COLLEGE OF ENGINEERING

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Professional Affiliates
J. Gerstman, C. Huang

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J. Bruneau, Assistant Professor of Economics

G. A. Cheston, Associate Professor of Computer Science

J. E. Greer, Professor and Head of Computer Science

P. Jonker, Extension Specialist

G. I. McCalla, Professor of Computer Science

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Assistant Professors
D. A. Degenstein, C. Mitchell

Sessional Lecturer
A. Ortlepp

*Denotes non-members of faculty.

GENERAL INFORMATION

ADMISSION REQUIREMENTS

See General Information section of the *Calendar*.

TRANSFER CREDIT

The admission of applicants with Transfer Credits or transferring from other post-secondary institutions, including The University of Regina, is governed by the following criteria:

(1) The applicant must have a sufficiently high academic standing to be eligible to continue in an engineering program at the last institution he or she attended. An applicant who has been advised or required to discontinue elsewhere, either temporarily or permanently, will not normally be accepted.

(2) The applicant's past academic record will be assessed as if the equivalent academic grades had been obtained at the University of Saskatchewan and the current College of Engineering promotion regulations applied.

(3) Credit for courses taken elsewhere may be granted on a course by course basis following an assessment of the transcripts by Admissions, Office of the Registrar, in consultation with the College of Engineering.

ADMISSION AND ENROLMENT LIMITS

Entry into the College of Engineering at the first year level is limited by an admission quota. There are also enrolment limits for all departments or branches of engineering beginning in second year and continuing into the upper years. Admission to, or continuation within, a program is based upon the applicant's academic performance in the preceding year.

Students entering second year are accepted on a priority basis due to the enrolment limits in each branch. Those having successfully completed one year in the College of Engineering are granted first priority. Transfer applicants must submit application forms by May 15.

FEES, PAYMENT OF FEES, CANCELLATIONS AND REFUNDS, AND COURSE CHANGES

See General Information section of the *Calendar.*

ACCREDITATION

The programs offered by the College of Engineering have been reviewed by the Canadian Engineering Accreditation Board of the Canadian Council of Professional Engineers. All programs have received the Board's approval and have been granted accreditation.

PROGRAMS

The program prescribed for the Bachelor of Science in Engineering (B.E.) extends over four years. There are seven fields of specialization: Agricultural and Bioresource, Chemical, Civil, Electrical, Engineering Physics, Geological, and Mechanical Engineering. The work of the first year provides the theoretical and mathematical base necessary for specialization in the upper years, but at the same time shows how the basic fundamentals are applied to the solution of engineering problems.

Competence in writing is expected in all courses in the College of Engineering.

ENGINEERING PROFESSIONAL INTERNSHIP PROGRAM

The Engineering Professional Internship Program is a five-year program which includes a minimum of eight months of supervised work experience in industry. Normally, the work terms commence after the student has completed at least 84 credit units of an Engineering program. For a student to be admitted to the internship program he or she must have achieved and must maintain a 65% sessional weighted average. A student must have at least 18 credit units remaining in the B.E. program. Interested students are encouraged to contact either the Dean's Office, Engineering or the Student Employment and Career Centre (SECC).

Students are required to apply to SECC by early October for round one postings, late November for round two postings and an open third round beginning in February for an opportunity to compete for an internship starting in January, May or September. Students who do not meet the admission requirements should contact the SECC or the Dean's Office for alternative dates. For more information and specific dates, please check the web site:
www.usask.ca/sas/secc/students.html

Students must complete a minimum of two of the following courses in addition to the regular requirements for the B.E. degree: EPIP 401, EPIP 402, EPIP 403, EPIP 404. Each EPIP course represents a four month professional internship work term.

The Engineering Internship work experience is for a minimum of eight continuous months and a maximum of sixteen months. Students are reminded that internship is *not* a summer work program. A student who does not successfully complete the internship program is deemed to have failed the EPIP program.

The work in each course is supervised by a Professional Engineer in the host company. Students are required to submit written reports to the Dean's Office at the end of each work term. The last report is a comprehensive technical report on the student's work experience. All reports must be approved by the student's industrial supervisor and are graded by a member of the faculty (pass/fail).

Students are referred to the Dean's Office or SECC for further details.

SECOND DEGREE PROGRAMS

It is possible to undertake programs which lead to a degree in both Engineering and Arts and Science. In particular, specific second degree programs have been developed for most engineering disciplines which lead to a B.E. and a B.Sc. with a major in computer science in five or five and one-half years. Students must complete all of the requirements of the four-year program in Engineering and 30 to 45 credit units in Arts and Science directly related to one Arts and Science major. Optimum sequences of courses for most disciplines have been developed.

For the completion of the B.Sc. degree as a second degree, students must meet all the requirements of Program C in Arts and Science with 90 credit units in Arts and Science, and may not consider any professional electives for this purpose. In some programs it may be possible to satisfy this regulation in one year with as few as 30 additional Arts and Science credit units not specifically included in the Engineering program.

Students interested in the humanities, social sciences or natural sciences may wish to consider a special arrangement of studies which will enable them to complete the work leading to the B.E. degree and the B.A. or B.Sc. degree in approximately five years.

Students wishing to take a second degree program should check with the Deans' offices of the College of Arts and Science and the College of Engineering as well as their Engineering discipline Department Head.

GRADUATE STUDIES

Students who have done well in their undergraduate program are encouraged to continue their studies at the graduate level. This will enable them to specialize or broaden their undergraduate training and earn a Postgraduate Diploma, a Master of Engineering Degree, a Master of Science degree or a Doctor of Philosophy degree. Students who are interested in these programs should consult the College of Graduate Studies and Research section of this *Calendar.*

OTHER PROGRAMS

Please contact the Dean's Office for information on other engineering programs not offered at the University of Saskatchewan.

B.E. PROGRAM (1999 AND AFTER)

The B.E. program was changed effective September 1999. The following sections list the program requirements for students who have entered the college in September 1999 or later. Students who were in the college prior to September 1999 should see the B.E. PROGRAM (Prior to 1999), ahead, for the program requirements. These students have the option of moving to the new program, however, to receive the B.E. degree, they will be required to satisfy all the requirements of the new program.

To receive a B.E. degree, students must meet the requirements of the program listed below. Credit for equivalent courses taken previously, either from the University of Saskatchewan or another post-secondary institution, will only be given on a course by course basis. Approval for credit for equivalent courses must be obtained from the Dean's Office.

FIRST YEAR (30 CREDIT UNITS)

Term 1

CHEM 111.3 Introduction to Modern Chemistry
COMM 102.3 Introduction to Business Management
G E 110.3 Engineering I
G E 124.3 Engineering Mechanics I
MATH 110.3 Calculus I

Term 2

E P 155.3 Electric and Magnetic Circuits I
G E 120.3 Engineering II
G E 125.3 Engineering Mechanics II
MATH 124.3 Calculus II for Engineers
CHEM 242.3 Physical Chemistry I*
or
GEOL 121.3 Physical Geology**
or
PHYS 128.3 Contemporary Physics

*Students who select the Chemical Engineering program must take CHEM 242 as an elective in first term of second year if they do not take CHEM 242 in first year.

**Students who select the Geological Engineering program must take GEOL 121 as an elective in second year if they did not take GEOL 121 in first year.

COMPLEMENTARY STUDIES

Each engineering program includes a certain portion of non-engineering non-science subject matter that complements the technical content of the program. To fulfill the Complementary Studies requirement of the degree, each student must complete a minimum of 18 credit units of courses acceptable in this category. Some of these courses are specified in the programs while others are electives but within certain subject categories. All programs contain the following complementary studies components.

- G E 300.3
- G E 348.3
- G E 449.3
- COMM 102.3 (subject to approval of the Dean's office, another business science course may be substituted)
- 6 credit units (minimum) in humanities or social sciences. At least 3 credit units must be at the 200- or higher level. Language courses in which the course content is to impart language skills (e.g. FR 103, GREEK 112) cannot be used to satisfy the humanities/social sciences requirement. The objectives of 100-level English courses are judged to be one-half humanities and social science (literature) and one-half to impart language skills (composition). Consequently, only one-half of the credit units of these courses may be used towards meeting the humanities/social sciences requirement. A list of acceptable humanities/social science courses is maintained on the College of Engineering web site (www.engr.usask.ca). Students wishing to select other courses must get approval from the Dean's Office.

UPPER YEARS

AGRICULTURAL AND BIORESOURCE ENGINEERING

Agricultural and Bioresource Engineering, often referred to as Biosystems Engineering, integrates engineering science and design with applied biological sciences for the solution of problems involving plants, animals and the natural environment. It deals with patterns of relationships among organisms and their environments, and engineering design to develop processes, machines, and systems that influence, control, or utilize biological materials and organisms for the benefit of society. Graduates are employed in the agricultural and food industries, as well as in other resource industries such as forestry and mining.

Second Year (36 credit units)

Term 1

AB E 211.3 Principles of Biological Systems
C E 212.3 Civil Engineering Materials
CMPT 116.3 Computing I
G E 210.3 Probability and Statistics
M E 227.3 Thermodynamics I
MATH 223.3 Intermediate Calculus

Term 2

AB E 212.3 Physical Principles of Plant Biosystems
AB E 295.3 Introduction to Biosystems Engineering
CH E 210.3 Fluid Mechanics I
G E 213.3 Strength of Materials
MATH 224.3 Differential Equations
Technical, Science or Engineering elective (3 credit units)*

Third Year (36 credit units)

Term 1

AB E 311.3 Mathematical Methods
AB E 323.3 Properties of Materials in Biosystems
G E 348.3 Engineering Economics
Technical, science or engineering elective (3 credit units)*

Humanities or social science elective (3 credit units)

Term 2

AB E 313.3 Instrumentation
AB E 324.3 Mechanics of Materials in Biosystems
AB E 327.3 Transport Processes in Biosystems
AB E 395.3 Design Capstone I
Senior humanities or social science elective (3 credit units)

Term 1 or Term 2

AB E 312.3 Electrical Power
or
C E 319.3 Hydrology and Hydrogeology
G E 300.3 Oral and Written Communication

Fourth Year (36 credit units)

Term 1

AB E 422.3 Modeling of Biosystems
G E 449.3 Engineering in Society

Term 2

AB E 495.3 Design Capstone II

Term 1 or Term 2

Agricultural or life science electives (6 credit units)*
Engineering electives (18 credit units, minimum 12 credit units from AB E course offerings)*
Complementary studies elective (3 credit units business science or humanities or social science)

* Requires approval of the Department Head. Students are strongly encouraged to fulfill the elective courses by selecting a "theme". A theme is a predetermined set of courses approved by the department. The set of courses will have a focus and serve an integrative purpose. Students may select courses from more than one theme. Completion of a theme will not be indicated on the university transcript but can be indicated on a resume or verified for an employer by the department. Consult with the department for further information on the following three themes:

Agricultural Systems Engineering, creating safer, more efficient, and environmentally sustainable production systems for plants and animals; machinery design for agriculture, horticulture, acquaculture and forestry; building systems for livestock, laboratory animals, horticulture, controlled-environment chambers, and storage of agricultural and food products; instrumentation, monitors and controls; standards and safety.

