INDUSTRIAL ENGINEERING

Contact Information

Industrial Engineering
https://mie.rice.edu
2036 Duncan Hall
713-348-4178

Andrew J. Schaefer
Program Director
andrew.schaefer@rice.edu

Eylem Tekin
Program Director
eylem.tekin@rice.edu

The Master of Industrial Engineering degree is a graduate degree program administered by the George R. Brown School of Engineering and overseen by the Department of Computational Applied Mathematics and Operations Research.

The program is designed to explore modern industrial systems, which arise in fields such as manufacturing, services, supply chain management, energy, transportation and healthcare. Analyzing and optimizing their performance is very challenging; for example, the number of ways that Federal Express can route its vehicles vastly exceeds the number of atoms in the universe. These analyses are crucial; their financial impact typically exceeds the profit margins in many industries, such as transportation and retailing.

To meet these challenges, the Master of Industrial Engineering degree emphasizes improving the quality and reliability of complex systems. It provides students with a deep set of analytical and engineering skills to make data-driven decision needed in every major economic sector. Graduates will help industry, governments, and non-profits improve efficiency in changing and uncertain environments.

Industrial Engineering does not currently offer an academic program at the undergraduate level.

Master's Program

- Master of Industrial Engineering (MIE) Degree (https://ga.rice.edu/programs-study/departments-programs/engineering/industrial-engineering/industrial-engineering-mie/#outcomestext)

Directors

Andrew J. Schaefer
Eylem Tekin

Professors

Michael D. Byrne, *Psychological Sciences*
Patricia DeLucia, *Psychological Sciences*
Fathi Ghorbel, *Mechanical Engineering*
Illya V. Hicks, *Computational Applied Mathematics and Operations Research*

C. Fred Higgs III, *Mechanical Engineering*
Marcia K. O'Malley, *Mechanical Engineering*

Amit Pazgal, *Business*
Eduardo Salas, *Psychological Sciences*
Andrew J. Schaefer, *Computational Applied Mathematics and Operations Research*
Laura Schaefer, *Mechanical Engineering*
Pol D. Spanos, *Mechanical Engineering*
Richard A. Tapia, *Computational Applied Mathematics and Operations Research*
Yin Zhang, *Computational Applied Mathematics and Operations Research*

Associate Professors

Leonardo Dueñas-Osorio, *Civil and Environmental Engineering*
Philip A. Ernst, *Statistics*
Philip T. Kortum, *Psychological Sciences*

Assistant Professors

Matthew Brake, *Mechanical Engineering*
Pedram Hassanzadeh, *Mechanical Engineering*
Joseph Huchette, *Computational Applied Mathematics and Operations Research*
Santiago Segarra, *Electrical and Computer Engineering*

Professor in the Practice

John Dobelman, *Statistics*

Lecturer

Eylem Tekin, *Industrial Engineering*

For Rice University degree-granting programs:
To view the list of official course offerings, please see Rice's Course Catalog (https://courses.rice.edu/admweb/!SWKSCAT.cat?p_action=cata).
To view the most recent semester's course schedule, please see Rice's Course Schedule (https://courses.rice.edu/admweb/!SWKSCAT.cat).

Industrial Engineering (INDE)

INDE 501 - FUNDAMENTALS OF INDUSTRIAL ENGINEERING
Short Title: FUND INDUSTRIAL ENGINEERING
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: Introduction to fundamental tools in industrial engineering. Topics include productivity analysis, material handling, logistics, design of experiments, quality control, location theory, warehouse design, supply chain management and scheduling.

INDE 509 - INTRODUCTION TO HUMAN FACTORS ENGINEERING
Short Title: INTRO TO HUMAN FACTORS ENG
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Prerequisite(s): INDE 501
Description: Analysis and design of engineering systems considering human characteristics and limitations. Design of control, displays, tools, workstations and groups. Human factors research methods. Instructor Permission Required.

