Industrial and Systems Engineering

Industrial and Systems Engineers plan, design, implement, and analyze systems. This engineering discipline is where technology, people, business and information intersect. The degree provides graduates with broad, flexible career opportunities with manufacturing, consulting, service or governmental organizations. The degree can also provide the foundation and background for further studies in engineering and business as well as professions such as law or medicine. The curriculum builds on a solid engineering mathematics and science core and adds courses manufacturing, ergonomics and safety, operations research, statistics, quality control, engineering economics, simulation, and information technologies. The curriculum graduates students who have:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- An ability to communicate effectively with a range of audiences
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Major

- Industrial and Systems Engineering ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/industrialandsystemsengineering_major](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/industrialandsystemsengineering_major))

Minor

- Automotive Engineering and Manufacturing ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/automotiveeng_manufacturing_minor](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/automotiveeng_manufacturing_minor))
- Nuclear Power Generation Systems ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/nuclearpowergensystems_minor](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofindustrialandsystemsengineering/nuclearpowergensystems_minor))

Courses

**INSY 3010 PROGRAMMING AND DATABASE APPLICATIONS FOR ISE (3)** LEC. 3. Pr. COMP 1200. Programming and database applications for ISE students. Focus is on algorithm development as related to optimization, probability, statistics, and data analysis.

**INSY 3020 OCCUPATIONAL SAFETY ERGONOMICS (3)** LEC. 3. Basic principles of occupational safety engineering and ergonomics in the evaluation and design of occupation work areas and processes that include human operators.

**INSY 3021 METHODS ENGINEERING AND WORK MEASUREMENT (3)** LEC. 2. LAB. 3. Coreq. INSY 3020. Develops the student's ability to design workplaces and methods while providing an understanding of the work measurements process. Enables students to generate much of the basic methods data utilized in most industrial engineering projects.

**INSY 3030 CAD FOR ENGINEERS WITH INDUSTRIAL APPLICATIONS (1)** LAB. 3. Pr. COMP 1200 or COMP 1210 or COMP 1217 or COMP 3000 or ENGR 1110 or ENGR 1113. Use of computer technology to aid engineering design in industrial applications, e.g. represent and modify mechanical parts, diagrams, schematics, tools, equipment, office and plant layouts, etc.

**INSY 3400 STOCHASTIC OPERATIONS RESEARCH (3)** LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and STAT 3600. with a grade of C or better in STAT 3600. Modeling and analysis of decision-making and operations subject to randomness including decision analysis, stochastic dynamic programming, Markov chains, and queuing theory.
**INSY 3410** DETERMINISTIC OPERATIONS RESEARCH (3) LEC. 3. Pr. (ENGR 1110 or ENGR 1113) and MATH 2660 and P/C INSY 3010. Coreq. INSY 3010. Formulation, solution, interpretation, and implementation of mathematical models in operations research including linear programming, integer programming and network flows.

**INSY 3420** SIMULATION (3) LEC. 2. LAB. 3. Pr. INSY 3400 and (COMP 3010 or COMP 3013 or INSY 3010) and STAT 3610. with a grade of C or better in INSY 3400. Simulation procedures for solving complex systems analysis problems. Emphasis on random processes, model building and construction of computer simulation models.

**INSY 3600** ENGINEERING ECONOMY (3) LEC. 3. Pr. ENGR 1110 or ENGR 1113. Principles required in engineering economic studies.

**INSY 3700** OPERATIONS PLANNING AND CONTROL (3) LEC. 3. Pr. INSY 3400 and INSY 3410 and STAT 3610. with a grade of C or better in both INSY 3400 and INSY 3410. Analytical methods for operations planning and control, including forecasting systems, production planning, inventory control systems, scheduling systems, and project management.

**INSY 3800** MANUFACTURING SYSTEMS I (3) LEC. 2. LAB. 3. Introduction to the design, analysis, and operation of manufacturing systems, the first course in a required two-course sequence including Manufacturing Systems II.