Bioprocess Engineering, improving and converting biological materials; added value-processing (drying, binding, separation) of agricultural crops for use as food, feed, fibre, energy; nutriceuticals and pharmaceuticals; primary processing of waste materials for land application; quality control in processing operations; handling systems for granular and fibrous materials; energy conservation and utilization; computer image analysis; engineering in support of biotechnology.

Natural Resources Engineering, managing and protecting resources; soil and water conservation; water management for agricultural use, irrigation and drainage; soil remediation; utilization of waste materials in plant-soil systems; modeling environmental systems; decision support and simulation.

CHEMICAL ENGINEERING

Chemical Engineering deals chiefly with industrial processing to produce value-added products from raw materials. The processing of organic (crude oils, natural gas, lumber), inorganic (ores, air, salts) and biological (starches, cellulose, fats) materials into a wide range of useful commodity products, such as fuels, plastics, pharmaceuticals, fertilizers and foods is carried out within a framework of environmental sustainability and concern for worker/public safety. Emphasis is on the design, construction and economic operation of equipment in these areas, and on related research and development. Some emphasis on environmental studies and biotechnology is permitted through the choice of electives.

Second Year (36 credit units)

Term 1

AB E 312.3 Electric Power
or
E E 201.3 Electric and Magnetic Circuits II
CHEM 251.3 Organic Chemistry I
CMPT 116.3 Computing I
MATH 223.3 Intermediate Calculus
English 100-level (3 credit units)

Term 2

CH E 210.3 Fluid Mechanics I
CH E 220.3 Introduction to Process Engineering
CHEM 347.3 Chemical Thermodynamics
G E 213.3 Strength of Materials I
MATH 224.3 Differential Equations
Humanities or social science elective (3 credit units)

Term 1 and Term 2

CH E 332.0 Seminar

Term 1 or Term 2

Elective 1*: Group A or B Elective (3 credit units)**

*If a student does not have credit for CHEM 242, it must be taken in Term 1.

Third Year (35 credit units)

Term 1

CH E 311.3 Mathematical Modelling I
CH E 320.3 Fluid Mechanics II
CH E 323.3 Chemical Engineering Thermodynamics
G E 300.3 Oral and Written Communication
CHEM 231.3 Inorganic Chemistry I
or
Approved option science elective***

Term 2

CH E 315.3 Mass Transfer I
CH E 322.3 Mathematical Modelling II
CH E 324.3 Heat Transfer
CH E 325.3 Process Engineering & Design I
CH E 333.2 Chemical Engineering Laboratory I
CH E 370.0 Field Trips
CHEM 221.3 Analytical Chemistry
or
BIOCH 212.3 Introductory Biochemical Techniques

Term 1 and Term 2

CH E 332.0 Seminar

Term 1 or Term 2

Elective 2: Group A or B Elective (3 credit units)**

Fourth Year (38 credit units)

Term 1

CH E 411.3 Chemical Reaction Engineering
CH E 413.3 Process Dynamics
CH E 414.2 Chemical Engineering Laboratory II
CH E 421.3 Mass Transfer II
G E 348.3 Engineering Economics

Term 2

CH E 423.3 Process Control
CH E 424.2 Chemical Engineering Laboratory III
CH E 470.0 Field Trips
G E 449.3 Engineering in Society
Senior humanities or social science elective (3 credit units)

Term 1 and Term 2

CH E 431.1 Seminar
CH E 422.6 Process Engineering & Design II

Term 1 or Term 2

Elective 3: Group A or B****
(3 credit units)**
Elective 4: Group B Elective
(3 credit units)**

**Group A - AP MC 212; BIOCH 200, 230, 310; CHEM 243, 252, 322, 374, 375, 377; CMPT 117, 215; E E 311, 314; M E 214, 324 and (GEOL 121 or PHYS 128).

**Group B – one of CH E 453, 454, 460, 461, 464. Group B electives are offered in alternating years. Consult with faculty advisor to determine the availability of a specific elective.

*** Consult with faculty advisor.

****If a Group A elective was taken as Elective 2 then a Group B elective must be taken as Elective 3. If a Group B Elective was taken as Elective 2 then a Group A Elective must be taken as Elective 3.

Options

An "Option" within the College of Engineering is a prescribed set of courses that provides a concentration of specialized training in one particular field of study. Options are approved at the College level but are unique to Departments within the College, consisting of at least 18 credit units, none of which are core courses taken by all students within the Department. Students may elect to have the "Option" appear on their transcripts at the time of graduation.

1) Biochemical Option (cannot be taken with the Biotechnology Option). This option provides specialization in sciences/engineering courses that apply to traditional bioprocessing industries such as brewing, food, enzymes, gasohol and pharmaceutical. The following electives are required for this option:

BIOCH 200.3 Molecules of Life
AP MC 212.3 General Microbiology
BIOCH 212.3 Introductory Biochemical Techniques
BIOCH 310.3 Proteins and Enzymes
CH E 454.3 Design of Industrial Waste Treatment Systems
CH E 461.3 Biochemical Engineering

2) *Biotechnology Option* (cannot be taken with the Biochemical Option). This option provides more extensive training involving the science of genetic manipulation. This technology is necessary for developing process systems using genetically altered cells to produce biomass and biochemicals. Examples include pharmaceuticals, enhanced waste treatment, and the production of gasohol from cellulose. The following electives are required for this option:

BIOL 110.6 General Biology
BIOCH 200.3 Molecules of Life
AP MC 212.3 General Microbiology
BIOCH 212.3 Introductory Biochemical Techniques
BIOCH 230.3 Information Transfer - DNA to Proteins
BIOCH 311.3 Introductory Molecular Biology
CH E 454.3 Design of Industrial Waste Treatment Systems
CH E 461.3 Biochemical Engineering

CIVIL ENGINEERING

Civil Engineering also administers the Geological Engineering Program. Program requirements are listed below.

Civil Engineering

Civil Engineering covers the broad areas of environmental, geoenvironmental, hydrology, hydrotechnical structures, materials, and transportation engineering. The program is designed in such a way that students are exposed to the basic civil engineering science during the second and third years of the program. During this time, the students are required to take courses that introduce the fundamental concepts in all of the areas listed above. In the final year, students will have the opportunity to select electives that will allow some degree of specialization. However, students are strongly encouraged to select electives that will provide them with a broad-based technical background. Project/design courses are provided in each of the three upper years. These courses are designed to give students experience in solving open-ended problems, in working in partnership with others and, where possible, in becoming involved in interdisciplinary activities.

Second Year (38 credit units)

Term 1

C E 212.3 Civil Engineering Materials
CMPT 116.3 Computing 1
G E 210.3 Probability and Statistics
GEO E 218.3 Engineering Geology
MATH 223.3 Intermediate Calculus
English 100-level (3 credit units)

Term 2

C E 225.3 Fluid Mechanics
C E 295.3 Project
G E 213.3 Mechanics of Materials
G E 300.3 Oral and Written Communication
MATH 224.3 Differential Equations
Humanities or social science or fine arts elective (3 credit units)

Term 3

C E 271.2 Surveying (Spring Camp)

Third Year (36 credit units)

Term 1

C E 311.3 Continuum Mechanics
C E 315.3 Fluid Mechanics and Hydraulics
C E 316.3 Geomatics
C E 317.3 Structural Analysis
C E 318.3 Applied Math for Civil Engineers
C E 328.3 Introduction to Geotechnical Engineering

Term 2

C E 319.3 Hydrology and Hydrogeology
C E 321.3 Structural Systems and Materials
C E 327.3 Sanitary/Environmental I
C E 329.3 Transportation Engineering
G E 348.3 Engineering Economics
Science or business elective or permission of the Department Head (3 credit units)

Fourth Year (36 credit units)

Term 1

C E 420.3 Project Engineering
C E elective courses (6 credit units)*

Term 2

G E 449.3 Engineering in Society
C E elective courses (9 credit units)*

Term 1 and Term 2

C E 495.6 Capstone Project

Term 1 or Term 2

Engineering or science elective (3 credit units)**
Senior humanities or social science elective (3 credit units)
Open elective (3 credit units)**

*AB E 481; C E 414, 415, 416, 417, 418, 463, 464, 466, 467, 468, 469, 470

** May be taken from outside the Department and outside the College.

Geological Engineering

Geological Engineering is designed for those interested in the exploration, development, recovery and stewardship of subsurface resources. A broad background in aspects of geotechnical, mining and petroleum engineering is provided. Some degree of specialization in each of these areas is possible in the selection of upper year electives.

Second Year (38 credit units)

Term 1

C E 212.3 Civil Engineering Materials
CMPT 116.3 Computing I
G E 210.3 Probability and Statistics
GEO E 218.3 Engineering Geology
MATH 223.3 Intermediate Calculus
English 100-level (3 credit units)

Term 2

C E 225.3 Fluid Mechanics
C E 295.3 Project 1
G E 213.3 Strength of Materials I
G E 300.3 Oral and Written Communication
MATH 224.3 Differential Equations
Senior humanities or social science elective (3 credit units)*

Term 3

C E 271.2 Surveying (Spring Camp)

Third Year (39 credit units)

Term 1

C E 318.3 Applied Mathematical Methods
C E 328.3 Introduction to Geotechnical Engineering
GEOL 224.3 Mineralogy and Petrology
GEOL 243.3 Sedimentology
GEOL 258.3 Structural Geology I
Open elective (3 credit units)

Term 2

C E 319.3 Hydrology and Hydrogeology
G E 348.3 Engineering Economics
GEO E 315.3 Rock Mechanics
GEOL 246.3 Stratigraphy and Stratigraphic Palaeontology
or
Group B elective (3 credit units)
GEOL 463.3 Petroleum Geology*
Group A elective (3 credit units)

Term 3

GEO E 378.3 Engineering Geological Mapping (Fall Camp)

Fourth Year *(36 credit units)*

Term 1

C E 316.3 Geomatics
C E 420.3 Project Management
G E 449.3 Engineering and Society

Term 2

GEO E 412.3 Reservoir Mechanics
GEO E 414.3 Rock Mechanics Design
GEO E 466.3 Petroleum Geomechanics
Group B elective (3 credit units)
GEOL 463.3 Petroleum Geology*

Term 1 and Term 2

GEO E 495.6 Design Project

Term 1 or Term 2

Group A elective (3 credit units)*
Group C electives (6 credit units)

Group A – GEOG 335; GEOL 229, 282, 358, 411(P), 445, 465(P)

Group B – GEOL 384 or 334(P) or 335(P)

Group C – AB E 481; C E 416, 466; CH E 464; GEO E 475

(P) Elective subject to prerequisite requirements not covered in the core program.

