SYSTEM ENGINEERING (SYST)

100 Level Courses

SYST 101: Understanding Systems Engineering. 3 credits.
Introduces systems engineering and curriculum for BS in field. Introduces large and small systems, and explains them through some hands-on experiences. Key concepts include understanding requirements for system and translation of system-level requirements to component-level requirements. Several different kinds of example systems presented and discussed: objectives, major components, how system works, and major design issues. Each student gives a similar presentation on system of choice. Students work in groups design, develop, and test system, and give oral presentation. Students are responsible for writing several short papers on curriculum and presentations they have heard. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 198: Independent Study in Systems Engineering. 1-3 credits.
Must be arranged with instructor and approved by department chair before registering. Directed self-study of special topics of current interest in systems engineering. Notes: May be repeatable if topics are substantially different. Offered by Systems Engr & Operations Rsch. May be repeated within the term for a maximum 6 credits.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Independent Study

200 Level Courses

SYST 202: Engineering Systems in a Complex World. 3 credits.
This course introduces students to the study of engineering systems as a means of understanding larger historical trends in a global society. Students will use case studies and historical analyses to think strategically and globally about the management and execution of complex systems in the context of culture, environment, politics and economics, and learn how to employ such analyses as decision-making tools for leadership. Students will be required to critically analyze articles and books, and work in groups to investigate and present topics of current national and international relevance. Offered by Systems Engr & Operations Rsch. Limited to two attempts. Equivalent to HIST 202, SYST 100.

Mason Core: Global Understanding

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 210: Systems Design. 3 credits.
Systems engineering design and integration process, development of functional, physical, and operational architectures. Emphasizes requirements engineering, functional modeling for design, and formulation and analysis of physical design alternatives. Introduces methods, software tools for systems engineering design. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: SYST 101.

Registration Restrictions:
Students with a class of Freshman may not enroll.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 220: Dynamical Systems I. 3 credits.
Introduces modeling of dynamical systems. Formulation of mathematical models from system descriptions, including computer, biological, economic, transportation, and mechanical systems. Analytical and numerical methods for solving models and studying their behavior. Discrete-time and continuous time systems. Linear and nonlinear systems. Introduction to computer modeling using MATLAB. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (MATH 114C or 116C) and (PHYS 160C) and (SYST 221C and MATH 203C).* May be taken concurrently.
C Requires minimum grade of C.

Enrollment is limited to students with a major, minor, or concentration in Systems Engineering.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 221: Systems Modeling Laboratory. 1 credit.

Registration Restrictions:
Required Prerequisites: SYST 101C, CS 112C and SYST 220C.* May be taken concurrently.
C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Laboratory

300 Level Courses

SYST 320: Dynamical Systems II. 3 credits.

Registration Restrictions:
Required Prerequisites: (SYST 220C, MATH 203C, 214C and PHYS 260C). C Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture
SYST 330: Systems Methods. 3 credits.
Provides students with a general introduction to a variety of quantitative
techniques that are relevant to systems engineering. Focuses on the
use of quantitative techniques to model and evaluate design options.
Scope includes: Analysis methods of system engineering design and
management; decision analysis, models for engineering economics
and evaluations, probability and statistical methods for data analysis,
management control techniques, reliability, and maintainability analysis,
risk and uncertainty management, and life-cycle cost analysis. Offered by
Systems Engr & Operations Rsch. Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (MATH 114\textsuperscript{C} or 116\textsuperscript{C}) and (STAT 344\textsuperscript{C} and
SYST 221\textsuperscript{C}).
\textsuperscript{*} May be taken concurrently.
\textsuperscript{C} Requires minimum grade of C.

Enrollment is limited to students with a major in Systems Engineering.
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 335: Discrete Systems Modeling and Simulation. 3 credits.
Introduces basic concepts of modeling complex discrete systems by
computer simulation. Topics include Monte-Carlo methods, discrete-
event modeling, specialized simulation software, and statistics of input
and output analysis. Offered by Systems Engr & Operations Rsch. Limited
to two attempts. Equivalent to OR 335.

Registration Restrictions:
Required Prerequisites: CS 112\textsuperscript{C} and (STAT 344\textsuperscript{C}, 346\textsuperscript{C} or MATH 351\textsuperscript{C})
and CS 211\textsuperscript{C}.
\textsuperscript{*} May be taken concurrently.
\textsuperscript{C} Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 371: Systems Engineering Management. 3 credits.
Study of basics of systems engineering management. Includes
engineering economics, planning, organizing, staffing, monitoring, and
controlling process of designing, developing, and producing system
to meet stated need in effective and efficient manner. Discusses
management tools, processes, and procedures, including various
engineering documentation templates, managerial processes, and
dealing with personnel issues. Offered by Systems Engr & Operations
Rsch. Limited to two attempts.

