

**INDUSTRIAL AND SYSTEMS
ENGINEERING
UNDERGRADUATE STUDENT
HANDBOOK
2009-10**



VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Grado Department of Industrial and Systems Engineering

THE GRADO DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING
UNDERGRADUATE STUDENT HANDBOOK

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Dr. Eileen M. Van Aken, Chair
Joyce Vest, ISE Academic Advisor
3-4 ISE faculty members
ISE Student representative**

* The UCC was established to consider all undergraduate curricular matters and any issues that pertain to the ISE Undergraduate Program. Please see your Academic Advisor for questions pertaining to the UCC or for assistance with petitions for course substitutions.

** The student representative is determined each year based upon self- and faculty-nomination.

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I. INTRODUCTION TO ISE UNDERGRADUATE PROGRAM

This ISE Undergraduate Student Handbook, along with the **Undergraduate Catalog** and the **Timetable of Classes** (which are both online), provides supplemental information about the ISE Undergraduate Program including curriculum requirements, working with the ISE Academic Advisor, etc. It is intended to assist ISE undergraduate students in successfully completing requirements for the BSISE degree. It is not meant to supersede directives in the **Undergraduate Catalog**, statements from the Office of the Academic Dean of Engineering, or information from the University Registrar.

The ISE Academic Advisor provides advice and guidance to students on matters of academic, career, and professional development. It is the student's responsibility to ensure that they correctly complete the courses that meet the requirements for graduation. For more information on student and advisor responsibilities, see Appendix J. You may schedule advising appointments by calling (540) 231-6388 or emailing vestjs@vt.edu.

Mission of the ISE Department and Undergraduate Program

The mission of the ISE Department and of the ISE Undergraduate Program are shown below:

The ISE Department at Virginia Tech advances the discipline and imparts knowledge to students, peers and practitioners. In an environment that fosters leadership, achievement, and diversity, we:

- 1) *Prepare undergraduate and graduate students for life-long success and leadership in the profession, in industry, and in higher education;*
- 2) *Conduct and disseminate research that promotes the economic prosperity and well-being of Virginia and the nation; and*
- 3) *Provide valuable services to industry, society, and the ISE profession.*

The mission of the ISE Undergraduate Program is to prepare industrial and systems engineering students to create value for organizations, the profession, and society. We achieve this mission by recruiting, retaining, and educating high quality and diverse students and by creating a rigorous and collegial environment enabling students to learn industrial engineering methods and tools, built upon a foundation of mathematical, physical, and engineering sciences, and to apply them in any global organizational setting. Students are able to achieve academic and professional success through opportunities to participate in various educational experiences, to develop capabilities as future leaders, and to embark on a lifelong journey of professional development and learning.

The Industrial and Systems Engineering program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

ISE Program Educational Objectives and Program Outcomes

The ISE faculty have defined the following Program Educational Objectives and Program Outcomes that support our UG Program mission. PEOs are statements that describe the expected accomplishments of ISE graduates within 3-5 years after graduation. Program Outcomes are statements that describe what students are expected to know and be able to do at the time of graduation. Significant input from students, ISE Advisory Board members, and the faculty are used in developing and revising our PEOs.

Program Educational Objectives: Within 3-5 years of graduation, ISE alumni will have:

1. Created value by applying the appropriate industrial engineering tools to design/redesign integrated systems/processes, solve problems, and improve results.

2. Provided formal and informal leadership to their respective organization.
3. Stayed current by pursuing professional development through graduate study, professional certification, and continuing education.
4. Communicated effectively using written, oral, and visual media adapted to different audiences and stakeholders.
5. Worked effectively in cross-functional team environments comprised of members with varying organizational backgrounds, positions, and geographic locations.
6. Served the profession, community, and society.

Program Outcomes: At the time of graduation, ISE students will have the:

1. Ability to apply computational and industrial engineering tools and techniques encompassing manufacturing systems, operations research, human factors and ergonomics, and management systems engineering.
2. Ability to apply knowledge of mathematics, statistics, physical and social sciences, and engineering to IE problems.
3. Ability to identify, formulate, and solve structured and unstructured IE problems.
4. Ability to model, analyze, and evaluate work systems and processes, using appropriate experimental design, measurement tools/techniques, and data.
5. Ability to generate and evaluate alternatives to design an integrated work system or process to meet requirements through a systems perspective.
6. Ability to evaluate the impact of IE solutions in the broader context of the organization and society, with an appreciation of different cultures and perspectives.
7. Knowledge of the role of industrial engineers in contemporary issues.
8. Ability to communicate effectively to a variety of audiences and using written, oral, and visual media.
9. Understanding of professionalism, good citizenship, and ethical behavior.
10. Ability to work collaboratively in multi-disciplinary teams.
11. Understanding of the need for continued professional development and ability to engage in life-long learning.

To support the ISE Undergraduate Program, the ISE Undergraduate Program Committee (comprised of ISE faculty, the Academic Advisor, and an undergraduate student representative) is established to fulfill the following mission:

The mission of the ISE UPC is to manage the ISE Undergraduate Program by overseeing the recruitment and retention of students, monitoring and improving the BSISE curriculum, addressing individual student appeals, and serving as an advocate for the Undergraduate Program in Departmental planning and decision making.

Advising in ISE

The ISE Department has an Academic Advisor who serves as a resource for all students. Students with interests or questions in specific technical areas are referred to the appropriate faculty in that research area. All faculty in ISE have schedule cards posted on their office doors. For assistance in scheduling an appointment with a faculty member or with Dr. Van Aken, please see the Academic Advisor or the receptionist in 250 Durham Hall.

The Academic Advisor is the primary contact for all students regarding questions about University and departmental policies and procedures, the ISE curriculum, program of study planning, registration procedures, course loads, course substitutions, prerequisite rules, transfer credit, procedures for transferring into or out of ISE, and other related matters. When appropriate, the Academic Advisor will refer students to other resources on campus, such as the Thomas E. Cook Counseling Center or Schiffert Health Center.

The Career Services Co-op Advisor assists students with the administrative details of the Cooperative Education Program. The Undergraduate Program Director will resolve questions of a unique nature, for example, discussions concerning a particular class or the procedures in the class. If you are unsure whom to see about a particular question or concern, please see Appendix C.

Helpful Hints

Students should keep this handbook as a permanent reference, and should obtain an updated copy at the start of each academic year. Each Fall Semester when you return to campus, check the Student Advising Center waiting room in Durham 239 for copies of the relevant Checksheet for your graduation year and associated approved electives lists as well as any other additional handouts that might be relevant to you. The most recently approved Checksheet is the 2010 Checksheet for students graduating in the 2010 calendar year. Students graduating in 2011 should also use the 2010 Checksheet (in other words, the requirements for graduation did not change compared to the 2010 Checksheet).

At the end of each semester, file a copy of your grade report after recording your grades on a curriculum Checksheet for your class graduation date (e.g., “Class of 2009,” “Class of 2010,” etc.). Calculate your ISE (in-major) GPA or see your Academic Advisor for assistance.

Take your updated Checksheet with you when you meet with your Academic Advisor. Also, make sure you have applied for your degree on Hokie Spa and checked your DARS (Degree Auditing Report) before or during your junior year.

When you register, be sure that you use the appropriate Checksheet and the lists of approved current electives to guide you in your selection of courses.

Check prerequisites for courses, especially if you are taking courses out of sequence or in another department. Students are responsible for ensuring they have the proper prerequisites before registering for a course. The ISE Department checks prerequisites each semester – students not meeting prerequisite requirements for a class will be dropped.

Courses that you have failed, ISE courses in which you received less than a C- and that are prerequisites for other ISE classes (see Appendix F), and courses in which you are behind should take precedence in scheduling. Discuss D's and F's as soon as possible with your Academic Advisor.

The maximum course load is 19 credit hours per semester. To schedule an overload, you must have Senior standing, a 2.0 or better GPA, and approval from the Dean's Office. If you make less than 2.0 for any semester, you should reduce your course load for the next term.

Regularly check the ISE departmental bulletin board, located on the second floor of Durham Hall, for notices concerning academic policies and procedures, course offerings, Thomas E. Cook Counseling Center and Career Services seminars, information on summer and permanent job opportunities, etc.

II. ACADEMIC POLICIES AND PROCEDURES

The following discussion on policies and procedures is not meant to be completely exhaustive. Please refer to the **Undergraduate Catalog** for further information on these policies and procedures.

Academic Eligibility Policy

All students must maintain a cumulative GPA of 2.0. Those earning less than a 2.0 will be placed on probation until the GPA has reached 2.0. Academic Performance is reviewed in the fall and spring. A student placed on academic probation at the end of the academic year may enroll in the summer or fall term

(but not both) to bring up his/her grades. A student who does not raise his/her GPA to the minimum that was required is not eligible for readmission until the following summer session. For all programs except Honors, the minimum GPA for graduation is 2.0 for all courses taken, including those in your major.

Evaluation and Examination Policies

Evaluation — The instructor is solely responsible for evaluating a student's performance and assigning grades. Grades are based on assigned activities rather than on class attendance per se. However, the faculty have the option of checking and using attendance as part of the grading criteria. Faculty members are expected to prepare, appropriate to the level of each course, a statement (syllabus) outlining the course objectives, topics to be covered, and method of grading. Normally, such course objectives should be substantially the same for different sections of courses. A copy of the syllabus should be made available to students by the first day of class. Justifiable modification of the syllabus may result from classroom experience during the course, but the Department Head and the enrolled students are to be informed if changes are made.

Final Examination Schedule — An examination schedule is available at www.registrar.vt.edu and through the Timetable each academic semester. Examinations are required at the end of every course unless other methods of evaluation are approved by the Department Head and by the Dean. Students are entitled to review their graded examination papers. Failure to take an examination without pre-approval yields a zero grade for the examination. The grade will then be weighted as specified in the course statement on grading criteria. Examination periods for one-credit courses and laboratory courses are scheduled during the last regular class period; for all other courses, follow the examination schedule provided at www.registrar.vt.edu.

Rescheduling Final Examinations — Students with conflicting examinations or more than three (3) examinations within 24 hours may reschedule an exam by arrangement with the instructor and permission of the student's Dean. See www.registrar.vt.edu for deadline to schedule an exam change.

Students unable to take an examination because of illness or other circumstances beyond their control may reschedule the examination by obtaining permission from both their Dean and Schiffert Health Center and making arrangements with their instructor. In some cases, a grade of "I" (incomplete) is assigned. An "I" will not affect your grade unless the requirement is not made up before the end of the first subsequent semester of enrollment; i.e., failure to make up the "I" before the end of the next semester in which you are enrolled will result in the "I" grade automatically being changed to an "F."

Tentative Grades for Degree Candidates — Several days before the last day of classes of Spring Semester, the faculty will submit tentative grades for degree candidates to the Registrar. (See www.registrar.vt.edu for the specific date.) Classes continue as scheduled for all students; examinations are required except as noted. After final grades are computed, they will be reported to the University Registrar with the exception of final grades for degree candidates that are lower than the tentative grades reported earlier. These must be reported on a grade change form and delivered to the Registrar within 48 hours after the examination, but not later than 5:00 p.m. on the day before commencement.