*If Geol 121 is not taken as the science elective in Year 1, it must be taken in Year 2 in place of the humanities or social science elective and the Group A elective in Year 4 must be replaced by a senior humanities or social science elective.

*If GEOL 463 is taken in third year, then Elective B must be taken in fourth year and vice-versa.

ELECTRICAL ENGINEERING

Electrical Engineering is designed as a foundation for work in the fields of analog and digital electronics, microelectronics, signal processing, communications, power generation, transmission and distribution, electrical machines, computing systems, controls and general electrical engineering applications. In the second, third and fourth years emphasis is placed on theory and practice. Some specialization is possible by choosing appropriate electives in the third and fourth years.

Second Year (38 credit units)

Term I

CMPT 116.3 Computing I
E E 201.3 Electric and Magnetic Circuits II
E E 216.3 Probability, Statistics & Numerical Methods
E E 221.3 Analog Electronics
E E 271.3 Electrical Engineering Materials & Heat Conduction
MATH 223.3 Intermediate Calculus

Term 2

CMPT 117.3 Computing II
E E 212.3 Passive AC Circuits
E E 214.3 System Modeling and Network Analysis
E E 232.3 Digital Electronics
E E 292.2 Electrical Engineering Laboratory I
G E 300.3 Oral and Written Communication
MATH 224.3 Differential Equations

Third Year (42 credit units)

Term 1

E E 301.3 Electricity, Magnetism and Fields
E E 323.3 Electronic Instrumentation
E E 331.3 Microprocessor Hardware and Software
E E 342.3 Power Systems I
E E 351.3 Spectrum Analysis and Discrete Time Systems
E E 372.3 Electronic Devices
E E 391.3 Electrical Engineering Laboratory II

Term 2

E E 332.3 Real Time Computing
E E 341.3 Electric Machines I or E E 362.3 Digital Signal Processing I *
E E 352.3 Communication Systems
E E 392.3 Electrical Engineering Laboratory III
E E 395.3 Electrical Engineering Design
Group B/C or D electives (6 credit units)

Fourth Year (39 credit units)

Term 1

E E 481.3 Control Systems
E E 491.3 Electrical Engineering Laboratory IV
G E 449.3 Engineering in Society
Humanities or social science elective (3 credit units)
Group A (6 credit units)

Term 2

E E 362.3 Digital Signal Processing I or E E 341.3 Electric Machines I*
G E 348.3 Engineering Economics
Senior Humanities or social science elective (3 credit units)
Group B/C, D or E electives (6 credit units)

Term 1 and Term 2

E E 495.6 Design Project

Group A: E E 441, 444, 456, 461

Group B: Offered odd University Calendar years - E E 344, 402, 432, 442

Group C: Offered even University Calendar years - E E 431, 445, 458, 472

Group D: M E 483; CMPT 424 or a course from another branch of Science or Engineering approved by the Department Head

Group E: E E 480

*Must take both E E 341 and E E 362.

ENGINEERING PHYSICS

Engineering Physics is designed for students who wish to enter fields of research and development that require extra training in physics, mathematics, electronics and computers. The program emphasizes the application of scientific principles to the design of experiments and electronic systems for use in measurements, communications, and data acquisition. The program is recommended for students interested in newly developing areas of physics, high technology, instrumentation and communications. Graduates may proceed to a post-graduate degree in Physics and Engineering Physics or in other branches of engineering. There is also a double degree program in Engineering Physics/Computer Science that has proven to be very effective for the high technology job market and for graduate work.

Second Year (36 credit units)

Term 1

CMPT 116.3 Computing I
G E 210.3 Probability and Statistics
MATH 223.3 Intermediate Calculus
MATH 238.3 Introduction to Differential Equations and Series
PHYS 251.3 Relativistic Mechanics and Quantum Physics
Humanities or social science electives (3 credit units)

Term 2

E P 225.3 Waves, Fields and Optics
E P 228.3 Computer Tools for Engineering Physics
E P 271.3 Heat, Kinetic Theory, and Thermodynamics
G E 226.3 Mechanics III
PHYS 227.3 Electricity and Magnetism I
Humanities or social science electives (3 credit units)

Third Year (36 credit units)

Term 1

E P 311.3 Electronics I
E P 317.3 Applied Physics of Materials
G E 300.3 Oral and Written Communication
PHYS 371.3 Statistical and Thermal Physics
PHYS 381.3 Quantum Mechanics I

Term 2

E P 320.3 Discrete Linear System and Applied Information Theory
E P 321.3 Electronics II
E P 324.3 Engineering Mechanics IV
E P 356.3 Electricity and Magnetism II
G E 348.3 Engineering Economics

Term 1 and Term 2

MATH 338.6 Differential Equations II

Fourth Year (36 credit units)

Term 1

E E 481.3 Control Systems
E P 413.3 Instrumentation and Design
E P 414.3 Instrumentation Laboratory
E P 421.3 Optical Systems and Materials I
PHYS 463.3 Electricity and Magnetism III

Term 2

G E 449.3 Engineering in Society
PHYS 404.3 Techniques of Experimental Physics
Engineering or science electives* (6 credit units)
Senior humanities/social science elective (3 credit units)

Term 1 and Term 2

E P 495.6 Capstone Design Project
PHYS 490.0 Physics Seminars

*Engineering or science electives: E E 432, 480; E P 431; PHYS 470.

The other 3 credit units elective also can be from that list, or may be any science or engineering course (or other course with approval of the Head of the Department of Physics and Engineering Physics) at the 200 level or higher.

MECHANICAL ENGINEERING

Mechanical Engineering provides the student with a fundamental training in the basic areas of thermodynamics and fluid dynamics; material properties, metallurgy and strength of materials, engineering analysis, synthesis, dynamics, mechatronics and controls. Practical applications and design are introduced.

Second Year (36 credit units)

Term 1

CMPT 116.3 Computers I
E E 201.3 Electric and Magnetic Circuits II
G E 213.3 Strength of Materials I
M E 214.3 Introduction to Materials and Manufacturing
M E 227.3 Thermodynamics I
MATH 223.3 Intermediate Calculus

Term 2

G E 226.3 Mechanics III
G E 300.3 Oral and Written Communication
M E 215.3 Fluid Mechanics I
M E 229.3 Introduction to Engineering Design
M E 251.3 Probability, Statistics and Analysis I
MATH 224.3 Differential Equations

Third Year (42 credit units)

Term 1

G E 348.3 Engineering Economics
M E 313.3 Mechanics of Materials I
M E 316.3 Dynamics and Vibrations
M E 318.3 Mechanical Engineering Laboratory I
M E 321.3 Advanced Engineering Analysis II
M E 324.3 Engineering Materials
M E 327.3 Heat Transfer

Term 2

M E 323.3 Mechanics of Materials II
M E 328.3 Mechanical Engineering Laboratory II
M E 330.3 Manufacturing Processes
M E 335.3 Fluid Mechanics II
M E 352.3 Engineering Analysis III
Humanities or social science elective (3 credit units)

Term 1 or Term 2

Technical electives (3 credit units)*

Fourth Year (39 credit units)

Term 1

M E 413.3 Machine Design I
M E 417.3 Thermodynamics II
M E 418.3 Mechanical Engineering Laboratory III
M E 431.3 Controls Systems I
M E 450.3 Finite Element Analysis

Term 2

G E 449.3 Engineering in Society
Senior humanities or social science elective (3 credit units)

Term 1 and Term 2

M E 495.6 Industrial Design Project

Term 1 or Term 2

Technical Electives (9 credit units)**
Design Elective (3 credit units)***

*Technical Electives – Term 1 - E E 311, 314 Term 2 - AB E 313; M E 469, 471, 477 or Term 1 or Term 2 - 200-,300-and 400-level courses from the Department of Computer Science or a course from another branch of science or engineering approved by the Department Head.

**Technical Electives – Term 1 - E E 311, 314; M E 460, 473, 476 Term 2 - AB E 313; M E 463, 468, 469, 471, 472, 475, 477

***Design Elective (3 credit units or more) – Term 1 - M E 491 Term 2 – M E 490, 492, 493

B.E. PROGRAM (PRIOR TO 1999)

The following sections list the program requirements for students who were in the college prior to September 1999. These students have the option of moving to the new program, however, to receive the B.E. degree, they will be required to satisfy all the requirements of the new program. Course requirements are listed ahead in this section. To receive a B.E. degree, students must meet the requirements of the program indicated below. Credit for equivalent courses taken previously, either from the University of Saskatchewan or another post-secondary institution, will only be given on a course by course basis. A list of equivalent courses in the new program is maintained on the College of Engineering web site (www.engr.usask.ca). Approval for credit for equivalent courses must be obtained from the Dean's Office.

FIRST YEAR (34 CREDIT UNITS)

The first year requirements have been published in previous *University of Saskatchewan Calendars*. Some courses in this past program may no longer be available. Students returning after an absence from the college may need to follow the new program requirements if they cannot complete their program by October 2004.

COMPLEMENTARY STUDIES

Each engineering program includes a certain portion of non-engineering non-science subject matter that complements the technical content of the program. To fulfill this Complementary Studies requirement of the degree, each student must complete a minimum of 18 credit units of courses acceptable in this category. Some of these courses are specified in the programs while others are elective but within certain subject categories. All programs contain the following complementary studies components:

- ENGLISH 100 level (3 credit units)
- G E 348.3
- G E 390.3
- G E 449.3
- 3 credit units (minimum) in business science from COMM 101.3, 102.3, 201.3, 202.3, 204.3, 205.3, 206.3, 304.3, or 404.3.
- 3 credit units (minimum) in humanities or social sciences. GEOG 111.3, 112.3, and ECON 114.3 cannot be used to satisfy this requirement. A list of areas of study that are used for the humanities/social sciences requirements can be found under the College of Arts and Science section of the *Calendar*.

