COURSE AND OPTIONS SELCTION HANDBOOK

INDUSTRIAL ENGINEERING

4TH YEAR

Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

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WHAT IS COURSE AND OPTIONS SELECTION (COS)?

Each year the Office of the Registrar asks you to provide them with indicators as to which program option and technical elective courses you plan to take in the coming academic year. The information that you provide to us through Course and Options Selection (COS) helps us identify the demand for program options and courses. This information is used for the course scheduling process and for uploading your course selections to ACORN. When selecting your technical electives, be sure that your selections meet the program requirements for your program of study. Please be advised that students who do not participate in COS will not be guaranteed a space in technical elective courses, so it is in your best interest to submit your selections.

We greatly appreciate your cooperation with this exercise.

It can be completed on Degree Explorer

ALL INFORMATION IN THIS HANDBOOK WAS MOST RECENTLY UPDATED IN JUNE 2022. COURSES, DEGREE REQUIREMENTS, AND DATES MAY CHANGE FROM YEAR TO YEAR. PLEASE REFER TO THE CURRENT YEAR'S ENGINEERING ACADEMIC CALENDAR.

IMPORTANT DATES

DATE	
MID FEBRUARY – EARLY MARCH	**COURSE & OPTION SELECTION OPENS** Students may not login and make their curriculum selections for the upcoming academic year
EARLY MARCH	**LAST DAY FOR STUDENTS TO APPLY TO RE-ENROL OR SWITCH TO FULL-TIME FOR 2022 FALL SESSION***
MID JULY	TIMETABLES BECOME AVAILABLE ON ROSI
LATE JULY	**COURSE SELECTION (ROUND 1) OPENS** www.acorn.utoronto.ca For electives offered by the Faculty of Engineering and Enhanced Enrollment Arts & Science electives. Students may now make changes to their timetable.
EARLY AUGUST	**COURSE SELECTION (ROUND 2) OPENS** www.acorn.utoronto.ca **For electives offered by Arts & Science**
MID/LATE AUGUST	**MIE490 CAPSTONE PROJECT SELECTION**
LATE AUGUST	**LAST DAY TO PAY OR DEFER TUITION FEES**
EARLY SEPTEMBER	**ENGINEERING FALL (F) LECTURES BEGIN** Last day to receive a 100% tuition refund if you are choosing to withdraw for the 2022-2023 academic year
MID SEPTEMBER	**DEADLINE TO SUBMIT TECHNICAL ELECTIVE SUBSITUTION REQUESTS FOR 4F** **DEADLINE TO SUBMIT THESIS ENROLMENT FORMS FOR FALL (F) & FULL-YEAR (Y) PROJECTS** **DEADLINE TO SUBMIT COURSE REQUEST FORMS FOR FALL (F) & FULL-YEAR (Y) COURSES**
LATE SEPTEMBER	**FALL (F) & FULL-YEAR (Y) COURSE ADD DEADLINE**
NOVEMBER 16	**FALL (F) COURSE DROP DEADLINE AND EXTRA DEADLINE** Last day to drop Fall (F) Session courses without academic penalty, withdraw from the Fall (F) session without academic penalty, or transfer to part-time studies for the Fall (F) session Last day to receive a 50% tuition refund if you are choosing to withdraw for the 2022-2023 academic year.

EARLY JANUARY	**ENGINEERING WINTER (S) LECTURES BEGIN**
MID JANUARY	**DEADLINE TO SUBMIT TECHNICAL ELECTIVE SUBTITUTION REQUESTS FOR 4S** **DEADLINE TO SUBMIT THESIS ENROLMENT FORMS FOR WINTER (S) PROJECTS** **DEADLINE TO SUBMIT COURSE REQUEST FORMS FOR WINTER (S) COURSES**
LATE JANUARY	**DEADLINE TO SUBMIT PER HOURS FOR IRON RING**
EARLY MARCH	**IRON RING CEREMONY**
MARCH 19	**WINTER (S) COURSE DROP DEADLINE AND EXTRA DEADLINE**
LATE MARCH	**NAME CHANGE DEADLINE** Deadline to submit any name changes to the Office of Convocation that are to appear on your degree
JUNE	**CONVOCATION - CONGRATS**

For a complete list of the Sessional Dates click here
For Fee and Refund Schedule information click here

CURRICULUM

FALL SESSION – YEAR 4

REQUIRED CORE COURSES	
MIE463H1	Integrated System Design
MIE490Y1	Capstone
TECHNICAL ELECTIVE (CHOOSE TWO):	
APS502H1	Financial Engineering
MIE344H1	Ergonomic Design of Information Systems
CSC384H1	Introduction to Artificial Intelligence
MIE354H1	Business Process Engineering
MIE365H1	Operations Research III: Advanced OR
MIE368H1	Analytics in Action

MIE523H1	Engineering Psychology and Human Performance
MIE440H1	Design of Innovative Products
MIE451H1	Decision Support Systems
MIE498H1	Research Thesis (half year)
MIE498Y1	Research Thesis (full year)
MIE562H1	Scheduling
MIE566H1	Decision Making Under Uncertainty
COMPLEMENTARY STUDIES OR HUMANITIES AND SOCIAL SCIENCES ELECTIVE	
CS/HSS ELECTIVE*	

For further information, visit the Engineering Academic Calendar

WHAT'S THE DIFFERENCE BETWEEN AN AREA OF FOCUS AND A STREAM?

In the Mechanical Engineering program, students select streams. These streams require them to take a continued stream course in 4F from their stream selections in 3W. In the Industrial Engineering program, it is not mandatory to continue with courses in your particular area of focus. If you choose a Human Factors technical elective in third year, you can choose another Human Factors course in fourth year or choose a course in information engineering or operations.

WHAT IS A CS ELECTIVE?

Complementary Studies (CS) can be broadly defined as studies in humanities, social sciences, arts, management, engineering economics and communication that complements technical curriculum. Engineering, math or science courses—including astronomy and psychology—may not be used to fulfill your CS elective requirement. Additionally, the Rotman School of Management does not typically permit students outside of their faculty to take their courses (i.e. RSM courses).

WHAT IS AN HSS ELECTIVE?

Humanities and Social Sciences (HSS) courses explore the central issues, thought processes and scholarly methods found in these disciplines. Please note HSS electives are a subset of Complementary Studies (CS) courses; they can be used to satisfy CS elective requirements.

Students must complete 4 CS/HSS electives, including 2 mandatory HSS electives. Every HSS is considered a CS, but not every CS is considered an HSS.

WINTER SESSION – YEAR 4

REQUIRED CORE COURSES	
MIE459H1	Organization Design
MIE490Y1	Capstone Design
TECHNICAL ELECTIVE (CHOOSE TWO):	
APS360H1	Applied Fundamentals of Deep Learning
MIE345H1	Case Studies in Human Factors and Ergonomics
MIE367H1	Cases in Operations Research
MIE369H1	Introduction to Artificial Intelligence
MIE424H1	Optimization in Machine Learning
MIE457H1	Knowledge Modelling and Management
MIE469H1	Reliability and Maintainability Engineering
MIE498H1	Research Thesis (half year)
MIE498H1	Research Thesis (full year)
MIE519H1	Advanced Manufacturing Technologies
MIE542H1	Human Factors Integration
MIE561H1	Healthcare Systems
MIE567H1	Dynamic & Distributed Decision Making
COMPLEMENTARY STUDIES OR HUMANITIES AND SOCIAL SCIENCES ELECTIVE	
CS/HSS ELECTIVE*	

For further information visit the Engineering Academic Calendar

CAN I APPLY FOR A TECHNICAL ELECTIVE SUBSTITION? Fourth year students are permitted one technical elective substitution per term. If you would like to take a course from a different department, you may submit a form to see if you can count it as a technical elective. If you would also like to complete 3 technical electives from the approved list in the Fall term and 1 in the Winter, you will also need to submit a technical elective substitution form to see if one of the Fall technical electives can count towards the Winter term. To view the Technical Elective Substitution Form click here

Students must complete 4 CS/HSS electives, including 2 mandatory HSS electives. Every HSS is considered a CS, but not every CS is considered an HSS.

MIE490/APS490: CAPSTONE DESIGN

The capstone design course provides an experience in engineering practice through a significant design project. Student teams meet specific client needs through a creative, iterative, and open-ended design process.

Throughout the fourth year of your program, you will work with a faculty Supervisor and an industry Client on a Capstone Design Project. The Capstone Design Project provides you with an opportunity to work on a problem of real value to your Client. You will work with them and your Supervisor to define your project goals (within the scope of the problem identified), to decide how you will go about achieving these goals and to organize yourself to achieve them.

All capstone projects fall into one of the following categories:

STANDARD CAPSTONE PROJECT: These projects are sourced by Capstone Coordinators and each project is supervised by a single MIE Faculty member. Students are matched with projects in early September.

STUDENT-SOURCED CAPSTONE PROJECT: These projects are sourced by students through PEY, eSIP employer or other industry contacts. Students must form a team and find a single MIE faculty member to supervise their project. Students interested in this type of project must submit for approval by mid-June.

CAPSTONE INNOVATION PROJECTS: The projects are sourced by University or MIE faculty members. These projects entail the design of new and patentable technologies, and come along with high risk, high visibility, and high impact potential. Students are supervised by a single MIE faculty member. ***Competitive Selection**

MULTIDISCIPLINARY PROJECTS (APS490Y): These projects are sourced by capstone coordinators across the Faculty of Applied Science and the Multidisciplinary Capstone course coordinator. These projects require team members from at least two disciplines and are supervised by a single engineering faculty member. ***These projects have an accelerated self-selection and matching process, and require a competitive interview.**

INTERNATIONAL CAPSTONE PROJECTS: These projects are sourced by the International Capstone coordinator. In these projects, students work with University partners from China, Hong Kong and USA.
***Competitive Interview Required**

PROJECT SELECTION

For those interested in the **Multidisciplinary or International** Capstone Projects, you must submit your name by **Late February.**

For those interested in the **Student-sourced projects,** you must submit your project for review by **Mid June.**

For those interested in **Standard Capstone Projects or Capstone Innovation Projects,** you will be contacted mid-August to initiate the matching process.

MIE498H1/Y1: RESEARCH THESIS

The purpose of MIE498 is two-fold: to let students pursue a technical project of interest, and to improve their communication skills. **It is particularly useful for students thinking about graduate school and who want to learn more about engineering research.** Preparing a Progress Report and a Thesis gives students experience in technical writing, and making oral presentations about their projects helps students improve their oral communication skills. MIE498 is an important course in the curriculum because an engineering graduate should be able to present to prospective employers proficiently.

Formal approval to register for the fourth-year thesis must be obtained from the Undergraduate Office. **Enrollment in our thesis course is restricted to students with a 2.7 CGPA or above.**

At the beginning of the term, students will establish with the supervisor, in writing, which reports are to be submitted, the content of these reports, their due dates, and the grading scheme. **The Thesis Topic Form, however, must be submitted to the undergraduate office by one week before the course add date and is not negotiable**. Notice that your supervisor may choose to follow these guidelines, but modifications may be desirable to best fit the nature of the thesis.

In the event your thesis project is not approved, as part of COS and on course selection day, please select a back-up approved curriculum technical elective. By submitting your thesis form on time, you will receive a decision before the course add deadline.

ENROLMENT PROCEDURE

1. Find a supervisor and a thesis topic: You can independently contact MIE faculty members who you are interested in working with, to discuss a research topic. 10 MIE498: THESIS
2. Once you have found a faculty member who will supervise you, complete a thesis enrollment form. Ensure that your supervisor signs the form. The thesis enrollment form can be found here.
3. Attach a 1-page outline of the project you plan to undertake:
    a. Explain how the research project builds upon one or more aspects of engineering science introduced in the student's academic program
    b. Provide an estimate of a level of effort not less than 40 productive hours of work per term
    c. Specify a deliverable in each term to be submitted by the last day of lectures
4. Submit your completed thesis enrollment form and 1-page outline to the MIE Undergraduate Office by the following deadlines:
    a. **Mid September** for a Fall-term (MIE498H1F) or full year (MIE498Y1Y) thesis
    b. **Mid January** for a Winter-term (MIE498H1S) thesis
5. If approved, your research thesis will be added to your transcript on ACORN by the MIE Undergraduate Office. If it is not approved, we will notify you by email.
6.

HUMAN FACTORS

Industrial Engineers also improve productivity and efficiency by studying and improving the actual physical work environment. Human factors engineering is the study of people as workers and as managers, both from the physiological and psychological points of view. The study of human physiology, particularly the nervous system, leads to fascinating discoveries concerning reaction to stimuli, sensory perception, human performance at operator tasks, and people's ability to process information. These principles are applied to the design of human-machine systems, with particular attention to problems of information display, control layout, compensatory controls systems, and the design of work environments.

For example, a mechanical engineer may design a new car, and a human factors engineer would be responsible for the design of the interior: control layout, seating, vision, reachability, usability in unusual circumstances, etc. A nuclear engineer will design a nuclear generator, and a human factors engineer will design the control system displays to minimise the probability of human error.

SUGGESTED TECHNICAL ELECTIVES

4F – MIE344H1F – ERGONOMIC DESIGN OF INFORMATION SYSTEMS

The goal of this course is to provide an understanding of how humans and machines can be integrated with information systems. By the end of the course, students will be able to: Observe, and engage in dialogue with, users in ways that clarify users' views, needs, and capabilities; Develop all phases of the user interface design process in response to the needs of a user interface design project; Demonstrate initiative, personal responsibility and accountability in both personal and group contexts; Communicate information, analyses, and solutions accurately, reliably, orally, and in writing to a range of audiences (e.g., the professor, the TAs, classmates, users); Extend the insights they have gained from their experience through the course in their future interactions with users in the workplace; Use the completed project to promote their candidacy for employment opportunities.

4W – MIE345H1S – CASE STUDIES IN HUMAN FACTORS AND ERGONOMICS

A detailed analysis will be made of several cases in which human factors methods have been applied to improve the efficiency with which human machine systems operate. Examples will be chosen both from the area of basic ergonomics and from high technology. Emphasis will be placed on the practical use of material learned in earlier human factors courses and ergonomics methods to a set of circumstances under which humans are considered central to the proposed solution; Understand

and mitigate obstacles associated with conducting human factors and ergonomics activities in different situations; Map human factors and ergonomics characteristics of different case studies to the Human-Tech ladder; Demonstrate initiative, personal responsibility, and accountability in both personal and group contexts; Use "real-world" knowledge acquired from this course to market candidacy for employment opportunities

4W - MIE440H1 - DESIGN OF INNOVATIVE PRODUCTS

Recently developed methods applied at different stages of the design process include: Identification of unmet/underserved user needs through a modified definition of lead users (those who experience needs in advance of the mainstream population) including identifying/studying lead users, identifying which lead-user needs are relevant to the general population; Roles of function and affordance in successful products; Obstacles of fixation and cognitive bias to creativity; Concept generation methods including TRIZ/TIPS (Theory of Inventive Problem Solving, use of unrelated stimuli and analogy (e.g., from biology); Configuration design methods including design for transformation, design for assembly and end-of-life, e.g., reuse, repair and recycling. Hands-on experience of these topics in lectures, tutorials, and labs support successful application of the methods for the course project, as well as future design activities.

4F – MIE448H1F – ENGINEERING PSYCHOLOGY AND HUMAN PERFORMANCE

The aim of the course is to study, and model, the relationship between human information processing and the design of human-machine systems, especially for complex workplaces.

4W – MIE457H1 – KNOWLEDGE MODELLING AND MANAGEMENT

This course explores both the modelling of knowledge and its management within and among organizations. Knowledge modelling will focus on knowledge types and their semantic representation. It will review emerging representations for knowledge on the World Wide Web (e.g., schemas, RDF). Knowledge management will explore the acquisition, indexing, distribution and evolution of knowledge within and among organizations. Emerging Knowledge Management System software will be used in the laboratory.

4F – MIE523H1F – ENGINEERING PSYCHOLOGY & HUMAN PERFORMANCE

An examination of the relation between behavioural science and the design of human-machine systems, with special attention to advanced control room design. Human limitations on perception, attention, memory and decision-making, and the design of displays and intelligent machines to supplement them. The human operator

in process control and the supervisory control of automated and robotic systems. Laboratory exercises to introduce techniques of evaluating human performance.

4W – MIE542H1S – HUMAN FACTORS INTEGRATION

The aim of this course is to develop an understanding of approaches to integrating human factors in systems design engineering, for complex, safety-critical environments; describe and apply methods and approaches for integrating Human Factors into design processes; understand systems design processes and cycle; develop an understanding of the roles and responsibilities of Human Factors practitioners within the design process and team; develop an understanding of how to communicate requirements arising from human factors integration analyses and methods; develop design concepts which meet the identified requirements; and to prepare for continuous learning through professional practice of HFI methods.

4W – MIE561H1S – HEALTHCARE SYSTEMS

MIE 561 is a "cap-stone" course. Its purpose is to give students an opportunity to integrate the Industrial Engineering tools learned in previous courses by applying them to real world problems. While the specific focus of the case studies used to illustrate the application of Industrial Engineering will be the Canadian health care system, the approach to problem solving adopted in this course will be applicable to any setting. This course will provide a framework for identifying and resolving problems in a complex, unstructured decision-making environment. It will give students the opportunity to apply a problem identification framework through real world case studies. The case studies will involve people from the health care industry bringing current practical problems to the class. Students work in small groups preparing a feasibility study discussing potential approaches. Although the course is directed at Industrial Engineering fourth year and graduate students, it does not assume specific previous knowledge, and the course is open to students in other disciplines.

4W – MIE567H1S – DYNAMIC & DISTRIBUTED DECISION MAKING

Fundamental concepts and mathematical frameworks for scientific sequential decision making in the presence of uncertainty. Utility theory, uncertainty modeling, theory of games, dynamic programming, and multi-agent system. Discussion of how the decision theories can be applied to design algorithms and processes for real-world cases.

FIELDS OF APPLICATION

Transportation, Communication, Healthcare, Military, Energy, Banking

OPERATIONS RESEARCH

Operations research and management science involve the mathematical modelling of real systems and processes with a view to being able to predict and optimally control their performance. For example, we can use statistics to determine how much inventory should be carried in a warehouse to minimise expected costs of carrying the stock and of shortages. We use queueing theory to analyse the waiting time of people or jobs waiting for service in banks, emergency rooms and production facilities. We use linear algebra (called linear programming) to determine the optimal product mix to maximise profit subject to capacity constraints on resources, or the optimal allocation of service facilities (like fire stations) to minimize the expected service time. Areas include scheduling, reliability, maintenance, forecasting, queueing, value analysis and decision making under uncertainty.

Operations Research came into its own during the Second World War, when it became apparent that many problems of scheduling and deployment of resources, which had previously been managed intuitively, could be quantitatively modelled and solved analytically. Since the war, operations research techniques and models have been applied in an ever-increasing variety of industries, from finance to healthcare to government. The modern manager can no longer rely on seat-of-the-pants judgement, but must take a scientific approach to decision making. Much of today's industrial engineering activity is the application of management science in support of decision making at all levels of any organisation. Design, develop and use simulation models for improved decision making.

SUGGESTED TECHNICAL ELECTIVES

4F - APS502H1F – FINANCIAL ENGINEERING

This course will focus on capital budgeting, financial optimization, and project evaluation models and their solution techniques. In particular, linear, non-linear, and

integer programming models and their solutions techniques will be studied. The course will give engineering students a background in modern capital budgeting and financial techniques that are relevant in practical engineering and commercial settings.

3W - MIE335H1S – ALGORITHMS & NUMERICAL METHODS

Algorithmic analysis, big-O asymptotic analysis; numerical linear algebra, solution techniques for linear and non-linear systems of equations; matrix factorization, LU and Cholesky factorization, factorization in the revised simplex method; Newton's method, Gale-Shapley method, greedy methods for combinatorial optimization, branch-and-bound search methods; graph theory and graph theoretic algorithms; design and implementation of algorithms to optimize mathematical models.

4F – MIE354H1F – BUSINESS PROCESS ENGINEERING

This course focuses on grouping, assessing, designing and implementing appropriately integrated and distributed information systems to support enterprise objectives. The emphasis is on understanding how Business Process Management techniques and tools can contribute to align an organization's business and information technology perspectives, as well as the characteristics of application and system types and the implications for their design, operation, and support of information needs. The course reviews platforms and technology infrastructure, including; legacy systems, client/server, the Internet, the World Wide Web, and the emergence of a web-service-based service oriented architecture. Students will work in the laboratory to develop a business process. The course covers Information Systems concepts, tools and techniques, and it is addressed primarily to an audience of process/business analysts instead of targeting an audience of developers/programmers.

4F – MIE365H1F – OPERATIONS RESEARCH III: ADVANCED OR

Design of operations research models to solve a variety of open-ended problems. Linear programming extensions are presented: goal programming, column generation, Dantzig-Wolfe decomposition, and interior point solution methods. Non-linear programming solution methods are developed: optimality conditions, quadratic programming. Solutions to advances stochastic models: stochastic programming, Robust Optimization and Semi-Definite Programming.

4W – MIE367H1S – CASES IN OPERATIONS RESEARCH

To provide students with the experience and confidence to apply Operational Research techniques to solve a variety of cases that industrial engineers may face in their professional life. The course will use one case per week which describes a real situation. Students will be required to analyze the case on their own, in a small

group and with the class. Extensive preparation of each case prior to class participation is essential. After initial discussion, students will be required to fully solve the case, including a numerical solution.

3F – MIE368H1F - ANALYTICS IN ACTION

This course showcases the impact of analytics focusing on real world examples and case studies. Particular focus on decision analytics, where data and models are combined to ultimately improve decision-making. Methods include: linear and logistic regression, classification and regression trees, clustering, linear and integer optimization. Application areas include: healthcare, business, sports, manufacturing, finance, transportation, public sector.

4F - MIE451HF – DECISION SUPPORT SYSTEMS

Provides students with an understanding of the role of a decision support system in an organization, its components, and the theories and techniques used to construct them. Focuses on information analysis to support organizational decision-making needs and covers topics including information retrieval, descriptive and predictive modeling using machine learning and data mining, recommendation systems, and effective visualization and communication of analytical results.

4W – MIE468H1S – FACILITY PLANNING

Fundamentals of developing efficient layouts of production/ service systems and determining optimal locations of facilities in a network. Activity relationships, manufacturing flow patterns, layout procedure types (construction and improvement algorithms), manual and computerized layout techniques, single and multiple facility location, and supply chain (location) network-distribution design.

3W – MIE469H1S – RELIABILITY & MAINTAINABILITY ENGINEERING

An introduction to the life-cycle costing concept for equipment acquisition, operation, and replacement decision-making. Designing for reliability and determination of optimal maintenance and replacement policies for both capital equipment and components. Topics include: identification of an item's failure distribution and reliability function, reliability of series, parallel, and redundant systems design configurations, time-to-repair and maintainability function, age and block replacement policies for components, the economic life for capital equipment, provisioning of spare parts.

4W – MIE519H1S – ADVANCED MANUFACTURING TECH

This course is designed to provide an integrated multidisciplinary approach to

Advanced Manufacturing Engineering, and provide a strong foundation including fundamentals and applications of advanced manufacturing AM. Topics include: additive manufacturing, 3D printing, micro and nanomanufacturing, intelligent manufacturing, Advanced Materials, lean manufacturing, AM in machine design and product development, process control technologies. New applications of AM in sectors such as automotive, aerospace, biomedical, electronic, food processing.

4F – MIE561H1F – COMBUSTION AND FUELS

Introduction to combustion theory. Chemical equilibrium and the products of combustion. Combustion kinetics and types of combustion. Pollutant formation. Design of combustion systems for gaseous, liquid and solid fuels. The use of alternative fuels (hydrogen, biofuels, etc.) and their effect on combustion systems.

4F – MIE562H1F – SCHEDULING

This course takes a practical approach to scheduling problems and solution techniques, motivating the different mathematical definitions of scheduling with real world scheduling systems and problems. Topics covered include: job shop scheduling, timetabling, project scheduling, and the variety of solution approaches including constraint programming, local search, heuristics, and dispatch rules. Also covered will be information engineering aspects of building scheduling systems for real world problems.

4F – MIE566H1F - DECISION MAKING UNDER UNCERTAINTY

Methods of analysis for decision making in the face of uncertainty and opponents. Topics include subjective discrete and continuous probability, utility functions, decision trees, influence diagrams, bayesian networks, multi-attribute utility functions, static and dynamic games with complete and incomplete information, bayesian games. Supporting software.

FIELDS OF APPLICATION

Logistics, Supply Chain Management, Healthcare, Production System, Financial Engineering, Maintenance

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Artificial intelligence (AI) is the study of computational processes that simulate intelligent behaviour. These processes include knowledge representation and reasoning, optimal sequential decision-making under uncertainty, and learning from experience. Specifically, the last area comprises the subfield of AI known as Machine learning (ML) that focuses on computational and statistical methods for learning patterns from historical data for descriptive and predictive purposes.

Together, AI and ML represent the forefront of technology innovation powering a wide range of industrial applications including search engines, conversational assistants, e-commerce, autonomous driving, intelligent logistics scheduling, digital marketing, adaptive user interfaces, and health applications ranging from prediction of adverse outcomes to automated diagnosis in medical imaging. AI and ML both contribute to and benefit from techniques developed in Operations Research (OR) although AI and ML techniques often tend to focus more heavily on the computational and algorithmic aspects of proposed solutions.

To this end, strong preparation in programming and software design is an essential skill for AI and ML practitioners. AI and ML expertise is in high demand in industry with employment in all of the aforementioned application areas and many more; it is also an excellent course of study for those wishing to pursue future research careers in this field with rapidly expanding frontiers.

SUGGESTED TECHNICAL ELECTIVES

3F - MIE368H1F - ANALYTICS IN ACTION (FORMERLY MIE465)

This course showcases the impact of analytics focusing on real world examples and case studies. Particular focus on decision analytics, where data and models are combined to ultimately improve decision-making. Methods include: linear and logistic regression, classification and regression trees, clustering, linear and integer

optimization. Application areas include: healthcare, business, sports, manufacturing, finance, transportation, public sector.

4F - MIE451H1F - DECISION SUPPORT SYSTEMS

This course provides students with an understanding of the role of a decision support system in an organization, its components, and the theories and techniques used to construct them. The course will cover basic technologies for information analysis, knowledge-based problem solving methods such as heuristic search, automated deduction, constraint satisfaction, and natural language understanding.

4F - MIE566H1F - DECISION ANALYSIS

The purpose of this course is to provide a working knowledge of methods of analysis of problem and of decision making in the face of uncertainty. Topics include decision trees, subjective probability assessment, multiattribute utility approaches, goal programming, Analytic Hierarchy Process and the psychology of decision-making.

4F - CSC384H1F – INRODUCTION TO ARTIFICIAL INTELLIGENCE

Theories and algorithms that capture (or approximate) some of the core elements of computational intelligence. Topics include: search; logical representations and reasoning, classical automated planning, representing and reasoning with uncertainty, learning, decision making (planning) under uncertainty. Assignments provide practical experience, in both theory and programming, of the core topics.

4S - MIE424H1S - OPTIMIZATION IN MACHINE LEARNING

1. To enable deeper understanding and more flexible use of standard machine learning methods, through development of machine learning from an Optimization perspective. 2. To enable students to apply these machine learning methods to problems in finance and marketing, such as stock return forecasting, credit risk scoring, portfolio management, fraud detection and customer segmentation.

4S – MIE369H1S – INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Introduction to Artificial Intelligence. Search. Constraint Satisfaction. Propositional and First-order Logic Knowledge Representation. Representing Uncertainty (Bayesian networks). Rationality and (Sequential) Decision Making under Uncertainty. Reinforcement Learning. Weak and Strong AI, AI as Engineering, Ethics and Safety in AI.

4S - MIE457H1S - KNOWLEDGE MODELING AND MANAGEMENT

This course explores both the modeling of knowledge and its management within and among organizations. Knowledge modeling will focus on knowledge types and

their semantic representation. It will review emerging representations for knowledge on the World Wide Web (e.g., schemas, RDF). Knowledge management will explore the acquisition, indexing, distribution and evolution of knowledge within and among organizations. Emerging Knowledge Management System software will be used in the laboratory.

4S – APS360H1S – APPLIED FUNDAMENTALS OF DEEP LEARNING

A basic introduction to the history, technology, programming and applications of the fast evolving field of deep learning. Topics to be covered may include neural networks, autoencoders/decoders, recurrent neural networks, natural language processing, and generative adversarial networks. Special attention will be paid to fairness and ethics issues surrounding machine learning. An applied approach will be taken, where students get hands-on exposure to the covered techniques through the use of state-of-the-art machine learning software frameworks.

4S – ROB311H1S – ARTIFICIAL INTELLIGENCE

An introduction to the fundamental principles of artificial intelligence from a mathematical perspective. The course will trace the historical development of AI and describe key results in the field. Topics include the philosophy of AI, search methods in problem solving, knowledge representation and reasoning, logic, planning, and learning paradigms. A portion of the course will focus on ethical AI, embodied AI, and on the quest for artificial general intelligence.

INFORMATION ENGINEERING

The Information Engineering specialization of the Industrial (Systems) Engineering program creates professionals that address the challenge of successfully applying information technology to help people and organizations innovate and become more efficient.

Our graduates have outstanding employment opportunities in numerous private and public organizations as well as in the global consulting firms that service them. There is current and future demand for professionals that combine expertise in process design and management, business analysis, project management, systems integration, and a fusion of industry knowledge and information technology skills.

Information engineering provides exciting and diverse career opportunities that encompass the development and evolution of information systems. Our graduates address the following challenging issues: how to provide doctors and nurses with timely access to electronic patient data wherever is needed, how to design information systems that run the business of online stores such as music download sites and bookstores, how to reduce large volumes of data into information that is useful to the decision-making processes of government officials, and how to take advantage of information technology to plan, coordinate and support disaster recovery and relief efforts.

SUGGESTED TECHNICAL ELECTIVES

4F - APS502H1F – FINANCIAL ENGINEERING

This course will focus on capital budgeting, financial optimization, and project evaluation models and their solution techniques. In particular, linear, non-linear, and integer programming models and their solutions techniques will be studied. The course will give engineering students a background in modern capital budgeting

and financial techniques that are relevant in practical engineering and commercial settings.

4F – MIE344H1 – ERGONOMIC DESIGN OF INFORMATION SYSTEMS

The goal of this course is to provide an understanding of how humans and machines can be integrated with information systems. The focus will be on the design of human-machine interfaces, and on the analysis of the impact of computers on people. The course will also include coverage of usability engineering and rapid prototyping design, analysis of user mental models and their compatibility with design models, and quantitative modelling of human-computer interaction.

4F – MIE354H1 – BUSINESS PROCESS ENGINEERING

This course focuses on understanding multiple perspectives for grouping, assessing, designing and implementing appropriately integrated and distributed information systems to support enterprise objectives. The emphasis is on understanding how Business Process Management techniques and tools can contribute to align an organization's business and information technology perspectives, as well as the characteristics of application and system types and the implications for their design, operation and support of information needs, including those associated with different platforms and technology infrastructure e.g., legacy systems, client/server, the Internet and World Wide Web including the emergence of a web-service-based service oriented architecture. Students will work in the laboratory to develop business processes that can be specified and executed by information systems supporting BPEL, a widely supported standard for describing web-service-based business process.

4F – MIE368H1 - ANALYTICS IN ACTION (FORMERLY MIE465)

This course showcases the impact of analytics focusing on real world examples and case studies. Particular focus on decision analytics, where data and models are combined to ultimately improve decision-making. Methods include: linear and logistic regression, classification and regression trees, clustering, linear and integer optimization. Application areas include: healthcare, business, sports, manufacturing, finance, transportation, public sector.

4F – MIE451H1F – DECISION SUPPORT SYSTEMS

Provides students with an understanding of the role of a decision support system in an organization, its components, and the theories and techniques used to construct them. Focuses on information analysis to support organizational decision-making needs and covers topics including information retrieval, descriptive and predictive modeling using machine learning and data mining, recommendation systems, and effective visualization and communication of analytical results.

4S – MIE519H1S - ADVANCED MANUFACTURING TECHNOLOGY

This course is designed to provide an integrated multidisciplinary approach to Advanced Manufacturing Engineering, and provide a strong foundation including fundamentals and applications of advanced manufacturing AM. Topics include: additive manufacturing, 3D printing, micro and nanomanufacturing, intelligent manufacturing, Advanced Materials, lean manufacturing, AM in machine design and product development, process control technologies. New applications of AM in sectors such as automotive, aerospace, biomedical, electronic, food processing.

4F – MIE566H1F - DECISION MAKING UNDER UNCERTAINTY

Methods of analysis for decision making in the face of uncertainty and opponents. Topics include subjective discrete and continuous probability, utility functions, decision trees, influence diagrams, bayesian networks, multi-attribute utility functions, static and dynamic games with complete and incomplete information, bayesian games. Supporting software.

4S – MIE561H1S – HEALTHCARE SYSTEMS

MIE 561 is a "cap-stone" course. Its purpose is to give students an opportunity to integrate the Industrial Engineering tools learned in previous courses by applying them to real world problems. While the specific focus of the case studies used to illustrate the application of Industrial Engineering will be the Canadian health care system, the approach to problem solving adopted in this course will be applicable to any setting. This course will provide a framework for identifying and resolving problems in a complex, unstructured decision-making environment. It will give students the opportunity to apply a problem identification framework through real world case studies. The case studies will involve people from the health care industry bringing current practical problems to the class. Students work in small groups preparing a feasibility study discussing potential approaches. Although the course is directed at Industrial Engineering fourth year and graduate students, it does not assume specific previous knowledge, and the course is open to students in other disciplines.

4F – MIE562H1F – SCHEUDULING

This course takes a practical approach to scheduling problems and solution techniques, motivating the different mathematical definitions of scheduling with real world scheduling systems and problems. Topics covered include: job shop scheduling, timetabling, project scheduling, and the variety of solution approaches including constraint programming, local search, heuristics, and dispatch rules. Also

covered will be information engineering aspects of building scheduling systems for real world problems.

FIELDS OF APPLICATION

Data Analysis, Database Design, Business Process Modelling, Information Systems, Ontologies

DEGREE REQUIREMENTS

For official and up-to-date information on the Industrial Engineering Degree Requirements visit the Engineering Academic Calendar

DEGREE EXPLORER

Degree Explorer is a planning tool designed to help students and advisors evaluate academic progress towards completion of requirements for graduation. It is not a transcript. It allows you to map out your degree and can help you determine if you are on track. Just because you are able to enrol in a course on ACORN does not mean it will fulfill your degree requirements.

TO GRADUATE, YOU NEED

- All Core Courses
- 2.0 CS Credits (1.0 or more must be HSS)
- 3.0 Technical Elective Credits
- 600 hours of professional experience, or PEY credit

COMPLEMENTARY STUDIES (CS) AND HUMANITIES & SOCIAL SCIENCES (HSS)

To graduate, you must take 2.0 credits in complementary studies, of which at least 1.0 credits are HSS courses. 0.5 credits = 1 half year course. These are typically taken in second and fourth year, or in the summer (have to pay extra tuition). Students must complete 4 CS/HSS electives, including 2 mandatory HSS. For a list of faculty approved elective lists, please consult the following links. You can also request other A&S courses to act as a substitute:

For approved HSS electives click here

For approved CS electives click here

TECHNICAL ELECTIVES

- One in each semester 3rd year, two in each semester in 4th year
- Select from list of approved electives
- Can apply for another course to substitute for a Technical Elective
- Can substitute at most two technical electives

PRACTICAL EXPERIENCE REQUIREMENT (PER)

- Minimum of 600 hours to graduate
- Work should support professional career of student
- Must contain a good measure of responsibility
- Form must be filled out and submitted to MIE Undergrad Office
- If you do PEY, you do not need to submit PER form

To view a complete list of the MIE UG Forms click here

ENGINEERING MINORS & CERTIFICATES

CONTACT INFORMATION

In addition to academic programs in Core 8 subjects/TrackOne and Engineering Science, undergraduate Engineering students may pursue a number of minors and certificates that add breadth and depth to their academic careers. To obtain a minor, students must take six (6) courses in a particular field. A certificate requires three (3) courses. There are many minors and certificates and enrolling for a minor puts it on your Degree Explorer, which can help you plan. You can de-enrol at any point.

Minors and Certificates are managed by the Cross-Disciplinary Programs (CDP) Office and all inquiries associated with the minors should be addressed to **engineering.minors@utoronto.ca**. For further information on the types of minors available etc. click here

HOW DO I ENROL IN A MINOR?

Each minor has a specific enrolment form for you to complete and submit to the Cross-Disciplinary Programs Office. Please note that enrolling in a minor does not guarantee you a spot in any of the engineering minor electives, as they are open to everyone. To avoid disappointment, plan ahead and select courses 6 AM on course selection days. You are responsible for making sure you fulfill the requirements.

I DIDN'T GET INTO THE COURSES I WANTED TO, AND I'M WORRIED I WONT FINISH MY MINOR BEFORE GRADUATION. WHAT DO I DO?

Due to popularity, many engineering minor courses are offered in the summer. You are also welcome to complete those courses following graduation, it just may not appear on your degree until later. You can also visit the Cross-Disciplinary Programs Office to de-enrol you in a minor.

WILL MY HSS/CS ELECTIVES BE ADDED TO MY TIMETABLE AUTOMATICALLY? WHAT IF I AM ENROLLED IN A MINOR THAT REQUIRES THAT COURSE?

No, you must add them yourself on course selection days. Enrolling in a minor does not guarantee you a spot in its required courses.

I'M NOT SURE WHICH ELECTIVES TO TAKE.

The Arts & Science Student's Union puts together a publication called the Anti-Calendar, which provides honest student feedback about many Arts & Science elective courses offered. http://assu.ca/anti-calendar.

ENROLLMENT & REGISTRATION

OVERLOADS

• To take more than 5 courses in a semester, must receive approval from undergrad office
• Need to have a 2.7 CGPA

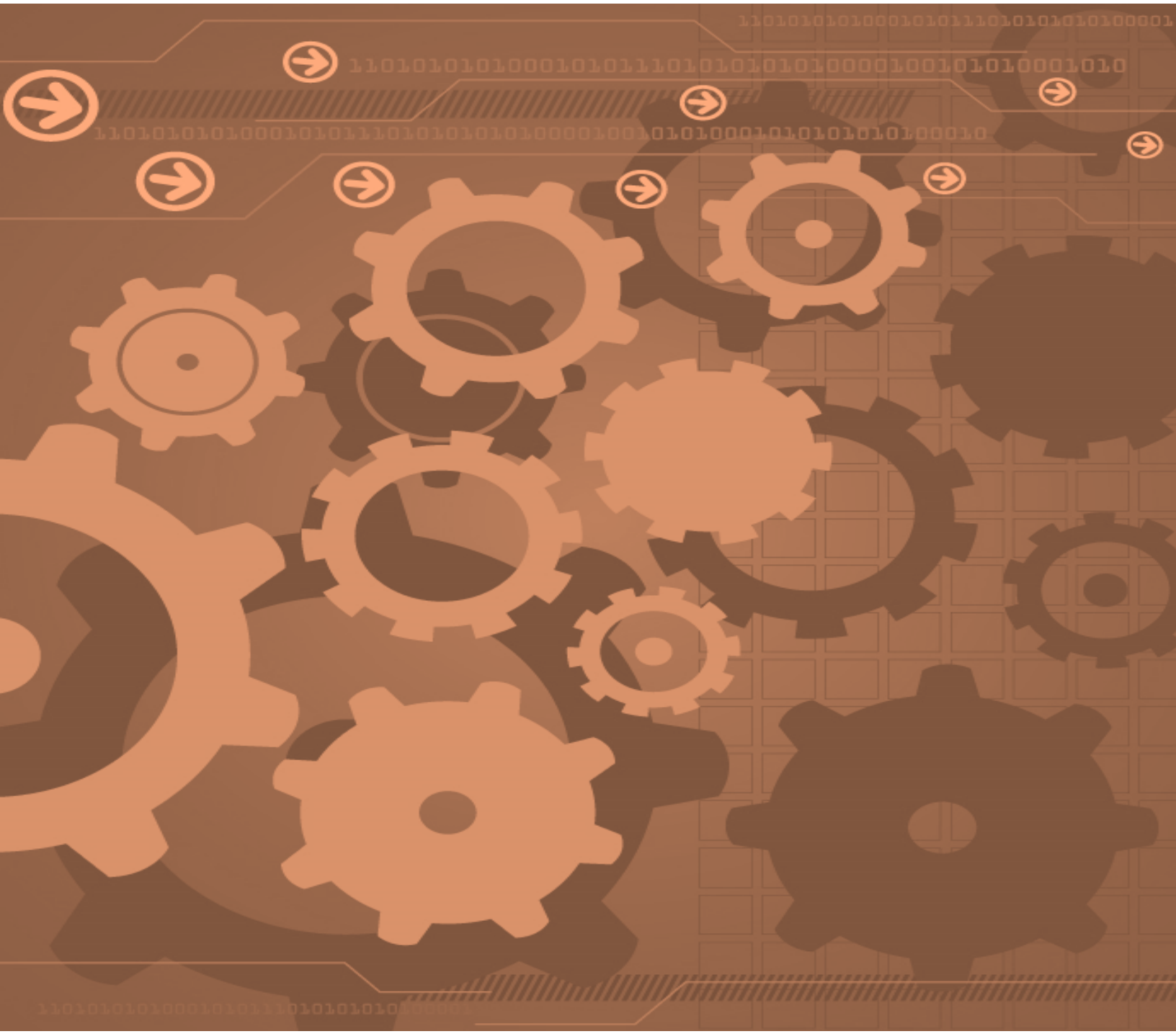
"EXT" OR EXTRA COURSES

• If taking a course not needed for your degree, you can apply to designate it as EXT.
• All courses that are above and beyond a students' degree requirements MUST be marked as Extra
• Mark will not count towards your GPA, but till shows up on transcript
• Credit can be used for minors/certificates
• Deadline to designate EXT is the same as drop deadline

FAILED COURSES

If you have failed a core curriculum course, you must re-take it at the next available opportunity. Many first year engineering courses are offered during the summer. If you were unsuccessful in a second or third year course that is a pre-requisite for an upper level course, you must retake the pre-requisite course first. To add a core curriculum course, submit the Course Request Form (https://www.mie.utoronto.ca/programs/ undergraduate/forms-policies/) to the Undergraduate Office by one week before the add course deadline. To add a failed stream course or CS/HSS elective, you may do so yourself on the course selection dates.

To view a complete list of the MIE UG Forms click here



MIE UG OFFICE CONTACT INFORMATION

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