Grade Changes — After grades have been submitted to the University Registrar, a grade change is permitted only to correct errors. Grade changes should be made before the end of the student's first subsequent term of enrollment. Approval by the instructor's Department Head and the student's Dean is required before acceptance of a grade change by the University Registrar. Reason(s) for the grade change must be given on the change-of-grade card, which must be signed by the instructor and then turned into 241 Durham Hall.

Reading Day — There will be at least one full day for study between the last day of classes and the first day of the examination period each semester and at least one-half day each summer term.

Credit by Examination — Credit, not to exceed 12 hours, may be allowed by special examination where exceptional command of the subject can be demonstrated in lieu of formal course work. This privilege is intended to recognize informal educational experiences that may be the equivalent of organized class work. It is not available to a student who has audited or enrolled previously in the course, or who has previously attempted credit by examination in the course. Credit by examination may not be used to satisfy the resident requirements for graduation and no grades or quality credits will be assigned. Only undergraduate students currently enrolled in a degree program are eligible for credit by examination. Approval must be obtained from the Department Head and the Dean of the College offering the course, as well as the student's Dean. Please see the current **Undergraduate Catalog** for additional information.

Re-examinations — A re-examination in one course, in which the final grade is C– or below, may be authorized when a student was enrolled in that course during the final term of his or her senior year and when satisfactory performance on the re-examination qualifies the student for graduation. A re-examination request must be made and the exam must be completed by the student as soon as possible after the first examination. Re-examination must be approved by the instructor, the student's Department Head, and the student's Academic Dean. Request forms are available from the Dean's office.

Honor System

The ISE Department operates within the guidelines of the University's Honor System. Any violations of classroom, departmental, or university academic policy are dealt with as an Honor System violation. Please understand that posted departmental information, homework solutions, homework returned through centralized mailboxes, and reserved library materials are included under the Honor Code.

ISE Departmental Policy Regarding Term Projects

Students submitting reports in partial fulfillment of the requirements for an ISE course are not permitted to use reports, in whole or in part, which were done to satisfy requirements in another course. Reports must be prepared solely (clerical items excepted) by the student (or group of students, when applicable), with the express purpose of satisfying the requirement of a particular ISE course. Information taken from other sources (including previous reports) must be properly credited. Use of another's report or failure to give credit constitutes a violation of the Honor Code.

Exceptions to this policy may be given by an individual instructor. Students wishing to be exempt from the policy must discuss their intentions thoroughly with each instructor involved and receive written permission.

The Industrial and Systems Engineering curriculum, through instruction in both technical matters and their presentation, is designed to educate students to enter the engineering profession. Written documents constitute a vital part of the engineering profession; therefore, students are expected to submit written documents of professional quality. Reports with numerous spelling, punctuation, or grammatical errors, are unprofessional and evaluated accordingly. Students may request assistance through the Writing Center in the English Department.

Pass/Fail System

The P/F grading option is available to all undergraduate students who have completed a minimum of 30 credit hours and have a cumulative GPA of 2.5 or above. **No required course or course used for the Curriculum for Liberal Education, including Humanities and Social Sciences, may be taken on a P/F basis.** The University policy permits students to take up to 10% of their electives on a P/F basis. No more than two courses per semester may be taken P/F, excluding physical education courses, the Fundamentals of Professional Engineering Review class, and other courses offered on a P/F basis only.

ISE students are allowed to take free electives and the non-technical electives (6 credits) on a P/F basis, if they meet University requirements as stated above. Those students completing the Business Minor must take all required courses with the A/F option.

Once credit is received for a course taken P/F, the course cannot be repeated under the A/F grading system. Any course to be taken under the P/F option should be designated as such upon request for the course. Courses may be changed to P/F until the **drop deadline** and to A/F until the **deadline for resigning without penalty** each semester.

See the Academic Advisor or **Undergraduate Catalog** for clarification or additional information.

Policy Memo 91/Satisfactory Progress

The University requires that students must meet the following minimum criteria to be certified as making satisfactory progress toward a degree:

1. An overall GPA at or above that specified in the Academic Eligibility Schedule at the end of the Spring Semester.
2. Upon having attempted 36 credits (including transfer, advanced placement, advanced standing, and credit by examination), at least 12 semester credits must apply toward meeting the Curriculum for Liberal Education requirements.
3. Upon having attempted 72 hours, students must (a) have passed at least 24 credits which apply to meeting the Curriculum for Liberal Education requirements, (b) be enrolled in a degree granting program, and (c) be certified at the close of the academic year, by the major department, as making satisfactory progress toward a degree, based upon departmental Checksheet requirements.

The most recent ISE Checksheet (the ISE 2010 Checksheet) describes the requirements for satisfactory progress towards the degree. Satisfactory progress toward the BSISE requires that an ISE major must meet the following criteria (refer to http://www.registrar.vt.edu/registration/documents/restricted_program.pdf);

- 1) Completion of all enrollment requirements for General Engineering;
- 2) Credit for MATH 1205, 1206, 1114, 1224; CHEM 1035, 1045; ENGL 1105, 1106; PHYS 2305;
- 3) Min grade of C- or better in ENGE 1024 and ENGE 1104 or 1114;
- 4) Min overall GPA of 2.0 or better;
- 5) In addition, ISE students, after having completed 72 hours (including transfer, advanced placement, advanced standing, and credit by examination), must meet the following criteria:
 - a. Min in-major GPA of 2.0 or better;
 - b. Have completed ENGE 1104 or 1114, ISE 2014, ISE 2204, ISE 2214, MATH 2214, and MATH 2224;
 - c. Be enrolled in 12 or more credits of ISE classes per year;
 - d. Not have taken any ISE or STAT designated course required for the degree more than twice, including attempts ending in course withdrawal;
 - e. Not have repeated more than 3 ISE or STAT designated courses required for the degree, including attempts ending in course withdrawal.

Course Withdrawal Policy

The Course Withdrawal Policy is intended to assist students who find themselves enrolled in courses for which they are insufficiently prepared, or for those who initially enroll in majors that they subsequently change. Presidential Policy 196 allows currently enrolled students to designate a course status of "Course Withdrawn." A maximum of six (6) hours may be dropped beyond the normal six-week drop deadline date during a student's academic career at Virginia Tech subject to the following stipulations:

1. This option may be exercised up through the last regular day of the last FULL week of classes (i.e., the day before Reading Day), prior to a student's scheduled graduation.
2. Students must formally request to drop a course by the last regular day of classes in the semester in which they are enrolled in it.
3. Courses from which a student withdraws under the terms of this policy will appear on their transcript with a "W" grade, but will not count in the GPA hours nor in any GPA calculations. The "W" signifies that this policy was invoked. The reasons for use remain the student's responsibility.
4. A student decision to invoke this policy is irrevocable and unappealable.
5. Withdrawals under this policy may not be employed to reduce or obviate any penalty otherwise accruing to students under the University Honor System.
6. Students may request withdrawal from any course, irrespective of the evaluation earned in it up to the point of their request for withdrawal.
7. Students already enrolled when this policy takes effect who have exercised their option to use the previously existing Freshman Rule shall not be eligible to use this policy.

To exercise this option, interested students should see their Academic Advisor to obtain a course withdrawal form and submit it to their Academic Dean (Hancock 212) for approval.

III. REGISTRATION AND SCHEDULING PROCEDURES

Registration Procedures

Details of registration procedures are not provided in this handbook, as these are specified in the **Timetable of Classes** and/or www.registrar.vt.edu for each semester. However, a few general comments of importance are discussed below.

Force-adds for ISE courses require the signature of the Academic Advisor. Students should turn the form into 241 or 243 Durham Hall for approval. Those who are in the process of transferring into the department need to see the Academic Advisor concerning restricted ISE courses.

Force-Add Form

Force-Add Forms -- Use this form to add a class that cannot be added normally (i.e., the class is full or restricted). ISE force-adds **must be approved by the Academic Advisor** and, in some situations, the Undergraduate Program Director. **ISE is not able to force-add classes from other departments.** These forms can be used only during the period of time designated as Drop/Add at the beginning of each semester. Please see the Academic Advisor regarding the use of this form.

Programs of Study

The ISE Undergraduate Program provides students with a very strong foundation in all four areas of the discipline: human factors engineering and ergonomics, management systems engineering, manufacturing systems engineering, and operations research. However, the department does not currently offer options in any particular area at the undergraduate level.

Graduation Checksheets

Color-coded checksheets for each class are available in 239 Durham Hall:

Class of 2009 = yellow
Class of 2010 and 2011=blue

Students must fulfill the departmental Checksheet requirements according to the calendar year of graduation, i.e., students should fulfill the requirements for the **graduating** class year and not the **entering** class year. Please bring your updated Checksheet, with all grades entered, to advising sessions. **Students planning to graduate in 2011 should follow the 2010 Checksheet.**

Please note that the Checksheet indicates recommended course sequencing, based on prerequisite and corequisite requirements.

At the beginning of the junior year, all students are required to log onto Hokie Spa, apply for a degree and request a Degree Audit Report (DARS) from the University Registrar's Office. A DARS lists all completed and future requirements for graduation. Please see your Academic Advisor for direction on applying for and interpreting the DARS. If you decide to postpone your graduation, you may do that through Hokie Spa as well.

Electives in ISE

Including the University Curriculum for Liberal Education, there are 7 types of electives in the ISE curriculum. An updated list of classes that meet CLE requirements is available online in the Curriculum for Liberal Education Guide. Please note comments under each elective type as follows:

1. **Creativity and Aesthetic Experience (Area 6)**
 - 1 credit hour required. FA 2004 is P/F only and can be taken
2. **Critical Issues in a Global Context (Area 7)**
 - 3 credit hours required. *ISE 4304 Global Issues in Industrial Management* is a required ISE class and meets the Area 7 requirement
3. **Engineering Science Electives (Appendix D)**
 - 6 credit hours required
4. **Humanities/Social Science Electives (Areas 2 and 3)**
 - required of all students in the university

The current policy requires completion of 6 credit hours in Area 2, "Ideas, Cultural Traditions, and Values" and 6 credit hours in Area 3, "Society and Human Behavior." The specific courses in each area are listed on the University web page and in the **University Curriculum for Liberal Education Guide**, distributed to incoming students during orientation and available on line.

The College of Engineering takes considerable care to ensure that its students are exposed to sufficient courses in the humanities and social sciences. The minimum of one-half year (16 credit hours) of humanities and social sciences is satisfied with 4 credit hours from the 6-credit hour required Freshman English sequence and 12 credit hours total in Areas 2 and 3.

All courses taken to fulfill the University Curriculum for Liberal Education must be taken on an A/F (not P/F) basis (with the exception of Area 6, as noted above). The latest issue of the Undergraduate Catalog or the University Curriculum for Liberal Education Guide should be consulted for course descriptions, prerequisite requirements, and restrictions.

5. **ISE Technical Electives (Appendix D).**
 - 6 credit hours minimum. ISE courses are used to fulfill this technical elective requirement.

Any ISE graduate level course may be taken for credit as an ISE Technical Elective if (1) the student is within one semester of graduation, (2) has a 3.0 GPA, and (3) obtains permission of both the Academic Advisor and the instructor.

Students are allowed to take 3 credits of either ISE 4974 (Independent Study) or ISE 4994 (Undergraduate Research) to satisfy 3 credits of ISE Technical Elective. These courses must be arranged on an individual basis with an ISE faculty member, and a request for the approval of such credits should be submitted on the appropriate form to the ISE Advising Center by the deadline specified by the College of Engineering.