**INSY 4330** STATISTICAL QUALITY DESIGN AND CONTROL (3) LEC. 3. Pr. STAT 3610. Statistical process control and methods for quality improvement. Acceptance sampling for attributes and for variables.

**INSY 4500/4503** PROFESSIONAL PRACTICE (1) LEC. Discussion and activities in current problems, the global context of, professional practice, professional opportunities and lifelong learning in Industrial and Systems Engineering. Senior standing in INSY.

**INSY 4610** INTERNATIONAL ENGINEERING PROJECT (3) LEC. 3. This course provides students with a real-life work experience in solving engineering-business problems through teamwork in an international setting. At the course end, students present their project to faculty and industry sponsors. The course is Auburn University Faculty led in which students work in groups mentored by faculty from Auburn and foreign universities and company sponsors. Students will be involved in projects that expose them to theory and practice of problem solving techniques involving data collection, statistical analysis, computational modeling, and experimental design of problems related to the service and manufacturing industries.

**INSY 4700** MANUFACTURING SYSTEMS II (3) LEC. 3. Pr. INSY 3420 and INSY 3600 and INSY 3700 and INSY 3800. Continuation of the design, analysis, and operation of manufacturing systems, the second course in a required two-course sequence including Manufacturing Systems I.

**INSY 4800** SENIOR DESIGN (3) LEC. 3. Pr. INSY 3021 and P/C INSY 4700. Coreq. INSY 4700. Capstone course in which undergraduate course-work principles are brought to bear upon a design problem in a cooperating industry or institution.

**INSY 4960** SPECIAL PROBLEMS (1-5) IND. Departmental approval. Individual student endeavor under faculty supervision involving special problems in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.

**INSY 4970** INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-10) AAB. Departmental approval. Special topics in Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 10 credit hours.

**INSY 4997** HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student endeavor consisting of direct research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

**INSY 5010** SAFETY ENGINEERING I (3) LEC. 3. Pr. INSY 3020. Departmental approval. Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design, and maintenance, and operation of effective safety programs. Credit will not be given for both INSY 5010 and INSY 6010/6016.

**INSY 5240** PRODUCTION AND INVENTORY CONTROL SYSTEMS (3) LEC. 3. Pr. INSY 3700. Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240/6246.

**INSY 5250** PROJECT MANAGEMENT (3) LEC. 3. Pr. INSY 3700. Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.
INSY 5330 DATA BASED DECISION MAKING USING SIX SIGMA (3) LEC. 3. Pr. INSY 4330 or departmental approval. Covers statistical tools needed for implementation of "Six Sigma", "Learn Six Sigma" and "Design for Six Sigma". Credit will not be given for both INSY 5330 and INSY 6330/6336.

INSY 5500 INFORMATION TECHNOLOGY FOR OPERATIONS (3) LEC. 3. Pr. COMP 3010 or COMP 3013. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.

INSY 5550 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Pr. COMP 3010 or COMP 3013. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550/6556.

INSY 5600 MANUFACTURING AND PRODUCTION ECONOMICS (3) LEC. 3. Pr. INSY 3600. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600/6606.

INSY 5630 REAL OPTIONS AND DECISION ANALYSIS (3) LEC. 3. Pr. INSY 3600 and STAT 3600. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 5753 INFORMATION TECHNOLOGY AUDITING (3) DSL. 3. Pr. ISMN 5730. In-depth instruction on the range of skills required of persons engaged in the performance of IT audit. The skills include those required by but not limited to a technology analyst, data scientist, or CIO.

INSY 5800/5803 LEAN PRODUCTION (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800/6806.

INSY 5830 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830/6836.

INSY 5840 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multidisciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia, and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840/6846.

INSY 5850 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850/6856.

INSY 5860 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assembly plant. Credit will not be given for both INSY 5860 and INSY 6860/6866.

