ISE Elective Tracks for Increased Depth in Select Areas

In this packet we describe five elective tracks that are available as part of the curriculum for ISE undergraduates in addition to the required set of core courses. These tracks give students an opportunity to acquire greater depth in one of the following areas of specialization:

- Data Analytics & Optimization Track*
- Supply Chain Management & Logistics Track*
- Management Systems & Operations Research Track
- Manufacturing Track
- Human Systems Integration & Design Track

In addition to these tracks, students frequently complete coursework and projects to pursue Lean Six Sigma Yellow or Green Green Belt certification, as well as minors in business, computer science, entrepreneurship or design.

Please contact the ISE Undergraduate Academic Advisor, Brittany Mellor at mellor.187@osu.edu with questions.

*Students must apply and be accepted to both the Data Analytics & Optimization Track and the Supply Chain Management & Logistics Track prior to beginning the concentration. For deadlines regarding these applications, contact the ISE Advisor listed above.
Industrial and Systems Engineering
Undergraduate Data Analytics & Optimization Track

With the big data analytics trend, skills that encompass both data management and business analysis are in great demand. Big Data Analytics and Optimization focuses on using large data sets, computer models, and optimization methods to support data-driven decision-making. This powerful combination of big data analytics with optimization has been successfully demonstrated and will be increasingly needed in the management of:

- healthcare and transportation networks
- retail and financial decision making
- supply chain and logistics systems
- large scale information systems
- manufacturing operations
- energy and smart grids
- social networks.

The ISE Data Analytics and Optimization track is an undergraduate elective track designed with a comprehensive and applied curriculum providing students with a strong background in data science, computer science and optimization methods. The track requires a sequence of courses in:

- computer science
- operations research
- cognitive engineering
- probability and statistics.

Students will be prepared in the use of critical tool sets necessary for managing, visualizing, and extracting useful information from big data, as well as powerful skill sets such for modeling, simulation, optimization and decision analysis in order to support efficient data-driven decision making.

Entry into this track is competitive, as there is only space for a limited number of students in the required courses. Students will be admitted based on their EPHR, performance in CSE 1222/1223 and their math, programming and statistics courses. They should apply once all upper level math courses (Linear Algebra & Differential Equations) and statistics (Statistics 3470) have been completed.
Full completion of the Data Analytics Track requires the following ISE & Non-ISE coursework:

As part of the Core Courses required of all ISE undergraduates, students must complete the following courses relevant to this track (as well as all other ISE Core Courses):

* CSE 1222 (Programming in C++) or CSE 1223 (Introduction to Computer Programming in Java)
* CSE 2112 (Modeling & Problem Solving with Spreadsheets & Databases)
* MECHENG 2850 (Numerical Methods Using MATLAB)
* STAT 3470 (Probability & Statistics)
* ISE 3200 (Linear & Integer Programming) (this course can be taken concurrently with CSE 2221)
ISE 3210 (Non-Linear & Dynamic Optimization)
ISE 3700 (Cognitive Systems Engineering)
ISE 4120 (Quality & Reliability Engineering)
ISE 4100 (Stochastic Modeling & Simulation)

*These courses must be completed before beginning the first required CSE course within the Data Analytics Track. The full list of all 5 required Data Analytics courses are listed below.

Specific Data Analytics Track Coursework:

In addition to the ISE & Non-ISE courses above, students must also complete the following:

CSE 2221 (Software I) (4) (prereq of CSE 1222 or 1223) (offered AU & SP)
CSE 2231 (Software II) (4) (prereq of CSE 2221) (offered AU & SP)
CSE 2321 (Foundations I) (3) (prereq of CSE 2221 and Math 1151) (offered AU & SP)
CSE 3241 (Database systems) (3) (prereq of CSE 2231 & CSE 2321) (offered AU & SP)
CSE 5243 (Data mining) (3) (prereq of CSE 2331 & CSE 3241)
  (offered every AU & SP’16 (this is only guaranteed for spring ’16 for now)
  *Can be taken concurrently with CSE 3241

To ensure additional background in ISE, students completing the analytics track must take 3 credits of an ISE course from the either the Manufacturing Track, Management Systems & Operations Research Track or the Human Factors Track. All three of these tracks are listed within this packet.

It’s important to note, students taking this track will complete 129 credit hours to graduate, as this track requires students to take a total of 20 hours of technical electives (5 CSE courses totaling 17 hours, plus one 3-credit hour ISE course).
Industrial and Systems Engineering
Undergraduate Supply Chain Management & Logistics Track

Complementing their broader background as industrial engineers, the Supply Chain Management & Logistics Track will provide students with an exceptional background for the design and management of supply chains. This includes quantitative modeling of supply chain systems, as well as the use of such modeling to support system design and decision making. Such skills are in great demand for career paths in areas such as healthcare, energy systems, financial management, insurance, manufacturing and production systems, military planning, shipping and distribution, and transportation.

Entry into this track is competitive, as there is only space for a limited number of students in the required courses. Students will be admitted based on their EPHR, performance in CSE 1222/1223 and their math, programming and statistics courses. They should apply once all upper level math courses (Linear Algebra & Differential Equations) and statistics (Statistics 3470) have been completed.

Full completion of the Supply Chain Management & Logistics Track requires the following ISE & Non-ISE coursework:

As part of the Core Courses required of all ISE undergraduates, students must complete the following courses relevant to this track (as well as all other ISE Core Courses):

ECON 2001.01 (take as Social Science GEC, subgroup C: Human, Natural & Economic Resources)
MATH 1151 (Calculus I)
MATH 1172 (or MATH 1152 – Calculus II)
STAT 3470 (Introduction to Probability and Statistics for Engineers)
MECHENG 2850 (Numerical Methods Using MATLAB)
CSE 2112 (Modeling and Problem Solving with Spreadsheets & Databases)
ISE 2040 (Engineering Economics)
ISE 3200 (Linear and Integer Programming)
ISE 3210 (Non-Linear Programming)
ISE 3400 (Production Planning and Facility Design)
ISE 3800 (Project Management)
ISE 4120 (Quality Control and Design of Experiments)
ISE 4100 (Stochastic Modeling and Simulation)

Continue to next page for additional track requirements...
Specific Supply Chain Management & Logistics Track Coursework:

In addition to the ISE & Non-ISE courses above, students must also complete a combination of 3 of the following for a minimum of 9 credit hours:

- ISE 5110 (Design of Engineering Experiments) *(SP’17)* (3)
- ISE 5350 (Probabilistic Models and Methods in Operations Research) *(offered SP)* (3)
- ISE 5830 (Decision Analysis) *(offered AU during even years)* (3)

Additionally, students must take **ONE** of the following ISE options for a total of 12 credit hours in ISE specific coursework:

- ISE 5682 (Fundamentals of Product Design Engineering) (4) *(offered AU & SP)*
  OR
- ISE 5820 (Systems Thinking) *(AU odd years)* or ISE 5870 (Resilience Engineering) *(AU even years)*
  OR
- ISE 5800 (Advanced Project Management) *(offered AU & SP)* (3)
  OR
- ISE 5760 (Visual Analytics & Sense Making) *(offered SP)* (3)
  OR
- ISE 5810 (Integrated Lean Sigma Foundations) (4) *(offered AU & SP, by permission)*

Students must take the following 7 week course from Business which is 1.5 credit hours:

- M&L 3380 (Logistics Management) *(pre-requisite is Econ 2001.01)*

*Check Fisher College of Business website for updates on Course Offerings each term:*

  http://fisher.osu.edu/departments/management-and-hr/course-list

Students must also take 4.5 credit hours of the following additional courses in Business. Note that some of these courses are 7 week courses and only 1.5 credits meaning that three 7 week courses would be required to fulfill this requirement OR a combination of one 3-credit hour course plus one 7 week course.

- M&L 4383 (Supply Chain Management) *(pre-requisite is M&L 3380)* (1.5 credits)
- M&L 4380 (Advanced Logistics Management) (1.5 credits)
- M&L 4382 (Logistics Analytics) (3 credits)
- M&L 4387 (Lean Logistics) (1.5 credits)
- M&L 4385 (Sustainable Supply Chains) (1.5 credits)

*Check Fisher College of Business website for updates on Course Offerings each term:*

  http://fisher.osu.edu/departments/management-and-hr/course-list
Industrial and Systems Engineering
Undergraduate Management Systems & Operations Research Track

The ISE track in Management Systems will be of interest to students who would like to apply their ISE and Operations Research knowledge and skills to careers paths in areas such as healthcare, energy systems, financial management, manufacturing and production systems, insurance, and transportation. This track includes a focus on logistics, supply chain management, optimization, simulation, lean sigma, logistics and supply chain management, as well as management systems engineering and the design of quality and productivity improvement programs.

Full completion of the Management Systems & Operations Research Track requires the following ISE & Non-ISE coursework:

As part of the Core Courses required of all ISE undergraduates, students must complete the following courses relevant to this track (as well as all other ISE Core Courses):

- MATH 1151
- MATH 1172 (or equivalent)
- CSE 2112 (Modeling and Problem Solving with Spreadsheets & Databases)
- STATS 3470 (Introduction to Probability and Statistics for Engineers)
- MECHENG 2850 (Numerical Methods Using MATLAB)
- ISE 2040 (Engineering Economics)
- ISE 3200 (Linear and Integer Programming)
- ISE 3210 (Non-Linear & Dynamic Optimization)
- ISE 3400 (Production Planning and Facility Design)
- ISE 3800 (Project Management)
- ISE 4120 (Quality & Reliability Engineering)
- ISE 4100 (Stochastic Modeling and Simulation)

Continue to next page for additional track requirements...
Specific Management Systems & Operations Research Track Coursework:

Students must complete any combination of 3 of the following ISE options for a minimum of 9 ISE technical elective credit hours:

- ISE 5110 (Design of Engineering Experiments) \( (SP'17) \) (3)
- ISE 5800 (Advanced Project Management) (3) \( (offered \ AU \ & \ SP) \)
- ISE 5810 (Integrated Lean Sigma Foundations) (4) \( (offered \ AU \ & \ SP, \ by \ permission) \)
- ISE 5820 (Systems Thinking in Engineering and Design) (3) \( (AU \ odd \ years) \)
- ISE 5870 (Resilience Engineering) (3) \( (AU \ even \ years) \ (7 \ weeks, \ 2^{nd} \ session) \)
- ISE 5350 (Probabilistic Models and Methods in Operations Research) (3) \( (offered \ SP) \)
- ISE 5830 (Decision Analysis) (3) \( (offered \ AU \ even \ years) \)

A total of 15 hours of technical electives are required for the ISE Degree. After completing the 9 hours from the above list, students may complete the remaining 6 hours a number of ways. These 6 hours can be fulfilled with ISE technical electives in the student’s current track of choice, or from any of the other ISE tracks (excluding Supply Chain & Logistics or Data Analytics). Additionally, these 6 hours can be fulfilled using the approved list of “outside” electives offered toward the back of this packet or the options below which are approved “outside” electives offered through Business that streamline with the Management Systems and Operations Track:

- M&L 3380 (Logistics Management) (1.5)
- M&L 4380 (Advanced Logistics Management) (1.5)
- M&L 4382 (Logistics Analytics) (3)
- M&L 4383 (Supply Chain Mgmt) (1.5)
- M&L 4387 (Lean Logistics) (1.5)
- M&L 4388 (Warehouse Operations) (1.5)
- M&L 4385 (Sustainable Supply Chains) (1.5)
- M&L 5389 (Logistics Decision Making) (3)

Please note some of the courses listed above are only 7 week courses and are only 1.5 credit hours.

*Check Fisher College of Business website for updates on Course Offerings each term: [http://fisher.osu.edu/departments/management-and-hr/course-list](http://fisher.osu.edu/departments/management-and-hr/course-list)
Industrial and Systems Engineering
Undergraduate Manufacturing Track

Full completion of the Manufacturing Track requires the following ISE & Non-ISE coursework:

As part of the Core Courses required of all ISE undergraduates, students must complete the following courses relevant to this track (as well as all other ISE Core Courses):
- ISE 2400 (Design of Work)
- ISE 2500 (Introduction to Manufacturing Engineering)
- ISE 3400 (Production Planning & Facilities Planning)
- ISE 3600 (Workplace Ergonomics)
- ISE 4120 (Quality and Reliability Engineering)
- ME 2040 (Statics and Introduction to Mechanics of Materials)

Specific Manufacturing Track Coursework:

Students must complete both of the following Manufacturing courses for a total of 6 hours:
- ISE 3500 (Process Engineering for Machining Operations) (3) (offered Au&SP)
- ISE 5682 (Fundamentals of Product Design Engineering) (4) (offered Au&SP)

Students must pick 1 of the following 3-credit hour Manufacturing courses, or two 1.5-credit hour Manufacturing courses:
- ISE 5463 (Manufacturing of Energy Systems) (3) (ask ISE Advisor)
- ISE 5530 (Tool Engineering) (3) (ask ISE Advisor)
- ISE 5501 (Fundamentals of Solid State Processing) (3) (offered SP odd years)
- ISE 5502 (Molten Metal Processing) (3) (ask ISE Advisor)
- ISE 5520 (Industrial Automation) (1.5) (7 wks, session 2) (ask ISE Advisor)
- ISE 5521 (Forming) (1.5) (7 wks, session 1) (ask ISE Advisor)
- ISE 5540 (Polymer Processing Fundamentals) (3) (offered SP)