Registration Restrictions:
Required Prerequisites: SYST 210\textsuperscript{C} and 330\textsuperscript{C}.
\textsuperscript{*} May be taken concurrently.
\textsuperscript{C} Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 395: Applied Systems Engineering. 3 credits.
The course will enhance the student's system engineering experience by
designing and building projects involving real world complex systems.
The course will build physical models that follow the steps of system
life cycle process: statement of need, design, requirements, architecture,
implementation, testing, verification and validation. Projects are
multidisciplinary in nature, requiring the student teams to learn about
various real world systems such as internet communications, navigation,
robotics, creating a GUI, and transmitting and receiving data from
sensors. Offered by Systems Engr & Operations Rsch. Limited to two
attempts.

Registration Restrictions:
Required Prerequisites: (SYST 210\textsuperscript{C} and 101\textsuperscript{C}) and (SYST 220\textsuperscript{C}, 221\textsuperscript{C},
335\textsuperscript{C} and 371\textsuperscript{C}).
\textsuperscript{*} May be taken concurrently.
\textsuperscript{C} Requires minimum grade of C.

Students cannot enroll who have a major in Undeclared.
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

400 Level Courses

SYST 420: Network Analysis. 3 credits.
Network nomenclature. Elementary graph theory. Linear and nonlinear
network models: multimodality flow, mathematical games and
equilibria on networks, network design and control: dynamic network
models; applications to transportation, telecommunications, data
communications, and water resource systems. Offered by Systems Engr
& Operations Rsch. Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (OR 441\textsuperscript{C}) and (MATH 213\textsuperscript{C} or 216\textsuperscript{C}).
\textsuperscript{C} Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 421: Classical Systems and Control Theory. 3 credits.
Introduction to analysis and synthesis of feedback systems. Functional
description of linear and nonlinear systems. Block diagrams and
signal flow graphs. State-space representation of dynamical systems.
Frequency response methods: Root Locus, Nyquist, and other stability
criteria. Application to mechanical and electromechanical control
systems. Offered by Systems Engr & Operations Rsch. Limited to two
attempts. Equivalent to ECE 421.

Registration Restrictions:
Required Prerequisite: ECE 220\textsuperscript{C}.
\textsuperscript{C} Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 438: Analytics for Financial Engineering and Econometrics. 3 credits.
Introduces the basic analytics for financial engineering and
econometrics. Topics include financial transactions and econometric
data management, correlation, linear and multiple regressions for
financial and economic predictions, financial time series analysis,
portfolio theory, and risk analysis. Provides a foundation of basic theory
and methodology as well as applied examples with techniques to
analyzing large financial and econometric data. Hands-on experiments
with R will be emphasized throughout the course. Offered by Systems
Engr & Operations Rsch. Limited to two attempts. Equivalent to OR 438.
Recommended Corequisite: STAT 354.
Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 460: *Introduction to Air Traffic Control*. 3 credits.
Introduction to Air Traffic Control (ATC) for those who plan professions in the air transportation industry. Surveys the entire field, presenting the history of ATC and how it came to be as it is, the technology on which the system is based, the procedures used by controllers to meet the safety and efficiency goals of the system, the organizational structure of the FAA, challenges facing the system, and means under investigation to meet these challenges. Some fieldwork will be required to acquire and analyze airport operational data. A brief introduction to airport design will be discussed. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: Junior standing or graduate standing.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 461: *Air Transportation System Engineering*. 3 credits.
Focuses on the theory and practice of system engineering in a national air transportation system. Stresses the application of mathematical techniques to analyze and design complex network transportation systems, airports, airspace, airline schedules, and traffic flow. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: SYST 460 or permission of instructor.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 462: *Flight Training Lab I*. 3 credits.
This course fulfills the requirements of 14 CFR, Section 141, Appendix B for obtaining a private pilot certificate with airplane category, single engine land class rating. Flight Training 1 will include the flight training up to and including maneuvering and navigating the aircraft. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Corequisite: SYST 460.

Registration Restrictions:
Enrollment is limited to students with a major, minor, or concentration in Aviation Flight Trng and Mgmt.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Laboratory

SYST 463: *Flight Training Lab II*. 3 credits.
This course fulfills the requirements of 14 CFR, Section 141, Appendix B for obtaining a private pilot certificate with airplane category, Airplane - Single Engine Land class rating. Flight Training II will include the flight training up to and including the dual and solo flight instruction in cross-country navigation by pilotage, dead reckoning, and use of VOR, NDB, and HSI. Flight test preparation for private pilot certification. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: SYST 462.

