

**SCHOOL OF  
OPERATIONS RESEARCH AND INFORMATION ENGINEERING  
COLLEGE OF ENGINEERING  
CORNELL UNIVERSITY**

**UNDERGRADUATE  
STUDENT  
HANDBOOK**

**REVISED – SEPTEMBER 2009**

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**IMPORTANT INFORMATION:**

Information about Cornell University and Engineering College guidelines for graduation and honors are provided here for reference only.

**RESPONSIBILITY FOR MEETING DEGREE REQUIREMENTS:**

Ultimately, it is your responsibility to understand the degree requirements for the major and to plan your course of study accordingly. You should consult the ORIE undergraduate major office (203 Rhodes) for specific information relating to the fulfillment of degree requirements. Your faculty advisor will assist you in course selection, but it is your responsibility to ensure that the courses you select will fulfill degree requirements.

## **OR&IE AT CORNELL**

### **Introduction**

This handbook has been designed to inform you about the School of Operations Research and Information Engineering (OR&IE) at Cornell. It will help you gain an understanding of the major program, the courses, the faculty and staff, various procedures, career opportunities, graduate studies, and student activities. This handbook, together with consultations with your faculty advisor, should provide you with the information you need concerning the Operations Research and Engineering major.

The faculty and staff welcome you to the School. We look forward to getting to know you and are confident that you will have a challenging and rewarding educational experience.

### **What Operations Research Engineering Is About**

The operations research and engineering undergraduate major will give you a broad understanding of the techniques and modeling concepts needed to analyze and design complex systems. As an operations researcher, you'll make many decisions that involve the interplay of people, time, money, energy and materials. All business systems are complex and need sophisticated decision-making methods that enable employees and the equipment they operate to perform most efficiently. The allocation of resources may be represented and analyzed mathematically. Specialists in operations research and engineering use a variety of mathematical techniques and specialized computing tools to develop and apply techniques to get the most out of valuable resources.

An automobile manufacturer, for example, might be able to save millions of dollars a year by identifying and eliminating bottlenecks in an assembly line. If an airline improves its ability to forecast passenger demand, and adjusts its schedules accordingly, more seats may be filled. If a hospital schedules the use of its operating rooms more efficiently, costs may be reduced improving service to patients. These are the types of problems that may be solved by experts in operations research and engineering. As work becomes technologically more complex and the demands of the economy require a more efficient use of resources, a growing number of specialists in this field will be needed.

### **Employment Opportunities**

Historically, the field of operations research and engineering has been concerned with manufacturing and the delivery of goods and services, and many operations researchers continue to find opportunities in those areas. In recent years, however, the field has expanded as business and industry have recognized that the methods of operations research and engineering may also be used profitably in fields like finance and information technology. As a result, you'll likely find OR&E graduates working as investment bankers and in information technology offices, as well as consultants, analysts, industrial engineers and managers in a wide variety of areas. The major provides analytical tools that will allow you to seek flexible career pathways.

Below are some career choices of recent OR&E graduates:

- Abercrombie & Fitch, Assistant Allocator
- Boeing Integrated Defense Systems, Quality Engineer
- Capital One, Financial Analyst
- IBM Corporation, Industrial Engineer
- Lockheed Martin Corporation, Operation Leadership Program
- Merrill Lynch, Investment Banking Analyst
- Microsoft Corporation, Program Manager
- United Parcel Service (UPS), Industrial Engineering Management Program

## History of the School

Cornell's educational contributions to our discipline reach back almost to its beginning. In the 1890's, Frederick Taylor introduced ideas for improving the efficiency of labor by breaking down the steps required for a task and designing "the one best method" for all steps and the task they comprise. When Taylor presented a paper, "Shop Management," at the 1903 meeting of the American Society of Mechanical Engineers, Dexter Kimball, then works manager at Stanley Electric Manufacturing Company, later the first Dean of the College of Engineering at Cornell, was in the audience. By 1905 Kimball was teaching about the economics of production at Cornell. In 1913, Kimball wrote in *Principles of Industrial Organization*, "the application of these well-known methods .... has become known as efficiency engineering, industrial engineering, or scientific management." Since that time, many other terms have been linked to the discipline(s) that grew from this approach, among them: *administrative science, administrative engineering, systems analysis, systems engineering, management science, engineering management, management engineering, operations management, operations research*. One could debate whether these terms are all variations on a theme, or whether they represent distinct descendants of a common ancestor. Their standard short definitions are very similar – application of *scientific methods* to *systems* in order to design and operate them *efficiently*. They might diverge only when the succinct definitions were expanded to include shades of emphasis and delineations of both methods and application areas.

The designation *operations research* first emerged during World War II in England. Military planners worked with civilians from a variety of disciplines, including mathematics and engineering, to tackle the challenges imposed by the logistical support of massive military operations. Operations Analysis (or, Operational Analysis, in British English) was the name that was initially associated with their systematic approach to planning and with the collection of mathematical tools employed. Over time, it came to be called Operations Research.

Even within Cornell, the name of the academic unit tasked with teaching industrial engineering and its namesakes has changed several times to reflect changes in emphasis within the unit at Cornell, as well as changes in perspective within the broader professional community: administrative engineering, industrial engineering, operations research and information engineering have all appeared in the name of our unit at various times. It was part of the Sibley School of Mechanical Engineering until the 1960's, when a separate unit was created, which (eventually) became the School of OR&IE. Until very recently OR&IE stood for Operations Research and Industrial Engineering; it now decodes as Operations Research and Information Engineering.

Why the change in 2006 to Operations Research and *Information Engineering*? The information revolution of the past two decades has dramatically broadened the impact of OR. Information Engineering, the process of transforming data into useful information, has always played a key role in OR, but the rapidly increasing scope and scale of available data challenges us to better understand this process. The role of information is further highlighted by the transformation of the US economy from one based primarily on manufacturing to one oriented towards service industries, where information itself is often a key commodity. The names of courses recently introduced in OR&IE – "Revenue Management", "Statistical Data Mining", "Service System Modeling and Design", and "Delivering OR Solutions with Information Technology" – reveal how the School's mission is expanding in this direction.

The current OR&IE faculty has carried forward the strong traditions established by an earlier generation, building more powerful mathematical foundations, developing faster more robust methods, and expanding greatly the scope of applications. OR is a multidisciplinary field, and, a natural outcome of the new initiatives in such application areas as data mining, information technology, financial engineering, and supply chain management has been a trend toward work that synthesizes diverse methods.

In teaching, as in research, OR&IE at Cornell has put a premium on mathematical rigor, pushing the envelope, not merely knowing what works and what doesn't, but also understanding why it works or doesn't. Armed with such training, graduates of the OR&E major are typically able to make broader, more fundamental contributions to the practice of OR. They are able to adapt to the ever more rapidly changing workplace, where tools that work today may be based on assumptions that won't hold tomorrow.

## PERSONNEL

### Faculty

Among faculties in operations research and the related disciplines (industrial engineering, systems engineering, engineering management, etc.), Cornell's faculty is among the most distinguished.

<u>Name</u>	<u>Area(s) of Teaching and Research</u>
Robert G. Bland, Prof. & Assoc. Dir.	Optimization, Algorithms
Kathryn E. Caggiano, Sen. Lect. & Assoc. Dir.	Supply Chain Management
John R. Callister, Senior Lecturer	Entrepreneurship, Economic Analysis
Peter Frazier, Asst. Prof.	Statistical Learning
Eric J. Friedman, Assoc. Prof.	Game Theory, Info. Tech. Modeling, Network Design
Shane G. Henderson, Prof. & Dir.	Applied Prob., Financial Engr., Info. Tech. Modeling
Peter L. Jackson, Prof.	Supply Chain Management
Adrian S. Lewis, Prof.	Optimization, Algorithms
Mark E. Lewis, Assoc. Prof.	Applied Prob., Financial Engr., Supply Chain Mgt.
John A. Muckstadt, Acheson-Laibe Prof.	Supply Chain Management, Public Health Logistics
Narahari U. Prabhu, Prof. Emeritus	Applied Probability
Philip E. Protter, Prof.	Applied Probability, Financial Engineering
James Renegar, Prof.	Optimization, Algorithms
Sidney I. Resnick, Prof. Financial Engr.	Applied Prob., Network Models, Stats.,
David Ruppert, Andrew Schultz Jr Prof.	Statistics, Data Mining, Financial Engineering
Paat Rusmevichientong, Asst. Prof.	Data Mining, Info. Tech. Modeling, Supply Chain Mgt.
Gennady Samorodnitsky, Prof.	Applied Probability, Financial Engr., Statistics
David B. Shmoys, Prof.	Optimization, Algorithms, Supply Chain Mgt.
Michael J. Todd, L.C. Welch Prof.	Optimization, Algorithms, Applied Probability
Huseyin Topaloglu, Assoc. Prof.	Supply Chain Mgt., Optimization, Algorithms

Leslie E. Trotter, Prof. & Dir. Grad. Studies	Optimization, Algorithms, Network Design & Analy.
Bruce W. Turnbull, Prof.	Statistics
David P. Williamson, Prof.	Optimization, Algorithms, Info. Tech. Modeling
Dawn B. Woodard, Asst. Prof.	Statistics, Data Mining

### **Support Staff**

You may also have occasion to interact with some of the support staff of the School, including:

Cindy Jay	Undergraduate Major Coordinator	203 Rhodes Hall
Kathy King	Graduate Student Services Coordinator	201 Rhodes Hall
Selene Cammer	Admin. Asst., OR&IE Main Office	206 Rhodes Hall

Cindy Jay is responsible for tracking your progress through the School and may answer your questions about the administrative aspects of the undergraduate program.