A total of 15 hours of technical electives are required for the ISE Degree. After completing 9 hours from the above lists, students may complete the remaining 6 hours a number of ways. These 6 hours can be fulfilled with ISE technical electives in the student’s current track of choice, or from any of the other ISE tracks (excluding Supply Chain & Logistics or Data Analytics). Additionally, these 6 hours can be fulfilled using the approved list of “outside” electives offered toward the back of this packet. ISE 5460 Occupational Safety: Analysis and Design of Work Environments and ISE 5810 Integrated Lean Sigma Foundations are two other courses on the list of approved technical electives that are particularly relevant to students interested in the Manufacturing track.
Industrial and Systems Engineering
Undergraduate Human Systems Integration & Design Track

The ISE track in Human Systems Integration & Design will be of interest to students who are “people-oriented” and are interested in designing work and work systems that rely on and/or support human performance. Students interested in product design will also find this track valuable. All types of operations can benefit from improvements in Human Systems Integration & Design, including companies involved in:

- healthcare
- transportation
- energy management
- information management
- retail and financial systems
- manufacturing and production systems.

This track in Human Systems Integration & Design focuses on strategies for improving productivity, quality, resilience and safety. In addition to general courses on human factors engineering and design, it includes courses concerned with occupational safety and health, as well as courses concerned with cognitive systems engineering.

**Full completion of the Human Systems Integration & Design Track requires the following ISE & Non-ISE coursework:**

As part of the Core Courses required of all ISE undergraduates, students must complete the following courses relevant to this track (as well as all other ISE Core Courses):

- ISE 2040 (Engineering Economics)
- ISE 2400 (Design of Work)
- ISE 3600 (Workplace Ergonomics)
- ISE 3700 (Cognitive Systems Engineering)
- ISE 3800 (Project Management)

Continue to next page for additional track requirements...
Specific Human Systems Integration & Design Track Coursework:

Students must complete any combination of 3 of the following ISE options for a minimum of 9 ISE technical elective credit hours:

- ISE 5110 (Design of Engineering Experiments) *(SP’17)* (3)
- ISE 5610 (Ergonomics in the Product Design Process) (3) *(offered AU)*
- ISE 5620 (Risk Assessment Tools for Occupational Musculoskeletal Disorders) (3) *(Ask ISE Advisor)*
- ISE 5640 (Occupational Safety: Analysis & Design of Work Environments) (3) *(offered AU)*
- ISE 5710 (Safety & Complex Systems) (3) *(SP even years)*
- ISE 5740 (Cognitive Engineering Systems: Human-Centered Automation) *(SP’17)*
- ISE 5682 (Fundamentals of Product Design Engineering) (4) *(offered AU&SP)*
- ISE 5705 (Cognitive Systems Engineering: Distributed & Cooperative Work) *(ask ISE Advisor)*
- ISE 5760 (Cognitive Engineering Systems: Visualization and Human-Computer Interfaces) (3) *(SP)*
- ISE 5820 (Systems Thinking in Engineering & Design) (3) *(AU odd years)*
- ISE 5870 (Resilience Engineering) (3) *(AU even years)* (7 weeks, 2nd session)

A total of 15 hours of technical electives are required for the ISE Degree. After completing 9 hours from the above list, students may complete the remaining 6 hours a number of ways. These 6 hours can be fulfilled with ISE technical electives in the student’s current track of choice, or from any of the other ISE tracks (excluding Supply Chain & Logistics or Data Analytics). Additionally, these 6 hours can be fulfilled using the approved list of “outside” electives offered toward the back of this packet. The options below are approved “outside” electives that streamline with the Human Systems Integration and Design Track:

- DESIGN 3105 (Design Concepts for Non-Majors) (3) *(offered AU&SP)*
- PUBH-EHS 3320 (Fundamentals of Environmental Health Risk Assessment) (3) *(offered AU&SP)*
- PUBH-EHS 3310 (Current Issues in Global Environmental Health) (3) *(offered AU&SP)*
- PUBH-EHS 5325 (Principles of Occupational Health Science) (3) *(offered AU&SP)*
Approved List of Technical Elective Courses Outside of the ISE Major

BUSMGT 3230: Introduction to Operations management: Improving Competitiveness in Organizations
BUSMGT 4232: Operations Planning and Control
BUSMGT 4233: Information Systems in Operations Management
BUSMGT 4239: Managing Process Improvement
BUSMGT 4240: Management of Technology

