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# ROOM AND TELEPHONE NOTES

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1. INTRODUCTION

This guide has been prepared to aid students who are currently enrolled in the Department of Engineering Science and Mechanics (ESM) in fulfilling the requirements for a B.S. in ESM and to provide information about the curriculum for others who may be interested in becoming ESM majors. It should be considered as a supplement to the requirements published in the Virginia Tech Undergraduate Catalog and is in no way intended to supersede any statements in the Undergraduate Catalog.

This guide is subject to revision by the faculty; notices of such changes will be circulated through the student list-serv. Changes will not be enforced retroactively. Students affected by curriculum revisions should see the Associate Department Head.

The basic responsibility for the fulfillment of requirements for a degree rests with the student. Advisors will assist as much as possible but are not responsible for checking that all requirements have been satisfied. In particular, transfer students (from other departments, colleges, or universities) who wish to substitute transferred courses for required courses should receive and keep in their personal records a written confirmation of the acceptability of the substitution. Requests for such substitutions must be made at the time of entry into the ESM Department. Currently, the Office of the Registrar does not check to see that graduation requirements have been met until the student has made his or her application for a degree. Such applications should be made upon changing to ESM and must be made at least two months prior to the awarding of a degree.

A semester-by-semester listing of courses to be taken is available on the ESM web site. These checksheets and the other material in this guide give the student an up-to-date listing of required courses and suggestions for optional elective courses.

The Department of Engineering Science and Mechanics has a rich tradition for providing an interdisciplinary engineering education. We strive to prepare our graduates to succeed in advanced graduate or professional study, industry, and government. In these activities, our alumni will:

1. Apply fundamentals of engineering mechanics and related areas of applied science to define, model, and solve a wide range of engineering problems.

2. Apply fundamental mathematical and scientific principles, as well as computational and experimental techniques, to the demands of engineering and scientific practice.

3. Function on and lead teams that engage in new areas of research and development in engineering, particularly those that cross the boundaries of traditional disciplines.

4. Maintain high productivity and high ethical standards.

5. Continually enhance their knowledge throughout their careers.

6. Communicate effectively to a broad range of audiences.

These educational objectives are supported by a curriculum that seeks to have its graduates achieve the following program outcomes:

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

2. an ability to design and conduct mechanics experiments
3. an ability to analyze and interpret experimental and computational mechanics data
4. an ability to design a system, component, or process to meet desired needs by synergistically combining mechanics of materials, fluid mechanics, and dynamics, when necessary
5. an ability to effectively function as the leader, or member, of a multi-disciplinary team
6. an ability to identify, formulate, and solve engineering problems involving mechanics of materials, fluid mechanics, and/or dynamics
7. an understanding of professional and ethical responsibility
8. an ability to communicate effectively – orally, graphically, and in writing
9. the broad education necessary to understand the impact of engineering solutions on society and the environment
10. a recognition of the need for, and an ability to engage in, life-long learning and accomplishment
11. a knowledge of contemporary issues (e.g., social, political, technical, economic, etc.)
12. a fundamental understanding that will enable the appropriate use and development of the techniques, skills, and modern engineering tools necessary for engineering practice
13. a recognition of the importance of safety in phases of engineering design and practice
2. MAJOR REQUIREMENTS FOR GRADUATION

1. The courses required for graduation are available by graduation year on the ESM web site.

2. In addition to the required 6 hours of Freshman English (Engl 1105-1106), the student must take 12 hours of Humanities and Social Science (Areas 2 and 3) electives. Further information may be found in the Undergraduate Catalog and the Curriculum for Liberal Education.

3. Twelve hours of technical elective course work are required. These courses should be chosen with a definite goal in mind, and must be approved by Associate Department Head. (The required approval form may be found on page 16 of this document.) The goal may be to specialize in the area of solid mechanics/materials, fluid mechanics, motion, engineering physics, or biomechanics. Also permissible is the goal of developing a general background in engineering science and mechanics. (See Section 4 for details.)

4. Six hours of mathematics courses must be taken at the 4000 level. These courses are MATH 4564 and MATH 4574. When ESM students have satisfied the requirement of 6 hours of 4000-level mathematics courses, they are within 3 hours of meeting the requirements for a Minor in Mathematics—something certainly worthy of consideration when choosing elective courses. (See Section 6 for details.)

5. Each student in the Department must take 6 hours of senior project - Creative Design and Project. Details are given in Section 5.

6. The minimum number of credits for graduation is 131 hours. You must have a GPA of 2.00 overall, and in ESM courses, to graduate (University requirement).
3. GENERAL INFORMATION

1. You may not register for a course in which you do not have the prerequisite. If you are out of sequence with the listings given on the ESM web site, be sure to check the prerequisites before registering for a course.