INSY 6010/6016 SAFETY ENGINEERING I (3) LEC. 3. Occupational safety engineering and management with emphasis on control of hazardous materials, fire prevention, safety considerations in production facility design and maintenance, and operation of effective safety programs. Departmental approval. Credit will not be given for both INSY 5010 and INSY 6010.

INSY 6240/6246 PRODUCTION AND INVENTORY CONTROL SYSTEMS (3) LEC. 3. Analysis and design of production and inventory control systems with emphasis on quantitative methods, algorithms, and information technology. Credit will not be given for both INSY 5240 and INSY 6240.

INSY 6250/6256 PROJECT MANAGEMENT (3) LEC. 3. Introduction to project management for engineering, business and technology including; project management concepts, project life cycle, planning techniques, scheduling and network analysis, cost estimating and budgeting, risk management, execution and control, and evaluation and closeout.

INSY 6330/6336 DATA BASED DECISION MAKING USING SIX SIGMA (3) LEC. 3. Departmental approval. Covers statistical tools needed for implementation of "Six Sigma", "Lean Six Sigma" and "Design for Six Sigma". Credit will not be given for both INSY 5330 and INSY 6330/6336.
INSY 6500/6506 INFORMATION TECHNOLOGY FOR OPERATIONS (3) LEC. 3. Introduction to modern data science tools with applications in manufacturing and service industries and operations. Focus on the manipulation and use of small and large datasets. Tools include Jupyter, Python, R, and MySQL along with the related packages that support data modeling, visualization, and analysis.

INSY 6550/6556 DECISION SUPPORT SYSTEMS FOR OPERATIONS (3) LEC. 3. Fundamentals for modeling, designing, and implementing decision support systems for the operation of manufacturing and service industries. Credit will not be given for both INSY 5550 and INSY 6550.

INSY 6600/6606 MANUFACTURING AND PRODUCTION ECONOMICS (3) LEC. 3. Continuation of INSY 3600. Emphasis on design economics and cost estimating techniques and applications to various manufacturing and service operations. Credit will not be given for both INSY 5600 and INSY 6600.

INSY 6630/6636 REAL OPTIONS/DECISION ANALYSIS (3) LEC. 3. Analysis of engineering and business decisions under risk and contemporary risk management methods including statistical decision theory and real options. Credit will not be given for both INSY 5630 and INSY 6630/6636.

INSY 6800/6806 LEAN PRODUCTION (3) LEC. 3. Manufacturing system design based on a strategy of linked cells providing a continuous flow of materials. Evaluation strategies and analysis tools are studied. Credit will not be given for both INSY 5800 and INSY 6800.

INSY 6830/6836 VEHICLE TECHNOLOGY AND TRENDS (3) LEC. 3. Investigation of the advances in automotive technology and the impact of future technologies on the design and manufacture of the automobile. Credit will not be given for both INSY 5830 and INSY 6830.

INSY 6840/6846 CONTROL OF THE MANUFACTURING FLOOR AND PROCESSES (3) LEC. 2. LAB. 3. Students work within multi-disciplinary teams to apply the principles of Computer Aided Manufacturing and the Toyota Production System (TPS) on the modern automated floor. Laboratory features CNC Controls, Robots, Programmable Logic Controllers (PLC) and Kanban system. DELMIA Catia and MasterCAM. Credit will not be given for both INSY 5840 and INSY 6840.

INSY 6850/6856 ELECTRONICS MANUFACTURING SYSTEMS (3) LEC. 3. Introduction to electronics packaging and electronics manufacturing technologies including current and future trends, design and quality, and manufacturing for high volume. Credit will not be given for both INSY 5850 and INSY 6850.

INSY 6860/6866 AUTOMOTIVE MANUFACTURING SYSTEMS (3) LEC. 3. History of automotive manufacturing and the automotive manufacturing systems for a typical automotive assemble plant. Credit will not be given for both INSY 5860 and INSY 6860.