Updated lists of ISE Technical Elective offerings are available each semester from the ISE Advising Center. Courses that are offered as 4984 (Special Study) will also be indicated on these lists (see Appendix E). Please watch the bulletin board outside the student lounge and check email from the Department for changes and announcements affecting course offerings. Non-ISE courses **may not** be substituted for ISE Technical Electives.

6. Non-Technical Electives (Appendix D).

- 6 credit hours required. There are several courses listed as approved Non-Technical Electives which are also approved in the Curriculum for Liberal Education Guide (e.g., as Area 3 or Area 7 electives). Any one course can **only be used to satisfy one requirement**.

7. Technical Electives (Appendix D).

- 3 hours required. ISE courses at the 3XXX or 4XXX level may also be used to fulfill this requirement.

When selecting electives, take care not to enroll in courses that duplicate requirements you have already taken or will be required to take in the future. Please refer to the Undergraduate Catalog or see your Academic Advisor for restrictions.

Business Minor

With proper planning, an ISE student may complete the requirements for the Business Minor by purposeful selection of elective courses and by taking 6 additional credit hours above and beyond the BISE requirements. Several classes which fulfill the Business Minor also fulfill departmental and University Curriculum for Liberal Education requirements. Interested students should obtain and complete the application for the Business Minor from the College of Business, located in Pamplin Hall. Appendix H provides a list of courses an ISE student should take to complete the Business Minor with the least amount of additional credits. Those students appropriately completing the program and the courses listed in the appendix will have succeeded in obtaining the minor.

Course Scheduling

ISE required courses are offered in the regularly scheduled semesters indicated on your class Checksheet. In addition, a "trailer" section for a number of courses is often offered during the summer to accommodate co-op/intern students. **At this time, senior level courses are offered only once during the academic year (spring or fall)**. Students should plan to take courses in the semester indicated by the appropriate Checksheet. Summer offerings change from year to year and are usually determined by January and posted by early Spring Semester. Please see your Academic Advisor if you are planning to attend summer sessions.

ISE Technical Electives are usually offered during the semesters indicated on the ISE Technical Elective handout (Appendix E). However, please consult with your Academic Advisor for revisions to this schedule. New courses may be added under the course number ISE 4984 (Special Study). Independent Study and

Undergraduate Research hours may be arranged with faculty; please see the Academic Advisor for the proper paperwork.

The University requires a minimum enrollment of 18 students for undergraduate level courses. If enrollment does not reach this minimum, the course(s) may be canceled. Students should not assume they can get an elective or non-departmental required course during the summer when course enrollments may not meet the minimum requirements. Students who leave two needed courses for the summer, expecting to graduate, take the risk of having the courses conflict if they are outside the ISE Department.

IV. PROFESSIONAL DEVELOPMENT AND STUDENT ORGANIZATIONS

Beginning in the freshman year, students are advised to start thinking about ways in which to develop themselves professionally, not only as engineers, but as individuals preparing for the workplace. ISE students are highly encouraged to take advantage of both work and organizational opportunities, in order to enhance their professional competencies, for example, by becoming involved in extracurricular activities and/or planning work experiences, as a co-op or intern student. This handbook provides some information below on the student professional societies, Cooperative Education Program, and summer internships. Please see the Academic Advisor for further advice of this nature.

Student Organizations

Institute of Industrial Engineers (IIE). The primary professional society in the discipline is IIE, an organization of practicing Industrial Engineers which has, as its general purpose, to enhance the development of the profession. One mechanism used to carry out this objective is the Virginia Tech Student Chapter. The Virginia Tech Student Chapter of IIE is very active and, as a result, has been recognized as the most outstanding student IIE Chapter in the nation a number of times over recent years. Activities in which the chapter is involved include (1) organizing and attending regional and national technical conferences; (2) organizing presentations by speakers from industry and government; (3) participating in community service activities; (4) sponsoring an annual spring departmental picnic and holiday party during the fall semester; (5) sponsoring annual departmental curriculum review sessions; (6) participating in campus-wide functions; and (7) sponsoring social activities to promote student and faculty interaction.

Alpha Pi Mu (APM). Alpha Pi Mu is the national honor society for Industrial Engineering. It is primarily a student organization whose purpose is to recognize and promote scholastic achievement and professional development in Industrial Engineering. There are currently 60 active chapters of the society and its membership has reached 15,000, with approximately 600 new members being initiated each year.

The Virginia Tech Student Chapter has been among the most active chapters in the nation, winning national awards on several occasions. The chapter usually conducts projects in support of the ISE Department, the College of Engineering, and the University.

Initiation into Alpha Pi Mu is by invitation and is restricted to duly registered students pursuing a graduate or undergraduate degree in ISE. At the undergraduate level, consideration is given to juniors in the upper one-fifth and seniors in the upper one-third of their classes who have demonstrated leadership and ethical behavior. Invitation for membership is made subsequent to a chapter election held in the Fall and Spring Semesters of each academic year.

Human Factors and Ergonomics Society (HFES). HFES is an interdisciplinary organization of professional people involved in the human factors field. The society promotes the discovery, exchange, and application of knowledge concerning the relationship of people to their machines and their environment. It furthers the assignment of appropriate roles to humans and machines in systems. It advocates the consideration of operators, maintainers, and users in the design of equipment and facilities. The society

supports the development of working and living environments that are comfortable and safe. It encourages the appropriate education and training of those who conceive, design, develop, manufacture, test, manage, and participate in systems (Human Factors Society Directory and Yearbook, Santa Monica, CA: The Human Factors Society, 1984).

The goal of the student chapter is to promote human factors as an interdisciplinary profession in the University community. The chapter accomplishes this by sponsoring external and internal speakers on wide-ranging human factors concerns. It also serves as a major social outlet for the chapter members. The chapter takes great pride in being one of the most active student chapters in the country.

Institute for Operations Research and the Management Sciences (INFORMS). INFORMS is the international society for the advancement of operations research and the management sciences and is an interdisciplinary society of both applied and theoretical professionals concerned with fields ranging from computer science and mathematics to forestry and mining. The society currently has over 6,000 members, and sponsors many different technical sections.

The Virginia Tech Student Chapter has been established to provide students with better exposure to the field of operations research by facilitating the exchange of ideas between practitioners, theoreticians, and students. It sponsors talks by faculty members and students, both in and outside the ISE Department.

Society of Manufacturing Engineers (SME). SME is an international professional society dedicated to the advancement of manufacturing technology. SME has over 80,000 regular members, and over 7,000 student members at the college level in more than 100 chapters.

The goal of Virginia Tech's SME Student Chapter is to acquaint students with the activities of practicing engineers. To meet this goal, the student chapter organizes plant trips to a wide variety of manufacturing facilities and invites engineers to campus to discuss manufacturing technology problems. In addition, SME student members receive *Manufacturing Engineering*, the monthly national trade journal, are invited to the monthly senior chapter technical meetings, and are eligible to attend SME National and Regional Conferences at a greatly reduced rate.

Please see the Academic Advisor for further information on these and other organizations not discussed in this handbook. Additional contact information is also available through the ISE home page at <http://.ise.vt.edu>

Cooperative Education Program

The Cooperative Education Program is available to all ISE majors who have completed the freshman course requirements and earned at least a 2.0 GPA. It is an alternative educational plan that makes practical experience an integral part of a student's education. Co-op opportunities are plentiful for those students who are geographically flexible, and students may choose from a variety of assignments in industry, government agencies, hospitals, and small businesses. A limited number of international co-op opportunities are also available.

Students are required to complete a minimum of three sessions of co-op experience in order to receive a certificate from the University. Departments have the flexibility of setting their own standard concerning when and where the co-op sessions occur. However, in order to qualify for the "alternative Checksheet" for graduation, at least two of the sessions of co-op experience must come from fall or spring terms.

Summer Internships

The Cooperative Education Program may not be an option for many students because it extends the program of study to five years. However, relevant work experience is invaluable. Even if a student plans to attend

graduate school, relevant work experience in the IE field is very beneficial. Students are advised to build a strong portfolio of academic and professional experiences (reflected in a resume) and to develop a repertoire of interviewing skills in preparation for pursuing internship opportunities. Many summer internship/job announcements come through the ISE Department and are posted to the ISE Undergraduate listserv. Others are available through the Career Services office. Please see the Academic Advisor for further information and assistance with the job search process.

V. ISE COURSES AND FACULTY

ISE Undergraduate Courses

Undergraduate courses offered by the ISE Department are listed below, along with a brief course description, pre-requisite requirements, and typical semester the course is offered (designated by I (Fall), II (Spring), III (Summer I), and IV (Summer 2)).

2014: ENGINEERING ECONOMY

Concepts and techniques of analysis for evaluating the worth of products, systems, structures, and services in relation to their cost. Economic and cost concepts, calculating economic equivalence, comparison of alternatives, replacement economy, economic optimization in design and operations, and after-tax analysis. Pre: ENGE 1024. (3H,2C) I, II, III, IV.

2204: MANUFACTURING PROCESSES

Survey of manufacturing processes, including casting, forming, machining, joining, and nontraditional processes such as laser and electrical discharge machining. Emphasis on process capabilities and limitations and design for manufacturability. Also includes topics in product design, material selection, process planning, and manufacturing automation. Pre: ENGE 1104 or ENGE 1114. (2H,2C) I,II

2214: MANUFACTURING PROCESSES LABORATORY

Laboratory exercises and experimentation in manufacturing processes. Emphasis on metrology, casting and molding, forming, machining, welding and computer-aided manufacturing. Pre: ENGE 1104 or ENGE 1114. (3L,1C) I,II

2404: DETERMINISTIC OPERATIONS RESEARCH

Deterministic operations research modeling concepts; linear programming modeling, assumptions and algorithms, duality and sensitivity analysis with economic interpretation; transportation and assignment problems; convexity issues, optimality conditions for continuous unconstrained and constrained nonlinear optimization problems, numerical optimization methods; and discrete optimization concepts. Co: MATH 2224. (3H,3C) II,III.

2984: SPECIAL STUDY

Variable credit course.

2994: UNDERGRADUATE RESEARCH

Variable credit course.

3004: INDUSTRIAL COST CONTROL

Fundamentals of general and cost accounting practices applied to manufacturing and service organizations. Cost accounting, standard cost determination, cost and budgetary control systems. A grade of C- or better required in prerequisite ISE 2014. Pre: 2014 or ME 2024. (4H,3C) II

3014: WORK MEASUREMENT AND METHODS ENGINEERING

Survey of methods for assessing and improving performance of individuals and groups in organizations. Techniques include various basic industrial engineering tools, work analysis, data acquisition and

application, performance evaluation and appraisal, and work measurement procedures. Pre: (2204 or 2214) (C- or better), STAT 4105 (C- or better). (2H,3L,3C) I,III.

3024: DATA MANAGEMENT FOR INDUSTRIAL ENGINEERS

Investigation of data modeling, storage, acquisition, and utilization in Industrial Engineering via manual and computerized methods. Development of effective spreadsheet applications using Excel. Design and implementation of relational databases via E-R modeling, relational schema, normalization, SQL, and MS Access. Web-based database applications using HTML, JavaScript, and ASP. Interface design and the system development life cycle applied to data management applications. All topics covered within the context of typical Industrial Engineering problems. Pre: 2214 (C- or better), ENGE 2314. Co: 3214. (3H,3C) II, IV

3214: FACILITY PLANNING AND MATERIAL HANDLING

Theory and concepts involved in model formulation for design and analysis of facility plans. Includes facility layout, facility location and material handling system design. Application of quantitative tools and techniques for flow analysis, layout planning, and automated material handling system design.