Registration Restrictions:
Enrollment is limited to students with a major, minor, or concentration in Aviation Flight Trng and Mgmt.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Laboratory

SYST 465: *Pricing in Optimization and Game Theory*. 3 credits.
Allocation of limited resources among competing activities to maximize the outcome or minimization of expenses required to produce a given assortment of goods and services are two typical problems faced by any economic institution. Mathematical modeling of such problems and finding efficient mathematical tools for solving them are two main goals of modern optimization theory. Pricing limited resources, goods, and services is the key instrument for theoretical analysis of complex economical systems. Pricing theory can also give rise to numerical methods for finding optimal solutions and economic equilibrium. Fundamental tools in pricing theory are the classical Lagrangian and Lagrange multipliers for constrained optimization. Covers the basic ideas and methods of linear programming and matrix games. Particular emphasis to pricing for both theoretical analysis and numerical methods. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: MATH 203 or 216 and OR 441, or permission of instructor.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 466: *Applied Predictive Analytics*. 3 credits.
Introduces students to the fundamentals of data analysis and some of the most widely used models in applied predictive analytics. The students learn how to summarize data and explore relationship between variables, including principle component analysis and multidimensional scaling. Class instruction follows with a presentation of commonly used tables, visualizations, and statistical tests for comparing groups. Linear predictive models for both continuous and binary outcomes (logistic regression) are discussed in detail. The course introduces students to clustering and classification using random forest and naive Bayes. The course concludes with topics on choice modeling. Hands-on programming with R is emphasized. While no prior knowledge on R is required, students must be well prepared in programming. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (STAT 344\(^c\), 346\(^c\), 250\(^c\) or MATH 351\(^c\)) and (IT 206\(^c\) or CS 112\(^c\)).

\(^c\) Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

Covers principles of human-computer interaction, including information processing design, cognitive models, ergonomics, and design metaphors. Students learn to evaluate interface design in terms of effectiveness, efficiency, and cost. Notes: Students who receive credit for SYST 470 may not receive credit for this course. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Registration Restrictions:
Financial models such as Brownian motion, Ito's formula, and Black-Scholes model. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: OR 441.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 489: Senior Seminar. 3 credits.
Introduces several important topics in systems engineering, providing additional experience in writing and giving presentations, and obtaining feedback on curriculum for BS in systems engineering. Several lectures devoted to ethics; writing and making presentations also covered. Students attend technical lectures and write paper. Students are required to write a long paper on new technology. Instructor and guest lecturers present material not part of required course load to expand horizons. Examples are "knowledge-based" design, enterprise-wide reengineering, electronic commerce, and optimization by "natural analogy" (simulated annealing, neural networks, genetic algorithms). In addition, students work in teams to critique and redesign curriculum. Each group delivers written product, and provides at least one briefing to class. Best critique and redesign presented to faculty. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Specialized Designation: Writing Intensive in the Major

Registration Restrictions:
Required Prerequisite: SYST 490C.

Required Prerequisite: SYST 490.

Registration Restrictions:
Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 490: Senior Design Project I. 3 credits.
First part of capstone course in systems engineering program. Students apply knowledge they have gained to group project. During first semester, students perform concept definition and requirements analysis. Plan for carrying out project is developed, culminating in proposal presented to faculty at end of semester. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

Recommended Prerequisite: 90 satisfactory credits.

Registration Restrictions:
Required Prerequisites: (SYST 335C, 371C and 395C) and (SYST 320C, 470C, 473C and OR 441C).

May be taken concurrently.

C Requires minimum grade of C.

Enrollment is limited to students with a major in Systems Engineering.

Enrollment limited to students in a Bachelor of Science degree.

Students with the terminated from VSE major attribute may not enroll.

Schedule Type: Lecture

SYST 491: Industrial Project. 1-3 credits.
Semester-long work experience in systems engineering in industrial or governmental organization. Work supervised jointly by systems engineer from sponsoring organization and department faculty member. Project and arrangements for supervision must be approved by student’s faculty.
advisor. Periodic reports, presentations, and a written final report are required. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

**Recommended Prerequisite:** 75 credits toward BS in Systems Engineering; SYST 330; GPA of at least 3.00.

**Registration Restrictions:** Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**SYST 495: Senior Design Project II. 3 credits.**
Second part of capstone course. Design project plans formulated in SYST 490 are reviewed and modified. Additional instruction on documentation and project management is given. Design project completed; formal report prepared, presented, and evaluated. Students are strongly recommended to take STAT 354 before enrolling in SYST 490/495. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

**Mason Core:** Capstone, Synthesis

**Registration Restrictions:**

Required Prerequisites: (SYST 320C), (SYST 470C), (SYST 473C) and (SYST 330C) and (SYST 354C). 1

1 May be taken concurrently.

Required Prerequisite: Requires minimum grade of C.

Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**SYST 498: Independent Study in Systems Engineering. 1-3 credits.**

**Recommended Prerequisite:** 60 credits towards BS in systems engineering, and GPA of at least 3.00.

**Registration Restrictions:** Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Independent Study

**SYST 499: Special Topics in Systems Engineering. 3 credits.**
Topics of special interest to undergraduates. Offered by Systems Engr & Operations Rsch. Limited to two attempts.

**Recommended Prerequisite:** 60 credits toward BS in systems engineering; specific prerequisites vary with nature of topic.

**Registration Restrictions:** Students with the terminated from VSE major attribute may not enroll.

**Schedule Type:** Lecture

**500 Level Courses**

**SYST 500: Quantitative Foundations for Systems Engineering. 3 credits.**
Provides quantitative foundations necessary for core courses in systems engineering and operations research master's program, and certificate program in C4I. Topics include vectors and matrices, infinite series, partial differentiation, multiple integrals, differential and difference equations; linear systems; Laplace and Z-transforms, and probability theory. Students receive graduate credit for this course, which, when used on plan of study, extends minimum credit requirements for degree. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to CSI 600.

**Recommended Prerequisite:** MATH 203 and 213.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 505: Systems Engineering Principles. 3 credits.**
This course serves as a foundation for the other courses in the MS/SE curriculum. Different components of the systems life cycle will be explored. Basic principles including requirements, design frameworks, functional systems, models, qualification strategy, maintenance and disposal will be covered as well as systems thinking. Students gain practical knowledge concerning this subject by modeling functional, state, and object primitives. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 508: Complex Systems Engineering Management. 3 credits.**
Introduces the organizational, economic, technological and societal factors (POETS) that apply to the development of large-scale, complex mega-systems, and shows that "one size does not fit all" when it comes to the project management of mega-systems. Notes: Course cannot be applied for credit towards the MS in Systems Engineering degree. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture
SYST 510: Systems Definition and Cost Modeling. 3 credits.
Comprehensive examination of methods and processes for the identification and representation of system requirements. Investigation of the systems acquisition life cycle with emphasis on requirements definition, including functional problem analysis. Examination of the systems engineering definition phase including requirements, problem analysis, definition, and functional economics. Specification of functional and nonfunctional requirements, and associated requirements proto-typing. Functional economic analysis, including the use of prevailing cost estimation models and planning and control of common operating environments. Lecture and group project including creation of requirements and use of cost estimation model. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 513: Total Systems Engineering, Reengineering and Enterprise Integration. 3 credits.
Principles of strategic quality, including TQM. Quality standards including ISO9000 and 14000. Organizational leadership, cultures, and process maturity, reengineering. Quality, organization learning, and reengineering approaches to enable information integration and management and environment and framework integration in the systems engineering of knowledge intensive systems. Emphasis is placed on the role of integrated product and process design teams, standard and commercial off-the-shelf products in enterprise integration. Architecture-driven system characteristics are studied, as is transition management of legacy systems. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 510 or 520.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 514: Systems Thinking. 3 credits.
Enables students to understand and use systems thinking concepts, tools and techniques that can apply across all system types, especially those which exhibit a fusion of technology and human activities. Additionally, the course extends the understanding of systems beyond technology, to systems with significant human activity components, such as organizations and enterprises. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Corequisite: SYST 505.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 520: System Engineering Design. 3 credits.
System engineering design methods are studied and practiced, including object-oriented and structured analysis based techniques. Design description languages such as UML, SysML, IDEF0 and IDEF1x are introduced and used in carrying out complete system designs. Teams make presentations of their designs. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 550.

Recommended Corequisite: SYST 505.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 521: Network Analysis. 3 credits.

Recommended Prerequisite: MATH 203 and 213, OR 441 or OR 541.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture
SYST 523: Engineering Resilient and Agile Enterprise Systems. 3 credits.
Large-scale enterprise systems have ill-defined boundaries, complex behaviors, and evolve in unplanned ways. Enterprise systems need to be resilient and agile. This course introduces several tools and frameworks that can be used to understand resilience and agility, design resilience and agility into enterprises, and measure the degree of enterprise resilience and agility. Case studies are used to explore these concepts. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 530: Systems Engineering Management I. 3 credits.
Provides techniques for evaluating cost and operational effectiveness of system designs and systems management strategies. Discusses performance measurement, work breakdown structures, cost estimating, quality management, configuration management, standards, and case studies of systems from different application areas. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 510.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 538: Analytics for Financial Engineering and Econometrics. 3 credits.
This course introduces the basic analytics for financial engineering and econometrics, topics include financial transactions and econometric data management, correlation, linear and multiple regressions for financial and economic predictions, financial time series analysis, portfolio theory and risk analysis. It will provide a foundation of basic theory and methodology as well as applied examples with techniques to analyzing large financial and econometric data. Hand-on experiments with R will be emphasized throughout the course. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 538.