INSY 7020/7026 SAFETY ENGINEERING II (3) LEC. 3. Pr. (INSY 6010 or INSY 6016). Systems safety analysis techniques including human error and reliability, fault trees, and cost benefit analysis.


INSY 7050/7056 INDUSTRIAL HYGIENE AND ENVIRONMENTAL HAZARDS (3) LEC. 3. Introduction to the basic concepts of industrial hygiene with emphasis on the industrial hygiene/safety interface and on the evaluation and control of noise and vibration stress.

INSY 7060/7066 ERGONOMICS I (3) LEC. 3. Overview of the human body systems and evaluation of the physiological response of the human body to occupational activities with emphasis on task design.

INSY 7070/7076 ERGONOMICS II (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Use of biomechanics in the evaluation and design of work activities. Emphasis is placed on biomechanical modeling, manual materials handling, tool design, and repetitive motion trauma.

INSY 7080/7086 HUMAN FACTORS ENGINEERING (3) LEC. 3. Examination of human factors, ergonomics and safety research methodologies. Emphasis is on human information input, output and control processes with the objective of optimizing integration of the human into simple and complex systems.

INSY 7081 HUMAN FACTORS LABORATORY (1) LAB. 3. Coreq. INSY 7080. Laboratory experience in testing human factors principles and concepts covered in INSY 7080. Experience in proper writing of laboratory reports.
INSY 7100/7106 ADAPTIVE OPTIMIZATION (3) LEC. 3. Departmental approval. Adaptive search methods inspired by nature for
continuous and combinatorial optimization. Methods include simulated annealing, genetic algorithms, evolutionary strategies, tabu
search and ant colony systems.

INSY 7120/7126 DATA ANALYTICS FOR OPERATIONS (3) LEC. 3. Pr. INSY 6500. or equivalent. This course covers the broad
topics of predictive analytics, data visualization, and big data in the context of operations analysis. Focus will be on the application of
modern computer tools with previously learned statistical and mathematical modeling tools, culminating in a semester project.

INSY 7130/7136 DATA MINING TECHNIQUES AND APPLICATIONS FOR OPERATIONS (3) LEC. 3. Pr. INSY 6500. or equivalent.
This introductory course will cover the most common techniques for extracting useful information and models from numerical or
categorical data. Techniques include clustering and classification, regression and spline models, kriging, and artificial neural networks.
Also considered are data pre-processing, model building and model validation. Modeling and validation under conditions of sparse data
will be addressed as well. Applications include those in finance, manufacturing, health care, and more.

INSY 7190 OCCUPATIONAL SAFETY AND HEALTH FORUM I (1) LEC. 1.

INSY 7200/7206 ENGINEERING APPLICATIONS OF FUZZY SYSTEMS AND NEURAL NETWORKS (3) LEC. 3. Departmental
approval. Introduction to fuzzy systems and neural networks with emphasis on their uses in engineering applications in clustering,
modeling, optimization, control, forecasting, and classification. A

INSY 7230/7236 ADVANCED LAYOUT AND LOCATION (3) LEC. 3. Facility layout algorithms and the facility design process. Facility
location models and their relationship to strategic organization goals.

INSY 7240/7246 PRODUCTION AND INVENTORY CONTROL THEORY (3) LEC. 3. Theoretical foundations for the analysis and
design of production and inventory control systems with emphasis on quantitative methods and current areas of research.

INSY 7290 OCCUPATIONAL SAFETY AND HEALTH PRACTICUM I (1) LEC. 1. Study of contemporary interdisciplinary issues in
occupational safety and health. Investigation of real-world interdisciplinary OSH problems. Analysis and presentation of OSH concerns
and solutions.

INSY 7300/7306 ADVANCED ENGINEERING STATISTICS I (3) LEC. 3. Advanced concepts of experimental design including blocked
designs, analysis of variance regression approach, and fractional factorials in base-2 designs. Emphasis throughout is on developing
and improving industrial products and processes. Credit will not be given for both INSY 7300 and STAT 7300.