Pre: 2014 (C- or better), 2404 (C- or better), 3414 (C- or better), ENGE 2344. Co: 3424. (3H,3C) II, IV

3414: PROBABILISTIC OPERATIONS RESEARCH

This course introduces probability models used to investigate the behavior of industrial systems. The major topics include conditioning, elementary counting processes and Markov chains. Emphasis is on the use of these tools to model queues, inventories, process behavior and equipment reliability. Pre: ENGE 2314, MATH 2214 (C- or better), MATH 2224(C- or better), STAT 4105(C- or better). (3H,3C) I,III.

3424: DISCRETE-EVENT COMPUTER SIMULATION

Introduction to the analysis of systems through discrete simulation. Topics include an introduction to systems analysis and modeling, random variable generation, model development and testing, and problem analysis through simulation. Pre: 3414 (C- or better) Co: STAT 4706 (2H,3L,3C) II, IV

3614: INTRODUCTION TO HUMAN FACTORS ENGINEERING

Survey of human factors engineering emphasizing the systems approach to workplace and machine design. Discussion of basic human factors research and design methods, visual processes and design methods, selection of statistical techniques for application to human factors data, visual and auditory processes, display and control design and effects of environmental stressors on humans. Pre: STAT 4105 (C- or better). (2H,3L,3C) I,IV.

3624: INDUSTRIAL ERGONOMICS

Introduction to ergonomics with an emphasis on people at work. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including manual materials handling, cumulative trauma disorders, environmental stresses, safety, and legal issues. Pre: 3014 (C- or better), ESM 2104. (3H,3C) I,II.

4004: THEORY OF ORGANIZATION

A theory of cooperative behavior in formal organizations, including the structure and elements of formal organizations. The executive process and the nature of executive responsibility also are examined. (3H,3C) I, II.

4005-4006: PROJECT MANAGEMENT & SYSTEM DESIGN

The capstone design sequence for ISE majors. Survey of methods, tools and techniques used to plan, communicate, manage and control projects. Students work in teams to develop a proposal for and implement an industrial engineering design project for actual manufacturing or service industry clients. Pre: 3024 (C- or better), 3214 (C- or better), 3424 (C- or better), 3614 (C- or better) for 4005; 4005 (C- or better) for 4006. Co: 4204, 3624 for 4005. 4005: (3H,3C) 4006: (2H,2C)

4015,4016: MANAGEMENT SYSTEMS THEORY, APPLICATIONS, AND DESIGN

Systems approach to management, domains of responsibility, structured and synergistic management tools, management system model, contextual frameworks, information portrayal, automation objectives model, evaluation, shared information processing, information modeling. A management process for definition, measurement, evaluation and control, the organization as an information processor, corporate culture, scoping agreements, schemas and management elements, structured design. (3H,3C)

4204: PRODUCTION PLANNING AND INVENTORY CONTROL

Theory and concepts involved in model formulation for analysis and control of production processes. Systems for planning and controlling production and inventory including material requirements planning (MRP), just-in-time (JIT), and synchronous production systems. I. Pre: 2404 (C- or better), STAT 4706 (C- or better). (3H,3C)

4234: MODELING AND SIMULATION LANGUAGES

Modeling of industrial situations and introduction to the use of simulation languages. Several simulation languages commonly used for industrial engineering applications such as GPSS, SLAM, and SIMAN will be covered. Pre: 3424 (C- or better). (3H,3C)

4244: FUNDAMENTALS OF COMPUTER INTEGRATED MANUFACTURING

Concepts and techniques for modeling, designing, and implementing Computer Integrated Manufacturing (CIM) systems. Emphasis on relational databases and communications networks and their use in modern manufacturing enterprises. Fundamentals and role of Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Process Planning (CAPP) in CIM systems. Pre: (2204 or 2214) (C- or better), 4204 (C- or better). (3H,3C)

4264: INDUSTRIAL AUTOMATION

A survey of the various technologies employed in industrial automation. This includes an emphasis on industrial applications of robotics, machine vision, and programmable controllers, as well as an investigation into problems in the area of CAD/CAM integration. Examination of the components commonly employed in automation systems, their aggregation and related production process design. Laboratory work is required. Pre: (2204 or 2214) (C- or better). (2H,3L,3C)

4304: GLOBAL ISSUES IN INDUSTRIAL MANAGEMENT

Industrial management topics of current interest explored from a global perspective. Current domestic and international challenges resulting from a global marketplace and the proliferation of information and technology. Industrial management and organizational performance, total quality management, business process re-engineering, leadership, organizational change, role of communication and information, and ethics. Examination and comparison across international boundaries. II (3H,3C)

4404: STATISTICAL QUALITY CONTROL

Application of statistical methods and probability models to the monitoring and control of product quality. Techniques for acceptance sampling by variables and attributes are presented. Shewhart control charts for both classes of quality characteristics are examined in depth. The motivation for each method, its theoretical development, and its application are presented. The focus is upon developing an ability to design effective quality control procedures. Pre: 3414 (C- or better), STAT 4105 (C- or better), STAT 4706 (C- or better). (3H,3C) I

4414: INDUSTRIAL QUALITY CONTROL

Implementation of statistical quality control techniques in an industrial setting. Development and analysis of cost models for use in the design of optimal quality control plans. Also included are new techniques, advanced quality control models, and an examination of the role of industrial statistics in the overall product quality assurance function. Pre: 4404 (C- or better). (3H,3C)

4424: LOGISTICS ENGINEERING

Introduction to the key issues in the integrated support of a product or process. Synthesis of topics from earlier studies to provide a cohesive approach to their applications. Logistics engineering provides a survey of product support issues and methods of resolving them within the context of the overall production activity. Pre: 3414 (C- or better). (3H,3C)

4624: WORK PHYSIOLOGY

Anthropometry, skeletal system, biomechanics, sensorimotor control, muscles, respiration, circulation, metabolism, climate. Ergonomic design of task, equipment, and environment. Pre: 3614 (C- or better). (3H,3C)

4644: OCCUPATIONAL SAFETY AND HAZARD CONTROL

Survey of occupational safety. Topics include: history of occupational safety; hazard sources related to humans, environment, and machines; engineering management of hazards. Pre: 3614 (C- or better). (3H,3C)

4654: PRINCIPLES OF INDUSTRIAL HYGIENE

Introduction to the foundations of the field of Industrial Hygiene, that discipline devoted to the anticipation, recognition, measurement, evaluation, and control of occupational health hazards. Includes biological (e.g. microbial agents, allergens), chemical (e.g. solvents, carcinogens, dusts), and physical (e.g. radiation, temperature) hazards. Overview of control of health hazards, such as personal protective equipment, administrative controls, and engineering controls. Will involve lecture and participatory "case-study" activities. Will provide ample opportunity for hands-on use of monitoring equipment, protective equipment and controls testing devices. (3H,3C)

4974: INDEPENDENT STUDY

Variable credit course.

4984: SPECIAL STUDY

Variable credit course.

4994: UNDERGRADUATE RESEARCH

Variable credit course.

Please see the Graduate Catalog for graduate course listings.

NOTE: The ISE Department does **not** permit an undergraduate student to work on an independent study, undergraduate research, or a senior design project while they are simultaneously being compensated by an outside agency for the same work.

ISE Faculty

Agnew, Michael, Ph.D., (from Queen's University, 2008), Assistant Professor. Areas of interest: ergonomics and occupational biomechanics; guidelines and exposure limits; biomechanical modeling; human factors; work physiology; psychophysics; electromyography.

Bish, Doug, Ph.D., (from Virginia Tech, 2006), Assistant Professor. Areas of interest: applied operations research; network models in transportation, logistics, and interdiction; disaster management and public health issues; revenue management; simulation of complex systems.

Bish, Ebru, Ph.D., (from Northwestern University, 1999), Associate Professor. Areas of interest: design and management of business processes that deliver goods and services; analysis of decision-making models integrating strategic and operational perspectives; management and investment decision-making under

uncertainty considering supply- and demand-side flexibility; modeling and analysis of algorithms; and combinatorial optimization.

Casali, John G., Ph.D., (from Virginia Tech, 1982), John Grado Professor. Areas of interest: Human/machine interfacing; vehicular simulation and safety; industrial hearing protection and communications in noise.

Camelio, Jaime. Ph.D. (from University of Michigan, 2002), Assistant Professor. Areas of interest: Assembly systems modeling, analysis, and control; data mining for manufacturing systems; remanufacturing; and micromanufacturing.

Ellis, Kimberly P., Ph.D., (from Georgia Institute of Technology, 1996), Associate Professor. Areas of interest: Design and analysis of manufacturing systems, production planning and control, applied operations research, information and systems design.

Harmon, L. Kenneth, Jr., MBA, (from Wright State University, 1970), Associate Professor; Director, ISE Extended Campus Program; Director, Engineering Administration Program. Areas of interest: Management of technology, performance improvement, and systems engineering; quality assurance engineering (TQM); productivity/profitability improvement; total enterprise assessment; strategic planning and employee involvement techniques.

Koelling, C. Patrick, Ph.D., (from Arizona State University, 1982), Associate Professor; Co-Director ISE Computational Laboratory, Management Systems Engineering Option Coordinator. Areas of interest: Information engineering, data systems, systems integration, applied operations research.

Kleiner, Brian M., Ph.D., (from SUNY at Buffalo, 1990), Professor; Director, Macroergonomics and Group Decisions Systems Lab. Areas of interest: Macroergonomics (work system design); computer augmented work systems; computer supported collaborative work (CSCW); function allocation in automation and job design; human reliability and decision making in quality control.

Lockhart, Thurmon E., Ph.D., (from Texas Tech University, 2000), Associate Professor. Areas of interest: Occupational ergonomics; biomechanics; work physiology; workplace design; human motor control; psychophysics.

Nachlas, Joel A., Ph.D., (from University of Pittsburgh, 1974), Associate Professor. Areas of interest: Quality control and reliability; operations research.

Nussbaum, Maury A., Ph.D., (from The University of Michigan, 1994), Professor. Areas of interest: Models of lumbar back kinetics & kinematics; occupational biomechanics; artificial neural networks; industrial ergonomics and work physiology; occupational safety and health; measurement of human performance and motion; statistics and design of experiments; quality control; statics and solid mechanics.

Pasupathy, Raghu K., Ph.D., (from Purdue University, 2005), Assistant Professor. Areas of interest: Monte Carlo simulation modeling and analysis methods, stochastic root finding/optimization, transportation systems.

Rahmandad, Hazhir., Ph.D., (from M.I.T., 2006), Assistant Professor. Areas of interest: system dynamics and agent-based modeling, product development, organizational learning and strategy, and barriers to learning.

Sarin, Subhash C., Ph.D., (from North Carolina State University, 1978), Paul T. Norton Professor. Areas of interest: Production planning and scheduling; applied mathematical programming; design and mathematical analysis of manufacturing systems.

Sherali, Hanif D., Ph.D., (from Georgia Institute of Technology, 1979), W. Thomas Rice Professor. Areas of interest: Mathematical programming; transportation applications; location theory; linear, integer, nonlinear and nonconvex programming.