Recommended Prerequisite: STAT 515 or STAT 544.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture
SYST 563: Evidence-Based Systems Engineering. 3 credits.
A common cause of failure and risk in system development is making decisions when lacking clear evidence to support them. This course presents frameworks and methods used to make sound, evidence-based decisions throughout the system lifecycle. Students learn what information to gather, how to analyze it, and how to present those analyses when deciding on the adequacy of programmatic decisions. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: STAT 344 and STAT 354 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 568: Applied Predictive Analytics. 3 credits.
Introduces predictive analytics with applications in engineering, business, and econometrics. Topics include time series and cross-sectional data processing, correlation, linear and multiple regressions, time series decomposition, predictive modeling and case study. Provides a foundation of basic theory and methodology with applied examples to analyze large engineering and econometric data for predictive decision making. Hands-on experiments with R will be emphasized. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 568.

Recommended Prerequisite: STAT 515 or enrollment in the MSOR or MSSE programs.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 563: Decision and Risk Analysis. 3 credits.
Study of analytic techniques for rational decision making that address uncertainty, conflicting objectives, and risk attitudes. Covers modeling uncertainty; rational decision-making principles; representing decision problems with value trees, decision trees, and influence diagrams; solving value hierarchies, decision trees, and influence diagrams; defining and calculating the value of information; incorporating risk attitudes into the analysis; and conducting sensitivity analysis. Note: Students may not receive credit for both SYST 473 and 573. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 581.

Recommended Prerequisite: STAT 344 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 574: Quality Control and Process Management. 3 credits.
Provides fundamentals of quality control and process management methodologies that are applicable in manufacturing industries. Introduces the basic concepts of engineering process and product quality management techniques. Provides exposition of fundamentals of lean Six Sigma and total quality management and maintainability. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 574.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 576: Manufacturing Systems Analysis. 3 credits.
Provides fundamentals of modeling and analysis of general manufacturing systems that are also applicable to semiconductor manufacturing. Introduces the basic concepts of scheduling, inventory control, and enterprise resource management. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 576.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 580: Introduction to C4I Systems. 3 credits.
This course provides a high-level introduction to fundamental principles of Command, Control, Communication, Computing, and Intelligence (C4I). The principles and techniques are applicable to a wide range of civilian and military situations. The sensing, fusion, and situation assessment processes for decision making as well as the concepts of modeling, simulation, and C4 architectures are discussed. Several cases studies of
Financial Systems Engineering I: Introduction to Options, Futures, and Derivatives. 3 credits.
This course is an introduction to financial engineering. Financial engineering is a cross-disciplinary field which relies on mathematical
finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions. This course will introduce basic types
of derivatives, such as forward, futures, swaps, and options; as well as financial models such as Brownian motion, Ito's formula, and Black-
Scholes model. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 588.

Recommended Prerequisite: Eng. or Math Graduate standing, or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

600 Level Courses

SYST 588: Financial Systems Engineering I: Introduction to Options, Futures, and Derivatives. 3 credits.
Provides broad yet rigorous foundations and applications of dynamic modeling. Emphasizes methodologies used across various disciplines. Topics include modeling and analysis of time-driven and event-driven, linear and nonlinear systems. The applications are presented with real-world example systems. Methodologies address dynamic systems using the concepts of composition, abstraction, execution, and performance. The issues of stochastic modeling and decision analysis are also covered. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 500 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 588: Heterogeneous Data Fusion. 3 credits.
Introduces the theory, design and implementation of multi-source information fusion systems in various domains. The course covers distinct technologies for combining data from multiple, heterogeneous sources and performing inferences in support to applications such as cyber security, Semantic Web, decision support systems, situational awareness, intrusion detection, crisis management, and others. The technical content is largely multi-disciplinary, encompassing disciplines such as knowledge engineering, ontologies, statistical learning, artificial intelligence, and data mining. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 584: Heterogeneous Data Fusion. 3 credits.
Introduces the theory, design and implementation of multi-source information fusion systems in various domains. The course covers distinct technologies for combining data from multiple, heterogeneous sources and performing inferences in support to applications such as cyber security, Semantic Web, decision support systems, situational awareness, intrusion detection, crisis management, and others. The technical content is largely multi-disciplinary, encompassing disciplines such as knowledge engineering, ontologies, statistical learning, artificial intelligence, and data mining. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 500 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 588: Model-based Systems Engineering. 3 credits.
Model-based Systems Engineering (MBSE) provides a formalized application of modeling to support the engineering of systems. The purpose of the course to study and practice the leading methodologies for MBSE and illustrate the MBSE approaches in systems engineering and management. The advanced object-oriented systems engineering methodology and model transformation techniques are addressed. Software tools are introduced and used for supporting systems engineering design. Students are expected to develop a system design of their choice using MBSE approaches presented in class and they will make presentations on these designs. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 520.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 611: System Methodology and Modeling. 3 credits.
Provides broad yet rigorous foundations and applications of dynamic modeling. Emphasizes methodologies used across various disciplines. Topics include modeling and analysis of time-driven and event-driven, linear and nonlinear systems. The applications are presented with real-world example systems. Methodologies address dynamic systems using the concepts of composition, abstraction, execution, and performance. The issues of stochastic modeling and decision analysis are also covered. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Recommended Prerequisite: SYST 500 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 588: Model-based Systems Engineering I: Introduction to Options, Futures, and Derivatives. 3 credits.
This course is an introduction to financial engineering. Financial engineering is a cross-disciplinary field which relies on mathematical
finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions. This course will introduce basic types
of derivatives, such as forward, futures, swaps, and options; as well as financial models such as Brownian motion, Ito's formula, and Black-
Scholes model. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 588.