INDE 511 - GRAPH ALGORITHMS
Short Title: GRAPH ALGORITHMS
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: Graph Algorithms in Operations Research. Topics include: spanning trees, graph search algorithms, shortest path problems, worst case time complexity analysis, computational complexity, dominating set problems, vertex and edge cover problems, python implementations, and other problems in graph optimization. Instructor Permission Required. Recommended Prerequisite(s): INDE 545 or CAAM 378

INDE 513 - OPERATIONS RESEARCH IN HEALTHCARE
Short Title: OPER RES IN HEALTHCARE
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: Operations research in healthcare systems and medical decision-making. Application areas will include hospital resource management, patient scheduling, treatment planning and organ transplantation. Modeling techniques will include mathematical programming, stochastic processes, Markov decision processes and simulation. Recommended Prerequisite(s): INDE 545 and INDE 572

INDE 517 - MATHEMATICAL OPTIMIZATION FOUNDATIONS OF DATA SCIENCE
Short Title: MATH OPT FOUND OF DATA SCIENCE
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: Optimization methods for machine learning. Topics included are as follows: basics of optimization theory, gradient-based optimization (e.g., gradient descent, stochastic gradient descents, AdaGrad, Adam, RMSProp, etc.), linear regression and its extensions (e.g., ridge regression and lasso), least-squares classification and logistic regression, Newton methods in machine learning, basics of constrained optimization, Lagrangian relaxation and duality, support vector machines, and optimization in neural networks.

INDE 543 - MANUFACTURING PROCESSES AND SYSTEMS
Short Title: MANUFACTURING PROC AND SYS
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Prerequisite(s): INDE 501
Description: Fundamentals of manufacturing processes and systems. Topics include machining, casting, 2D printing, material flow, capacities, bottlenecks, and just-in-time systems. Simulation and optimization of various manufacturing systems. Trade-offs among various processes. Instructor Permission Required.

INDE 545 - PRESCRIPTIVE ANALYTICS
Short Title: PRESCRIPTIVE ANALYTICS
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: A survey of methods for combining mathematical models and large data sets to produce optimal decisions. Topics include decision analysis, dynamic programs, mathematical programs and various heuristics. Instructor Permission Required.

INDE 546 - COMPUTATIONAL PRESCRIPTIVE ANALYTICS
Short Title: COMP PRESCRIPTIVE ANAYLTICS
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Prerequisite(s): INDE 545
Description: A continuation of INDE 545 that focuses on computational approaches to prescriptive analytics. Topics include decomposition approaches to large-scale optimization, modeling languages, decision analysis and discrete-even simulation software. Emphasis will be placed on using relevant software on practical problems. Graduate/Undergraduate Equivalency: CMOR 442. Mutually Exclusive: Cannot register for INDE 546 if student has credit for CAAM 476.

INDE 561 - SUPPLY CHAIN MANAGEMENT
Short Title: SUPPLY CHAIN MANAGEMENT
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Prerequisite(s): INDE 545
Description: Supply chain management is the integrated management of the flow of materials, products, services, and cash from the suppliers all the way to the customers and from the customers back to the suppliers. Due to the complex nature of today's supply chains, effective management of these flows is a challenging task. This course aims to familiarize students with the concepts and models that are useful in designing and managing effective and efficient supply chains. Topics include facility location and distribution models, forecasting, sales & operations planning, supply chain coordination, inventory management, transportation, supplier selection, pricing & revenue management, and sustainability in supply chains. Instructor Permission Required. Graduate/Undergraduate Equivalency: CMOR 461. Mutually Exclusive: Cannot register for INDE 561 if student has credit for CAAM 421.

INDE 562 - INTRODUCTION TO CONTINUOUS OPTIMIZATION
Short Title: INTRO TO CONTINUOUS OPT
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: An introduction to the formulation of unconstrained and constrained optimization models, and their numerical implementations to problems in science and engineering. Emphasis on Newton-type and interior-point methodologies. Instructor Permission Required. Recommended Prerequisite(s): INDE 545 or CAAM 378

INDE 567 - OPTIMIZATION METHODS IN FINANCE
Short Title: OPT METHODS IN FINANCE
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Prerequisite(s): MATH 212 and (CAAM 210 or CMOR 220)
Description: Fundamentals of financial optimization. Asset-liability management, arbitrage and asset pricing, mean-variance models, portfolio optimization. This course covers models and algorithms for solving linear, quadratic, integer, and stochastic optimization models encountered in financial and data science applications. Students who have taken CAAM 467 should consult their advisor before attempting to register for INDE 567. Department Permission Required. Graduate/Undergraduate Equivalency: CMOR 462. Recommended Prerequisite(s): INDE 545 Mutually Exclusive: Cannot register for INDE 567 if student has credit for CAAM 467.

INDE 571 - PROBABILITY AND STATISTICAL INFERENCE
Short Title: PROB & STATISTICAL INFERENCE
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: Topics include probability, random variables, probability distributions, transformations, moment generating functions, common families of distributions, independence, sampling and convergence, basics of estimation theory, hypothesis testing, Bayesian inference, ANOVA, regression. Introduction to statistical software. Department Permission Required.

INDE 572 - STOCHASTIC PROCESSES AND SIMULATION
Short Title: STOCH PROCESSES & SIMULATION
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Prerequisite(s): INDE 571
Description: Topics include Markov chains, renewal processes, queueing theory, statistical quality control, discrete-event simulation, random number generators, Monte Carlo methods, resampling methods, Markov Chain Monte Carlo, importance sampling and simulation based estimation for stochastic processes.

INDE 573 - DISCRETE-EVENT SIMULATION
Short Title: DISCRETE-EVENT SIMULATION
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Prerequisite(s): (STAT 518 and STAT 519) or INDE 571
Description: Simulation of discrete-event dynamic systems. Topics include introduction to simulation models; modeling with Simio, a comprehensive simulation package with animation capabilities; statistical aspects such as input and output analysis, random variate generation, variance reduction techniques; optimization via simulation. Students who have taken CAAM 485 should consult their advisor before attempting to register for INDE 573. Department Permission Required.

INDE 577 - DATA SCIENCE AND MACHINE LEARNING
Short Title: DATA SCI & MACHINE LEARNING
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students. Enrollment limited to students in a Master of Comp & Appl Math, Master of Comp Sci & Eng, Master of Computer Science, Master of Data Science, Master of Electrical Comp Eng, Master of Eng Mgmt & Leadershp, Master of Industrial Eng, Master of Mechanical Eng or Master of Statistics degrees.
Course Level: Graduate
Description: Fundamentals of data science and machine learning. Topics include: introduction to scikit-learn, Keras and tensorflow2, linear and logistic regression, clustering, support vector machines, random forest trees, neural networks, deep learning, natural language processing. Recommended Prerequisite(s): Three semesters of calculus recommended. A background in some programming language would be extremely useful.

INDE 590 - MASTER'S IN INDUSTRIAL ENGINEERING CAPSTONE EXPERIENCE
Short Title: MIE CAPSTONE EXPERIENCE
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Research
Credit Hour: 1
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: MIE students are required to write a field report related to one of the required core courses in the curriculum. Students should coordinate this with the INDE 590 instructor/capstone director, prepare a report relevant to the course material, and present it in class. Instructor Permission Required. Recommended Prerequisite(s): INDE 501 and INDE 545 and INDE 571. Repeatable for Credit.

INDE 597 - TOPICS IN INDUSTRIAL ENGINEERNG
Short Title: TOPICS IN INDUSTRIAL ENG
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Instructor Permission Required. Repeatable for Credit.

INDE 677 - SPECIAL TOPICS
Short Title: SPECIAL TOPICS
Department: Industrial Engineering
Grade Mode: Standard Letter
Course Type: Internship/Practicum, Laboratory, Lecture, Seminar, Independent Study
Credit Hours: 1-4
Restrictions: Enrollment is limited to Graduate or Visiting Graduate level students.
Course Level: Graduate
Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

Description and Code Legend

Note: *Internally, the university uses the following descriptions, codes, and abbreviations for this academic program. The following is a quick reference:*

Course Catalog/Schedule

- Course offerings/subject code: INDE

Department (or Program) Description and Code

- Industrial Engineering: INDE

Graduate Degree Description and Code

- Master of Industrial Engineering: MIE

Graduate Degree Program Description and Code

- Degree Program in Industrial Engineering: INDE

CIP Code and Description [1]

- **INDE** Major/Program: CIP Code/Title: *14.3701 - Operations Research*

[1]   Classification of Instructional Programs (CIP) 2020 Codes and Descriptions from the National Center for Education Statistics: https://nces.ed.gov/ipeds/cipcode/