# Industrial & Systems Engineering - INSY

## Courses

**INSY 3010 PROGRAMMING AND DATABASE APPLICATIONS FOR ISE (3)** LEC. 3. Pr. COMP 1200 or COMP 1220 or COMP 1230. 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. 2.5. 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 or MATH 2667) 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. 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. Junior or Senior standing.

**INSY 3607 HONORS 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. Departmental approval required for non-INSY majors.

**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 PROFESSIONAL PRACTICE (1)** LEC. 1. Pr. P/C INSY 3700. 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 3010 and INSY 3400 and INSY 3410 and INSY 3420 and (INSY 3600 or INSY 3607) 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. 0. LAB. 3. Pr. INSY 3021 and (INSY 4500 or INSY 4503) and P/C 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 5010 OCCUPATIONAL SAFETY ENGINEERING (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 5050 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 chemical exposures, biological hazards, noise and heat stress for undergraduate engineers.

**INSY 5080 HUMAN FACTORS ENGINEERING (3)** LEC. 3. Human Factors Engineering is the science of designing products and systems for optimal human well-being and system performance. This course will focus on information processing and the cognitive aspects of ergonomics design. Students will gain insight into the effects of various environments (hot, cold, noise, information overload, etc.) on humans and human performance. Physical ergonomics will be addressed somewhat as well. Emphasis is on human information input, output, and control processes with the objective of optimizing the integration of the human into simple and complex systems.

**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. 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 SIX SIGMA (3)** LEC. 3. This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.

**INSY 5400 MULTI-PARADIGM MODELING AND SIMULATION (3)** LEC. 2. LAB. 1. Pr. INSY 3420. Multi-paradigm simulation modeling procedures for analyzing real-world complex systems. Emphasis on model building, and construction of multi-paradigm computer simulation models using Agent Based Modeling, System Dynamics, and Discrete Event Simulation approaches.

**INSY 5450 SIMULATION-BASED PLANNING AND SCHEDULING (3)** LEC. 3. Pr. INSY 3420. A graduate/undergraduate course in simulation-based planning and scheduling. Topics include intermediate simulation modeling, dispatching and scheduling methods, and implementation of scheduling systems and supply chain planning systems using a commercial simulation software package.

**INSY 5500 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (3)** LEC. 3. Pr. INSY 3010. 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. INSY 3010. 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 ENGINEERING ECONOMIC SYSTEMS (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 5800 LEAN SYSTEMS (3)** LEC. 2. LAB. 2. 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 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 6840/6846.

**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 INNOVATIONS IN MANUFACTURING SYSTEMS (3)** LEC. 3. This course reviews the history of manufacturing and discusses the contributions of the automotive manufacturing industry in developing most of the major manufacturing systems improvements over the decades. Issues associated with suppliers are presented related to processes, supply chain, product and process improvement, quality control, and costs. In addition, the issue of globalization and the digitalization of manufacturing is investigated. Finally, a discussion of future manufacturing technologies and impacts will be discussed. Credit will not be given for both INSY 5860 and INSY 6860/6866.

**INSY 5870 INTERACTIVE SENSING SYSTEMS (3)** LEC. 3. Pr. (INSY 3010). Interactive Sensing Systems is an advanced course designed to provide students with in-depth knowledge and hands-on experience in developing intelligent systems that integrate microcontrollers and sensors. The course emphasizes the practical application of sensor technologies and microcontroller programming to solve real-world problems.

**INSY 6010 OCCUPATIONAL SAFETY ENGINEERING (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. Credit will not be given for both INSY 5010 and INSY 6010.

**INSY 6050 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 chemical exposures, biological hazards, noise and heat stress for graduate engineers.

**INSY 6080 HUMAN FACTORS ENGINEERING (3)** LEC. 3. Human Factors Engineering is the science of designing products and systems for optimal human well-being and system performance. This course will focus on information processing and the cognitive aspects of ergonomics design. Students will gain insight into the effects of various environments (hot, cold, noise, information overload, etc.) on humans and human performance. Emphasis is on human information input, output, and control processes with the objective of optimizing the integration of the human into simple and complex systems.

**INSY 6100 SYSTEMS ENGINEERING I (3)** LEC. 3. Processes and tools for engineering large-scale, 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. Credit will not be given for both INSY 5100 and INSY 6100.

**INSY 6240 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 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 SIX SIGMA (3)** LEC. 3. This course covers the six sigma engineering techniques. The content emphasizes the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology combined with Lean management practices through analytical and quantitative tools.

**INSY 6400 MULTI-PARADIGM MODELING AND SIMULATION (3)** LLB. Pr. INSY 7400. Multi-paradigm simulation modeling procedures for analyzing real-world complex systems. Emphasis on model building, and construction of multi-paradigm computer simulation models using Agent Based Modeling, System Dynamics, and Discrete Event Simulation approaches. Students must have successfully passed a graduate level course in Probability and Statistics or an equivalent course, INSY 7400, or request instructor approval.

**INSY 6450 SIMULATION-BASED PLANNING AND SCHEDULING (3)** DSL/LEC. A graduate/undergraduate course in simulation-based planning and scheduling. Topics include intermediate simulation modeling, dispatching and scheduling methods, and implementation of scheduling systems and supply chain planning systems using a commercial simulation software package. Knowledge of simulation and basic understanding of Simio is required to enroll in course.

**INSY 6500 MODERN TOOLS FOR DATA ANALYTICS AND MODELING (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 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 ENGINEERING ECONOMIC SYSTEMS (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 6700 DIGITAL DRAWINGS, GEOMETRIC TOLERANCES, AND METROLOGY FOR INDUSTRY 4.0 (4)** LEC. 3. LAB. 2.33. Departmental approval. Digital manufacturing begins with accurate electronic drawings designed with precision measurement in mind. This course covers the design, dimensioning, tolerancing, and inspection for part and assembly manufacturing from the ASME Y14.5 (2018) Standard. Students will model parts in a CAD program, create manufacturing inspection drawings with applied GD&T concepts, and work with an industry grade Coordinate Measurement Machine (CMM) software to develop inspection plans. Basic Computer Aided Design (CAD) concepts are taught in Fusion 360.

**INSY 6710 BASIC CONCEPTS OF 21ST CENTURY MANUFACTURING PROCESSES (3)** LEC. 3. Departmental approval. This is the first of a two-semester program detailing all the manufacturing concepts and processes available in the 21st Century. There is a heavy emphasis on the interaction of shapes, materials and process in design and economic decision making. Students will review basic fundamentals of acceptance testing, material properties and characteristics as a foundation for all process decisions. Processes introduced in this course will include metal casting, rolling, and extrusion.

**INSY 6720 ADVANCED CONCEPTS OF 21ST CENTURY MANUFACTURING PROCESSES (3)** LEC. 3. Departmental approval. This is the second of a two-semester program detailing all the manufacturing concepts and processes available in the 21st Century. There is a heavy emphasis on the interaction of shapes, materials and process in design and economic decision making. This course covers all the classic and modern subtractive methods as well as the joining methods. Automation of manufacturing processes, computer aided and computer integrated manufacturing along with industry 4.0 are covered.

**INSY 6730 CONCEPTS OF COMPUTER NUMERICAL CONTROLS (4)** LEC. 3. LAB. 2.33. Pr. INSY 5700 or INSY 6700. Departmental approval. This course will introduce key concepts involved in the use of Computer Aided Machining. Concepts include the construction of tools within CAM software, determining feeds and speeds from tool manufacturer specifications, basics of G-Code and M-Code, and various tool pathing operations. The course covers model-based CAM, conversational CAM, and basic 3D printing concepts. The model-based CAM portion will cover 3 axis and 5 axis mill work, lathe operations, and mill turn operations.

**INSY 6740 CONCEPTS OF INDUSTRY 4.0 (3)** LEC. 2. LAB. 2.33. Pr. INSY 5700 or INSY 6700. Departmental approval. Students develop a firm understanding of the fundamentals of Mechatronics and learn how to utilize these new tools in conjunction with the Industrial Internet of Things (IIOT) via the MTConnect Standard. Topics include circuits, sensors, actuators, controls, communication protocols, Industry 4.0, and the MTConnect Standard. Labs will be held at the Interdisciplinary Center for Advanced Manufacturing Systems (ICAMS).

**INSY 6800 LEAN SYSTEMS (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 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 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 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 INNOVATIONS IN MANUFACTURING SYSTEMS (3)** LEC. 3. This course reviews the history of manufacturing and discusses the contributions of the automotive manufacturing industry in developing most of the major manufacturing systems improvements over the decades. Issues associated with suppliers are presented related to processes, supply chain, product and process improvement, quality control, and costs. In addition, the issue of globalization and the digitalization of manufacturing is investigated. Finally, a discussion of future manufacturing technologies and impacts will be discussed. Credit will not be given for both INSY 5860 and INSY 6860.

**INSY 6870 INTERACTIVE SENSING SYSTEMS (3)** LEC/LLB. Interactive Sensing Systems is an advanced course designed to provide students with in-depth knowledge and hands-on experience in developing intelligent systems that integrate microcontrollers and sensors. The course emphasizes the practical application of sensor technologies and microcontroller programming to solve real-world problems.

**INSY 7020 SYSTEM SAFETY ENGINEERING (3)** LEC. 3. Systems safety analysis techniques including human error and reliability, fault trees, and cost benefit analysis.

**INSY 7040 COGNITIVE ENGINEERING AND SYSTEM DESIGN (3)** LEC. 3. Cognitive Engineering and System Design is an introduction into human capabilities and limitations in human-machine interaction, with a focus on human cognition, memory, attention, and error. The course emphasis is on cognitive engineering theory and its application to automated system design.

**INSY 7060 FUNDAMENTALS OF ERGONOMICS (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 OCCUPATIONAL BIOMECHANICS (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 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 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 DATA ANALYTICS FOR OPERATIONS (3)** LEC. 3. Pr. INSY 6500 or INSY 6506. 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 DATA MINING TECHNIQUES AND APPLICATIONS FOR OPERATIONS (3)** LEC. 3. 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 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 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 7380 RELIABILITY ENGINEERING (3)** LEC. 3. Departmental approval. Reliability Engineering is a sub-discipline of systems engineering that emphasizes the ability of a system or component to function without failure. This course covers concepts and methods to evaluate the reliability of engineering systems. The primary focus is on statistical reliability distributions, analysis of reliability data, prediction of failure and reliability modeling, accelerated life testing, reliability of complex systems, and design for reliability.

**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 APPLIED DISCRETE-EVENT SIMULATION MODELING (3)** LEC. 3. Introductory graduate course in discrete event modeling and simulation. Course focus is on the application of modern simulation tools and techniques for solving design and analysis problems in manufacturing, service systems, and general operations.

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

**INSY 7430 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 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 7450 STOCHASTIC OPTIMIZATION AND RISK (3)** LEC. 3. Pr. INSY 7420. Stochastic Optimization and Risk is a course for graduate students in engineering, operations research, management science, etc. The objective of the course is to familiarize students with the challenges that uncertain or randomized data bring into the decision making/design process and introduce the general methods and approaches for dealing with such challenges. We will discuss various approaches to modeling of uncertainties and risk in optimization problems, properties of the resulting stochastic programming formulations, and several common techniques for solving stochastic programs.

**INSY 7470 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 7550 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 SYSTEM LIFECYCLE REQUIREMENTS (3)** LEC. 3. The System Lifecycle Requirements course focuses on developing and writing proper requirements for systems across the entire life cycle. Well written requirements are a solid foundation for system design development and this course will identify design considerations at early concept identification, design maturation, implementation, production, operations & sustainment, and disposal phases. Students will exercise stakeholder needs elicitation, requirements writing, requirements decomposition, and applying life cycle considerations during requirements development process during a semester long project.

**INSY 7730 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 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 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 7760 ENGINEERING & TECHNOLOGY MANAGEMENT (3)** LEC. 3. Engineering Management is the branch of management that focuses on leading technical personnel in the management of engineering driven enterprises. This course emphasizes the application of management principles to the engineering of large-scale systems and research efforts. It focuses on the planning, individual & team motivation, strategic /tactical management, change and risk management and decision-making necessary to manage a company's technical portfolio.

**INSY 7940 INDUSTRIAL AND SYSTEMS ENGINEERING PROBLEMS (1-5)** DSL/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 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 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 MASTER'S IN INDUSTRIAL AND SYSTEMS ENGINEERING PROJECT (1-5)** DSL/IND. SU. Non-thesis master's project. Course may be repeated for a maximum of 5 credit hours.

**INSY 7990 RESEARCH AND THESIS (1-10)** MST. Departmental approval. Individual masters research. May be repeated for credit. Course may be repeated with change in topics. No more than six hours may be counted toward meeting degree requirements. Must be an INSY major.

**INSY 8010 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 8020 RESEARCH METHODS IN OCCUPATIONAL SAFETY, ERGONOMICS, AND INJURY PREVENTION (3)** LEC. 3. Pr. INSY 7300 or INSY 7306 or INSY 7060 or INSY 7066 or INSY 6010 or INSY 6016. To introduce students to contemporary and developmental research methods in occupational safety, ergonomics, and injury prevention with emphasis on the public health model as applied to occupational injury prevention and epidemiology. Instructor approval may be required.

**INSY 8060 CONTEMPORARY 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 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 RESEARCH AND DISSERTATION (1-10)** DSL/DSR. Departmental approval. Individual doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics. Must be INSY major.