Recommended Prerequisite: Eng. or Math Graduate standing, or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture
SYST 620: Discrete Event Systems. 3 credits.
Introduces modeling and analysis of discrete event dynamical systems. Course covers elements of discrete mathematics and then focuses on Petri Net models and their basic properties. Relation to other discrete event models of dynamical systems. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 673.

Registration Restrictions:
- Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.
- Registration is limited to graduate, Non-Degree or Undergraduate level students.
- Students in a Non-Degree Undergraduate degree may not enroll.
- Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

Recommended Prerequisite: SYST 611 or ECE 521, or permission of instructor.

SYST 621: Systems Architecture Design. 3 credits.
Architecture design and representation and the methodologies used to obtain them. Approaches based on system engineering constructs such as object orientation and service oriented architectures are used to design architectures and then represent them in conformance with an architecture framework such as DoDAF. Executable models of the architecture are derived to be used for architecture evaluation. Examples from current practice are used. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 674, SWE 641.

Registration Restrictions:
- Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.
- Enrollment is limited to graduate, Non-Degree or Undergraduate level students.
- Students in a Non-Degree Undergraduate degree may not enroll.
- Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

Recommended Prerequisite: SYST 520/ECE 550.

SYST 632: System Integration and Architecture Evaluation. 3 credits.
Examines the system integration problem and its human, organizational, societal cultural, and technological aspects. The role of architectures in systems integration. Integration in a system of systems and a federation of systems. Measures of performance and effectives. Analysis of alternatives. Notes: This course does not meet the requirements for the MS SE degree. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

Registration Restrictions:
- Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.
- Enrollment is limited to graduate, Non-Degree or Undergraduate level students.
- Students in a Non-Degree Undergraduate degree may not enroll.
- Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

Recommended Prerequisite: ECE 678.

SYST 659: Topics in Systems Engineering. 3 credits.
Topics not covered in department's regular systems engineering offerings. Course content may vary each semester depending on instructor and the perception of students' needs. Offered by Systems Engr & Operations Rsch. May be repeated within the term for a maximum 6 credits.

Registration Restrictions:
- Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.
- Enrollment is limited to graduate, Non-Degree or Undergraduate level students.
- Students in a Non-Degree Undergraduate degree may not enroll.
- Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

SYST 660: Air Transportation Systems Modeling. 3 credits.
Introduces wide range of current issues in air transportation. Issues include public policy toward industry, industry economics, system capacity, current system modeling capability, human factors considerations, safety analysis and surveillance systems, and new technological developments. Develops broad understanding of contemporary and future issues. Knowledge evaluated through class discussions, take-home midterm exam, and term project to be completed.
by end of semester. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 660.

**Recommended Prerequisite:** SYST 460/560 or permission of instructor.

**Registration Restrictions:** Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 664: Bayesian Inference and Decision Theory.** 3 credits. Introduces decision theory and relationship to Bayesian statistical inference. Teaches commonalities, differences between Bayesian and frequentist approaches to statistical inference, how to approach statistics problem, and how to combine data with informed expert judgment to derive useful and policy relevant conclusions. Teaches theory to develop understanding of when and how to apply Bayesian and frequentist methods; and practical procedures for inference, hypothesis testing, and developing statistical models for phenomena. Teaches fundamentals of Bayesian theory of inference, including probability as a representation for degrees of belief, likelihood principle, use of Bayes Rule to revise beliefs based on evidence, conjugate prior distributions for common statistical models, and methods for approximating the posterior distribution. Introduces graphical models for constructing complex probability and decision models from modular components. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to CSI 674, STAT 664.