INSY 7310/7316 ADVANCED ENGINEERING STATISTICS II (3) LEC. 3. Pr. (STAT 7300 or STAT 7306) or (INSY 7300 or INSY
7306). Fractional factorial experimentation applied for the purpose of process and quality improvement and optimization, introduction
to analysis of covariance, multiple regression analysis, and response surface analysis. Credit will not be given for both INSY 7310 and
STAT 7310.

INSY 7330/7336 OFF LINE AND ON LINE QUALITY CONTROL (3) LEC. 3. Pr. STAT 7010 or (STAT 7300 or STAT 7306) or (INSY
7300 or INSY 7306). Departmental approval. Taguchi's quality loss functions. Taguchi's orthogonal arrays and their relationships
to fractional factorial designs. Taguchi's parameter and tolerance designs, on-line process control concepts and methods. Process
capability. CUSUM charts and other process control charts.

INSY 7380/7386 RELIABILITY ENGINEERING (3) LEC. 3. Reliability, maintenance, replacement with emphasis on failure-rate
estimation and life testing. Hazard functions, parameter estimation and reliability testing including exponential and Weibull distributions.
Markov models and repairable systems. Credit is not given for both INSY 7380 and STAT 7780. Departmental permission.

INSY 7390 OCCUPATIONAL SAFETY AND HEALTH FORUM II (1) LEC. 1. Pr. INSY 7190. Continuation of OSH Forum I
(contemporary interdisciplinary issues in occupational safety and health). Emphasis is placed on leadership and mentoring of other
OSH students (INSY 7190).

INSY 7400/7406 SIMULATION MODELING AND ANALYSIS (3) LEC. 3. Introduction to discrete event modeling and simulation.
Fundamental concepts of Monte Carlo and discrete event simulation and the application of those concepts using commercial simulation
software.

INSY 7420/7426 LINEAR PROGRAMMING AND NETWORK FLOWS (3) LEC. 3. Linear programming and network flows emphasizing
algorithms and theory.

INSY 7430/7436 INTEGER AND NONLINEAR PROGRAMMING (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Departmental approval.
Integer and non linear programming, emphasizing algorithms and theory.
INSY 7440/7446 DYNAMIC PROGRAMMING (3) LEC. 3. Departmental approval. Aspects of sequential decision making with emphasis on formulation and solution using the dynamic programming algorithm. Approximation methods for problems involving large state spaces. Solution techniques for problems under uncertainty.

INSY 7470/7476 SEARCH METHODS FOR OPTIMIZATION (3) LEC. 3. Single and multivariate search techniques and strategies that are used in finding the optimum of discrete and continuous functions.

INSY 7490 OCCUPATIONAL SAFETY AND HEALTH PRACTICUM II (1) LEC. 1. Pr. INSY 7290. Investigation of real-world interdisciplinary OSH problems. Analysis and presentation of OSH concerns and solutions. Emphasis is placed on leadership and mentoring of other OSH students (INSY 7290).

INSY 7500/7506 ADVANCED SIMULATION (3) LEC. 3. Pr. INSY 7400 or INSY 7406. Coverage of advanced simulation and simulation language design concepts. Includes advanced input/output analysis, modeling concepts, and language design/implementation concepts.

INSY 7550/7556 STOCHASTIC OPERATIONS RESEARCH (3) LEC. 3. Stochastic operations research models with emphasis on model formation, solution and interpretation of results. Emphasis on stochastic processes, queuing theory and their applications.


INSY 7710/7716 LIFE CYCLE ENGINEERING (3) LEC. 3. The life cycle engineering course focuses on various life cycle methodologies and tools like life cycle design, product life cycle, life cycle assessment (LCA) and inventory (LCI), service, reuse, remanufacturing, sustainable design, risk assessment and management and other related topics. May count either INSY 7710 or INSY 7716.

