

# **RENSSELAER POLYTECHNIC INSTITUTE**

# School of Engineering

# Industrial & Systems Engineering

INDUSTRIAL & SYSTEMS ENGINEERING UNDERGRADUATE HANDBOOK 11/8//2010

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#### Introduction

This document provides information and guidance to students either interested in or enrolled in Rensselaer's Industrial and Management Engineering (IME) Bachelor's degree in the department of Industrial and Systems Engineering (ISE). Guidance covers the four undergraduate years and the fifth year if students continue to a master's degree under Rensselaer's Co-Terminal program.

Topics covered include an introduction to the profession of Industrial and Management Engineering, the engineering foundation semesters, the major semesters, cooperative education options, international experiences, continuing to a Masters degree under the Co Terminal program, academic advising, and course descriptions.

#### What is Industrial and Management Engineering (IME)?

Industrial and Management Engineering is an interdisciplinary engineering field about choices. The most distinctive aspect of IME is the flexibility it offers. Whether it's shortening a rollercoaster waiting line, streamlining an operating room procedure, distributing products worldwide, or manufacturing superior automobiles, all these challenges share the common goal of saving money and increasing efficiencies. IME gives practitioners the opportunity to work in a variety of businesses.

Industrial engineering is not just about manufacturing. It also encompasses service industries, with IMEs employed in entertainment industries, shipping and logistics businesses, and health care organizations. A multidisciplinary approach to problem solving is common among IME's.

IMEs design the optimal combination of human and economic resources to make systems perform at their best. The integration of people, materials, capital, equipment and energy into production systems is the IME's main concern. An IME may be involved in scheduling crews and flights at an airline, planning production at a manufacturing plant, designing automation solutions in a distribution warehouse or building information systems to support organizational decision making.

As companies adopt management philosophies of continuous productivity and quality improvement to survive in the increasingly competitive world market, the need for IME's is growing. IME's are the only engineering professionals trained specifically to be productivity and quality improvement specialists. Many practitioners say that an IME education offers the best of both worlds: an engineering and business education. This is why many industrial engineers end up being promoted into management positions.

IMEs make processes better in the following ways:

- More efficient and more profitable business practices
- Better customer service and product quality
- Making work safer, faster, easier, and more rewarding
- Helping companies produce more products quickly
- Making the world safer through better designed products
- Reducing costs associated with new technologies

The U.S. Bureau of Labor Statistics [BLS] has described a typical IME's function as follows: Industrial engineers determine the most effective ways for an organization to use the basic factors of production-people, machines, materials, information, and energy-to make or process a product. They are the bridge between management and operations. They are more concerned with increasing productivity through the management of people, methods of business organization, and technology than are engineers in other specialties, who generally work more with products or processes.

The above material was adapted from material of the Institute of Industrial Engineering using their web site <u>http://www.iienet2.org/Details.aspx?id=716</u>, April 15, 2010.

#### Are you a candidate for IME?

IME's are curious about how and why things work the way they do. They typically have an interest in planning, organizing and implementing worthwhile projects. Additionally, they have a strong desire to serve human needs by finding practical solutions to problems and they enjoy working with other people. Numerous professional industrial engineers have underscored the notion that IME's often help coordinate the actions of various types of engineers and managers in order to make a project successful.

# **Objectives of Our Undergraduate Curriculum**

The IME curriculum seeks to graduate high quality industrial and management engineers and prepare them for successful careers in the 21st Century. The IME bachelor's degree program provides students with a strong technical skill base in process design and reengineering, computer information systems, data analysis, systems modeling, facility design, quality systems and management. Additionally, IME students gain experience in the use of a variety of technologies, including computer-aided design tools, simulation modeling tools and a diversity of measurement instrumentation. Three to five years after graduation, graduates of Rensselaer's Bachelor's program in Industrial and Management Engineering will:

**Objective 1** - exhibit a total integrated systems perspective enabling: a.) thorough understanding of manufacturing systems, service systems and supply chains, b.) knowledge of engineering relationships to the planning, organization, implementation and control of human centered systems, and c.) the effective application of information through computing and other emerging technologies.

**Objective 2** - be creative and innovative designers of systems, processes, facilities, services, products, organizational teams, and equipment with an understanding of the stochastic nature of management systems enabling the skillful identification, modeling, analysis, solution and management of real world problems.

**Objective 3** - be effective oral and written communicators with a solid foundation for using communications media and interpersonal skills to facilitate their roles as contributors and leaders of diverse teams.

**Objective 4** - be broadly educated in the humanities, social sciences and engineering professionalism which informs their socially responsible and ethical professional practice.

**Objective 5** - understand the importance of life long learning and be capable and motivated to pursue continued growth, learning and innovation throughout the professional career.

**Objective 6** - apply a solid foundation in math and science in professional practice.

Rensselaer's IME program has an outstanding national and international reputation and has many regional and national awards for excellence from Alpha Pi Mu, the international academic honor society for industrial engineering.

# Employment

IMEs are employed by a wide variety of settings in the public and private sectors. IME's work for insurance companies, banks, hospitals, airlines, retail organizations, government agencies and as business consultants. In the past five years, our graduates have accepted positions in a variety of firms including Citicorp, Accenture, the U.S. Postal Service, Proctor & Gamble, IBM, General Electric, American Airlines, General Motors, and Intel.

#### **Rensselaer's Curriculum**

IME's training reflects the profession's interdisciplinary approach. In a recent forum on IME, Walt Disney World's Director of Industrial Engineering, noted that "Two important skills that IME's should develop are creative thinking and strategic thinking. In our roles, we encounter new problems all the time, and in 99 percent of the cases you won't find the answer in a book".