2. Courses in which you are behind, or which you failed, should take precedence during registration.

3. To be a full-time student you must register for a minimum of 12 hours, but not more than 19 hours, per semester. (See the Undergraduate Catalog for details.)

4. If a course is taken on an audit basis, it may not be repeated for credit.

5. To register for the Pass/Fail (P/F) option, you must have completed a minimum of 30 credit hours at Virginia Tech and have a cumulative GPA of 2.50 or above. You may not take a required course or course used for the University Core Curriculum on a P/F basis. A course taken P/F may not be repeated under the A-F system. (NOTE: some graduate schools currently average P/F courses as D’s in computing the GPA to determine whether admission requirements have been met.) (Further details may be found in the Undergraduate Catalog.)

6. In the senior year, students may enroll in graduate level coursework if they have a GPA of 3.0 or above. Before registering for the course, they must have advisor approval. (Additional approval is required for non-ESM courses.) (See the Undergraduate Catalog for details.)

7. A student must consult with the ESM Academic and Career Advisor and obtain approval in writing from the Associate Department Head before he or she deviates from the normal course requirements.

8. The ESM Department encourages its undergraduates to participate in the University Cooperative Education Program. (See Section 6 of this guide and the Undergraduate Catalog for additional information.)

9. Elective courses may not duplicate previous coursework. The 12 hours of technical electives courses must be approved by the Associate Department Head.

10. Whenever a student enrolls in ESM 2974, 2994, 4974, or 4994 (special and independent studies), an authorization form, available on the College of Engineering web site, must be completed and signed prior to the beginning of the semester in which the course is to be taken. To be eligible for these courses, the student must have a 2.0 GPA overall and in the Department.

11. The ESM Department encourages its senior students to take ESM 4404 - Fundamentals of Professional Engineering during the spring semester. This course is P/F only, and may not be used for credit toward graduation.

12. Eligibility for Continued Enrollment: Upon having completed 72 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" toward a B.S. degree will include the following minimum criteria: (1) all courses in the freshman year, including a minimum grade of C- or better in ENGE 1024 and ENGE 1114; (2) credit for MATH 2214, 2224; ESM 2014, 2104, 2204, 2304, 2074; and PHYS 2305, 2306; and (3) a 2.5 GPA.
4. NOTES ON TECHNICAL ELECTIVES

1. All 12 hours of technical electives must be taken on an A-F grade basis unless approval from the Associate Department Head is obtained for a pass/fail grade basis.

2. The student who is not specializing in solid mechanics and materials, fluids, motion, engineering physics, or biomechanics, but who is developing a broad background as the 12 hours of technical electives are taken, may wish to take one or two courses under each of the columns shown at the end of this section.

3. The following list is not meant to be all-inclusive. Any technical elective in the university, normally at the 3XXX or 4XXX level, may be taken with approval to partially fulfill the 12 hours of technical electives.

4. Note that a student may obtain a minor in mathematics by taking one additional math course approved by the Mathematics Department (see Section 6).

5. In taking the 12 hours of technical electives, the student must obey all prerequisite rules.

6. There must be no duplication of course material as the 12 hours of technical electives are taken.

7. For qualified students, a 5XXX-level course may be taken as part of the 12 hours of technical electives. See the Associate Department Head for approval.

By the end of first semester of the junior year, each ESM student must obtain the approval of the Associate Department Head for a proposed course of study which indicates those courses that will be used to fulfill the requirements for technical electives. The required form may be found on page 16 of this document, or obtained in the ESM office. Earlier presentation is encouraged.

Any changes in the approved program, regardless of the reason for the change, must have approval from the Associate Department Head.
SUGGESTED TECHNICAL ELECTIVE COURSES

Listed in the table below are courses which the student may take in fulfilling the 12 hours of technical electives. One asterisk (*) denotes *recommendation* for the particular area; two asterisks (**) denotes *strong recommendation*.