Although students have latitude in choosing electives in certain categories, some courses may not be acceptable to take for credit because of similarities with other mandatory courses in their programs.

UPPER YEARS

AGRICULTURAL AND BIORESOURCE ENGINEERING

Agricultural and Bioresource Engineering, often referred to now as Biosystems Engineering, integrates engineering science and design and applied biological sciences for the solution of problems involving plants, animals and the natural environment. It deals with patterns of relationships among organisms and their environments, and engineering design to develop processes, machines, and systems that influence, control, or utilize biological materials and organisms for the benefit of society. Graduates are employed in the agricultural and food industries, as well as in other resource industries such as forestry and mining.

Fourth Year (36 credit units)

Term 1

A E 411.3 Control Systems I
G E 449.3 Engineering in Society

Term 1 and Term 2

A E 495.6 Design Project

Term 1 or Term 2

Agricultural and Bioresource Engineering electives (9 credit units)*
Technical or science electives (9 credit units)**
Open electives (6 credit units)***

*Electives to be chosen from AB E 431, 432, 451, 452, 462, 481 and 482. Electives must be chosen in consultation with a faculty advisor as most courses are given only once every two years.

** Technical or science electives may be chosen from 300- or 400-level courses from the Colleges of Engineering, Agriculture, or Veterinary Medicine, or the Department of Mathematics and Statistics; 200-, 300- or 400-level courses from the Department of Computer Science, or other courses approved by the Head of the Department.

*** Open electives may be chosen from any of the courses in the *Calendar* provided prerequisites have been met and there is not a significant amount of overlap with courses taken previously.

Although the student has considerable latitude in choosing the technical or science and open electives, all courses selected must be approved by the Department Head. Technical or science electives and open electives must be chosen to satisfy the following requirements (a course may satisfy more than one requirement): 3 credit units must be from Agriculture or other life science; 3 credit units must be from Engineering (including Agricultural and Bioresource Engineering) and the course content must include a major amount of design; 9 credit units must be from outside of the Department of Agricultural and Bioresource Engineering.

CHEMICAL ENGINEERING

Chemical Engineering deals chiefly with industrial processing to produce value-added products from raw materials. The processing of organic (crude oils, natural gas, lumber), inorganic (ores, air, salts) and biological (starches, cellulose, fats) materials into a wide range of useful commodity products, such as fuels, plastics, pharmaceuticals, fertilizers and foods is carried out within a framework of environmental sustainability and concern for worker/customer safety. Emphasis is on the design, construction and economic operation of equipment in these areas, and on related research and development. Some emphasis on environmental studies and biotechnology is permitted through the choice of electives.

Fourth Year (35 credit units)

Term 1

CH E 411.3 Chemical Reaction Engineering
CH E 413.3 Process Dynamics
CH E 414.2 Chemical Engineering Laboratory II
CH E 421.3 Mass Transfer II
G E 449.3 Engineering in Society

Term 2

CH E 423.3 Process Control
CH E 424.2 Chemical Engineering Laboratory III
CH E 470.2 Field Trips
G E 213.3 Strength of Materials I
Humanities or social science elective (3 credit units)

Term 1 and Term 2

CH E 422.3 Process Engineering and Design II
or
CH E 455.3 Project
CH E 431.1 Technology and Society II

Term 1 or Term 2

Technical elective (6 credit units)**

** Technical elective – two of CH E 453, 454, 460, 461or 464. These electives could be given on alternate years. Check with the Department Head.

CIVIL ENGINEERING, GEOLOGICAL ENGINEERING

Civil Engineering

Civil Engineering covers the broad areas of transportation, environmental, geoenvironmental, geotechnical, hydrology and hydrotechnical engineering, materials, structures and transportation engineering. The program provides a sound training in fundamentals and instruction in their practical applications. Electives in the final year permit some degree of specialization.

Fourth Year (39 credit units)

Term 1

C E 415.3 Structures for Water Management
C E 416.3 Geotechnical Engineering Practice
C E 417.3 Pavement, Materials and Design
C E 418.3 Design in Reinforced Concrete
C E 419.3 Environmental and Sanitary Engineering Fundamentals
G E 449.3 Engineering in Society

Term 2

C E 420.3 Project Engineering
C E 461.3 Structural Engineering Systems Design*
or
C E 463.3 Advanced Structural Analysis*
C E 464.3 Water Resources Engineering*
or
C E 465.3 Environmental Control Engineering*
C E 466.3 Modelling of Earth Structures*
or
C E 467.3 Transportation and Regional Development*
Technical elective (3 credit units)*
Complementary Studies (3 credit units from the business science group or humanities or social sciences**)

Term 1 and Term 2

C E 495.3 Project

* Technical electives: At least one from each of the three main areas must be selected, i.e. C E 461 or 463, and 464 or 465, and 466 or 467, and one additional course. The fourth elective can be CMPT 393, or a course from this list or other departments, subject to the approval of the Head of the Department of Civil Engineering.

** Students wishing to pursue a second degree program in Civil Engineering and Computer Science should take courses in humanities or social sciences only.

Geological Engineering

The Geological Engineering program is designed for students interested in the extraction and exploitation of natural resources: minerals, water, oil and gas.

Fourth Year (41 credit units)

Term 1

C E 416.3 Geotechnical Engineering Practice
G E 449.3 Engineering in Society
GEO E 411.3 Well-Logging
GEO E 475.3 Advanced Hydrogeology

Term 2

C E 466.3 Modeling of Earth Structures
GEO E 335.3 Seismology, Radar and Electrical Methods
GEO E 414.3 Rock Mechanics Design
GEOL 445.3 Phanerozoic History of North America
GEOL 463.3 Petroleum Geology

Term 1 and Term 2

GEO E 495.6 Design Project

Term 1 or Term 2

Business science elective (3 credit units)
Humanities, social science or fine arts elective (3 credit units)

Term 3

GEO E 479.2 Field Survey and Design

ELECTRICAL ENGINEERING

Electrical Engineering is designed as a foundation for work in the fields of analog and digital electronics, signal processing, communications, power generation, transmission and distribution, electrical machines, computing systems, controls and general electrical engineering applications. In the second, third and fourth years emphasis is placed on theory and practice. Some specialization is possible by choosing appropriate electives in the first and second terms of the fourth year.

Fourth Year (45 credit units)

Term 1

E E 410.3 Control systems I
E E 419.3 Electrical Engineering Laboratory IV
E E 431.3 Hardware Descriptive Language*
E E 452.3 Instrumentation*
E E 453.3 Electrical Machines II*
E E 454.3 Power Systems II*
E E 455.3 Signals and Systems II*
E E 457.3 Communications Electronics*
E E 489.3 Digital Systems III*
M E 435.3 Heat Transfer in Electrical Engineering
Business science elective (3 credit units)

Term 2

E E 451.3 VLSI Circuit Design*
E E 480.3 Digital Control Systems*
E E 482.3 Power Electronics*
E E 483.3 Electrical Machines III*
E E 484.3 Signal Processing*
E E 485.3 Communication/Transmission*
E E 486.3 Microwave Engineering*
E E 487.3 Microelectronics and Optoelectronics*
E E 488.3 Reliability Engineering*
E P 356.3 Electric and Magnetic Field Theory*
G E 348.3 Engineering Economics
G E 449.3 Engineering in Society

Term 1 and Term 2

E E 438.6 Engineering Design III

* Elective courses. Students must take seven technical electives in the fourth year.

ENGINEERING PHYSICS

Engineering Physics is designed for students who wish to enter fields of research and development that require extra training in physics, mathematics, electronics and computers. The program emphasizes the application of scientific principles to the design of experiments and electronic systems for use in measurements, communications, and data acquisition. The program is recommended for students interested in newly developing areas of physics, high technology, instrumentation and communications. Graduates may proceed to a post-graduate degree in Physics and Engineering Physics or in other branches of engineering. There is also a double degree program in Engineering Physics/Computer Science that has proven to be very effective for the high technology job market and for graduate work.

Fourth Year (39 credit units)

Term 1

E E 410.3 Control Systems 1
E P 413.3 Instrumentation and Design
E P 414.3 Instrumentation Laboratory
E P 421.3 Optical Systems and Materials
G E 449.3 Engineering in Society
PHYS 463.3 Electricity and Magnetism III

Term 2

E E 451.3 VLSI Circuit Design
E E 480.3 Digital Control Systems
E P 424.3 Design Laboratory
E P 425.3 Engineering Physics Systems
PHYS 404.3 Techniques of Experimental Physics
PHYS 470.3 Atomic, Molecular and Solid State Physics

Term 1 and Term 2

PHYS 490.0 Physics Seminar
Business science elective (3 credit units)

GEOLOGICAL ENGINEERING

See Civil Engineering.

GEOPHYSICAL ENGINEERING

Geophysical Engineering is designed for those interested in resource exploration and the remote measurement of the physical properties of the Earth. Students intending to enter the geophysics program require a strong mathematics/physics background.

Note: Accreditation of the Geophysical Engineering program terminated on June 30, 1999. Students graduating after that date will not receive an accredited degree.

Third Year (42 credit units)

E E 315.3 Signals and Systems I
E E 326.3 Applied Mathematics
E P 356.3 Electric and Magnetic Field Theory
G E 390.3 Oral and Written Communication
GEO E 314.3 Computer Methods for Geological Sciences
GEO E 315.3 Rock Mechanics
GEO E 334.3 Gravity, Magnetics and Radiation Methods
GEO E 335.3 Seismology, Radar and Electrical Methods
GEOL 243.3 Sedimentology
GEOL 246.3 Stratigraphy and Stratigraphic Palaeontology
GEOL 282.3 Earth Physics
GEOL 358.3 Structural Geology II
GEOL 465.3 Metalliferous Mineral Deposits
Humanities, social science or fine arts elective (3 credit units)

Fourth Year (33 credit units)

G E 348.3 Engineering Economics
G E 449.3 Engineering in Society
GEO E 312.3 Reservoir Mechanics
GEO E 411.3 Well-Logging
GEOL 463.3 Petroleum Geology
GEOL 481.3 Potential Field Methods
GEOL 482.3 Electrical Methods in Geophysical Prospecting
GEOL 483.3 Seismology
GEOL 485.6 Geophysics Field Camp
Business science elective (3 credit units)
Humanities, social science or fine arts elective (3 credit units)

MECHANICAL ENGINEERING

Mechanical Engineering provides the student with a fundamental training in the basic areas of thermodynamics and fluid dynamics; material properties, metallurgy and strength of materials, engineering analysis, synthesis, dynamics and controls. Practical applications and design are introduced.