Shewchuk, John P., Ph.D., (from Purdue University, 1995), Associate Professor. Areas of interest: Modeling and analysis of manufacturing systems; computer integrated manufacturing, production systems, simulation, scheduling in manufacturing.

Smith-Jackson, Tonya, Ph.D., (from North Carolina State University, 1998), Associate Professor. Areas of interest: Cognitive ergonomics applied to the design of safety information, individual differences in safety and compliance, universal access: user interface design for disadvantaged users, and individual differences in focused attention.

Sturges, Robert H., Ph.D., P.E., (from Carnegie Mellon University, 1985), Professor. Areas of interest: Design theory and methodology, product and process design, manufacturing and assembly processes, robotics, flexible manufacturing systems.

Taaffe, Michael R., Ph.D., (from Ohio State University), Associate Professor. Areas of interest: computational aspects of applied probability modeling and analysis, Monte Carlo simulation modeling and analysis methodology, and combined use of discrete-event simulation methods and computational probability models.

Taylor, G. Donald, Ph.D., (from University of Massachusetts), Charles O. Gordon Professor and Department Head. Areas of interest: Manufacturing, logistics, production systems, simulation and optimization.

Torgersen, Paul E., Ph.D., (from Ohio State University, 1959), John W. Hancock Professor. Areas of interest: organization theory, applied operations research, and quality control.

Triantis, Konstantinos P., Ph.D., (from Columbia University, 1984), Professor, Northern Virginia Graduate Center. Areas of interest: Productivity measurement and analysis; distributed database systems; engineering economics; operations research.

Van Aken, Eileen M., Ph.D., (from Virginia Tech, 1995), Associate Professor and Associate Department Head. Areas of interest: Performance measurement and management systems; organizational assessment and improvement; collaborative work systems; and lean work systems.

Wernz, Christian, Ph.D. (from University of Massachusetts-Amherst, 2008), Assistant Professor. Areas of interest: quantitative and behavioral decision theory; game theory; applied operations research; modeling; manufacturing/service organizations.

Winchester, W.W. III., Ph.D., (from NC A&T, 2005), Assistant Professor. Areas of interest: human-computer interaction, augmented reality, cognitive ergonomics, affective engineering and design, investigating novel approaches to product and systems design, usability engineering.

Appendix A. Departmental “In Honors” Degree

All students having a 3.5 or better GPA may participate in honors seminars and honors sections of regular courses. Incoming freshmen are invited to participate based on their standardized test scores and high school records. During the junior and senior years, students may choose to pursue candidacy for a degree “**in honors,**” a program which focuses on independent study and undergraduate research in the student's major field of study. Presently, virtually every academic department at the University, including ISE, offers a degree “in honors.” Admission to candidacy for a degree “in honors” is based on the following:

- completion of between 60 and 90 hours of credit, at least 15 hours of which must have been completed at Virginia Tech;
- an overall GPA of 3.5 or above; and
- approval of the appropriate college, division, or department committee.

Requirements for the “in honors” degree are established by each college, division, or department, subject to approval of the Faculty Honors Advisory Committee. They include the following as minimum requirements:

- a minimum of 6-9 hours of Independent Study and Undergraduate Research with a professor in a student’s major;
- an honors thesis, to be completed at least two weeks before graduation, carrying a maximum of 6 credits (in addition to those above);
- a minimum of 9 credits in Honors Colloquia, graduate courses, or honors courses; and
- a final GPA of 3.5
- filing the candidacy form in the Honors Office, first floor of Hillcrest Hall.

Honors course numbers: Independent Study (H4974), Undergraduate Research (H4994), Honors Colloquia (UH3004).

In addition to the “in Honors” degree, the honors program offers several other options for advanced study to be credited toward graduation. These include:

- 1) The Commonwealth Scholar Diploma
- 2) The Honor’s Baccalaureate
- 3) The Five Year Bachelor’s/Master’s
- 4) Scholar in Health Studies
- 5) Honors Scholar

Information about these diplomas is available through the University website at <http://www.univhonors.vt.edu/>.

Appendix B. Some Frequently Asked Questions

The following is an effort to answer some commonly asked questions regarding registration, core requirements, and various policies and procedures.

If I get a “D” in a required course, do I have to take it over?

Yes and no. If you received less than a “C-“ in an ISE, STAT, or MATH course that is a prerequisite for another ISE course, you must repeat the course to satisfy the prerequisite requirement. See Appendix I in this handbook for more information. In other cases, you do not have to repeat the course, but you may choose to do so if the low grade means you are ill-prepared to take subsequent courses which build on the material from the class in which you received a “D.” Please discuss your situation with the Academic Advisor. Also, please keep in mind that you need to maintain both 2.0 overall and 2.0 in-major GPAs in order to maintain satisfactory progress within ISE.

If I get an “F” in a required course, can I take it in summer school at another college or university?

Yes, but only with permission from the Academic Dean's office and the department that normally offers the course. ISE classes must be pre-approved by the ISE department. The grade you receive in the class taken at another school must be a “C” or better. Only the credits will transfer; the grade does not affect your GPA at Virginia Tech. However, if you retake the class at Virginia Tech and make an “A,” your GPA will be positively affected.

Once enrolled at Virginia Tech, do I need prior approval to take classes in summer school at another institution?

If you want them to transfer to Virginia Tech to fulfill graduation requirements, the answer is **yes**. Elective and required courses must be approved by the College of Engineering's Associate Dean for Academic Affairs in Hancock 212, and, as noted above, taking classes off campus requires approval both at the college and departmental levels. There are forms for obtaining this approval at the College of Engineering web site (<http://www.eng.vt.edu>). You should not wait until the last minute to submit the form.

Can I retake a course — initially taken at Tech — primarily for the purpose of improving my grade and bringing up my GPA?

Yes, if the initial grade was below “C” and the course is retaken at Virginia Tech.

How many hours of Independent Study or Undergraduate Research can I take altogether?

No more than 12 hours of Independent Study and/or Undergraduate Research combined may be counted toward a degree. Hours and credits are arranged with the faculty member who will be supervising the work. ISE Department and College of Engineering approval are required. Please read the section on “Field Study, Independent Study, Special Study, and Undergraduate Research” in the current Undergraduate Catalog.

How many courses can I take pass/fail?

Under the pass/fail grading system option, a student is permitted to take up to 10 percent of the required hours for graduation completed at Virginia Tech. **Curriculum for Liberal Education requirements and major requirements cannot be taken on a pass/fail basis, whereas free and non-technical electives may be taken pass/fail. Students who complete the Business Minor need to take the non-technical electives on an A/F basis.** A student must also have completed 30 hours toward graduation and have a cumulative GPA of 2.50 or above. There are a number of other important factors relevant to the pass/fail option, therefore, you should read the section on this in the current Undergraduate Catalog very carefully and see your Academic Advisor.

Are there deadlines for applying for transfer into other departments or colleges during a particular semester?

Yes. In most cases, formal requests for changes in curriculum are due at least two weeks before the beginning of registration for the semester for which the change is to be effective. Students wishing to transfer into or within the College of Engineering must apply to the Enrollment Coordinator in the Academic Affairs Dean's Office, 212 Hancock Hall, College of Engineering; the relevant form is located on the College of Engineering web site (<http://www.eng.vt.edu>).

Can I participate in May graduation ceremonies if I have not completed all required course work for graduation?

Yes, but you must usually be within 18 hours, or one semester, of completing graduation requirements and be able to finish by the end of the second summer semester. You must be in good standing (a 2.0 or better GPA overall and in major), and both the department and the Dean's Office must approve participation. You will not actually receive your diploma until you have finished all requirements for graduation satisfactorily.

Can I take a graduate level course?

An undergraduate who desires to take graduate-level courses must be in the senior year and have at least a 3.0 GPA. He or she must have approval from the instructor, Academic Advisor, and, if outside the ISE department, the Dean of the Graduate School. For more information on graduate courses and programs, see Appendix H.

Is it true that 27 of my last 45 hours must be taken on campus?

Yes, and only approved elective courses taken off campus may be transferred to complete requirements.

What constitutes a course overload?

Anything over 19 semester hours in a regular term and 7 semester hours in a summer session is considered an overload. You must have permission from the academic dean (Hancock 212) to take an overload of course-work; the relevant form is located on the College of Engineering web site (<http://www.eng.vt.edu>).

Can I get a double major in ISE and another curriculum?

Yes, but you must plan very carefully to fulfill all requirements for both curricula. Assistance from Academic Advisors is highly recommended. A second major must be approved by the College of Engineering. Grade reports will be sent to both departments, and it is very important that you indicate both majors on your graduation analysis request form.

What is a graduation analysis?

This is an analysis, also called a DARS report, completed by the Graduation Analysis section of the University Registrar's Office. It states in detail where you stand in terms of fulfilling graduation requirements according to information the University Registrar's Office has at the time the analysis is completed. Students should fill out an "Application for Degree" in their junior year; this may be completed via your Hokie SPA account. Given the number of analyses processed and the diversity of college and departmental requirements, there may be errors on some of the analyses. Do not panic! Please consult with your Academic Advisor after receipt of the analysis, even if you believe it is correct.

Do I need a minimum GPA to graduate?

Yes, you must have at least a 2.0, both in-major and overall. If necessary, you may retake a course in which you received below a “C” or take additional ISE Technical Electives to bring your in-major GPA up to 2.0.

Who needs to sign a force-add form for an ISE class?

It depends on the class. It is best to contact the Academic Advisor because some courses have waiting lists.

What happens if I make schedule changes using student add/drop and I find out later there is a mistake on my schedule?

It is best to see the Academic Advisor. If you have been attending regularly and completing assignments, a class you thought was on your course schedule may be able to be force-added after the deadline. Likewise, if you have not been attending a course on your class ticket, a late drop can be arranged in some cases.

Can I force-add a non-ISE class through the ISE department?

No, you must force-add at the department that offers the class. Also, certain departments have very specific regulations regarding force-adds, so avoid waiting until the last minute to find out about these.

If a college at Virginia Tech other than Engineering (e.g., College of Sciences) gives me transfer credit for certain courses taken at other institutions, and I later transfer to Engineering, does the transfer credit remain the same?

Not necessarily. The College of Engineering's Academic Dean's Office evaluates credit from other institutions for all students transferring into the college.

If I have Advanced Placement credit in social science or humanities, can these be used to fulfill the Humanities/Social Science Curriculum for Liberal Education requirements for Engineering students?

Yes, if the AP credit courses conform to those courses listed under Area 2 (Humanities) and Area 3 (Social Sciences) in the Curriculum for Liberal Education Guide or Undergraduate Catalog. ABET accreditation requires that students still meet depth and breadth requirements for the core. Contact your Academic Advisor if you are unsure of how to meet this requirement.

Can Instrumental Ensemble Music (MUS 3314), Choral Ensemble Music (MUS 3414), or Physical Education credit (EDPE 1XXX) be used for Free Elective credits?

Yes, but the University will only allow 8 credits of ensemble or choral music and 2 credits of physical education courses toward graduation requirements. Those who are required to meet the one credit Area 6 requirement (i.e., Class of 1988 and after) can use MUS 3314 or MUS 3414 to meet the requirement.

Is it possible to substitute Humanities/Social Science courses not on the approved list for some on the approved list?