<table>
<thead>
<tr>
<th>Area of Concentration</th>
<th>Course</th>
<th>Solid Mechanics and Materials</th>
<th>Fluids</th>
<th>Motion</th>
<th>Biomechanics</th>
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<tbody>
<tr>
<td><strong>ESM 4024</strong> (Advanced Mechanical Behavior of Materials)</td>
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<td><strong>ESM 4044</strong> (Mechanics of Composite Materials)</td>
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<td><strong>ESM 4084</strong> (Engineering Design Optimization)</td>
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<td><strong>ESM 4105-4106</strong> (Engineering Analysis of Physiologic Systems)</td>
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<td><strong>ESM 4114</strong> (Nonlinear Dynamics)</td>
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<td><strong>ESM 4204</strong> (Musculoskeletal Biomechanics and Biologic Control)</td>
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<td><strong>ESM 4224</strong> (Biodynamics &amp; Control)</td>
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<td><strong>ESM 4234</strong> (Mechanics Bio Matls and Struct)</td>
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<td><strong>ESM 4245-4246</strong> (Mechanics of Animal Locomotion)</td>
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<td><strong>ESM 4304</strong> (Hemodynamics)</td>
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<td><strong>ESM 4444</strong> (Stability of Structures)</td>
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<td><strong>ESM 4574</strong> (Biomaterials)</td>
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<td><strong>ESM 5405-5406</strong> (Clinical Internship in Biomedical Engineering) (3 hours countable as technical electives, the other 3 hours countable as free electives)</td>
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<td><strong>AOE 3024</strong> (Thin-Walled Structures)</td>
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<td><strong>AOE 3124</strong> (Aerospace Structures)</td>
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<tr>
<td><strong>AOE 3224</strong> (Ocean Structures)</td>
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<tr>
<td><strong>AOE 3134</strong> (Stability and Control)</td>
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<tr>
<td><strong>AOE 4134</strong> (Astromechanics)</td>
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<td><strong>AOE 4214</strong> (Ocean Wave Mechanics)</td>
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<td><strong>CEE 3404</strong> (Theory of Structures)</td>
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<td><strong>CEE 3414</strong> (Design of Wood Structures)</td>
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<td><strong>CEE 3424</strong> (Reinforced Concrete Structures I)</td>
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<td><strong>CEE 3434</strong> (Design of Steel Structures I)</td>
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<td><strong>ECE 3105-3106</strong> (Electromagnetic Fields)</td>
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<td><strong>ECE 4405-4406</strong> (Control Systems)</td>
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<td><strong>ME 3304</strong> (Heat and Mass Transfer)</td>
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<td><strong>ME 4234</strong> (Aerospace Propulsion Systems)</td>
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<td><strong>ME 4224</strong> (Aircraft Engines and Gas Turbines)</td>
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<td>Area of Concentration</td>
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<td>Fluids</td>
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<td>ME 4504 (Dynamic Systems Controls Engineering I)</td>
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<td>ME 4514 (Controls Engineering II)</td>
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<td></td>
<td>ME 4524 (Introduction to Robotics and Automation)</td>
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<td>MSE 4304 (Metals and Alloys)</td>
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<td></td>
<td>MSE 4055 (Materials Selection and Design I)</td>
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<td>MSE 4164 (Corrosion)</td>
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Additional Courses for Technical Elective Credit

The following list includes additional courses which might be considered as technical electives by all ESM students:

CHEM 2535 – 2536, 2545 – 2546 (Organic Chemistry and Laboratory)
CHEM 4654 (Adhesive and Sealant Science)
MATH 3214 (Calculus of Several Variables)
MATH 4164 (Advanced Discrete Mathematics)
MATH 4234 (Elementary Complex Analysis)
MATH 4445 – 4446 (Introduction to Numerical Analysis)
PHYS 3405 – 3406 (Intermediate Electricity and Magnetism)
PHYS 4455 – 4456 (Introduction to Quantum Mechanics)
PHYS 4504 (Introduction to Nuclear and Particle Physics)
PHYS 4714 (Introduction to Biophysics)
5. CREATIVE DESIGN AND PROJECT

Each student in the Department must complete a Senior Design Project. The project consists of an independent or group investigation in which principles of engineering science and mechanics are applied to design formulations of an experimental apparatus, process, or product. Specifically, each student will follow the following process to achieve his or her design:

- Develop the scope and technical details required to solve a design-focused engineering problem;
- Develop a set of specifications for the construction of the component, machine, device, or system, where appropriate;
- Derive the specifications and form of the design from mechanics principles secured through the ESM curriculum;
- Identify the market, social, environmental, political, ethical, etc. constraints that influence the design, and vice-versa;
- Incorporate both quantitative (mechanics, economics) and qualitative (social, environmental, political, ethical, etc.) constraints necessary to derive a compromise on the design;
- Deliver hardware and/or software in a prototype form, when possible and where appropriate;
- Develop performance verification tests to assess if the system meets/exceeds design specifications, when possible and where appropriate; and
- Communicate the progress and specifics of the design with team members and the advisor.

