

RUTGERS

The State University of New Jersey

**Undergraduate Handbook:
Department of Industrial &
Systems Engineering**

Academic Year 2020-2021



The State University of New Jersey

Department of industrial and Systems Engineering (ISE)

Welcome to ISE!

In today's complex and competitive world, industrial engineers are in great demand to design, improve, and operate integrated *systems* of people, materials, equipment, and energy. The industrial and systems engineering discipline applies fundamentals from the mathematical, physical, and engineering sciences to efficiently design and analyze large systems that serve industry and government both in manufacturing and service sectors.

The undergraduate industrial engineering program at Rutgers provides students with a broad engineering education along with specialization in the industrial engineering, manufacturing, financial and energy fields. We believe that a broad education is necessary to understand the impact of engineering solutions in a global/societal context. Academic strength in mathematics, physics, and basic engineering science is required. Specialization is offered in mathematical modeling, quality engineering and statistical techniques, computer-aided design, computer-aided manufacturing, simulation, manufacturing processes, engineering economics, production planning and control, design of engineering systems and information technology. Students have access to state-of-the-art laboratory facilities where hands-on instruction is emphasized in robotics, machine vision, manufacturing, automated material handling, quality engineering, electronic and sensor devices, simulation, and computer information systems.

The industrial engineering program focuses on classroom instruction fostered by learning in project-teams. These teams frequently formulate and find engineering solutions to real-world industry problems. The ability to communicate effectively is emphasized by having students provide both oral and written reports.

ISE graduates work in several areas including electronic, pharmaceutical, and other manufacturing; health services, transportation, distribution, and communication; and computers, finance, marketing, and management. Students pursue graduate studies in engineering and in management at leading institutions.

The ISE faculty is dedicated to excellence in teaching, research, and professional service. They bring experience, real-life industrial problems, and enthusiasm to the classroom, setting a standard for students to follow in their professional careers.

WELCOME TO INDUSTRIAL AND SYSTEMS ENGINEERING!

We have carefully prepared this handbook for you. It contains information about the undergraduate program in Industrial Engineering (IE) at Rutgers. Here, you will find descriptions of the IE curriculum, specialized tracks and many course electives. We've also enclosed information on academic policies, department facilities, faculty advisors, and student societies.

Currently, students in the classes of 2021 require a total of 129 credit hours with major credit hours totaling 67. Starting with the ISE Class of 2022, there is a still total of 129 credit hours with major credit hours totaling 67; however, 01:220:102 Introduction to Micro Economics has been replaced with a course from List B Departmental/Technical (D/T) elective. Students can select a track for area of concentration by taking the courses listed under each track. A certification will be provided upon the completion of the track.

The Department of Industrial and Systems Engineering (ISE) offers courses in various areas including: work design and ergonomics, optimization, simulation modeling, probability, manufacturing processes, design of engineering systems, facilities layout, production planning and control, industrial information systems, energy systems modeling, reliability engineering, quality engineering and statistics.

In addition, the department gives students the opportunity to attain hands-on experiences in the ISE labs with work design, manufacturing processes; computer-controlled manufacturing systems, and quality engineering and statistics and simulation. Our labs include the Manufacturing Automation Lab, the Quality and Reliability Lab, the Microcomputer Lab, the Manufacturing Processes Lab, the Computer Control and Mechatronics Laboratory, the Design Laboratory and the Advanced Simulation Laboratory.

This handbook and other information about the Department of Industrial and Systems Engineering at Rutgers can be found on the web at <http://ise.rutgers.edu>. Our mailing address is Department of Industrial and Systems Engineering, Rutgers University, 96 Frelinghuysen Road, Piscataway, NJ 08854-8018; fax (732) 445-5467; telephone (848) 445-3654; email for the undergraduate director, Dr. Elin M. Wicks at elin.wicks@rutgers.edu

Once again, we welcome you to the Department of Industrial and Systems Engineering. If you have any questions regarding your undergraduate study please feel free to stop by the departmental office. We are located in Room 201 of the CoRE Building. We are always available to help.

Enjoy Your Studies,

Dr. Mohsen Jafari, Chairman, CoRE 201
Dr. Elin M. Wicks, Undergraduate Director, CoRE 210
Ms. Laura Kasica, CoRE 201

WELCOME TO ISE!

Welcome ISE Undergraduate Students! Here is some valuable information:

1. **IMPORTANT – IE Program Changes:** Starting with the ISE Class of 2022, there are IE program changes.
2. You must follow the course requirements listed in the ISE Undergraduate Handbook (<http://ise.rutgers.edu>). As stated in the Handbook, “Each student must be aware that he or she is ultimately the person responsible for completing the BS degree requirements.” Also, your official IE curriculum checklist is being maintained in Degree Navigator. You should periodically check on it, especially if you are close to graduation.
3. Prerequisite knowledge for a course is important to help you succeed. Prerequisite overrides are **not** automatically granted and are based on consultations with the course instructor and the ISE Undergraduate Director on a case-by-case basis.
4. **Co-Ops:** If you are planning a co-op, be sure to make an appointment to meet with Undergraduate Director.
5. **STUDY ABROAD:** If you are planning a study abroad, be sure to make an appointment with the Undergraduate Director for discussion and approval.
6. **BS/MBA:** meet with Undergraduate Director.
7. **LABS:** Labs are co-requisites in most IE courses. If you register for the course, you must register for the lab.
8. Should you require a Special Permission Number (SPN), you will need to meet with the Undergraduate Director. Adhering to the curriculum as given in the ISE Handbook will eliminate the need for SPN.
9. FYI - 540:343 Engineering Economics is offered during 1st Summer Session in addition to Fall and Spring semesters.
10. **Dept/Tech (D/T) electives:** Acceptable List A and List B electives are listed in the ISE Handbook. No exceptions will be made.

Dr. Elin Wicks, ISE Undergraduate Director

Office: CoRE 210

Telephone: (848) 445-8787

E-mail: *elin.wicks@rutgers.edu*

(Just send an e-mail to make an appointment)

What Is Industrial Engineering?

According to the Institute of Industrial Engineers (1975), the Industrial Engineering profession is described as follows:

“Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, equipment, and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.”

What are the Program Educational Objectives (PEOs) of the Industrial and Systems Engineering Department at Rutgers University?

The Program Educational Objectives (see <http://ise.rutgers.edu>) of the Industrial Engineering program are aligned with Rutgers University’s mission of sustaining highest standards in teaching, research and public service and to educate exceptional leaders of the next generation. They are also aligned with the School of Engineering (SOE) mission.

The **Program Educational Objectives (PEOs)** are:

1. *Graduates will meet the expectations of employers of Industrial engineers.*
2. *Qualified graduates will pursue advanced study if they so desire.*
3. *Graduates will pursue leadership positions in their profession and/or communities.*

To meet these objectives, the department has designed its curriculum in order to insure the following Student Outcomes (SOs):

The following list of **Student Outcomes** is currently used to evaluate the IE program and is listed on the department web site. A graduate who has successfully gained all the skills, knowledge, and behaviors present in the following outcomes would have a complete knowledge and training necessary to achieve the program’s objectives. Each Industrial Engineering student will have demonstrated the following:

1. *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*
2. *an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*
3. *an ability to communicate effectively with a range of audiences*
4. *an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*
5. *an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*
6. *an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions*
7. *an ability to acquire and apply new knowledge as needed, using appropriate learning*

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1. INDUSTRIAL ENGINEERING CURRICULUM

1.1 CLASS OF 2021

Freshman Year (17 cr. hrs.)		(18 cr. hrs.)			
01:160:159	Gen Chem for Eng.	3	01:160:160	Gen Chem for Eng.	3
01:160:171	Intro to Experiment	1	01:640:152	Calc Math Phy Sci	4
01:355:101	Expository Writing	3	01:750:124	Analytic Physics IB	2
01:640:151	Calc Math Phy Sci	4	14:440:127	Intro to Computers	3
01:750:123	Analytic Physics IA	2	14:440:221	Engr Mech-Statics	3
14:440:100	Intro to Engr	1	__:__:__	Hum/Soc Elective	3
__:__:__	Hum/Soc. Elective	3			

Sophomore Year (17 cr. hrs.)		(16 cr. hrs.)			
01:640:251	Multivar Calc	4	01:220:102	Intro to Micro Econ	3
01:750:227	Analytic Phys IIA	3	01:640:244	Diff Eqns Eng & Ph	4
01:750:229	Anal Phys II Lab	1	14:440:222	Engr Mech-Dyn.	3M
33:010:310	Account for Eng.	3	14:540:210	Eng. Probability	3M
14:540:201	Work Des & Ergo	3M	01:355:302	Sci & Tech Writing	3
14:540:202	Work Des Lab	1M			
14:540:213	IE Lab	2M			

Junior Year (17 cr. hrs.)		(16 cr. hrs.)			
14:540:320	Eng Statistics	3M	14:540:303	Mfg. Processes	3M
14:180:215	Eng. Graphics	1M	14:540:304	Mfg. Processes Lab	1M
14:332:373	Elements of EE	3M	14:540:311	Deter. Models in OR	3M
14:635:407	Mech. Prop Materials	3M	14:540:343	Eng. Economics	3M
14:540:338	Prob. Models in OR	3M	14:540:384	Simulat. Models IE	3M
14:540:382	Comp. Contr Mfg Sys	3M	14:540:399	Design of Eng Syst I	3M
14:540:383	Comp. Contr Lab	1M			

Senior Year (13 cr. hrs.)		(15 cr. hrs.)			
14:540:400	Design of Eng Syst. II	3M	14:540:462	Fac Layout & MH	3M
14:540:433	Quality Eng & Stat	3M	__:__:__	Dpt/Tech Elec (List A)	3M
14:540:434	Quality Eng. Lab	1M	__:__:__	Dpt/Tech Elec (List B)	3M
14:540:453	Prod Plan & Control	3M	__:__:__	Hum/Soc Elective	3
14:332:402	Sustainable Energy	3M	__:__:__	Hum/Soc Elective	3

M - Course is included in major average.

Total credit hours: 129

Major credit hours total: 67

1.2 CLASS OF 2022/2023/2024

Freshman Year (17 cr. hrs.)			(18 cr. hrs.)		
01:160:159	Gen Chem for Eng.	3	01:160:160	Gen Chem for Eng.	3
01:160:171	Intro to Experiment	1	01:640:152	Calc Math Phy Sci	4
01:355:101	Expository Writing	3	01:750:124	Analytic Physics IB	2
01:640:151	Calc Math Phy Sci	4	14:440:127	Intro to Computers	3
01:750:123	Analytic Physics IA	2	14:440:221	Engr Mech-Statics	3
14:440:100	Intro to Engr	1	__:__:__	Hum/Soc Elective	3
__:__:__	Hum/Soc. Elective	3			

Sophomore Year (17 cr. hrs.)			(16 cr. hrs.)		
01:640:251	Multivar Calc	4			
01:750:227	Analytic Phys IIA	3	01:640:244	Diff Eqns Eng & Ph	4
01:750:229	Anal Phys II Lab	1	14:540:343	Eng. Economics	3M
33:010:310	Account for Eng.	3	14:540:210	Eng Probability	3M
14:540:201	Work Des & Ergo	3M	01:355:302	Sci & Tech Writing	3
14:540:202	Work Des Lab	1M	14:440:222	Eng Mech-Dyn	3M
14:540:213	IE Lab	2M			

Junior Year (17 cr. hrs.)			(16 cr. hrs.)		
14:540:320	Eng Statistics	3M	14:540:303	Mfg. Processes	3M
14:180:215	Eng. Graphics	1M	14:540:304	Mfg. Processes Lab	1M
14:332:373	Elements of EE	3M	14:540:311	Deter. Models in OR	3M
14:635:407	Mech. Prop Materials	3M	14:540:384	Simulat. Models IE	3M
14:540:338	Prob. Models in OR	3M	14:540:399	Design of Eng Syst I	3M
14:540:382	Comp. Contr Mfg Sys	3M	__:__:__	Dpt/Tech Elec (List B)	3M
14:540:383	Comp. Contr Lab	1M			

Senior Year (16 cr. hrs.)			(12 cr. hrs.)		
14:540:400	Design of Eng Syst. II	3M	14:540:462	Fac Layout & MH	3M
14:540:433	Quality Eng	3M	__:__:__	Dpt/Tech Elec (List A)	3M
14:540:434	Quality Eng. Lab	1M	__:__:__	Hum/Soc Elective	3
14:540:453	Prod Plan & Control	3M	__:__:__	Hum/Soc Elective	3
14:332:402	Sustainable Energy	3M			
__:__:__	Dpt/Tech Elec (List B)	3M			

M - Course is included in major average.

Total credit hours: 129

Major credit hours total: 67

1.3. Departmental/Technical Electives

Students graduating in 2021 are required to take one course from the Departmental/Technical Electives List A (Design Elective) and one course from the Departmental/Technical Electives List B. Students graduating in 2022/2023/2024 are required to take one course from the Departmental/Technical Electives List A (Design Elective) and **two** courses from the Departmental/Technical Electives List B. These lists are given below.

ISE and other listed graduate courses are possible electives for students with a 3.0 major average or greater. **Students must obtain permission from the Undergraduate Director to take a graduate course.** Note: This is a good practice for many students who are interested in pursuing graduate studies. ISE graduate courses can be approved by the Undergraduate Director to count as a technical elective.

NOTE: Course # and title may be changed by other departments without our knowledge! Please inform the Undergraduate Director of any changes you are aware of.

List A

10:762:315 Designing Cities
10:762:472 Transportation Planning
10:762:475 Designing for Sustainability
10:762:492 Design Studio: Plan and Design a Sustainable Small Town
10:971:316 Introduction to Site Planning and Urban Design
 OR 10:762:316 Physical Design & Site Planning
11:117:462 Design in Solid Waste Treatment Systems
11:117:468 Hazardous Waste Treatment Engineering
11:550:301 Social and Cultural Aspects of Design
14:125:475 Design and Advanced Fabrication of Biomedical Devices
14:440:403 Safety Engineering in Packaging
14:540:485 Industrial Information Systems
14:540:486 Automated Manufacturing Systems
14:540:487 Energy Systems Modeling and Optimization
14:540:488 Design of Decision Support Systems
14:635:405 Solar Cell Design & Processing
14:540:491/492 Introduction to Reliability Engineering (3.2 GPA required)
14:650:231 Mechanical Engineering Computational Analysis and Design
14:650:342 Design of Mechanical Components
14:650:388 Computer-Aided Design in Mechanical Engineering
14:650:455 Design of Mechanisms
16:540:530 Forecasting and Time Series Analysis
16:540:575 Advanced Engineering Economics I
33:390:380 Investment Analysis (pre-req: 33:390:310)
33:799:301 Intro. to Supply Chain Management

List B

01:198:112 Data Structures
01:198:205 Introduction to Discrete Structures
01:198:206 Introduction to Discrete Structures II
01:198:211 Computer Architecture
01:198:314 Principles of Programming Languages
01:198:323 Numerical Analysis and Computing
01:198:336 Principles of Information and Data Management
01:198:424 Modeling and Simulation of Continuous Systems
01:198:440 Introduction to Artificial Intelligence
01:220:311 Methods of Cost-Benefit
01:220:322 Econometrics
01:220:334 Energy Economics
01:220:400 Advanced Time Series and Financial Econometrics
01:220:485 Mathematical Economics
01:640:250 Introductory Linear Algebra OR 01:640:350 Linear Algebra
01:640:300 Introduction to Mathematical Reasoning
01:640:321 Introduction to Applied Mathematics
01:640:373 Numerical Analysis
01:640:423 Elementary Partial Differential Equations (NB)
01:960:490 Introduction to Experimental Design
01:960:384 Intermediate Statistical Analysis
01:640:454 Combinatorics
01:750:313 Modern Physics
01:750:323 Advanced General Physics
01:750:324 Advanced General Physics
01:750:326 Computer Based Experimentation and Physics Computing
01:750:327 Modern Instrumentation
01:750:341 Principles of Astrophysics
01:750:381 Mechanics
01:750:397 Physics of Modern Devices
01:750:431 Introduction to Computational Biology for Physicists
01:750:464 Mathematical Physics
01:960:463 Regression Methods
10:971:201 Introduction to Urban Planning and Design
10:971:315 Introduction to GIS
11:117:450 Applied Instrumentation and Control
11:375:434 Principles of Industrial Hygiene
14:125:201 Introduction to Biomedical Engineering
14:125:304 Biomaterials

List B (continued)

14:125:305 Numerical Modeling in Biomedical Systems
14:125:308 Biomechanics
14:125:409 Introduction to Prosthetic and Orthotic Devices
14:125:431 Introduction to Optical Imaging
14:332:312 Discrete Mathematics
14:332:476 Virtual Reality **with** corequisite 14:332:478 Virtual Reality Laboratory
14:440:392 Undergraduate Research in Engineering OPEN ONLY to Aresty students (3 cr. for entire year.)
14:440:404 Innovation and Entrepreneurship for Science and Technology
14:540:461 Engineering Law
14:540:475 Introduction to Pharmaceutical Manufacturing
14:540:485 Industrial Information Systems
14:540:486 Automated Manufacturing Systems
14:540:487 Energy Systems Modeling and Optimization
14:540:496 Co-Op Internship in ISE (upon approval of the undergrad director)
16:540:507 Data Analytics in Engineering Systems
16:540:580 Quality Management (requires 3.0)
14:635:361 Materials Science and Engineering of Polymers
14:635:440 Electromechanical Materials and Devices
14:650:350 Mechanical Engineering Measurements **with** co-requisite 14:650:349
14:650:401 Mechanical Control Systems
14:650:447 Probabilistic Models in Mechanical and Aerospace Systems
14:650:449 Introduction to Mechanics of Composite Materials
33:390:380 Investment Analysis (pre-req: 33:390:310)
33:390:400 Corporate Finance (pre-req: 33:390:310)
33:390:420 Futures and Options (pre-req: 33:390:380)
33:799:300 Global Procurement and Sourcing Strategies
33:799:301 Intro to Supply Chain Management
33:799:320 Fundamentals of Supply Chain Solutions with SAP
33:799:380 Project Management
33:799:460 Introduction to Six Sigma & Lean Manufacturing

2. ACCEPTABLE HUMANITIES/SOCIAL SCIENCE ELECTIVES

For a list of the Humanities/Social Science Electives, please go the link below:

http://soe.rutgers.edu/sites/default/files/imce/pdfs/humanities_list.pdf

A copy of this list is included in Appendix A.

3. ACADEMIC STANDING

For the School of Engineering Academic Standing Policy, please go to the link below:

<http://soe.rutgers.edu/oas/scholasticstanding>

4. SUMMARY OF ACADEMIC PROGRAMS**4.1. Five Year Dual Degree Program**

The School of Engineering in cooperation with the liberal arts colleges at Douglass, Livingston, Rutgers, Camden and Newark offers cooperative five-year programs leading to a BS in Engineering and a BA in liberal arts major. The current Rutgers University Catalog gives the details of the program. To receive both degrees, it is necessary for the student to satisfy the following three requirements: (1) take all the courses required for the ISE degree; (2) take all courses required for the liberal arts major; and (3) make sure the total number of credits is the required number of ISE credits plus 30.

Some courses may satisfy both ISE and liberal arts requirements. For example, an ISE and Economics double major can satisfy engineering and liberal arts requirements with the sequence of courses Engineering Probability and Intermediate Statistics. In fact, it may be possible to fulfill the requirements for both degrees with fewer credits than the total ISE credits plus thirty. If that occurs, the student must take additional courses to satisfy item (3) above.

4.2. James J. Slade Scholar (Honors Program)

In the junior year, students with a GPA of 3.2 or better may apply for admission to this program. The program requires that you write a senior thesis. This program gives a student the opportunity to do independent research while still an undergraduate. Also, this program gives the student recognition (at graduation and with a certificate) for outstanding achievement.

4.3. Four Year and One Semester Co-Op Program

The co-op internship provides the student with the opportunity to practice and/or apply knowledge and skills in various industrial and systems engineering environments. This co-op internship is intended to provide a practical engineering experience to the student's undergraduate education by integrating prior course work into a working engineering environment. In addition to receiving compensation for their on-site job experience, students earn credits for the educational benefits of the experience. The 6 co-op credits are in addition to the 129 credit hours required for graduation. Students may use 3 of the 6 co-op credits as Dept/Tech Elective (List B) under the approval of ISE Undergraduate Director. Students who choose the co-op internship option will complete their undergraduate degree requirements in the 9th semester. See page 14 for more details.

4.4. Study Abroad

There are several universities abroad that are suitable for engineering students. Opportunities exist for students to study at schools in Australia, the United Kingdom, Ireland, Germany, Argentina, Chile, France, China, Spain, Japan, Mexico, Israel, Turkey and South Korea. It is possible to create a program of study such that a student will not lose time in finishing ISE degree requirements. It is not a straightforward transfer of credit though. For information see Dean Ciervo and the ISE Undergraduate Director. More information is available from the Rutgers Study Abroad Office at <http://studyabroad.rutgers.edu>

4.5. Engineers Made in Germany (EGIM) Program

Engineers Made in Germany Summer School at Pforzheim University is a 6 week program for Mechanical Engineering and Industrial Engineering students. Up to 9 credits can be earned toward your degree (6 credits of List B technical electives and 3 credits Humanities/Social Science electives). Please contact the Assistant Dean for Transfer Services for more information.

4.6 Co-Op Internship Option

540:496/497 CO-OP INTERNSHIP IN INDUSTRIAL AND SYSTEMS ENGINEERING (6 CREDITS, PASS/NO CREDIT BASIS ONLY)

All ISE students interested in pursuing the ISE co-op, must schedule a meeting with the ISE Undergraduate Director.

CATALOG DESCRIPTION:

The co-op internship program is designed to provide a practical engineering experience to the student's undergraduate education by integrating prior course work into a working engineering environment. It presents a unique opportunity to the student to practice and/or apply knowledge and skills in various industrial and systems engineering environments. The credits earned are for the educational benefits of the experience. **Students may use 3 of the 6 co-op credits as Dept/Tech Elec (List B) upon approval of the ISE Undergraduate Director.**

Prerequisite: The normal prerequisite is 90 credits completed with a cumulative grade point average of at least 2.5. Students may be approved with slightly fewer credits at the discretion of the Undergraduate Director.

Course Outline: The students must satisfy the following criteria to be eligible for an internship:

The co-op internship must be with the same company for six consecutive months, normally the spring and the summer semester.

Note that the 6 credits shown on page 15 are in addition to the 129 credit hours required for graduation unless the student is approved to use 3 credits as a Dept/Tech elective. Students who choose the co-op internship option will normally complete their undergraduate degree requirements in the 9th semester.

The following are the requirements to satisfy an internship or co-op for 3 credits. Only 3 credits count towards the degree requirement (either the internship or co-op, not both). To receive credit the students **must** follow these steps (no credits will be given if they are not followed). The credits will be used as a List B Departmental Technical Elective.

1. A written proposal must be submitted to the Undergraduate Director of the ISE Department by the student. The proposal must be approved by the Undergraduate Director. The written proposal should include the offer letter from the company, educational benefits, engineering related responsibilities at the work site, project tasks, and the plan for evaluation.
2. The student must have a faculty advisor (check with all faculty members about their interest in overseeing the internship or co-op) who agrees to oversee the work on a weekly basis by meeting with the student and reviewing a weekly report prepared by the student. The faculty and student must notify the Undergraduate Director of the arrangement.
3. A copy of the final report should be provided (after review by the faculty) to the Undergraduate Director.
4. The registration is by special permission only, obtained from the Undergraduate Director.
5. Students hired as technicians within the Department cannot use this to fulfill the Co-op / Internship requirement.
6. Students on co-op must be registered for co-op credit during the semesters that they are working as a co-op.

ISE Curriculum (Co-op Option)

If you plan to pursue a co-op, it is important that you make an appointment with the ISE Undergraduate Director, prior to the start of your co-op to discuss implementation details. All ISE co-ops must be approved by the ISE Undergraduate Director.

Freshman Year (17 cr. hrs.)	(18 cr. hrs.)
01:160:159 Gen Chem for Eng 3	01:160:160 Gen Chem for Eng 3
01:160:171 Intro to Experiment 1	01:640:152 Calc Math Phy Sci 4
01:355:101 Expository Writing 3	01:750:124 Analytic Physics IB 2
01:640:151 Calc Math Phy Sci 4	14:440:127 Intro to Computers 3
01:750:123 Analytic Physics IA 2	14:440:221 Engr Mech-Statics 3
14:440:100 Intro to Engr 1	__:__:__ Hum/Soc Elective 3
__:__:__ Hum/Soc Elective 3	
Sophomore Year (17 cr. hrs.)	(16 cr. hrs.)
01:640:251 Multivar Calc 4	__:__:__ Dpt/Tech Elec (List B) 3M
01:750:227 Analytic Phys IIA 3	01:640:244 Diff Eqns Eng & Ph 4
01:750:229 Anal Phys II Lab 1	14:440:222 Engr Mech-Dyn. 3M
33:010:310 Account for Eng. 3	14:540:210 Eng Probability 3M
14:540:201 Work Des & Ergo 3M	01:355:302 Sci & Tech Writing 3
14:540:202 Work Des Lab 1M	
14:540:213 IE Lab 2M	
Junior Year (17 cr. hrs.)	
14:540:320 Eng Statistic 3M	
14:180:215 Eng Graphics 1M	
14:332:373 Elements of EE 3M	CO-OP – 6 Credits
14:635:407 Mech Prop Materials 3M	Spring and Summer
14:540:338 Prob Models in OR 3M	
14:540:382 Comp Contr Mfg Sys 3M	
14:540:383 Comp Contr Lab 1M	
Fourth Year (16 cr. hrs.)	(16 cr. hrs.)
14:540:343 Eng Economics 3M	14:540:303 Mfg Processes 3M
14:540:433 Quality Eng & Stat 3M	14:540:304 Mfg. Processes Lab 1M
14:540:434 Quality Eng Lab 1M	14:540:311 Deter Models in OR 3M
__:__:__ Dpt/Tech Elec (List A) 3M	14:540:384 Simulat Models IE 3M
__:__:__ Dpt/Tech Elec (List B) 3M	14:540:399 Design of Eng Sys I 3M
__:__:__ Hum/Soc Elective 3	14:540:462 Fac Layout & MH 3M
Fifth Year (12 cr. hrs.)	
14:540:400 Design of Eng Syst II 3M	
14:540:453 Prod Plan & Control 3M	
14:332:402 Sustainable Energy 3M	
__:__:__ Hum/Soc Elective 3	

M – Course is included in major average.

Total credit hours: 129.

Major credit hours total: 67.

The Dept/Tech electives (List A & List B) are given in Section 1.3 of this handbook (pp. 8-10).

5. ACADEMIC POLICIES

This handbook has been compiled for undergraduate Industrial and Systems Engineering students. The department wants you to be aware of your degree requirements and of changes in college and university rules. We welcome suggestions for new material for the handbook and clarifications of material already included.

When you declare an engineering major, a check-list of course requirements is put into Degree Navigator. As you complete courses, the Dean's staff crosses the courses off the list. Check Degree Navigator often to monitor your progress.

Each class has a departmental faculty advisor (check the ise.rutgers.edu website). Your advisor will post special office hours during registration periods. At other times during the semester, you may make an appointment with your advisor if the need arises.

EACH STUDENT **MUST** BE AWARE THAT HE OR SHE IS ULTIMATELY THE PERSON RESPONSIBLE FOR COMPLETING THE BS DEGREE REQUIREMENTS.

Keep track of your own progress through the IE program and speak with your advisor when you run into academic or other problems. Always make sure you are following the ISE Handbook curriculum guidelines when you are creating your schedule. During registration, look at the check-list of courses in Degree Navigator to make sure your understanding of your status agrees with the view of the School of Engineering. It is especially important for graduating seniors to check Degree Navigator with their advisors to ensure that summer courses, transfer credits, and electives have been recorded as expected.

Before meeting with your advisor each student should be well informed. Please be sure to read this handbook and the current New Brunswick Undergraduate Catalog. In particular, students should be familiar with the sections regarding ISE degree requirements, ISE courses, Academic Policies and Procedures, and University Policies and Procedures.

5.1. Major Average

The courses that are included in the major average are marked "M" on the ISE curriculum. To graduate, your major average must be 2.0 or greater. If you fail a course and then repeat it, both grades are computed into your major average.

Every semester, compute your major average. Keep track of it carefully.

5.2. Courses Included In Major Average

Please refer to this link: <http://soe.rutgers.edu/oas/gpa-calculation>

5.3. Withdrawal From Courses

It happens, unfortunately, that students encounter major problems during their college years. Don't wait to be dismissed from the School of Engineering to seek help. Take responsibility for your situation. If you know you are unable to do the required work, you must do what is necessary to let the college know of your difficulty. Further, there are many resources at Rutgers that can help you with your situation - from substance abuse to the death of a parent or friend.

Here are the rules: If you fail a course, it is computed into your university and major averages. If you drop a course, it is **not** computed into these averages.

Please refer to this link: http://soe.rutgers.edu/oas/add_drop

5.4. Course Substitution

As a matter of policy, there are no course substitutions for ISE courses.

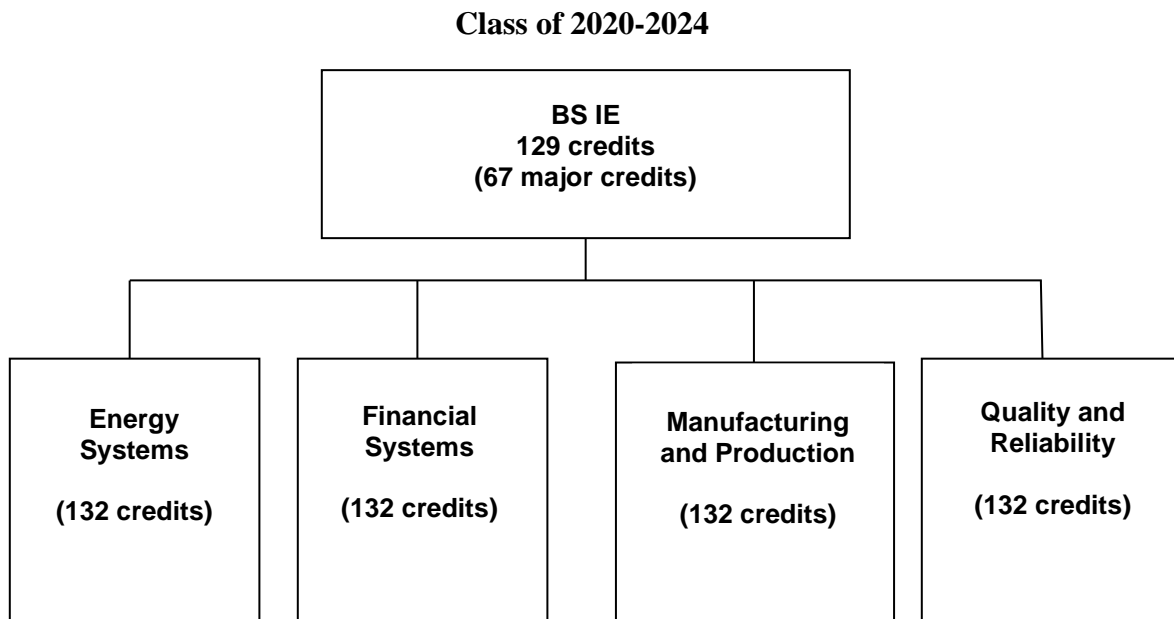
5.5. Academic Dishonesty

The Industrial and Systems Engineering Department expects each student to conduct him or herself in a professional manner. The policy of the ISE Department is as follows: we do not hesitate to report offenses of cheating to the school or the university. An engineer starting out a career cannot afford to have this kind of report on his or her record. A student who gives information is considered guilty as well as a student who receives information.

The University Policy on Academic Dishonesty is carefully spelled out in your catalog. Note that copying from or giving others assistance or using forbidden material on an hourly or final examination is a level three violation. The recommended sanction is suspension from the university for one or more terms with a notation of academic disciplinary suspension placed on the student's transcript.

6. UNDERGRADUATE TRACKS

The IE program provides tracks that enable students to choose a specialization area in order to emphasize specific areas of interest. The IE curriculum offers four tracks as shown and explained below:



Requires a total of 12 credit hours. (9 credit hours can be used as part of List A and B Dept/Tech Elec – one MUST be from List A)

6.1. Energy Systems Track

Energy engineering or energy systems engineering is a broad field of engineering dealing with energy efficiency, energy services, facility management, plant engineering, environmental compliance, sustainable energy and renewable energy technologies. Energy engineering is one of the more recent engineering disciplines to emerge. Energy engineering combines knowledge from the fields of physics, math, and chemistry with economic and environmental engineering practices. Energy engineers apply their skills to increase efficiency and further develop

renewable sources of energy. The main job of energy engineers is to find the most efficient and sustainable ways to operate buildings and manufacturing processes (Wikipedia).

Select four:

01:220:334 Energy Economics
14:540:487 Energy Systems Modeling and Optimization
14:540:488 Design of Decision Support Systems
14:635:405 Solar Cell Design and Processing

6.2. Financial Systems Track

Financial Systems track provides ISE students with opportunities to build on financial related courses such as 33:10:310 Accounting for Engineers and 14:540:343 Engineering Economics to have a deeper knowledge in corporate finance, investment analysis and futures and options. It is designed for students who wish to work in industries such as securities, banking, and financial management and consulting, or general manufacturing and service firms. The following are the track courses.

Required:

33:390:300 Introduction to Financial Management (Fall, Spring, Summer) – the prerequisites for this course are Calculus I, Accounting for Engineers, and Engineering Statistics

Select three:

01:220:423 Advanced Time Series and Financial Econometrics
16:540:530 Forecasting and Time Series Analysis (Fall)
16:540:575 Advanced Engineering Economics I
33:390:380 Investment Analysis (Spring, Summer) – prerequisite is 33:390:300
33:390:400 Corporate Finance (Spring, Summer) – prerequisite is 33:390:300
33:390:420 Derivatives – prerequisite is 33:390:380

Special Permission Numbers for the ISE Financial Systems Track:

The process for obtaining a special permission number for the Rutgers Business School courses is that the ISE Undergraduate Director will verify that the ISE students have met the prerequisites for 33:390:300 (and 33:390:380 and 33:390:400 as well) and then send a confirmation e-mail to the Undergraduate Program Coordinator at the Rutgers Business School. The ISE students will then be advised to contact the Rutgers Business School Undergraduate Program Coordinator directly for the special permission #.

6.3. Manufacturing and Production Track

Manufacturing and Production uses workers and machines to transform raw material into products. It builds on the students' background in chemistry, physics, materials properties and mathematics toward the understanding and improvement of manufacturing materials, processes, and systems. In addition, it deals with production planning, control, job and machine scheduling and distribution systems. It prepares students for careers in production, manufacturing and distribution and logistics systems.

Select four:

14:540:486 Automated Manufacturing Systems
14:540:485 Industrial Information Systems
14:150:330 Introduction to Nanomaterials Science and Engineering
16:540:520 Supply Chain and Logistics Engineering (Requires 3.0 GPA)
Or 33:799:301 Introduction to Supply Chain Management
14:650:388 Computer-Aided Design in Mechanical and Aerospace Engineering

6.4. Quality and Reliability Track

Quality and Reliability deals with ensuring that the quality of products and services achieves a target quality level by assessing the quality performance indicators and monitoring and improving the processes during production and in field use. It also provides fundamentals of reliability for product and system design. In-depth education in reliability engineering, system resilience, condition based maintenance, software reliability and warranty policy is provided. It prepares students for careers in system engineering enterprises and corporations and in production and manufacturing systems.

Select four:

01:960:490 Introduction to Experimental Design

01:960:463 Regression Methods

14:540:491/492 Introduction to Reliability

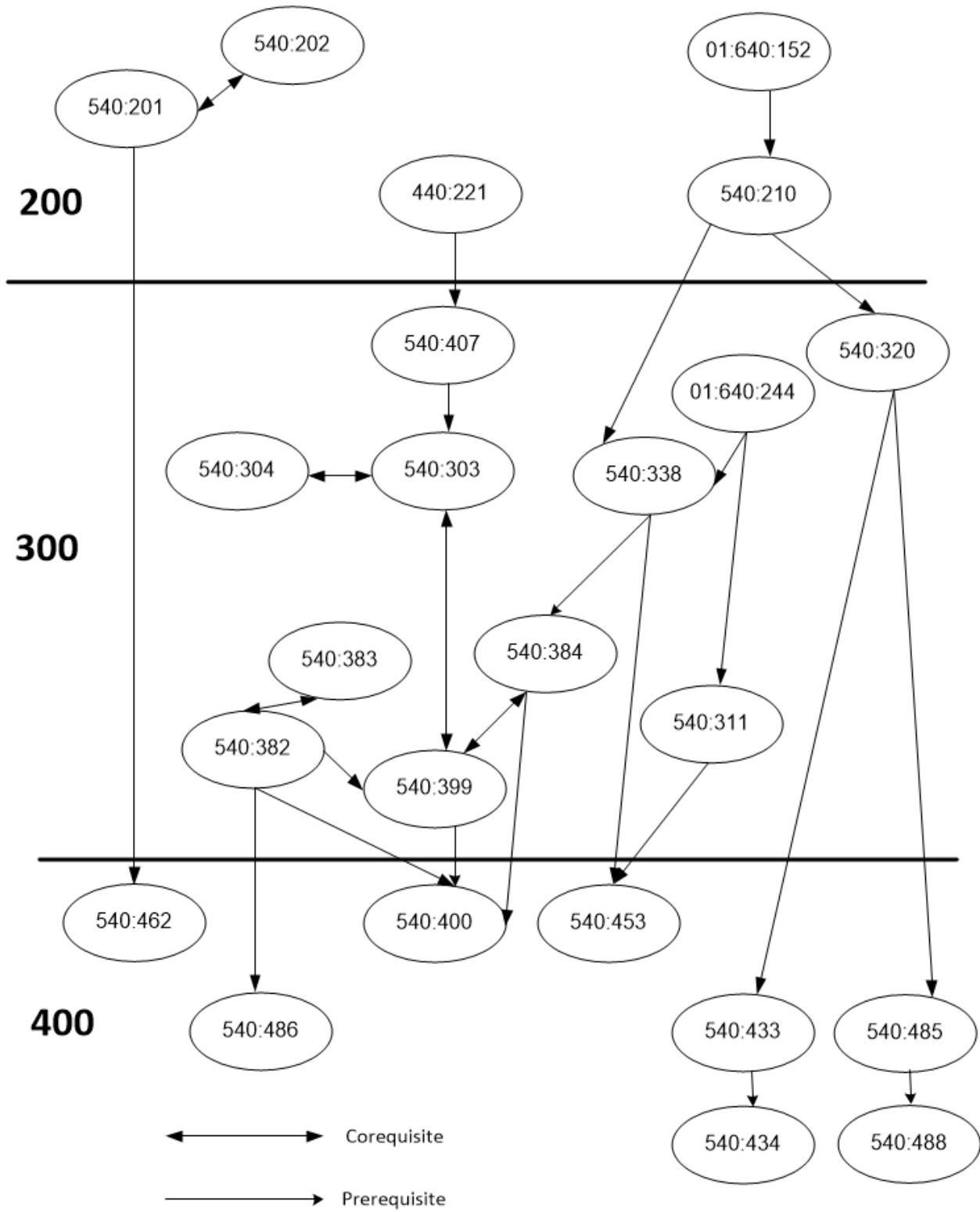
16:540:507 Data Analytics in Engineering Systems

16:540:580 Quality Management

17:610:560 Foundations of Data Science

7. ISE PREREQUISITE/COREQUISITE FLOW

IE Prerequisite/ Corequisite Flow Chart



8. UNDERGRADUATE COURSE DESCRIPTIONS

Note: M denotes course is included in major average

14:540:201 Work Design and Ergonomics (3M)

Corequisite: 14:540:202, *Prerequisite:* (01:640:151 or 01:640:191 or 21:640:135 or 50:640:121)

Man-machine analysis, motion economy, time study, predetermined time systems, work sampling; introduction to robotics, facilities layout, material handling; introduction to ergonomics and anthropometric, biomechanical, and human-machine interface models.

14:540:202 Work Design and Ergonomics Laboratory (1M)

Corequisite: 14:540:201, *Prerequisite:* (01:640:151 or 01:640:191 or 21:640:135 or 50:640:121)

Experiments in robotics, time study, work measurement, workplace design and the human-machine interface, facilities layout.

14:540:210 Engineering Probability (3M)

Prerequisite: (01:640:152 or 01:640:192 or 21:640:136 or 50:640:122)

Probability problems in engineering, conditional probability, discrete and continuous distributions, functions of random variables, interval estimates.

14:540:213 Industrial Engineering Laboratory (2M)

Prerequisite: (01:640:151 or 01:640:191 or 21:640:135 or 50:640:121) AND (14:440:127)

Introduction to programming, fundamental data types, flow control, and function; arrays, pointers, and do loops; algorithms and flow charts; GUI concepts.

14:540:303 Manufacturing Processes (3M)

Corequisite: 14:540:304, *Prerequisite:* 14:635:407

Properties of engineering materials; metals, polymers, ceramics and composites, bulk and sheet forming, traditional and non-traditional material removal processes, polymer processing, laser and energy-beam processes, additive layered manufacturing processes and micro/nano fabrication processes. Basic and computerized machine tools. Process chains, planning and process optimization. Engineering metrology and product quality.

14:540:304 Manufacturing Process Laboratory (1M)

Corequisite: 14:540:303, *Prerequisite:* 14:635:407

Experiments on machine tools: lathes, drilling machines, milling machines, and CNC milling machines; robot workplace design and computer control of machine tools.

14:540:305,306 Honor Candidacy Problems (0,0)

Prerequisite: Permission of departmental chairperson. *Prerequisite for industrial engineering students who wish to be James J. Slade Scholars.*

Extensive reading and study in a particular problem area of industrial engineering under the guidance of a faculty member.

14:540:311 Deterministic Models in Operations Research (3M)

Prerequisite: (01:640:244 or 21:640:314 or 50:640:314)

Elements of modeling and problem solving. Use of a software package like LINDO, EXCEL to solve real life industrial engineering problems. Linear programming, duality, sensitivity analysis, integer programming, transportation and assignment problems.

14:540:320 Engineering Statistics (3M)

Prerequisite: 14:540:210

Statistical estimation; confidence interval; testing hypothesis; engineering applications throughout the course.

14:540:338 Probability Models in Operations Research (3M)

Prerequisite: (14:540:210) AND (01:640:244 or 21:640:314 or 50:640:314)

Modeling and decision making under uncertainty. Markov chains, Poisson processes, inventory models and queueing systems.

14:540:343 Engineering Economics (3)

Economic decisions involving engineering alternatives, annual cost, present worth, rate of return, and benefit-to-cost; before and after tax replacement economy; organizational financing; break-even charts; unit and minimum-cost public sector studies.

14:540:382 Computer Control of Manufacturing Systems (3M)

Corequisite: 14:540:383, Prerequisite: (01:640:244 or 21:640:314 or 50:640:314) AND (01:750:227)

Programmable automation applied to manufacturing. Computer architecture, sensors and automatic data acquisition, computer control of actuators, continuous and discrete control of processes, computer integration, and local area networks.

14:540:383 Computer Control of Manufacturing Systems Laboratory (1M)

Corequisite: 14:540:382, Prerequisite: (01:640:244 or 21:640:314 or 50:640:314) AND (01:750:227)

Use of microcomputers and industrial controllers in controlling machines and processes. Assembly language programming, ladder logic programming, and interfacing controllers to sensors and actuators. Experiments in manufacturing applications.

14:540:384 Simulation Models in Industrial Engineering (3M)

Prerequisite: 14:540:338

Modeling and analysis of industrial and service systems using ARENA, simulation modeling perspectives, discrete event and continuous simulation, simulation languages, statistical aspects of simulation.

14:540:399 Design of Engineering Systems I (3M)

Prerequisites: (14:540:338) AND (14:540:382) AND (14:540:383)

OPEN TO 540 STUDENTS ONLY

Design principles, material selection, design for assembly, design for manufacturing, and effect of environmental issues on product design.

14:540:400 Design of Engineering Systems II (3M)

Prerequisite: (14:540:303) AND (14:540:304) AND (14:540:384) AND (14:540:399)

OPEN TO 540 STUDENTS ONLY

A team approach to the redesign of a "real-life" product. Alternative engineering plans for improved designs will be developed and implemented. Both written and oral reports will be completed.

14:540:433 Quality Engineering (3M)

Corequisites: 14:540:434, Prerequisite: 14:540:320

Statistical methods for monitoring and improving product quality and decreasing variation. Factorial experiments, variables and attribute control charts, acceptance sampling, on- and off-line process controls.

14:540:434 Quality Engineering Laboratory (1M)

Corequisite: 14:540:433, Prerequisite: 14:540:320

Practical application of quality engineering methodologies, statistical software, gage studies, online process control, design of experiments to improve product design, industrial manufacturing processes, and system design.

14:540:453 Production Planning and Control (3M)

Prerequisites: (14:540:311) AND (14:540:338)

Coordination of activities of both manufacturing and service systems. Systems design; input and output; planning and scheduling. Decision-making problems employing mathematical techniques of linear programming. Sequencing jobs on machines and line balancing techniques.

14:540:461 Engineering Law (3M)

Open to Juniors and Seniors

Legal and ethical aspects of engineering; bids, awards, and negotiated contracts. Liabilities to the public and to employees, contract labor law. Contracts, patents, copyrights, trademarks, and engineering specifications.

14:540:462 Facilities Layout and Materials Handling (3M)

Prerequisite: (14:540:201) AND (14:540:202)

Fundamentals of the design, layout, and location of industrial and nonmanufacturing facilities. Selection of machines and material handling equipment and their efficient arrangement. Emphasis on quantitative methods. Warehouse layout. Facility location theory.

14:540:485 Industrial Information Systems (3M)

Prerequisite: 14:540:320 or equivalent

The course focuses on acquiring hands-on experience in the organization, modeling, and analysis of raw data to extract pertinent information and actionable insights for industrial and engineering systems. Covered topics include database management using structured query language programming, data processing, analysis, and modeling using statistical programming software, as well as the design and implementation of data science solutions and forecasting methods through project-based learning and case studies from manufacturing, materials engineering, and energy systems.

14:540:486 Automated Manufacturing Systems (3M)

Prerequisites: (14:540:382) AND (14:540:383)

Introduction to computer-aided design and computer-aided manufacturing (CAD/CAM), numerical control, hardware and programming, mechatronics systems, robotics hardware and programming, and machine vision with applications in manufacturing.

14:540:487 Energy Systems Modeling and Optimization (3M)

Prerequisite: (14:540:311) AND (14:332:402)

This course addresses the design, analysis, modeling and optimization of selected energy systems (including conventional fossil fuels and renewable wind and solar). This course will provide the basis for applying mathematical modeling and optimization techniques in energy systems. A set of projects and case studies focused on modeling and optimization of a variety of energy systems will be assigned to students and discussed in details. The course will have hands on experience with data collection, experimentation, simulation and optimization tools as they apply to energy systems.

14:540:488 Design of Decision Support Systems (3M)

Prerequisite: 14:540:485

Designing, building and testing computer systems that emulate human thinking and can draw conclusions based on incomplete and fuzzy data. Design and implementation of user interfaces. Students are required to design and build a decision support system. Students will use various test tools to validate their systems.

14:540:491, 492 Special Problems

Studies in phases of industrial engineering of special interest.

14:540:496, 497 Co-op Internship in Industrial Engineering (3,3)

Prerequisite: Permission of department, Graded Pass/No credit.

Intended to provide a capstone experience to the student's undergraduate studies by integrating prior course work into a working industrial engineering professional environment. Credits earned for the educational benefits of the experience and granted only for a continuous, six-month, full-time assignment.

9. STUDENT SOCIETIES

ALPHA PI MU

Alpha Pi Mu is the Industrial Engineering Honor Society. Both academic excellence and leadership in service activities is emphasized for membership. Scholarship opportunities are also available. Faculty Advisor: Dr. Hoang Pham

INSTITUTE FOR OPERATIONS RESEARCH AND THE MANAGEMENT SCIENCES (INFORMS)

The goal of the student chapter of INFORMS at Rutgers University is to encourage interest in Operations Research, Analytics, and the Management Sciences, through seminars, social events, and visits to companies actively using such quantitative techniques. The Chapter also provides a forum for sharing information about educational and research opportunities, internships, and summer job possibilities. Faculty Advisor: Dr. Ezzat

INSTITUTE OF INDUSTRIAL AND SYSTEMS ENGINEERS (IISE)

The student chapter of IISE at Rutgers University is committed to the promotion of the industrial engineering profession. Professional activities include plant tours, industry speakers, alumni night, technical paper contests, and an engineering outreach program. Social activities typically include picnics, Freshman night, and a holiday mixer. By joining this society, each student receives a complimentary copy of ISE magazine with dues payment. Faculty Advisor: Dr. Wicks

SOCIETY OF MANUFACTURING ENGINEERS (SME)

The student chapter of SME at Rutgers University is committed to the promotion of manufacturing engineering. There are plant tours, industry speakers, professional development conferences, certification and scholarship opportunities. Social activities include joint picnics with IIE student chapter and meetings. Upon joining this society, each student receives a free subscription to Manufacturing Engineering with dues payment. Faculty Advisor: Dr. Ozel

TAU BETA PI

Tau Beta Pi is the National Engineering Honor Society. Academic excellence and service to the University community are stressed. Membership is open to juniors and seniors who rank near the very top in their respective classes. Faculty Advisor: Dr. Elsayed

10. ISE FACULTY

Susan Albin is Professor in Industrial and Systems Engineering. Her areas of research are data science, quality engineering, process monitoring and stochastic modeling. Her work has been applied in areas including medical device manufacturing, semiconductor manufacturing, food processing, advanced display technology, and plastics recycling. Prof. Albin's research has been supported by NSF, FAA, DOD, the Council for Solid Waste Solutions, and industrial partners. Prof. Albin received her D. Eng.Sc in Operations Research from Columbia University and her MS and BS in Industrial Engineering from NYU. Prof. Albin was the 2010 President of INFORMS, the Institute for Operations Research and the Management Sciences, the largest professional society in the world for educators, investigators, scientists, students, managers, and consultants in the field of Operations Research. She has served as INFORMS Secretary and as a Member of the Board of Directors and was the founding chair of the INFORMS Section on Quality, Statistics and Reliability advisory board. Prof. Albin served as the Editor-in-Chief of IIE Transactions, the flagship journal of the Industrial Engineering profession and also as the Focus Issue Editor for Quality and Reliability Engineering. She served as Director of the Rutgers Graduate Program in Industrial and Systems Engineering for 14 years and, as a visiting professor at Peninsula Technikon in South Africa, helped establish their program in Quality Engineering. Prof. Albin is dedicated to active learning in the classroom and served as co-chair of the Rutgers University Strategic Planning Committee for Instructional Technology. Prof. Albin has been a keynote speaker at conferences in China and Brazil. She is the recipient of the Rutgers Engineering Governing Council Excellence in Teaching Award and the Exxon Education Foundation Award. She is a Fellow of IIE, the Institute of Industrial Engineers, a Fellow of INFORMS, a recipient of the INFORMS George Kimball Medal., and was named Professor of the Year 2020 by the Rutgers University School of Engineering.

Melike Baykal-Gürsoy is a Professor and the Director of Laboratory for Stochastic Systems, and of GRIST-Game Research for Infrastructure Security Lab, in the department of Industrial and Systems Engineering at Rutgers University. She received her BS in Electrical Engineering and her MS in Electrical Engineering with a major in Control from Bogazici University, Istanbul, Turkey. Dr. Baykal-Gürsoy received her doctorate in Systems Engineering from the University of Pennsylvania, Philadelphia. Her specific fields of interest include stochastic modeling, queueing, Markov decision processes, stochastic games, and their applications. The current research in the Laboratory for Stochastic Systems focuses on the areas of modeling, optimization and control of stochastic systems, such as transportation and production/inventory networks. In GRIST Lab, Dr. Baykal-Gürsoy and her team are developing game-theoretic models and algorithms in order to protect infrastructure networks and their users against adversaries. Her research and teaching have been supported through grants from NSF, United Nations, DOD, and Transportation Coordinating Council/Federal Transit Administration. Dr. Baykal-Gürsoy is the co-author of a book entitled "An Introduction to Probability and Statistics."

David W. Coit is a Professor, he received his BS in Mechanical Engineering from Cornell University, an MBA from Rensselaer Polytechnic Institute, and MS and PhD degrees in Industrial Engineering from the University of Pittsburgh. His research interests are in the areas of reliability, optimization and energy systems modeling. In 1999, he was awarded a CAREER grant from the NSF to develop reliability optimization strategies that consider reliability estimation uncertainty. Previously, he worked for twelve years at IIT Research Institute (IITRI), Rome, NY, where he was a reliability engineer and project manager, and then later, the Manager of Engineering at IITRI's Assurance Technology Center. He is a member of IIE, INFORMS.

E. A. Elsayed is Distinguished Professor of the Department of Industrial and Systems Engineering, Rutgers University. He served as Chairman of the Industrial and Systems Engineering, Rutgers University, from 1983 to 2001. He is also the Director of the NSF/ Industry/ University Co-operative Research Center for Quality and Reliability Engineering. His research interests are in the areas of quality and reliability engineering and Production Planning and Control. He is a co-author of *Quality Engineering in Production Systems*, McGraw Hill Book Company, 1989. He is also the author of *Reliability Engineering*, Addison-Wesley, 1996. These two books received the 1990 and 1997 IIE Joint Publishers Book-of-the-Year Award respectively. His recent book *Reliability Engineering 2nd Edition*, Wiley, 2012 received the *2013 Outstanding IIE Publication*.

Dr. Elsayed is also a co-author of *Analysis and Control of Production Systems*, Prentice-Hall, 2nd Edition, 1994. His research has been funded by the DoD, FAA, NSF, Defense Logistics Agency and many industrial companies including Lockheed Martin and Cummins Filtration. Dr. Elsayed has been a consultant for AT&T Bell Laboratories, Ingersoll-Rand, Johnson & Johnson, Personal Products, AT&T Communications, BellCore and other companies. He served as a Member of the Panel on Theory and Applications of Reliability Growth Modeling to Defense Systems, National Research Council of National Academic. He also served as the Editor-in-Chief of the *IIE Transactions* and the Editor of the *IIE Transactions on Quality and Reliability Engineering*. Dr. Elsayed is the Editor of the *International Journal of Reliability, Quality and Safety Engineering*. He serves on the editorial boards of eight journals in different capacities. He served an external evaluator for many undergraduate and graduate programs.

Dr. Elsayed is a frequent keynote speaker in National and International Conferences and is the recipient of many awards including the *Rutgers University Board of Trustees Award for Excellence in Research* for the academic year 2015-2016, *Golomski Award* for the outstanding paper, several Best Paper awards, *William Mong Distinguished Lecturers Award*, *David F. Baker Research Award* of the Institute of Industrial and Systems Engineering for Research Contributions to the discipline, *IISE* (Institute of Industrial and Systems Engineering) Fellow Award, ASME (American Society of Mechanical Engineers) Fellow, Senior Fulbright Award and the Recipient of 2011 Thomas Alva Edison Award for US Patent 7,115,089 B2. Most recently, Dr. Elsayed was awarded the Doctor Honoris Causes from University of Agers, France in January 2018 for his achievements in the reliability engineering field.

Ahmed Aziz Ezzat is an Assistant Professor in the Department of Industrial and Systems Engineering. He received his Ph.D. in Industrial and Systems Engineering from Texas A&M University in 2019, and his M.Sc. and B.Sc. degrees in Industrial and Management Engineering from the Arab Academy for Science, Technology, and Maritime Transport in Alexandria, Egypt, in 2016 and 2013, respectively. His broad research interests are in the areas of spatio-temporal data science, quality and reliability

engineering, with focus on renewable energy analytics and materials informatics. Dr. Ezzat's work has been published in journals such as *The Annals of Applied Statistics*, *Technometrics*, *IEEE Transactions on Sustainable Energy*, among others. His awards include the 2019 ISEN Outstanding Graduate Student at Texas A&M, INFORMS Outstanding Member of the Year at Texas A&M in 2018, First Place at the QSR Student Poster and Interaction Competition at the 2017 INFORMS Annual Meeting, Best Oral Presentation at the 2016 Texas A&M Conference on Energy, and the IISE Sierleja Memorial Fellowship in 2014. He has been nominated as a finalist for the Texas A&M 3 Minute Thesis (3MT) Competition in 2018 for his presentation titled: Wind Energy, A New Solution to a 5000 Year Old Problem. His teaching interests include quality engineering, applied statistics, industrial data science, and energy analytics. He is a member of IISE, IEEE-PES, and INFORMS.

Weihong “Grace” Guo is an Assistant Professor in the Department of Industrial and Systems Engineering. She earned her B.S. degree in Industrial Engineering from Tsinghua University, China, in 2010 and her Ph.D. in Industrial & Operations Engineering from the University of Michigan, Ann Arbor, in 2015. At Rutgers ISE, Dr. Guo is the founding co-director of the Data Analytics & Process Insights Laboratory. Her research interests are in the areas of statistical quality control and process monitoring, data mining for manufacturing and healthcare systems modeling and improvement, and quality-oriented design and modeling of complex manufacturing systems. Her current research focuses on data fusion methods in the interface between applied statistics and system control/optimization. Her research has been funded by DOT, NJOHSP, and industry. Dr. Guo received the Outstanding Young Manufacturing Engineer Award from the Society of Manufacturing Engineers. She received the 1st place Best Paper Award at the 2018 ASME Manufacturing Science and Engineering Conference (MSEC), a 2nd place Best Paper Award at MSEC 2016, the Best Paper Award at the 11th International Conference on Frontiers of Design and Manufacturing, and the Wilson Prize for the Best Student Paper in Manufacturing from the University of Michigan. She was a finalist in IISE and INFORMS Best Paper Competitions. Her teaching interests include quality engineering, data analytics, and manufacturing systems. She is a member of IISE, INFORMS, and ASME.

Mohsen A. Jafari is a Professor of Industrial & Systems Engineering at Rutgers University. He has directed or co-directed a total of over \$15.5M funding from various government agencies and industry, in areas of automation, system optimization, data modeling, information systems, and risk analysis. His research application areas include energy systems, manufacturing, transportation, and healthcare. His work has led to major technological advances and product development including, multi-material deposition in solid free form fabrication; decision support system for traffic safety (Plan4Safety); integrated closed loop approach to planning, operation and investment of energy systems; cyber risk assessment of power networks; building energy asset management (BEAM); and Berth Planning. He actively collaborates with universities and research institutes in the US and abroad. He has advised thirteen Ph.D. theses and nine postdoctoral & research fellows. Presently, he is advising additional ten Ph.D. theses focusing on energy systems, zero-net communities, risk analysis and process improvement in healthcare. He is a member of IEEE and was recipient of the IEEE excellence award in service and research. He has been consultant to several fortune 500 companies, and national and international government agencies.

Myong K. (MK) Jeong is a Professor and Graduate Director in the Department of Industrial and Systems Engineering, RUTCOR (Rutgers Center for Operations Research), and DIMACS (Center for Discrete Mathematics and Theoretical Computer Science) at Rutgers University. Currently, he is the Director of Laboratory for Data Analytics and Process Insights. He received his BS in Industrial Engineering from Han Yang University, Seoul, Korea, in 1991, MS in Industrial Engineering from Korea Advanced Institute of Science and Technology, Taejon, Korea, in 1993, MS in Statistics from Georgia Institute of Technology, Atlanta, Georgia, in 2002, and Ph.D. in Industrial and Systems Engineering from Georgia Institute of Technology, Atlanta, Georgia, in 2004. He was formerly an Assistant Professor in the Department of Industrial and Information Engineering, the University of Tennessee, Knoxville. He worked as a senior researcher from 1993 to 1999 at the Electronics and Telecommunications Research Institute (ETRI).

He has focused on developing data mining and machine learning techniques for process monitoring and improvement. The applications include various industries such as gas/oil, semiconductor, transportation, bio-energy, computing, electronics, and automobile. He has published over 100 journal papers including *Technometrics*, *IEEE Transaction on Semiconductor Manufacturing*, *IEEE Transactions on Systems, Man, Cybernetics*, *Pattern Recognition Letters*, and *IIE Transaction on*

Quality and Reliability. He received the Freund International Scholarship and the National Science Foundation (NSF) CAREER Award in 2002 and in 2007, respectively. His research has been supported by the National Science Foundation, National Transportation Research Center, United States Department of Agriculture, Qatar National Research Fund, Electronics and Telecommunications Research Institute, and various industries. He has been a consultant for Samsung Electronics, Intel, IBM Watson Research Lab., ETRI, KISTI, and other companies. He served as the President of Data Mining Society of INFORMS (Institute for Operations Research and Management Science). He served as an Associate Editor and Advisory Board Member of various journals including IEEE Transactions on Automation Science and Engineering, International Journal of Quality, Statistics and Reliability, and International Journal of Advanced Manufacturing Technology. He is a senior member of IEEE.

Tuğrul Özel has been an Associate Professor in the Department of Industrial and Systems Engineering at Rutgers since 2008. He received his Ph.D. degree from Ohio State University in 1998. Dr. Özel's research programs focus on advanced manufacturing, additive manufacturing, precision machining, laser materials processing, computational modeling and optimization of advanced manufacturing processes, and development of innovative micro/nano devices, processes, and integrated manufacturing systems. Dr. Özel has established an internationally recognized research program in the precision machining and additive manufacturing of advanced materials including alloy steels, titanium, and nickel-based superalloys. Dr. Özel has published four edited books; *Intelligent Machining* (2009), *Micromanufacturing: Design and Manufacturing of Micro-Products* (2011), *Biomedical Devices: Design, Prototyping and Manufacturing* (2016), and most recently, *Modern Manufacturing Processes* (2020). He published over 150 peer-reviewed articles in leading engineering journals and conferences. His journal articles received high number of citations (over 10,000) and his current author h-index is 49 in Google Scholar database. He has been on the scientific committee of over 60 international conferences, chaired numerous conference sessions, delivered 70 conference presentations, keynote and planetary papers. He is the Editor-in-Chief of the International Journal of Mechatronics and Manufacturing Systems, Associate Editor of ASME Journal of Manufacturing Science and Engineering, Editorial Board Member of The International Journal of Machine Tools and Manufacture, and Production Engineering, Research and Development. Dr. Özel's research has been well funded (over \$1.2 million as sole or lead-PI) by the National Science Foundation, Department of Commerce-NIST, TK Tribology Research Foundation NASA/New Jersey Space Grant Consortium, and industry. He has graduated 6 Ph.D. and 22 Masters students, and supervised 20 visiting PhD or Master's students, and 10 Aresty Research assistants, and many undergraduate student projects in these research areas. Dr. Özel is a senior member of SME, ASME, NAMRI and former Associate Member of CIRP-International Academy for Production Engineering. He received three major NSF Grant Awards as sole or lead-PI, the Most Cited Articles Awards from Elsevier where his articles appeared several times in *The Journal of Materials Processing* and *The International Journal of Machine Tools and Manufacture*, the Best Paper Award at the 8th CIRP MMO Workshop in 2005, and the Machine Tool Technologies Research Foundation Award in 2008.

Hoang Pham is Distinguished Professor in the Department of Industrial and Systems Engineering at Rutgers University. Before joining Rutgers, he was a Senior Engineering Specialist with the Idaho National Engineering Laboratory and Boeing Company. He received his Ph.D. from the State University of New York at Buffalo. His research areas include reliability modeling of systems with competing risks and random environments, software reliability, and statistical inference. He is the editor-in-chief of the International Journal of Reliability, Quality and Safety Engineering and an associate editor and editorial board member of several journals, and the editor of Springer Series in Reliability Engineering. His several awards include the 2009 IEEE Reliability Society Engineer of the Year Award. Dr. Pham is the author/coauthor of 6 books, edited 17 books and has published over 190 journal articles. He has delivered over 40 invited keynote and plenary speeches at many international conferences and institutions. He is a Fellow of IEEE and IIE.

Elin M. Wicks is an Assistant Teaching Professor and Undergraduate Director in the Department of Industrial and Systems Engineering. She earned a B.S. and M.S. in Industrial Engineering from Rutgers University where her masters research focused on a method for quantifying non-economic factors in monetary terms. She went on to earn her Ph.D. in Industrial and Systems Engineering from Virginia Tech focusing on the design of cellular manufacturing systems. She is an author of the well-known textbook, *Engineering Economy*, currently in its 17th Edition. She has been a contributing co-author of this text since the publication of the 10th edition.

Zhimin Xi is an Assistant Professor in the Department of Industrial and Systems Engineering at the Rutgers University – New Brunswick. He received his B.S. and M.S. degree in Mechanical Engineering at the University of Science and Technology Beijing in 2001 and 2004, respectively. He obtained his Ph.D. in Reliability Engineering at the University of Maryland – College Park in 2010. His research interests include reliability and safety for energy storage systems, design for reliable energy systems, prognostics and health management for engineering systems, model validation under uncertainty, and system reliability analysis. He has published more than 60 papers in prestigious journals and peer-reviewed conference proceedings. He is the recipient of 2016 DARPA (Defense Advanced Research Projects Agency) - Young Faculty Award. He is the winners of multiple (including twice Top 10) Best Paper Awards from ASME – Design Automation Conference in 2008, 2011, 2013, and 2015 respectively. He received research funding support from National Science Foundation, DARPA, Department of Energy, Ford Motor Company, Denso North American Foundation, and The Woodbridge Group.

11. DEPARTMENTAL FACILITIES

Automation Laboratory. This laboratory provides students with the opportunity to explore and learn about modern manufacturing automation and production processes. The laboratory is equipped with state-of-the-art equipment in CAD/CAM (Computer Aided Design and Computer Aided Manufacturing) and computer integrated manufacturing automation systems. It includes production type Computer Numerical Controlled (CNC) milling machines, CNC lathes equipped with force dynamometers and acoustic emission sensors, a mini-CNC high speed milling machine tool, laser micro-machining station, an innovative and automated sheet folding machine, Universal MTS testing machine for the assessment of material properties, fatigue life, and an Inston Impact tester for impact properties, an automated storage and retrieval system, programmable logic controllers and programmable mobile platforms, a material handling carousel, and a robotic assembly cyber-physical work station.

Manufacturing Processes Laboratory. This laboratory provides students with the opportunity to study and practice manufacturing processes by supporting experimental learning of the fundamentals and the techniques of manufacturing processes. Students can set up and operate machine tools, manufacture parts, measure process variables, and inspect manufactured parts. Student learning from lab experiences is integrated with prior and subsequent learning of other engineering topics such as engineering materials, process planning, and quality control. The laboratory includes modern facilities to demonstrate and explore examples of manual turning, milling, drilling, grinding, conversational Computer Numerical Controlled (CNC) turning and milling, plastic filament extrusion based 3-D printing machines, heat-treating, welding, and joining processes. The laboratory also includes a variety of modern metrology instruments for measurement of process variables and dimensional and surface quality of manufactured parts. The laboratory is used on a scheduled basis for the Manufacturing Processes (ISE 303/304) and Design of Engineering Systems (ISE 399/400) courses. It also acquired an array of 3-D printing machines that are frequently used in undergraduate courses and design projects. The equipment is also used to perform laboratory experiments in heat treatment, chip formation, tool life, cutting forces, temperature, chip metallurgy, and power consumption.

Advanced Simulation Laboratory. This laboratory is intended to serve student term projects in the areas of simulation, design, statistical modeling and machine learning. With access to large screens, fast computers and different media tools the students are able to analyze and simulate large volume of data and build models using R, Python, MATLAB, ARENA, LINDO, and other commercial tools. The lab also includes 3D modeling tools such as Solid-Works and FactoryTalk for student projects. There is also an PLC server that can be connected to remote devices and robots for real time motion and supervisory controls, and for cyber-physical systems controls. This PLC is usually used in two or three student design projects every year.

Quality and Reliability Engineering Laboratory. This lab has been developed to allow the students to have hands-on experience in actual methods for quality control and reliability engineering. A variety of software for control charts, sampling plans, and design of experiments is available. The laboratory has a wide array of metrology equipment such as digital calipers and micrometers, roundness

measurement equipment, surface profilometers, and a coordinate measuring machine. It also has various materials testing equipment, a Rockwell hardness tester temperature chambers, vibration test stands, and failure analysis equipment such as voltage stressing equipment, and measuring microscopes. LABVIEW, Minitab, and STATGRAPHICS software are available for students' use.

Computer Control and Mechatronics Laboratory. This laboratory provides students with hands on experience in motion and supervisory controls. With WiFi connection to the ISE remote PLC and host of PLCs and instructional kits (with motors, sensors, I/O boards) in the lab where students are able to work on hands -on projects that involve control of devices, motors, actuators, and higher level supervisory controls. This lab is used primarily for the Computer Control course and its lab. The lab also includes a small scale physical simulation of IOT sensors and devices for student projects.

Design Laboratory. The ISE Department has shared space for ISE and MAE design projects. The shared space is intended to promote interdisciplinary design activities and will include primary tools that can be used for system assembly and testing, with remote access to other department resources. This lab is located in Richard Weeks Hall building (second floor).

12. GENERAL INFORMATION

School of Engineering

Peng Song: Associate Dean for Undergraduate Education, peng.song@rutgers.edu

Lydia Prendergast: Assistant Dean for Academic Services, Lprend@soe.rutgers.edu

Cecilia Vargas: Assistant Dean for First Year Students, cecilia.vargas@rutgers.edu

Robert Ciervo: Assistant Dean for Transfer Students, robert.ciervo@rutgers.edu

Jasmine Bundy: Transfer Academic Advisor, jasmine.bundy@rutgers.edu

Ilene Rosen: Associate Dean for Student Services, ilrosen@rutgers.edu

Undergraduate Registrar - Room 200F, Administrative Service Building, Davidson Road, Busch Campus, 445-3557

Career Services - 56 College Avenue, College Avenue Campus, 932-7997

Financial Aid Room - 140 Records Hall, College Avenue Campus, 932-7057

Housing - On-Campus - Taylor Road, Busch Campus General Information, 445-2992;
Off-Campus - 445-7766

International Student Center - 180 College Avenue, College Avenue Campus,

Counselor to International Students - 932-7015

Student Accounting Records Hall, College Avenue Campus, Room 138, 932-7581

13. ADDITIONAL INFORMATION

Departmental Office: The Department of Industrial and Systems Engineering office is located on the second floor of the CORE Building (Room 201). The office has copies of most forms you might need and the staff working there can answer many questions. Office hours are 8:30-5:00 PM, Monday through Friday. Closed for lunch between 12:00 - 1:00 PM.

Employment Opportunities: Job announcements are posted on the ISE bulletin boards. Students are encouraged to make use of the Career Exploration and Success Office on Busch campus (<https://careers.rutgers.edu/>).

Bulletin Boards: In the hallways on the 1st and 2nd floors, there are bulletin boards, which list course changes, seminars, fellowships, and other miscellaneous notices.

The Telephone Number for the Department of Industrial and Systems Engineering is (848) 445-3654 and the fax number is (848) 445-5467. The area code and prefix is (848) 445 for all telephones - the extensions are given below.

NAME	EXT	CORE	EMAIL
Albin, Susan	2238	206	salbin@rutgers.edu
Coit, David	2033	214	coit@soe.rutgers.edu
Elsayed, Elsayed A.	3859	226	elsayed@soe.rutgers.edu
Ezzat, Ahmed Aziz	3625	228	aziz.ezzat@rutgers.edu
Guo, Weihong	8556	220	wg152@rutgers.edu
Gursoy, Melike B.	5465	218	gursoy@soe.rutgers.edu
Jafari, Mohsen A.	3627	201	jafari@soe.rutgers.edu
Jeong, Myong K.	4858	222	mjeong@soe.rutgers.edu
Ozel, Tugrul	1099	208	ozel@soe.rutgers.edu
Pham, Hoang	5471	216	hopham@soe.rutgers.edu
Wicks, Elin	8787	210	elin.wicks@rutgers.edu
Xi, Zhimin	3657	224	zhimin.xi@soe.rutgers.edu
Kasica, Laura	8506/3654	201	lk405@soe.rutgers.edu
Ponnuraj, Barthi	8507/3654	204	barthi@soe.rutgers.edu
Manufacturing Automation Lab	5480	116	
Manufacturing Processes Lab	5480	112	
Advanced Simulation Lab	5480	106	
Quality & RelibilityLab	5480	114	
Comp. Contl & Mechatronics Lab		602	
Design Lab			Richard Weeks Hall
IE Conference Room	8555	203	

14. SECURITY AND SAFETY

Providing a secure and safe environment for all is a top priority.

Emergency Phone Number: The number is 932-7111 for university police and emergency.

CORE Building Access: The door is open weekdays from 8 AM to 9 PM.

Access to First Floor IE Corridor: The door is open weekdays from 9-6 PM For your safety, the corridor is under camera surveillance.

Access to Labs: The labs are open from 8:30 AM to 4:30 PM.

DON'T LET STRANGERS IN: Don't open the door for people who have no entry keys. Don't keep any door ajar by placing an object in front of it.

Laboratory Rules and Safety:

Refer to Design Specialist for lab specific rules.

APPENDIX A

For the most current list of the Humanities/Social Science Electives, please go the link below:

http://soe.rutgers.edu/sites/default/files/imce/pdfs/humanities_list.pdf

LIST OF ACCEPTABLE HUMANITIES/SOCIAL SCIENCE REQUIREMENTS EFFECTIVE SPRING TERM 2018 (Last Revised Sept 2017)

NOTE: This list is based on the New Brunswick Undergraduate Catalog, 2009-2011, and supersedes all previous lists. Any new courses added after publication of the 2009-2011 Catalog are subject to review. Questions or appeals regarding course acceptability should be directed to a dean in the Office of Academic Services.

Rationale for H/SS Electives in the Curriculum: A good undergraduate education should provide more than the development of technical skills. Properly chosen, H/SS electives can complement your technical courses by helping you to develop an understanding of the problems facing our society, a historical consciousness, a sense of values, knowledge of other cultures, an appreciation of the fine arts, and an ability to communicate effectively. Think seriously about your choices, and use them to enhance your educational experience. Foreign language courses are allowed to be used to satisfy this requirement, with the exception of introductory courses in the student's native tongue. Engineering students are encouraged to complete a **minor** or even a **second major** in these disciplines; see <http://soe.rutgers.edu/oas/minors-majors> for more details.

School Requirements: All candidates for the B.S. degree must complete a minimum of **18 credits** of NON-technical humanities/social science coursework*. If a course on this list bears less than 3cr, multiple courses may be combined to total the credit requirement. H/SS courses and requirements include the following:

- 01:355:101;
- 540:343 (class 2022+), formerly 01:220:102.
- Four free electives chosen from the list below;
- Free electives must be selected in a manner such that at least **two courses are at the 200/300/400 level**;
- 6cr (2 courses) out of the 18cr must be from the same subject, including at least 3cr (or 1 course) 200+ level course.
- *If any new technical courses are developed within one of the subjects below, SOE reserves the right to adjust this list. If you find a course of a technical nature on this list (some keywords: science, data, analytics, technical), please check with the Office of Academic Services for verification.

Department	Courses - MUST BE 3cr EACH
01:013 African Lang & Lit	All courses
01:014 Africana Studies	All Courses EXCEPT: 223,224, 341,342,460, 490-498
01:016 Africana Area Studies	All Courses EXCEPT: 301-304
01:050 American Studies	All Courses EXCEPT: 281-284
01:070 Anthropology	All Courses EXCEPT: 291-294,334,335,349,354,355,358,359,390-395,495-498
07:080	131
01:082 Art History	All Courses EXCEPT: 111,112,291-94,345,462,473,491-499
01:090 Arts and Sciences	320, 321, 322
01:098 Asian Studies	All courses
01:145 Catalan	All courses
01:165 Chinese	All courses
01:190 Classics	All Courses EXCEPT: 101,102,431,432,491-496
04:192 Communication	380
01:195 Comparative Lit	All Courses EXCEPT: 160,399,493-496
01:202 Criminal Justice	201,301,310,311,312,322,327,405
07:203 Dance	101,131
01:214 East Asian Studies	241, 242, 310, 338
01:220 Economics	All Courses EXCEPT: 102, 110, 212, 322,326,386,,397-399,401-410,421,490-496
05:300 Education	306
14:332 Elec/Cmptr Eng'g	301
01:350-354 & 358 English	All Courses
01:355 English (Writing)	201,302, 402 Note, if 355:302 is a req't for your major, you cannot use it to fulfill a h/ss elective
01:360 European Studies	301, 401
11:372 Environ Planning	202,444
11:373 Envrn & Busn Econ	323,331,361,362,363,371
11:374 Envrn. Policy Instit & Behavior	101,102,175,211,220,223,269,279,301,308,312,313,314, 315,322,331,335,336,341

Department	Courses
33:382 Entrepreneurship	202, 302, 303, 310, 340, 342, 355
01:420 French	All courses
14:440 General Engineering	404
01:450 Geography	102,103,205,214,222,250, 262,309,311,320, 330-338,341,342,361,363, 370,405, 413, 470
01:470 German	All courses
01:489 Modern Greek	All courses
01:490 Greek	All courses
10:501 Health Administration	All Courses
01:505 Hindi	All courses
01:506-512 History	All Courses
37:533 Human Resourcs Mgt	All Courses
01:535 Hungarian	201, 202, 259, 260, 301,321,355,360,401,402,460,490
11:554 Interdisc Studies-SEBS	196,296
01:556 Interdisc Studies	103, 104, 220
01:560 Italian	All courses
01:563 Jewish Studies	All courses
01:565 Japanese	All courses
04:567 Journalism and Media Studies	All Courses EXCEPT 207, 212, 331, 438
01:574 Korean	All courses
37:575 Labor Studies	All Courses EXCEPT: 401,450-499
01:580 Latin	All courses
01:590 Latin Amer Studies	All Courses
01:595 Latino & Hispanic Carribean Studies	All Courses EXCEPT: 304, 354, 356, 493-496
11:607 Leadership Skills	All Courses EXCEPT 383, 384, 388 and any other course under 3cr.
01:615 Linguistics	All Courses
33:620 Management	301
33:630 Marketing	301, 368
07:631 Mason Gross Arts Online	101,103,106,120,121,210, 211,226,230,281,282,295,425
01:667 Medieval Studies	281,282,388,481
01:685 Middle East Studies	All Courses EXCEPT: 480-499
07:700 Music	101, 102, 103, 121, 122,125,131,133,211-222,226-238,290,295, 296, 301, 302, 303, 305, 306, 310
01:730 Philosophy	All Courses EXCEPT: 493-496
10:762 Planning & Public Policy (formerly 975-Urban Studies)	101, 202,233,303-306,310, 324, 331, 335, 350, 352,413, 421, 444, 448, 451, 460,462, 471, 473, 474, 476,478,
01:787 Polish	201,202,259,370,401,402,470,475
01:790 Political Science	All Courses EXCEPT: 250-253,300,391-400,481-498
33:799 Supply Chain Mgt	300, 301, 380
01:810 Portuguese	All Courses
01:830 Psychology	All Courses EXCEPT: 200,210, 300,323,395-398, 411,413, 490-498
10:832 Public Health	All Courses
01:840 Religion	All Courses
01:860 Russian	All courses
01:880 Science, Technology, Society	210
01:920 Sociology	All Courses EXCEPT: 311,312,393,398,399,493-498
01:940 Spanish	All courses
07:965 Theatre Arts	211, 212, 231, 300, 311, 312, 398, 401
01:988 Women's Studies	All Courses EXCEPT: 370,399,425,426,430,493-498

H/SS Check list

A. Courses selected from the H/SS list.

B. 6 courses or 18cr completed

1. 355:101 Expository Writing
2. 540:343 Engineering Economics (or 220:102 for class 2020 + 2021)
3. _____ 3cr (any level)
4. _____ 3cr (any level)
5. _____ 3cr (200+ level)
6. _____ 3cr (200+ level)

List the two courses from the same subject, including at least one 200+ course:
