Compiled by officers of UC Berkeley's Alpha Pi Mu chapter. Accurate to June 2014.

Questions

In the short term, the most useful information is about goals and structure of the programs.

1. Which course are required when,
2. What is covered (at a very high level) in those courses
3. To what extent is each course focused on theory? Practice?
4. How much of a computer programming emphasis do each of the courses have?
5. How many in-major electives do students have to take?
6. Do students have to take any specific general engineering courses (e.g. thermodynamics or materials)? If so, what are these courses?

Schools

School	Relevant departments	Progress	APM officer responsible
Georgia Institute of Technology	Industrial Engineering	Public information gathered.	Riley
University of Michigan, Ann Arbor	Industrial and Operations Engineering	Public information gathered	Riley
Purdue University	Industrial Engineering	Public information gathered.	Riley
Stanford University	Management Science & Engineering	Public information gathered.	Wesley and Riley
Texas A&M University	Industrial & Systems Engineering	Public information gathered.	Ellen and Riley
Berkeley	Industrial Engineering & Operations Research	Public information gathered.	Riley
Pennsylvania State University	Industrial & Manufacturing Engineering	Public information gathered. Reached out to APM chapter.	Riley
University of Wisconsin	Industrial & Systems Engineering	Public information gathered.	Ellen and Riley
Virginia Tech	Industrial & Systems Engineering	Public information gathered.	Wesley and Riley
Cal Poly (SLO)	IME	Public information gathered	Riley

University of Florida	Industrial and Systems Engineering	Public information gathered	Riley
Arizona State	Industrial Engineering	Public information gathered, APM chapter contacted	Riley
Columbia	IE, OR, Management OR, FE	Public information gathered for IE and OR.	Riley
Cornell	Operations Research & Engineering	Public information gathered.	Riley

UC Berkeley

Technical Electives[1]

Type	Unrestricted	Restricted	Concentration
Quantity	4	2	0

Upper Division Requirements (course outcomes)

E 120 - Principles of Engineering Economics

1. Being able to read and understand financial statements.
2. Understand the time value of money.
3. Develop the ability to identify, evaluate and compare cash-flow streams.
4. Understand the concept of tradeoff between risk and return and how it affects the prices of financial assets as well as investment decisions.

IEOR 172 or Stat 134 - Probability and Risk Analysis for Engineers

1. Focus on random variables and their applications
2. Study discrete and continuous random variables
3. Study independence and conditional expectation

IEOR 131 - Simulation

1. Recognize the fundamental similarities among simulation software products,
2. Model discrete event dynamics using a wide variety of different methodologies,
3. Understand how to simulate randomness and the potential pitfalls in doing so,
4. Design and run effective and efficient simulation experiments and correctly analyze the results of those experiments.

IEOR 160 - Operations Research I (Deterministic)

[1] The "Technical Electives" sections will not include electives that are required throughout a college or school (such as "engineering breadth" courses)

Deterministic methods and models in operations research. Unconstrained and constrained optimization. Equality, inequality, and integer constraints. Sequential decisions; dynamic programming. Resource allocation, equipment replacement, inventory control, production planning.

IEOR 161 - Operations Research II (Stochastic)

1. Students understand the concept of a random model.
2. Students can use the building blocks of the course -- Poisson processes, Markov processes, queuing and reliability theory -- to formulate a realistic model for many industrial engineering applications.
3. Students can analyze the model to understand and improve the performance of the underlying system.

IEOR 162 - Linear Programming

Formulation to linear programs. Optimal allocation and control problems in industry and environmental studies. Convex sets; properties of optimal solutions. The simplex method; theorems of duality; complementary slackness. Problems of post-optimization. Special structures; network problems. Digital computation.

IEOR 165 - Engineering Statistics, Quality Control, and Forecasting

This course will introduce students to basic statistical techniques such as parameter estimation, hypothesis testing, regression analysis, analysis of variance. Specific applications in forecasting and quality control will be considered in detail.

IEOR 180 - Senior project

Pennsylvania State University

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	2	2	0

Semester 1

Calculus 1, Engineering Design, Rhetoric, Chemistry (lecture), Social Science.

Engineering Design: create a personal webpage. Become familiar with SolidWorks. Complete a CAD project of a home entertainment center. Complete an open ended design project for a corporate sponsor (details here).

Semester 2

Calculus 2, Physics (Mechanics), Chemistry (lab), Introduction to Economics (micro or macro), Social Science, first year seminar.

Semester 3

Calculus 3, Physics (E&M), Speech, Statics and Material Properties, Social Science.

Speech: Write and deliver impromptu, informal, persuasive, and group speeches.

Semester 4

Differential equations, linear algebra, {Matlab, C, or Fortran}, one science elective and two engineering elective.

Semester 5

Course	Course Description	Credits
IE 302	Engineering Economy	3
IE 305	Product Design, Specifications & Measurement	3
IE 322	Probabilistics Models in IE	3
IE 327	Introduction to Work Design	3
MATSE 259	Materials, Properties & Processing	3

Engineering Economy

Principles and methods for analyzing the economic feasibility of technical alternatives leading to a decision or recommendation.

{Product Design, Specifications, & Measurement}

Course Description: exposes students to the principles required for designing a product and developing the specifications for its components and the methods for product verification and checking conformance to specifications.
Pre-requisities? {Materials, Properties & Processing}

Probabilistic Models in IE

Course Description: exposes students to the probability theory and models and discrete and continuous probability distributions which are necessary for solving real life engineering problems with uncertainty. Reliability modeling, one such problem of interest to the manufacturers and consumers, will be taught in this course. The course will also cover sampling distributions and point and interval estimation of mean, variance and proportion.

Introduction to Work Design

Course Description: job and worksite design. Measuring job output. Become familiar with human information processing, basic auditory and visual displays, anthropometry and musculoskeletal principles, cumulative trauma disorders, work measurement and stopwatch time study.
Pre-requisities? {Statics and Strength of Materials}

{Materials, Properties, and Processing}

Course Description: Relationship of structure and processing variables to the properties and service behavior of metals, polymers, and ceramics.
Pre-requisities? Statics and Material Properties.

Semester 6

Course	Course Description	Credits
IE 323	Statistical Methods in IE	3
IE 405	Deterministic Models in OR	3
IE 330	Engineering Analytics	3
Manufacturing Processing Elective C	no description	3
ENGL 202C	Technical Writing	3

Statistical Methods in IE

Description: exposes students to the statistical tools such as estimation, testing of hypotheses, control charts, process capability indexes, gage R & R studies, simple regression and design of experiments, which are necessary for analyzing and solving real life engineering problems using data.
Pre-requisities? Probabilistic Models in IE

Deterministic Models in OR

Description: the student will learn to formulate linear programs, network models, and integer programs. The student will also learn solution strategies such as the simplex method and branch and bound. Duality and sensitivity analysis will be covered along with their economic interpretation. Optimization software will be used for solving the formulations. Practical examples along with a detailed case study will be presented to help the student to synthesize the topic.
Pre-requisities? Linear Algebra.

Engineering Analytics

Description: provides students with a quantitative background in descriptive analytics which deals with data mining, predictive analytics which deals with forecasting, and the use of Big Data in analysis. Examples of analytics will be presented in various industries including manufacturing, healthcare, and distribution. The students will learn to work in settings to make data-informed decisions from large data sets.
Pre-requisities? Probabilistic Models in IE, {Matlab, C++, or Fortran}

Manufacturing Processing Elective C (chose from the following)

IE 306-Machining Process Design and Analysis
IE 307 Additive Manufacturing Process and Reverse Engineering

IE 311-Principles of Solidification Processing
IE 463-CAD/CAM (Computer Aided Manufacturing)

Semester 7

Course	Course Description	Credits
IE 425	Stochastic Models in OR	3
IE 408,418 or 419	Human Factors Elective	3
IE 460	Service Systems Engineering	3
IE 470	Manufacturing Systems Design & Analysis	3
Technical Elective	There's a *long* list online...	3

Stochastic Models in OR

Poisson processes, Markov Chains, Dynamic Programming, and Queueing systems.
Direct connections will be made to manufacturing and service systems.
Inventory theory, including fundamental tradeoffs, EOQ modeling, and stochastic models.
Pre-requisities? Linear algebra, Probabilistic Models in IE, Deterministic Models in OR.

Human Factors Elective

IE 408: Cognitive Work Design (Emphasis on human performance)
IE 418: Human Computer Interface Design
IE 419: Work Design (Productivity and Safety)

Service Systems Engineering

Solve service-system problems using mathematical programming, network analysis and applied probability.
topics will include measuring service quality, methods for evaluating service systems, financial engineering & portfolio optimization, supply chain design & operations, manpower planning & scheduling, and revenue management.
Several case studies will be used to illustrate applications. Course grades are based on homework, case studies, mini-project, midterm and final exams.
Pre-requisities? Probabilistic Models in IE, Deterministic Models in OR.

Manufacturing Systems Design and Analysis

Description: Students will learn to design manufacturing systems (human and automated) to satisfy differing types of product demand.
Pre-requisities? Probabilistic Models in IE, Deterministic Models in OR.

Semester 8

Course	Course Description	Credits
IE 453	Simulation Modeling for Decision Support	3
IE 480 W	Capstone Design Course	3
Technical Elective	no description	3
H&SS	no description	3
H&SS	no description	3

Simulation Modeling for Decision Support

Description: apply discrete event simulation modeling for decision support in IE problems through developing skills in model building, simulation output analysis, and communication of technical information and conclusions drawn from data analysis. Pre-requisities? Probabilistic Models in IE, Deterministic Models in OR, programming.

Capstone Design Course

Students interested in taking this course should have senior standing and be familiar with basic principles in manufacturing, operations research, and human factors engineering.

University of Florida

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	3	0	0

"Critical Courses"

MAC2311: Analytical Geometry & Calculus 1
MAC2312: Analytical Geometry & Calculus 2
MAC2313: Analytical Geometry & Calculus 3
MAP2302: Differential Equations
PHY2048: Physics with Calculus 1
PHY2049: Physics with Calculus 2
COP2271: VB.net

Honors Policy

The requirement for "magna cum laude" or "summa cum laude" involves a thesis, research project or some other approved body of creative work … the appropriate departmental faculty committee decides whether a project warrants a magna cum laude or summa cum laude designation. The requirement for "cum laude" is based on only grade point average.

Department Courses (+ Statistics and Accoutning)

STA 4321 – Mathematical Statistics 1

Introduction to the theory of probability, counting rules, conditional probability, independence, additive and multiplicative laws, Bayes Rule. Discrete and continuous random variables, their distributions, moments and moment generating functions. Multivariate probability distributions, independence, covariance. Distributions of functions of random variables, sampling distributions, central limit theorem.

STA 4322 – Mathematical Statistics 2

Sampling distributions, central limit theorem, estimation, properties of point estimators, confidence intervals, hypothesis testing, common large sample tests, normal theory small sample tests, uniformly most powerful and likelihood ratio tests, linear models and least squares, correlation. Introduction to analysis of variance.

ACG 2021C – Accounting

Identify the information conveyed in each of the four basic financial statements and the way that it is used by different decision makers. Identify what constitutes a business transaction and apply transaction analysis to record the effects of those transactions. Prepare basic financial statements based upon Generally Accepted Accounting Principles. Describe common financial statement relationships used in financial analysis.

EIN 4354 – Engineering Economy

Basic principles and applications of economic decision-making between alternatives encountered in engineering systems projects. The analysis will include methodologies of economics and finance in addition to engineering fundamentals

ESI 4523 – Industrial Systems Simulation

This purpose of this course is to introduce you to the digital simulation techniques and industrial applications. The emphasis is on building computer-based models for real systems and performing simulation experiments to evaluate the behavior of a system under different sets of conditions. Students are required to do a term project, as detailed in a separate handout.

Kelton, Sadowski and Sturrock, "Simulation Using ARENA," 5th Edition

ESI 4327C – Matrix and Numerical Methods in Systems Engineering

MATLAB

Pre-requisites: MAC 2313 (multivariable calculus), MAP 2302 (differential equations)

ESI 4356 – SPREADSHEET BASED DECISION SUPPORT SYSTEMS

Applications of decision support systems in industrial and systems engineering; Developing and implementing decision support systems arising in industrial and systems engineering using popular database management and spreadsheet software; Microsoft Excel; Visual Basic for Excel. (3 credits).

ESI 4357 – Web Based Decision Support Systems for Industrial and Systems Engineers

The objectives of the course are (i) to demonstrate to students the usefulness of decision support systems arising in the practice of industrial and systems engineering; (ii) to illustrate to students the essential concepts in database design; (iii) to teach them popular database management systems; and (iv) to enable them to design, develop, and implement integrated decision support systems for industrial and systems engineering applications using latest available IT tools.
Uses Visual Studio .NET

ESI 4312 – Operations Research 1

Introduction to the use of linear decision models, particularly linear programming and related decision analysis optimization software, to aid in the analysis and solution of complex, large-scale decision problems. Consideration of related network modeling concepts.

Required text: Operations Research: Applications and Algorithms: Wayne L. Winston.

ESI 4313 – Operations Research 2

Dynamic programming and optimization. Markov processes and queuing theory. Network analysis. Applications.
Software: GAMS
To be successful in this class, you need to have a knowledge of basic programming techniques and a working knowledge of calculus and probability. Further, "ESI4312 " and "STAT 4321 " are formal pre-requisites for the class.

ESI 4221C – Industrial Quality Control

The DMAIC Process, Statistical Methods Useful in Quality Improvement, Methods and Philosophy of Statistical Process Control, Control Charts for Variables, Control Charts for Attributes, Process and Measurement System Capability Analysis, Process Design and Improvements with Designed Experiments, Acceptance Sampling

EIN 4451 – Lean Production Systems

Topics: Design of flow line, cellular and flexible manufacturing systems. Design and control of lean manufacturing systems. Continuous improvement, small lot production, setup-time reduction, equipment improvement and maintenance. Principles and control of push and pull manufacturing systems. Production planning and operations scheduling.
Goals: In this course, we will cover the following topics: history of manufacturing systems, design of different manufacturing systems, design and control of lean manufacturing systems, and planning and control problems encountered in manufacturing systems. At the end of the semester the students should be have a basic understanding of the design, operation and control of lean manufacturing systems and be able to use quantitative methods to model, analyze, and optimize such systems.
Detailed timeline on syllabus

EIN4360C: Facility Planning and Work Design

This course introduces fundamental concepts in several main areas of industrial engineering such as facility planning, material handling systems, work analysis and design. Topics such as analysis and design of work space and flow, facility location and layout, material handling systems, motion and time studies and work sampling are covered.

EIN 4343 INVENTORY & SUPPLY CHAIN SYSTEMS

Catalogue Description. Demand forecasting. Deterministic and stochastic inventory models for single- and multiple-item systems. Analysis and design of logistics systems. Supply chain management and coordination.
PREREQS: OR1, OR2, statistics
A detailed schedule is available on the course syllabus

EIN 4335 Senior Design

Syllabus is online.

Arizona State University

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	1	0	3

Program overview

*Career Focus Areas include Electronics Manufacturing, Entrepreneurship, Global Industrial Engineering, Leadership, Human Factors, Industrial Management Systems, Industrial Engineering Mastery, Industrial Statistics, Information and Telecommunications Systems, Manufacturing, Operations Research, Pre-professional Service Systems, Supply Chain and Logistics, Urban Systems.

They have a video that explains IE to lay people.

Courses

A pdf includes a flowchart and course numbers + descriptions. See that PDF for annotations.

Significant Observations

1. Separate Linear Algebra and Diff Eq courses. Diff Eq course uses MATLAB.
2. Requires Engineering Mechanics and Material Properties.
3. Two full Java courses.
4. Includes Macro-economics and "engineering economics"
5. Intro to probability and statistics is computational.
6. Intro to probability and statistics → engineering probability → quality control
7. Two capstone projects.

The probability and statistics series

IEE 380: Introduction to Probability and Statistics for Engineering Problem Solving

Understand the differences between probability and statistics
Be able to recognize and use common discrete and continuous probability functions
Use sample statistics to draw inferences about a population of interest through hypothesis testing of means, variances and proportions
Build simple empirical models from data
Design simple experiments and analyze results
Understand and apply basic statistical process control charts and analyses

IEE 385: Engineering Statistics - Probability

Students will understand the differences between probabilistic (stochastic) models and statistical applications
Students will be able to recognize applications of and use important discrete and continuous distribution functions such as the
Binomial, Geometric, Poisson, Multinomial, Uniform, Exponential, Gamma, and Normal
Students will be able to develop Maximum Likelihood Estimators for distribution parameters
Students will be able to perform Chi Square Goodness of Fit tests on data to determine underlying distributions
Students will understand reliability models and concepts

IEE 474: Quality Control

Course description: Basic statistical process control techniques, capability analysis, design of experiments, and acceptance sampling plans.

Cal Poly – SLO

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	3	0	0

PDF of coursework timeline downloaded and highlighted.

IME course catalog downloaded and highlighted.

STAT 321. Probability and Statistics for Engineers and Scientists.

Tabular and graphical methods for data summary, numerical summary measures, probability concepts and properties, discrete and continuous probability distributions, expected values, statistics and their sampling distributions, point estimation, confidence intervals for a mean and proportion. Use of statistical software. 4 lectures. Fulfills GE B6.

Columbia - IE

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	1	2	0

Program Notes

The last two years require a total of at least (1) technical elective in the department of IEOR, and (2) technical electives focusing in IE.

Required courses

Semesters 1 through 4

W1105: Introduction to Economics (micro and macro).

IEOR E2261x: Introduction to Accounting and Finance.

Topics covered in this course include: principles of accrual accounting; recognizing and recording accounting transactions; preparation and analysis of financial statements, including balance sheets, income statements, cash flow statements, and statements of owners' equity; ratio analysis; pro-forma projections; time value of money (present values, future values and interest/discount rates); inflation; discounted-cash-flow (DCF) project evaluation methods; deterministic and probabilistic measures of risk; capital budgeting.

COMS W1004x and y Introduction to Computer Science and Programming in Java

A general introduction to computer science for science and engineering students interested in majoring in computer science or engineering. Covers fundamental concepts of computer science, algorithmic problem-solving capabilities, and introductory Java programming skills. Assumes no prior programming background.

COMS 3134: Data Structures in Java

Not intended for computer science majors.
Data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs.
Programming techniques for processing such structures: sorting and searching, hashing, garbage collection.
Storage management.
Rudiments of the analysis of algorithms.

MATH V2010: Linear Algebra

Prerequisites: V1201 (Calculus III (of 4)), or the equivalent.

Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications. (SC)

SIEO W3600: Intro. to Probability and Statistics (covers much more than IEOR 172)

This class must be taken during the fourth semester.

This course serves as an introduction to both probability theory and statistics as used in engineering and applied science.

In probability the course covers random variables, both continuous and discrete, independence, expected values, variance, conditional distributions, conditional expectation and variance, moment generating functions, the strong law of large numbers and the central limit theorem.

In statistics it covers the basics of confidence intervals, hypothesis testing and linear regression.

Semester 5

IEOR 3106: Introduction to Operations Research: Stochastic Models

Probability at the level of SIEO W3600 or SIEO W4150.

Must be taken during or before the fifth semester.

Among the stochastic processes to be considered are discrete-time Markov chains, random walks, continuous-time Markov chains, Poisson processes, birth-and-death processes, renewal processes, renewal-reward processes, Brownian motion and geometric Brownian motion. Among the engineering applications to be considered are queuing, inventory and finance.

IEOR E3608x Introduction to Mathematical Programming

Prerequisites:MATH V2010: Linear Algebra. Corequisites: COMS W3134 (or COMS W3137): Data Structures.

This class must be taken during (or before) the fifth semester.

Linear programming and the simplex method, dynamic programming, network flow models and algorithms, implicit enumeration for integer programs. A wide range of applications is also discussed.

MATH E1210: Ordinary Differential Equations

Special differential equations of order one. Linear differential equations with constant and variable coefficients. Systems of such equations. Transform and series solution techniques. Emphasis on applications.

COMS 4111: Introduction to Databases

Requires fluency in Java.

The fundamentals of database design and application development using databases: entity-relationship modeling, logical design of relational databases, relational data definition and manipulation languages, SQL, XML, query processing, physical database tuning, transaction processing, security. Programming projects are required.

Semester 6

IEOR E3402y Production Inventory Planning and Control

Prerequisites: SIEO W3600:Introduction to Probability and Statistics and IEOR E3608: Introduction to Mathematical Programming

The course will cover inventory management and production planning; material requirements planning; aggregate planning of production, inventory, and work force; multi-echelon integrated production-inventory systems; and production scheduling. Students will have an opportunity to participate in a computer-simulation game where, as operations managers for a company, they work in teams to manage capacity, inventories, scheduling, and purchasing of parts.

IEOR E4404: Simulation

Prerequisites: SIEO W3600 or SIEO W4150: Introduction to Probability and Statistics, computer programming language such as C, C++, Java or Matlab.

Corequisites: IEOR E3106 or IEOR E4106: Introduction to Operations Research: Stochastic Models.

Topics covered in the course include the generation of random numbers, sampling from given distributions, simulation of discrete-event systems, output analysis, variance reduction techniques, goodness of fit tests, and the selection of input distributions. The first half of the course is oriented towards the design and implementation of algorithms, while the second half is more theoretical in nature and relies heavily on material covered in prior probability courses. The teaching methodology consists on lectures, recitations, weekly homework, and both in-class and take-home exams. Homework almost always includes a programming component for which students are encouraged to work in teams **Students who have taken IEOR E4703 Monte Carlo simulation may not register for this course for credit.**

Semester 7

IEOR E4003x Industrial Economics

Prerequisites: Probability and Statistics at the level of SIEO W3600 or SIEO W4150, and Deterministic Models at the level of IEOR E3608 or IEOR E4004, or instructor permission.

We describe how an investment project can be characterized by its cash flow profile, i.e., the amount and timing of costs and benefits of this project in the planning horizon. We show how firms should take into account the cost of capital, budgets, taxes, depreciation, inflation, and uncertainty, in order to decide which projects to undertake, reject, or postpone. This course is a good preparation for positions in investment banking, consulting, private equity, venture capital, corporate finance, and construction management, and for entrepreneurs. Students can take only one of IEOR E4003 andIEOR E4403, but not both.

IEOR E4207x Human Factors: Performance

This course provides a survey of human performance engineering in the design of consumer products, user interfaces and work processes.

The goal of the course is to provide the student with the ability to specify human performance variables affecting user performance, safety and satisfaction for a variety of products and task requirements. Topics include task analysis, information processing, anthropometry, control and display design, human computer interaction, usability testing, usability cost/ benefit analysis, forensics, motivation, group dynamics and personnel selection. Course requirements include a research paper and a (group) product redesign project. At the end of the course students will have a deeper understanding of the research and psychological principles underlying human performance capabilities and limitations. The hope is that this course will encourage students to become more of "a user advocate" in their future endeavors.

Semester 8

IEOR E4405y Production Scheduling

Prerequisites: SIEO W3600 or IEOR E4150: Introduction to Probability and Statistics, IEOR E3608: Introduction to Mathematical Programming or IEOR E4004: Introduction to Operations Research: Deterministic Models.

This class will cover models and algorithms for scheduling problems. We will cover a wide range of scheduling models including single machine, multiple machine, shop environments. In each environment we will study a variety of scheduling problems and their solution.

IEOR E4412y Quality Control and Management

This course covers modern methods for quality control and improvement: Statistical Process Control, introduction to Acceptance Sampling, and the relationships between quality and productivity.

We will introduce elements of latest concepts of Lean Manufacturing, Six Sigma, and ISO 9000-2008. The course discusses the methods and tools used to manage processes to achieve highest quality at lowest cost. We cover the interaction of management methods and quality productivity. The course covers methods used in manufacturing, as well as service industries such as finance, healthcare, etc.

IEOR E4510y Project Management

This course presents fundamental concepts of project management with an emphasis on the complex trade-offs that must be made by project managers - e.g., scheduling, costs, and quality.

The course describes methodologies and tools that have been developed to support project managers using spreadsheet models - e.g., Critical Path Method (CPM), Program Evaluation Research Task (PERT). The course demonstrates how these methodologies and tools can be extended to more realistic problems - e.g., resource

management. The course is targeted toward students planning careers in engineering management or technical consulting.

Columbia – OR

Technical Electives

Type	Unrestricted (in-major)	Restricted (one of four courses)	Concentration
Quantity	4	1	0

Semesters 1 through 5

First and second year requirements + first semester junior year are the exact same.

Semester 6

All courses from "Semester 6" for Industrial Engineers, *in addition to the following.*

IEOR E4600y Applied Integer Programming

Prerequisites: Linear programming, linear algebra, and computer programming.
This course covers applications of mathematical programming techniques, especially integer programming, with emphasis on software implementation.
This course also covers topics of modeling and solution of problems in supply chain, logistics, routing. Particular emphasis is placed on optimization modeling systems, such as AMPL and OPL and state-of-the-art solvers.

Semester 7

IEOR E4403 (same as IE degree)

IEOR E4407x Game Theoretic Models of Operations

Prerequisites: IEOR E3608: Introduction to Mathematical Programming or IEOR E4004: Introduction to Operations Research: Deterministic Models, IEOR E3106 or IEOR E4106: Introduction to Operations Research: Stochastic Models, familiarity with differential equations and computer programming; or instructor's permission.
One of the major discrepancies between traditional operations research models and the actual business decision making process is the presence of multiple agents and their mutual interaction. Competitors, consumers, and suppliers are agents seeking their self-interest, and their actions affect one's profit and optimal decision. This course exposes students to strategic thinking through game theory. Students will learn the theory of games and auctions and gain insights into their application to operations management. No previous knowledge of game theory is assumed.

Semester 8

IEOR E4405 (same as IE degree)

At least one of the following…

IEOR E4507 (Simulation, same as IE degree)
E4615 (service engineering)
E4700 (Introduction to Financial Engineering).

Cornell - OR&E

Technical Electives

Type	Unrestricted (in-dept)	Restricted (in-major)	Other
Quantity	3	3	3

The ORIE curriculum includes:

- One or more advanced courses on applications in: supply chain and manufacturing systems; data analysis; information engineering; financial engineering; or service systems.
- A collaborative systems design experience.
- Collaborative project experiences involving both written and oral presentations.
- Courses with significant experiential learning components.
- Experiences with identifying, accessing, evaluating, and interpreting information and data in support of assignments, projects, or research.
- Course experiences with large-scale datasets.

Must take at least 3 approved ORIE electives.

Foundational Courses

Calculus and Linear Algebra

CS 111x: Introduction to computer programming in MATLAB *or* Java

ENGRD 2700 - Basic Engineering Probability and Statistics

Fall, spring, summer. 3 credits.
Gives students a working knowledge of basic probability and statistics and their application to engineering. Includes computer analysis of data and simulation. Topics include random variables, probability distributions, expectation, estimation, testing, experimental design, quality control, and regression. Students will build familiarity with current software used for statistical inference and data analysis.

ENGRD 2110 - Object Oriented Programming and Data Structures

"ENGRI" Introduction to Engineering

courses are first-level courses intended to introduce students to various aspects of Engineering. They have no pre-requisites and most are cross-listed with a department. Students should take one ENGRI during the first year. No majors require any specific ENGRI and students are free to take any ENGRI regardless of their intended major.

Required ORIE courses (in no particular order)

ORIE 3120: Industrial Systems and Data Analysis

Database and statistical techniques for data mining, graphical display, and predictive analysis in the context of industrial systems (manufacturing and distribution). Database techniques include structured query language (SQL), procedural event-based programming (Visual Basic), and geographical information systems. Statistical techniques include multiple linear regression, classification, logistic regression, and time series forecasting. Industrial systems analysis includes factory scheduling and simulation, materials planning, cost estimation, inventory planning, and quality engineering.

ORIE 3150: Financial and Managerial Accounting

Covers principles of accounting, financial reports, financial-transactions analysis, financial-statement analysis, budgeting, job order and process-cost systems, standard costing and variance analysis, and economic analysis of short-term decisions.

ORIE 3300: Optimization I

Formulation of linear programming problems and solutions by the simplex method. Related topics such as sensitivity analysis, duality, and network programming. Applications include such models as resource allocation and production planning. Introduction to interior-point methods for linear programming.

ORIE 3310: Optimization II

A variety of optimization methods stressing extensions of linear programming and its applications but also including topics drawn from integer programming, dynamic programming, and network optimization. Formulation and modeling are stressed as well as numerous applications.

ORIE 3500: Engineering Probability and Statistics II

A rigorous foundation in theory combined with the methods for modeling, analyzing, and controlling randomness in engineering problems.
Specific topics include random variables, probability distributions, density functions, expectation and variance, multidimensional random variables, and important distributions including normal, Poisson, exponential, hypothesis testing, confidence intervals, and point estimation using maximum likelihood and the method of moments.

ORIE 3510: Introductory Engr. Stochastic Processes

Uses basic concepts and techniques of random processes to construct models for a variety of problems of practical interest. Topics include the Poisson process, Markov chains, renewal theory, models for queuing, and reliability.

ORIE 4580: Simulation Modeling and Analysis

Introduction to Monte Carlo simulation and discrete-event simulation. Emphasizes tools and techniques needed in practice. Random variate, vector, and process generation modeling using a discrete-event simulation language, input and output analysis, modeling.

Georgia Tech (OR Concentration)

Technical Electives

Type	Unrestricted	Restricted	Concentration (pre-determined)
Quantity	0	3	3

Semester 2

CS 1301: Introduction to Programming via Python

Semester 3

CS 2316: Data input and Manipulation via Python

ISYE 2027: Probability with Applications

Topics include probability, conditional probability, density and distribution functions from engineering, expectation, conditional expectation, laws of large numbers, and the central limit theorem.

Semester 4

Math 2602: Linear and Discrete Mathematics

Mathematical logic and proof, mathematical induction, counting methods, recurrence relations, algorithms and complexity, graph theory and graph algorithms.

ECON 2100: ECONOMIC ANALYSIS & POLICY

Learn the "Microeconomics" tools designed to help you understand the functioning of various markets (e.g., goods and services, labor, financial).
Examine selected economic policy issues (e.g., taxation, immigration, education, health, environmental regulation).
Focus on the "Macroeconomic" topics: business cycles, monetary policy (money supply, interest rates), fiscal policy (federal government revenues and expenditures, taxes), unemployment and inflation. We will also examine the current economic crisis.

ISYE 2028 BASIC STATISTICAL METHODS (uses the R programming language)

TWO WEEKS: Data Description: Random Sampling; Data Displays; Sampling Distributions include t-Distribution and F-Distribution.
FOUR WEEKS: Point and Interval Estimation: Estimating the Mean; Estimating the Differences between Means; Proportions, and Variances; Methods of Moments; Maximum Likelihood Estimation; Properties of Estimators.

FOUR WEEKS: Tests of Hypothesis: One-and Two-Sided Tests; Single Sample Tests; Two Sample Tests; Use of p-Values; Goodness-of-Fit Test; Test for Independence; Test for Homogeneity.
FOUR WEEKS: Linear Regression and Correlation: Least Squares and the Fitted Model; Properties of the Least Squares Estimators; Inferences Concerning the Regression Coefficients; Analysis of Variance.

Semester 5

CS 4400: Intro to Database Systems

Class Project: The course will involve a hands-on project to be done in teams of 3-4 students. The project will have three phases. Students will be given the choice of either the full or light version. In the light version, the third phase of the project will be replaced by assignments. The top teams doing the full project version will receive awards and be invited to demo their project to the class.
Prerequisites: Students are expected to already know or be willing to put in extra effort to master basic programming skills.

ISYE 3025 ESSENTIALS OF ENGINEERING ECONOMY (1 unit)

Financial Mathematics: Concept of Equivalence; Equivalence Formulas; Interest Rates. Decision making: Economic Decision Criteria. Fundamentals of Economic Decisions, Future, Present, and Annual Worth, Internal Rate of Return, Benefit/Cost Ratio and Payback Period. Multiple Alternatives.
Taxes: Corporate Income Taxes, Depreciation Accounting, Sale of and Asset, Financing with a Loan. Inflation and Uncertainty.

ISYE 3133 ENGINEERING OPTIMIZATION

Linear program models: objective functions, constraints, decision variables, absolute values, optimization software. Standard and advanced Integer Programming.
Linear program solution using simplex method and tableaus. Duality, sensitivity LP Relaxations, and branch and bound.
Use of commercial software tools.

ISYE 3232 STOCHASTIC MFG & SERVICE SYSTEMS

Learning outcomes:
• Model a system when randomness is significant
• Describe how variability affects a system's behavior and performance
• Apply Markov Chains
• Apply basic inventory models
• Define key concepts in production flow such as bottlenecks, line balancing, and Little's Law
• Use open and closed Jackson networks
• Maintain throughput in a closed Jackson network and compute corresponding WIP levels

ACCT 2101 or MGT 3000 or MGT 3150

An introduction to the measurement and financial reporting of organizations and the interpretation of the resulting financial statements.

Semester 6

ISYE 3044 SIMULATION ANALYSIS AND DESIGN

(1) Introduction to simulation models and simulation studies;
(2) Organization of simulation languages;
(3) Modeling with a state-of-the art simulation package with 3-D, true-to-scale animation capabilities such as Simio;
(4) Statistical aspects including input data analysis, generation of realizations from statistical distributions, output data analysis, and simulation-based optimization.

ISYE 4133 ADVANCED OPTIMIZATION

Programming skills required
Students will learn
• a deeper understanding of the key concepts, theory, and algorithms of linear optimization, integer optimization, and some modern convex optimization,
• more advanced modeling techniques,
• ways of solving optimization problems that are too hard, too large for direct solutions,
• ways of solving optimization problems faster when speed is essential,
• ways to assess the quality of sub-optimal solutions.

ISYE 4803 ADVANCED SIMULATION

A "special topics" course, might not be regularly offered?

Semester 7 (OR Track)

ISYE 4232 ADVANCED STOCHASTIC SYSTEMS

At the end of this course, students will be able to:
• Model a system when randomness is significant
• Apply Continuous Time Markov Chains
• Use open and closed Jackson networks
• Use Markov Decision Processes
• Develop models for sequential decision making under uncertainty

1 TRACK COURSE (in addition to the above)

Semester 8

ISYE 4106 SENIOR DESIGN

2 TRACK COURSES

University of Michigan - IOE

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	2	4	0

Notes

A download PDF displays the timeline for the major
Requires four in-major electives
The "practicum" series is the senior project

Courses

Engineering 101: Introduction to Programming

Engineering 101 focuses on the development of algorithms to solve problems of relevance in engineering practice and on the implementation of these algorithms using high-level computer languages. It is centered on quantitative and numerical problems that are suited to computational solutions. Topics include...
Finding area and volume, Simulating statistical processes, Data analysis, Physical simulation, Simulating complex systems with simple rules, Minimization and optimization, Computer graphics, Logic Puzzles

IOE 201. Economic Decision Making

Prerequisite: ENGR 100 and ENGR 101. I, II (2 credits) (7-week course)
Overview of business operations, valuation and accounting principles. Time value of money and net present values. Practical team project experience.

IOE 202. Operations Modeling

Prerequisite: ENGR 100 and ENGR 101. I, II (2 credits) (7-week course)
Process of mathematically modeling operational decisions including the role of uncertainty in decision-making. Basic tools for solving the resulting models, particularly mathematical programs, statistical models and queueing models. Cases may come from manufacturing and service operations and ergonomics.

IOE 265. Probability and Statistics for Engineers

Prerequisite: Math 116 and ENGR 101. I, II (4 credits)
Graphical Representation of Data; Axioms of Probability; Conditioning, Bayes Theorem; Discrete Distributions (Geometric, Binomial, Poisson); Continuous Distributions (Normal Exponential, Weibull), Point and Interval Estimation, Likelihood Functions, Test of Hypotheses for Means, Variances and Proportions for One and Two Populations.

IOE 310. Introduction to Optimization Methods

Prerequisite: Math 214, IOE 202 and ENGR 101. I, II (4 credits)

Introduction to deterministic models with emphasis on linear programming; simplex and transportation algorithms, engineering applications, relevant software. Introduction to integer, network and dynamic programming, critical path methods.

IOE 316. Introduction to Markov Processes

Prerequisite: IOE 265 and Math 214. I, II (2 credits) (7-week course)
Introduction to discrete Markov Chains and continuous Markov processes, including transient and limiting behavior. The Poisson/Exponential process. Applications to reliability, maintenance, inventory, production, simple queues and other engineering problems.

IOE 333. Ergonomics

Prerequisite: preceded or accompanied by IOE 265. I, II (3 credits)
Introduction to human sensory, decision, control, and motor systems in the context of visual, auditory, cognitive and manual task evaluation and design. Problems with computer displays, illumination, noise, eye-hand coordination as well as repetitive and high physical effort tasks are presented. Workplace and vehicle design strategies used to resolve these are discussed.

IOE 334. Ergonomics Lab

Prerequisite: preceded or accompanied by IOE 333. I, II (1 credit)
Principles of measurement and prediction of human performance in man-machine systems. Laboratory experiments investigating human capabilities of vision, hearing, information processing, memory, motor processes, strength and endurance.

IOE 366. Linear Statistical Models

Prerequisite: IOE 265 and Math 214. I, II (2 credits) (7-week course)
Linear statistical models and their application to engineering data analysis. Linear regression and correlation; multiple linear regression, analysis of variance, introduction to design of experiments.

IOE 373. Data Processing

Prerequisite: ENGR 101. I, II (4 credits)
Introduction to the systems organization and programming aspects of modern digital computers. Concepts of algorithms and data structure will be discussed with practical business applications.

IOE 460. Decision Analysis

Prerequisite: IOE 265, IOE 310. I (2 credits) (7-week course)
Analysis of decisions under uncertainty. Decision trees, influence diagrams, value of information, attitudes towards risk, expected utility; applications from production, inspection, quality control, medicine, finance.

IOE 474. Simulation

Prerequisite: IOE 316, IOE 366, IOE 373. I, II (4 credits)
Simulation of complex discrete-event systems with applications in industrial and service organizations. Course topics include modeling and programming simulations in one or more high-level computer packages such as ProModel or GPSS/H; input distribution modeling; generating random numbers; statistical analysis of simulation output data. The course will contain a team simulation project.

IOE 424. Practicum in Production and Service Systems
Prerequisite: Senior Standing, IOE undergraduates only. I, II (4 credits)
Student teams will work with an organization on an Industrial and Operations Engineering design project with potential benefit to the organization and the students. The final report should demonstrate a mastery of the established technical communication skills. The report will be reviewed and edited to achieve the outcome.

IOE 481. Practicum in Hospital Systems
Prerequisite: Senior Standing, IOE undergraduates only; I, II (4 credits)
Student team projects in hospital systems. Projects will be offered from areas of industrial and operations engineering, including work measurement and control, systems and procedures, management, organization and information systems. Lectures will deal with the hospital setting and project methodologies. The final report should demonstrate a mastery of the established technical communication skills. The report will be reviewed and edited to achieve the outcome.

Purdue – IE

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	3	2	0

At least one technical course must be at the "500 level."

Courses

First year (noteable courses)

ENGR 132: Transforming Ideas to Innovation II
MATLAB, statistics, GUI's, problem solving, mathematical modeling, problem solving

CS 159: Introduction to Programming

Semester 3

IE 200: Alumni Speakers

IE 230: Probability and Statistics in Engineering I

An introduction to probability and statistics. Probability and probability distributions. Mathematical expectation. Functions of random variables. Estimation. Applications oriented to engineering problems. Typically offered Fall Spring.

IE 343: Engineering Economics

Cost measurement and control in engineering studies. Basic accounting concepts, income measurement, and valuation problems. Manufacturing cost control and standard cost systems. Capital investment, engineering alternatives, and equipment replacement studies.

ME 270: Basic Mechanics

Semester 4

IE 330 - Probability And Statistics In Engineering II

1. Learn use of statistical software packages (e.g. Minitab).
2. Learn parametric statistical tests (e.g. t-test, ANOVA).
3. Learn non-parametric statistical tests.
4. Learn design of experiments (e.g. factorial).
5. Learn how to implement statistical process controls.

NUCL 273 - Mechanics of Materials

Analysis of stress and strain; equations of equilibrium and compatibility; stress-strain laws; extension, torsion, and bending of bars; membrane theory of pressure vessels; combined loading conditions; transformation of stresses and principal stresses; elastic stability, elected topics.

Semester 5

IE 332 - Computing In Industrial Engineering

Introduction to computing in industrial engineering. Reinforcement of scientific programming skills on typical IE tasks, together with introduction to simulation and related computer tools. Typically offered Fall Spring.

IE 335 - Operations Research (Optimization)

Introduction to deterministic optimization modeling and algorithms in operations research. Emphasis on formulation and solution of linear programs, networks flows, and integer programs. Typically offered Fall Spring.

ECE 201 - Linear Circuit Analysis

IE 370 - Manufacturing Processes I

Principal manufacturing processes; metal cutting, grinding and metal forming operations, machine tools, and tools and tooling. Nontraditional machining and welding. Introduction to computer-aided manufacturing and computer-aided graphics and design, N/C

programming, robots, and flexible manufacturing systems. Classroom and laboratory demonstrations included.

Semester 6

IE 336 - Operations Research (Stochastics)
Introduction to probabilistic models in operations research. Emphasis on Markov chains, Poisson processes, and their application to queueing systems.

IE 386 - Work Analysis and Design I
Fundamentals of work methods and measurement. Applications of engineering, psychological, and physiological principles to the analysis and design of human work systems. Typically offered Fall Spring.

IE 383 - Integrated Production Systems I
Basic concepts in the design and operational control of integrated production systems. Includes topics on facility layout and material handling, material flow and information flow, resource and capacity planning, and shop floor control and scheduling. Typically offered Fall Spring.

ME 200 - Thermodynamics

Semester 7

IE 474 - Industrial Control Systems
Introduction to automatic controls with reference to automation of industrial machines and processes, including linear dynamic systems, feedback control, and elements of systems analysis. Introduction to digital control. Typically offered Fall Spring.

IE 486 - Work Analysis and Deisgn II
Continuation of IE 386. Applications of engineering, computer sciences, information sciences, and psychological principles and methods to the analysis and design of human work systems. Typically offered Fall Spring.

TWO TECHNICAL ELECTIVES

Semester 8
IE 431 - Senior project

THREE TECHNICAL ELECTIVES

University of Wisconsin at Madison

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	1	3	0

Semester 2

Econ 111 (combined micro and macro), or Econ 101 (micro)

Semester 3

Stat 311 – Introduction to Theory and Methods of Mathematical Statistics I

Elements of probability, important discrete distributions, acceptance sampling by attributes, sample characteristics, probability distributions and population characteristics, the normal distribution, acceptance sampling plans based on sample means and variances, sampling from the normal, the central limit theorem, point and interval estimation.

Computer Science Elective

Semester 4

Stat 312 – Introduction to Theory and Methods of Mathematical Statistics II

Unbiased estimation, maximum likelihood estimation, confidence intervals, tests of hypotheses, Neyman-Pearson lemma, likelihood ratio test, regression, analysis of variance with applications.

ISyE – 313 Engineering Economic Analysis. 3 cr (same as ACCT I S 313)

Financial accounting principles and cost systems, interpretation and use of accounting reports and supplemental information for engineering economic analyses, consideration of cost-volume-profit analyses, use of discounted cash flow techniques, flexible budgeting, transfer pricing, and capital budgeting.

ISyE 315 – Production Planning and Control. 3 cr

Techniques and applications of control concepts in the design of inventory, production, quality and project-planning systems; use of the computer as a component in such systems. Prereq: CS 110 or equivalent, Stat 311 . I2; II5; S1

Semester 5

ISyE 323 – Operations Research-Deterministic Modeling. 3 cr.

Basic techniques for modeling and optimizing deterministic systems with emphasis on linear programming. Computer solution of optimization problems. Applications to production, logistics, and service systems. Prereq: Math 222, ISYE 313, and either Math 320 or 340. I5; II0; S1

ISyE 349 – Introduction to Human Factors. 3 cr

(Same as Psych 349) Design for people-machine interaction, including an introduction to the relevant underlying human sciences. Theory, data, and measurement problems in human information processing, anthropometry, training and industrial safety.

Laboratories, discussions, and a design project. Prereq: Intro. Probability or Statistics. I5; II5; S1

Acct IS 100 / 300 – Introduction to Financial Accounting

Examines generally accepted accounting principles for measurement and reporting of financial information in a balance sheet, income statement, and statement of cash flows; introduction to analysis and interpretation of financial accounting data for decision-making purposes.

Math/Stat elective

Semester 6

ISyE 320 – Simulation and Probabilistic Modeling. 3 cr

Analysis of stochastic systems using both analytic methods and computer simulation. Empirical and theoretical models of arrival and service processes. State spaces and state transition probabilities. Simulation of queuing and manufacturing systems. Continuous time Markov analysis of manufacturing systems. Prereq: Stat 311 or equiv. I4; II4; S0

ISyE 321 – 321 Simulation Modeling Laboratory. 1 cr

Computer exercises involving generation and analysis of random variables, spreadsheet models of queuing systems, use of simulation software packages. Project. Prereq: Concurrent registration in ISYE 320. I4; II4; S0

ISyE 350 – Junior Design Lab

Junior level lab will include open-ended problem solving projects or major homework assignments that:

- Develop the student's creativity and problem solving skills
- Require the formulation of design problem statements, and defined objectives and criteria for system synthesis, analysis, and evaluation
- Develop and use the student's concept of modern design theory and methodology Require the consideration and feasibility of alternative solutions
- Address realistic factors related to economics, safety, aesthetics, ethics, and societal impact
- Integrate and build upon basic sciences and knowledge presented in preceding classes Develop teamwork and communication skills
- Focus on designing "processes" to promote the understanding, acceptance, and testing of the solution.

Semester 7

ISyE 415 – Introduction to Manufacturing Systems, Design, and Analysis. 3 cr

Introduction to the technologies, processes and systems of modern discrete part manufacturing. Emphasis on development of an understanding of the behavior of integrated systems. Prereq: ISYE 315, 320, 321 or consent of instructor. I5; II5; S2

ISyE – 417 Health Systems Engineering. I; 3 cr.
Introduction to the application of industrial engineering methods to the analysis and improvement of health care delivery. Exploration of common problems of decision-making and control in health care. Examination of social, regulatory and economic factors unique to health care. P: ISyE 313, 320, 323 and 349, or cons inst.

Semester 8

Senior Design Elective (one of the following; consists of a project with an outside organization)
Industrial Engineering Design
Engineering Management
Human Factors Engineering Design and Evaluation Ergonomics in Service
Design and Analysis of Manufacturing Systems
Organization & Job Design
E-Business: Technologies, Strategies and Applications
E-Business Transformation: Design, Analysis and Justification

Texas A&M

Technical Electives

Type	Unrestricted	Restricted (in-major)	Concentration
Quantity	2	2	0

Semester 1

ENGR 111 - **Foundations of Engineering I**. (1-3). Credit 2. I, II, S
Introduction to the engineering profession, ethics, and disciplines; development of skills in teamwork, problem solving and design; other topics included, depending on the major, are: emphasis on computer applications and programming; visualization and CAD tools; introduction to electrical circuits, semiconductor devices, digital logic, communications and their application in systems; Newton's laws, unit conversions, statistics, computers, Excel; basic graphics skills; visualization and orthographic drawings.

Semester 2

ENGR 112 – Foundations of Engineering II. (1-3). Credit 2. I, II, S
Continuation of ENGR 111. Topics include, depending on the major: emphasis on computer applications and programming and solids modeling using CAD tools or other software; fundamentals of engineering science; advanced graphic skills.

Semester 3

CSCE 206 – Structured Programming in C++

MEEN 221 – Statics and Particle Dynamics

MEEN 222 – Materials Science

Semester 4

ECEN 215 – Principles of Electrical Engineering

MEEN 315 – Thermodynamics

ENTC 181 – Manufacturing & Assembly Processes I

Understand the global manufacturing trend and its impact.
Communicate graphically with 3D or 2D sketches.
Understand the principal of each process described in class and practiced in lab. Be able to compare processes, cite limitation, advantages & disadvantages for each process.
Use both SI and US-customary units competently.
Acquire problem-solving skills to filter out irrelevant information and integrate processes for fabrication of realistic components.

ISEN 220 – Introduction to Production Systems

The course is an introduction to spreadsheet-based modeling and the use of Visual Basic for Applications (VBA). Excel and VBA will be used to code and evaluate models related to production systems.

Stat 211 – Principles of Statistics I

Introduction to probability and probability distributions; sampling and descriptive measures; inference and hypothesis testing; linear regression, analysis of variance.

Semester 5

ISEN 303 – Engineering Economic Analysis

Principles of economic equivalence; time value of money; analysis of single and multiple investments; comparison of alternatives; capital recovery and tax implications; certainty; uncertainty; risk analysis; public sector analysis and break-even concepts.

**Math 304 – Linear algebra **

Stat 212 – Principles of Statistics II

Learn basic principles of regression analysis, experimental design, analysis of variance, categorical data analysis, and nonparametric (or distribution-free) methods.
Learn how to use the program JMP to perform various statistical analyses.
Gain an appreciation for the role that statistics plays in helping us to quantify and explain variability.

Semester 6

ISEN 3 14 – Statistical Control of Quality

Quality control with statistical principles applied to problems in various production systems, including probability concepts, density and distribution functions, control chart concepts and sampling inspection plans; laboratory exercises for exposure to basic metrology and applied statistics for quality control applications in discrete-item manufacturing systems.

ISEN 315 – Production Systems Planning. (3-0). Credit 3. I, II

Principles, models and techniques for planning, analysis and design of integrated production systems; optimization principles, including linear programming, unconstrained and equality constrained optimization and dynamic programming applied to production planning; topics to include capacity expansion models, learning curves, aggregate planning models, deterministic and stochastic inventory, MRP and project scheduling.

ISEN 420 – Operations Research I

Development and application of fundamental deterministic analytical methods including linear programming, integer programming, dynamic programming and nonlinear optimization.

ISEN 424 – Systems Simulation

Understand the fundamental methodologies of discrete event (process oriented) simulation modeling.
Understand the key statistical issues involved in simulation data preparation and the analysis of simulation output,
Become familiar with modeling using a commercial language (ARENA), and
Demonstrate effective written communication of a modeling problem, the solution method employed and recommendations

Semester 7

ISEN 316 – Production systems Operations

Analytical principles of manufacturing systems design, analysis and control; emphasis placed on stochastic analysis; role of variability and impact on cycle time; push versus pull production strategies including Kanban and constant WIP control; probability, queuing theory, Little's Law, heavy traffic approximations, and queuing networks.

ISEN 416 – Facilities, Location, Layout and Material Handling

Analytical treatment of facilities location, physical layout, material flow and handling, combined with heuristic algorithms to assist in the design of production/service facilities; fundamental concepts applied through a sequence of design projects.

Semester 8

ENGR 482 – Ethics and Engineering

ISEN 459 – Industrial Engineering Systems Design

Virginia Tech

Technical Electives

Type	Unrestricted	Restricted (in-major)	Concentration
Quantity	3	2	0

Semester 1

Math 1114 – Linear Algebra

Semester 2

Math 1224 – Vector Geometry

Semester 3

ISE 2014 – Engineering Economy

> Concepts and techniques of analysis for evaluating the worth of products, systems, structures, and services in relation to their cost. Economic and cost concepts, calculating economic equivalence, comparison of alternatives, replacement economy, economic optimization in design and operations, and after-tax analysis. Pre: ENGE 1024. (3H,2C)

One of the two…

> CS1044 – Introduction to Programming in C
> ENGE 2314 – Engineering Problem Solving in C++

ENGE 2344 – CAD

ESM 2104 – Statics

Semester 4

Stat 4105 – Theoretical Statistics I

> Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics.

ISE 2204 – Manufacturing Processes

> Survey of manufacturing processes, including casting, forming, machining, joining, and nontraditional processes such as laser and electrical discharge machining. Emphasis on process capabilities and limitations and design for manufacturability. Also includes topics

in product design, material selection, process planning, and manufacturing automation. I,II Pre: ENGE 1104 or ENGE 1114. (2H,2C)

ISE 2214 – Mandatory Manufacturing Processes Lab

Laboratory exercises and experimentation in manufacturing processes. Emphasis on metrology, casting and molding, forming, machining, welding and computer-aided manufacturing. I,II Pre: ENGE 1104 or ENGE 1114. (3L,1C)

ISE 2404 – Deterministic Operations Research

Deterministic operations research modeling concepts; linear programming modeling, assumptions and algorithms, duality and sensitivity analysis with economic interpretation; transportation and assignment problems; convexity issues, optimality conditions for continuous unconstrained and constrained nonlinear optimization problems, numerical optimization methods; and discrete optimization concepts. II,III. Co: MATH 2224. (3H,3C)

ESM 2304 – Dynamics

MSE 2034 – Materials Engineering

Semester 5

Stat 4706 – Statistics for Engineers

Multiple regression, analysis of variance, factorial and fractional experiments.

ISE 3014: WORK MEASUREMENT AND METHODS ENGINEERING

Survey of methods for assessing and improving performance of individuals and groups in organizations. Techniques include various basic industrial engineering tools, work analysis, data acquisition and application, performance evaluation and appraisal, and work measurement procedures. A grade of C- or better required in prerequisites ISE 2204 and 2214 and STAT 4105. Pre: (2204 or 2214), STAT 4105. (2H,3L,3C) I,III.

ISE 3414 – Probabilistic Operations Research

This course introduces probability models used to investigate the behavior of industrial systems. The major topics include conditioning, elementary counting processes and Markov chains. Emphasis is on the use of these tools to model queues, inventories, process behavior and equipment reliability.

ISE 3614 – Introduction to Human Factors

Survey of human factors engineering emphasizing the systems approach to workplace and machine design. Discussion of basic human factors research and design methods, visual processes and design methods, selection of statistical techniques for application to human factors data, visual and auditory processes, display and control design and effects of environmental stressors on humans. A grade of C- or better required in STAT 4105. Pre: STAT 4105. (2H,3L,3C) I,IV.

ECE 3054 – Electrical Theory

Semester 6

ISE 3214 – Facilities Planning and Material Handling

Theory and concepts involved in model formulation for design and analysis of facility plans. Includes facility layout, facility location and material handling system design. Application of quantitative tools and techniques for flow analysis, layout planning, and automated material handling system design. A grade of C- or better required in ISE prerequisites 2014, 2404, and 3414. II,IV Pre: 2014, 2404, 3414, ENGE 2344. Co: 3424. (3H,3C)

ISE 3424 – Discrete Event Computer Simulations

No description available

ISE 3024 – Data Management for IE's

Investigation of data modeling, storage, acquisition, and utilization in Industrial Engineering via manual and computerized methods. Development of effective spreadsheet applications using Excel. Design and implementation of relational databases via E-R modeling, relational schema, normalization, SQL, and MS Access. Web-based database applications using HTML, JavaScript, and ASP. Interface design and the system development life cycle applied to data management applications. All topics covered within the context of typical Pre: 2214, ENGE 2314. Co: 3214. (3H,3C) Industrial Engineering problems. A grade of C- or.

ISE 3624 – Industrial Ergonomics

Introduction to ergonomics with an emphasis on people at work. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including manual materials handling, cumulative trauma disorders, environmental stresses, safety, and legal issues. A grade of C- or better required in ISE prerequisite 3014. I,II. Pre: 3014, ESM 2104. (3H,3C)

Semester 7

ISE 4005 – Project Management and System Design (Capstone I)

The capstone design sequence for ISE majors. Survey of methods, tools and techniques used to plan, communicate, manage and control projects. Students work in teams to develop a proposal for and implement an industrial engineering design project for actual manufacturing or service industry clients. A grade of C- or better required in ISE prerequisites 3214, 3424, and 3024. Pre: 3024, 3214, 3424, 3614 for 4005; 4005 for 4006. Co: 4204, 3624 for 4005. 4005: (3H,3C) 4006: (2H,2C)

ISE 4204 – Production Planning and Inventory Control

Theory and concepts involved in model formulation for analysis and control of production processes. Systems for planning and controlling production and inventory including

material requirements planning (MRP), just-in-time (JIT), and synchronous production systems. A grade of C- or better is required in prerequisite ISE 2404 and STAT 4706. I. Pre: 2404, STAT 4706. (3H,3C)

ISE 4404 – Statistical Quality Control

Application of statistical methods and probability models to the monitoring and control of product quality. Techniques for acceptance sampling by variables and attributes are presented. Shewhart control charts for both classes of quality characteristics are examined in depth. The motivation for each method, its theoretical development, and its application are presented. The focus is upon developing an ability to design effective quality control procedures. A grade of C- or better required in ISE 3414, STAT 4105, and STAT 4706. I. Pre: 3414, STAT 4105, STAT 4706. (3H,3C)

Semester 8

ISE 4006 – Project Management and System Design (Capstone II)

ISE 4304 – Global Issues and Industrial Management

Industrial management topics of current interest explored from a global perspective. Current domestic and international challenges resulting from a global marketplace and the proliferation of information and technology. Industrial management and organizational performance, total quality management, business process re-engineering, leadership, organizational change, role of communication and information, and ethics. Examination and comparison across international boundaries. II (3H,3C)

Stanford (MS&E – Operations Management)

Technical Electives

Type	Unrestricted	Restricted	Concentration
Quantity	0	5	0

First year

Econ 1A – Principles of Economics

The economic way of thinking and the functioning of a modern market economy. The behavior of consumers and firms. Markets for goods and inputs. Analysis of macroeconomic variables: output, employment, inflation, interest rate. Determination of long-run growth and short-term fluctuations. The role of government: regulation, monetary, and fiscal policy.

Second Year

ENGR 60 – Engineering Economy

Fundamentals of economic analysis. Interest rates, net present value, and internal rate of return. Applications to personal and corporate financial decisions. Mortgage evaluation, insurance decision, hedging/risk reduction, project selection, capital

budgeting, and investment valuation. Effects of taxes on personal and business decisions. Investment decisions under uncertainty and utility theory. Please see http://www.stanford.edu/class/engr60. Prerequisites: precalculus and elementary probability.

Econ 50 – Economic Analysis I

Individual consumer and firm behavior under perfect competition. The role of markets and prices in a decentralized economy. Monopoly in partial equilibrium. Economic tools developed from multivariable calculus using partial differentiation and techniques for constrained and unconstrained optimization. Prerequisites: Econ 1, and Math 51 or CME 100. Must be taken for a Letter grade if majoring/minoring in Economics.

MS&E 111 – Introduction to Optimization

Formulation and analysis of linear optimization problems. Solution using Excel solver. Polyhedral geometry and duality theory. Applications to contingent claims analysis, production scheduling, pattern recognition, two-player zero-sum games, and network flows. Prerequisite: MATH 51.

STATS 110: Statistical Methods in Engineering and the Physical Sciences

Introduction to statistics for engineers and physical scientists. Topics: descriptive statistics, probability, interval estimation, tests of hypotheses, nonparametric methods, linear regression, analysis of variance, elementary experimental design. Prerequisite: one year of calculus.

MS&E 152W – Introduction to Decision Analysis

How to make good decisions in a complex, dynamic, and uncertain world. People often make decisions that on close examination they regard as wrong. Decision analysis uses a structured conversation based on actional thought to obtain clarity of action in a wide variety of domains. Topics: distinctions, possibilities and probabilities, relevance, value of information and experimentation, relevance and decision diagrams, risk attitude. Students seeking to fulfill the Writing in the Major requirement should register for MS&E 152W.

CS 106A – Programing Methodology in Java

CS 106B – Programming Abstractions in C++

Third Year

MS&E 260 – Introduction to Operations Management

Operations management focuses on the effective planning, scheduling, and control of manufacturing and service entities. This course introduces students to a broad range of key issues in operations management. Topics include determination of optimal facility location, production planning, optimal timing and sizing of capacity expansion, and

inventory control. Prerequisites: basic knowledge of Excel spreadsheets, probability, and optimization.

MS&E 130: Information Networks and Services
Architecture of the Internet and performance engineering of computer systems and networks. Switching, routing and shortest path algorithms. Congestion management and queueing networks. Peer-to-peer networking. Wireless and mobile networking. Information service engineering and management. Search engines and recommendation systems. Reputation systems and social networking technologies. Security and trust. Information markets. Select special topics and case studies. Prerequisites: 111, 120, and CS 106A.

MS&E 180: Organizations: Theory and Management
For undergraduates only; preference to MS&E majors. Classical and contemporary organization theory; the behavior of individuals, groups, and organizations. Limited enrollment. Admission by application. Students must attend first session.

MS&E 120: Probabilistic Analysis
Concepts and tools for the analysis of problems under uncertainty, focusing on model building and communication: structuring, processing, and presentation of probabilistic information. Examples from legal, social, medical, and physical problems. Spreadsheets illustrate and solve problems as a complement to analytical closed-form solutions. Topics: axioms of probability, probability trees, random variables, distributions, conditioning, expectation, change of variables, and limit theorems. Prerequisite: MATH 51. Recommended: knowledge of spreadsheets.

MS&E 121: Introduction to Stochastic Modeling
Stochastic processes and models in operations research. Discrete and continuous time parameter Markov chains. Queuing theory, inventory theory, simulation. Prerequisite: 120 or Statistics 116.

Fourth Year

MS&E 108: Senior Project
Restricted to MS&E majors in their senior year. Students carry out a major project in groups of four, applying techniques and concepts learned in the major. Project work includes problem identification and definition, data collection and synthesis, modeling, development of feasible solutions, and presentation of results. Service Learning Course (certified by Haas Center).

MS&E 140: Accounting for Managers and Entrepreneurs (MS&E 240)
Non-majors and minors who have taken or are taking elementary accounting should not enroll. Introduction to accounting concepts and the operating characteristics of accounting systems. The principles of financial and cost accounting, design of accounting systems, techniques of analysis, and cost control. Interpretation and use of

accounting information for decision making. Designed for the user of accounting information and not as an introduction to a professional accounting career. Enrollment limited. Admission by order of enrollment.