Each student must choose a faculty advisor for the project, either before or early during the semester in which the student is registered for ESM 4015 Creative Design and Project I. Students must meet with the potential advisor and obtain his or her agreement to serve during the time period for which the student will be registered. The faculty advisor is charged to “mentor” the student(s) in the technical details of their selected projects. At least one faculty advisor from the ESM faculty (including visiting professors) is required for each group or individual project although there may be outside advisors from other departments or organizations. The faculty advisor will actively advise students in the following manner:

- Set aside regular meeting times for the student(s) during both fall and spring semesters (to be mutually agreed upon by the student(s) and the Advisor [e.g. one half-hour per week]).
- Review drafts of reports for technical content and adherence to milestones described in the timeline. The advisor’s signature will be sought for verification that these reports have been reviewed and comments returned to the student. The student is responsible for securing these signatures at the advisor’s convenience.
- Assist with resources only when available and applicable. These resources are in addition to the $750 per team per year funding supplied by the Department.
• Assist in assigning grades based on the percentages specified in the syllabus. This responsibility is given solely to the instructor and advisor, and is not to be delegated to anyone else.

Each student must register for the total of six hours of ESM 4015-4016 while completing the Senior Project. (If a student wishes to continue work in the subject area of the project after 6 credits have been earned, and the faculty advisor agrees to continue in the advising role, the additional work must be under the auspices of ESM 4994 - Undergraduate Research.)

At the conclusion of the project, each student must present an oral report on his or her work, and also submit a typed formal report. The written report, signed by the faculty advisor, will be due when scheduled by the course instructors (typically during the exam period). Students who complete their projects at times other than the Spring Semester are subject to the same rules and must follow the same procedures as those who are on the regular schedule. Oral presentations will usually be scheduled during the latter part of April subject to the Fundamentals of Engineering (FE) Examination schedule, or during the Summer Semester in which the work is completed. Only one set of presentations will be scheduled in any semester or term, and all students who complete their work during that period must meet that schedule even if following the schedule requires the student to return to the campus from a job.

In the absence of special permission to depart from the standard schedule, the general schedule of procedures and deadlines must be met by the student. Special permission for a change from the standard schedule will be given by the Associate Department Head only for cause and only upon written petition by the student. Such petitions must be channeled though the student's course instructor and be recommended by the ESM Academic and Career Advisor. The student must submit this request in advance of registration for the semester in which the departure from the normal schedule will be made.
The Standard Senior Project schedule is as follows:

**Fall Semester: ESM 4015**

- Identify a project and advisor (descriptions of suggested projects will be handed out in ESM 4015 in the Fall Semester; students are free to devise their own projects if they so choose, but since they must work under the direction of a faculty member, they must enlist the services of an advisor); set project goals; review literature; and open a computer account for project (if necessary).

- Classes will meet twice a week for 75 minute periods to assist the students in the development of the design project. In addition, the class will receive instruction in communications, ethics, teamwork, and critical thinking as they relate to the field of design and professional development.

- Regular meetings with the advisor (a minimum of once every two weeks, more often if deemed necessary by advisor).

- A Fall Report will be submitted at the conclusion of the Fall Semester that builds on the work of that semester. This document includes a definition of the problem/effort, a literature review which identifies the prior art, deliverables, approach to the solution or design, timeline for accomplishing said goals, and a statement of progress.

**Spring Semester: ESM 4016**

- Classes will meet once a week allowing students ample opportunity to complete the details of their projects. The classes will include time for discussion and project oral progress reviews.

- Written progress reports will be due at regular intervals during the semester. These reports will help students maintain a schedule and identify problems.

- Regular meetings with the advisor (as in the Fall Semester).

- A draft of the final report will be due to the course instructors and the faculty advisor in late March or early April. This report will be graded and serve as an opportunity for the students to get feedback on the development of their project and report.

- Oral Presentations will be held (typically at the end of April) – All students registered for ESM 4016 (or 4904) are required to attend all presentations; all other students are welcome.
RECOGNITION OF OUTSTANDING SENIOR PROJECTS

Dan H. Pletta Award  -- Following the Spring Semester oral presentations, the Senior Project Committee will choose the most outstanding project completed during the year, and the faculty will award the Dan H. Pletta Award for the Most Outstanding Senior Project to the student whose project is selected. Students selected for this award will have their names engraved on a permanent plaque in Norris Hall. The Dan H. Pletta Award is given in honor of the late University Distinguished Professor Dan H. Pletta, who served as Head of the Department from 1948 to 1970.

James H. Sword Award  -- The Senior Project Committee will also choose the most outstanding project in computational mechanics completed during the year, and the faculty will award the James H. Sword Award for the Most Outstanding Senior Project in Computational Mechanics to the student whose project is selected. Students selected for this award will have their names engraved on a permanent plaque in Norris Hall. The James H. Sword Award is given in honor of Professor Emeritus James H. Sword, who served on the ESM faculty from 1951 to 1989, and as Assistant Department Head from 1973 to 1989.
6. SPECIAL UNDERGRADUATE PROGRAMS

Minor in Mathematics

Since ESM majors are required to take 6 credit hours of 4000-level mathematics, (MATH 4564, 4574) they can pick up a minor in mathematics with 3 additional credits. By properly selecting these 3 credits, you can use the Math courses to satisfy one of the ESM Technical Elective Courses. Students interested in obtaining a Minor in Mathematics should inform their advisor of their intent and should go to the main office of the Mathematics Department (Room 460, McBryde Hall) to discuss the program, register, and pick up a check sheet. The Undergraduate Catalog has additional information.

The Cooperative Education Program

Cooperative Education is an educational process which formally integrates the academic study program with related work experience. The University Cooperative Education Program is a five-year program based on alternating periods of work and study during the sophomore and junior years; the freshman and senior years are usually spent on campus. Students are required to complete a minimum of three sessions of co-op experience in order to receive a certificate from the University. Engineering students in the program must maintain a 2.0 GPA. Because of the work period requirement, the student must enter the program no later than the end of the sophomore year; transfer students must complete two academic semesters to be eligible for the program. Further information may be obtained from the Cooperative Education Office, and the Undergraduate Catalog.

Since some ESM courses are taught only once per year, it may be necessary to take a substitute course from another department to replace the required ESM course. Please see the Associate Department Head for details.

The ESM Department encourages students to participate in the Cooperative Education Program. Not only is the experience financially rewarding, it also provides the student with an opportunity to obtain practical first-hand engineering experience which is invaluable in the total education process.
7. GRADUATE PROGRAM CONSIDERATIONS

Master of Business Administration (MBA)

Students interested in an MBA should consult the College of Business. Through proper planning, the student can use his or her free electives to complete some of the requirements for entrance into the MBA program upon completion of the B.S. degree.

Pre-Medical/Pre-Dental Professional Programs

Pre-Health advising at Virginia Tech is handled by the Office of Pre-Health Advising located in the Smith Career Center and is under the direction of Dr. Judith Wubah. The program advises students in all curricula as to the specific requirements for program admission and assists students in moving toward the goal of becoming competitive applicants. The Health Professions Committee conducts campus interviews in the spring semester of a student’s junior year. The office maintains cordial relations with the admissions offices of medical schools in Virginia and neighboring states. Additional information is available from the Pre-Med and Pre-Dental website at http://www.univhonors.vt.edu/html/premed_intro.html. In addition, information sessions will be held twice weekly at the Career Center. Pre-registration is required and can be done via the Career Center’s website, http://www.career.vt.edu.

Accelerated Undergraduate/Graduate (UG/G) Degrees

Upon completion of 90 credit hours and with at least one semester remaining until all requirements for the bachelor’s degree are completed, undergraduate students at Virginia Tech having an overall grade point average of at least 3.3 may apply for the ESM Accelerated Undergraduate/Graduate Degree (BS/MS, BS/MEng or BS/PhD) Program. This program allows these students to count up to 12 credit hours taken during the last twelve months before the awarding of the bachelor’s degree toward both the bachelor’s and graduate (MS, MEng or PhD) degrees. These credit hours must be taken before the completion of the undergraduate degree and after admission into the Undergraduate/Graduate Degree Program. Only 6 credit hours of 4xxx level courses may be counted towards the graduate degree. A grade of at least a B is required in each course taken before the completion of the BS degree that is used for the graduate degree.

Upon admission into the program, the Associate Department Head and the Director of Graduate Studies will jointly advise the student until the Plan of Study is approved by the graduate school. The Plan of Study must be completed during the first semester after the completion of the bachelor’s degree. Students wishing to apply for the Accelerated Undergraduate/Graduate Degree Program should

1. Meet with the Associate Department Head to discuss courses that may be used in the program.
2. Complete an on-line graduate application, including all supporting material, at http://www.grads.vt.edu/homeapply.html by January 1st for spring, May 1st for summer, or August 1st for fall semester admission. At this point, they will need to pay the application fee to the Graduate School. The GRE is not required for admission into this program.

Acceptance into the program will be determined by the Department after review of the completed application.
8. UNDERGRADUATE TECHNICAL ELECTIVE APPROVAL FORM

Student Name: ___________________________________________

Student ID Number: _____________________________

Goals after graduation:

Technical Elective Courses:

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<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
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Total Credits (must equal 12): ___

Rationale for Course Selection:

Approval:

___________________________________________
Associate Department Head

___________________________________________
Date