## **CURRICULUM**

### **Description of the OR&E Curriculum & Graduation Requirements**

The curriculum for the B.S. degree with a major in Operations Research and Engineering is summarized on the curriculum checklist on page 23. When all the courses listed are completed successfully, and the student's cumulative GPA is at least 2.0, and the student's Major GPA is at least 2.0, the degree will be awarded. The Major GPA includes distribution courses (3 courses), ORIE required major courses (8 courses) and ORIE electives (3 courses). ENGRD 2700 and MATH 2940 must be completed with a C or better. All other MATH courses, ENGRD 2110, and ORIE required major courses must be completed with a C- or better to receive credit.

For each student, an updated copy of the study plan is kept in Room 203, Rhodes Hall. Each student should obtain a copy of his/her study plan and keep his/her own record of progress. Detailed comments on each section of the form follow.

### **Required Engineering Core Courses**

OR&E affiliates are required to complete Math 1910, 1920 and 2940. Either Math 2930, Math 3040 or CS 2800 may be used to satisfy the fourth mathematics requirement. Students should discuss with their advisor which of these three courses is most appropriate to their future program of study. Chemistry 2080, Math 2930 (if not used to meet the mathematics requirement), CS 2800 (if not used to meet the mathematics requirement), Math 3040 (if not used to meet the mathematics requirement), Math 3110 or Math 3360 may be taken in place of Physics 2214. Students who do not take Math 2930 may not enroll in Physics 2214 (Math 2930 is a pre-requisite for Physics 2214) and should plan to enroll in one of the alternative courses.

OR&E affiliates must receive at least a C in MATH 2940. Each remaining course in mathematics used to fulfill a core requirement must be passed with a grade of at least "C-". If this grade level is not achieved, the course must be repeated.

### **Engineering Distribution Courses**

The most suitable Introduction to Engineering course for OR&E majors is ENGRD 1101. ENGRD/CS 2110 is required of all OR&E majors and must be passed with a grade of C- or better before the end of the sixth semester. If this grade level is not achieved, the course must be repeated. ENGRD/CS 2110 may be taken as a distribution course or major approved elective. ENGRD 2700 is a required distribution course and must be passed with a grade of C or better.

### **Required Major Courses**

The following courses are required of all OR&E majors:

ORIE 3120, 3150, 3300, 3310, 3500, 3510, 4580, behavioral science course.

Each ORIE required major course must be passed with a grade of C- or better. If this requirement is not met the first time a course is taken, the course must be repeated within one year and a satisfactory grade attained before the next course in the sequence (ORIE 3310 and ORIE 3510 in particular) may be taken. Failure to achieve at least a C- the second time will generally result in withdrawal from the program. Courses taken a second time in order to meet this requirement do not yield additional credit toward the degree. Transfer credit will not be granted for required major courses except for (1) transfer students who took an equivalent course at another institution prior to enrollment at Cornell, and (2) students formally enrolled in Cornell's "Study Abroad" program.

The Behavioral Science (organizational behavior) requirement is satisfied by any one of the following courses: ENGR 3350, ILR 1220, 1750, 3200, 3700, 4610, NCC 5540, NBA 6630, 6660, and HADM 1115. These courses are offered at the discretion of the fields and are not always offered every term.

### **OR&IE Electives**

Any ORIE course (at the 4000 level or higher) not listed as required or in the note at the end of this section counts as an ORIE Elective. Also, ORIE 3800 and NBA 6410 may be used as ORIE Electives.

ORIE 4990 (Teaching in ORIE) may be counted as an ORIE elective (maximum of 3 credits).

Students must be in good academic standing to enroll in ORIE 4999 (Independent Study). No more than 3 credits of ORIE 4999 may be used as an ORIE elective.

NOTE: ORIE 4152, 9000, 9100 and 9101 MAY NOT be used to fill the ORIE elective requirement. ORIE 4152 may be used as a major approved elective (Category B).

### **Major-approved Electives**

All major-approved electives must be technical courses numbered 2000 or above. "Technical" means that in a significant part of the course students actively use their skills in mathematics, the sciences, or engineering design, in homework or projects. 9 hours of major approved electives are required. At least 3 hours must be outside of ORIE, so that with CS 2110 and the behavioral science elective at least 9 hours of the major program are outside of ORIE. Major-approved Electives are categorized into Category A (Engineering, Science, and Mathematics) and Category B (Engineering Design, Finance, and Economic Analysis). At least 6 hours must be in Category A.

The School of OR&IE maintains lists of popular courses that may be used as major-approved electives. Students may petition for other courses to be allowed. Petitions go to the Associate Director for Undergraduates who, with the Academic Standards Committee, will determine if the course meets the definition of "technical" and whether the course is in category A or B. A petition must be accompanied by a syllabus of the course indicating the textbooks used and types of assignments that will be given.

**Courses that MAY be used as major-approved electives in Category A (Engineering, Science, and Mathematics):**

AEM 4110 (Introduction to Econometrics) (but not with Econ 3200)  
 AEP 3210 (Mathematical Physics I)  
 BIOBM 3310 (Principles of Biochemistry: Proteins and Metabolism)  
 BIOBM 3320 (Principles of Biochemistry: Molecular Biology)  
 CHEM 2080 (General Chemistry)  
 CHEM courses with Chem 2080 or 2160 as a prerequisite  
 ECON 3200 (Introduction to Econometrics) (but not with AEM 4110)  
 ECON 4760 (Decision Theory)  
 All MATH courses numbered 3000 or above EXCEPT 4030, 4080, 4710, and 4720  
 All PHYSICS courses with Physics 2213 or 2214 as a prerequisite  
 All ENGRD Courses (except Engrd 2700 which must be used in the Distribution Category.)  
 CEE 4630 (Future Transportation Technologies and Systems)  
 CEE 6230 (Environmental Quality Systems Analysis)  
 All CS courses with CS 2110 as a prerequisite  
 CS 2800 (Discrete Structures)  
 CS 5722 (Heuristic Methods for Optimization)  
 All ORIE courses no. 3000 or above EXCEPT 4152, 9000, 9100, 9101 and 9110

**Courses that MAY be used as major-approved electives in Category B (Engineering Design, Finance, and Economic Analysis):**

AEM 4200 (Investments)  
 AEM 4210 (Derivatives and Risk Management)  
 AEM 4170 Decision Models for Small and Large Businesses  
 AEM 4230 (Topics in Applied Finance)  
 AEM 4260 (Fixed Income Securities)  
 AEM 4280 (Valuation of Capital Investment)  
 AEM 4290 (International Finance)  
 ECON 3330 (Financial Economics)  
 ECON 3510 (Industrial Organization I)  
 ECON 3520 (Industrial Organization II)  
 CEE 3610 (Introduction to Transportation Engineering)  
 CEE 4530 (Research in Environmental Engineering)  
 CEE 5800 (Project Management)  
 CEE 5970 (Risk Analysis and Management)  
 CS 2300 (Intermediate Web Design)  
 ENGRG 4610 (Entrepreneurship for Engineers)  
 BME 5010 (Bioengineering Seminar)  
 HADM 3343 (Marketing Research)  
 HADM 4441 (Strategic Management)  
 MAE 2225 (Mechanical Synthesis)  
 ORIE 4152 (Entrepreneurship for Engineers)  
 NBA 5060 (Financial Statement Analysis)  
 NBA 5061 (Comprehensive Financial Statement Analysis)  
 NBA 5420 (Investments and Portfolio Analysis)  
 NBA 5550 (Fixed Income Securities and Interest Rate Derivatives)  
 NBA 6200 (Marketing Research)  
 NBA 6410 (Logistics and Manufacturing Strategy)  
 NBA 6730 (Intro. to Derivatives, Part 1)  
 NBA 6740 (Intro. to Derivatives, Part 2)  
 NBA 6940 (Equity derivatives and related products)  
 TAM 3100 (Intro. to Applied Math)  
 "Team" courses such as MAE 4250 (FSAE Auto Design) may be use for a total of 3 credits of major approved electives in Category B.

### **Advisor Approved Electives**

Any course mutually agreed upon by a student and his/her advisor may be included in this category. Advisors approve courses in this category if the course is considered to be relevant to the student's educational objectives. For each such course, the advisor signs a form illustrated on page 32. These forms are available in Room 203, Rhodes Hall.

### **Liberal Electives**

A minimum of six courses (totaling at least 18 credits) is required, and should be chosen with as much care and foresight as courses from technical areas.

- The six courses must be chosen from at least three of the following six groups.
- At least two courses must be at the 2000 level or higher.

**Group 1.** Cultural Analysis (CA)

**Group 2.** Historical Analysis (HA)

**Group 3.** Literature and the Arts (LA)

**Group 4.** Knowledge, Cognition, and Moral Reasoning (KCM)

**Group 5.** Social and Behavioral Analysis (SBA)

**Group 6.** Foreign Languages (not literature courses)

#### 1. Cultural Analysis (CA)

Courses in this area study human life in particular cultural contexts through interpretive analysis of individual behavior, discourse, and social practice. Topics include belief systems (science, medicine, religion), expressive arts and symbolic behavior (visual arts, performance, poetry, myth, narrative, ritual), identity (nationality, race, ethnicity, gender, sexuality), social groups and institutions (family, market, community), and power and politics (states, colonialism, inequality).