Fourth Year (45 credit units)

Term 1

G E 449.3 Engineering in Society
M E 413.3 Machine Design I
M E 417.3 Thermodynamics II
M E 418.3 Mechanical Engineering Laboratory III
M E 431.3 Control Systems I
M E 450.3 Finite Element Analysis
M E 474.3 Behaviour of Engineering Materials

Term 2

M E 423.3 Machine Design II
M E 426.3 Vibration and Acoustics
M E 441.3 Control Systems II
Humanities or social science (3 credit units)
Technical or science electives (6 credit units)*

Term 1 and Term 2

M E 495.6 Design Project

* Selected from M E 460, 461, 462, 463, 464, 465, 467, 468, 469 or 200-, 300- and 400-level courses from the Department of Computer Science or a course from another branch of science or engineering approved by the Department Head.

GRADUATION REQUIREMENTS

To be awarded the Bachelor of Science in Engineering Degree (B.E.), a student must have obtained a pass standing in all of the courses required by the specific program in accordance with the rules and regulations of the College of Engineering and the university. These requirements must be completed within a ten year period. Under exceptional circumstances, the college may grant an extension.

To obtain a B.E. degree from the University of Saskatchewan, students transferring from another university must fulfill the program requirements, of which 48 credit units must be from the University of Saskatchewan, and 36 credit units must be from the last two years of a program in the College of Engineering.

COURSE LOAD

The normal course loads for each program are defined in this section of the *Calendar* under "B.E. Program". Students are normally required to take a course load equal to that indicated for their particular year and program. A student may not take more than the normal course load except with permission of the Dean's Office.

PROGRESS IN A GIVEN PROGRAM

Students will not normally be admitted into the College of Engineering if they have any deficiencies in admission requirements. Students who are admitted with deficiencies must remove them during their first year of study.

ATTENDANCE AND EXAMINATIONS

Information regarding *Guidelines for Academic Conduct* can be found in the General Information section under *Student Rights, Discipline and Appeals* and on the web at www.usask.ca/university_council/reports.shtml. Regular and punctual attendance is expected of students in all courses in which they are registered. Students who are persistently tardy or absent from classes or who neglect academic work may be subject to disciplinary action and may be excluded from the final examinations.

There will be two final examination periods, one in December, the other in April. Under special circumstances, the college may authorize supplemental examinations which are written in August. The instructors in a class may hold other examinations, tests or exercises that they consider appropriate.

UNIVERSITY COUNCIL REGULATIONS ON EXAMINATIONS

For provisions governing examinations, refer to the *University Council Regulations on Examinations* section of the *Calendar* or www.usask.ca/university_council/reports.shtml. *College Regulations on Examinations*, are available from the college office.

EXPECTATIONS OF STUDENT BEHAVIOR

Students are expected to respect the rights of other students and faculty by refraining from disruptive behaviour in the classroom, laboratory or tutorials in accordance with the Guidelines for Academic Conduct.

Students should be aware that they are considered responsible adults and will be treated as such in regard to academic dishonesty and non-academic offences. The results in such cases can be serious, and may lead to suspension or expulsion from the University.

GRADING

See the General Information section of this *Calendar* for an explanation of the grading system and the literal descriptors associated with percentage grades.

REGISTRATION AND PROGRAM CHANGES

Although the College of Engineering may review and audit all engineering registrations, all students are responsible for ensuring that their registration is complete and consistent with the regulations of the College of Engineering as contained in this *Calendar.* It is the student's responsibility to determine whether they have the prerequisites for courses they wish to take. Failure to adhere to these regulations may result in a cancellation of registration.

Students may drop a course at any time, but should note carefully that first-term courses dropped after November 15, second-term courses dropped after March 15, and courses extending over both terms

dropped after February 15 will be regarded as failed courses (withdraw fail), and that in the calculation of the student's weighted average, a grade of 30% will be used for the course dropped.

Non-attendance of a course does not constitute official withdrawal. Failure to officially withdraw will result in an ABF grade which will count as a 30% in calculation of the weighted average.

Students may be given approval by the Dean's Office, to replace one or more courses in the Engineering program by registering in equivalent courses in other colleges. This approval may also be obtained for courses which are to be repeated, but the minimum promotion requirements are transferred to the replacement course.

Students who have been required to repeat, or have been absent for one or more terms, must apply to Admissions, Office of the Registrar for re-admission to the college. Although the college makes every effort to respond to program needs of students returning after an absence of a year or more, the college has no responsibility to provide previous courses or their equivalent; rather, the student's program must be adjusted.

PROMOTION

The promotion of students in their Engineering program is determined on the basis of their performance during the Regular Session. Performance is judged on the basis of the Sessional Weighted Average (S.W.A.) and the number of credit units failed. Credit is given for courses satisfactorily completed during Spring and Summer Session but the grades obtained are not used to alter the ruling made on a student's performance during the previous Regular Session. For mixed programs the grades used in calculating the S.W.A. are at the discretion of the college.

Students with reduced course loads are required to maintain the same academic standards as students with normal course loads.

SESSIONAL WEIGHTED AVERAGE (S.W.A.)

To calculate the Sessional Weighted Average:

(1) Multiply the grade in each course by the number of credit units in the course. The result is the "weighted grade" of the course.

(2) Add together the weighted grades of all the courses taken.

(3) Add together the number of credit units taken.

(4) Divide the total weighted grades by the total number of credit units. The result is the Sessional Weighted Average.

PROMOTION REGULATIONS

Grades of up to 29% and "INF", "ABF" and "WF" will be recorded on the transcript as such, but will be considered as 30% for calculating averages.

Sessional Weighted Average greater than or equal to 58%

Failures: none

Action: Promote to the next year

Sessional Weighted Average greater than or equal to 58%

Failures: 1 to 6 credit units of courses

Action: Promote to the next year but must pass supplemental examinations or repeat the failed courses

Sessional Weighted Average greater than or equal to 55% but less than 58%

Failures: 6 or fewer credit units of courses including no failures*

Action: Advised to Discontinue

Sessional Weighted Average greater than or equal to 55%

Failures: 7 to 12 credit units of courses

Action: Advised to Discontinue

Any Average

Failures: 13 or more credit units of courses

Action: Required to Discontinue

Sessional Weighted Average less than 55%

Failures: Any number of failures including no failures

Action: Required to Discontinue

* Students in this category who receive permission to write supplemental examinations and do well enough in **one** of these exams to raise their average to 58% or greater are promoted to their next year. The action Advised to Discontinue will remain on the student's record. Students in this category are required to repeat all failed courses.

Advised to Discontinue - Students in this category are advised to discontinue their studies for at least one year but are not required to do so. Students who return must repeat the year (see below). Students in this category must repeat all courses below 60% in their *first* year back.

Required to Discontinue - Students in this category are not eligible to register in the college for at least one academic year. Subsequently they must submit an application for readmission. If accepted, they must repeat the year (see below). If students transfer to another college or post-secondary institution during their "Required to Discontinue" year and subsequently transfer back to the College of Engineering, they will only receive credit for courses taken during the "Required to Discontinue" year for which they receive a grade of 60% or greater. It will be at the discretion of the College, whether courses will be credited toward the B.E. degree.

Repeat the Year - Students in this category must repeat those courses taken during a previous academic session in which they received a grade of less than 60%. Students in this category must repeat all courses below 60% in their *first* year back. Students must receive a weighted average of 60% or greater on the repeated courses or they will be Required to Withdraw.

Required to Withdraw - Students are not normally permitted to repeat more than once in their program. The second time they are Advised to Discontinue and/or Required to Discontinue, they will be Required to Withdraw from the College of Engineering. Only under exceptional circumstances will subsequent readmission be considered.

Students who are Required to Discontinue or Required to Withdraw and could complete the requirements for the degree in one academic year may petition the Undergraduate Administration Committee for permission to return immediately. Permission to return will be at the discretion of the Undergraduate Administration Committee. Such a petition will only be considered once during the entire program of studies of a student.

Students may also be required to withdraw for non-academic reasons such as unethical conduct.

SUPPLEMENTAL EXAMINATIONS

At the discretion of the Undergraduate Administration Committee, supplemental examinations may be granted in courses in the Engineering program to students in the following categories who have met the criteria outlined: a) Students who did not fail any courses but had a sessional weighted average greater than or equal to 55% but less than 58% and who by writing a supplemental examination in one course may be able to raise their S.W.A. to 58% or greater; b) Students who failed only one course with a grade of less than 40% but received a S.W.A. of at least 65%; c) Students who failed one or two courses with grades of 40% or greater and received a S.W.A. of at least 55%.

Only the grade from **one** course can be used to raise a student's S.W.A to 58% or greater.

Students must apply in writing to the Dean's Office by **June 1** for the privilege to write supplemental examinations. The examinations, if granted, are subject to the guidelines listed under the Attendance and Examinations section of the General Information section of the *Calendar.*

CRITERIA FOR SUPPLEMENTAL EXAMINATIONS

(1) In any one year, students may be granted a supplemental examination in a course provided they a) fall in one of the categories outlined in the first paragraph under Supplemental Examinations; b) have only one or two or no failed courses in the year being considered and; c) will not have written more than a total of four supplemental examinations during their entire program of studies including the year under consideration.

(2) In any one course, the privilege of writing a supplemental examination will be granted only once without repeating the course.

(3) To receive credit for a course by means of a supplemental examination, a student must obtain a minimum grade of 58% in the course if the course is administered by the College of Engineering (including E P and GEO E courses). For a course administered by another college, credit for the course will be determined by the rules of that college. The supplemental examination will be accorded the same weight as the regular final examination when computing the student's final grade.

(4) To be promoted to the next year, or to graduate, students who have written supplemental examinations must satisfy the promotion regulations.