It is **rarely** possible; however, with a letter of support from the particular department offering the course, e.g., English or History, it is possible to substitute one course not on the list for another on the list. The Dean's office will evaluate these requests according to ABET criteria. Do not assume that transfer courses that are not part of the Virginia Community College System will transfer for core requirements. Please see your Academic Advisor.

How many hours do I need to be a Sophomore? Junior? Senior?

Sophomore = 30-59 hours
Junior = 60-89 hours

Senior = 90 and above hours

What is meant by “academic eligibility”?

Students who fail to maintain the required cumulative GPA shown in the academic eligibility schedule (see or “Academic Eligibility Policy” in the Undergraduate Catalog) are placed on academic probation. (The only exception to the required levels of achievement is that a student may satisfy requirements for continued enrollment by earning a minimum yearly GPA of 2.0, May to May.) Students are dropped for academic reasons only at the end of the academic year, unless the College of Engineering's Dean of Academic Affairs makes an exception to this policy.

I filled out the application for the Business Minor, but it lists several classes that aren't in the Handbook. Do I have to complete these classes as well?

No. A student who completes the ISE program and takes the additional classes listed on the Business Minor list in this Handbook (see Appendix E) has completed requirements for the Business Minor. The Academic Advisor will substitute the required ISE classes for the additional courses listed on the application.

Appendix C. Information and Referral Sheet

Ms. Joyce Vest
Academic/Career Advisor
243 Durham Hall
231-6388
e-mail: vestjs@vt.edu

- academic advising (academic progress in general)
- career counseling
- personal counseling (problems or concerns impeding academic progress)
- program-of-study planning
- course scheduling and registration information
- course substitutions and petitions for curriculum committee
- graduation analyses
- general information about graduate study
- information about university, college, departmental policies, procedures, resources
- information about selected scholarships, fellowships, awards, grants
- information about tutors available for selected courses
- information on student organizations
- orientation to the department
- undergraduate student records
- transferring into or out of ISE
- concerns with courses or instructors
- GTA concerns
- administrative details pertaining to the Cooperative Education and Internship Programs

Dr. Eileen M. Van Aken
Undergraduate Program Director and Associate Department Head
250 Durham Hall
231-6656
e-mail: evanaken@vt.edu

- undergraduate policies
- career information and advice
- Undergraduate Program Committee petitions
- concerns with specific courses or faculty

Dr. C. Patrick Koelling
Graduate Program Director and Assistant Department Head
235 Durham Hall
231-8755
e-mail: koelling@vt.edu

- information about graduate study
- career information and advice
- graduate program policies and procedures

Ms. Hannah Swiger
Program Support Technician
240 Durham Hall
231-5586

e-mail: hsswiger@vt.edu

- general information about and applications for graduate study in ISE
- graduate teaching assistants office assignments
- information about departmental and graduate school policies and procedures

Dean's Office, College of Engineering
Dr. Bevlee Watford, Associate Dean for Academic Affairs
Ms. Christi Boone, Enrollment Coordinator
212 Hancock Hall
231-3244
<http://www.eng.vt.edu>

- exam time changes and approval
- F.E. exam information and applications
- late drops, adds, and force-adds
- readmission
- resignations
- transfer course approval and transfer credit evaluation
- transferring into or out of the College of Engineering
- overload requests
- professional/career development workshops
- see <http://www.eng.vt.edu/forms/index.php> for a list of COE forms and documents referenced throughout this Handbook.

Other Campus Resources:

Career Services, Career Services Building – 231-6241, www.career.vt.edu
Center for Academic Enrichment and Excellence, 110 Femoyer Hall – 231-5499,
www.cae.vt.edu
Center for the Enhancement of Engineering Diversity (CEED), 215 Hancock Hall – 231-7404,
www.eng.vt.edu/academics/ceed.php
Cook Counseling Center, 240 McComas Hall – 231-6657, www.ucc.vt.edu
Dean of Students Office, 201 W. Roanoke St. – 231-3787, www.dos.vt.edu
Graduate School Admissions, Graduate Life Center @ Donaldson Brown, Room 120 – 231-8636,
www.grads.vt.edu/admissions/applying/index.html
Schiffert Health Center, McComas Hall – 231-5313, www.healthcenter.vt.edu
Services for Students with Disabilities, 250 S. Main Street, Suite 300, Kent Square – 231-0858,
www.ssd.vt.edu
Virginia Tech Undergraduate Honor System, 207 W. Roanoke Street, Second Floor, 540-231-9876,
www.honorsystem.vt.edu
University Honors, 137 Hillcrest Hall – 540-231-4591, www.univhonors.vt.edu
University Scholarships and Financial Aid, 200 Student Services Building – 231-5179, www.finaid.vt.edu

Appendix D. Graduation Checksheet, Course Requirements, and Electives

The sequence of courses reflected in the 2010 Checksheet (the most recently-approved Checksheet) is shown below, followed by the corresponding approved set of electives (for ISE Technical Electives, Technical Electives, Engineering Science, and Non-Technical electives). Any student graduating under earlier Checksheets should consult with the electives list **for that Checksheet**. All Checksheets are available on the ISE Department web site and in the Academic Advisor's office.

**COLLEGE OF ENGINEERING, INDUSTRIAL AND SYSTEMS ENGINEERING
GRADUATION CHECKSHEET FOR STUDENTS GRADUATING IN CALENDAR YEAR 2010 BACHELOR OF SCIENCE IN
INDUSTRIAL AND SYSTEMS ENGINEERING**

FALL SEMESTER FRESHMAN 2006		Credit Hrs	SPRING SEMESTER FRESHMAN 2007		Credit Hrs
<input type="checkbox"/>	ENGL 1105 English I		3	<input type="checkbox"/>	
<input type="checkbox"/>	CHEM 1035 Gen Chem for Engineers	3	<input type="checkbox"/>	PHYS 2305 Found of Physics I w/lab	4
<input type="checkbox"/>	CHEM 1045 Gen Chem Lab for Eng	1	<input type="checkbox"/>	MATH 1206 Calculus II	3
<input type="checkbox"/>	MATH 1114 Linear Algebra	2	<input type="checkbox"/>	MATH 1224 Vector Geometry	2
<input type="checkbox"/>	MATH 1205 Calculus I	3	<input type="checkbox"/>	ENGE 1104 Exploration Digital Future OR ENGE 1114 Exploration Engr Design	2
<input type="checkbox"/>	ENGE 1024 Engineering Exploration	2	<input type="checkbox"/>	Elective*	3
<input type="checkbox"/>	Elective*	3			
TOTAL		17	TOTAL		17
FALL SEMESTER SOPHOMORE 2007		Credit Hrs	SPRING SEMESTER SOPHOMORE 2008		Credit Hrs
<input type="checkbox"/>	PHYS 2306 Foundations of Physics II w/lab		4	<input type="checkbox"/>	
<input type="checkbox"/>	MATH 2224 Multivariable Calculus (C-)	3	<input type="checkbox"/>	STAT 4105 Theoretical Statistics (C-)	3
<input type="checkbox"/>	ISE 2014 Engineering Economy (C-) <i>Pre: ENGE 1024</i>	2	<input type="checkbox"/>	ISE 2204 Manufacturing Processes (C-) <i>Pre: ENGE 1104 or 1114</i>	2
<input type="checkbox"/>	ENGE 2314 Eng Prob Solving w/C++ <i>Pre: ENGE 1104 or 1114, MATH 1114, MATH 1206</i>	2	<input type="checkbox"/>	ISE 2214 Manufacturing Processes Lab (C-) <i>Pre: ENGE 1104 or 1114</i>	1
<input type="checkbox"/>	ENGE 2344 Computer-Aided Drafting	1	<input type="checkbox"/>	ISE 2404 Deterministic Oper Research (C-) <i>Co: MATH 2224</i>	3
<input type="checkbox"/>	ESM 2104 Statics	3	<input type="checkbox"/>	ESM 2304 Dynamics	3
			<input type="checkbox"/>	MSE 2034 Materials Engineering	3
TOTAL		15	TOTAL		18
FALL SEMESTER JUNIOR 2008		Credit Hrs	SPRING SEMESTER JUNIOR 2009		Credit Hrs
<input type="checkbox"/>	STAT 4706 Statistics for Engineers (C-) <i>Pre: STAT 4105</i>		3	<input type="checkbox"/>	
<input type="checkbox"/>	ISE 3014 Work Meas & Meth Eng (C-) <i>Pre: ISE 2204 or 2214, STAT 4105</i>	3	<input type="checkbox"/>	ISE 3424 Discrete-Event Comp Sim (C-) <i>Pre: ISE 3414; Co: STAT 4706</i>	3
<input type="checkbox"/>	ISE 3414 Probabilistic Oper Research (C-) <i>Pre: MATH 2214, MATH 2224, ENGE 2314, STAT 4105</i>	3	<input type="checkbox"/>	ISE 3624 Industrial Ergonomics <i>Pre: ISE 3014, ESM 2104</i>	3
<input type="checkbox"/>	ISE 3614 Intro to Human Factors (C-) <i>Pre: STAT 4105</i>	3	<input type="checkbox"/>	ISE 3024 Data Management for IEs (C-) <i>Pre: ISE 2214, ENGE 2314; Co: ISE 3214</i>	3
<input type="checkbox"/>	ECE 3054 Electrical Theory	3	<input type="checkbox"/>	Electives*	6
<input type="checkbox"/>	Elective*	1			
TOTAL		16	TOTAL		18
FALL SEMESTER SENIOR 2009		Credit Hrs	SPRING SEMESTER SENIOR 2010		Credit Hrs
<input type="checkbox"/>	ISE 4005 Proj Mgmt & System Design (C-) <i>Pre: ISE 3024, 3214, 3424, 3614; Co: ISE 3624, 4204</i>		3	<input type="checkbox"/>	

<input type="checkbox"/> ISE 4204 Production Planning and Inv Control <i>Pre: ISE 2404, STAT 4706</i>	3	<input type="checkbox"/> ISE 4304 Global Issues in Industrial Mgt	3
<input type="checkbox"/> ISE 4404 Statistical Quality Control <i>Pre: ISE 3414, STAT 4105, STAT 4706</i>	3	<input type="checkbox"/> Electives*	12
<input type="checkbox"/> Electives*	9		
TOTAL		18	TOTAL 17

*ELECTIVES: Choose electives from the approved lists in the ISE UG Student Handbook and the Curriculum for Liberal Education Guide.			
<input type="checkbox"/>	AREA 2 IDEAS, CULTURAL TRADITIONS, VALUES (6 hrs)	1)	2)
<input type="checkbox"/>	AREA 3 SOCIETY & HUMAN BEHAVIOR (6 hrs)	1)	2)
<input type="checkbox"/>	AREA 6 CREATIVITY & AESTHETIC EXPERIENCE (1 hr)	1)	
<input type="checkbox"/>	ISE TECHNICAL ELECTIVES (6 hrs)	1)	2)
<input type="checkbox"/>	TECHNICAL ELECTIVE (3 hrs)	1)	
<input type="checkbox"/>	ENGINEERING SCIENCE ELECTIVES (6 hrs)	1)	2)
<input type="checkbox"/>	NON-TECHNICAL ELECTIVES (6 hrs)	1)	2)

TOTAL Elective Credits: 34

ADDITIONAL REQUIREMENTS AND NOTES FOR 2010 ISE CHECKSHEET

GRADUATION REQUIREMENTS: A minimum of 136 hours is required for graduation. An in-major and overall GPA of 2.0 is required for graduation. In-major GPA is determined from all ISE classes, STAT 4105, and STAT 4706.