#### 2. Historical Analysis (HA)

Courses in this group interpret continuities and changes--political, social, economic, diplomatic, religious, intellectual, artistic, scientific--through time. The focus may be on groups of people, dominant or subaltern, a specific country or region, an event, a process, or a time period.

#### 3. Literature and the Arts (LA)

Offerings in this area explore literature and the arts in two different but related ways. Some courses focus on the critical study of artworks and on their history, aesthetics, and theory. These courses develop skills of reading, observing, and hearing and encourage reflection on such experiences; many investigate the interplay among individual achievement, artistic tradition, and historical context. Other courses are devoted to the production and performance of artworks (in creative writing, performing arts, and media such as film and video). These courses emphasize the interaction among technical mastery, cognitive knowledge, and creative imagination.

#### 4. Knowledge, Cognition, and Moral Reasoning (KCM)

Offerings in this area investigate the bases of human knowledge in its broadest sense, ranging from cognitive faculties shared by humans and animals such as perception, to abstract reasoning, to the ability to form and justify moral judgments. Courses investigating the sources, structure, and limits of cognition may use the methodologies of science, cognitive psychology, linguistics, or philosophy. Courses focusing on moral reasoning explore ways of reflecting on ethical questions that concern the nature of justice, the good life, or human values in general.

#### 5. Social and Behavioral Analysis (SBA)

Courses in this area examine human life in its social context through the use of social-scientific methods, often including hypothesis testing, scientific sampling techniques, and statistical analysis. Topics studied range from the thoughts, feelings, beliefs, and attitudes of individuals to interpersonal relations between individuals (e.g., in friendship, love, conflict) to larger social organizations (e.g., the family, society, religious or educational or civic institutions, the economy, government) to the relationships and conflicts among groups or individuals (e.g., discrimination, inequality, prejudice, stigmas, conflict resolution).

#### 6. Foreign Languages (not literature courses)

Courses in this area teach language skills, inclusive of reading, writing, listening, and spoken non-English languages, at beginning to advanced levels.

### **Physical Education**

In addition to the two semesters of Physical Education, a swimming test must be passed.

### **The Technical Writing Requirement**

The College of Engineering specifies certain courses as satisfying the technical writing requirement. Courses that currently satisfy this requirement are BEE 4890, ENGRD/AEP 2640, CHEME 4320, COMM 2600, COMM 2630, COMM 3520, ENGRC 3350, ENGRC 3500, MAE 4272.

AEP 2640 and MAE 4272 may be used as a major-approved elective or an advisor approved elective. BEE 4890 and COMM courses may be used as an advisor approved elective. ENGRC courses fulfill the Literature and the Arts (LA) in the liberal studies distribution. ENGRC 3350 may be used in the Liberal Arts category **OR** as the Organizational Behavior requirement in the ORIE Major courses category. It **MAY NOT** be counted in both areas.

### **ROTC Courses**

ROTC courses do not count toward the degree unless co-listed by some other department, in which case the co-listing determines how the course may be used.

### **Supplementary Courses, ENGRG 150 and Academic Excellence Workshop Credit**

Supplementary courses starting with the digit "0", such as Chemistry 0111, the Engineering Seminar (ENGRG 1050), and Academic Excellence Workshop credit (ENGRG 1920, etc) do NOT count toward the degree.

### **Junior and Senior Year Courses**

The following is a typical junior year schedule for an Operations Research and Engineering major who has completed ENGRD 2700, CS 2110, Math 2940 and ORIE 3120 .

#### **Fall Semester**

ORIE 3300 Optimization I  
ORIE 3500 Probability & Statistics II  
ORIE 3150 Accounting  
Approved/Major-approved Elective  
Liberal Elective

#### **Spring Semester**

ORIE 3310 Optimization II  
ORIE 3510 Stochastic Processes  
Behavioral Science Course  
Approved/Major-approved Elective  
Liberal Elective

In the Fall Semester of the senior year, ORIE 4580 must be taken. The rest of the schedule in the senior year will consist of the various types of electives necessary to complete degree requirements.

Excess credit hours beyond the minimum required in the various categories may be applied to the Advisor Approved Elective category, subject to the approval of the student's academic advisor.

The minimum course load required to be considered a full-time student is 12 credit hours in each semester, except in the student's final semester. In the final semester, the minimum course load is simply the number of credit hours required to complete degree requirements.

### **HONORS PROGRAM**

**Eligibility:** To be eligible for the OR&E honors program, a student must achieve and sustain a cumulative GPA of at least 3.5, both overall and in the major program.

**Timing:** A student must apply for and be admitted to the honors program no later than the beginning of his or her penultimate semester, i.e., the student must be in the program for at least two semesters prior to graduation. Students may apply for and be admitted to the program as early as the first semester of their junior year.

**Procedures:** Each applicant to the OR&E honors program must have a faculty advisor to supervise that student's individual program. This honors advisor need not be the student's faculty advisor. The application to the program shall be a letter from the student describing the specific proposed honors program and including the explicit approval of the honors advisor. Each program must be approved by the Associate Director, and any changes to the student's program must also be approved by the Associate Director.

**Content:** An OR&E honors program shall consist of at least nine credits beyond the minimum required for graduation in OR&E, so that no part of the honors program may also be used to satisfy graduation requirements. The nine credits shall be from one or more of the following with at least four hours in category 1:

1. Advanced courses in OR&IE at the 5000 level or above.
2. A significant research experience or honors project under the direct supervision of an ORIE faculty member using ORIE 4999 -- ORIE Project. A significant written report must be submitted as part of this component.
3. A significant teaching experience under the direct supervision of a faculty member in ORIE 4990: Teaching in ORIE.

No research, independent study, or teaching for which the student is paid may be counted toward the honors program.

### **POLICIES AND PROCEDURES**

To maintain fair and uniform academic standards, the School has adopted the following policies and procedures to govern course registration and academic credit. The Associate Director of Undergraduate Studies, Robert Bland, and the Major Coordinator, Cindy Jay are responsible for most administrative aspects of the undergraduate curriculum.

#### **Requirements for Affiliation (for students matriculating in Fall 09)**

Students apply for affiliation at the end of the first semester of their sophomore year by visiting the Undergraduate Office in 203 Rhodes Hall. Requirements for OR&E affiliation are: at least C in each of MATH 2940 and ENGRD 2700; GPA  $\geq$  2.2 in math, science, and engineering courses (both overall and in the term immediately before affiliation); at least C- in all ORIE courses completed thus far. Good academic standing in the College of Engineering.

Students that matriculated prior to Fall 2009 should contact Cindy Jay (203 Rhodes) about affiliation requirements.

### **Advising**

Advisors are assigned when a student is affiliated with the major. Students normally continue with this advisor through graduation.

Your advisor serves as a source of information on academic matters. These include: checking requirements, choosing elective courses, and advice on career planning and graduate schools. The approval of your assigned advisor is required on advisor approved elective forms and all petition forms.

You are encouraged to consult with other members of the faculty as well. One reason for getting acquainted with the faculty is that they act as references for jobs and graduate schools.

### **Good Standing Status**

Scholastic requirements are:

1. A cumulative grade point average of at least 2.0.
2. A cumulative grade point average of at least 2.0 in required ORIE courses.
3. At least C- in all Operations Research courses, and by the end of the sixth semester, a grade of at least C- in ENGRD 2110.
4. Satisfactory progress - a minimum of 12 credit hours per semester.
5. No failures or incompletes.

Students who fail to achieve good standing status may be warned, suspended for one or more terms, or denied permission to re-register in the major. The specific action in each case will be based upon the pertinent circumstances as well as the student's previous record.

Decisions regarding academic matters are made by the Academic Standards Committee of the School of OR&IE. Each student's record is reviewed at the end of each semester upon receipt by the School of semester grades. In cases for which some form of academic action is necessary, students may request the opportunity to appear personally before the committee.

### **Dean's List Certificate and Graduating with Distinction**

Dean's List Certificates are issued each semester to students excelling in their studies. The requirements for this honor are:

1. A semester average of 3.5 or higher (not rounded off).
2. 12 letter grade credits (courses graded S/U do not contribute to the 12 credit minimum).
3. No "F"s, "U"s, or incompletes (even in physical education).

Students may earn Dean's List status retroactively if they meet these criteria after making up all incompletes in a semester.

### **Requirements for Graduating with Distinction.**

Cum Laude requires a GPA  $\geq 3.50$  either overall or for each of the last four semesters. Magna Cum Laude requires a GPA  $\geq 3.75$  based on all credits taken at Cornell. Summa Cum Laude requires a GPA  $\geq 4.00$  based on all credits taken at Cornell. See "Courses of Study" for detailed information. Dean's List and Distinction are determined by the Engineering Registrar's Office in 158 Olin Hall.

## **Transfers**

Applications to transfer from other majors in the College of Engineering are considered by the Academic Standards Committee on a case-by-case basis. In no event will a student be considered unless:

- 1 the student has completed ENGRD 2700 with a grade of "C" or better  
AND
- 2 the student has a combined GPA of 2.0 or higher over all mathematics, computer science (including ENGRD 1110, 2110), and Operations Research and Information Engineering courses (including ENGRD 2700) taken so far.

A student contemplating transfer into OR&E should make an appointment with the Associate Director as early as possible. The student will need to complete a Change of Major form available in the Engineering Advising Office in 167 Olin Hall.

Applications to transfer from outside the College of Engineering and Cornell University are handled by the Office of Undergraduate Admissions, Hollister Hall.

## **Course Load**

The minimum course load for a full-time student in the School of Operations Research and Information Engineering is twelve credit hours, **except in the student's final semester**. If a smaller load is carried in any but the final semester, the Registrar will be informed that the student is not full-time. In addition, the Academic Standards Committee may take further academic action before the student's next semester.

## **Exceptions to Curriculum Requirements**

Occasionally a student may perceive a need for an exception to one or more of the curriculum requirements, either a College or School requirement. Such exceptions are considered on a case-by-case basis by the appropriate College or School committee. See the *General Petition Form* shown on page 33.

## **Add/Drop Deadlines**

In line with College policy, a student may freely add and drop courses in the first three weeks of a semester. After the third week, however, the student must petition the Engineering Advising Office to approve any addition and after the seventh week to drop a class. The petition form is available from Cindy Jay in 203 Rhodes Hall. Expectation of a poor or failing grade is NOT sufficient reason for dropping a course.

## **S/U Option**

Students may take one course per semester on an S/U basis after completing one full semester of study at Cornell. Only courses in the humanities, social sciences, and advisor approved electives may be taken as S/U courses. This decision is irrevocable after the first three weeks of the term.

The S/U policy does not apply to courses in physical education and other courses that are not taken to fulfill degree requirements. Students may enroll in one S/U course each semester in which the choice between the letter grade and S/U is an option.

### **Approval for Courses Taken at Other Colleges and Universities**

To receive credit for a course taken elsewhere, the student must obtain the approval of the department representative in charge of the course, or the Associate Director and his/her faculty advisor PRIOR to taking the course. The request should be accompanied by written documentation including the name of the college, a course description, the number of credit hours, and the duration of the course (one quarter, one semester, etc.). Only in exceptional circumstances will approval be granted for technical courses; these must be offered by an accredited school of engineering. See the *Transfer Credit Form* on page 34. This form may be obtained from 203 Rhodes Hall.

Transfer credit will not be granted for ORIE required major courses except for (1) transfer students who took an equivalent course at another institution prior to enrollment at Cornell, and (2) students formally enrolled in Cornell's Study Abroad program.

### **Credit for Foreign Language Ability**

The School is not involved in giving credit for foreign languages. This is handled through the Office of Admissions and Undergraduate Affairs and the appropriate foreign language department. College policy concerning non-course language credit, i.e., credits obtained with no formal enrollment in a class, is as follows:

"Up to 3 credits may be awarded for competency in a foreign (non-English) language as demonstrated by a score of at least 650 on the CEEB test in the language, or by passing the Cornell Advanced Standing Examination (CASE) in the language. AP credit earned through CASE must be earned prior to a student's first matriculation in the College, or as early as possible in the first semester of the student's residence. In no case will credit be awarded for foreign language competency achieved extracurricularly except under the provisions for AP credit stipulated above."

### **College Policy on Extramural Study, Withdrawal, Leaves of Absence**

Residence Requirements: A candidate for an undergraduate degree in engineering shall be required to spend a minimum of four semesters, or the equivalent, in residence (full-time study) at this University, and a minimum of three semesters in residence as a student in a major field of engineering, or in the Independent Major.

Credit Earned Through Extramural Study: No more than 11 credits earned through study in the Extramural Division may be used to satisfy the requirements for the bachelor's degree in engineering.

Study in Absentia: Candidates for the degree may study away from the campus, with the permission of the appropriate faculty authority. Such students must register for Study in Absentia and pay an appropriate fee. For example, students going on Coop assignments are required to register in Absentia for the term that they are away from campus.

Leave of Absence: Students may temporarily suspend study for a period of time by taking a Leave of Absence. A formal petition for Leave of Absence must be filed and written approval must be granted for such a leave to be in effect. Leaves of Absence are normally granted for no more than two years. Credit earned while on Leave of Absence is subject to the limitation placed on extramural credit.

Withdrawal: A student who voluntarily withdraws from the degree program severs all connection with the College and University, and may be re-admitted only on formal application for re-admission.

Students who fail either to register within the first three weeks of a semester, or to receive permission for Study in Absentia or Leave of Absence, may be involuntarily withdrawn by action of the faculty.

### **Student Responsibilities**

Each undergraduate enrolled in the School of Operations Research and Information Engineering is responsible for timely selection, registration (including any changes which may be necessary), and completion of appropriate courses in each of several categories needed to fulfill the curriculum requirements of this School and the College of Engineering. Failure to discharge these responsibilities in a timely manner is likely to result in a delay in graduation and/or incorrect entries on the student's transcript. Each student is encouraged to examine his/her CHECKLIST as frequently as necessary. A student may obtain a copy of his/her checklist from the OR&IE Undergraduate Office in 203 Rhodes Hall.

### **ACADEMIC INTEGRITY**

The School of Operations Research and Information Engineering adheres to the policies and procedures of the University on academic integrity, as stated in the *Policy Notebook for Students, Faculty, and Staff* (February, 2000).

The definition of academic integrity, as it appears in the *Policy Notebook* is as follows:

#### a. General Responsibilities

1. A student assumes responsibility for the content and integrity of the academic work she/he submits, such as papers, examinations, or reports.
2. A student shall be guilty of violating the Code and subject to proceedings under it if he/she:
  - a. Knowingly represents the work of others as his/her own.
  - b. Uses or obtains unauthorized assistance in any academic work.
  - c. Gives fraudulent assistance to another student.
  - d. Fabricates data in support of laboratory or field work.

#### b. Specific Guidelines

The following are the specific rules and regulations in regard to the general responsibilities listed under "a":

1. Examinations. During in-class examinations no student may use, give, or receive any assistance or information not given in the examination or by the proctor. No student may take an examination for another student. Between the time a take-home examination is distributed and the time it is submitted for grading by the student, the student may not consult with any persons other than the course professor and teaching assistants regarding the examination. The student is responsible for understanding the conditions under which the examination will be taken.
2. Course Assignments. Students are permitted to consult with others and receive advice and assistance. The copying of another student's work, computation, diagrams, analyses, laboratory reports, or commentaries is prohibited. It is plagiarism and a violation of this Code for anyone to represent another's published work as his own. If materials are taken from published sources, the student must clearly and completely cite the source of such materials. Work submitted by a student and used by a faculty

member in the determination of grade in a course may not be submitted by that student in a different course.

3. The crucial underpinning of all specific guidelines regarding academic integrity remains that the student's submitted work, examinations, laboratory reports and term project, must be his/her own work and no one else's.

c. Variations

A faculty member may, at his/her discretion, make additions to or revisions of those guidelines in a particular course. It is his/her responsibility to make clear to his/her students and teaching assistants specific regulations concerning academic integrity that apply to work in his/her course.

In the School of Operations Research and Information Engineering, students are expected to exercise reasonable care to prevent their work from being copied or used by others. Students who knowingly facilitate the use of their work by others will be considered guilty of a violation of academic integrity.

The general procedures to be followed in cases of violation of academic integrity are as follows (details are found in the *Policy Notebook*):

1. The faculty member may summon the student to an interview, called a Primary Hearing, but this is not mandatory; the student is entitled to one week notice of the Primary Hearing. At the primary hearing there must be a third party, appointed by the School, present to witness the proceedings. If the faculty member finds the charge supported, he may impose a penalty of a failing grade in all or part of the course. A finding of guilt is to be reported to the student's college.

In the School of Operations Research and Information Engineering, the penalty for violations of academic integrity is automatic failure of the course involved, unless the faculty member determines that there are mitigating circumstances and chooses to impose a lesser penalty. Courses failed because of such violations may not be dropped.

Violations of academic integrity will be reported to the student's college, which will maintain a record, and may recommend a review by the Dean in cases of repeated violations by a student.

2. The case may be heard by the Academic Integrity Hearing Board of the College of Engineering if:

- a. The student wishes to appeal the findings of the primary hearing on one of three grounds: lack of due process, excessively harsh penalty, or contested judgment of the faculty member;

or

- b. The faculty member wishes to impose a harsher penalty than failure of the course;

or

- c. The faculty member wishes to omit the primary hearing;

or

- d. The Dean summons the student because of repeated violations.

The Hearing Board may clear the student, affirm the penalty imposed by the faculty member, or impose a harsher penalty, including recording the violation on the student's transcript, suspension, or expulsion.

## **SPECIAL PROGRAMS**

### **Engineering Co-Op Program**

The Co-Op program is an excellent way to obtain practical experience, and therefore the School encourages participation in it. Each Co-Op student is visited by a faculty member while on work assignment. In addition, Co-Op students are invited to keep in contact with the School while on work assignment by calling or writing with any problems or questions. All sophomores and juniors should note that the OR&IE summer courses which are offered through the Co-Op program (ORIE 3150, 3300, 3500, etc.) are also open to non Co-Op students. Visit the Engineering Co-Op office (Carpenter Hall) for more information.

### **Cornell University's Study Abroad Program**

Opportunities for undergraduate students to spend a semester studying abroad for Cornell credit at selected universities are available. Contact 300 Caldwell Hall for detailed information and an application form.

### **Master of Engineering (OR&IE)**

As a two- or three-semester professional degree program, the ORIE Master of Engineering (MEng) has become highly valued in the marketplace and continues to be an attractive option for well prepared undergraduates in Operations Research, Industrial Engineering, Mathematics, Finance, and many other quantitative disciplines.

The main objectives of the MEng program at Cornell are to advance the breadth and depth of our students' technical knowledge and to provide students with opportunities to synthesize and apply this knowledge in a real-world environment. In ORIE, the technical tools of primary importance are mathematical modeling and the application of quantitative techniques instilled within the fields of optimization, probability, stochastic processes, statistics, and simulation. The areas of application for these tools are virtually limitless, but ORIE students generally apply their knowledge to the design, operation, and improvement of business systems.

The capstone component of the ORIE MEng program is the team-based engineering design project, completed with the guidance of a Cornell faculty advisor. The MEng project is fundamentally and purposefully different from traditional coursework and/or the completion of an individual Masters' thesis. The project is intended to prepare students for the professional arena by engaging them in client-sponsored project work with real data, deadlines, and deliverables. Students are expected to play major roles in all aspects of their projects, including formulating and analyzing the problem, managing the client relationship, monitoring the project timeline and milestones, and delivering the final results.

Early program planning is very important for students contemplating the MEng program. For further information please consult the School's Graduate Professional Program Representative (Ms. Kathy King, [kmk23@cornell.edu](mailto:kmk23@cornell.edu)) or the MEng Program Director (Dr. Kathryn Caggiano, [kec4@cornell.edu](mailto:kec4@cornell.edu)). The application deadline for fall admission to the MEng program is January 15. Apply online at <http://www.gradschool.cornell.edu/index.php?p=102>

### **M.S. and Ph.D. Programs**

In the Ph.D. and M.S. programs the problem areas and techniques of operations research are approached from a highly analytical viewpoint. Theories and techniques from mathematical programming, combinatorics, the theory of games, statistics, stochastic processes (queuing and inventory), scheduling, and simulation are developed and used extensively. Consideration is given to the construction of appropriate mathematical models to represent various real-life operational systems and to the development of techniques for analyzing the performance of these models. Each student pursues a course of study and research emphasizing the use of the mathematical, probabilistic, statistical, and computational sciences. The ultimate goal may range from making a fundamental contribution to the techniques of operations research to applying such techniques to problems in diverse fields. Those students contemplating M.S./Ph.D. study in operations research, either at Cornell, or elsewhere, should use their electives to obtain a strong mathematical background. Therefore, the optimization and applied probability and statistics sequences are recommended, as well as further work in mathematics (Math 4110, 4120, 4310, and 4320) and computer science.

Well-qualified applicants to the M.S./Ph.D. program may receive financial aid in the form of fellowships and teaching and research assistantships. Further information may be obtained from the Associate Director for Graduate Programs.

### **Six-Year Joint Master of Engineering/MBA Program**

The joint Master of Engineering/MBA program allows undergraduates in the College of Engineering to receive a Bachelor's degree and two professional Master's degrees in six years: the M.Eng. (OR&IE) degree after the fifth year, and the MBA degree after the sixth year. This program is attractive for several reasons. First, the solid engineering background combined with a business background makes graduates of this program some of the most highly recruited students in the Johnson Graduate School of Management. Second, each year, eight students in this program are chosen as Knight Scholars and receive an award to support each of their two years of graduate study. These awards are named for Mr. Lester B. Knight (ME '29), who has generously provided funding for them. Third, since the MBA is normally a two-year program by itself, the combined program shortens the time needed to complete both degrees by one year.

Planning for this program takes place during the first weeks of the Spring term of the junior year and students must submit a formal application to the Johnson School.

### **Five-Year Program**

This program allows a student to obtain a baccalaureate degree after four years and a professional graduate management degree (MBA, MPA, or MPS) after a fifth year of study with the Johnson Graduate School of Management.

Careful planning is required for a successful integration of the work toward the two degrees. Students accepted for the 5 year program will need to have fulfilled almost all of their undergraduate degree requirements by the end of the junior year. In this way it will be possible to complete most of the first year core requirements of the Master's degree during the last year of undergraduate studies.

General preparatory courses such as computer science, probability and statistics, calculus, and accounting are taken as part of your required curriculum. Beyond these general preparatory areas the student should pursue as broad an educational background of elective courses at the undergraduate level as his or her curriculum will allow. The Economics 3010, 3020 (or 1110, 1120, and 3130) sequence should be included in this group. Courses in the humanities and social sciences also enhance the student's preparation for graduate management education.

A small number of Cornell undergraduates, from all colleges in the University, are accepted for the 5 year program each year. The competition for these places is, therefore, extremely keen. Although there are no minimums of grades or test scores, those Cornell students accepted for these programs generally represent a high standard of overall academic achievement. The Admissions Committee

considers undergraduate academic performance, scores on the GMAT, work experience, extracurricular activities, and letters of evaluation in reaching admissions decisions. A formal application may be obtained through the Johnson School.

It should be noted that rejection for admission to the 5 year program does not preclude admission as a regular candidate the following year. If a student is rejected and wishes to reapply for regular admission the following year, all that need be done is an update of the same application.

The Graduate Management Admission Test (GMAT) must be taken by January of the student's junior year in order to be considered for admission for the following Fall semester.

As part of the admissions procedures, applicants should request that an official Cornell transcript be sent directly from the Registrar's Office in Day Hall following completion of their first semester of the junior year.

Interviews are required for all 5 year program applicants. Candidates should make an appointment for an interview after their application has been submitted. Interview appointments should be arranged at least two weeks in advance, and may be scheduled by calling the JGSM Admissions Office at 255-4526.

Admissions decisions are usually made by late May, and these decisions are communicated by letter prior to the end of the Spring semester.

During the senior year, students in the 5 year program officially register with their undergraduate college and pay the applicable undergraduate tuition. During the fifth year, these students register with JGSM and pay tuition at the same rate as first year students in the business school. A very limited amount of financial aid is available for students during their fifth year of study.

## **MISCELLANEOUS**

### **Career Services Office**

The Career Services Office (Carpenter Hall) has an extensive recruiting program, and 300-400 interviewing companies come to campus each year. Seniors should visit this office during the first week of classes. Seniors will need to make recruiting preparations early since interview sign-ups usually begin during the second or third week of the semester. Visit this office often and take advantage of the extensive opportunities it offers. The University Placement Office has a series of special lectures on how to approach the job market, preparation of resumes, how to take interviews, etc. Announcements of these lectures and meetings will be posted in Carpenter Hall. The Career Services Office publishes a very informative recruiting handbook that explains the Engineering School Recruiting Process in detail.

### **Cornell Student Chapter of the Institute for Operations Research and the Management Sciences (INFORMS)**

The Student Chapter of INFORMS serves the purpose of introducing students to the professional aspects of the field, career opportunities, and a variety of social activities. There may be guest speakers from industry, plant tours, seminars, intramural teams, a banquet with the parent chapter each spring, a senior banquet and lunches with ORIE faculty. Members benefit by the opportunity to meet other students and professional engineers and to learn about the latest developments and opportunities in OR&IE.

As a service to the students and the School, INFORMS presents awards for Outstanding Professor and Teaching Assistant, constructs a composite of each graduating class, and creates displays for the showcase. The peer advisory program gives students the opportunity to consult with seniors and graduate students concerning course selections and career planning.

### **The Society of Women Engineers**

The Society of Women Engineers is a professional, non-profit, educational service organization of graduate engineers and men and women with equivalent engineering experience. The objective of the Society is to encourage, assist, and inform young women, parents and counselors of the opportunities open to women in engineering. Hosting the Northeast Regional Conference and conducting a conference for high school students are a few of the major activities undertaken by the very active Cornell Chapter of SWE. The SWE mailing address is 162 Olin Hall.

### **Seminars**

In addition to the speakers sponsored by INFORMS, two regular seminar programs are organized by the School. There is a weekly seminar held on Tuesdays from 4:15-5:30 on research topics, and a seminar held on Wednesday from 4:30-5:30 on recent applications. Although the seminars are intended for faculty and graduate students, undergraduates are welcome. Notices are posted on the bulletin board near the student mailboxes.

NOTE: ORIE 9000, 9100, 9101 or 9110 MAY NOT be used to fill the ORIE Elective requirement.

### **Annual Prize for Outstanding Senior**

Each year the graduating senior with the highest grade point average is awarded the Byron W. Saunders Award in Operations Research and Information Engineering. There is a cash prize associated with the award.

### **Suggestions Requested**

This handbook was written to provide information to students who are currently enrolled in, or who are planning to enroll in the School of Operations Research and Information Engineering. Your suggestions would be appreciated. Please leave your comments in the School Office.





## ORE CHECKLIST

Name:

Advisor:

Updated:

Email:

Cornell ID:

Overall GPA:

Expected Degree Date:

Term	GPA	Term	GPA	Term	GPA

Engineering Core Courses				
Course	Cr	Sem	Gr	Advising Notes
MATH 1910	4			*Math Requirement: Either Math 2950, 3040 or CS 2800 can be used to satisfy the fourth math requirement. Students NOT taking Math 295 may not enroll in PHYS 2214. Math grades must be at least C-.
MATH 1920	4			
MATH 2930*	4			
MATH 2940	4			
CS1110	4			
CS 1132	1			
PHYS 1112	4			
PHYS 2213	4			
CHEM 2090	4			
PHYS 2214**	4			
**The following courses may be substituted for Phys 2214: Chem 2090, Math 3110, Math 3360, Math 2950 (if not used to meet the math req.), Math 3040 (if not used to meet the math req.) or CS 2800 (if not used to meet the math req.)				
Engr. Distribution Courses (must achieve a C- or above in ENGRD courses to receive cr.)				
Course	Cr	Sem	Gr	Advising Notes
ENGRD 2700	3			Required Distribution course
ENGRD 2111	3			Recommended Distribution course.
ENGR1	3			Intro. to Engineering
Freshman Writing Seminars				
Course	Cr	Sem	Gr	Advising Notes
FWS 1	3			
FWS 2	3			
Liberal Studies Courses				
Course	Cr	Sem	Gr	Advising Notes
Liberal Studies 1				At least 6 courses, 18 cred. min. taken from at least 3 of the following 6 groups: CA, HA, LA, KCM, SBA, Foreign Languages. 2 courses must be 2000 level or above.
Liberal Studies 2				
Liberal Studies 3				
Liberal Studies 4				
Liberal Studies 5				
Liberal Studies 6				
Physical Education				
Course	Cr	Sem	Gr	Advising Notes
PE 1	1			Must pass a swim test to fulfill requirement.
PE 2	1			
Additional Elective Courses - Do Not Count Toward Major				
Course	Cr	Sem	Gr	Advising Notes

ORIE Required Major Courses (must achieve a C- or above to receive credit)				
Course	Cr	Sem	Gr	Advising Notes
ORIE 3120	4			Industrial Data and Systems Analysis
ORIE 3150	4			Financial and Managerial Accounting
ORIE 3300	4			Optimization I
ORIE 3310	4			Optimization II
ORIE 3500	4			Engineering Probability & Statistics II
ORIE 3510	4			Introductory Engr. Stochastic Processes
ORIE 4580	4			Simulation Modeling and Analysis
Organizational Behavior	3			Behavioral Science course (from approved list)
ORIE Electives				
Course	Cr	Sem	Gr	Advising Notes
ORIE				At least 9 credits of ORIE courses not as a required major course. ORIE 415, 9000, 9100, 9101& 9110 do not fulfill requirement
ORIE				
ORIE				
Major Approved Electives				
Course	Cr	Sem	Gr	Advising Notes
Elective non ORIE				At least 9 cr. of technical courses numbered 2000 or above from the approved list. At least 3 cr. must be from Category A (Engineering, Science, & Math). 3 cr. may be from Category B (Engr. Design, Finance, Economic Analysis)
Elective				
Elective				
Advisor Approved Electives				
Course	Cr	Sem	Gr	Advising Notes
Elective				At least 6 credits. Any course agreed by student & advisor relevant to the student's educational objectives.
Elective				
Technical Writing Requirement: _____				Check when requirement is fulfilled

125 minimum required credits.

ORE Honors Program - 9 cr (Optional)				
Course	Cr	Sem	Gr	Advising Notes
ORIE 5XXX				9 credits beyond the minimum with at least 6 hours from category (1): (1) advanced course in ORIE at 5000 level or above; (2) Significant research project - ORIE 4999; (3) Significant teaching experience - ORIE 4990.
ORIE				
ORIE				
ORIE 4999				
ORIE 4990				

This document is intended to be a worksheet for students and advisors. It is not a transcript and is subject to change.

## **Appendix II: Courses Offered in OR&IE**

### **ENGRI 1101 Engineering Applications of Operations Research**

Fall, spring. 3 credits. Enrollment not open to OR&E upper-class majors.

An introduction to the problems and methods of Operations Research and Industrial Engineering focusing on problem areas (including inventory, network design, and resource allocation), the situations in which these problems arise, and several standard solution techniques. In the computational laboratory, students encounter problem simulations and use some standard commercial software packages.

### **ENGRD 2700 Basic Engineering Probability and Statistics**

Fall, spring, summer. 3 credits. Pre- or corequisite: MATH 2940.

This course gives students a working knowledge of basic probability and statistics and their application to engineering. Computer analysis of data and simulation are included. Topics include random variables, probability distributions, expectation, estimation, testing, experimental design, quality control, and regression.

### **ORIE 3120 Industrial Data and Systems Analysis**

Spring. 4 credits. Prerequisite: ENGRD 2700.

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

### **ORIE 3150 Financial and Managerial Accounting**

Fall. 4 credits.

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

### **ORIE 3300 Optimization I**

Fall. 4 credits. Prerequisite: grade of C- or better in MATH 2210 or 2940.

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

### **ORIE 3310 Optimization II**

Spring. 4 credits. Prerequisite: grade of C- or better in ORIE 3300 or permission of instructor.

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

### **ORIE 3500 Engineering Probability and Statistics II**

Fall. 4 credits. Prerequisite: grade of C- or better in ENGRD 2700 or equivalent.

This second course in probability and statistics provides a rigorous foundation in theory combined with the methods for modeling, analyzing, and controlling randomness in engineering problems. Probabilistic ideas are used to construct models for engineering problems, and statistical methods are used to test and estimate parameters for these models. Specific topics include: random variables, probability distributions, density functions, expectation and variance, multidimensional random variables, and important distributions including normal, Poisson, exponential, hypothesis testing, confidence intervals, and point estimation using maximum likelihood and the method of moments.

**ORIE 3510 Introductory Engineering Stochastic Processes I**

Spring. 4 credits. Prerequisite: grade of C- or better in ORIE 3500 or equivalent.

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

**ORIE 3800 Information System and Analysis**

Spring. 4 credits.

Presents a systematic and hierarchical approach to the development of information systems, featuring business case justification, requirements analysis, use case analysis, functional analysis, structural design, object-oriented modeling, database design, verification and validation, and project schedule estimation. Graphical tools of analysis (e.g., the Unified Modeling Language) are emphasized.

Examples are drawn from business and industrial processes. An integrative design project resulting in detailed information system design specification (but not necessarily implementation) is required.

**ORIE 4150 Economic Analysis of Engineering Systems**

Spring. 4 credits. Prerequisites: ORIE 3300 and ORIE 3150.

Course topics include: financial planning, including cash-flow analysis and inventory flow models; engineering economic analysis, including discounted cash flows and taxation effects; application of optimization techniques, as in equipment replacement or capacity expansion models, and issues in designing manufacturing systems. Includes a student group project.

**ORIE 4152 Entrepreneurship For Engineers (also ENGRG 4610)**

Fall. 3 credits. Enrollment open to upper class engineers; others with permission of instructor.

This course develops skills necessary to identify, evaluate, and begin new business ventures. Topics include intellectual property, competition, strategy, business plans, technology forecasting, finance and accounting, and sources of capital. A rigorous, quantitative approach is stressed throughout, and students create financial documents and plans, analyze human resource models, and work with sophisticated valuation methods, complicated equity structures, and legal and business documents. As such, this course represents the "red meat" of entrepreneurship, and the soft skills are left for other courses. Coursework consists of discussions, assignments, and the preparation and presentation of a complete business plan.

**ORIE 4154 Revenue Management**

Fall, 3 credits, Prerequisites: ORIE 3300 and 3500, or permission of instructor

Covers revenue management concepts, models used in practice, and possible extensions; forecasting techniques, including time series methods, booking curves, and customer preference models; demand uncensoring; overbooking and optimization with emphasis on stochastic models of demand, benefit measurement; computational and technological issues; bid-prices and dynamic programming techniques; examples from the airlines, hotels, car-rental agencies, restaurants and other industries.

**ORIE 4300 Optimization Modeling**

Spring. 3 credits. Prerequisites: a grade of at least B- in ORIE 3310/5310.

Emphasis is on modeling complicated decision problems as linear programs, integer programs, or highly-structured nonlinear programs. Besides modeling, students are required to assimilate articles from the professional literature and to master relevant software.

**ORIE 4320 Nonlinear Optimization**

Fall. 4 credits. Prerequisite: ORIE 3300.

This course is an introduction to the practical and theoretical aspects of nonlinear optimization.

Attention is given to the computational efficiency of algorithms and the application of nonlinear techniques to linear programming; e.g., interior-point methods. Methods of numerical linear algebra are introduced as needed.

**ORIE 4330 Discrete Models**

Fall. 4 credits. Prerequisites: ORIE 3300 and CS 2110, or permission of instructor. Course covers basic concepts of graphs, networks, and discrete optimization. Fundamental models and applications, and algorithmic techniques for their analysis. Specific optimization models studied include flows in networks, the traveling salesman problem, and network design.

**ORIE 4350 Introduction to Game Theory**

Fall. 4 credits. Prerequisites: ORIE 3300  
A broad survey of the mathematical theory of games, including such topics as: two-person matrix and bimatrix games; cooperative and noncooperative n-person games; and games in extensive, normal, and characteristic function form. Economic market games. Applications to weighted voting and cost allocation.

**ORIE 4360 A Mathematical Examination of Fair Representation**

Spring. 3 credits. Prerequisites: MATH 2210 or 2940 or permission of instructor. This course covers the mathematical aspects of the political problem of fair apportionment. The most recognizable form (in the United States) of apportionment is the determination of the number of seats in the U.S. House of Representatives awarded to each state. The constitution indicates that the apportionment should reflect the relative populations, but it does not prescribe a specific method. At first blush it appears that there is a straightforward approach that must lead to a fair, or fairest apportionment, for any fixed house size and known populations. However, indivisibility of seats leads us to interesting mathematical questions and a long, rich, and fractious political history involving many famous figures. The basic ideas extend beyond apportionment of legislatures (in both federal systems and proportional representation systems) to some other realms where indivisible resources are to be allocated among competing constituencies.