**Recommended Prerequisite:** STAT 544, STAT 554, or equivalent.

**Registration Restrictions:** Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 664: Bayesian Inference and Decision Theory.** 3 credits. Introduces decision theory and relationship to Bayesian statistical inference. Teaches commonalities, differences between Bayesian and frequentist approaches to statistical inference, how to approach statistics problem, and how to combine data with informed expert judgment to derive useful and policy relevant conclusions. Teaches theory to develop understanding of when and how to apply Bayesian and frequentist methods; and practical procedures for inference, hypothesis testing, and developing statistical models for phenomena. Teaches fundamentals of Bayesian theory of inference, including probability as a representation for degrees of belief, likelihood principle, use of Bayes Rule to revise beliefs based on evidence, conjugate prior distributions for common statistical models, and methods for approximating the posterior distribution. Introduces graphical models for constructing complex probability and decision models from modular components. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to CSI 674, STAT 664.

**Recommended Prerequisite:** STAT 544, STAT 554, or equivalent.

**Registration Restrictions:** Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 670: Metaheuristics for Optimization.** 3 credits. Course on the theory and practice of metaheuristics, i.e. solution search techniques for solving combinatorial optimization problems. It will introduce the theory, applications (scheduling in manufacturing, transportation, and in other engineering and service industries), and computational aspects of directly searching for solutions to solve computationally complex optimization problems without a well-defined analytical model. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 670.

**Recommended Prerequisite:** OR 441/541 or permission of instructor.

**Registration Restrictions:** Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 675: Reliability Analysis.** 3 credits. Introduction to component and system reliability, their relationship, and problems of inference. Topics include component lifetime distributions
and hazard functions, parameter estimation and hypothesis testing, life testing, accelerated life testing, system structural functions, and system maintainability. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 675.

**Recommended Prerequisite:** STAT 544/554, OR 542 or permission of instructor.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 680: Principles of Command, Control, Communications, Computing, and Intelligence (C4I).** 3 credits.

Broad introduction to fundamental principles of command, control, communications, computers, and intelligence (C4I). Principles and techniques applicable to wide range of civilian and military situations. Discusses modeling and simulation of combat operations. Studies in detail sensing, fusion, and situation assessment processes. Derives optimal decision-making rules; discusses concepts of C4 architectures; and develops tools to evaluate and design C4 systems such as queuing theory. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 670.

**Recommended Prerequisite:** ECE 528 or OR 542 or SYST 611 or equivalent.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 683: Modeling, Simulation, and Gaming.** 3 credits.


**Recommended Prerequisite:** MATH 213, SYST 500 or equivalent, and graduate standing.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 688: Financial Systems Engineering II: Derivative Products and Risk Management.** 3 credits.

Financial engineering is a cross-disciplinary field which relies on mathematical finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions, as well as facilitating the risk management of those decisions. This course will focus on risk management for both market risk and credit risk. It will cover a broad range of derivatives products and hedging strategies with emphasis on how risks are managed in financial institutions. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 688.

**Recommended Prerequisite:** OR 588 or SYST 588 or permission of instructor.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 698: Independent Study and Research.** 3 credits.

Study of a selected area in systems engineering or C3I under the supervision of a faculty member. Written report required. Offered by Systems Engr & Operations Rsch. May be repeated within the degree for a maximum of 12 credits.

**Recommended Prerequisite:** Completion of at least two core courses, permission of instructor.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Independent Study

**SYST 699: Masters Project.** 3 credits.

Capstone project course for MS/SE program. Key activity is completion of a major applied team project resulting in an acceptable technical report and oral briefing. Student should plan to take this course in the last
semester of studies. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to SYST 798.

**Recommended Prerequisite:** 21 graduate credits in OR or SYST.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

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### 700 Level Courses

**SYST 735:** *Advanced Stochastic Simulation.* 3 credits.

Special topics and recent developments in Monte Carlo simulation methodology for discrete-event stochastic systems. Contents vary; possible topics include statistical analysis of simulation output data, random number and random variate generation, variance reduction techniques, sensitivity analysis and optimization of simulation models, distributed and parallel simulation, object-oriented simulation, and specialized applications. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 735.

**Recommended Prerequisite:** OR 635 or permission of instructor.

**Registration Restrictions:**
Enrollment limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 740:** *Advances in Multi-Modeling.* 3 credits.