FOR STUDENTS IN THEIR GRADUATING YEAR

The Undergraduate Administration Committee, in consultation with the Department Head may grant a student a maximum of two supplemental examinations even if this brings the student's total supplemental exams (1 c above) to more than 4. Granting of such supplemental examinations will only be considered, if by receiving credit for the course(s), the student will be able to complete the requirements for the degree. To receive credit for a course, the student must satisfy criterion (3) listed in the Criteria for Supplemental Examination section. Special Supplementals will be written the last full week of May for students in their graduating year.

DEGREES WITH DISTINCTION

The Degree of Bachelor of Science in Engineering with Distinction or Great Distinction will be conferred on the basis of high academic standing in the courses of the second, third and fourth years. Students graduating with a three-year Cumulative Weighted Average (C.W.A.) of greater than or equal to 77% but less than 82% will be granted Distinction, and students graduating with a three-year C.W.A. of greater than or equal to 82% will be granted Great Distinction.

STUDENT RIGHTS, GRIEVANCES AND DISCIPLINE

See General Information section of the *Calendar.*

AWARDS

AGRA Memorial Scholarship in Honour of Lawrence H. Lashyn
Akzo Nobel Chemicals Ltd. Scholarship
Karl Allcock Bursary
AMEL Scholarship
American Society of Heating, Refrigerating & Air Conditioning Engineers (ASHRAE) – Saskatoon Chapter Design Award
BP Canada Energy Company Scholarships
Janet Anderson-Thomson Scholarship
John Anderson-Thomson Scholarship
Clinton L. Armstrong Memorial Award
Association of Professional Engineers and Geoscientists of Saskatchewan Prizes
Harold Balmforth Memorial Prize
Charles Edward Bell Scholarship
Gerard Belle Design Prize
Kenneth Bimmann Scholarship
Canadian Institute of Steel Construction Central Region Scholarship
Canadian Society for Chemical Engineers Prize
Cement Association of Canada Scholarship
Chemical Institute of Canada, Andre Boily EBM Scholarship
Chemical Institute of Canada, North Saskatchewan Section Award
First Year Chemistry Award
Chevron Canada Resources Limited Scholarship
Janet S. Clark Prize
Col. E. Churchill Memorial Scholarship
Civil Engineering Alumni Medal
Cominco Limited Scholarship in Engineering and Geology
Balfour Currie Memorial Scholarship
Harry T. Danyluk Scholarships
Dr. Edsel Darby Memorial Scholarship
Paul Del Frari Memorial Book Prize
Dow Chemical of Canada Limited Scholarship
William R. Ducie Scholarships
Electrical Engineering Achievement Award
Robert J. and Joyann M. Genereux Scholarship
Geological Engineering Distinguished Award
Evan Hardy Memorial Scholarship
Sylvia Fedoruk Scholarship

Bernard/Freda Frankenburger Scholarship
Fredeen Scholarship in Engineering
Gem Centennial Bursary
Joyann Marguerite Genereux Scholarship
Philip William Graham Scholarship
Grieg-Lovell Scholarships
Gunnar Hagblom Scholarship
E. J. Harrington Prize
Howard Douglas Scholarship
Husky Oil Scholarship
Mechanical Engineering Distinguished Award
Neil Hutcheon Prize
IEEE Saskatchewan Section Award
John Deere Limited Scholarship
Kevin Keayes Memorial Scholarship
Kilborn Engineering Ltd. Bursaries
George N. Listwin Scholarships
Virgil Loehr Memorial Award
Luscar Ltd. Scholarship
Mawdsley Memorial Book Prize
Mawdsley-Edmunds Memorial Scholarship
MESA Scholarship
Moore Memorial Award Scholarship
Joe Morgan Bursary in Mechanical Engineering
Helen Mary Morris Bursary
Teruo Natori Scholarship
Peter N. Nikiforuk Scholarship
PanCanadian Petroleum Ltd. Scholarship
Pirie Foundation Bursaries
Ramsay-MacDonald Memorial Scholarship
Andrew Alexander Rutherford Memorial Scholarship
Ethel Raymond Prize
Sarnia Chemical Engineering Community Scholarship
SaskTel Scholarships
Saskatchewan Wheat Pool Agricultural Scholarships
Saskatoon Engineering Society Scholarship
Saskatoon Geotechnical Group Prize
Schlumberger Collegiate Award Scholarship
SED Systems Inc. Scholarship
Separator Engineering Prize
S.E.S.S. Peter Nikiforuk Scholarship
J. M. Sharpe Memorial Prize
Shell Canada Scholarship in Geology and Geophysics
Society of Chemical Industry Merit Award
Society of Petroleum Engineers Award
Spectrum Scholarship
W. R. Staples Scholarship
John L. Stoik Bursaries
Suncor Energy Foundation Engineering Scholarship
Oliver L. Symes Memorial Award
Talisman Bursary
Ethel Thompson Prize
Dr. L. A. Thornton Prize
Thorvaldson Undergraduate Scholarship
Trapp Memorial Scholarship
Jennette Gertrude Traynor Bursary
I. W. Tweddell Memorial Award
UMA Group Ltd. Scholarship
J. E. Underwood and R. A. McLellan Memorial Scholarship
University Undergraduate Scholarships
Kevin Van Cleave Memorial Scholarship
Wong-Fredlund Scholarship

For details, consult the *Awards Guides.*

ENGINEERING SOCIETIES

The practice of Engineering throughout Canada is regulated by Professional Associations in each province. The right to practice and accept professional responsibility is limited to those who are registered with the professional organization in the particular province concerned. In Saskatchewan, this organization is the Association of Professional Engineers of Saskatchewan. Graduates are encouraged to join the Association as Engineers in Training. Several years of acceptable experience following graduation are necessary for registration as a Professional Engineer.

The practicing engineer keeps abreast of technological developments through membership in one of several technical societies. Students in Engineering may become student members of such technical societies as the Engineering Institute of Canada, the Canadian Society for Chemical Engineers, the Canadian Society of Civil Engineers, the Canadian Institute of Mining and Metallurgy, the Canadian Society of Agricultural Engineering, the Institute of Electrical and Electronic Engineering or the Society of Automotive Engineers. Engineering students are encouraged to join the society closest to their specialty.

The Engineering Student Society of the university is a voluntary organization of students within the college. Its object is to promote academic, social and athletic interests of the student body.

COURSE DESCRIPTIONS

See the General Information section of the *Calendar* for an explanation of the format used in course descriptions.

In this section, the term prerequisite, as applied to a course offered by the College of Engineering, without further qualification, means that a pass standing has been attained in the prerequisite course. Where a first-term course is a prerequisite for a second-term course that is taken in the same academic year a minimum grade of 40% is required in the prerequisite course.

If the prerequisite course is qualified by the term "taken", a minimum grade of 40% is required in the prerequisite course.

In exceptional cases the Dean's Office, on the recommendation of the Department Head, may grant permission for a student to register in a course without having the prerequisite course(s). This permission will normally be granted only to students who have demonstrated superior performance in the program, students with a lighter than normal load, or students whose previous experience has involved sufficient exposure to the subject matter. Students receiving such permission will be responsible for obtaining sufficient knowledge of the prerequisite material to successfully complete the course for which they are registering. If a prerequisite course is a required course in the program, it must be successfully completed before graduation.

AGRICULTURAL AND BIORESOURCE ENGINEERING

AGRICULTURAL ENGINEERING

A E 411.3 (Last offered 2001-2002)
Control Systems I
1(3L-3P)

Prerequisite(s): A E 311.

Introduction to feedback systems. Transfer functions for mechanical, hydraulic, pneumatic and electrical systems. Transient and frequency response. Basic feedback theory applied to physical systems, introduction to stability.

A E 495.6 (Last offered 2001-2002)
Design Project
1&2(1L-2P/3P)

Prerequisite(s): G E 390 and completion of at least 90 credit units of university study towards the B.E. degree.

The synthesis of components and systems into a complete design in one of the areas of agricultural and bioresource engineering. A specific design problem is considered and solved through individual and/or group participation. A formal written report must be submitted to the Department and presented orally as a seminar. Students are expected to interact with Professional Engineers as well as members of other professions and disciplines. Evaluations of oral and written presentations are made by advisors and external examiners.

AGRICULTURAL AND BIORESOURCE ENGINEERING

AB E 211.3
Introduction to Biological Systems
1(3L-1.5T)

An introduction to the biology of cells and tissues, including comparison among organisms. Emphasis is on the physical structures of plants and the physiological processes involved in plant growth. Growth models, the effects of the environment on plant growth and mechanisms of energy exchange with plants and between plants and their environment are studied An introduction is given to microbiology. The implications of physiological processes for agriculture are examined.

AB E 212.3
Physical Principles of Plant Biosystems
2(3L-3P)

Prerequisite(s): AB E 211.

An introduction to physical concepts governing movement and storage of nutrients, energy and water within the plant biosystem (soil-plant-atmosphere). Topics include: physical and mineralogical properties of soil, biogeochemical cycles of macronutrients, plant incorporation of water, nutrients and energy; psychrometrics as applied to evapotranspiration; and water transport within the soil-plant system. Course material will provide the basis for engineering decisions for optimizing production, harvesting and processing of plant materials.

AB E 295.3
Introduction to Biosystems Engineering
2(3L-3T)

Prerequisite(s): G E 120.

Introduction to the discipline of Agricultural and Bioresource (Biosystems) Engineering and to design principles and practices. Students will develop logical problem-solving skills through solution of problems involving energy and mass balances, bioprocessing, instrumentation and machinery systems, water and soil resources and waste management. Extensive use is made of computer software for calculation and graphical presentation of results.

AB E 311.3
Mathematical Methods
1(3L-1.5T)

Prerequisite(s): MATH 223 and 224.

A study of the application of mathematics to engineering problems involving biological systems. Students will develop proficiency in using the control volume technique to develop models describing mechanical, electrical, fluid and thermal systems. Analytical solutions are derived for commonly encountered ordinary and partial differential equations. An introduction is given to numerical procedures for solution of initial value and boundary value problems.

AB E 312.3
Electrical Power
1(3L-3P)

Prerequisite(s): E P 155.

Familiarization with electrical distribution systems and utility design within processing plants, and with electrical machines. Topics include DC power, and three-phase and single-phase AC power; electric motors and generators.

AB E 313.3
Instrumentation
2(3L-3P)

Prerequisite(s): E P 155.

Important characteristics of transducers and circuits used in the measurement of variables such as force, pressure, strain, temperature, humidity and electromagnetic radiation. Introduction to data loggers and digital data acquisition. The course emphasizes the importance of understanding the fundamental principles of transducers and associated circuitry from the standpoint of both design and selection of measurement systems.