An essential part of an IME's training is the development of modeling skills. A model is an abstraction of a real-world process such as package delivery, customer service or behavior of currency markets. Sound analysis of a model's output can help improve a company's performance.

Rensselaer's IME program requires a minimum of 128 credit hours of coursework building on the common foundation Core program engineering courses of all Rensselaer engineering disciplines. While coursework is extensive, the program provides opportunity generally in the junior year for a 9 month cooperative education experience, co-op, working as an engineer at a local or national company and for study abroad opportunities through the Rensselaer Education Across Cultural Horizons program administered through the Office of International Programs.

#### **ISE Department**

The Industrial and Systems Engineering department is located on the 5<sup>th</sup> floor of the Low Center for Industrial Innovation, the CII. Faculty of the department, contact information, and research interests are shown below.

	Agent based simulation and optimization	Automated and autonomous storage/ retrieval systems	Data analysis, data mining, time series, and knowledge acquisition	Emergency and disaster management decision models	Enterprise systems engineering	Error analysis in large scale systems	Homeland security/intelligence analysis decision optimization	Information diffusion and technology evaluation	Knowledge based activities and expert systems	Modeling ethics	Optimization in networks and scheduling	Power market s	Service and replacement parts inventory optimization	Social networks, Service networks	Supply chain information sharing, uncertainty and optimization	Technology impact in systems safety and operation
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Wai Kin (Victor) Chan Assistant Professor chanv@rpi.edu	V										$\checkmark$	V		$\checkmark$		
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Jennifer K Ryan Associate Professor ryanj6@rpi.edu													V		V	
Thomas C Sharkey Assistant Professor sharkt@rpi.edu William A. Wallace				V			V				V					
Professor wallaw@rpi.edu	$\checkmark$			V			√			V				V		
Thomas R. Willemain Professor willet@rpi.edu			$\checkmark$				$\checkmark$						$\checkmark$	$\checkmark$		

# **Advising Model**

Academic advising is a shared responsibility and service between the student and departmental faculty. Students seeking the undergraduate IME degree are assigned an academic advisor based on three factors: graduation year, entrance as a transfer admission, and entry into the co terminal program. In addition, special advising for students in preparation and on return from study abroad is assigned in the department.

<u>Graduation Year Advising</u>. All entering IME degree seeking freshman and students who change to the IME degree from other departments who share the same graduation year are assigned the same faculty advisor. This faculty member remains their advisor for their four years at Rensselaer. This advisor is the primary source for academic and career counseling. The advisor is a recipient of all academic concern warnings issued through Rensselaer's Early Warning

System, EWS. While action steps for addressing the concern remain with the student, outreach efforts are often the consequence of such notice to the advisor and others.

Meeting with your academic advisor is required at Rensselaer. Failure to meet regularly with the advisor will result in suspension of registration privileges. Freshmen are required to meet with their advisor both in the first and second semester. After that, a meeting is required in the twelve month period prior to the registration period. In addition to general advising, the advisor also is required to approve and sign many academic program forms such as pass / no credit election, minor forms, and co-op forms.

<u>Transfer Admitted Students.</u> All students who enter the IME degree through a transfer admission are assigned a common faculty advisor. This faculty member remains their advisor until graduation. This advisor is the primary source for academic and career counseling. The advisor is a recipient of all academic concern warnings issued through Rensselaer's Early Warning System, EWS. While action steps for addressing the concern remain with the student, outreach efforts are often the consequence of such notice to the advisor and others.

<u>Co Terminal Advising</u>. The co terminal program enables Rensselaer undergraduates with strong academic records to study for a master's degree while completing their bachelor's degree(s) in the same or a different department or school. The co terminal advisor becomes the student advisor for the master's degree portion of the program. The student maintains their relationship with their undergraduate advisor. First contact with the co terminal advisor is required in the junior year as part of the application process to the program. Currently, this advising role is filled by Professor William Foley.

<u>Study Abroad Advising.</u> Study abroad has become an integral part of a well-rounded undergraduate experience. A period of study abroad allows students to develop a broader perspective on their academic field of study while earning credit towards a Rensselaer degree. Because of the large number of options available to students, a special advisor has been designated in ISE to work with students planning the study abroad experience and to complete the paperwork for posting study abroad courses to the Rensselaer degree. This advisor works in a consultancy role only. The student retains their academic advisor. Currently, this advising role is filled by Professor William Foley.

# Advising Responsibilities.

The shared responsibility between the faculty academic advisor and the student involves the following parameters:

# **Student's Responsibilities**

- To know their advisor's office hours and advising schedule.
- To make an appointment and prepare for registration advising by reviewing the Catalog, Class-Hour Schedule, and Curriculum Advising & Program Planning (CAPP) Program.
- To formulate questions regarding curriculum, course selections, career options, etc.
- To be aware of their academic and personal needs and to seek assistance when needed.
- To understand that the role of their advisor is to advise them, not to make decisions for them. Each student needs to realize that it's his or her education at stake, and that, with advisement, *they* are ultimately responsible for making any final decisions.

# **Advisor's Responsibilities**

- To be accessible to students throughout the year at posted office hours. If an advisor will be away from campus for an extended period of time, he or she should post the names and office locations of alternate advisors outside their offices, so that students will have other advising resources.
- To set aside designated times for registration advising and individual discussions.
- To be knowledgeable about current curriculum requirements, academic policies and procedures, referrals and resources on campus, and career opportunities in the major field.
- To guide students through academic programs that will complement their personal, educational, and professional interests.

# IME Baccalaureate Program Curriculum

The first two years of the IME curriculum provide a strong foundation in the basic sciences, engineering science, mathematics, and the humanities and social sciences. In years three and four, students concentrate on building expertise in statistics, operations research, manufacturing and services systems engineering, and industrial engineering methods and models.