FOREIGN LANGUAGE REQUIREMENT: Students who did not complete 2 units of a foreign language in high school must earn 6 credits of a college-level foreign language in addition to the 136 credits normally required for graduation.

PREREQUISITES: There are no hidden prerequisites for any course on this Checksheet. Prerequisite courses are indicated in the Checksheet and are also listed in the University Undergraduate Catalog, and in the ISE Undergraduate Student Handbook.

GRADE OF C- OR BETTER: ISE, STAT, and MATH courses for which students must earn a C- or better in order to progress to more advanced ISE courses are indicated by a (C-) on the Checksheet and are identified in the University Undergraduate Catalog and the ISE Undergraduate Student Handbook.

CURRICULUM FOR LIBERAL EDUCATION REQUIREMENTS: Areas 1, 4, 5, and 7 are satisfied through the required set of courses, with ISE 4304 satisfying the Area 7 requirement. The ISE Department has an approved plan to fulfill the Visual Expression, Writing and Speaking (ViEWS) requirement. Areas 2, 3 and 6 are satisfied through selection of elective courses, found in the Curriculum for Liberal Education Guide, by taking 6 credits of Area 2, 6 credits of Area 3, and 1 credit of Area 6.

ELECTIVES: Students must also take 6 credits of ISE Technical Electives, 3 credits of a Technical Elective, 6 credits of Engineering Science Electives, and 6 credits of Non-Technical Electives. A listing of courses which the College of Engineering does not allow to be used to fulfill degree requirements can be found in the ISE Undergraduate Student Handbook or at the following web site: www.eng.vt.edu/overview/docs/non_degree_courses.pdf.

BUSINESS MINOR: Those students pursuing the Business Minor take 6 credits above and beyond the 136 credit hours required for graduation and need to select the pre-specified elective courses for ISE Technical Electives, Non-Technical Electives, and Area 3 Electives, identified in the ISE Undergraduate Student Handbook. Students should carefully select when they take these pre-specified electives in order to graduate in a timely manner.

CAPSTONE SENIOR DESIGN REQUIREMENT: The ISE 4005-4006 sequence is the capstone senior design experience for ISE majors and must be taken as a Fall-Spring sequence.

PROGRESS TOWARDS DEGREE POLICY: Satisfactory progress toward the BSISE requires that an ISE major must meet the following criteria (refer to http://www.registrar.vt.edu/regISTRATION/documents/restricted_program.pdf);

- 1) Completion of all enrollment requirements for General Engineering;
- 2) Credit for MATH 1205, 1206, 1114, 1224; CHEM 1035, 1045; ENGL 1105, 1106; PHYS 2305;
- 3) Min grade of C- or better in ENGE 1024 and ENGE 1104 or 1114;
- 4) Min overall GPA of 2.0 or better;
- 5) In addition, ISE students, after having completed 72 hours (including transfer, advanced placement, advanced standing, and credit by examination), must meet the following criteria:

- a. Min in-major GPA of 2.0 or better;
- b. Have completed ENGE 1104 or 1114, ISE 2014, ISE 2204, ISE 2214, MATH 2214, and MATH 2224;
- c. Be enrolled in 12 or more credits of ISE classes per year;
- d. Not have taken any ISE or STAT designated course required for the degree more than twice, including attempts ending in course withdrawal;
- e. Not have repeated more than 3 ISE or STAT designated courses required for the degree, including attempts ending in course withdrawal.

ELECTIVES FOR ISE 2010 CHECKSHEET

ISE TECHNICAL ELECTIVES

Students must take **two** ISE Technical Electives (**6 credit hours**) which must be selected from the list below. Non-ISE courses **may not** be substituted for ISE Technical Electives. Courses from the list below for ISE Technical Electives may also be used to satisfy the Technical Elective requirement. The purpose of the ISE Technical Elective requirement is to enable students to develop expertise in a particular area of the ISE discipline.

ISE 3004	Industrial Cost Control <i>Pre: ISE 2014 or ME 2024</i>
ISE 4004	Theory of Organization
ISE 4015	Management Systems Theory, Applications, and Design I
ISE 4016	Management Systems Theory, Applications, and Design II
ISE 4264	Industrial Automation <i>Pre: ISE 2204 or 2214. Requires Laboratory Work</i>
ISE 4414	Industrial Quality Control <i>Pre: ISE 4404</i>
ISE 4424	Logistics Engineering <i>Pre: ISE 3414</i>
ISE 4624	Work Physiology <i>Pre: ISE 3614</i>
ISE 4644	Occupational Safety and Hazard Control <i>Pre: ISE 3614</i>
ISE 4654	Principles of Industrial Hygiene
ISE 4974	Independent Study - Hours and credits established by faculty supervising work*
ISE 4984	Special Study - Hours and credits established when course is proposed/offered.
ISE 4994	Undergraduate Research - Hours and credits established by faculty supervising work*

*Note: *A maximum of 3 credit hours of either ISE 4974 or ISE 4994 is allowed as an ISE Technical Elective without approval in advance. Students wishing to take more than 3 credits of either ISE 4974 or ISE 4994 must contact the ISE Academic Advisor and Undergraduate Curriculum Committee.*

TECHNICAL ELECTIVES

Students must take **one** Technical Elective (**3 credit hours**), which may be chosen from the list of Suggested Technical Electives below. The requirement of technical content restricts this elective to fall within College of Engineering (including ISE), Statistics, Chemistry, Physics, Computer Science, or Mathematics. The purpose of the Technical Elective requirement is to:

- Further develop the student's technical skills; and/or
- Provide an opportunity for the student to focus on a particular topic or area of study.

A list of courses that can be used to satisfy the Technical Elective requirement is presented below. **Please note any prerequisites for these courses in the Undergraduate Course Catalog.** This list is followed by the set of restrictions for courses **not** allowed as Technical Electives (both general and specific restrictions).

Suggested Technical Electives in Engineering, Science, and Math

AOE 3034	Vehicle Vibration and Control
AOE 3104	Aircraft Performance
CHE 3115	Transport Operations in Chemical Engineering
CEE 3104	Introduction to Environmental Engineering
CEE 3604	Transportation Engineering
CEE 4344	Water Resources Planning
CEE 4624	Planning Transportation Facilities
CHEM 3615	Physical Chemistry
CS 3414	Numerical Methods
CS 4004	Data and Information Structures
ECE 4234	Microelectronics
ECE 4524	Survey of Artificial Intelligence and Pattern Recognition
ESM 4044	Mechanics of Composite
ESM 4614	Reliability Methods in Engineering
MATH 3034	Proofs and Algebraic Systems
MATH 3134	Applied Combinatorics and Graph Theory
MATH 3224	Advanced Calculus
MATH 4225	Elementary Real Analysis
MATH 4245	Intermediate Differential Equations
MATH 4404	Applied Numerical Methods
MATH 4445-6	Introduction to Numerical Analysis
MATH 4554	Numerical Methods for Engineers
MATH 4564	Operational Methods for Engineers
MATH 4574	Vector and Complex Analysis for Engineers
ME 3614	Mechanical Design I
ME 4504	Dynamic Systems Control Engineering I
ME 4514	Controls Engineering II
ME 4524	Introduction to Robotics and Automation
ME 4634	Introduction to CAD/CAM
MSE 4304	Metals and Alloys in Design
PHYS 4714	Introduction to Biophysics

Restrictions for courses that CANNOT be used to satisfy the Technical Elective requirement:

- *General Restrictions:*
 - Any 1000 or 2000 level course.
 - Any course not available for credit – see ISE Undergraduate Student Handbook.
 - Any ENGR course below the 5000 level.
 - Any undergraduate research or independent study course (3974, 3994, 4974, 4994) unless approved by the ISE Undergraduate Curriculum Committee (see the ISE Academic Advisor).
- *Specific Restrictions – Courses NOT Allowed as Technical Electives:*
 - AOE 3054 AOE Instrumentation and Laboratory
 - AOE 4065-6 AOE Senior Design
 - AOE 4154 Aerospace Engineering Laboratory
 - AOE 4254 Ocean Engineering Laboratory
 - BSE 4104 Energy in Agriculture
 - BSE 4114 Probabilistic Engineering Design
 - BSE 4125-6 BSE Senior Design
 - CHE 4064 Process Systems Analysis
 - CHE 4104 Process Materials
 - CHE 4185-6 ChE Senior Design

CEE 3014	Construction Management
CEE 4034	Contract Specifications
CEE 4054	Construction Law: Roles and Responsibilities
CEE 4234	Property Line Law
CEE 4274	Land Development Design
CEE 4804	Professional and Legal Problems in Engineering
CHEM 3034	Advanced Scientific Glassworking
CHEM 4014	Survey of Chemical Literature
CHEM 4024	Career Planning for the Chemical Profession
CHEM 4615-6	Physical Chemistry for the Life Sciences
CS 3604	Professionalism in Computing
CS 4214	Simulation and Modeling
ESM 3704	Basic Principles of Structures
ESM 4015-6	ESM Senior Design
ESM 4404	Fundamentals of Professional Engineering
MATH 4044	History of Mathematics
MATH 4624	Topics in Analysis for Teachers
MATH 4634	Topics in Algebra for Teachers
ME 4015/16	ME Senior Design
ME 4744	The Complexity of Socio-Technological Problems
MINE 3064	Mining, Man and the Environment
MINE 3074	History of Mining
MINE 3094	Energy and Minerals in Society
MINE 4045-6	MinE Senior Design
MINE 4124	Mining Law
MINE 4144	Marketing and Transportation of Coal
MSE 4085-6	MSE Senior Design
STAT 3xxx and 4xxx	

*Note: Most 3000 level STAT courses are **not allowed** - check with ISE Academic Advisor for details.*

*Some 4xxx STAT courses are also **not allowed** as Technical Electives given the required STAT courses for the ISE major – see Undergraduate Course Catalog.*

ENGINEERING SCIENCE ELECTIVES

Students must take **two** Engineering Science Electives (**6 credit hours**) from the list below. The purpose of Engineering Science Electives is to enable students to develop breadth in the engineering discipline. **Please note any prerequisites for these courses in the Undergraduate Course Catalog.**

CHE 2114	Mass and Energy Balances
CEE 3104	Intro to Environmental Engineering
CEE 3404	Theory of Structures
CEE 3304	Hydraulics I (Restricted to CEE's. ISEs may request an exception to a major restriction.)
CEE 3604	Intro to Transportation Engineering
CEE 4604	Traffic Engineering
ECE 2204	Electronics I (Restricted to ECE's. ISEs may request an exception to a major restriction.)
ECE 2574	Intro to Data Structures and Software Engineering
ECE 3574	Applied Software Engineering.
ECE 3254	Industrial Electronics
ECE 4364	Alternate Energy Systems
ENGR 3124	Introduction to Green Engineering
ENGR 3134	Environmental Life Cycle Assessment
ESM 2204	Mechanics of Deformable Bodies
ESM 3024	Introduction to Fluid Mechanics
ESM 3124	Intermediate Dynamics

ME 2124	Intro to Thermo Fluids Engineering
ME 3114	Engineering Thermodynamics
ME 3404	Fluid Dynamics
ME 3514	Dynamic Systems
ME 3604	Kinematics and Dynamics of Machinery (Restricted to ME's. ISEs may request an exception to a major restriction.)
ME 4524	Intro to Robotics and Automation
ME 4634	Intro to Computer-Aided Design and Manufacturing
ME 4644	Introduction to Rapid Prototyping
MSE 3304	Physical Metallurgy
MSE 3054	Mechanical Behavior of Materials
MSE 4304	Metals and Alloys in Design

NON-TECHNICAL ELECTIVES

Students must select **two** Non-Technical Electives (**6 credit hours**) from the list below. **Please note any prerequisites for these courses in the Undergraduate Course Catalog.** Non-technical electives are courses unrelated to engineering and basic sciences that provide students with a broad, well-rounded background and a perspective on global issues. The purpose of Non-Technical Electives may include:

- Enhance or complement knowledge and skills by providing breadth in those non-technical areas with relevance to most career paths in ISE;
- Enhance business, communication, and technical skills;
- Learn a foreign language;
- Develop an understanding of the basic functional aspects of business, including the areas of economics, finance, marketing, and management;
- Provide exposure to global issues for business and industry, including environmental and multicultural issues;
- Provide awareness/skills necessary for success in a globally competitive and multicultural workplace; and/or
- Develop an understanding of the meaning and role of ethics.