**ORIE 4370 Computational Optimization**

Spring, 4 credits. Prerequisites: ORIE 3300, Corequisite: ORIE 3310  
Covers computational implementation and related methodology for solving large-scale, real-world integer programming problems. Primary emphasis is on branch-and cut technology: pre-processing, cut strength, exact and heuristic separation techniques, branching strategies, multi-processing. Hands-on experience with state-of-the-art software for various discrete optimization models, including the traveling salesman, capacitated vehicle routing, and air crew scheduling models, experimentation with massively parallel computational implementation on the IBM BlueGene computer for the largest feasible subsystem problem.

**ORIE 4520 Introductory Engineering Stochastic Processes II**

Spring. 4 credits. Prerequisite: ORIE 3510 or equivalent.  
Course topics include: stationary processes, martingales, random walks, and gambler's ruin problems, processes with stationary independent increments, Brownian motion and other cases, branching processes, renewal and Markov-renewal processes, reliability theory, Markov decision processes, optimal stopping, statistical inference from stochastic models, and stochastic comparison methods for probability models. Applications to population growth, spread of epidemics, and other models.

**ORIE 4540 Extreme Value Analysis with Applications to Finance and Data Communications**

Spring. 3 credits. Prerequisites: open to undergraduate and M.Eng. students who have had a stochastic processes course at the level of ORIE 3510 as well as a prior course in statistics. The course will cover the basic models of extreme events used in hydrology, finance, insurance, environmental science (pollution controls), reliability, risk management. The basic models contain parameters that must be estimated and graphical and analytic estimation methods are discussed. Extreme quantiles and very small exceedence probabilities need to be estimated and usually the part of a distribution tail which is way beyond the range of the data needs to be considered. This leads to discussion of estimation needed for VAR (value-at-risk) calculations. The course material intersects the related field of heavy tailed modeling and the implications of heavy tails in insurance and data networks.

**ORIE 4580 Monte Carlo Simulation**

Fall. 2 credits. Weeks 1-7. Prerequisite: ORIE 3500 (may be taken concurrently) and CS/ENGRD 2110.

Introduction to Monte Carlo and discrete-event simulation. Emphasis on tools and techniques needed in practice. Random variate generation, input and output analysis, modeling using a discrete-event simulation package.

**ORIE 4600 Introduction to Financial Engineering**

Fall, 3 credits. Prerequisites: ORIE 3500 and 3510.

This is an introduction to the most important notions and ideas in modern financial engineering, such as arbitrage, pricing, derivatives, options, interest rate models, risk measures, equivalent martingale measures, complete and incomplete markets, etc. Most of the time the course deals with discrete time models. This course can serve as a preparation for a course on continuous time financial models such as OR&IE 568.

**ORIE 4630 Operations Research Tools For Financial Engineering.**

Spring. 3 credits. Prerequisites: engineering math through MATH 2940 and ORIE 2700 and 3500.

This course is an introduction to the applications of OR techniques, e.g., probability, statistics, and optimization, to finance and financial engineering. No previous knowledge of finance is required. The course first reviews probability and statistics and then surveys assets returns, ARIMA time series models, portfolio selection, regression, CAPM, option pricing, GARCH models, fixed-income securities, resampling techniques, and behavioral finance. The use of MATLAB, MINITAB, and SAS for computation is also covered.

**ORIE 4710 Applied Linear Statistical Models**

Spring; weeks 1-7. 2 credits. Prerequisite: ENGRD 2700.

Course topics include: multiple linear regression, diagnostics, model selection, inference, one and two factor analysis of variance. Theory and applications both treated. Use of MINITAB stressed.

**ORIE 4711 Experimental Design**

Spring; weeks 8-14 (alternates with 4712). 2 credits. Prerequisite: ORIE 4710.

Course covers: randomization, blocking, sample size determination, factorial designs,  $2^p$  full and fractional factorials, response surfaces, Latin squares, split plots, and Taguchi designs. Engineering applications. Computing in MINITAB or SAS.

**ORIE 4712 Regression**

Spring; weeks 8-14 (alternates with 4711). 2 credits. Prerequisite: ORIE 4710.

Course covers: nonlinear regression, advanced diagnostics for multiple linear regression, collinearity, ridge regression, logistic regression, nonparametric estimation including spline and kernel methods, and regression with correlated errors. Computing in MINITAB or SAS.

**ORIE 4740 Statistical Data Mining**

Fall. 3 credits. Prerequisites: ORIE 3500 and MATH 2940 or equivalent; programming experience. Exposure to multiple linear regression and logistic regression strongly recommended.

This course examines the statistical aspects of data mining, the effective analysis of large data sets. The first half of the course covers the process of building and interpreting statistical models in a variety of settings including multiple regression and logistic regression. The second half connects these ideas to techniques being developed to handle the large data sets that are now routinely encountered in scientific and business applications. Assignments are done using one or more statistical computing packages.

**ORIE 4800 Information Technology**

Fall. 4 credits. Pre- or corequisites: ENGRD 2110, plus either ORIE 3800 or ORIE 3120 or permission of the instructor.

This course covers a variety of fundamental aspects of information technology. Topics may include: information transmission, storage, encryption and security; the value of information and the economics of information goods; databases, the Internet, World Wide Web, wireless and cellular networks, and peer-to-peer networks.

**ORIE 4810 Delivering OR Solutions with Information Technology**

Spring; weeks 8-14. 2 credits. Prerequisites: ORIE 4800.

Study of ways in which information technology is used to deliver operations research methodology in real applications, including decision support systems, embedded operations research techniques, packaged software, web-based techniques, collaborative software, and expert systems. Several real applications are investigated.

**ORIE 4820 Spreadsheet-Based Modeling and Data Analysis**

Spring. 3 credits. Prerequisites: ORIE 3300, ENGRD 2700, or equivalent.

Students develop and implement practical spreadsheet models to analyze data and evaluate decision problems in a hands-on learning environment. Microsoft Excel is heavily used. A wide variety of application areas are covered that incorporate concepts from probability, statistics, and constrained optimization.

**ORIE 4850 Applications of Operations Research and Game Theory to Information Technology**

Spring. 3 credits. Prerequisites: ORIE 3310, ORIE 3510 or permission of instructor.

This course covers a variety of operations research and game theoretic problems arising in Information Technology. Examples include: web searching, network routing and congestion control, online auctions, and trust and reputations in electronic interactions.

**ORIE 5100 Design of Manufacturing Systems**

Fall. 4 credits. Senior OR&E students only. Others by permission of instructor only.

This is a project course in which students, working in teams, design a manufacturing logistics system and conduct capacity, material flow, and cost analysis of their design.

Meetings between project teams and faculty advisers are substituted for some lectures.

Analytical methods for controlling inventories, planning production, and evaluating system performance are presented in lectures.

**ORIE 5120 Production Planning and Scheduling Theory and Practice**

Spring. 4 credits. Corequisite: ORIE 3300, ORIE 3500.

Topics covered include: production planning, including MRP, linear programming, and related concepts. Scheduling and sequencing work in manufacturing systems. Job release strategies and control of work in process inventories. Focus is on setup time as a determinant of plans and schedules.

**ORIE 5122 Inventory Management**

Fall. 3 credits. Prerequisite: ORIE 3310, 3510, or permission of instructor.

The first portion of this course is devoted to the analysis of several deterministic and probabilistic models for the control of single and multiple items at one of many locations. The second portion of this course is presented in an experiential learning format. The focus is on analyzing and designing an integrated production and distribution system for a global company. Applications are stressed throughout.

**ORIE 5126 Principles of Supply Chain Management**

Spring. 2 credits. Prerequisites: ORIE 3310, 3510, or MBA courses in operations management.

Supply chain management focuses on the flow of products, information, and money through organizations that constitute the supply chain. The course provides an overview of the key principles on which an effective supply chain should be constructed. These principles are presented and illustrated through a collection of cases. These cases are taught using an experiential learning model. Additionally, applications of analytic and simulation tools to the design and operation of supply chains are given.

**ORIE 5127 Operations Research Applications in Supply Chain Management**

Spring. 2 credits Prerequisites ORIE 5126 and 5122 is desirable (or should be taken subsequently ) This course focuses on applying mathematical and simulation models to the design and operation of supply chains. The majority of the course focuses on on-line retailing supply chains. Through several cases, students will learn how to design such systems. Additional applications of supply chain principles and operations research techniques will be covered. Application areas include oil company, service parts, and public health supply chains.

**ORIE 5130 Service System Modeling and Design**

Spring. 3 credits. Prerequisites: ORIE 3310 or 5311; ability to program simple algorithms in some appropriate environment (e.g., VisualBasic or MATLAB). Today's economy is dominated by service industries. These systems differ from manufacturing industries in many ways, but primarily in the level of interaction with the customer. Examples of service systems include contact centers (aka call centers), airlines, and hospitals. This course covers various techniques that are useful in the analysis and design of such systems. The class is structured around a number of cases that drive the need for the theory. The emphasis is on modeling and solving the models. Both operational and strategic decisions are covered through appropriate examples.