AB E 323.3
Properties of Materials in Biosystems
1(3L-1.5P)

Prerequisite(s): AB E 211.3; 3 credit units Biology.

Corequisite(s): 3 credit units Statistics.

Familiarization with the terminology and definitions of physical properties of biological materials, including size, shape and density; water content, equilibrium moisture content, water activity, capillary tension, chemical potential and turgidity; chemical and molecular composition; thermal, optical, electrical and magnetic properties. Description of typical measurement methods and equipment for determination of material properties. Students develop an ability to indicate the uncertainty in property measurements and responsibly apply uncertainty in property values to engineering calculations. Emphasis is on describing the importance of biological material properties to engineering systems, and to understanding interactions between living and nonliving components of biological systems.

AB E 324.3
Mechanics of Materials in Biosystems
2(3L-1.5P-1.5T)

Prerequisite(s): G E 213 and AB E 323.

Analysis of the mechanical properties of biological materials, loads and failure modes. Topics include stress-strain responses for biomaterials in tension, compression and shear, contact stresses, static failure analysis, turgor and micro-mechanical cell models, viscoelastic response, mechanical damage, and friction. Applications relate to separation of plant parts, harvesting, loads imposed on storage structures, tillage and soil compaction, root growth, damage to fruits and seeds during handling, vertebrate locomotion, and rheology of agricultural materials.

Note: Students with credit for A E 310 may not take this course for credit.

AB E 327.3
Transport Processes in Biosystems
2(3L-1.5P)

Prerequisite(s): AB E 311; M E 227; CH E 210 or G E 225.

A unified approach to transport of energy and mass in biological and environmental processes. Emphasis is placed on the formulation and solution of mathematical models to represent heat and mass transfer in indoor and outdoor environments, in plant and mammalian systems, and for industrial processing of food and biomaterials. Students will apply analytical and numerical techniques to solve heat transfer problems involving steady state and transient heat conduction, convection and radiation, heat transfer with phase change, and mass transfer problems involving steady state and transient diffusion/dispersion and convection.

AB E 395.3
Design Capstone I
2(3L-1.5T)

Prerequisite(s): AB E 295.

Design is presented as both art and science, where solutions are developed using creative design processes that include analysis, synthesis and iterative decision making. Students explicitly define design problems, goals, objectives and constraints, complete an information search, and propose a plan for the analysis and specification of the design solution. A presentation of the design problem and the proposed approach to the design solution will be presented in a seminar to the department.

AB E 422.3 (First offered 2002-2003)
Modeling of Biosystems
1(3L-1.5T)

Prerequisite(s): AB E 324 and 327.

The student will be introduced to the concept of computer simulation as an analytical tool for understanding, designing and testing biology-related systems. Content includes introduction to systems modeling, classification of models, elements of dynamic simulation models, analytical models based on equilibrium, modeling growth and population dynamics, compartment models, feedback in biological systems and feedback mechanisms and stability of biological systems. Mathematical optimization and reliability analysis techniques are introduced.

AB E 431.3
Irrigation System Design
1(3L-1.5P)

Prerequisite(s): AB E 212 (or BIORE 212) and C E 225 (starting 2002 C E 319).

Engineering and hydrologic principles are applied to design of modern irrigation and drainage systems. Soil-plant-water relationships important to understanding water needs are emphasized.

AB E 432.3
Soil and Water Conservation
1(3L-1.5P)

Prerequisite(s): AB E 212 (or BIORE 212) or SL SC 220.

A study of the effects of management practices upon degradation and sustainability of agricultural, forest, wetland, and other land and water resource systems common to the Prairies. Topics include environmental factors governing soil development; degradation including erosion, salinization, soil organic matter depletion, soil compaction, and water contamination; preservation, mitigation and construction of wetlands; water conservation techniques; good agricultural, forestry and land management practices; economic and social-political implications of degradation versus conservation.

AB E 441.3 (First offered 2002-2003)
Design of Enclosed Environments
2(3L-1.5P)

Prerequisite(s): Completion of 90 credit units towards the B.E. degree.

This course emphasizes the physical aspects of environment control systems for agricultural buildings. The student will experience engineering designs involving greenhouses, animal shelters and vegetable storages. Emphasis is on solution of real-world problems, which depend upon making reasonable assumptions, integrating knowledge from more than one source, and interpreting mathematical results in terms of physical systems. Some use is made of computer programs. Laboratory periods are used for tours to buildings to observe environment control systems and for work on group design projects.

AB E 451.3
Design of Agricultural Machinery Systems
2(3L-1.5P)

Prerequisite(s): A E 310 or AB E 324.

Study of agricultural and other off-road machinery with special attention to the functional design requirements of various machine operations, cost analysis, machinery selection and testing. Topics include tillage force analysis, tillage tools, mechanisms for metering and applying seed, fertilizer and pest control chemicals, harvesting methods and machinery, hydraulic and other methods of transmitting power and controlling machines, application of computer aided design and finite element method in design analysis.

AB E 452.3
Machines in Biosystems: Current Topics
2(3L-1.5P)

Prerequisite(s): A E 313 or AB E 313.

Introduction to specialized components and analyses relevant to mechanized systems for production and processing of biological materials. Emphasis is on understanding the function of components within systems. Students will be able to recommend application of these components in a variety of situations and will develop conceptual designs for some of the components.

AB E 462.3
Agricultural Materials Handling
2(3L-1.5P)

Prerequisite(s): AB E 323 (or BIORE 323) ; (starting 2002 AB E 327)

Co-requisite(s): CH E 324 or M E 327.

A study of processes involved in conveying, storing, drying, cleaning and sorting agricultural products. Analysis and design of machines used for conveying bulk solids and liquids. Theory and practice of drying for grain and forage crops. Moisture and quality control in storage and transport.

Note: Students with credit for BIORE 462 or BIORE 460 may not take this course for credit.

AB E 481.3
Sustainability and Environmental Assessment
2(3L-3P)

Prerequisite(s): Completion of 90 credit units of university study.

A study of the principles of sustainable development and the process of environmental impact assessment with emphasis on Prairie agricultural and industrial settings. Case studies are used to illustrate the EIA process in engineering design of environmental control measures. Concepts of integrated resource management are analyzed as the basis for making linkages between protecting the environment, economic development and public participation.

AB E 482.3
Design for Waste Utilization
1(3L-1.5P)

Prerequisite(s): Completion of 90 credit units of university study towards the B.E. degree.

The design of systems and equipment for processing and utilization of wastes generated by the bioresource industries, including primary agriculture, food processing, and forestry. Pollution problems caused by these industries are examined and opportunities for recycling and utilization of wastes are identified. Emphasis is on land as opposed to surface water as a receptor of organic wastes. A comprehensive strategy is developed for approaching pollution control and waste product utilization problems. Students are expected to integrate sociological, regulatory, economic, biochemical and technological considerations in exploring waste treatment and utilization options. Students will work in teams to conduct an industrial waste survey and a feasibility study of waste reduction and enhanced waste utilization for a specific local industry, farm, or processing plant.

AB E 495.3 (First offered 2002-2003)
Design Capstone II
2(3P)

Prerequisite(s): AB E 395.

A continuation of AB E 395 in a self-directed course. Students perform the analysis associated with the design problem and are able to specify a design solution at the end of the course. Students must submit a comprehensive report, describing the design solution. The final design solution is also presented to the faculty and staff in the Department of Agricultural and Bioresource Engineering in the format of poster and oral presentations.

Special Topics

AB E 398.3
AB E 498.3

These are courses offered occasionally by visiting faculty and in other special situations. Students interested in these courses should contact the Dean's Office for further information.

CHEMICAL ENGINEERING

CH E 210.3
Fluid Mechanics I
2(3L-2P Alt. weeks)

Prerequisite(s): G E 125.

Corequisite(s): MATH 224.

Single phase fluid flow is considered for both gas and liquids. The mechanical energy balance and fluid force balance equations are developed with applications. Newtonian and non-Newtonian concepts are introduced including rheological measurement. The concepts of laminar and turbulent flow are developed and applied to flow in pipes and networks, and fluid metering. Compressible fluid flow is also introduced.

CH E 220.3
Introduction to Process Engineering
2(3L-1.5P)

Corequisite(s): CHEM 242.

The lectures and problems will illustrate the use of energy and material balances in chemical and biochemical engineering processes.

CH E 311.3
Mathematical Modelling I
1(3L-2P Alt. weeks)

Prerequisite(s): MATH 224 (taken) and CH E 220.

Numerical methods. Curve-fitting and approximation of functions. Fourier series and integral. Laplace transformation. Design of experiments

CH E 315.3
Mass Transfer I
2(3L-2P Alt. weeks)

Prerequisite(s): CH E 311 and 323.

Mass transfer operations involving contact by stages, including single-stage, binary multiple-stage contacting, and multicomponent multiple-stage contacting. Gas absorption, distillation, and liquid extraction are included.

CH E 320.3
Fluid Mechanics II
1(3L-2P Alt. weeks)

Prerequisite(s): CH E 210.

Pumping of fluids, gas-liquid pipe flow, flow through consolidated and unconsolidated porous media, fluidization and two-phase separation processes. Applications include topics of interest in the petroleum and mineral processing industries.

CH E 322.3
Mathematical Modelling II
2(3L-2P Alt. Weeks)

Prerequisite(s): CH E 311.

Ordinary and partial differential equations as they relate to chemical engineering processes. Laplace transforms for ordinary differential equations. Analytic and numerical solutions to partial differential

equations. An emphasis will be placed on the development of mathematical models for chemical engineering systems.

CH E 323.3
Chemical Engineering Thermodynamics
1(3L-2P Alt. weeks)

Prerequisite(s): CHEM 347.

Topics include the treatment of vapour-liquid equilibria at high pressures, expansion and compression of fluids, steam power-plant cycles, liquefaction of gases and refrigeration.

CH E 324.3
Heat Transfer
2(3L-2P Alt. weeks)

Prerequisite(s): CH E 210 (taken) and 311 (taken).

Steady and transient conduction. Convective transfer processes and heat transfer coefficients. Heat exchanger design. Radiant heat transfer.

CH E 325.3
Process Engineering and Design I
2(3L)

Prerequisite(s): CH E 220 and 323.

Corequisite(s): CH E 324.

The concepts of industrial chemical process design, industrial economics, process optimization, process simulation and plant troubleshooting. Encourages students to use their fundamental knowledge in science and mathematics to solve practical chemical engineering problems. Special emphasis will be placed on safety, hazards, operability and loss prevention issues in chemical plants.