Focuses on the inter-operation of multiple models expressed in different modeling languages but which draw from the same data set: i.e., multi-modeling. Socio-technical systems often require a variety of modeling tools to define their operation accurately. An ontology based approach is used to analyze the validity of a proposed modeling architecture and workflow to address a specific issue Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 760.

**Recommended Prerequisite:** SYST 620 or ECE 673 or permission of instructor.

**Registration Restrictions:**
Enrollment limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 750:** *Advanced Topics in Systems Engineering.* 3 credits.

Advanced topics not covered in department’s regular systems engineering offerings. Course content may vary each semester depending on instructor and the perception of students’ needs. May be repeated for credit when topics are distinctly different. Offered by Systems Engr & Operations Rsch. May be repeated within the degree for a maximum 12 credits.

**Recommended Prerequisite:** 600-level course that varies with content of course.

**Registration Restrictions:**
Enrollment limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 763:** *Research Methods in Systems Engineering and Information Technology.* 3 credits.

Examines alternative paradigms of scientific research and their applicability to research in information technology. Topics include fundamental elements of scientific investigation, basic principles of experimental design and statistical induction, philosophy of science and its relation to the information technology sciences, and case studies of information technology research. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 763.

**Recommended Prerequisite:** STAT 544, OR 542 or permission of instructor.

**Registration Restrictions:**
Enrollment limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 781:** *Data Mining and Knowledge Discovery.* 3 credits.

Statistical and computational methods and systems for deriving user-oriented knowledge from large databases and other information sources, and applying knowledge to support decision making. Information sources can be in numerical, textual, visual, or multimedia forms. Covers theoretical and practical aspects of current methods and selected systems for data mining, knowledge discovery, and knowledge management, including those for text mining, multimedia mining, and web mining. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to STAT 781.

**Recommended Prerequisite:** One of the following courses: CS 687, CS 650, INFS 614, STAT 663, SYST 664, or Permission of Instructor.

**Registration Restrictions:**
Enrollment limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture
**SYST 799: Master’s Thesis.** 1-6 credits.
Research project chosen and completed under the guidance of a graduate faculty member, which results in a technical report acceptable to a three-member faculty committee, and an oral defense. Offered by Systems Engr & Operations Rsch. May be repeated within the degree.

**Recommended Prerequisite:** 21 graduate credits and permission of instructor.

**Registration Restrictions:**
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Thesis

### 800 Level Courses

**SYST 842: Models of Probabilistic Reasoning.** 3 credits.
Survey of alternative views about how incomplete, inconclusive, and possibly unreliable evidence might be evaluated and combined. Discusses Bayesian, Baconian, Shafer-Dempster, and Fuzzy systems for probabilistic reasoning. Offered by Systems Engr & Operations Rsch. May not be repeated for credit.

**Recommended Prerequisite:** STAT 544, OR 542, OR 681 or permission of instructor.

**Registration Restrictions:**
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 850: Topics in Systems Integration Engineering.** 3 credits.
Covers lifecycles; large systems comprising heterogeneous components; human, organizational, and technological basis for integration; societal and cultural basis; conceptual frameworks; structure, function, and purpose of industry; risk management; user requirements and functional specifications; bid and proposal process; systems integration and federal government; standards; integration of systems and federations of systems; integrated process and product development; architectures; systems management and cost estimation; reengineering; quality management; increasing returns to scale, network effects, and path dependency issues; and systems integration ecology and evolutionary systems integration. Notes: May be repeatable if topics are substantially different. Offered by Systems Engr & Operations Rsch. May be repeated within the degree for a maximum 6 credits.

**Recommended Prerequisite:** SYST 510 or SYST 520.

**Registration Restrictions:**
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**SYST 888: Distributed Estimation and Multisensor Tracking and Fusion.** 3 credits.
Centralized and distributed estimation theory, hierarchical estimation, tracking and data association, multisensor multitarget tracking and fusion, distributed tracking in distributed sensor networks, track-to-track association and fusion, and Bayesian networks for fusion. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to ECE 753, OR 888.

**Recommended Prerequisite:** ECE 734 or SYST 611.

**Registration Restrictions:**
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

### 900 Level Courses

**SYST 944: The Process of Discovery and Its Enhancement in Engineering Applications.** 3 credits.
Studies ingredients of imaginative reasoning as they concern efficient discovery of new ideas and valid evidential test of them. Topics include different interpretations of Peirce’s theory of abductive reasoning and other forms of reasoning. Hintikka’s analysis of process of inquiry, and current attempts to design systems that provide assistance in discovery-related or investigative activities. Offered by Systems Engr & Operations Rsch. May not be repeated for credit. Equivalent to OR 944.

**Recommended Prerequisite:** IT 842, or permission of instructor.

**Registration Restrictions:**
Enrollment is limited to Graduate level students.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture