FAST TRACK CALCULUS

Integral and multivariable calculus, is offered during the summer (late July through late August) for selected members of our entering freshman class who have demonstrated outstanding ability in mathematics and studied a year of calculus during high school. Participants are expected to have scored at least 700 on the mathematics portion of the SAT or 31 on the mathematics portion of the ACT. Students, who have a 700 Math Score or 680 math/700 critical reading or better on the SAT, or a 30 mathematics score and at least a 31 English score on the ACT have also been admitted to the program. Participants who successfully complete Fast Track Calculus satisfy Rose-Hulman’s freshman Calculus requirement, are awarded 15 quarter hours of credit toward graduation, and begin their college careers as “mathematical sophomores.”

Admission to Fast Track Calculus is competitive. Interested students should contact the Head of the Mathematics Department or Director of Fast Track Calculus.

ACCELERATED MATH PHYSICS

An integrated calculus and physics course is offered during the summer (late July through late August) for selected members of our entering freshman class who have demonstrated outstanding ability in mathematics and physics having taken a year of college level calculus during high school and one year of high school physics. Participants are expected to have scored at least 700 on the mathematics portion of the SAT or 31 on the mathematics portion of the ACT. Students, who have a 700 mathematics score or 680 mathematics/700 critical reading or better on the SAT, or a 30 mathematics score and at least a 31 English score on the ACT have also been admitted to the program. Participants who successfully complete the Accelerated Math Physics Program will earn credit for MA113, PH111, and PH112. Selected students are expected to have the ability to place out of MA111 and MA112, so will start in the Fall quarter having credit for MA111, MA112, MA113, PH111, PH112 – effectively as sophomores. Admission to the Accelerated Math Physics Program is competitive. Interested students should contact the Directors of the Accelerated Math Physics Program.

NEW STUDENT ORIENTATION
To aid entering students in their adjustment to college life, a five-day orientation period for students precedes regular classroom instruction prior to the start of the academic year. Each freshman is required to be present for this program. The program offers a number of advantages to both the students and faculty. The students become acquainted with the facilities and surroundings, with each other, and with the regulations and routines of college life. Students learn about the various student organizations, opportunities for co-curricular activities and Rose-Hulman student traditions.

Further, students are introduced to the nature of science and engineering studies, and they meet with their faculty advisers and resident assistants. Talks and discussions offer them insight into the kinds of work engineers and scientists do and into the satisfactions to be derived from a career in science and engineering.

The orientation period also permits the faculty an opportunity to administer a number of diagnostic tests. These tests seek to determine achievement levels in academic areas and are useful for two purposes: they are tools to be used by the faculty advisers and counselors to do effective counseling, and they help to identify students who may need special attention.

Although Rose-Hulman uses the best available criteria to select its students, the undeniable fact is that students come to college with widely varying degrees of motivation and with widely differing qualities of high school preparation. The diagnostic efforts of the orientation period help to identify those students who could immediately qualify for advanced work in certain areas, and those who indicate a need for additional help. Students at Rose-Hulman normally complete their degree requirements in four years, but the Institute also wishes to provide for those students who, with encouragement and opportunity, do more than the normal student in four years and for those who may need special help or a slower pace of study.

SUSTAINABILITY MINOR

1. Curricular Requirement
   a. Core Courses (16 credits)
      i. GS130 Introduction to Sustainability (4 credits)
      ii. BIO191 Environmental Science (4 credits)
      iii. SV150 Microeconomics (4 credits)
      iv. MDS302 Sustainability in Practice (2 credits): prerequisites: GS130, BIO191, SV150
          This is a project-based course to provide hands-on experiences for student teams working on real-world problems related to sustainability. This could include design projects, scientific research, modeling-based projects, or studies to improve campus sustainability. The course instructor will mentor teams with routine assignments that relate to their design or research process through oral and written communication.
      v. MDS402 Seminar in Sustainability (2 credits): prerequisite MDS302
          This course provides students with the opportunity to examine, analyze, and reflect upon sustainability as it related to their project or research work. Course work includes weekly readings and discussions, individual essays, and in-class and public presentations. Successful completion of this course will require students to have completed the co-curricular requirements.
b. Three electives (4 credits each = 12 credits) Students must take a total of at least four credits from a list of Social courses and at least eight credits from a list of Technical and Scientific courses. Alternatively, students can design their own plan of study for elective courses that suit their particular interests and field of study with approval of the HERE Co-directors, Jenny Mueller Price and Mark Minster.

i. Social (HSS requirement)
   SV201 Religion and Ecology
   SV303 Business and Engineering Ethics
   SV304 Bioethics
   SV322 Disasters and Modern Society
   SV 354 Environmental Economics
   SV339 Literature and the Environment
   GS 425 Cities and Technology in the Industrial Age

ii. Technical and Scientific (Discipline Specific Tech Elective)
   BIO320 Ecology (prerequisite: BIO130)
   CE250 Sustainable Civil Engineering Design (2 credits)
   CE460 Introduction to Environmental Engineering
   CE471 Water Resources Engineering
   CHEM470 Green Chemistry (Special Topics)
   CHE465 Energy and the Environment
   CSSE241 Computing in a Global Society
   ECE371 Sustainable Energy Systems (prerequisite: ECE204)
   ECE398 Appropriate Technologies for Developing Countries (Special Topics)
   EMGT587 Systems Engineering
   ME408 Renewable Energy (prerequisite: ES202)

2. Co-curricular requirements: Students record via Co-curricular Report on Banner Web. Students will need to complete these requirements to pass MDS402 Seminar, which is taken senior year. Requirements will be prorated for students joining the program after their freshman year.

a. Three professional development activities per year (guest speakers; trips to St. Louis, Bloomington, Chicago, and Subaru plant each year; Terre Haute Farmer's Market; etc.)

b. Six project hours per year (Campus garden and greenhouse, Ryves neighborhood, RHIT Campus Day of Service, RHIT Campus Beautification, Keep Terre Haute Beautiful, Student-led initiatives, etc.)

MULTIDISCIPLINARY MINOR IN COGNITIVE SCIENCE

The Multidisciplinary Minor in Cognitive Science has the following requirements:

2. Object-Oriented Software Development (CSSE 220) or Fundamentals of Software Development Honors (CSSE 221)
3. Philosophy of Mind (IA 301) or Philosophy of Science (IA 401) or Human Nature (SV 472)
4. Three additional courses from the list below. At least two courses must be from the same group. A course may not satisfy more than one requirement of the minor.
5. Substitutions may be made with the approval of the Minor Advisor.
Courses:

Mind and Behavior group

• IA 301 Philosophy of Mind
• IA 352 Game Theory
• SV 171 Introduction to Psychology
• SV 402 Human Nature
• SV 472 Studying Human Behavior

Computation and Artificial Intelligence group

• CSSE 290 Cognitive Computing
• CSSE 413 Artificial Intelligence
• CSSE 453 Topics in Artificial Intelligence
• CSSE 463 Image Recognition
• IA 471 Computational Psychology
• MA 490 Deep Learning

Neuroscience group

• BE 310 Analysis of Physiological Systems I
• BE 520 Introduction to Brain Machine Interfaces
• BE 543 Neuroprosthetics

CONSULTING ENGINEERING PROGRAM

Through the generosity of J. B. Wilson, a prominent consulting engineer of Indianapolis, a program was established in 1973 to emphasize career opportunities in the field of consulting engineering and to provide selected courses which would be beneficial to students interested in consulting engineering careers.

Listed below is a program guide of recommended courses for a student interested in consulting engineering. This is not a degree program but is a supplement to the normal engineering degree programs. Some of the courses are in addition to the normal engineering degree programs and may result in a student earning more credits than are required for the B.S. degree in a specific discipline.

Students desirous of pursuing the Consulting Engineering Program should enroll in the Program by filing a declaration-of-intent form with the Chairman of the Commission. In order to be certified as having completed the Program, a student is required to successfully complete the prescribed list of courses, complete the requirements for a degree in Engineering, and take the Fundamentals of Engineering examination prior to graduation.

Upon completion of the program, students will receive a Certificate of Completion at the time of their graduation from Rose-Hulman Institute of Technology. Completion of the program will be noted on the student’s official transcript but not on the diploma. The Consulting Engineer Program advisor is Dr. Kevin Sutterer P.E., Ph.D., Department of Civil and Environmental Engineering.
EM102/EM104 Graphical Communications 2
RH330 Technical Communications 4
Or
IA230 Fundamentals of Public Speaking 4
SV351 Managerial Economics 4
Or
EMGT 432/532 Technical Entrepreneurship 4
CE303 Engineering Economy 4
Or
CHE416 Design I: Process Economics and Equipment Design 4
EMGT552 Business Law for Technical Managers 4
CE420/CHE420/ECE466 or ME420 Consulting Engineering Seminar 2
Engineering Design (any senior Engineering design course) 4

Total 24
Exceptions to these program course requirements require approval by the Consulting Engineering Program Advisor.
Registration for & sitting for the Fundamentals of Engineering Exam required.

MULTIDISCIPLINARY MINOR IN DATA SCIENCE
Any student may obtain a Multidisciplinary Minor in Data Science by taking the following courses:

Introductory Statistics Course (4 credit hours):
One of the following courses
• MA223 Engineering Statistics I
• MA382 Introduction to Statistics with Probability

Introductory Computer Science Courses (8 credit hours):
• CSSE120 Introduction to Software Development
• CSSE220 Object Oriented Software Development

Electives (16 credit hours):
Two courses from the list below:
• MA386 Statistical Programming
• MA384 Data Mining
• CSSE 230 Data Structures & Algorithm Analysis

A minimum of two additional course from the list below: (See degree separation requirement below.)
• BMTH312 Bioinformatics
• CSSE333 Database Systems
• CSSE413 Artificial Intelligence
• CSSE433 Advanced Database Systems
• CSSE434 Introduction to the Hadoop Ecosystem
• CSSE463 Image Recognition
• CSSE481 Web-Based Info Systems
• CSSE490 Internet of Things
• CSSE335/MA335 Introduction to Parallel Computing
• MA384 Data Mining
• MA386 Statistical Programming
• MA480 Bayesian Inference
• MA482 Bioengineering Statistics
• MA485 Applied Regression and Time Series
• MA490 Machine Learning
• MA490 Deep Learning
• ME447 Visualizing Data
• ME497 Reproducible Research
• PH327 Thermodynamics and Statistical Mechanics
• SV450 Econometrics

Notes and limitations on requirements:

• Degree Separation Requirement: The Multidisciplinary Minor in Data Science must be separated from any other minor and the named required courses of any major by a minimum of 16 credit hours. Exceptions to this requirement must be approved by the minor advisor for Data Science and the heads of both the Department of Mathematics and the Department of Computer Science and Software Engineering.
• Electives not listed above may be substituted with other courses with the approval of the minor advisor for Data Science.
• The minor plan of study must be approved by the minor advisor for Data Science and the student’s advisor.

STUDY ABROAD

Students are provided the opportunity to enhance their academic experience by studying at an institution abroad. The Office of Global Programs offers information and support for students interested in immersive study abroad. To ensure the integrity of the experience, the following policies have been established.

• Students with a cumulative grade point average of 2.75 or higher, and who will have completed at least 45 earned credit hours at Rose-Hulman by the time of study abroad may apply for approval to enroll in a study abroad program.
• Students must be in good academic standing to apply for study abroad, including dual degree programs. Students who fall out of good academic standing between approval and the beginning of study abroad will be ineligible to study abroad until they are back in good standing.
• Students must remain in good standing during their study abroad program.
• Approved study abroad students will remain enrolled at the institute during the quarter or academic-year study abroad period.
• Students studying in a single location where English is not an official language are expected to study the official language of that country while studying abroad if they do not already have proficiency in that language.
• Students must maintain full-time status at the host institution and must receive a grade of “C” or better (converted to US system) in order for courses to be transferred in. Courses taken abroad for pass/fail credit will not be considered for transfer in.
• All study abroad credit, including dual degree, will be treated as transfer credit and will not be factored into cumulative GPA.
• Students may not have already graduated at the time of study abroad.
• Academic Misconduct will be taken into consideration as part of the approval process.
• Students will be subject to Rose-Hulman’s Code of Ethics while participating in study abroad.

Exceptions to the above policies may be considered for transfer students and on a case-by-case basis by the Office of Global Programs.

A full listing of study abroad opportunities is available from the Office of Global Programs.

INTEGRATED CIRCUIT TESTING CERTIFICATE

Testing integrated circuits is a critical element in the integrated circuit industry. In fact, testing has become the bottleneck for many companies, with inefficient test programs preventing the release of products onto the market. With few colleges offering courses in this area, students at RHIT have a unique specialization opportunity, making them marketable and extremely valuable in the integrated circuit industry.

This certificate intends to provide the student with a solid background in test and product engineering and broaden that background with other courses pertinent to the test and product engineering field. A strong test/product engineer requires knowledge about integrated circuit design, systems design, board design, semiconductor fabrication, and statistics. Therefore, courses in these areas can be chosen for the elective portion of the certificate.

The test and product engineering certificate could be completed by an electrical or computer engineering student without overloading if the certificate courses are mapped to all but one of the Area, Technical, and Free electives. Electives have been chosen so that students can pursue the semiconductor certificate or a math minor in conjunction.

Certificate Requirements

ECE351: Analog Electronics is required.

Two of the three testing courses are required.
ECE557: Analog Test and Product Engineering
ECE558: Mixed-Signal Test and Product Engineering
ECE531: Digital Test and Product Engineering

Three of ten elective courses are required.
ECE551: Digital VLSI
ECE552: Analog Integrated Circuit Design
ECE553: RF Integrated Circuit Design
ECE343: High-Speed Digital Design (required for CPE program)
ECE416: Intro to MEMS
ECE419: Advanced MEMS
ECE454: System Level Analog Electronics
ECE557: Analog Test and Product Engineering (if not used for required testing course)
ECE558: Mixed-Signal Test and Product Engineering (if not used for required testing course)
ECE531: Digital Test and Product Engineering (if not used for required testing course)
PH405: Semiconductor Materials and Device I
EP406: Semiconductor Materials and Devices II
MA385: Quality Methods Engineering
MA387: Statistical Methods in Six Sigma

For further information about the certificate program, please contact Tina Hudson (hudson@rose-hulman.edu).

MULTIDISCIPLINARY MINOR IN IMAGING

Imaging concerns the collection, manipulation, analysis, generation, understanding and processing of images. It includes computer graphics, computer vision, optical imaging and filtering, signal processing and aspects of artificial intelligence. Rose-Hulman Institute of Technology offers a multidisciplinary minor in imaging. Hands-on experience is emphasized in the Imaging Systems Laboratory, which is used for project work by imaging students and graduate students whose theses involve imaging.

The minor recognizes undergraduate students who have gained a grounding in imaging systems while at Rose-Hulman. The minor requires 6 courses (at least 22 credits). Three courses are required core courses, two are electives, and one is the imaging systems project. A student would expect to take these courses starting in the junior year. A student in any major should be able to obtain an imaging minor with minimal, if any, course overload. Students interested in pursuing the minor should see the certificate advisor (listed below).

Required Courses
CSSE351 - Computer Graphics, Prerequisites: CSSE220, or CSSE221, and MA212 (Fall)
ECE480/PH437 - Introduction to Image Processing, Prerequisites: MA212, Junior standing (Winter)
OE295 - Optical Systems, Prerequisites: PH113, MA211 (Spring)

Elective Courses (choose 2 that are not named courses required for your major)
CSSE325/MA325 - Fractals and Chaotic Dynamical Systems, Prerequisites: MA212, and CSSE220 or CSSE221 (Spring)
CSSE451 - Advanced Computer Graphics, Prerequisites: CSSE351 (Winter)
CSSE461 - Computer Vision, Prerequisites: MA212, CSSE220 or CSSE221 (Spring)
CSSE463 – Image Recognition, Prerequisites MA212, Junior Standing, Programming Experience (Winter)
ECE580 - Digital Signal Processing, Prerequisites: ECE380 or consent (Winter)
ECE582/PH537 - Advanced Image Processing, Prerequisites: CSSE 220 or CSSE221 or ME 323 or ECE 380 or consent; MA 212 (Spring)
MA323 - Geometric Modeling, Prerequisites: MA113 (Winter)
MA439 - Mathematical Methods of Image Processing, Prerequisites: MA212 (Fall)
OE480 - Lens Design and Aberrations, Prerequisites: OE 280 or SR/GR standing or consent of instructor (Fall)
OE592 - Fourier Optics and Applications, Prerequisites: SR/GR standing or consent of instructor (Fall)
ECE497 - Medical Imaging Systems, Prerequisites: ECE300 (Spring)
BE491 - Biomedical Imaging, Prerequisites: SR/GR standing or consent of instructor (Fall)

Other courses and independent studies which are consistent with an individual's imaging systems studies may also be used to satisfy the elective course requirements, subject to approval by the imaging systems faculty.

**Imaging Project**

A project with a significant imaging component is required. This may be done in any discipline. Projects must be approved by the Imaging Faculty. Projects must include both a written report and a public presentation, and be made available for future use. Students may meet this requirement in three ways: (1) A student may complete a 4-credit independent study, approved by the Imaging Faculty. (2) A student may begin the project in a course and then extend and document the project and make a public presentation during an independent study approved by the Imaging Faculty. (3) A student may complete an approved senior thesis or project involving imaging and substitute a senior thesis or project course for the independent study.

**Imaging Systems Program Director**

Matt Boutell, Department of Computer Science and Software Engineering

**Imaging Systems Faculty**

Matt Boutell, Department of Computer Science and Software Engineering
S. Allen Broughton, Department of Mathematics
Robert M. Bunch, Department of Physics and Optical Engineering
Kurt Bryan, Department of Mathematics
Ed Doering, Department of Electrical and Computer Engineering
David L. Finn, Department of Mathematics
Charles Joenathan, Department of Physics and Optical Engineering
Cary Laxer, Department of Computer Science and Software Engineering
Michael F. McInerney, Department of Physics and Optical Engineering
J.P. Mellor, Department of Computer Science and Software Engineering
Wayne T. Padgett, Department of Electrical and Computer Engineering
Deborah Walter, Department of Electrical and Computer Engineering
Alan Chiu, Department of Biology and Biomedical Engineering
Kosta Popovic, Department of Physics and Optical Engineering

**CERTIFICATE IN SEMICONDUCTOR MATERIALS AND DEVICES**

The Certificate will consist of 20 credit hours of which 12 credit hours will be required courses. Students interested in pursuing this Certificate should see a PHOE certificate advisor (S. Kirkpatrick, Liptak, McInerney, Siahmakoun, Syed and Wagner). Students taking solid state/material science minor cannot take this certificate.

**Required Courses**
1. PH405 Semiconductor Materials and Applications -- 3R-3L-4C F Pre: PH113 or PH255 or PH265 or consent of instructor.
2. EP406 Semiconductor Devices and Fabrication -- 3R-3L-4C W Pre: PH405 or consent of instructor.
3. EP410 Intro to MEMS: Fabrication and Applications -- 3R-3L-4C S Pre: JR or SR standing or consent of the instructor.
   or:
   CHE440 Process Control 4R-0L-4C W Pre: CHE202

**Electives**

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>OE 450</td>
<td>4</td>
<td>Laser Systems and Applications</td>
</tr>
<tr>
<td>OE 485</td>
<td>4</td>
<td>Electro-Optics and Applications</td>
</tr>
<tr>
<td>PH 330</td>
<td>4</td>
<td>Material Failure</td>
</tr>
<tr>
<td>PH 401</td>
<td>4</td>
<td>Introduction to Quantum Mechanics</td>
</tr>
<tr>
<td>PH 440</td>
<td>4</td>
<td>X-rays and Crystalline Materials</td>
</tr>
<tr>
<td>EP 408</td>
<td>4</td>
<td>Microsensors</td>
</tr>
<tr>
<td>EP 411</td>
<td>4</td>
<td>Advanced Topics in MEMS</td>
</tr>
<tr>
<td>ECE 351</td>
<td>4</td>
<td>Analog Electronics</td>
</tr>
<tr>
<td>ECE 551</td>
<td>4</td>
<td>Digital Integrated Circuit Design</td>
</tr>
<tr>
<td>ECE 552</td>
<td>4</td>
<td>Analog Integrated Circuit Design</td>
</tr>
<tr>
<td>ME 302</td>
<td>4</td>
<td>Heat Transfer</td>
</tr>
<tr>
<td>ME 328</td>
<td>4</td>
<td>Materials Engineering</td>
</tr>
<tr>
<td>ME 424</td>
<td>4</td>
<td>Composite Materials &amp; Mechanics</td>
</tr>
<tr>
<td>ME 415</td>
<td>4</td>
<td>Corrosion and Engineering Materials</td>
</tr>
<tr>
<td>CHE 314</td>
<td>4</td>
<td>Heat Transfer</td>
</tr>
<tr>
<td>CHE 315</td>
<td>4</td>
<td>Material Science and Engineering</td>
</tr>
<tr>
<td>CHE 440</td>
<td>4</td>
<td>Process Control</td>
</tr>
<tr>
<td>CHE 441</td>
<td>4</td>
<td>Polymer Engineering</td>
</tr>
<tr>
<td>CHEM 441</td>
<td>4</td>
<td>Inorganic Chemistry I</td>
</tr>
<tr>
<td>CHEM 451</td>
<td>4</td>
<td>Organic Structure Determination</td>
</tr>
</tbody>
</table>
Overall aim of the Certificate

A certificate holder will understand how semiconductor devices work, have practical experience in the main stages of device production, have practical experience in the more common forms of device testing and characterization, and have broad understanding of the mechanical and chemical properties of the material used.

A Certificate holder will be well suited for jobs requiring an understanding of semiconductor devices and their production. These jobs include not only those directly related to device fabrication, but also those involved with testing and trouble-shooting electronic equipment and the design of machines that contain electronic equipment. The experience in simple device fabrication that the Certificate provides is particularly useful for future engineers in “process” industries.

THE MANAGEMENT STUDIES PROGRAM

The Management Studies Program is a selected group of courses which develops a broad understanding of management in business and society. Like the Rose-Hulman Technical Translators Program, the Management Studies Certificate is a supplement to an engineering or science degree. The curriculum is a core of required courses in ethics, engineering management, economics, and technical communication with electives dealing with the role of management in society and specific tools for managers.

Statement of Objectives

The Management Studies Program broadens the education of engineers and scientists through a curriculum which:

• teaches the quantitative and economic concepts needed in management decision-making;
• promotes productivity through people;
• stresses communication skills required in management;
• examines intended and unintended impacts of management decisions;
• explores the social, legal, and ethical contexts of management.

Although the nine courses necessary to receive the certificate are a challenging addition to the undergraduate’s academic load, many of them may simultaneously be used to fulfill Humanities and Social Science, technical elective, and other degree requirements. Science majors should be able to complete the program easily within the regular four year pattern, but engineering majors may have to overload. In order to minimize conflicts and meet individual needs, each student will design a specific program with the Management Studies Adviser in the first quarter of the sophomore year.

Requirements:
1. All of the following core Courses:
   SV151 Principles of Economics
   SV303 Business and Engineering Ethics
   RH330 Technical and Professional Communication
   SV350 Managerial Accounting or SV356 Corporate Finance
   SV351 Managerial Economics

2. Two of the following Management in Society Courses (in addition to the core courses):
   SV171 Principles of Psychology
   EMGTXXX Engineering Management
   SV304 Bioethics
   EMGT533 Intercultural Communication
   GS432 Literature and Film of the Global Economy
   SV353 Industrial Organization
   SV357 Labor Economics
   IA352 Game Theory
   SV463 Seminar on America’s Future
   IA453 The Entrepreneur
   EMGT526 Technology Management and Forecasting

3. Two courses from the following list. The student may choose to emphasize a strength area such as quantitative analysis, economics, or engineering management. Courses not included in this list may be approved by the Management Studies Advisor:
   CE303 Engineering Economy
   SV353 Industrial Organization
   IA350 Intermediate Microeconomics
   IA351 Intermediate Macroeconomics
   GS350 International Trade: Globalization
   GS351 International Finance
   CE441 Construction Engineering
   CE442 Cost Engineering
   MA444 Deterministic Models in Operations Research
   MA445 Stochastic Models in Operations Research
   CSSEXXX Courses beyond CSSE 120 in Computer Science
   MAXXX Any statistics courses
   EMGTXXX Any engineering management course

**GERMAN TECHNICAL TRANSLATOR’S CERTIFICATE PROGRAM**

A student may earn, in addition to one of the regular degree programs in science or engineering, a certificate of proficiency in German technical translation. Successful completion of this non-degree program partially fulfills the graduation requirements in humanities and social sciences.

**Certificate Requirements**

A student must have a 3.0 in the first two years of the foreign language and in his/her major, as well as permission of the instructor, to enter the third year language courses. Exceptions may be made by the instructor in charge of the program.
1. A student must complete all the technical courses required by one of the Institute’s degree-granting programs.

2. A student must successfully complete the third and fourth year courses of the German Studies program (GE 311/312/313 and GE 411/412/413). See the Humanities and Social Sciences (HSS) section of this catalogue for a description of these courses.

3. A student who successfully completes the requirements for the German Technical Translator Certificate is exempted from RH 131 Rhetoric and Composition, and from both courses in Global Studies (GS). This generally means that the student will only need to take three HSS courses other than German (one IA, one SV, and RH330 Technical and Professional Communication).

Commentary

A student who qualifies through the Foreign Language Examination administered at Rose-Hulman during Freshman orientation week, will be permitted to enroll in the appropriate level of German as determined by the foreign language faculty. A student who successfully completes a quarter of more advanced language at Rose-Hulman with a grade of C or better will be granted 4 hours of Credit by Examination for each quarter of language by-passed. (Note: a minimum of two terms of college language must be completed in order to receive HSS graduation credit.)

1. A student who is in the German Studies Program in Culture and Technology is not required to take RH131, Rhetoric and Composition.

2. In order to obtain the Translator’s Certificate, some students in some curricula may have to take more than the minimum number of credits required for graduation.

3. Due to scheduling requirements of some regular degree programs, a student may also have to carry an overload in some terms. This means that the student will have to maintain a better-than-average grade point average to meet the Institute requirements permitting an overload. See the Student Handbook for details.

4. A student is strongly urged, but not required, to spend at least one summer studying in an approved program for foreigners in Germany. Some small grants may be available to help defray expenses.

<table>
<thead>
<tr>
<th>Summary</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year German (GE 111, 112, and 113 or approved equivalent)</td>
<td>12</td>
</tr>
<tr>
<td>Second Year German (GE211, 212, 213 or approved equivalent)</td>
<td>12</td>
</tr>
<tr>
<td>Third Year German (GE311 Topics in German Culture I; GE312 Reading German Texts; and GE313 Advanced Grammar and Translation Methods</td>
<td>12</td>
</tr>
<tr>
<td>Course</td>
<td>Credits</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Fourth Year German (GE411 Technical Translation; GE412 Topics in</td>
<td>12</td>
</tr>
<tr>
<td>German Culture II; and GE413 Contemporary Germany)</td>
<td></td>
</tr>
<tr>
<td>One IA course (any)</td>
<td>4</td>
</tr>
<tr>
<td>One SV course (any)</td>
<td>4</td>
</tr>
<tr>
<td>RH330 (required for most majors)</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

**MULTIDISCIPLINARY MINOR IN ROBOTICS**

Robotics is a fast-growing field that is inherently multidisciplinary, incorporating mechanical systems, electrical systems, and software. It includes mobile robotics, mechatronics, and assistive technologies. Rose-Hulman Institute of Technology offers a multidisciplinary minor in robotics to recognize students who have gained experience in these areas while at Rose-Hulman.

To earn the Multidisciplinary Minor in Robotics, a student needs to complete the three courses listed below plus additional courses listed below per the student’s major.

**Courses that all majors must complete [12 credit hours]**

- CSSE120 Introduction to Software Development
- ME435/CSSE435 Robotics Engineering
- ECE425 Introduction to Mobile Robotics

Note for ME and BE students: CSSE120 can be used as a course substitution for the required introduction to programming course (ME123 or BE100). However, ME and BE students may take both the required class AND CSSE120. CSSE120 will then count as a free elective.

In addition to the courses listed above students completing the robotics minor need to complete the courses below that apply to their major. (Students with a double major or double degree may choose which major to use. If a student decides to switch majors, that student must complete a track below appropriate for their final degree. These degree requirements are evaluated only at the time of your graduation.)

(1) **CS and SE majors - Additional required courses:**
- ME430 Mechatronic Systems
- 8 credits of Robo Electives (see list below)

(2) **CPE majors - Additional required courses:**
- CSSE463 Image Recognition
- 8 credits of Robo Electives (see list below)

(3) **EE majors - Additional required courses:**
• CSSE220 Object-Oriented Software Development
• 8 credits of Robo Electives (see list below)

(4) ME majors - Additional required courses:

• CSSE220 Object-Oriented Software Development
• ME403 Kinematics of Machinery -or- ME497 Robot Dynamics and Control
• ME406 Control Systems
• 4 credits of Robo Electives (see list below)

2 Note, the list of additional required ME courses appears to be 1 course longer than other tracks, but ME students are required to take either Control Systems (ME406) or Vibration Analysis (EM406) already, so the requirement to take ME406 should not cause the ME track to be any longer.

(5) For majors not listed above - Additional required courses:

• CSSE220 Object-Oriented Software Development
• ME430 Mechatronic Systems
• BE350 or ECE 320 or ME 406 [or a Controls course from any major]3
• 4 credits of Robo Electives (see list below)

3 For BE majors, a controls course will fill an area requirement. So, much like the ME track, the requirement to have a controls course should not cause this track to be longer for BE majors than tracks for other majors.

Robotics Electives
Students choose Robotics Electives from the list below subject to the restrictions that a student’s Robotics Elective courses(s) cannot be any course listed above as an additional required course for the student’s major, and cannot be a course listed as a named requirement for the student’s major.

• BE350 Biocontrol Systems
• BE520 Brain Machine Interfaces
• BE543 Neuroprosthetics
• CSSE413 Artificial Intelligence
• CSSE480 Web App Frameworks with AppEngine
• CSSE483 Android Application Development
• CSSE484 iOS Application Development
• CSSE461 Computer Vision
• CSSE463 Image Recognition
• CSSE490 Swarm Intelligence
• CSSE290/490 Teamwork and Robotics
• CSSE290/490 Software Challenges in Robotics
• ECE320 Linear Controls
• ECE300 Continuous Time Signals and Systems
• ECE414 Wireless Systems
• ECE420 Discrete-time Control Systems
• ECE480/PH437 Image Processing
• ECE483 Digital Signal Processing System Design
• ECE582/PH537 Advanced Image Processing
• ECE583 Pattern Recognition
• IA471 Computational Psychology
• ME403 Kinematics of Machinery
• ME406 Control Systems
• ME497 Robot Dynamics and Control
• ME497 Three Dimensional Dynamics
• ME506 Advanced Control Sys
• ME518 Advanced Kinematics
• EM502 Advanced Dynamics
• EP408 Microsensors
• CSSE490/ME497/ECE497 Robotics Studio
• Independent study courses in robotics [requires approval BEFORE the course is taken]

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