**INDUSTRIAL ENGINEERING (IE)**

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

### Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (https://louisville.edu/bursar/tuitionfee/university-fees/).

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Term Typically Offered</th>
<th>Prerequisite(s)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE 515</td>
<td>Operations Research Methods</td>
<td>Fall Only</td>
<td>ENGR 307 or MATH 407 - Formulation of basic models in operations research</td>
<td>Topics to be covered include applications of linear, integer and nonlinear programming; transportation and assignment problems, and network flows models. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>3 Units</td>
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<tr>
<td>IE 516</td>
<td>Stochastic Operations Research</td>
<td>Spring Only</td>
<td>IE 360 or equivalent</td>
<td>A selection of the probabilistic topics of operations research are included: queuing, renewal and Markov processes, simulation, decision analysis. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>3 Units</td>
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<tr>
<td>IE 525</td>
<td>Project Management</td>
<td>Fall, Spring, Summer</td>
<td>Admission in IE or EM program or instructor permission</td>
<td>Use of CPM, PERT, precedence diagramming, resource allocation heuristics, and other techniques for planning, managing, and controlling engineering projects involving research and development, production, maintenance, and construction. Computer procedures and codes for analyzing complex project networks will be covered. Note: Cross-listed with EM 525</td>
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<td>3 Units</td>
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<tr>
<td>IE 540</td>
<td>Robots and Manufacturing Automation</td>
<td>Fall, Spring, Summer</td>
<td>IE 360</td>
<td>Computer aided manufacturing; robot programming, implementation, application, and computer control; research trends; social impacts. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>3 Units</td>
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<tr>
<td>IE 541</td>
<td>Simulation</td>
<td>Fall Only</td>
<td>IE 240, IE 250, and IE 360</td>
<td>The use of discrete event simulation to analyze systems. Topics include Monte Carlo techniques, sampling from and identifying stochastic distributions, estimating performance measures from simulation outputs, validation methods, and SIMIO simulation language. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>3 Units</td>
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<tr>
<td>IE 560</td>
<td>Probability and Statistics for Engineers</td>
<td>Fall, Spring, Summer</td>
<td>ENGR 102 OR (Calc I AND graduate status)</td>
<td>Engineering applications using probability, random variables, distribution functions, confidence intervals, estimation and hypothesis testing. Note: Students cannot receive credit for both IE 360 and IE 560. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>3 Units</td>
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<tr>
<td>IE 561</td>
<td>Developing Decision Support Systems with Excel</td>
<td>Fall, Spring</td>
<td>IE 250</td>
<td>This course teaches the fundamentals of computer programming using Excel's macro language, Visual Basic for Applications (VBA), as the language of instruction. The course starts by teaching students to simplify and extend code generated by Exce's macro recorder and then builds on that base toward developing applications that analyze information and enhance decision making. The course also provides an introduction to the concepts and methods of Decision Science, which involves the application of mathematical modeling and analysis to management problems. It also provides a foundation for modeling with VBA in Excel. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>3 Units</td>
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<tr>
<td>IE 563</td>
<td>Experimental Design in Engineering</td>
<td>Spring, Summer</td>
<td>IE 360 OR IE 560</td>
<td>Design of engineering experiments and projects using theory of least squares, analysis of variance, randomized blocks, factorial experiments, nested designs, split plot designs and logistic regression techniques. Covers a combination of analysis by hand and using Minitab statistical software. Students may not obtain credit for both IE 563 and ME 611; or for IE 563 and EM 661. Note: Cross-listed with CSE 563</td>
</tr>
<tr>
<td>3 Units</td>
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</tbody>
</table>
IE 580. Introduction to Human Factors Engineering and Ergonomics 3 Units
Term Typically Offered: Fall Only
Description: The main goal of this course is to introduce students to the study of human cognitive and physical abilities and limitations, and application of that knowledge to engineering design. This course will demonstrate how the application of the human factors and ergonomics principles can improve the design of systems involving the interaction of humans with tools, technology, and the work environment.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 581. Advanced Topics in Human Factors Engineering 3 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): IE 580.
Description: The main goal of this course is to learn and apply advanced methods in human factors engineering, as well as newer models, theories, and frameworks related to the field.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 585. Usability Engineering 3 Units
Term Typically Offered: Spring Only
Description: This course exposes students to the constructs of usability, usefulness, user-centered design, and user-experience (UX) and their relation to engineering design. The course covers an interactive evaluation-centered user experience (UX) lifecycle as a template intended to be instantiated in many different ways to match the constraints of a particular development project. The UX lifecycle, sketching, conceptual design, and formative UX evaluation.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 590. Special Topics in Industrial Engineering 1-6 Units
Term Typically Offered: Fall, Spring, Summer
Description: A theoretical and/or experimental investigation of an industrial engineering design topic.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 600. Additive Manufacturing Processes 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): IE 320 (or equivalent) and Graduate standing in the JB Speed School of Engineering.
Description: This course introduces students to additive manufacturing, also known as rapid prototyping or 3D printing, processes. An overview of all additive manufacturing processes is provided. Projects are used to develop in-depth knowledge in key applications of additive manufacturing. Design project gives students an opportunity to apply their knowledge to the design and/or re-design of a component.
Note: Students cannot receive credit for both IE 600 and IE 400.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 601. Additive Manufacturing Structure Design 3 Units
Description: This course focuses on the overview of design issues in additive manufacturing (AM), including the design of structures, materials and processes. The students are expected to gain in-depth understanding of the design issues with current AM technologies. Hands-on projects will be assigned that gives the students the opportunity of understanding the design issues and applying the knowledge to the design of functional parts and assemblies.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 602. Graduate Internship in Industrial Engineering 1 Unit
Grading Basis: Pass/Fail
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): Admission to Graduate Study, Permission of Department Chair, and Permission of Director of Career Services.
Description: Supervised professional experience in industry at the graduate level. This course provides the structure and focus for the graduate intern field assignment to ensure that the assignment is appropriate and consistent with the intern's graduate course of study and professional development. May be repeated for credit.
Course Attribute(s): CBL - This course includes Community-Based Learning (CBL). Students will engage in a community experience or project with an external partner in order to enhance understanding and application of academic content.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 610. Foundations of Optimization I 3 Units
Prerequisite(s): IE 515.
Description: Formulation and solution of applicable optimization models for linear, integer, and network problems. Efficient algorithmic methods and use of computer modeling languages and systems.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 611. Discrete Optimization 3 Units
Prerequisite(s): IE 515.
Description: A study of the techniques and applications of discrete optimization, especially as related to integer and dynamic programming.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 614. Foundations of Optimization II 3 Units
Prerequisite(s): ENGR 330 and IE 610.
Description: Formulation and solution of applicable optimization models for nonlinear, stochastic programming, robust optimization and convex problems. Efficient algorithmic methods and use of computer modeling languages and systems.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
IE 615. Exact and Heuristic Algorithms for Optimization 3 Units
Term Typically Offered: Fall Odd Years
Prerequisite(s): CSE 120 (or equivalent previous permission of the instructor) and IE 515 (or basic knowledge of linear programming, duality theory and integer programming).
Description: This course is a survey of the most common search methods for optimization problems. We will focus on exact methods (including: Exhaustive Search, Branch and Bound, Column Generation, Decomposition methods), and on heuristic methods (including, Random search, Greedy Search, Local Search, Simulated Annealing (SA), Greedy Randomized Adaptive Search (GRASP), Genetic Algorithms (GA)). Both combinatorial and continuous optimization problems will be considered, with emphasis on combinatorics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 619. Advanced Manufacturing Systems 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): Previous course preparation in the areas of manufacturing process principles and industrial digital automation control is required.
Description: This course focuses on providing a more comprehensive exposure of science, engineering and practice associated with the modern manufacturing engineering. A broad range of topics, including manufacturing engineering, industrial automation, design for manufacturing, process concept design and prototyping, industrial sensing, internet of things, data analytics, statistics and additive manufacturing. This course does not attempt to establish a rigorous theoretical knowledge base for all the covered topic areas, but instead focuses on establishing the connections among the different topic areas for real-world application scenarios. The course utilizes project-based learning as the primary tool for knowledge learning and hands-on practice. Throughout the course, 5-6 labs/projects are anticipated, all requiring team works and structured reporting. Assignments such as individual homework will be employed as additional learning tools for necessary knowledge for solving manufacturing problems.
Note: Students cannot receive credit for both IE 419 and IE 619
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 621. Facility Location and Layout 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): IE 240.
Description: Design and layout of industrial facilities, facility location, space requirement, flow charts, relationships diagrams, material handling, quantitative layout techniques, production line balancing, and computer programs for layout planning. Students cannot receive credit for both IE 621 and IE 421.
Note: Cross-listed with IE 421.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 625. Production and Inventory Control 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): IE 240 and IE 560.
Description: Topics include the context of inventory management and production planning decisions, economic order quantities, heuristics and models for probabilistic and time-varying demand patterns, coordinated replenishment systems, and aggregate planning.
Note: Students cannot receive credit for both IE 425 and IE 625.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 629. Quality Control 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): This course is only available for those who have not taken IE430.
Description: Previous course preparation in the areas of engineering statistics is required and approved by instructor. Developing an effective total quality control (TQC) system: integrating the quality development, maintenance, and improvement efforts of an organization; control charts, process capability, value engineering, product liability prevention, and computer control.
Note: Students cannot receive credit for both IE 629 and IE 430.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 630. Advanced Production Systems Design 3 Units
Term Typically Offered: Spring Odd Years
Prerequisite(s): IE 421, IE 425, IE 430.
Description: This course is organized around the principles of Lean Manufacturing Engineering. Topics include lean manufacturing, including value, value stream, flow, pull and continuous improvement. Improvement and efficiency are facilitated through a study of factory dynamics, the influence of variability, and "Push and Pull" production systems.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 631. Advanced Quality Control 3 Units
Description: Advanced techniques for quality improvement and process control are investigated; these include advanced techniques of SPC, trouble shooting and diagnostics and Taguchi methods of experimental design.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 634. Case Studies in Production and Industrial Engineering 3 Units
Prerequisite(s): IE 425, IE 515, IE 541.
Description: Case studies illustrate the application of industrial engineering techniques to the design of production systems, the control of construction projects, and health care delivery systems.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
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<tbody>
<tr>
<td>IE 640</td>
<td>Applied Systems Analysis</td>
<td>3</td>
<td></td>
<td>IE 360, IE 370, IE 515</td>
<td><strong>Prerequisite(s):</strong> IE 360, IE 370, IE 515. <strong>Description:</strong> Problem formulation, data collection, alternative design generation, design evaluation, specification, and implementation for large scale systems. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 642</td>
<td>Statistical Methodology in Simulation</td>
<td>3</td>
<td></td>
<td>IE 360 and IE 515</td>
<td><strong>Prerequisite(s):</strong> IE 360 and IE 515. <strong>Description:</strong> Discrete simulation modeling, input probability distributions, random variate generators, output data analysis, validation, variance reduction, experimental design and optimization. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<td>IE 643</td>
<td>Analysis for Decision Making</td>
<td>3</td>
<td>Spring Only</td>
<td>IE 360 or IE 560, and Graduate standing in the JB Speed School of Engineering. <strong>Description:</strong> The goal of this course is to give the student a basic working knowledge of the concepts of simulation modeling and analysis, especially as applied in the design and operation of both manufacturing-oriented and service-oriented systems. <strong>Note:</strong> Students may not receive credit for both IE 445 and IE 645. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 645</td>
<td>Simulation</td>
<td>3</td>
<td>Spring Only</td>
<td>IE 360 and IE 515</td>
<td><strong>Prerequisite(s):</strong> IE 360 and IE 515. <strong>Description:</strong> The role of decision analysis in design; techniques for multicriteria decision analysis; systematic creativity in design. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 646</td>
<td>Operations Research Methods</td>
<td>3</td>
<td>Fall Only</td>
<td>IE 360 or IE 560, and Graduate standing in the JB Speed School of Engineering. <strong>Description:</strong> Formulation and solution of basic models in operations research. Topics to be covered include applications of linear, integer and nonlinear programming; transportation and assignment problems, and network flows models. <strong>Note:</strong> Students may not receive credit for both IE 446 and IE 646. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 650</td>
<td>Material Flow Systems Design</td>
<td>3</td>
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<td>IE 515</td>
<td><strong>Prerequisite(s):</strong> IE 515. <strong>Description:</strong> Material handling and equipment concepts; computerized plant layout; problem formulation; requirements definition; queuing; location analysis; conveyor theory; simulation; developing and evaluating alternative systems; systems implementation. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 655</td>
<td>Supply Chain Engineering</td>
<td>3</td>
<td>Fall Only</td>
<td>IE 240 (or equivalent) and Graduate Standing in the JB Speed School of Engineering. <strong>Description:</strong> This course is designed to offer a balanced coverage on concept survey, analytics and modeling for operations and engineering in supply chain and logistics systems. Emphasis will be on analysis of strategic, tactical and operational supply chain problems including inventory decisions, revenue operations &amp; modeling, distribution &amp; network design, supply contracts and coordination among supply chain partners. Other related topics to be covered include various critical concepts and strategies such as risk pooling, information sharing, and the role of information systems in supply chain engineering. <strong>Note:</strong> Students cannot receive credit for both IE 655 and IE 455. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 657</td>
<td>Models for Design and Analysis of Logistical Systems</td>
<td>3</td>
<td></td>
<td>IE 425, IE 515</td>
<td><strong>Prerequisite(s):</strong> IE 425, IE 515. <strong>Description:</strong> This modeling oriented course for the design, analysis and operation of logistical systems includes topics such as inventory control, transportation, distribution network design, and supply chain management. Both deterministic as well as stochastic models are studied. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 660</td>
<td>Reliability and Maintainability</td>
<td>3</td>
<td>Fall Only</td>
<td>IE 360</td>
<td><strong>Prerequisite(s):</strong> IE 360. <strong>Description:</strong> Design, development, and test techniques required to assure the reliability and maintainability of new systems. Design of maintenance programs for new and existing systems. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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<tr>
<td>IE 662</td>
<td>Predictive Analytics for Decision Making I</td>
<td>3</td>
<td>Fall Only</td>
<td>IE 560 (Probability and Statistics) or similar course. <strong>Description:</strong> This course will prepare students with various predictive analytics methods for manufacturing, healthcare, etc., which will be illustrated in examples. Different data types from real-world examples will be shown. Subsequently, it will be demonstrated how the predictive analytics methods can be used for better decision making. The methods will be implemented in non-programming based standard software such as Matlab, Excel, and Minitab. <strong>Note:</strong> Students cannot receive credit for both IE 662 and IE 462. For class offerings for a specific term, refer to the Schedule of Classes <a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">here</a></td>
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### IE 663. Predictive Analytics for Decision Making II

**Term Typically Offered:** Spring Only  
**Prerequisite(s):** IE 462 or IE 662 or similar; Experience with Python; IE 560 (Prob&Stats) or similar course.  
**Description:** This course provides an introduction to several classical and state-of-the-art machine learning methods and their applications for engineers. Fundamentals of linear model and shallow neural networks, multilayer perceptrons, and deep neural networks will be covered. Modern convolutional neural networks (CNN, including AlexNet, NiN, GoogleNet, ResNet, DenseNet), recurrent neural networks (RNN, including GRU, LSTM, Bi-LSTM, Transformer), and optimization techniques will be discussed with engineering examples implemented in Python.  
**Note:** Students cannot receive credit for both IE 663 and IE 463.

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

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<th>Units</th>
<th>Term Typically Offered</th>
<th>Prerequisite(s)</th>
<th>Description</th>
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<tbody>
<tr>
<td>IE 663</td>
<td>3</td>
<td>Spring</td>
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<tr>
<td>IE 664</td>
<td>3</td>
<td>Spring</td>
<td>IE 360 or IE 560 (or equivalent)</td>
<td>Design of engineering experiments and projects using theory of least squares, analysis of variance, randomized blocks, factorial experiments, nested designs, split plot designs and logistic regression techniques. Covers a combination of analysis by hand and using Minitab statistical software.</td>
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<tr>
<td>IE 669</td>
<td>3</td>
<td>Fall</td>
<td>Graduate Standing in the JB Speed School of Engineering</td>
<td>Human factors engineering is the study of human cognitive and physical abilities and limitations, and applying that knowledge to engineering design. &quot;Ergonomics&quot; typically relates to physical abilities and limitations. This course will provide a broad coverage of human factors and ergonomics and show how the application of human factors and ergonomics principles can improve the design of systems involving the interaction of humans with technology.</td>
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<tr>
<td>IE 670</td>
<td>3</td>
<td>Fall</td>
<td>IE 370.</td>
<td>Inflation; cost of capital; revenue requirements; uncertainty and risk; propagation of errors; Hillier’s results; simulation; capital budgeting.</td>
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<tr>
<td>IE 671</td>
<td>3</td>
<td>Spring</td>
<td>IE 669 or equivalent; graduate Standing in the JB Speed School of Engineering</td>
<td>Human factors engineering is the study of human cognitive and physical abilities and limitations, and applying that knowledge to engineering design. The main goal of this course is to learn and apply advanced methods in human factors engineering, as well as newer models, theories, and frameworks related to the field.</td>
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<td>IE 675</td>
<td>3</td>
<td>Spring</td>
<td>Graduate Standing in the JB Speed School of Engineering</td>
<td>This course provides an introduction to several classical and state-of-the-art machine learning methods and their applications for engineers. Fundamentals of linear model and shallow neural networks, multilayer perceptrons, and deep neural networks will be covered. Modern convolutional neural networks (CNN, including AlexNet, NiN, GoogleNet, ResNet, DenseNet), recurrent neural networks (RNN, including GRU, LSTM, Bi-LSTM, Transformer), and optimization techniques will be discussed with engineering examples implemented in Python.</td>
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<td>IE 682</td>
<td>3</td>
<td>Fall</td>
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<td>This course provides students an overview of the healthcare system and the different types of healthcare delivery, as well as factors that determine quality of care. This course also exposes students to tenets of patient safety from a human factors engineering perspective. Students will learn models of patient safety and incident analysis tools, including Root Cause Analysis (RCA) and Healthcare Failure Mode and Effects Analysis (HFMEA).</td>
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IE 684. Health IT and Clinician Support  
**3 Units**  
**Term Typically Offered:** Spring Only  
**Description:** This course provides students an overview of various types of health information technology (IT) systems, as well as strategies, methods, and tools used to support the work and health of clinicians. This course also exposes students to applied tools and guidelines of the design and evaluation of health IT systems. Students will learn to use software to prototype high-fidelity, interactive user interfaces, and to conduct human factors evaluation on health IT systems based on the FDA guidelines. Documentation of such design and evaluation process will also be practiced with the semester project.  
**Note:** Students cannot receive credit for both IE 684 and IE 484.

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IE 690. Master of Science Thesis in Industrial Engineering  
**1-6 Units**  
**Grading Basis:** Pass/Fail  
**Prerequisite(s):** Department Chair permission required.  
**Description:** Research on MS thesis project. Grade shall be deferred by the major professor until evaluation of the thesis by the student’s committee. Grade on pass-fail basis by the examining committee.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 693. Independent Study in Industrial Engineering  
**1-12 Units**  
**Description:** Opportunity for the student, under the supervision of a sponsoring faculty member, to pursue individualized study related to research or practice that is not included in regular courses in the curriculum.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 694. Advanced Topics in IE  
**1-6 Units**  
**Prerequisite(s):** Consent of instructor.  
**Description:** An advanced course in Industrial Engineering topics not covered by regularly scheduled courses.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 695. PhD Seminar  
**1 Unit**  
**Grading Basis:** Pass/Fail  
**Term Typically Offered:** Fall, Spring  
**Prerequisite(s):** consent of advisor This course is a series of seminars covering topics related to Industrial Engineering (IE).  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 699. Industrial Engineering Master’s Degree Project  
**3 Units**  
**Prerequisite(s):** Instructor permission required.  
**Description:** The Industrial Engineering MS student carries out an engineering project under the supervision of a faculty mentor, prepares an acceptable written report, and presents a seminar on the project.  
**Note:** Cross-listed with EM 699.

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

IE 700. Dissertation Research in Industrial Engineering  
**1-18 Units**  
**Grading Basis:** Pass/Fail  
**Prerequisite(s):** Department Chair permission required.  
**Description:** Research on dissertation project. Grade will be deferred by the major professor until evaluation of the dissertation by the student’s committee. Graded on a Pass/Fail basis by the examining committee.  
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)