INSY 7720/7726 SYSTEMS ENGINEERING I (3) LEC. 3. Processes and tools for engineering large-scale, complex complex systems: architecture, requirements, risk management, evaluation, concept exploration, decision-making, tradeoff studies, life cycle models, decomposition, system coupling, test, verification, validation, system modeling, business process re-engineering, sensitivity analysis, teamwork, process maturity and documentation. May count either INSY 7720 or INSY 7726.

INSY 7730/7736 PRODUCT DESIGN, DEVELOPMENT, AND TEST (3) LEC. 3. This class teaches modern tools and methods for product design, development, and test of highly complex and large systems including technical specification, reliability, maintainability, manufacturability, testability, marketing, costs, etc. May count either INSY 7730 or INSY 7736.

INSY 7740/7746 PRODUCT LAUNCH, MANUFACTURING, AND DELIVERY (3) LEC. 3. This course teaches students the issues, strategies, and approaches related to launching, manufacturing, and delivering new products or services including customer focus, marketing, manufacturing and launch strategies, delivery and related tools and techniques.

INSY 7750/7756 INTELLECTUAL PROPERTY, LEGAL, AND VENTURE CAPITAL (3) LEC. 3. This course teaches students the US law of intellectual property with major emphasis on patents. Students also learn venture capital including stages of funding, funding presentations, various requirements of funding, types of partnership, exit plans, etc. May count either INSY 7750 or INSY 7756.

INSY 7940/7946 INDUSTRIAL AND SYSTEMS ENGINEERING PROBLEMS (1-5) IND. Departmental approval. Individual student endeavor under staff supervision involving special problems of an advanced undergraduate or graduate nature in Industrial and Systems Engineering. Interested student must submit written proposal to department head. Course may be repeated for a maximum of 5 credit hours.

INSY 7950/7956 SEMINAR (1) LEC. 1. SU. Presentation and discussion of ISE research by graduate students, faculty and guests. Must be taken at least one term and cannot be used in the plan of study to apply towards the minimum number of hours for a degree.

INSY 7970/7976 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. 1. LAB 1. Departmental approval. Special topics of a graduate nature pertinent to Industrial and Systems Engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 7980/7986 MASTER'S IN INDUSTRIAL AND SYSTEMS ENGINEERING PROJECT (1-5) IND. SU. Non-thesis master's project. Course may be repeated for a maximum of 5 credit hours.

INSY 7990/7996 RESEARCH AND THESIS (1-10) MST. Course may be repeated with change in topics.
INSY 8010/8016 ADVANCED SAFETY ENGINEERING (3) LEC. 3. Pr. INSY 7020 or INSY 7026. Topics of current interest in occupational safety research. Occupational safety research methodology and research priorities.

INSY 8060/8066 ADVANCED ERGONOMICS (3) LEC. 3. Pr. INSY 7060 or INSY 7066. Topics of current interest in occupational ergonomics and human factors research. Occupational ergonomics and human factors research methodology and research priorities.

INSY 8250 SCHEDULING THEORY (3) LEC. 3. Pr. (INSY 6250 or INSY 6256) and (INSY 7420 or INSY 7426). The theory for various scheduling methods and models is presented. Emphasis is on current research in the scheduling area.

INSY 8420/8426 TOPICS IN OPTIMIZATION (3) LEC. 3. Pr. INSY 7420 or INSY 7426. Basic concepts and theory of optimization, including saddlepoint conditions for differentiable and non-differentiable programs, duality, approximation, decomposition and partitioning, illustrated by application to specific algorithms.

INSY 8970 INDUSTRIAL AND SYSTEMS ENGINEERING SPECIAL TOPICS (1-5) LEC. Departmental approval. Special topics of an advanced graduate nature pertinent to industrial and systems engineering. Specific prerequisites will be determined and announced for each offering. Course may be repeated for a maximum of 5 credit hours.

INSY 8990/8996 RESEARCH AND DISSERTATION (1-10) DSR. Course may be repeated with change in topics.