**SYSTEMS ENGINEERING (SYS ENG)**

**SYS ENG 5000 Special Problems** (IND 1.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SYS ENG 5001 Special Topics** (LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

**SYS ENG 5040 Oral Examination** (IND 0.0)
After completion of all other program requirements, oral examination for on-campus MS/PhD students may be processed during intersession. Off-campus MS students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive exam (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**SYS ENG 5099 Research** (IND 1.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required. Prerequisite: Graduate standing.

**SYS ENG 5101 System Engineering and Analysis I** (LEC 3.0)
The concepts of Systems Engineering are introduced through a project. Students work in virtual teams. The topics covered are architecture development, basic system architectural design techniques, functional decomposition, design and technical review objectives, and initial specifications. Prerequisite: Graduate or senior standing.

**SYS ENG 5211 Computational Intelligence** (LEC 3.0)
Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Comp Sci 1510 or programming competency. (Co-listed with Elec Eng 5310 and Comp Eng 5310).

**SYS ENG 5212 Introduction To Neural Networks & Applications** (LEC 3.0)
Introduction to artificial neural network architectures, adaline, madaline, back propagation, BAM, and Hopfield memory, counterpropagation networks, self organizing maps, adaptive resonance theory, are the topics covered. Students experiment with the use of artificial neural networks in engineering through semester projects. Prerequisites: Math 3304 or 3329; graduate standing. (Co-listed with Elec Eng 5370).

**SYS ENG 5323 Wireless Networks** (LAB 1.0 and LEC 2.0)
Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Comp Eng 5430 and Elec Eng 5430).

**SYS ENG 6000 Special Problems** (IND 1.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SYS ENG 6001 Special Topics** (LEC 1.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

**SYS ENG 6010 Seminar** (RSD 0.0-6.0)
Discussion of current topics.

**SYS ENG 6040 Oral Examination** (IND 0.0)
After completion of all other program requirements, oral examination for on-campus MS/PhD students may be processed during intersession. Off-campus MS students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive exam (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**SYS ENG 6050 Continuous Registration** (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from campus must continue to enroll for at least one credit hour each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

**SYS ENG 6099 Research** (IND 1.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required. Prerequisite: Graduate standing.

**SYS ENG 6102 Systems Engineering Analysis II** (LEC 3.0)
This course uses customized case studies based on team projects from prior courses. Topics covered include physical and functional analysis, analysis and traceability of requirements and specifications, verification and validation, optimization, simulation, and trade studies. Prerequisite: Sys Eng 5101.

**SYS ENG 6103 Economic Analysis for Systems Engineering** (LEC 3.0)
Methods of economic evaluation for engineering projects involving complex systems. Economic impacts on choosing system alternatives, life cycle costing, economic decisions involving risk and uncertainty, and engineering cost estimation for projects in government, defense, and commercial industries. Prerequisite: Sys Eng 5101.

**SYS ENG 6104 Systems Architecting** (LEC 3.0)
The objective of the course is to provide the basic tools and concepts of architecting complex engineering systems. Systems thinking, ambiguity in system architecting, search as an architecting process, SysML and DoDAF Architecting Framework, System of Systems and Network-Centric Architectures. Prerequisite: Sys Eng 6102.

**SYS ENG 6105 Complex Engineering Systems Project Management** (LEC 3.0)
The course topics include issues specific to distributed project management, team development, resource management, constraint planning, development of Integrated Master Schedule and Integrated Master Plan, monitoring technical performance, schedule, cost, and risk. Prerequisite: Sys Eng 6102.

**SYS ENG 6110 Function-Based Risk Analysis** (LEC 3.0)
Risk analysis of products and systems will be explored using product functionality as the starting point. Traditional probabilistic risk assessment techniques will be covered along with recent approaches that use historical data to produce automatic risk assessments. Prerequisite: Graduate standing.
SYS ENG 6167 Software Intensive Systems Architecting (LEC 3.0)
Basic tools and concepts of architecting complex software intensive systems are introduced. The following topics are covered under four main sections; namely Architecting Process, Architecting Heuristics, Architecting Patterns and Frameworks, and Architecture Assessment. Prerequisite: Graduate Standing.

SYS ENG 6196 Systems Engineering Capstone (LEC 3.0)
The topics covered are Systems Engineering Management Plan (SEMP), Systems Engineering processes, process re-engineering, standards, and systems engineering case studies. Students will apply the skills and theory that they mastered in previous five core courses to the analysis of assigned cases. Prerequisites: Sys Eng 6105 and 6104.

SYS ENG 6213 Advanced Neural Networks (LEC 3.0)
Advanced artificial neural network architectures, namely; Radial-Basis Function Networks, Support Vector Machines, Committee Machines, Principal Components Analysis, Information-Theoretic Models, Stochastic Machines, Neurodynamic Programming, Temporal Processing are the topics covered. Prerequisite: Sys Eng 5212 or equivalent neural network course.

SYS ENG 6214 Clustering Algorithms (LEC 3.0)
An introduction to cluster analysis and clustering algorithms rooted in computational intelligence, computer science and statistics. Clustering in sequential data, massive data and high dimensional data. Students will be evaluated by individual or group research projects and research presentations. Prerequisite: At least one graduate course in statistics, data mining, algorithms, computational intelligence, or neural networks, consistent with student's degree program. (Co-listed with Comp Eng 6330, Elec Eng 6340, Comp Sci 6405 and Stat 6239).

SYS ENG 6215 Adaptive Dynamic Programming (LEC 3.0)
Review of Neurocontrol and Optimization, Introduction to Approximate Dynamic Programming (ADP), Reinforcement Learning (RL), Combined Concepts of ADP and RL - Heuristic Dynamic Programming (HDP), Dual Heuristic Programming (DHP), Global Dual Heuristic Programming (GDHP), and Case Studies. Prerequisites: Elec Eng 5370 or Comp Eng 5310. (Co-listed with Comp Eng 6320, Elec Eng 6360, Mech Eng 6458 and Aero Eng 6458).

SYS ENG 6216 Advanced Topics in Data Mining (LEC 3.0)
Advanced topics of current interest in the field of data mining. This course involves reading seminal and state-of-the-art papers as well as conducting topical research projects including design, implementation, experimentation, analysis, and written and oral reporting components. Prerequisite: A "C" or better grade in Comp Sci 5001 Introduction to Data Mining. (Co-listed with Comp Sci 6402 and Comp Eng 6302).

SYS ENG 6239 Smart Engineering System Design (LEC 3.0)
This course covers the emerging approaches for designing of smart engineering systems architectures for complex systems through evolutionary acquisition, namely; adaptive architecture generation for family of systems, complexity theory, evolutionary programming, fuzzy logic, collaborative behavior, artificial life, and chaos. Prerequisite: Sys Eng 5212 or graduate standing.

SYS ENG 6321 Network Centric Systems (LEC 3.0)
Network-centric systems comprises a diverse category of complex systems with the primary purpose is providing network-type services. Network-centric systems are also known as collaborative systems. This course address the intersection between network engineering and the needs of systems architecting and engineering. Prerequisite: Sys Eng 6104 or graduate standing. (Co-listed with Comp Eng 6410).

SYS ENG 6322 Resilient Networks (LEC 3.0)
This course presents reliability and fault tolerance for network-centric systems, including models, metrics, and analysis techniques. This course also concentrates on security, including technical tools and methods for audit and assessment as well as management and policy issues. Prerequisites: Sys Eng 6410, Comp Eng 6410, or Comp Eng 5420. (Co-listed with COMP ENG 6510).

SYS ENG 6324 Wireless Ad hoc and Sensor Networks (LEC 3.0)
Introduction to ad hoc and sensor networks, IEEE standards, heterogeneity, quality of service, wireless channel issues, energy awareness, power and topology control, routing, scheduling, rate adaptation, self-organization, admission and flow control, energy harvesting, security and trust levels, hardware and applications. Prerequisite: Comp Eng 5430 or Comp Eng 5420 or equivalent. (Co-listed with Comp Eng 6420 and Elec Eng 6430).

SYS ENG 6541 Distributed Systems Modeling (LEC 3.0)
This course will discuss issues related to distributed systems architecting, modeling, analysis and representation, with specific focus on discrete-part manufacturing domain. Distributed modeling techniques and other model decomposition methods using simulation modeling and scalability issues will also be addressed.

SYS ENG 6542 Model Based Systems Engineering (LEC 3.0)
Provides the student with understanding of the use of models to represent systems and validate system architectures. The student will gain proficiency in using a systems modeling language and shifting systems engineering from a document centric to a model centric paradigm. Prerequisite: Sys Eng 6541 or both a "C" or better grade in Comp Sci 3100 and instructor approval. (Co-listed with Comp Sci 6102).

SYS ENG 6612 Investment (LEC 3.0)
An introduction to the theory and practice of investment, including financial markets and instruments, security trading, mutual funds, investment banking, interest rates, risk premiums, the capital asset pricing model, arbitrage pricing theory, market efficiency, bonds and the fixed income market, equity valuation, fundamental and technical analysis. Prerequisite: Eng Mgt 1210 or 5210. (Co-listed with Eng Mgt 6212).

SYS ENG 6613 Financial Engineering (LEC 3.0)
An introduction to financial engineering, with an emphasis on financial derivatives, including the future markets, the pricing of forwards and futures, forward rate agreements, interest and exchange rate futures, swaps, the options markets, option strategies, the binomial and Black-Scholes models for option valuation, the option Greeks, and volatility smiles. Prerequisites: Eng Mgt 1210 or 5210. (Co-listed with Eng Mgt 6213).

SYS ENG 6614 Financial Engineering II (LEC 3.0)
This course introduces advanced topics in financial engineering, which includes introduction to Wiener processes, martingales and Ito's lemma; basic numerical methods for options pricing, exotic options; interest rate models; stochastic volatility models and jump-diffusion models; and value-at-risk. Prerequisite: Eng Mgt 6213/Sys Eng 6613. (Co-listed with Eng Mgt 6214).
SYS ENG 6615 Financial Risk Management (LEC 3.0)
Techniques and methods for managing financial risk, including portfolio theory, Monte Carlo methods, ARIMA, time series forecasting, Value-at-Risk, stress testing, extreme value theory, GARCH and volatility estimation, random variables and probability distributions, real options, decision trees, utility theory, statistical decision techniques, and game theory. Prerequisite: Eng Mgt 1210 or 5210. (Co-listed with Eng Mgt 6215).