The set of courses list below which are approved as Non-Technical Electives also includes some courses approved in the Curriculum for Liberal Education Guide (e.g., as Area 3 electives). For these courses, **students may not use the course to satisfy both requirements.** Any given course will satisfy only one requirement.

AAEC 4304	Environment and Sustainable Development Economics
ACIS 2115	Principles of Accounting
AS 3215-6	Air Force Management and Leadership
AS 4215-6	National Security Forces in Contemporary American Society
CEE 4804	Professional and Legal Issues in Engineering
COMM 2004	Public Speaking
COMM 3124	Interpersonal Communication
COMM 3134	Argumentation and Decision-Making
COMM 4044	International Communication
COMM 4074	Organizational Communication
ECON 2005-6	Principles of Economics
ECON 3104	Microeconomic Theory
ECON 3204	Macroeconomic Theory
ECON 3214	Money and Banking
ECON 4135	International Trade
ECON 4136	International Finance
ENGL 3764	Technical Writing

FIN 3104	Introduction to Finance
FIN 3055	Business Law
FIN 4144	International Financial Management
FL 1105-6	Elementary Language
FL 2105-6	Intermediate Language
FL 3104	Commercial Language* (Spanish only offered)
FL 3105-6	Grammar, Composition, and Conversation (Arabic, Japanese, Portuguese not offered)

**Note: Latin, Greek, or a student's native language are NOT acceptable.*

ME 4744	The Complexity of Socio-Technological Problems
MGT 3304	Management Theory and Leadership Practice
MKTG 3104	Marketing Management
MKTG 4254	Product and Price Management
MKTG 4704	International Marketing
MN 4005-6	Leadership and Management
MS 4005-6	MS IV, AROTC
PHIL 4324	Business and Professional Ethics
PSCI 2055	World Politics and Economy I
PSCI 3516	European Political Systems
PSCI 3615	International Relations I
PSCI 3625	American Foreign Policy
PSYC 4024	Industrial and Organizational Psychology
SOC 4604	Organization of the Workplace
SOC 4614	Occupations in Social Context
UAP 3014	Urban Policy and Planning
UAP 3354	Environmental Policy and Planning

Appendix E. Business Minor for ISE Majors

Requirements*	Course Counts As
ACIS 2115	Additional requirement
ECON 2005	Area 3 Elective
ECON 2006	Area 3 Elective
FIN 3055 Pre: Jr. Standing	Non-technical Elective
MKTG 3104 Pre: Econ 2005, Jr. Standing	Non-technical Elective
FIN 3104 Pre: ACIS 2115	Additional requirement
ISE 3004 Pre: ISE 2014	ISE Technical Elective & substitution for ACIS 2116
ISE 4004	ISE Technical Elective & substitution for MGT 3304

*While the Business Minor has a requirement of 24 credits of coursework, 16 of the required credits can be taken as part of the regular ISE curriculum. Only two courses, **ACIS 2155 and FIN 3104**, need to be added to the ISE degree requirements to complete the minor.

Additional ENGR/ISE requirements which are part of the Business minor include: Math 1205-1206, Math 1114, ENGE 1024, ENGE 1016 or 1114, STAT 4105, ISE 2404, ISE 3414, and ISE 4204 (note: students who have taken a different ENGE course based on the year they entered Engineering as a freshmen should talk to the ISE Academic Advisor regarding substitutions). The courses listed above, combined with a completed ISE degree, fulfill the Business Minor requirements, using the ISE curriculum.

Applications for the Business Minor are available in the Dean's Office, Pamplin College of Business, in 1046 Pamplin Hall and from the ISE Academic Advisor. Please see the ISE Academic Advisor in Durham 243 if you need assistance completing the form.

Appendix F. Prerequisites and Corequisites for ISE Classes

The following is a list of immediate prerequisites for both required and elective ISE classes. Only immediate prerequisites are identified below. The full ISE prerequisite list for ISE 4005-6 is also provided (i.e., including immediate prerequisites to ISE 4005-6 as well as prerequisites to those prerequisites). Students must achieve a C- or better in any ISE, STAT, or MATH course that is a prerequisite for another ISE course, as noted below.

2014 Engineering Economy

Pre: ENGE 1024¹

2204 Manufacturing Processes

Pre: ENGE 1104 or 1114²

2214 Manufacturing Processes Laboratory

Pre: ENGE 1104 or 1114²

2404 Deterministic Operations Research

Co: MATH 2224

3004 Industrial Cost Control

Pre: 2014 (C- or better) or ME 2024

3014 Work Measurement and Methods Engineering

Pre: 2204 or 2214 (C- or better), STAT 4105 (C- or better)

3024 Data Management for Industrial Engineers

Pre: 2214 (C- or better), ENGE 2314, Co: 3214

3214 Facility Planning and Material Handling

Pre: 2014 (C- or better), 2404 (C- or better) and 3414 (C- or better) and ENGE 2344, Co: 3424

3414 Probabilistic Operations Research

Pre: MATH 2214 (C- or better), MATH 2224 (C- or better), STAT 4105 (C- or better), ENGE 2314

3424 Discrete-Event Computer Simulation

Pre: 3414 (C- or better), Co: STAT 4706

3614 Introduction to Human Factors Engineering

Pre: STAT 4105

3624 Industrial Ergonomics

Pre: 3014 (C- or better) and ESM 2104

4004 Theory of Organization

4005-4006 Project Management and Systems Design

Pre/Co: see following list

4015, 4016 Management Systems Theory, Application, and Design

4204 Production Planning and Control

Pre: 2404 (C- or better), STAT 4706 (C- or better)

4264 Industrial Automation

Pre: 2204 or 2214 (C- or better)

4304 Global Issues in Industrial Management

¹ Note: students who have taken a different ENGE course based on the year they entered Engineering as a freshman should talk to the ISE Academic Advisor regarding a substitution.

- 4404 Statistical Quality Control**
Pre: 3414 (C- or better), STAT 4105 (C- or better), STAT 4706 (C- or better)
- 4414 Industrial Quality Control**
Pre: 4404 (C- or better)
- 4424 Engineering Logistics**
Pre: 3414 (C- or better)
- 4624 Work Physiology**
Pre: 3614 (C- or better)
- 4644 Occupational Safety and Hazard Control**
Pre: 3614 (C- or better)
- 4654 Principles of Industrial Hygiene**

Prerequisites for “Senior Capstone Design” (ISE 4005-6 Project Management and Systems Design)

The following ISE courses are required prerequisites for ISE 4005-6 Project Management and Systems Design. Students MUST have successfully completed ALL of these classes with a C- or better BEFORE taking ISE 4005 or they will be dropped from the class.

- 2014 Engineering Economy
- 2204 Manufacturing Processes
- 2214 Manufacturing Processes Laboratory
- 2404 Deterministic Operations Research
- 3014 Work Measurement and Methods Engineering
- 3024 Data Management for IEs
- 3214 Facility Planning and Material Handling
- 3414 Probabilistic Operations Research
- 3424 Discrete-Event Computer Simulation
- 3614 Introduction to Human Factors Engineering

The following ISE courses are corequisites for ISE 4005 and must be taken before or during the same semester that ISE 4005 is taken. Students who are taking one of these classes and drop it during the term, will be dropped from ISE 4005 if they are taking it that semester.

- 3624 Industrial Ergonomics
- 4204 Production Planning and Control

Appendix G. Framework for Advising at Virginia Tech

Definition

Advising at Virginia Tech is a collaborative process between student and advisor leading to the exchange of information that encourages the individual student to make responsible academic and career decisions.

Statement of Student Responsibility

The student shares the responsibility for developing an advising partnership with the advisor. Over time, the partnership results in increased responsibility for the student. This is achieved through the student:

- Communicating goals, needs, wants, concerns to the advisor in a respectful and sincere manner;
- Keeping abreast of her/his own academic progress and requirements related to their academic programs;
- Making, keeping, and being prepared for appointments with the advisor;
- Informing the advisor of changes in plans and/or circumstances that might impact academic performance;
- Knowing departmental procedures regarding changing advisors;
- Bringing concerns regarding quality of advising to the attention of the advisor; and
- Seeking out and taking advantage of opportunities for professional development.

Statement of Advisor Responsibility

The advisor shares the responsibility for developing an advising partnership with the student. This is achieved through the advisor:

- Communicating with students and delivering individualized and accurate information in a professional and sincere manner;
- Being informed of, and providing, accurate information about current academic policies and procedures;
- Keeping appointments and being available for assistance;
- Providing appropriate referrals, contacts, and information; and
- Conducting appropriate follow-up with students.

Appendix H. Information about Taking Graduate Courses and Programs

Undergraduates Taking Graduate Courses

Dual Students (Virginia Tech undergraduates)

Seniors at this university who intend to receive a bachelor's degree, are within the last semester of graduation, and have a GPA of 3.0 or better, may take graduate level course work to satisfy an advanced degree program as dual registrants. Such work may only be used to satisfy graduate degree requirements when it is not used for the bachelor's degree and with the consent of the graduate advisory committee.

Seniors

Students in their senior year, with a 3.0 or better GPA, may enroll in 5000-level courses for undergraduate credit within their department when qualified by the course instructor and the department head. Taking 5000-level courses outside the department requires Graduate School approval. Should the student become a graduate student, these courses may not be used for graduate credit.

Five-Year Bachelor/Master's Degree

Undergraduate students with a 3.5 or above GPA may apply for admission to the Graduate School upon the completion of 75 credit hours (see department for specific information and additional requirements) of undergraduate study.

The student submits the Application for Graduate Study to the department. Upon approval of the application, the department head will attach a letter affirming the department's acceptance of the student into the graduate program and agreement that the student can complete his or her undergraduate studies upon demonstration of 6 hours of graduate study.

The student may be required to complete the Graduate Record Examination/GMAT at the discretion of the department. During the two semesters following admission to graduate school, the student may complete up to 6 hours of graduate work, jointly enrolled in the Graduate School and undergraduate department. Successful completion of 6 hours of graduate work with no less than a "B" average will be considered completion of the last 6 hours of the undergraduate degree.