Through the appropriate choice of electives, students can focus on areas of interest. Design projects include problems in manufacturing services and public systems. It is advisable to develop a Plan of Study leading to the desired degree and concentration by the beginning of the third year. The department recommends that students declare their intent to major in industrial and management engineering as early as possible in their academic career.

The university requirements of the baccalaureate degree are:

• Minimum grade point average (GPA) of 1.80.

• Course content in humanities and social sciences (H&SS) must total a minimum of 24 credit hours, including at least eight credit hours in the humanities and eight credit hours in the social sciences. Engineering students automatically take two of the 24 credit hours as professional development in their engineering design sequence and take a two-credit H&SS professional development course in their junior year.

• To ensure depth in the H&SS core, at least two courses within a single topic code (STSH and STSS can be counted as a single area) and at least one at an advanced level (above 1000) must be completed. No course within the depth sequence may be taken as Pass/No Credit.

• No more than three 1000-level H&SS courses may be applied to the core requirement, no more than six credits may be taken as Pass/No credit, and at least one course (four credits) must be at the 4000 level. *For information on additional requirements see the School of Humanities, Arts, and Social Sciences section of the course catalog.* 

• Every student is required to take at least **two** communication-intensive courses, one in the students' major and one writing intensive course in the School of Humanities, Arts, and Social Sciences.

• The student must be registered full-time for a minimum of four semesters. Two semesters of part-time study at Rensselaer will be considered equivalent to one semester of full-time study. In addition, the student must complete a minimum of **64 credit hours** towards the undergraduate degree at Rensselaer. If a transfer student elects to study abroad or enroll in the co-op program, no more than 12 such credits may apply to the credits needed for the bachelor's degree.

• Transfer courses are limited to two courses or eight credits counting toward the student's last 30 credits and require approval of the director of the Advising and Learning Assistance Center. *Refer to the catalogue for updates on graduation requirements.* 

The 128 credit hour IME curriculum requires completion of the course requirements shown in the typical four-year program presented below and submittal of <u>senior portfolio</u> of academic work organized in conformance with guidance issued by ISE. Courses shown in the typical four year program are coded into three categories.

<b>Bold</b> - Must complete in year and semester shown							
Bold Italic – Must complete in year shown							
Italic - Recommended in semester / year shown.							

Fall	First Y	Zea	r	Spring		
MATH-1010	Calculus I	4		MATH-1020	Calculus II	4
	Hum. or Soc. Sci. Elective	4			Hum. or Soc. Sci. Elective	4
ENGR-1100	Intro. to Engineering Analysis	4		PHYS-1100	Physics I	4
CHEM-1100	Chemistry I	4			Science Elective (1)	4
ENGR-1300	Engineering Processes	1		ENGR-1200	Engineering Graphics & CAD	1
Fall	Secon	d Y	'ea	r Spring		
ENGR-2050	Intro to Engineering Design	4		ISYE-2210	Prod & Ops Mgt & Cost Acctg	4
MATH-2400	Intro. to Differential Equations	4		ENGR-2600	Mod& Analysis of Uncertainty	3
PHYS-1200	Physics II	4			Management Elective (2)	4
	Hum. or Soc. Sci. Elective	4			Multidisciplinary Engineering (3)	4
				CSCI-1190	Intro to Programming	1
Fall	Third	Ye	ar	Spring		
				ISYE-	Discrete Event Simulation &	
ISYE-4140	Statistical Analysis	4		4290ISYE	Modeling	3
ISYE-4600	<b>Operations Research Methods</b>	4		ISYE	Technical Elective (4)	3
	Multidisciplinary Engineering (3)	3			Free Elective	4
	Hum. or Soc. Sci. Elective	4			Hum. or Soc. Sci. Elective	4
	Professional Development II (5)	2				
Fall	Fourth	ıΥe	ar	Spring		
ISYE-4530	Information Systems	4		ISYEISYE	Technical Elective	3
ISYE	Technical Elective (4)	3		ISYE-4210	Supply Chain Management	3
ISYE	Technical Elective (4)	3		ISYE-4270	IME Design	3
ENGR-4760	Engineering Economics	3		ENGR-4100	Professional Development III	1
	Free Elective	4			Free Elective	4

# Typical Four Year Program

Notes.

1. Science elective cannot be taken Pass / No Credit.

2. Management Elective cannot be taken Pass / No Credit and must be selected from any course listed below. The Economics courses cannot be counted for meeting the Social Science requirement and the Management Elective.

ECON 2010 Managerial Economics

ECON 4210 Cost-Benefit Analysis

MGMT 1100 Introduction to Management MGMT 4530 Starting Up a New Venture MGMT 4430 Marketing Principles MGMT 2320 Managerial Finance MGMT 4510 Invention, Innovation, and Entrepreneurship MGMT 4520 Introduction to Technological Entrepreneurship MGMT 4850 Organizational Behavior in High Performance Organizations MGMT 4860 Human Resources in High Performance Organizations 3. Select two courses from the list below. ENGR 1600 Materials Science for Engineers **ENGR 2090 Engineering Dynamics** ENGR 2250 Thermal and Fluids Engineering I ENGR 2710 General Manufacturing Processes ENGR 2350 Embedded Control ENGR 2530 Strength of Materials ENGR 4300 Electronic Instrumentation ENGR 4710 Advanced Manufacturing Lab I ENGR 4720 Advanced Manufacturing Laboratory II MANE 4050 Model & Control of Dynamic Sys 4. Ideally, students should plan on taking 2 technical electives in the Fall and 2 in the Spring to accommodate course scheduling which includes offering courses on a 2 or 3 year cycle. In general, only 3 such electives will be offered each term. The courses that satisfy this requirement will be identified prior to registration for the upcoming term. When offered, the courses below meet the technical elective requirement. ISYE 4200 Design and Analysis of Work Systems ISYE 4230 Quality Control ISYE 4240 Engineering Project Management ISYE 4250 Facilities Des & Industrial Logistics ISYE 4260 Industrial Safety and Hygiene ISYE 4280 Decision Focused Systems Engr ISYE 4810 Computational Intelligence **ISYE 4960 Topics in ISYE** 

**IME Senior Portfolio.** IME students are required to submit a professional portfolio prior to graduation. For all students, this portfolio is part of the course *ISYE-4210 Design and Analysis of Supply Chains*. Although the portfolio is not a graded deliverable, students cannot receive a grade in the course until the portfolio has been submitted. Materials from the last two to three years of study should be retained by IME students in preparation for submitting the portfolio.

ISYE 4961 Optimization Algorithms and Applications

<u>What is the Purpose of the Portfolio?</u> The materials for the portfolio should document that you have achieved the eleven educational outcomes associated with the IME undergraduate program. Packaged in a single binder, the portfolio should contain an introduction section and eleven divided sections corresponding to the educational outcomes listed below.

<u>What type of material goes in the portfolio?</u> Materials used in each of the sections must be drawn from work completed within a subset of the courses listed under that outcome. In most cases, exhibits will include items such as project reports, labs, exams and other significant course assignments. The same exhibit can serve multiple objectives. You are encouraged to supplement the exhibits for any given outcome from work done outside of the associated courses such as coop assignments and extracurricular activities *but the majority of exhibits under a given outcome must be drawn from work completed in the courses associated with that outcome*. Use materials that most clearly demonstrate that you've achieved the highest benchmark of performance under a given outcome.

What are the criteria for demonstrating that exhibits of student work in the portfolio demonstrate <u>outcome attainment?</u> Different criteria are associated with each outcome. Outcome attainment is scored on one of three levels; high, medium or low. In general, the guideline is to add the best

examples of your work that demonstrate your capabilities as an Industrial and Management Engineer relative to a given outcome.

<u>How should the portfolio be organized?</u> The introduction section of your portfolio should include an updated one page statement of career objectives and plans following graduation to the extent you know them, an up-to-date resume, a current transcript (an unofficial transcript is acceptable), and the completed senior survey for your graduation year (available from ISE website). The eleven sections are given below. The courses corresponding to each outcome are listed in the complete portfolio guidance available through the ISE website.

1. An ability to apply knowledge of mathematics, science and engineering.

2. An ability to design and conduct experiments, as well as to analyze and interpret data.

3. An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental social, political, ethical, health and safety, manufacturability, and sustainability.

- 4. An ability to function on multi-disciplinary teams.
- 5. An ability to identify, formulate and solve engineering problems.
- 6. An understanding of professional and ethical responsibility.
- 7. An ability to communicate effectively.

8. That you have attained the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

9. That you recognize the need for, and have an ability to engage in life-long learning.

10. That you have knowledge of contemporary issues.

11. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

# **Undergraduate Degree Options**

<u>Double Degrees.</u> A student may become a candidate for a second baccalaureate degree when he or she has completed: (1) the equivalent of at least two terms (30 credit hours) of additional work beyond the requirements of a single degree, and (2) the courses in the department in which the student is registered and such other courses as are required for the second degree.

<u>Dual Majors.</u> Undergraduate students who fulfill all the degree requirements for two curricula and who have met the conditions below will have completed a dual major. They will receive one diploma noting both majors. The student must designate a first-named and second-named major in writing at least one semester prior to graduation, and have the appropriate department(s) approve this designation prior to filing the dual major form with the registrar. Each student will be assigned an adviser in each department who will monitor progress towards degrees in that department. The degree clearance officer in each department will certify that the student has met the degree requirements in that department.

# **Co-Op and Study Abroad Timing**

The Co-Op and Study Abroad opportunities available at Rensselaer are excellent experiences for both professional and personal growth. But because both are time way from the Rensselaer campus, planning is required to minimize the impact on the graduation plans of the participant. In many situations, the time away does not delay graduation.

ISE has designed the undergraduate curriculum so that the sixth semester, the second semester of the Junior year, is the best time for either program. While the typical plan of study presented above shows the student taking two technical electives in this semester, there are no required courses that must be taken in this semester.

For students studying abroad, this semester could be filled with a humanities or social science course and free electives moved from the senior year if the host university does not have courses that might fit into the technical electives category. The technical electives listed for this semester can be moved to the senior year in place of the free electives.

For students on co-op, advance planning can look for application of advanced placement courses to free electives, humanities, or social science courses moving typical course timing out of this semester and senior year. The technical electives from the junior year would become senior year courses. With planning, a student who completed a co-op assignment could be left with just one or two free electives to complete during the summer term after their normal graduation date.

When looking at both experiences, some cautionary notes on course transfer apply. The courses easiest to find and transfer from a university that does not have engineering are:

1. Any course that RPI will accept as a free elective. These courses have to be more than 1 credit and must have some link back to a course or department at RPI. So a course in "Pub Crawling" would not count. The course you want to transfer in cannot also overlap extensively with a course you have already taken here at RPI.

2. Humanities and Social Science (H&SS) courses which are above the 1000 level here at RPI. Courses that the host university states or shows up as being junior level or senior level course can be brought in subject to the transfer maximums for H&SS courses stated in the catalogue. If you exceed this transfer credit limit, the course gets posted to Free Electives if there is still room to bring it in and have it count to the degree.

3. Science courses (this includes Mathematics and Computer Science) that can count as a Science Elective. The problem here is with the credit hours of the course. The system at RPI is based on 4 credit hour courses while the rest of the world relies principally on 3 credit courses so one can wind up one credit short. So you may wind up taking 2 science courses to fill the science credit hour requirement with the extra credits going to 'Free Elective' as a split course on the CAPP report.

4. Listed Mathematics or Statistics courses can be brought in often as direct substitutes for RPI courses but the credit hour problem arises here as well. The practice is to give credit for the course by name but to do so at a lower credit hour level meaning you wind up short a credit hour in a section of the CAPP. In most cases of this type, the system allows this one credit shortness but still does require a minimum of 128 credits for the degree.

For universities with engineering programs, any exact named equivalent for the core engineering courses (Strengths, Dynamics, Thermo, Circuits) can be taken and transferred in. For ISE courses, students should get approval in advance before assuming that a course will transfer. For core courses, the credit hour question often arises but the previous method for handling applies.

In all cases, prior approval of transfer is encouraged and from a student perspective, this prior approval is the 'guarantee' they should have with them, the contract. For prior approval, the

course description from the university attended and if possible a syllabus really makes the process work quickly and to the advantage of the student.

#### **Selected ISE Course Descriptions**

Below are course descriptions for some of the courses in the undergraduate IME program. For a complete listing and description of all Rensselaer courses see the online catalogue available under the Registrar web site.

#### **ISYE 2210 Production and Operations Management and Cost Accounting**

The design and analysis of production and service systems. Topics include forecasting, scheduling, inventory systems, total quality management, line balancing, and capacity planning. Introduction to cost accounting. Use of analytic techniques in accounting-based decision making. Formulation and solution of POM models practiced on computers. Students cannot obtain credit for both this course and ENGR 4700. Prerequisites: MATH 1020 or equivalent. Spring term annually. *4 credit hours* 

#### **ISYE 4140 Statistical Analysis**

Review of simple and multiple regression, selection procedures, regression diagnostics, residual analysis, stepwise regression, analysis of variance, design of experiments including factorial experiments, analysis of ordinal data and nonparametric inference, basic time series models. Extensive use of statistical software. Emphasis on statistical applications to industrial engineering. Prerequisites: ENGR 2600 and knowledge of calculus. Fall term annually. *4 credit hours* 

#### **ISYE 4200 Design and Analysis of Work Systems**

Analysis and design of work and workplace. Topics covered include human-machine systems, ergonomics, work measurement systems, methods and standards, process design, direct time study, standard time data, predetermined time systems, work sampling, work load balancing, and workplace layout. Computer-based analysis of problems in work systems. Prerequisite: ENGR 2600 or equivalent. *3 credit hours* 

#### **ISYE 4210 Design and Analysis of Supply Chains**

An overview of the principles involved in the design and operation of supply chains with applications to manufacturing and service industries. Topics include dynamics of manufacturing systems and supply chains, lean manufacturing, lead time reduction in manufacturing and office operations, advanced pull systems, concurrent design of products and supply chains, rapid new product introduction, emanufacturing and reverse supply chains, and integration of information technology in supply chain operations. The goal of the course is to enable students to synthesize models and tools and to understand how these could be applied to address emerging challenges in manufacturing and service systems and their supply chains. Prerequisites: ISYE 2210 or ENGR 4700, and ENGR 2600 or equivalent. Spring term annually. *3 credit hours* 

#### **ISYE 4230 Quality Control**

The statistical approach to manufacturing quality control is emphasized. Consideration is given to the managerial implications and responsibilities in implementing the statistical approach. Topical coverage includes construction and interpretation of various control charts; special control charts (e.g., CUSUM, EWMA); graphical methods; specifications, tolerance limits, process capability indices; acceptance sampling; discussion of experimental design; and Taguchi methods of quality improvement. Prerequisites: ISYE 4140 or ISYE 4760 (MATP). *3 credit hours* 

#### **ISYE 4240 Engineering Project Management**

Planning, controlling, and evaluating engineering projects. Use of network analysis techniques, PERT/CPM, budget control, time/cost tradeoff, time estimation, resource allocation, and resource leveling. Extensions include probabilistic models, multiple resource models, project organization, risk analysis, technical forecasting, and network theory. Students cannot obtain credit for both this course and ENGR 4750. *3 credit hours* 

#### **ISYE 4250 Facilities Design and Industrial Logistics**

An in-depth study of the major design issues in location and physical configuration of production and service facilities. The course emphasizes the use of mathematical models, computer modeling, and quantitative analysis as aids to the design process. Topics include plant layout and location, material handling, material flow analysis, and distribution systems. Major course concepts are developed through case studies and projects. Prerequisites: ISYE 2210 or equivalent, ISYE 4140 or equivalent, and an introductory operations research course. *3 credit hours* 

#### **ISYE 4260 Industrial Safety and Hygiene**

Survey of procedures and practices in industrial safety and hygiene including government regulation (OSHA), life safety, electrical safety, air contamination, noise, radiation, ventilation, illumination, toxicology, and safety engineering organization. Contemporary topics (asbestos, PCBs, AIDS) are also covered. *3 credit hours* 

#### **ISYE 4270 Industrial and Management Engineering Design**

This course provides a capstone and professional experience. Student teams work on independent projects in any field of industrial and management engineering approved by a faculty adviser. Typically, projects involve a manufacturing and service sector client who provides the student with an opportunity to gain an actual industrial experience. Memos, progress reports, and a final written and oral report are submitted to the project adviser and client. This is a communication-intensive course. Prerequisite: senior standing. Fall and spring terms annually. *3 credit hours* 

# **ISYE 4280 Decision Focused Systems Engineering**

The objective of this course is to introduce students to systems engineering, especially from a decision focused perspective. System concepts, methodologies, models and analysis are covered in relation to a system's design, development, test, evaluation, and operation. Decisions concerning a system's reliability, maintainability, usability, disposability, and affordability are systematically considered. A range of systems, including service systems, is also considered. Pre- or corequisite: ENGR 2600. *3 credit hours* 

# **ISYE 4290 Discrete Event Simulation Modeling and Analysis**

Introduction to discrete-event simulation modeling and analysis techniques including; graphical simulation modeling approaches, animation techniques, modeling large-scale and complex systems, pseudorandom number and random variate generation, stochastic processes, input modeling (data collection, analysis, and fitting distribution), output analysis (initial bias and termination bias, variance reduction techniques), sensitivity analysis, design of experiments, interactive simulation-based decision support systems. Prerequisites: ISYE 4140 or equivalent and CSCI 1190 or equivalent. Spring term annually. *3 credit hours* 

#### **ISYE 4530 Information Systems**

This course surveys information-systems technology for the management of enterprise information as a resource. Topics include elements of system design life cycle, database concepts, and decision support. Managerial and technical dimensions of information systems are blended in a framework for IS systems. Additional topics include telecommunications, artificial intelligence (including expert systems), and structured design. The implementation, operation, and maintenance of information systems are also discussed. Projects are required. Prerequisite: CSCI 1190 or equivalent. Fall term annually. *4 credit hours* 

# **ISYE 4600 Operations Research Methods**

An introduction to commonly used methods of deterministic and stochastic operations research. Topics include linear programming, simplex algorithms, duality, linear networks, integer programming, dynamic programming, goal programming, location models, exact and heuristic solution procedures for integer and sequencing problems, queuing theory, Markov chains, multicriteria decision making, and decision analysis. This is a communication-intensive course. Prerequisites: ENGR 2600 and Math 1020. Fall term annually. *4 credit hours* 

#### **Registration Steps**

Registration for the spring semester generally occurs in early November. Registration for the Fall semester and Summer terms occurs the preceding Spring, usually in early April. Exact dates are included in the <u>Academic Calendar</u>.

Step 1 is to check your advising status on the Student Information System (SIS). Are you cleared to register by your advisor? If a freshman, did you have an academic advising meeting with your advisor this semester? For other class years, did you have such a meeting in the past 12 months? If not, schedule a meeting with your advisor and have your status updated.

Step 2 is to review your Curriculum Advising and Program Planning (CAPP) report and to compare your progress to your goals and to the plan of study you are following. You can access your CAPP report via the main menu of the Student Information System (SIS). If not on schedule, develop options to pursue and do so on paper so you have them when discussing your plans with your advisor. Update your plan of study as needed.

Step 3 can be done prior to 4 or following 4 depending on the timing in the semester. Step 3 is drafting a schedule of courses and sections based on the course offerings for the upcoming semester. Registration is by sections so develop some options to use when registering in the event you find sections closed or class time changed.

Step 4 is to schedule a visit with your advisor to discuss your plans. This visit is almost mandatory if you plan on completing a co-op assignment or to study abroad.

Step 5 is the physical act of registering for classes. A quick primer on class registration is below. **How:** Use the Student Information System (SIS) to register for your courses.

**Where**: There are no assigned rooms for registration. You can register for your classes using any computer with Internet access.

**Time tickets:** You are issued a "time ticket," which assigns you a specific window of time during which you may register for the next semester. Your time ticket will be sent to your RPI email address, 2 - 3 weeks before registration. This e-mail message will also notify you of any existing holds which may prevent you from registering if you do not resolve them.

#### **Adjusting Your Class Schedule**

All adjustment to your class schedule is done the Student Information System (SIS). Adjustments can include switching sections, dropping a class, or adding a class. The academic calendar contains cutoff dates for each of these actions. You do not need to wait until classes start to adjust your schedule of classes. The catalogue describes class schedule adjustment procedures that fall outside of the windows given on the Academic calendar such as late add and late drop. Consult the catalogue for the procedure if that is needed by you.

#### **Undergraduate Research Program (URP)**

Rensselaer has a very strong Undergraduate Research Program. This is a program that allows students to work in a professor's laboratory for credit, cash, or experience. Details on the program university wide are available at <u>http://undergrad.rpi.edu/update.do?catcenterkey=77</u>. The application form is available at <u>http://undergrad.rpi.edu/update.do?artcenterkey=117</u>.

<u>How to find a project.</u> Most URP projects are found through direct contact with the faculty member supervising the research. Most undergraduates find projects from faculty members from

whom they have taken classes. Check their website to investigate their field of research. If it sounds interesting, approach them about a possible URP project.

<u>What if I have my own idea for a project?</u> You may work with a faculty member on an existing research project or on a project based on your own ideas. If you want to pursue your own project, find a faculty advisor who may be interested in your topic since you will be required to have a project advisor.

<u>For credit, funding or the experience?</u> You can earn from one to four credit hours per semester for your participation in the URP. If you choose this option you and your sponsor need to:

- Determine how many credit hours you will earn
- Decide exactly what is expected of you, such as your time commitment, the type of work to be submitted, etc.
- Agree on how your grade will be determined

URP funding comes from two sources:

- Your sponsoring faculty member or department
- The Office of Undergraduate Education

The faculty sponsor or department is responsible for the financial support of your research. In addition, the Office of Undergraduate Education pays URP participants a maximum of \$400 per semester in the form of matching funds.

If the motivation is for experience, the process is simple just between you and the researcher. No deadline specified.

#### Study Abroad for Industrial and Management Engineering (IME) Undergraduates

#### Industrial and Systems Engineering Department (ISE)

The Study Abroad opportunities available at Rensselaer are excellent experiences for both professional and personal growth. Study abroad has become an integral part of a well-rounded undergraduate experience. A period of study abroad allows students to develop a broader perspective on their academic field of study while earning credit towards a Rensselaer degree. But because both are time way from the Rensselaer campus, planning is required to minimize the impact on the graduation plans of the participant. In many situations, the time away does not delay graduation.

Because of the large number of options available to students, a special advisor has been designated in ISE to work with students planning the study abroad experience and to complete the paperwork for posting study abroad courses to the Rensselaer degree. This advisor works in a consultancy role only. The student retains their academic advisor. Currently, this advising role is filled by Professor William Foley.

ISE has designed the undergraduate curriculum so that the sixth semester, the second semester of the Junior year, is the best time for study abroad. While the typical plan of study recommended for the IME degree shows the student taking two technical electives in this semester, there are no required courses that must be taken in this semester. The policy of ISE is to allow at most three ISYE courses, technical electives combined with required ISYE courses, to be counted toward degree requirements from a one semester study abroad experience.

For students studying abroad, this semester could be filled with a humanities or social science course and free electives moved from the senior year if the host university does not have courses that might fit into the technical electives category. The technical electives listed for this semester can be moved to the senior year in place of the free electives.

A valuable resource when planning courses to take at a Rensselaer Affiliated Exchange University is the list of approved courses available under the title <u>REACH Transfer</u> <u>Equivalencies</u> accessible on the login page of the Student Information System (SIS). This list is a working document updated on a continuing basis as new courses are reviewed and identified equivalent to Rensselaer courses. Courses completed at Affiliated Universities on this list do not need transfer credit prior approval.

When looking at study abroad at other universities or at courses not now approved for transfer, some cautionary notes on course transfer apply. The courses easiest to find and transfer from a university that does not have engineering are:

1. Any course that Rensselaer will accept as a free elective. These courses have to be more than 1 credit and must have some link back to a course or department at Rensselaer. So a course in "Pub Crawling" would not count. The course you want to transfer in cannot also overlap extensively with a course you have already taken here at RPI.

2. Humanities and Social Science (H&SS) courses which are above the 1000 level here at Rensselaer. Courses that the host university states or shows up as being junior level or senior level course can be brought in subject to the transfer maximums for H&SS courses stated in the catalogue. If you exceed this transfer credit limit, the course gets posted to Free Electives if there is still room to bring it in and have it count to the degree.

3. Science courses (this includes Mathematics and Computer Science) that can count as a Science Elective. The problem here is with the credit hours of the course. The system at Rensselaer is based on 4 credit hour courses while the rest of the world relies principally on 3 credit courses so one can wind up one credit short. So you may wind up taking 2 science courses to fill the science credit hour requirement with the extra credits going to 'Free Elective' as a split course on the CAPP report.

4. Listed Mathematics or Statistics courses can be brought in often as direct substitutes for Rensselaer courses but the credit hour problem arises here as well. The practice is to give credit for the course by name but to do so at a lower credit hour level meaning you wind up short a credit hour in a section of the CAPP. In most cases of this type, the system allows this one credit shortness but still does require a minimum of 128 credits for the degree.

For universities with engineering programs, any exact named equivalent for the core engineering courses (Strengths, Dynamics, Thermo, Circuits) can be taken and transferred in. For IME

courses, students should get approval in advance before assuming that a course will transfer. For core courses, the credit hour question often arises but the previous method for handling applies. In all cases, review of planned courses with an advisor prior to departure is encouraged. Prior approval of transfer is encouraged when a course is not shown on an equivalency list. From a student perspective, this prior approval is the 'guarantee' that transfers should be problem free. For prior approval, the course description from the university attended and if possible a syllabus really makes the process work quickly and to the advantage of the student.

# Co-Terminal B.S. / M.S. or M.E. Program

The Co Terminal Graduate Degree Program enables Rensselaer undergraduates with strong academic records to study for a master's degree while completing their bachelor's degree(s) in the same or a different department or school. Co terminal applications must be submitted before the end of the applicant's junior year. The application form and general procedures are available at http://admissions.rpi.edu/graduate/Co-TerminalBS-MS Application and Procedures.pdf.

ISE offers both thesis and non thesis options at the master's level. The application and admission requirements in the ISE department for this program are:

1. All applicants must take the Graduate Record Exam (GRE) and submit the scores to Rensselaer and include a paper copy of the scores with the completed application.

2. The minimum undergraduate GPA for admission is 3.3. Applicants with a GPA above 3.0 but below 3.3 may be considered for admission if the GRE scores exceed 550 verbal and 650 quantitative.

3. The application form must be signed by the undergraduate advisor who attests to the GPA stated on the application.

4. The applicant must schedule an appointment with the ISE Co-Terminal advisor bringing the completed application including GRE score report. During this meeting, a graduate plan of study will be drafted listing the courses that must be completed and the semester the course will be completed for the master's degree segment. The requirements will be based on the published requirements in the university catalogue. At a minimum, 30 credits beyond the bachelor requirement must be completed. The draft plan must be typed by the student on the Graduate School Plan of Study form available at <a href="http://gradoffice.rpi.edu/update.do?catcenterkey=20">http://gradoffice.rpi.edu/update.do?catcenterkey=20</a>. The applicant must submit the completed application package to the ISE Co-Terminal advisor who will direct its review within the ISE department.

The final admission decision rests with the Graduate School. Notice of the decision on admission will be forwarded to the applicant soon after the ISE department is notified of the final decision.

#### FAQs

#### **Accelerating Courses**

1. If I have advanced placement, what course should I take in place of the listed course? For many topics, the first years are sequences of 2 or 3 courses that are taken in order. Advanced placement credit will be posted by the Rensselaer course name so the action by you might be to take the next topic course in the sequence. The Mathematics sequence is a prime example of this. A second option is to delay taking the next course in the sequence and to substitute in its place another future semester course provided all the prerequisites for the course are met.

2. Can I take senior level courses as a sophomore when I meet the course prerequisites? The general guidance provided in course level numbering is that 1000 level courses are freshman level, 2000 are sophomore, and 4000 are junior – senior level. The recommendation is to respect this guidance especially when looking at 4000 level courses.

# Pass No Credit Usage

1. Can pass - no credit be used for courses selected from a list?

All courses listed by name as degree requirements including ones that are selected off a list of applicable courses cannot be applied to the named degree requirement if taken pass – no credit. 2. Can pass – no credit be used for the science elective?

The science elective cannot be taken pass – no credit and be applied to this stated requirement. 3. Who signs the pass – no credit election form?

Your advisor must sign the form. The purpose of this signature is to force a meeting between you and your advisor so that the consequences of your election are fully understood. No signature is required to remove the designation.

# **Humanities and Social Science Requirements**

1. Can pass – no credit be used for H&SS courses?

Pass – no credit can be used for H&SS courses with restrictions. The catalogue lists the current restrictions so refer to the latest issue of the catalogue to get the current policy. No course used for the depth sequence in a topic can be graded pass – no credit.

2. Are there limits on transfer courses for the requirement?

There are limits on the number of courses that can be transferred from another university and be applied to the H&SS requirement. The catalogue has the most up to date policies. The restriction does account for students who enter as transfer students. If a course is taken from another area college affiliated with Rensselaer, there is no restriction on application of these to the H&SS requirement.

# **Technical Electives**

1. What are the technical electives?

Courses that apply to the degree as technical electives are announced before the registration period opens. This document lists several courses that are technical electives but the list expands as scheduling allows.

2. Can I take all 4 technical electives in one semester?

The current scheduling policy typically offers 3 technical electives each semester so it is usually not feasible to complete this requirement in one semester. The guidance directs students to split technical electives between the fall and spring term because some courses are repeated each season so there may not be 4 different technical electives offered in the same season in two adjacent years.

# **Co-Terminal FAQ's**

1. When do I apply?

Co-terminal applications must be submitted before the end of applicants' junior year. Applicants must have 90 credits (in progress or earned) of coursework towards their undergraduate degree (101 credits for Architecture students).

2. Where do I find a Plan of Study?

The Plan of Study is available on-line at the Office of Graduate Education website <u>Plan of Study</u> <u>Form.</u>

3. What if the courses I list on the Plan of Study change?

If the courses listed change, an updated plan must be filed with your Department, the Office of Graduate Education, and the Office of the Registrar.

4. Do I have to file a FAFSA for my 5th year to get the Undergraduate aid?

Yes - you must file a FAFSA, if you receive need based aid

5. When/how does a student get assigned a graduate adviser?

Co-terminal students will continue to work with their undergraduate adviser until completion of the 8<sup>th</sup> semester and will have a graduate advisor assigned in the 8<sup>th</sup> semester.

6. How many credits will I be eligible to register for?

Since the primary degree you will be pursuing is your bachelor's degree, you will be eligible to register for up to 21 credits but the regular full time load for graduate work is usually no more than 16 credits.

7. Can I become a part-time student in the Co-Terminal Program?

Co-terminal student must remain as full time students and cannot shift to part-time status.

8. Should I apply for my undergraduate degree if I will be registered into an 11th semester? If you are continuing into an 11th semester, you will no longer be eligible for undergraduate aid. You should apply for your bachelor's degree at that point.

9. When do I receive my BS degree? I was supposed to graduate in May 2010 but I will be completing 2 more semesters to receive my Master's degree under the co-terminal program? You will receive both degrees at the end of your 10th semester. You should file a degree application with the Office of the registrar for each degree at the beginning of the semester in which you will actually graduate with both degrees. See the academic calendar for deadline information.

10. Can I use a course for both my undergraduate and graduate degree?

No - credits applied toward satisfying requirements of the undergraduate degree cannot be used to satisfy the requirements for the master's degree.

11. I finished my 9th semester but decided not to continue in the master's program. How do I receive my BS degree?

You must first, formally withdraw from the co-terminal program. This is done using the <u>Graduate Student Request for Change of Status</u> form. You must then file a <u>Degree Application</u> for the next graduation date. Rensselaer has three official graduation dates - the end of August, the end of December, and mid-May. Check the academic calendar for application submission deadlines.

12. Can I still designate courses as Pass/No Credit?

Co-terminal students are subject to graduate degree program guidelines after they've earned the minimum number of credits required for their bachelor's degree, 128 credits. Any courses taken after a student has reached the minimum, will be subject to graduate level policies, and graduate policies prohibit designating a graduate course as Pass/No Credit.

13. Can I participate in the Commencement ceremony with my class?

You must meet the criteria for participation and file a petition, available in the Registrar's Office.

# Registration

1. What do I do if a class I want to register for is full?

Core Engineering has a formal wait list for full courses. Contact in person the Core Engineering office to complete the paperwork for this list. For many courses, the class size listed on SIS is the room size so no additional students can be added to the room. Meet with the instructor of the course and request to be admitted to the course. If there is physical space to accommodate you, your request is very often honored. If this is an elective course you may be asked to take it in a subsequent semester.