CHEM 2310: Introductory Organic Chemistry
CHEM 2510: Organic Chemistry I

CIVILEN 3510: Civil Engineering Materials

DESIGN 3105: Design Concepts for Non-Majors
DESIGN 3305: Design Visualization for Non-Majors
DESIGN 4405: Design Media for Non-Majors
DESIGN 4505: 3-D Visualization
DESIGN 5405: Web Communications
DESIGN 5505: Information Design

MATH 2366: Introduction to Discrete Mathematics
MATH 4512: Partial Differential Equations for Science and Engineering
MATH 4530: Probability
MATH 4551: Vector Analysis
MATH 4552: Complex Analysis

MATSCEN 2251: Thermodynamics of Materials

MECHENG 5665: Reliability Engineering I
MECHENG 5666: Reliability Engineering II
MECHENG 5680: Computer Aided Design and Manufacturing
MECHENG 5682: Fundamentals of Product Design Engineering
MECHENG 5716: Probabilistic Reliability and Safety Assessment

PSYCH 3310: Sensation and Perception
PSYCH 3312: Memory and Cognition
PSYCH 3325: Introduction to Social Psychology
PSYCH 4508: Psychology of Judgment and Decision
PUBH-EHS 3310: Current Issues in Global Environmental Health
PUBH-EHS 3320: Fundamentals of Environmental Health Risk Assessment
PUBH-EHS 5325: Principles of Occupational Health Science

STAT 5510: Statistical Foundations of Survey Research
STAT 5550: Introductory Time Series Analysis

Any Business Minor Course (ECON 2001.01 is a pre-requisite for the business minor)
Any CSE course above 1222 and Advanced Excel Course, CSE 2112 (students who took CSE 2111 are not eligible to take CSE 2112)
Any Entrepreneurship Minor Course (this minor is part of Fisher College of Business)

Additional Business courses:

- M&L 3380 (Logistics Management) (1.5)
- M&L 4380 (Advanced Logistics Management) (1.5)
- M&L 4382 (Logistics Analytics) (3)
- M&L 4383 (Supply Chain Mgmt) (1.5)
- M&L 4387 (Lean Logistics) (1.5)
- M&L 4388 (Warehouse Operations) (1.5)
- M&L 4385 (Sustainable Supply Chains) (1.5)
- M&L 5389 (Logistics Decision Making) (3)

*Note, for the above courses, M&L 3380 (Logistics Management) is a pre-requisite for the remainder courses in the list.

*Check Fisher College of Business website for updates on Course Offerings each term:
http://fisher.osu.edu/departments/management-and-hr/course-list

Also, the following courses IF they have not already fulfilled the “additional science” requirement:
Bio 2100  Bio 1113  Chem 1220  Chem 1250  Physics 1240 & 1241
Industrial and Systems Engineering
Integrated LeanSigma Certification Program

The ISE Department offers the opportunity for candidates to earn a Yellow Belt, Green Belt or Black Belt Certification while completing their ISE degree in any of the four above tracks. A Certification in Integrated LeanSigma differentiates a candidate and is in very high demand in business and industry. The program is rigorous and requires focus discipline, it readies the candidate to enter the ‘real world’ and hit the ground running.

The program has been offered since 2007 and over 250 candidates have chosen this path. 95% of the candidates in this program have landed full time positions before graduating indicating the popularity of this additional work and skill development in the eyes of employers. Disney, Discover, Boeing, UPS, Walmart, John Deere, Parker Hannifin, Unilever, Lincoln Electric, Cameron International, Timken, GE Aviation, Chase, The Limited, Accenture, Schneider Electric, are just a small sample of representative companies pursuing candidates with the ISE Degree and the ILSS Certification.

**ISE 5810—Integrated LeanSigma Foundations.** This is the Black Belt Foundation Course. Upon successfully completing this course and the five-hour final exam, the candidate will receive a Certificate (not Certification). This course has four labs associated with it and is one of our more popular courses in the ISE Curriculum.

**ISE 5811-12—Integrated LeanSigma Capstone Certification Project.** This capstone option replaces ISE 4900 for a candidate taking this add-on program. The projects are industry sponsored and cover two semesters. Successful completion of the ‘real world’ project leads to Green Belt Certification.

For candidates not able or wanting to take a 2 semester capstone project, ISE4900ILSS is available (limited basis). Successful completion of ISE 4900 (ILSS) on top of ISE 5810 leads to a Yellow Belt Certification.

Black Belt Certification is feasible but requires special planning and two projects. Those interested in this should speak with Dr. Sink.