this transition, with an emphasis on the electric power sector. The course is broken into two halves. The first focuses on the economic viability of individual projects. The second develops system level models and considers interactions between competing energy sources.
Prerequisites: CEE 3040 or ENGRD 2700, CEE 3230 or ENMGT 5940.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5211 - Quantitative Methods for Systems Analysis (3 Credits)
This course will cover quantitative methods for analyzing and solving complex problems. Students will learn both classical and advanced methods, including linear and nonlinear programming, integer programming, heuristic algorithms, simulation, and multi-objective optimization. The course will also cover data-driven optimization to integrate uncertainty in decision-making. This leverages data analytics to enhance the accuracy and reliability of parameter estimation in optimization models. Through a combination of theoretical instruction and hands-on case studies, students will gain the skills to model, analyze, and solve optimization problems in various domains. Emphasis is placed on problem formulation, computational efficiency, and practical implementation using industry-standard tools.
Enrollment Information: Priority given to: Systems Engineering M.Eng. students.
Last Four Terms Offered: Spring 2026
Learning Outcomes:

- Understand and apply various optimization approaches to solve complex problems.
- Integrate uncertainty into decision problems using alternative solution approaches.
- Dynamically refine models as information gets revealed over time.
- Implement and evaluate optimization algorithms using software tools.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5220 - Systems Dynamics (3 Credits)
This course focuses on the design and development of computational models to understand and predict the dynamic behavior of systems. In particular considerable emphasis will be placed on the development of systems thinking skills in the analysis of systems, the translation of those skills into the creation of computational tools to support modeling of these systems and the testing of those models. Students will build realistic models in commercial software packages including Vensin.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5230 - Energy Efficiency in the Circular Economy (1.5 Credits)
On a net-zero emissions pathway, energy efficiency is a key component. This course discusses different angles to tackle energy efficiency, from energy-efficient technologies to energy and resource-efficient systems. Working with various sectors and case examples, students learn how to address energy efficiency within different systems' boundaries, tracking energy and resources in the circular economy. Students learn how to promote energy efficiency using a system approach and identifying entry points for building a circular economy. The course is designed for students from different backgrounds interested in the multiple dimensions of energy efficiency and implementation of a circular economy, particularly those from engineering.
Enrollment Information: Open to: Systems Engineering students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Learning Outcomes:

- Explain and contrast energy efficiency improvement potentials at unit and system levels. (i.e. product level, plant level, infrastructure system level).
- Analyze synergies between energy and material flows in the circular economy (as opposed to the linear economy).
- Define energy efficiency potentials and constraints using the circular economy framework.
- Explain system boundaries to explore energy efficiency in different sectors and propose actions for energy efficiency improvements.
- Critically review energy efficiency options considering multiple criteria including potential energy efficiency improvements at different levels, stakeholder perspectives, and contributions to the circular economy.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5240 - Strategies for Climate Action (1.5 Credits)
Scientific knowledge on climate change has expanded, policies have been put in place and a global agenda has evolved to engage multiple stakeholders in climate action. Various mechanisms and tools provide a framework for action. Understanding these mechanisms helps stakeholders define strategies, start projects, and become protagonists in climate mitigation and adaptation actions. This course provides analytical and practical knowledge on climate mechanisms and equips students to design climate projects and evaluate implementation pathways in the climate agenda. The focus is on energy-related projects and mitigation measures towards a low-carbon future. The course is designed for students from different backgrounds.
Enrollment Information: Open to: Systems Engineering students. Non-SYSEN students must request department permission.
Last Four Terms Offered: Fall 2025, Fall 2024
Learning Outcomes:

- Explain the roles of national and international stakeholders in the implementation of the global climate change agenda.
- Explain climate implementation mechanisms (i.e. finance, capacity building, technology transfer, reporting) and their role in addressing climate change and meeting the goals of international agreements (i.e. Paris Agreement).
- Analyze and compare climate strategies and climate-related actions and their effect.
- Design climate-mitigating projects in different sectors and demonstrate how they contribute to climate change mitigation.
- Calculate the effect of mitigation options (climate policy measures) using transparent and harmonized GHG accounting procedures.
- Propose strategies and actions for system transformation and explain how they contribute to addressing climate change.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5250 - Systems Integration, Verification, and Validation (3 Credits)
This course examines methods and approaches to integration, verification, and validation of complex systems. Systems integration focuses on the interfaces, data flows, and control mechanisms. Verification is the formal process of obtaining objective evidence that a system or system element, product or service fulfils its specified requirements and characteristics during the lifecycle. Validation is used to provide objective evidence that the system, product or service fulfills its business or mission objectives and stakeholder requirements, achieving its intended use in its intended operational environment. Topics include the processes for integrating, verifying, and validating a set of system elements into a system, system-of-systems, product or service that satisfies system stakeholder requirements, system requirements, architecture, and design. Statistical methods and modeling and simulation are presented as quantitative methods applied to system integration, verification, and validation. Complex systems are addressed at larger scales including integration, verification, and validation of combinations of novel, evolving, and legacy components, subsystems, systems, and systems-of-systems. Covers the application of methods and techniques from traditional systems to more complex systems including consideration of multiple disciplines, varying scales, and uncertainty.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Identify the key variables for integration, verification, and validation effectiveness.
- Apply appropriate methods and tools to systems and system-of-systems integration, verification, and validation
- Analyze system integration, verification and validation for system effectiveness and suitability, such as operational functionality, reliability, maintainability, human factors, producibility, interoperability, and supportability.
- Create architecture, design, and operational product or service models and simulations to test and evaluate system characteristics.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5260 - Software Systems Engineering: Design, Develop, and Deliver Software in the Modern Enterprise (3 Credits)
Students will learn how software is designed, developed, and delivered in the modern enterprise. This class will give project leaders the ability to effectively incorporate Software Engineering into a broader multidisciplinary Systems-Engineering project. Through a mix of principles and hands-on projects students will master the essential concepts and techniques for successful delivery of the software component of a broader Systems Engineering project. We will cover topics in software project management, development tools and environment, techniques for software integration and delivery, software systems architecture, cloud-computing, and designing for security and reliability.
Enrollment Information: Prerequisite: CS 1110 or equivalent.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Spring 2023
Learning Outcomes:

- Design and develop software using modern tools and best practices.
- Evaluate software architecture and design decisions.
- Participate in the delivery and deployment of an enterprise software solution.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5270 - Sociotechnical System Modeling and Simulation (3 Credits)
This transdisciplinary course provides an in-depth learning experience on the fundamentals of the modeling and simulation of social and sociotechnical systems. This course welcomes students from all academic disciplines (especially outside of engineering) if they have had experience with system architecture and/or systems thinking in any domain application. System perspectives are increasingly being used to engage with the complexity of environmental, social, economic and cultural dimensions of technology, and simulation is a powerful tool in the development of policies that affect these dimensions. Students do not need to have strong computational experience before taking this course, but they need to have a strong systems background. Using system dynamics modeling, this course teaches how to develop simulations of the sociotechnical dimensions of technology design, development and implementation with a strong focus on inclusive, participatory, stakeholder-centric modeling (e.g., Living Labs). In a hybrid asynchronous lab-based environment, students in this course will gain practical skills in using a modeling process to develop models and simulations of sociotechnical systems.
Prerequisites: SYSEN 5180.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5280 - Adaptive and Learning Systems (3 Credits)
Crosslisted with MAE 5280, MAE 6280
This course focuses on the design and development of self-awareness and learning models to understand and predict the dynamic behavior of systems. In particular considerable emphasis will be placed on the development of critical thinking skills in the analysis of time-varying systems in response to system data. Students will be provided prototype computer code to help them build realistic models from first principles in MATLAB/SIMULINK without commercial software packages. The goal is for students to leave the course with the independent ability to utilize learning systems to analyze and predict behavior of systems without the aid of any tailored commercial software package.
Prerequisites: knowledge of linear regression and matrix operations.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020
Learning Outcomes:

- Identify variation of systems from data.
- Analyze system variation from data.
- Demonstrate application of system learning for decision and control.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5290 - Transdisciplinarity and Systems (3 Credits)
Transdisciplinarity involves gaining insights about patterns that occur across or connect disciplines. The course presents multiple perspectives to study the nature, scope, value, and potential of transdisciplinarity as there is no existing universal definition, theory, or methodology. The course examines several kinds of disciplinarity as approaches to problem solving. Problems are investigated in the areas of society, engineering, and nature. Topics include characteristics, management, methodologies, analysis, and tools for understanding and applying approaches. Complex systems are addressed with consideration of interdisciplinary systems, systems-of-systems, varying scales, uncertainty, and nonlinearity.
Enrollment Information: Open to: graduate students.
Last Four Terms Offered: Fall 2024, Spring 2024
Learning Outcomes:

- Identify disciplinarity of various systems.
- Develop transdisciplinary methods for defining, describing, and analyzing systems.
- Demonstrate transdisciplinary approaches to solving systems problems.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5300 - Systems Engineering and Six Sigma for the Design and Operation of Reliable Systems (3-4 Credits)
Crosslisted with MAE 5930
Develops skills in the design, operation and control of systems for reliable performance. Focuses on four key themes; risk analysis (with a particular emphasis on risk assessment and risk characterization), modeling system reliability (including the development of statistical models based on accelerated life testing), quality control techniques and the optimization of system design for reliability. Six Sigma Green or Blackbelt can be earned through activities associated with course. Students in distance-learning programs enroll in SYSEN 5100.
Prerequisites: ENGRD 2700 or CEE 3040, SYSEN 5100, or permission of instructor.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5330 - Software Systems Engineering (3 Credits)
Last Four Terms Offered: Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5340 - Digital Twins of Future Systems (3 Credits)
In this course students learn how to setup a mathematical simulation model to predict the system outcomes based on variable data. To be an expert in DT one need to know about data science, predictive analytics, machine learning, and artificial intelligence. Digital Twin can be thought of as a bridge between the physical and digital system. The virtual presentation of a physical system enables us to link all steps of a process including input supply, production process, performance evaluation, and customer satisfaction. DT allows us to analyze the data and monitor a system, so to head off problems before they occur. Thus, mangers will be able to consistently improve efficiency of a system by reducing its failure rates. This can open up new business opportunities.
Prerequisites: STSCI 2100.
Last Four Terms Offered: Spring 2021
Learning Outcomes:

- Collect and analyze data to evaluate system performance.
- Mathematically model systems.
- Design digital twins of complex systems.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5350 - Multidisciplinary Design Optimization (4 Credits)
Crosslisted with MAE 5350
This course presents a rigorous, quantitative multidisciplinary design methodology that incorporates the creative side of the design process. Through a topic of your choice, learn how to use multidisciplinary design optimization (MDO) to create advanced and complex engineering systems that must be competitive in performance and life-cycle value. Multidisciplinary design aspects appear frequently during the conceptual and preliminary design of complex new systems and products, where different disciplines (e.g. structures, aerodynamics, controls, optics, costing, manufacturing, environmental science, marketing, etc.) have to be tightly coupled in order to arrive at a competitive solution. This course is designed to be fundamentally different from most traditional university optimization courses which focus mainly on the mathematics and algorithms for search. Focus will be equally strong on all three aspects of the problem: (i) the multidisciplinary character of engineering systems, (ii) design of these complex systems, and (iii) tools for optimization. Students will demonstrate mastery of the subject by working in small teams on a term project to apply the multidisciplinary design optimization principles to design and optimize an engineering system of their choice.
Prerequisites: undergraduate linear algebra and knowledge of MATLAB, Python or R.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Fall 2021
Learning Outcomes:

- Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model.
- Identify the most suitable optimization algorithm between gradient-based numerical optimization algorithms (i.e. sequential quadratic programming (SQP)) and various modern heuristic optimization techniques (i.e. simulated annealing (SA) or genetic algorithms (GA)) for their design problem and use it to find the optimal design for a single objective of their choice.
- Critically evaluate and interpret analysis and optimization results, including sensitivity analysis and exploration of performance, cost and risk tradeoffs.
- Utilize basic concepts of multi-objective optimization, including the conditions for optimality and Pareto front computation techniques, to optimize their design with respect to two objectives of their choice.
- Work as a team to formulate a realistic engineering design problem, optimize the design for a single objective and multiple competing objectives, and present the results in a final oral presentation and written report.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5360 - Design and Construction of IoT Devices (4 Credits)
This class provides a hands-on introduction to the design of Internet-of-Things (IoT) devices using microprocessor-based embedded controllers. Students will design, debug and construct real-time IoT digital systems that illustrate and employ techniques of systems engineering. Special emphasis will be placed on communications hardware, network connectivity and network security.
Last Four Terms Offered: Spring 2022
Learning Outcomes:

- Student will be comfortable working with and selecting different microcontrollers, sensors, actuators and other hardware components as appropriate for an application.
- Students will be cognizant of the various engineering tradeoffs between different communication technologies used in IoT devices.
- Students will be able to demonstrate basic understanding of computer network systems.
- Students will be able to analyze and identify common security-related issues pertaining to the design of IoT devices.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5371 - Circular Systems (3 Credits)
Crosslisted with GDEV 5900
This transdisciplinary project-based course features small teams advancing technology and policy for the circular economy using the Cornell Campus as a living lab. Students are first grounded in concepts of circular economy, industrial ecology and systems engineering. Using this knowledge, students will be developing simulation models as part of the course using system dynamics modeling. All modeling and simulation are taught from the ground up, and students do not need to have a strong computational background before taking this course. Please note that the distance learning is only available for the graduate level.
Last Four Terms Offered: Spring 2025, Spring 2024
Learning Outcomes:

- Describe, explain and discuss the central principles of the circular economy. Apply these concepts in real-world applications.
- Use a system model to evaluate social and environmental impact and to develop ideas and strategies for making change. Students will design plans for increasing circularity on campus, identifying barriers and thresholds for a more sustainable campus systems.
- Demonstrate their ability to apply the results of life cycle assessment and material flow analysis in different domain applications.
- Build networks and coalitions for change. By connecting with experts in their fields of interest. Students will gain advisors and mentors to guide them as they develop their projects, building a collective network to advance circular economy at Cornell (CE@CU).
- Produce ethical modeling deliverables that evaluate marginalization of stakeholder groups in the lifecycle of technology.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5380 - Collective Intelligence (3 Credits)
The field of collective intelligence studies how groups solve problems. You'll learn what creates the wisdom of crowds and intelligent groups; analyze real management, engineering, & computing processes; and design new collective intelligence studies or techniques.
Last Four Terms Offered: Spring 2026, Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5381 - Data Science and AI for Systems Engineering: APIs, Apps, and Analytics for Cloud Systems (3 Credits)
Modern engineering systems increasingly rely on cloud-based, AI-driven data processing, automation, and analytics. This course equips Systems Engineering students with the coding skills needed to interact with cloud-hosted data, automate workflows, and build scalable AI-powered apps and analytics. Students will gain hands-on experience in querying web APIs, building APIs, and leveraging AI models for automation. Topics include API calls, querying Generative AI, and automation, all to serve automated data reporting. Participants will learn to examine and critique uses of AI in modern systems, considering risk, value, tradeoffs, and policy issues for the customer and society. By the end of the course, students will have built cloud-hosted, AI-powered applications and reporting systems that can dynamically retrieve, process, and visualize data using generative AI.
Prerequisites: At least one course of prior programming experience (Python, R, Java, etc.), such as SYSEN 5151 or SYSEN 5300.
Enrollment Information: This course is intended to be the sequel to the coding work done in SYSEN 5151. Priority given to: Systems Engineering M.Eng. Students.
Last Four Terms Offered: Spring 2026
Learning Outcomes:

- Design data pipelines that interact with public and private APIs to retrieve, process, and analyze structured data for engineering applications.
- Build REST APIs to automate data analytics and AI operations.
- Build AI-powered applications using queries to generative AI models and prompt engineering.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5390 - Cybersecurity for Cyber-Physical and Aerospace Systems (3 Credits)
Crosslisted with MAE 5390
The goal is to identify and analyze the unique cybersecurity challenges faced by cyber-physical systems, particularly within the constraints of assets like space systems and their infrastructure. The course will then focus on applying practical mitigation techniques to enhance the security of such critical infrastructure operations.
Prerequisites: SYSEN 5100 and MAE 5160.
Last Four Terms Offered: Spring 2026, Spring 2025
Learning Outcomes:

- Engineer an attack against a cyber-physical system using methods and frameworks discussed in class.
- Explain the motivations of attackers, the unique security challenges of cyber-physical systems and the expansive surface areas that attackers are interested in as both targets and vectors.
- Identify opportunities to infuse practical, implementable low-hanging fruit security practices into space system development processes.
- Articulate future cyber-physical system capabilities and propose how these assets and their services will need to be secured.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5400 - Theory and Practice of Systems Architecture (3 Credits)
Crosslisted with MAE 5950
Every system has an architecture (its essence, or DNA), i.e., a high-level abstraction of its design that provides a unifying concept for detailed design and commits most of the system's performance and lifecycle cost. This course presents the frameworks, methods, and tools required to analyze and synthesize system architectures. The course has a theory part that emphasizes synergies between humans and computers in the architecture process, and a practical part based on a long project and guest lectures by real system architects. The theory part covers topics such as architecture views, layers and projections, stakeholder networks, dealing with fuzziness, automatic concept generation, architecture space exploration, patterns and styles, heuristics, and knowledge engineering. The practice part focuses on special topics such as commonality, platforming, reuse, upstream and downstream influences, and software architecture.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5410 - Cyber-Physical Systems (4 Credits)
Cyber-Physical Systems (CPS) is a comprehensive course designed for students interested in the integration of computational and physical systems. It covers core concepts such as sensors, actuators, communication protocols (e.g., I2C, SPI, Wi-Fi, Bluetooth), signal processing, computer vision, and control algorithms essential for modern systems like autonomous vehicles, smart grids, and robotics. Through hands-on labs, students will gain practical experience in programming microcontrollers (Raspberry Pi Pico W), system integration, and problem-solving by implementing an autonomous robotic platform (Sparkfun XRP). The course emphasizes design trade-offs, systems architecture, and adaptability to new technologies, preparing students for careers in industries where CPS is increasingly critical. Whether you're a systems engineer, or someone passionate about integrating emergent technologies to solve real-world problems, this course equips you with the tools to tackle complex, interdisciplinary challenges in CPS.
Prerequisites: must have familiarity with C++ and Python.
Last Four Terms Offered: Spring 2026, Spring 2025
Learning Outcomes:

- Demonstrate proficiency and familiarity with a broad range of technologies used in cyber-physical systems.
- Be able to analyze complex cyber-physical systems and design subsystems, interfaces, and broader system architecture.
- Analyze design trade-offs within a cyber-physical system to optimize system performance and meet end user requirements.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5411 - Introduction to Robotics (1 Credit)
Last Four Terms Offered: Fall 2025
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5412 - Creating Solutions with Embedded Systems (1 Credit)
This introductory course is designed for on-campus and distance learning students to learn the fundamentals of embedded systems, emphasizing microcontroller-based design, programming, and debugging. Students will explore the role of embedded systems in modern technology, learning how to interface with sensors, actuators, and communication protocols such as UART, SPI, and I2C. The course follows a hands-on approach, culminating in a project where students build a digital theremin using Python. Topics include GPIO control, interrupts, real-time operating systems, pulse-width modulation, filtering, and direct memory access. The course also integrates SYSEN principles, on how to define user stories, interface requirements, and performance metrics. Through lessons and practical applications, students will develop a foundation in embedded system development, preparing to collaborate effectively with embedded systems experts in industries.
Enrollment Information: Enrollment limited to: Systems Engineering Master of Engineering students, on-campus and distance learning.
Distribution Requirements: (CE-EN)
Last Four Terms Offered: Fall 2025
Learning Outcomes:

- Identify and describe key components of embedded systems, including microcontrollers, sensors, and communication protocols.
- Analyze and implement embedded system programming techniques, including GPIO control, interrupts, and real-time operating concepts.
- Demonstrate the ability to design and develop an embedded system project, applying systems engineering principles to define requirements and evaluate performance.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5413 - Make it Smart — Fundamentals of IoT (1 Credit)
This 1-credit, introductory-level course is designed for on-campus and distance learning students and introduces them to the fundamentals of IoT, connectivity, and smart devices. Students will explore how embedded systems, sensors, and networks combine to create intelligent, connected systems that are now central to industries such as agriculture, healthcare, manufacturing, and consumer technology. Through a blend of lectures and hands-on exercises, learners will gain practical experience programming microcontrollers, collecting and transmitting sensor data, and visualizing information on cloud dashboards. Special emphasis will be placed on understanding IoT-specific protocols, resource constraints, and basic security practices to ensure safe, efficient, and reliable systems. By the end of the course, students will have the confidence to design simple IoT prototypes, understand where IoT technology is headed, and recognize the opportunities and challenges that come with a rapidly expanding connected world.
Last Four Terms Offered: Spring 2026
Learning Outcomes:

- Identify the fundamental components of an IoT system, including embedded devices, sensors, communication protocols, and cloud services.
- Analyze data flows within IoT architectures, explaining how information moves from physical devices through networks to cloud platforms and applications.
- Demonstrate the ability to design and prototype a simple IoT solution by integrating sensors with a microcontroller, transmitting data to a cloud service, and visualizing it on a dashboard.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5420 - Network Systems and Games (3 Credits)
Network systems pervade our society in both social and technological contexts. On the one hand, social networks play a central role in the transmission of information and viruses with fundamental consequences for product marketing, technology adoption, voting decisions, spread of false news and epidemiology. On the other hand, network topology fundamentally affects the performance and resilience properties of large-scale multi-agent systems, such as the electric power grid, the internet of things, traffic or robotic sensor networks.The main objective of this course is to introduce fundamental mathematical tools to model and control the behavior of both social and engineered network systems. Questions of interest will be how the network structure impacts the dynamics of network systems, how network properties can be exploited to maximize system performance or resilience and how one can address these questions while accounting for strategic human behavior. The course will introduce tools that can be used to address these questions and overcome challenges related to the coupled, distributed, and large-scale nature of network systems.
Prerequisites: MATH 2930, MATH 2940,ECE 2720, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Fall 2021
Learning Outcomes:

- Understand how to mathematically describe network interactions.
- Analyze linear and nonlinear dynamics over networks.
- Understand and analyze strategic behavior over networks.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5430 - Decision Making under Uncertainty (3 Credits)
Last Four Terms Offered: Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5440 - System Analysis and Design (3 Credits)
This course examines the time-dependent behavior of managed systems to describe, analyze, and understand them. Students will first learn concepts of feedback and system structure and apply these to problem identification. Qualitative and quantitative mental models will be used to define and describe interrelationships that define the system behavior. Principles of how to intervene in a system will also be discussed in this course. Simulation approaches for both discrete and continuous processes will be utilized to set baseline performance metrics and likewise quantify the effects of the identified interventions.
Last Four Terms Offered: Fall 2024
Learning Outcomes:

- Recognize historical data sets and differentiate modeling approaches for dynamic and static systems.
- Define system structure with mental models.
- Demonstrate the ability to verify and validate simulation models.
- Design and quantify the effects of policy interventions.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5450 - Industrial Blockchain Systems and Applications (3 Credits)
Last Four Terms Offered: Spring 2026, Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5460 - Data Science for Socio-Technical Systems: Decision-Making and Data Communication at Scale (3 Credits)
Last Four Terms Offered: Spring 2026, Summer 2025, Summer 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5470 - Network Science and Applications for Systems Engineering (3 Credits)
Modern engineering systems—like supply chains, power grids, and logistics networks—rely on complex, interconnected networks. This course trains Systems Engineers to model, analyze, and optimize these systems using network science, statistics, machine learning, and AI. Students gain hands-on experience with network visualization, clustering, routing optimization, and performance modeling under uncertainty. Case studies include logistics networks, power grids, data centers, and crisis response systems. Participants will learn to identify critical nodes, simulate and optimize flows, and communicate results through interactive visualizations. By course end, students will develop complete network analysis workflows connecting theory to systems engineering practice. Designed for graduate students in technical roles, the course requires 3–4 hours of work per credit hour.
Learning Outcomes:

- Analyze network data and structure – process and analyze network datasets using relational databases and network analysis libraries to understand system connectivity and topology.
- Visualize and communicate network insights – create publication-quality network visualizations to communicate complex network relationships to stakeholders.
- Measure network centrality and importance – apply centrality measures and network statistics to identify critical nodes, edges, and system vulnerabilities across different network types.
- Model network dynamics and outcomes – develop network models to predict edge and node-wise outcomes, including network permutation tests and statistical validation.
- Optimize network routing and flows – solve routing problems and network optimization challenges for transportation, logistics, and information flow systems.
- Apply network clustering techniques – use clustering algorithms to identify communities, groups, and hierarchical structures within complex networks.
- Use machine learning and statistics for network analysis - compare value-added of new machine learning and AI approaches to network inference against network statistical frameworks.
- Build network analysis codes and procedures to communicate network insights for data-driven decision-making.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5480 - Human-Centered Design for Change in Complex Systems (3 Credits)
Bringing about change in ourselves, our teams, our organizations and the complex systems we inhabit and interact with each day can be a challenging undertaking. This interdisciplinary course brings together conversations, theories, and methodologies from design, organizational behavior, human factors, and systems engineering to consider how we might approach change efforts in a manner that considers the complexity of the system and the individuals who affect and are affected by it. Individually and in small teams, students will critically examine stakeholders and systems at a range of scales, starting from a single person to large-scale systems with diverse stakeholder groups. A variety of large-scale systems will be explored, including but not limited to education, healthcare, and energy. Throughout the course, students will engage with methods for deeply understanding system stakeholders, approaches to systems analysis and modeling, change theories, and well-documented change processes.
Last Four Terms Offered: Spring 2025
Learning Outcomes:

- Articulate the similarities and differences among diverse approaches and perspectives on change in complex systems.
- Analyze existing complex systems and identify system and stakeholder constraints that may support or inhibit change and identify insights about the complex system and stakeholder groups under consideration.
- Apply systems engineering, design, organizational change approaches that account for contextual characteristics of the system and appropriate theoretical understanding of the system to propose and enact a change within the system.
- Design, prototype, reflect on, and redesign a team experience to account for individual and collective growth and development and an overall positive team experience.
- Communicate the motivation for, approach to, and implications of a particular change effort through a diverse set of mediums and to a diverse set of interested groups.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5490 - Digital Twins and Model-Based Systems Engineering (3 Credits)
This course introduces students to the concepts of Digital Twins and Model-Based Systems Engineering, exploring their applications in modern engineering practices. Students will learn how to create and utilize digital representations of physical systems to optimize design, testing, and operation processes.
Prerequisites: SYSEN 5100 or SYSEN 6150.
Last Four Terms Offered: Spring 2026, Spring 2025
Learning Outcomes:

- Apply MBSE techniques to engineering problems.
- Analyze and interpret data from digital twin simulation.
- Evaluate the potential of digital twins in various industries.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5492 - Cybersecurity for Systems Engineering (3 Credits)
Enrollment Information: Enrollment limited to: Systems Engineering Master of Engineering students, on-campus and distance learning.
Distribution Requirements: (CE-EN)
Last Four Terms Offered: Fall 2025
Learning Outcomes:

- Identify and assess cybersecurity threats and vulnerabilities in engineering systems.
- Design and implement secure system architectures using industry-standard frameworks.
- Demonstrate proficiency in employing computational tools for cybersecurity simulation and risk analysis.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5493 - Coding with Generative AI for Systems Engineers (1 Credit)
Coding with Generative AI for Systems Engineers is a 1-credit course that introduces students to the use of generative artificial intelligence tools for coding tasks in systems engineering. Students learn how to leverage AI coding assistants (such as large language models) to generate, refine, and debug code, and to integrate these models into engineering workflows. Topics include prompt engineering for code generation, the use of AI in model-based systems engineering, and understanding the limitations and ethical considerations of AI-generated code. Through lectures and small hands-on projects, students gain practical experience employing generative AI to solve real-world engineering problems. The course culminates in a final project where students demonstrate AI-assisted coding in a systems context. This course equips future systems engineers with essential skills in AI-augmented software development.
Enrollment Information: Priority given to: Systems Engineering M.Eng. students.
Last Four Terms Offered: Spring 2026
Learning Outcomes:

- Identify and explain the capabilities and limitations of generative AI tools for coding tasks within systems engineering projects.
- Apply prompt engineering techniques and generative AI models to generate, debug, and optimize code as part of solving systems engineering problems.
- Develop a small-scale project integrating AI-generated code into a systems engineering application, and evaluate the results, including ethical considerations of AI-assisted development.

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SYSEN 5500 - Systems Modeling Language: Fundamentals and Practice (2 Credits)
Fundamentals and practice of Systems Modeling Language (SysML) for graphically specifying, analyzing, designing, and verifying complex systems. The focus and vision is on building unambiguous and computable models of systems behavior and structure that capture systems requirements and specifications.
Course Fee: Course Fee, TBA. TBA.
Exploratory Studies: (CU-CEL, CU-ITL, CU-SBY, CU-UG)

Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5530 - Digital Systems Modeling with Generative AI (3 Credits)
Digital Systems Modeling with Generative AI focuses on the integration of digital technologies in the design, simulation, and management of complex systems. The course covers key concepts such as Digital Twins, Cyber-Physical Systems (CPS), and Digital Threads, with a strong emphasis on real-time simulation, data-driven modeling, and the application of Artificial Intelligence. Students will collaboratively address complex engineering challenges, allowing them to refine their problem-solving skills, apply recent technologies, and explore the practical implications of their designs in real-world scenarios. The course includes guest lectures from industry experts, providing insights into emerging trends in smart cities, IoT, and industrial applications of Digital Twins. By the end of the course, students will have gained practical skills in building and optimizing digital systems for modern engineering challenges.
Last Four Terms Offered: Fall 2025, Spring 2025
Learning Outcomes:

- Develop a comprehensive model and system, including its concept and functional operations
- Explain concepts of digital twins and digital threads and their applications in modern systems engineering
- Develop and deploy Generative Agents and AI in digital systems for real-time applications.
- Analyze real-world case studies to understand the role of digital technologies in industries
- Design, manage, and optimize digital threads and systems through hands-on projects. Assess the ethical and responsible use of AI in generative agents and digital systems.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5600 - System Integration, Verification, and Validation (3 Credits)
The System Integration, Verification, and Validation course covers the realization part of the systems engineering process. This course has been designed to be taken concurrently with SYSEN 5100, following the same top-down approach. This allows the students to work on the same type of problems, from two different perspectives, at the same time in the Fall semester. While an introduction to the definition part of the systems engineering process is provided, the focus is to equip the students with the tools and mindset that allow them to be sure that the system of interest is built correctly and satisfies the stakeholder needs. The successful student will understand the importance of proper planning for verification and validation activities and will learn best practices for design and management of large-scale testing. The course is also built with an eye on innovative approaches to system realization and state-of-the-art practices such as continuous early validation, and continuous integration.
Last Four Terms Offered: Fall 2020
Learning Outcomes:

- Identify the various phases of the systems engineering process and the specific role of integration, verification, and validation.
- Recognize the relationship of integration, verification, and validation to system architecture, requirements, and stakeholder needs.
- Plan and manage processes for systems integration, verification, and validation.
- Analyze the impact of integration, verification, and validation activities on program risk.
- Demonstrate proficiency in tools and methods for verification and validation.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5610 - Introduction to the US Healthcare System, Data, and Interoperability (3 Credits)
In a modern healthcare system, exchange of clinical data across multiple stakeholders - between healthcare organizations, between providers and patients, and among agencies and governmental entities - is pivotal. Health information standards provide the backbone to achieve uniform data interoperability and exchange across multiple heterogeneous systems. This course will introduce various existing and emerging clinical data modeling, terminology and knowledge representation standards that are part of Meaningful Use Regulations, and discuss scenarios and use cases where the standards have been applied for routine clinical practice and research. Through lectures, case studies, midterm, and a final project, students will gain insights into topics such as disease classification systems, health information exchanges, and electronic health records (EHR) interoperability.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2024
Learning Outcomes:

- Identify and describe the clinical data and interoperability standards.
- Discuss practical applications and implementation scenarios using health information standards.
- Analyze and synthesize policies for standards-based health information exchange for research and clinical care.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5620 - Health Data Management and Analytics (3 Credits)
Last Four Terms Offered: Fall 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5630 - Clinical Natural Language Processing and Large-Language Models (3 Credits)
Natural Language Processing (NLP) is a pivotal technology in artificial intelligence. Its significance has noticeably amplified within the medical field in recent years, as vast amounts of unstructured text data await analysis from databases such as Electronic Medical Records, biomedical literature, and clinical trials. Moreover, the advent of technologies like ChatGPT and other Large Language Models (LLMs) holds the promise of vastly transforming research methodologies and clinical practice. This course aims to provide students comprehensive knowledge of Natural Language Processing, generative AI, and related health applications. Students will learn about various text data sources, integral linguistic structures, and a range of processing methods.
Last Four Terms Offered: Spring 2026, Spring 2025
Learning Outcomes:

- Describe different applications of natural language processing in health.
- Identify sources of unstructured data (corpora).
- Analyze unstructured data in terms of linguistic structures.
- Apply pre-processing methods to prepare unstructured data for analysis.
- Define different kinds of structural and statistical features of unstructured data and apply methods for extracting them.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5640 - AI for Healthcare System Engineering (3 Credits)
The purpose of this class is to teach students the fundamentals of artificial intelligence (AI) technologies and how they can be applied in various healthcare system engineering problems. We will introduce conventional AI technologies including supervised learning for tasks like clinical risk prediction and computer assisted diagnosis, unsupervised learning methods for subtype identification and pattern discovery; as well as deep learning methods, including the basic perceptron and feedforward neural networks for standard vectorized data, convolutional neural networks for analyzing medical images, recurrent neural networks and transformer for analyzing event sequences and temporal signals, and graph neural networks for analyzing networks and relational data. The class includes both lectures introducing algorithms and theories, and programming exercises to get hands-on experience on implementing these algorithms with Python.
Last Four Terms Offered: Spring 2026, Spring 2025
Learning Outcomes:

- Analyze health system engineering problems and their typical setups.
- Identify and implement appropriate machine learning algorithms for solving different health system engineering problems.
- Analyze the results of machine learning solutions and demonstrate their effectiveness.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5650 - Programming Essentials for Health AI and Data Science (3 Credits)
The course "Programming Essentials for Health AI and Data Science" is designed for advanced students and clinicians seeking to develop programming expertise in healthcare applications. This course provides hands-on experience with Python, Pytorch, data science/ machine learning libraries, LLM and agents techniques, focusing on real-world health data, including EHRs, medical imaging, and clinical text. Participants will explore AI models for disease prediction, causal inference, and natural language processing etc. The course emphasizes practical implementation, from preprocessing messy health data to deploying AI models in clinical settings. Capstone projects will apply AI to real-world health challenges.
Enrollment Information: Enrollment limited to: Systems Engineering Master of Engineering students, on-campus and distance learning.
Distribution Requirements: (CE-EN)
Last Four Terms Offered: Fall 2025
Learning Outcomes:

- Demonstrate the ability to preprocess, clean, analyze, and visualize real-world health datasets, including EHRs, medical imaging, and clinical text, using Python and data science libraries.
- Identify and utilize appropriate Python/PyTorch development environments, tools, and libraries for implementing machine learning and deep learning techniques. These methods will be applied to health-related challenges such as disease prediction, computational phenotyping, effect estimation, classification, clustering, predictive modeling, and causal inference.
- Demonstrate essential programming skills for advanced studies in fields like AI/ML in medicine, and NLP for healthcare, among others.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5680 - Optimal Control and Decision Theory (3 Credits)
Crosslisted with CEE 6680, SYSEN 6680
Covers the basic models and solution approaches for individual and team decision-making problems under uncertainty and provide a unified mathematical treatment of the subject, suitable for a broad engineering audience. The material will consider optimal decision-making of systems over a finite- and an infinite-time horizon. Topics include: (1) Stochastic optimization: finite- and infinite-horizon problems with complete or partial state information, separation principle, dual control; (2) Team Theory: mathematical framework of cooperating members in which all members have the same objective yet different information; (3) Reinforcement learning: approximate dynamic programming, forward references to the approximate dynamic programming formalism, learning policies.
Enrollment Information: Primarily for: graduate students.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5690 - Information Design for Strategic Decision-Making (3 Credits)
Crosslisted with CEE 6690
The course covers the basic models and solution approaches in problems that involve interactions among strategic agents distilling the key results in mechanism design theory. Over the last seventy years, the theory of mechanism design was developed as an approach to efficiently align the individuals' and system's interests in problems where individuals have private preferences. It can be viewed as the art of designing information and protocols to achieve a desired outcome. Mechanism design has broad applications spanning many fields, including transportation routing, smart grid, communication networks, social media, online advertising, and resource allocation problems. The objective of this course is to gain a sound understanding of the science behind the use of mechanism design in solving modern problems that involve strategic interactions among agents. The course will provide a unified treatment of the subject, suitable for a broad engineering audience.
Last Four Terms Offered: Fall 2024
Learning Outcomes:

- Formulate a mechanism design problem, identify the set of outcomes, and define the social choice function.
- Identify whether a direct or indirect mechanism is appropriate to use for a given problem.
- Implement a social choice function using different solution concepts, e.g., dominant strategy implementation, Bayesian Nash implementation, etc.
- Solve resource allocation problems using mechanism design.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5700 - Special Topics in Systems Engineering (1-6 Credits)
Supervised study by individuals or small groups of one or more specialized topics not covered in regular courses.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5740 - Design Thinking for Complex Systems (2 Credits)
In this project-based class, interdisciplinary teams will combine design thinking and systems engineering techniques to define and solve complex systems and organization problems. Throughout the entire design process (from fieldwork to brainstorming, prototyping and testing) students will benefit from systems engineering tools in capturing and organizing essential information. Direct interaction with real sponsors, stakeholders and final users is an important part of this class.
Prerequisites: SYSEN 5940 for Distance Learning students in Systems Engineering. No prerequisite for on campus students.
Course Fee: Course Fee, TBA. TBA.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5800 - Computational Optimization (4 Credits)
Systems optimization modeling, computation, and applications. Includes theory and algorithms of linear, nonlinear, mixed-integer linear, mixed-integer nonlinear, and deterministic global optimization, as well as stochastic programming, robust optimization and optimization methods for big-data analytics. Real-world applications of large-scale computational optimization in process manufacturing, bioengineering, energy systems, and sustainability.
Prerequisites: MATH 2220 and MATH 2940.
Enrollment Information: Enrollment preference given to: Systems Engineering Distance Learning students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5830 - Astronautic Optimization (3 Credits)
Crosslisted with MAE 5830
This course provides a brief review of several topics in sufficient detail to amplify student success: estimation, allocation, and control; classical feedback; sensor noise; and Monte Carlo analysis. The review leads to application of the methods of Pontryagin applied to examples including single-gimballed rocket engines, guidance, and control problems including least squares estimation, and the famous Brachistochrone problem as a motivating example illustrating the minimum time solution is not necessarily the minimum path-length solution, particularly in a gravity field. After taking this course, students will be able to apply their expertise to actual systems in advanced courses or in laboratory settings leveraging analytic (non-numerical) nonlinear programming and real-time optimal control. Graduates will understand the application of constrained (smooth constrained, box constrained, with brief introduction to inequality constrained) and unconstrained optimization; linear-quadratic programming; and Bellman's principle of optimality.
Prerequisites: undergraduate-level coursework in dynamics, calculus (understanding of extrema), and classical feedback control or system dynamics. Recommended prerequisite: coursework or understanding of spacecraft attitude control or rotational mechanics.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- The student will be able to apply their expertise to actual systems in space in advanced courses or in spacecraft attitude control laboratory settings leveraging nonlinear programming and real time optimal control.
- The student will be able to understand the application of constrained (smooth constrained, box constrained, inequality constrained) and unconstrained optimization.
- The student will be able to understand the application of linear-quadratic programming; and Bellman's principle of optimality; all strictly applied to the problem of spacecraft attitude control.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5840 - Introduction to Technical Management (3 Credits)
This course is taught from the perspective of a chief technology officer and is targeted at M. Eng. and management students interested in real world problems. It provides an introduction via case examples to the technical, management, and organizational issues of developing and marketing products in high-tech businesses. The focus is on the unique nature of this type of business, including managing with high risk/uncertainty levels, learning to manage very diverse project teams, and recognizing technical versus market success in order to make good business decisions.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Learning Outcomes:

- Be able to articulate the personal characteristics required for leadership in a technical organization. Recognize the forces that define industry success and determine how they influence behavior. Define the complexity of today's technical environment and present a strategy for successfully competing against established leaders and innovative newcomers. Define the strategy for a technical company and be able to apply it. Analyze complex technical/business situations which need to be managed and controlled for success. Gain experience working with leading tools for planning and management. Acquire the ability to make effective written and oral presentations. Resolve Problems that do not lend themselves' to well defined outcomes.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5880 - Industrial Big Data Analytics and Machine Learning (4 Credits)
This course covers the basic concepts, models and algorithms of Bayesian learning, classification, regression, dimension reduction, clustering, density estimation, artificial neural networks, deep learning, and reinforcement learning. Application and methodology topics include process monitoring, fault diagnosis, preventive maintenance, root cause analysis, soft sensing, quality control, machine learning for process optimization, data-driven decision making under uncertainty, missing data imputation, data de-noising, and anomaly/outlier detection.
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5888 - Deep Learning (4 Credits)
Covers the basic concepts, models, methods, and applications of deep learning. Topics include basics of artificial neural networks, training of neural networks, convolutional neural networks, recurrent neural networks, generative models, deep reinforcement learning, and deep learning hardware and software packages. Application and methodology topics include deep learning for pharmaceutical discovery, deep learning for process control, deep learning for molecular design, deep learning for material screening, deep learning for product yield and quality estimation, and deep learning for optimization.
Last Four Terms Offered: Spring 2026, Spring 2025, Fall 2023, Summer 2021
Learning Outcomes:

- Analyze and understand modern deep learning models, algorithms, and applications.
- Demonstrate ability to develop deep learning models and algorithms for real-world applications.
- Demonstrate ability to apply deep learning to solve application problems.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5900 - Systems Engineering Design Project (1-6 Credits)
A design project that incorporates the principles of systems engineering for a complex system. Projects are performed by teams of students working together to meet the requirements of the project.
Last Four Terms Offered: Spring 2026, Fall 2025, Summer 2025, Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5920 - Systems Engineering Management for Virtual Teams (1 Credit)
First of two one-week intensive experiential courses (35 hours) in systems engineering management, with emphasis on laying the social groundwork for students to conduct projects in geographically dispersed teams. Course involves a significant design challenge that must be completed within the week. A leadership laboratory is run simultaneously with the design experience to encourage students to self-assess their leadership style and practices in systems engineering projects.
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Summer 2025, Summer 2024, Summer 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5930 - Project Management and Leadership for Complex Systems (4 Credits)
This course examines fundamental modern techniques of project management from a systems perspective, including project planning, organization, and control. Topics include leadership, the management process, risk management, scheduling methodologies, management of project activities, and project control mechanisms. Complex systems are addressed at larger scales including combinations of novel, evolving, and legacy systems, implementing adaptive leadership and management strategies and approaches. Complex system leadership, management, risk analysis and mitigation, integrated product and process development, quality management, and contracting are addressed. Complex system leadership and management also includes consideration of communications, interpersonal skills, emotional intelligence, ethics, team dynamics, multiple disciplines, varying scales, uncertainty, and nonlinearity. Covers application of fundamental project leadership and management processes from traditional systems to more complex systems.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023
Learning Outcomes:

- Develop project management plans, processes and approaches and use appropriate tools for traditional and complex systems to control and monitor project management-related tasks.
- Explain project management organizations tailored to appropriate levels applying different types of approaches.
- Construct project breakdown structures, programmatic reviews, and milestones that translate system scope and requirements into an organized list of deliverables and tasks as part of a project plan.
- Demonstrate effective interpersonal behavior and communication with quantitative analysis and reporting as a project team leader.
- Analyze project uncertainty for cost, schedule and risk by applying mathematical techniques.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5940 - Creativity and Innovation within Systems Engineering (1 Credit)
Second of two one-week intensive courses (35 hours) in systems engineering management with emphasis on understanding individual creativity and organizational innovation and on developing the required systems engineering leadership skills to foster both.
Prerequisites: CEE 6910, SYSEN 5920.
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Summer 2025, Summer 2024, Summer 2023, Summer 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 5999 - MEng Technical Internship (1 Credit)
Students spend a semester in a Systems Engineering relevant internship. Working with their advisor they draft a paper about their systems engineering experience and the systems engineering educational benefits from that experience. In the semester after the internship, students work with their advisor on the final version of the paper, helping the student to crystalize the value of their experience in developing their systems engineering knowledge and careers.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6000 - Foundations of Complex Systems (3 Credits)
This course covers the scientific foundations of the behavior of complex systems. The course is organized in a number of modules motivated by real-life examples of complex systems including aerospace systems, transportation systems, infrastructure systems, or biological systems among others. Each module will introduce, in the context of a specific problem, a number of concepts such as complexity, emergence, collective behavior, self-organization, evolution and adaptation, and pattern formation. Students will learn to use a variety of mathematical tools to analyze these systems, such as non-linear dynamics and controls, game theory, agent-based simulation, network theory, genetic algorithms, neural networks, and cellular automata. Students will be required to do a substantial amount of reading, and there will be roughly biweekly homework and a final project related to one or more of the topics covered.
Enrollment Information: Enrollment limited to: Systems Engineering Ph.D. students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6100 - Systems Seminar Series (1 Credit)
This is a weekly seminar course designed to give graduate students experience in improving their skills in presenting their research, judging peers' and field experts' research, as well as learning to accurately dissect and summarize the main points of a research talk. Being part of the Systems Engineering program, this course will strongly focus on developing the ability to present research in a broader context or as it relates to a larger system or process, and communicate the importance of the students' work to a more varied audience; a particularly important skill for both future job talks and grants' importance paragraphs. Students' presentations will also include some research depth as part of developing stronger conference talks and to aid classmates in expanding their knowledge.Graduate students will be expected to give one presentation on their research as well as attend the majority of their peers' presentations and the field experts' presentations that are part of the Erza's Roundtable seminar series.Students will also be given the opportunity to receive critiques and feedback from not only their colleagues but from faculty, including potential individual or small groups meetings with the instructing faculty.
Enrollment Information: Enrollment limited to: Masters Program.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6150 - Model Based Systems Engineering (3 Credits)
Fundamental ideas of systems engineering, and their application to design and development of various types of engineered systems. Defining system requirements, creating effective project teams, mathematical tools for system analysis and control, testing and evaluation, economic considerations, and the system life cycle. Content utilizes model-based systems engineering, which is the integration of systems modeling tools, such as SysML, with tools for systems analysis, such as Matlab and Modelica. The vision for this integration is the ability to create and analyze complete parametric representations of complex products and systems. These systems make it possible to investigate the impact of changing one aspect of a design on all other aspects of design and performance. This course will familiarize students with these modeling languages. Off-campus students must provide their own Windows 7, internet-connected, computer with administrator access in order to install the commercial software used in this course.
Enrollment Information: Enrollment limited to: Systems Engineering Ph.D. students.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6170 - Quantitative Foundations for Systems Engineering (3 Credits)
This course integrates systems thinking in analyzing and solving complex problems. Students will first learn to conduct situation appraisals using a systems approach. This will be followed by concepts of feedback and system structure and the application of these to problem identification. Mental models will be used to define and describe interrelationships and system behavior. Principles of how to intervene in a system using optimization techniques will also be discussed. Optimization models will be utilized to set baseline performance metrics and quantify the effects of the identified interventions.
Enrollment Information: Enrollment limited to: Systems Engineering Ph.D. students.
Distribution Requirements: (CE-EN)
Last Four Terms Offered: Fall 2025
Learning Outcomes:
- Define system structure with analytical models.
- Develop models that achieve system targets and are robust to uncertainty.
- Demonstrate the ability to verify and validate mathematical models.
- Design and quantify the effects of policy interventions.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6180 - Sociotechnical Systems and Policy (3 Credits)
This transdisciplinary course provides an in-depth learning experience on the fundamentals of sociotechnical systems, and welcomes students from all academic disciplines. Sociotechnical systems increase system complexity of engineered systems/technology, and this course teaches how to embrace them as part of systems engineering practice. An important dimension of sociotechnical systems is technology policy, and this course brings theory from social science disciplines and systems science together to evaluate how technical products interact with policy systems using systems engineering tools/analysis. Policy development, implementation and analysis in an engineering and technology context and its relationship with life cycle management, risk and quality are important themes in this course. There will be an application component to this class to illustrate the relevance for students from all backgrounds.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022
Learning Outcomes:
- Analyze engineered systems/technical products as embedded sociotechnical systems and their relationship to policy.
- Apply systems science to social science concepts and apply them in systems engineering tools and methods, including but not limited to: perception and identity; society and culture; and rural and urban spaces.
- Understand stakeholder engagement and how to practice inclusive, stakeholder-centric systems engineering and technology policy analysis.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6220 - Systems Dynamics (3 Credits)
This is an advanced course in the application of the systems engineering process to the design and operation of complex systems. Topics include techniques for design, simulation, optimization, and control of complex systems. Case studies and system simulations in diverse areas provide context for the application of these techniques. PhD students will be required to complete additional work.
Enrollment Information: Enrollment limited to: Systems Engineering Ph.D. students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6230 - Power System Economics and Electricity Markets (3 Credits)
Crosslisted with ECE 6240
This graduate-level course covers the fundamentals of power systems economics and electricity markets, emphasizing the application of microeconomics and optimization tools. The course introduces basic microeconomic concepts in the context of retail and wholesale electricity markets: consumer preference, consumer choice, production costs and profit maximization, individual and market demand and supply functions, competitive markets and equilibria, welfare optimization, market power, monopoly and price discrimination, regulated monopoly and utility pricing. The course covers electricity market design: energy markets, reserve markets, ancillary service markets, capacity markets, ancillary service markets, scarcity pricing, capacity markets, financial transmission rights, inter-regional transaction markets, and virtual transaction markets. Advanced topics on distributed energy resources and energy aggregation are discussed and assigned as part of class projects.
Prerequisites: MATH 2940, ECE 3100 or equivalent.
Last Four Terms Offered: Spring 2024, Fall 2021, Spring 2020, Spring 2019
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6270 - Sociotechnical System Modeling and Simulation (3 Credits)
This transdisciplinary course provides an in-depth learning experience on the fundamentals of the modeling and simulation of social and sociotechnical systems. This course welcomes students from all academic disciplines (especially outside of engineering) if they have had experience with system architecture and/or systems thinking in any domain application. System perspectives are increasingly being used to engage with the complexity of environmental, social, economic and cultural dimensions of technology, and simulation is a powerful tool in the development of policies that affect these dimensions. Students do not need to have strong computational experience before taking this course, but they need to have a strong systems background. Using system dynamics modeling, this course teaches how to develop simulations of the sociotechnical dimensions of technology design, development and implementation with a strong focus on inclusive, participatory, stakeholder-centric modeling (e.g., Living Labs). In a hybrid asynchronous lab-based environment, students in this course will gain practical skills in using a modeling process to develop models and simulations of sociotechnical systems.
Prerequisites: SYSEN 6180.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6300 - Systems Engineering and Six Sigma for Design and Operation of Reliable Systems (3-4 Credits)
Develops skills in the design, operation and control of systems for reliable performance. Focuses on four key themes; risk analysis (with a particular emphasis on risk assessment and risk characterization), modeling system reliability (including the development of statistical models based on accelerated life testing), quality control techniques and the optimization of system design for reliability. Six Sigma Green or Blackbelt can be earned through activities associated with course.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6400 - Theory and Practice of Systems Architecture (3 Credits)
Every system has an architecture (its essence, or DNA), i.e., a high-level abstraction of its design that provides a unifying concept for detailed design and commits most of the system's performance and lifecycle cost. This course presents the frameworks, methods, and tools required to analyze and synthesize system architectures. The course has a theory part that emphasizes synergies between humans and computers in the architecture process, and a practical part based on a long project and guest lectures by real system architects. The theory part covers topics such as architecture views, layers and projections, stakeholder networks, dealing with fuzziness, automatic concept generation, architecture space exploration, patterns and styles, heuristics, and knowledge engineering. The practice part focuses on special topics such as commonality, platforming, reuse, upstream and downstream influences, and software architecture.
Enrollment Information: Enrollment limited to: Ph.D. students.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6410 - Multiobjective Systems Engineering Under Uncertainty (3 Credits)
Crosslisted with CEE 6660
Exploration of engineering design frameworks that effectively exploit simulation, optimization, and uncertainty assessments when balancing large numbers of conflicting performance objectives. Students will learn and advance software frameworks that combine evolutionary multiobjective optimization, high performance computing, uncertainty modeling techniques, and visual design analytics. The primary focus will be improving multi-stakeholder design of complex engineered systems. Course concepts will be demonstrated using case studies and projects drawn from the disciplines of the students enrolled.
Prerequisites: programming experience, CS 4210 or ENGRD 3200, ORIE 3310, CEE 5970 or equivalents.
Enrollment Information: Enrollment limited to: graduate students.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Spring 2025, Spring 2024, Fall 2020, Spring 2019
Learning Outcomes:
- Incorporate conflicting objectives, account for system uncertainties, and exploit careful design diagnostics to guide problem formulation and capture key design dependencies.
- Use and advance software frameworks that combine evolutionary multiobjective optimization, high performance computing, uncertainty modeling techniques, and visual design analytics.
- Facilitate improved decision making in multi-stakeholder systems engineering design processes.
- Effectively communicate design analysis results visually and in writing.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6450 - Policy Meets Design: High-Impact Facilities of the 21st Century (3 Credits)
Crosslisted with DEA 6540
This course has been co-created and co-led by forward-thinking community, national and global leaders. This course challenges our notions on the ways policy and design can empower people, organizations, and communities to achieve health-related operational and business objectives. In this class, we think critically together and apply a systems approach to analyze policies, identify environmental strategies, and propose and design solutions to improve lives. Course modules examine how concepts such as environmental psychology, behavioral economics, spatial analyses, human centered design, LEAN, and systems approach can be used to optimize environments and policies to produce healthy, and sustainable facilities and communities. We study the issues from multiple stakeholder perspectives, explore bottom up and top down approaches to catalyze positive change. The lessons learned and case studies shared are from health and healthcare and can be applied by the students to their area and sector of interest. Students contribute actively to the course content by customizing their readings and leading discussion sessions on a weekly basis.
Last Four Terms Offered: Fall 2025, Spring 2014, Spring 2013, Spring 2012
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6480 - Human-Centered Design for Change in Complex Systems (3 Credits)
Bringing about change in ourselves, our teams, our organizations and the complex systems we inhabit and interact with each day can be a challenging undertaking. This interdisciplinary course brings together conversations, theories, and methodologies from design, organizational behavior, human factors, and systems engineering to consider how we might approach change efforts in a manner that considers the complexity of the system and the individuals who affect and are affected by it. Individually and in small teams, students will critically examine stakeholders and systems at a range of scales, starting from a single person to large-scale systems with diverse stakeholder groups. A variety of large-scale systems will be explored, including but not limited to education, healthcare, and energy. Throughout the course, students will engage with methods for deeply understanding system stakeholders, approaches to systems analysis and modeling, change theories, and well-documented change processes.
Last Four Terms Offered: Spring 2025
Learning Outcomes:
- Articulate the similarities and differences among diverse approaches and perspectives on change in complex systems.
- Analyze existing complex systems and identify system and stakeholder constraints that may support or inhibit change and identify insights about the complex system and stakeholder groups under consideration.
- Apply systems engineering, design, organizational change approaches that account for contextual characteristics of the system and appropriate theoretical understanding of the system to propose and enact a change within the system.
- Design, prototype, reflect on, and redesign a team experience to account for individual and collective growth and development and an overall positive team experience.
- Communicate the motivation for, approach to, and implications of a particular change effort through a diverse set of mediums and to a diverse set of interested groups.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6600 - Applied Model Based Systems Engineering I (3 Credits)
This course introduces fundamental ideas of Systems Engineering and their application to the design and development of various types of engineered systems. The systems engineering technical design process is emphasized, following the entire Vee-diagram process from initial problem definition and defining of system requirements, thru systems design & architecture, to implementation planning, and & testing and evaluation. The course also provides an applied introduction to a variety of areas that are commonly a part of Systems Engineering including creating effective project teams, customer needs evaluation, mathematical tools for system analysis, control & optimization, risk analysis and mitigation, decision making strategies, project organization & management, and the system life cycle. The course requires students to combine their work in this course with an outside-of-course MEng project.
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6610 - Applied Model Based Systems Engineering II (3 Credits)
This course introduces fundamental ideas of Systems Engineering and their application to the design and development of various types of engineered systems. The systems engineering technical design process is emphasized, following the entire Vee-diagram process from initial problem definition and defining of system requirements, thru systems design & architecture, to implementation planning, and & testing and evaluation. The course also provides an applied introduction to a variety of areas that are commonly a part of Systems Engineering including creating effective project teams, customer needs evaluation, mathematical tools for system analysis, control & optimization, risk analysis and mitigation, decision making strategies, project organization & management, and the system life cycle. The course requires students to combine their work in this course with an outside-of-course MEng project
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Spring 2026, Spring 2025, Spring 2024, Spring 2023
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6620 - Applied Model Based Systems Engineering III (3 Credits)
This course introduces fundamental ideas of Systems Engineering and their application to the design and development of various types of engineered systems. The systems engineering technical design process is emphasized, following the entire Vee-diagram process from initial problem definition and defining of system requirements, thru systems design & architecture, to implementation planning, and & testing and evaluation. The course also provides an applied introduction to a variety of areas that are commonly a part of Systems Engineering including creating effective project teams, customer needs evaluation, mathematical tools for system analysis, control & optimization, risk analysis and mitigation, decision making strategies, project organization & management, and the system life cycle. The course requires students to combine their work in this course with an outside-of-course MEng project.
Enrollment Information: Enrollment limited to: Systems Engineering distance learning students.
Last Four Terms Offered: Summer 2025, Summer 2024, Summer 2023, Summer 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6680 - Optimal Control and Decision Theory (3 Credits)
Crosslisted with CEE 6680, SYSEN 5680
Covers the basic models and solution approaches for individual and team decision-making problems under uncertainty and provide a unified mathematical treatment of the subject, suitable for a broad engineering audience. The material will consider optimal decision-making of systems over a finite- and an infinite-time horizon. Topics include: (1) Stochastic optimization: finite- and infinite-horizon problems with complete or partial state information, separation principle, dual control; (2) Team Theory: mathematical framework of cooperating members in which all members have the same objective yet different information; (3) Reinforcement learning: approximate dynamic programming, forward references to the approximate dynamic programming formalism, learning policies.
Enrollment Information: Primarily for: graduate students.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6800 - Computational Optimization (4 Credits)
Crosslisted with CHEME 6800
Systems optimization modeling, computation, and applications. Includes theory and algorithms of linear, nonlinear, mixed-integer linear, mixed-integer nonlinear, and deterministic global optimization, as well as stochastic programming, robust optimization and optimization methods for big-data analytics. Real-world applications of large-scale computational optimization in process manufacturing, bioengineering, energy systems, and sustainability.
Prerequisites: MATH 2220 and MATH 2940 or equivalents.
Enrollment Information: Enrollment limited to: graduate or professional students only.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6810 - AI for Sustainability (3 Credits)
Crosslisted with CHEME 6810
This studio-style course emphasizes collaborative learning and innovation in sustainability. Students will explore foundational and cutting-edge literature, research, and potential future directions in AI for Sustainability. The course will cover a range of topics related to the use of AI and machine learning in sustainability science and engineering, including energy systems decarbonization, sustainable agriculture, climate modeling, resource optimization, and biodiversity conservation. Students will gain hands-on experience with AI/ML methodologies, tools, and software and engage in discussions on the latest advancements and applications of AI in addressing global sustainability challenges.
Enrollment Information: Permission of instructor required.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025
Learning Outcomes:

- Describe the key challenges in applying AI to sustainability.
- Explain how to define and formulate AI-driven solutions to sustainability challenges, applying computational and AI techniques to address problems that span multiple scales and systems.
- Analyze and discuss existing literature on AI for Sustainability and related interdisciplinary research in science and engineering.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6820 - AI for Energy Systems (1 Credit)
Crosslisted with CHEME 6830
This course focuses on the application of artificial intelligence (AI) to energy systems over four weeks. Students will explore how AI techniques can optimize the performance of energy and power systems, with a particular focus on sustainable energy systems and renewable energy transition. Key topics include the optimization of energy generation, distribution, storage, and consumption. Specific case studies will cover topics such as optimizing solar and wind energy integration into the grid, improving battery storage management for renewable energy, and enhancing energy efficiency in smart grids. The course will also highlight AI applications in balancing supply and demand for renewable energy systems.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2025
Learning Outcomes:

- Understand the role of AI in energy and power systems.
- Apply AI techniques to optimize the efficiency and sustainability of energy generation, distribution, and consumption, with a focus on renewables like solar, wind, biomass, and geothermal.
- Analyze case studies of AI-driven innovations such as optimizing renewable energy integration, improving battery storage, and managing smart grids.
- Identify challenges and emerging trends in the use of AI for renewable energy systems and energy transition.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6830 - Astronautic Optimization (3 Credits)
Crosslisted with MAE 6830
This course provides a brief review of several topics in sufficient detail to amplify student success: estimation, allocation, and control, classical feedback, sensor noise, and Monte Carlo analysis. The review leads to application of the methods of Pontryagin applied to examples including single-gimballed rocket engines, guidance, and control problems including least squares estimation, and the famous Brachistochrone problem as a motivating example illustrating the minimum time solution is not necessarily the minimum path-length solution, particularly in a gravity field. After taking this course, students will be able to apply their expertise to actual systems in advanced courses or in laboratory settings leveraging analytic (non-numerical) nonlinear programming and real-time optimal control. Graduates will understand the application of constrained (smooth constrained, box constrained, with brief introduction to inequality constrained) and unconstrained optimization; linear-quadratic programming; and Bellman's principle of optimality.
Prerequisites: undergraduate-level coursework in dynamics, calculus (understanding of extrema), and classical feedback control or system dynamics. Recommended prerequisite: coursework or understanding of spacecraft attitude control or rotational mechanics.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- After taking this course, students will be able to apply their expertise to actual systems in space in advanced courses or in spacecraft attitude control laboratory settings leveraging nonlinear programming and real-time optimal control.
- Graduates will understand the application of constrained (smooth constrained, box constrained, inequality constrained) and unconstrained optimization.
- Graduates will understand the application of linear-quadratic programming; and Bellman's principle of optimality; all strictly applied to the problem of spacecraft attitude control.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6840 - AI for Digital Agriculture (1 Credit)
Crosslisted with CHEME 6840
This course focuses on the application of artificial intelligence (AI) in the digital transformation of agriculture. Students will explore how AI techniques are applied to optimize and automate agricultural systems, improve productivity, and enhance sustainability. The course covers a broad range of topics, including AI-driven crop management, precision farming, livestock monitoring, and data analytics for sustainable agriculture. Case studies on AI applications in plant and animal production systems, as well as food supply chains, will provide practical insights into the future of farming. Students will engage in discussions on the ethical, social, and economic implications of AI in agriculture, while hands-on projects will offer experience in applying AI tools to real-world agricultural challenges.
Enrollment Information: Enrollment limited to: graduate or professional students only.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2025
Learning Outcomes:
- Understand the role of AI in transforming agricultural practices for improved efficiency and sustainability.
- Apply AI techniques to optimize crop production, livestock management, and resource use in agriculture.
- Analyze case studies of AI-driven innovations in digital agriculture, including precision farming, smart irrigation, and disease detection.
- Identify challenges and trends in AI for sustainable food systems, addressing environmental, social, and economic considerations.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6880 - Industrial Big Data Analytics and Machine Learning (4 Credits)
Crosslisted with CHEME 6880
This course covers the basic concepts, models and algorithms of Bayesian learning, classification, regression, dimension reduction, clustering, density estimation, artificial neural networks, deep learning, and reinforcement learning. Application and methodology topics include process monitoring, fault diagnosis, preventive maintenance, root cause analysis, soft sensing, quality control, machine learning for process optimization, data-driven decision making under uncertainty, missing data imputation, data de-noising, and anomaly/outlier detection.
Prerequisites: CEE 3040 or MATH 4710 or ORIE 3500 or equivalent, CHEME 6800/SYSEN 6800 or ORIE 3310 or ORIE 5310 or ORIE 5380.
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6888 - Deep Learning (4 Credits)
Crosslisted with CHEME 6888
This course provides a comprehensive overview of deep learning, covering basic concepts, models, algorithms, and applications. Topics include artificial neural networks, training techniques, convolutional neural networks, recurrent neural networks, generative deep learning, deep reinforcement learning, and deep learning hardware and software. Recent advances in deep learning, such as graph neural networks, attention, Transformer, ViT, BERT, and GPT, will also be discussed. The course explores deep learning-based applications in optimization, sensing, control, and automation, and in AI for Science, including molecular design, material discovery, and pharmaceutical development.
Enrollment Information: Enrollment limited to: juniors, seniors, graduate or professional students.
Last Four Terms Offered: Spring 2026, Spring 2025, Fall 2023
Learning Outcomes:
- Analyze and understand modern deep learning models, algorithms, and applications.
- Demonstrate ability to develop deep learning models and algorithms for real-world applications.
- Demonstrate ability to apply deep learning to solve application problems.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 6950 - Engineering Education Teaching and Research Methods (3 Credits)
Crosslisted with CHEME 6950
Intended for graduate students who are interested in teaching engineering or related fields as part of their future careers. Includes both discussion and practice of effective teaching techniques, assessments and technologies, an overview of current engineering education research, equity and inclusion in the undergraduate engineering classroom, and action research methods using qualitative/quantitative/mixed methodologies to develop teacher scholars.
Last Four Terms Offered: Fall 2025, Spring 2025, Spring 2024
Learning Outcomes:
- Reflect on and analyze instructional approaches to effectively design learning experiences and include diverse learner needs.
- Reflect on and describe the attributes of effective learning experience design in engineering or closely related fields grounded in evidence from literature.
- Interpret and connect current trends and literature in STEM education research to learning experience design.
- Leverage educational design principles and learning theory to design and facilitate a learning experience.
- Articulate a philosophy of and approach to designing learning experiences.

Schedule of Classes (https://classes.cornell.edu/)

SYSEN 8000 - Systems Doctoral Colloquium (1 Credit)
Students will be exposed to different research methodologies and engage in critical reviews and discussion of selected research articles in the fields of systems science and engineering. A substantial amount of reading and presentation will be required.
Enrollment Information: Enrollment limited to: Ph.D. students.
Last Four Terms Offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

SYSEN 8100 - Systems Seminar Series - PhD (1 Credit)
This is a weekly seminar course designed to give graduate students experience in improving their skills in presenting their research, judging peers' and field experts' research, as well as learning to accurately dissect and summarize the main points of a research talk. Being part of the Systems Engineering program, this course will strongly focus on developing the ability to present research in a broader context or as it relates to a larger system or process, and communicate the importance of the students' work to a more varied audience; a particularly important skill for both future job talks and grants' importance paragraphs. Students' presentations will also include some research depth as part of developing stronger conference talks and to aid classmates in expanding their knowledge.
Enrollment Information: Enrollment limited to: Ph.D. students.
Last Four Terms Offered: Spring 2026, Fall 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)