**ORIE 5140 Applied Systems Engineering**

Fall. 3 credits. Prerequisites: senior or graduate standing in an engineering field; concurrent or recent (past two years) enrollment in a group-based project with a strong system design component that is approved by a course instructor. Fundamental ideas of systems engineering, and their application to design and development of various types of engineered systems. Defining system requirements, creating effective project teams, mathematical tools for system analysis and control, testing and evaluation, economic considerations, and the system life cycle.

**ORIE 5142 Systems Analysis Architecture, Behavior, and Optimization**

Spring. 3 credits. Prerequisite: ORIE 5140. An advanced course in the application of the systems engineering process to the design and operation of complex systems. It focuses on the descriptive and analytical tools of systems engineering including optimization, discrete event simulation, dynamic systems, statistics for design and control, and decision analysis. Case studies are presented in the application of these techniques to space transportation, power, manufacturing, transportation, nuclear power licensing, and military systems.

**ORIE 5340 Heuristic Methods for Optimization**

Fall, 3 or 4 credits. Prerequisites: ENGRD 2110 or 3510, ENGRD 3200 or permission of instructor. Teaches heuristic search methods including simulated annealing, tabu search, genetic algorithms, derandomized evolution strategy, and random walk developed for optimization of combinatorial and continuous variable problems. Application project options include wireless networks, protein folding, job shop scheduling, partial differential equations, satisfiability, or independent projects. Statistical methods are presented for comparing algorithm results. Advantages and disadvantages of heuristic search methods for both serial and parallel computation are discussed in comparison with other optimization algorithms.

**ORIE 5550 Applied Time-Series Analysis**

Fall. 3 credits. Prerequisites: ORIE 3510, or permission of instructor. The first part of this course treats regression methods to model seasonal and nonseasonal data. After that, Box-Jenkins models, which are versatile, widely used, and applicable to nonstationary and seasonal time series, are covered in detail. The various stages of model identification, estimation, diagnostic checking, and forecasting are treated. Analysis of real data is carried out. Assignments require computer work with a time-series package.

**ORIE 5560 Queueing Systems: Theory and Applications**

Fall. 3 credits. Prerequisite: ORIE 3510 or permission of instructor.

Course covers: basic queueing models; delay and loss systems; finite source, finite capacity, balking, reneging; systems in series and in parallel; FCFS versus LCFS; busy period problems; output; design and control problems; priority systems; queueing networks; the product formula; time sharing; server vacations; and applications to equipment maintenance, computer operations and flexible manufacturing systems.

**ORIE 5582 Monte Carlo Methods in Financial Engineering**

Spring. 2 credits. Weeks 8-14. Prerequisite: ORIE 4580

An overview of Monte Carlo methods as they apply in financial engineering. Generating sample paths. Variance reduction (including quasi random number), discretization, and sensitivities. Application to derivative pricing and risk management.

**ORIE 5600 Financial Engineering with Stochastic Calculus I**

Fall. 4 credits. Prerequisite: knowledge of probability at the level of ORIE 3500.

This course is an introduction to continuous-time models of financial engineering and the mathematical tools required to use them, starting with the Black-Scholes model. Driven by the problem of derivative security pricing and hedging in this model, the course develops a practical knowledge of stochastic calculus from an elementary standpoint, covering topics including Brownian motion, martingales, the Ito formula, the Feynman-Kac formula, and Girsanov transformations.

**ORIE 5610 Financial Engineering with Stochastic Calculus II**

Spring. 4 credits. Prerequisite: ORIE 5600.

Building on the foundation established in ORIE 5600, this course presents no-arbitrage theories of complete markets, including models for equities, foreign exchange, and fixed income securities, in relation to the main problems of financial engineering: pricing and hedging of derivative securities, portfolio optimization, and risk management. Other topics include model calibration and incomplete markets.

**ORIE 5620 Credit Risk: Modeling, Valuation and Management**

Spring. 4 credits. Prerequisite: ORIE 5600.

Credit risk refers to losses due to changes in the credit quality of a counter party in a financial contract. This course is an introduction to the modeling and valuation of credit risks. Emphasis is on credit derivative instruments used for hedging credit risks, including credit swaps, spread options, and collateralized debt obligations.

**ORIE 5640 Statistics for Financial Engineering**

Spring. 4 credits. Pre- or corequisite ORIE 3500 and at least one of OIRE 4600, 4630 or 5600.

Time series, GARCH, and stochastic volatility models. Calibration of financial engineering models. Estimation of diffusion models. Data mining in financial engineering. Estimation of risk measures. Bayesian statistics. This course is intended for M.Eng. student in financial engineering and assumes some familiarity with finance and financial engineering. Students not in the M.Eng. program are welcome if they have a suitable background. Students with no background in finance should consider taking ORIE 4600.

**ORIE 5650 Quantitative Methods of Financial Risk Management**

Fall. 3 credits. Prerequisites: ORIE 3500

Market Risk. We start with a historical perspective of market risk measurement including the Markowitz, CAPM and APT models. We will then give a closer description of the value-at-risk approach and give an overview of VaR variants and extensions such as delta-VaR, CVaR etc. This section will require a survey of extreme value methods for determining VaR. We will also survey rapidly other methods for evaluating risk and consider multivariate methods for evaluating portfolios requiring copula tools which have become popular. Time permitting we will survey topics in credit risk: methods for determining default probabilities and company ratings based on financial ratios (logit, probit and discriminant analysis, decision trees etc.), and introduce the main approaches to measuring credit risk which can be roughly divided into structural models and reduced-form models. The course will require completion of several projects. A final project will include a reading and request for evaluation. The course will use the software package Splus. For 80% of the course, R or matlab could be used as a substitute.

**ORIE 5770 Quality Control**

Fall. 3 credits. Prerequisites: ENGRD 2700.

Course covers: concepts and methods for process and acceptance control; control charts for variables and attributes; process capability analysis; acceptance sampling; continuous sampling plans; life tests; and use of experimental design and Taguchi methods for off-line control.

**School of Operations Research & Information Engineering  
Approved Elective Form**

\_\_\_\_\_  
**Name** \_\_\_\_\_  
**Expected Degree Date**

\_\_\_\_\_  
**Email Address** \_\_\_\_\_  
**CU ID Number** \_\_\_\_\_  
**Advisor's Name**

**Course to be applied towards the Approved Elective Requirement (6 credits total):**

Course #	Course Title	Term Taken
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<b>Advisor's Signature</b>	<b>Date</b>
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(Please submit form to ORIE Undergraduate Office in 203 Rhodes.)

**School of Operations Research & Information Engineering  
General Petition Form**

\_\_\_\_\_  
**Last Name**

\_\_\_\_\_  
**First Name**

\_\_\_\_\_  
**Today's Date**

\_\_\_\_\_  
**Expected graduation date**

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**Advisor's Name**

\_\_\_\_\_  
**Email Address**

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**I request permission to:**

\_\_\_\_\_  
**Signature**

\_\_\_\_\_  
**Date**

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**Advisor Statement:**

\_\_\_\_\_  
**Signature**

\_\_\_\_\_  
**Date**

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**Departmental Approval:**

\_\_\_\_\_ **Request Approved**

\_\_\_\_\_ **Request Denied**

**Comments:**

\_\_\_\_\_  
**Associate Director Signature, Date**

Received: ___/___/___	By: _____
Entered: ___/___/___	By: _____

**CORNELL UNIVERSITY COLLEGE OF ENGINEERING**

**TRANSFER CREDIT FORM**

Note: To transfer math courses go to [www.mst.cornell.edu/courses/bsm/transfer.html](http://www.mst.cornell.edu/courses/bsm/transfer.html) or contact the Math Department at 310 Malott Hall.

TO BE COMPLETED BY STUDENT		
(please attach course description of course)		
Student's Name: _____	CUID # (page) _____	Current Phone #: _____
Major, if chosen: _____	Current Address _____	
Faculty Adviser's Name: _____	Adviser's Address: _____	
Did you transfer to Cornell? <input type="checkbox"/> Yes <input type="checkbox"/> No	Have you ever received transfer credits? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Course Title: _____	Course # _____	
Credit Hours _____	Term/Session _____	Year _____
Institution Where Taken: _____		

TO BE COMPLETED BY DEPARTMENT	
Department and Course #: _____	
Cornell Equivalent Course Title: _____	Credit Hours _____
<input type="checkbox"/> I have reviewed the appropriate material related to the courses described above and believe that the two are reasonably equivalent in content, rigor, and level. I recommend that credit be awarded only if a minimum grade of (C) _____ is received.	
<input type="checkbox"/> This department does not evaluate transfer credit and recommends this student's Major/Department judge the suitability of this course for use in the engineering curriculum of:	
Department: _____	Date: _____
Signature: _____	Title: _____

TO BE COMPLETED BY FACULTY ADVISOR	
Transfer credit should be assigned to the curriculum area category of _____	
Adviser's Signature: _____	Date: _____

COLLEGE ACTION TO BE COMPLETED BY ENGINEERING ADVISING OFFICE	
<input type="checkbox"/> Refer to student's department for decision	<input type="checkbox"/> Approve _____ credits in Distribution Area assigned above
<input type="checkbox"/> Cannot be approved for credit	<input type="checkbox"/> Approve _____ credits in _____ area only
Signature _____	Date _____

RETURN FULLY COMPLETED FORM WITH COPY OF COURSE DESCRIPTION TO:  
ENGINEERING ADVISING, 167 OLIN HALL, CORNELL UNIVERSITY