CH E 332.0
Seminar
1&2(1S)

Current and future technological changes and their impacts on society are explored from a chemical engineering point of view. Impacts of petroleum production, mineral industries, and chemical industries.

CH E 333.2
Chemical Engineering Laboratory I
2(3P)

Corequisite(s): CH E 210 and 324.

A series of experiments using bench scale and pilot plant scale apparatus to study fluid mechanics, heat transfer, and thermodynamics. The method of reporting results is emphasized.

CH E 370.0
Field Trips
1/2(P)

Visits to industrial plants.

CH E 411.3
Chemical Reaction Engineering
1(3L)

Prerequisite(s): CHEM 242.

An examination of the principles of applied chemical kinetics and their use in chemical reactor design and chemical plant operation. Both homogeneous and heterogeneous kinetics, including catalysis, are considered.

CH E 413.3
Process Dynamics
1(3L-2P Alt. weeks)

Prerequisite(s): CH E 311 (starting 2002 CH E 322).

Simulations of chemical process control systems is introduced. Low order dynamic equations are developed. Nonparametric process identification is studied.

CH E 414.2
Chemical Engineering Laboratory II
1(3P)

Prerequisite(s): CH E 320 and 333 (taken).

Corequisite(s): CH E 413.

Experiments are chosen from the fields of fluid mechanics, biochemical engineering, heat transfer, thermodynamics, data logging and process dynamics.

CH E 421.3
Mass Transfer II
1(3L-2P Alt. weeks)

Prerequisite(s): CH E 315.

Further topics in mass transfer operations. Molecular diffusion, mass transfer coefficients, continuous contacting, gas absorption, air-water contacting, drying.

CH E 422.3 (Last offered 2001-2002)
Process Engineering and Design II
1&2(1.5P)

Prerequisite(s): CH E 325

Corequisite(s): CH E 315 and 411.

Detailed design of an actual industrial chemical process including preparation of the engineering flowsheet, process simulation and optimization, plant energy and material balances, equipment sizing and design, plant lay-out and economic analysis of the chemical process.

CH E 422.6 (First offered 2002-2003)
Process Engineering and Design II
1&2(1.5P)

Prerequisite(s): CH E 325

Corequisite(s): CH E 315 and 411.

Detailed design of an actual industrial chemical process including preparation of the engineering flow sheet, process simulation and optimization, plant energy and material balances, equipment sizing and design, plant layout, hazards and operability and environmental impacts, and economic analysis of the chemical process.

CH E 423.3
Process Control
2(3L-2P Alt. weeks)

Prerequisite(s): CH E 413.

The instrumentation and the distributed control systems will be discussed. The classical linear control theory and the stability criteria for control system design are introduced. The development of dynamic equations for elements of control loops is emphasized. Data acquisition, interfacing and digital computer control with emphasis on the analysis of sampled data systems are studied. Survey and discussion of particular control schemes for chemical engineering processes.

CH E 424.2
Chemical Engineering Laboratory III
2(6P)

Prerequisite(s): CH E 414 (taken).
Corequisite(s): CH E 421 and 423.

Experiments are chosen from the fields of process dynamics and control, reactor design, and mass transfer.

CH E 431.1
Seminar
1&2(1S)

Corequisite(s): G E 449.

Current and future technological changes and their impacts on society are explored from a chemical engineering and a professional engineering point of view. Impacts of petroleum production, mineral industries, and chemical industries.

CH E 453.3
Corrosion Engineering
1/2(3L)

Prerequisite(s): 60 credit units of university study towards the B.E. degree.

Intended for engineers and others who wish to develop an appreciation of the principles of corrosion and corrosion control and their application to the selection of materials of construction and the protection of engineering systems.

CH E 454.3
Design of Industrial Waste Treatment Systems
1/2(3L)

Prerequisite(s): 60 credit units of university study towards the B.E. degree.

Air pollution topics include causes and effects of air pollution, sampling and analysis of air and stack gas samples, stack gas dispersion models, and the design of industrial control measures for particulates. Water pollution topics include causes and effects of water pollution, biology of receiving waters and treatment systems, sampling and analysis of wastewaters, and industrial control measures including biological methods such as trickling filters, aeration basins and activated sludge systems.

CH E 455.3 (Last offered 2001-2002)
Project
1&2(1.5P)

Prerequisite(s): 100 credit units towards the B.E. degree.

Involves independent design work by a small team of students on an innovative project. Projects are chosen from a group of projects prepared by the Department with possible input from local industries. A final formal report including economic analysis is required by each design team.

CH E 460.3
Oil and Natural Gas Upgrading
1/2 (3L)

Prerequisite(s): 70 credit units in CH E program including CH E 220.

The application of chemical engineering principles to the petroleum refining and petrochemical industries. A refinery survey looks at key unit operations such as atmospheric distillation catalytic cracking, and reforming. Bitumen and heavy oil upgrading are also discussed. Processes for the production of petrochemicals from natural gas constituents are examined.

CH E 461.3
An Introduction to Biochemical Engineering
1/2(3L)

Prerequisite(s): 60 credit units of university study towards the B.E. degree.

To provide the engineering student with an understanding of the behaviour of microorganisms and their industrial application. The elements of organism structure, and enzyme and cell functions are discussed. Attention is given to the evaluation of batch and continuous fermentation processes and the operations of aeration, agitation and sterilization. Some industrial processes are considered.

CH E 464.3
Petroleum Production Engineering
1/2(3L)

Prerequisite(s): CH E 210 or C E 225 or G E 225 or M E 215.

An introduction to the techniques used in the production of oil and natural gas. Topics include an introduction to petroleum geology, properties of reservoir rocks and petroleum fluids, inflow performance of vertical and horizontal wells. Wellbore hydraulics, well testing and well stimulation.

CH E 470.0
Field Trips
1/2(P)

Visits to industrial plants.

CH E 498.3
Special Topics

These are courses offered occasionally by visiting faculty and in other special situations. Students interested in these courses should contact the Dean's Office for further information.

CHEMISTRY

For descriptions of Chemistry courses see the College of Arts and Science section of the *Calendar*.

CIVIL ENGINEERING, GEOLOGICAL ENGINEERING

Civil Engineering also administers the Geological Engineering courses. Courses are listed below:

CIVIL ENGINEERING

C E 212.3
Civil Engineering Materials
1(3L-1.5P)

Prerequisite(s): CHEM 111.

An introduction to the physical and mechanical properties of materials and the phenomenological bases for these behaviours. Fundamental concepts of materials science and engineering are introduced and applied to materials commonly encountered in civil engineering applications, including Portland cement concrete, metals and alloys, ceramics, polymers and polymer composites, and other materials such as wood, asphalt concrete, and soils.

C E 225.3
Fluid Mechanics
2 (3L-1.5P)

Prerequisite(s): G E 125 and MATH 223 (taken).

Provides an introduction to the subject area of fluid mechanics, including the properties of fluids, concepts of a continuum, fluid statics, kinematics, the general control volume conservation equation, continuity equation, momentum equation, Bernoulliis equation and measurement of fluid properties, pressure, velocity and discharge.

C E 271.2
Surveying (Spring Camp)
3(P, 2 weeks)

Basic introduction to the use and adjustments of survey equipment, and the associated field work and data interpretation required for engineering projects.

C E 295.3
Project 1
2(1L-1.5P)

Prerequisite(s): G E 120, G E 210,C E 212, GEO E 218, MATH 223 and CMPT 116.

Corequisite(s): C E 225, G E 213, 300 or permission of the Department Head.

A design course in which the principles of design are learned by application to a suitable civil engineering project. The course requires that the students work in groups to achieve the desired outcome. Group interaction and performance is monitored throughout. Guest lectures from various industrial and other representatives will be provided to enhance the student's design experience.

C E 311.3
Continuum Mechanics
1(3L-1.5P)

Prerequisite(s): C E 212 and G E 213.

The application of equilibrium analysis to materials and systems that can be treated as continua. The laws of equilibrium, compatibility, and constitutive relationships are used to reduce physical problems to mathematical expressions. Concepts are introduced in the context of elastic theory and extended to other areas of relevance to civil engineering such as fluid flow, plasticity, viscoelasticity, and multi-phase material behaviour.

C E 315.3
Fluid Mechanics and Hydraulics
1(3L-1.5P)

Prerequisite(s): C E 225.

Builds on the concepts studied in C E 225 Fluid Mechanics. Introduces the concepts of dimensional analysis, boundary layer development, incompressible flow in pressure conduits, flow past objects, steady flow in open channels and hydraulic transients.

C E 316.3
Geomatics
1(3L-1.5P)

Prerequisite(s): C E 271, AutoCAD Level 1 training; or equivalent.

An introduction to Geomatics. This course describes the land subdivision system in Canada and briefly discusses land subdivision and encumbrances. Coordinate systems are presented, including a discussion of astronomic and Geometric reference ellipsoids to approximate the shape of the earth. Map projections used to show the position of points on the surface of the earth on a two-dimensional surface are also discussed. Universal Transverse Mercator (UTM) projections are presented in detail, and the theory and application of this coordinate system are studied as the basis for most Canadian control surveys. The use and application of digital surveying equipment is presented along with the elements of total station and data collector operation. The combined use of UTM coordinate and digital surveying information, along with Softdesk Civil computer software for earthwork design, is also discussed. Global positioning satellite (GPS) surveys are also discussed, along with the integration of satellite data with base maps and total station surveys. Geographic information systems are also described and presented with applications in this course.

C E 317.3
Structural Analysis
1(3L-1.5P)

Prerequisite(s): G E 213.

Introductory concepts for the analysis of structures are presented. Axial forces, shear forces and bending moments in statically determinant structures due to applied loads are determined, and methods for estimating deflections are covered. Computer analysis using the stiffness method is introduced and applied to 2D trusses. Manual analysis methods for statically indeterminate structures are considered briefly. An emphasis is placed on the application of basic analytical techniques, followed by the use of computer-based verifications.

C E 318.3
Applied Mathematics for Civil Engineers
1(3L-1.5P)

Prerequisite(s): MATH 224,CMPT 116, C E 225 (taken) and G E 213 (taken).

An introduction to the use of mathematical methods in applied civil engineering problems. Topics will include: matrix solution methods for systems of coupled equations, eigenvalue problems, and coordinate transformations; optimization and linear programming; and the solution of differential equations describing non-stationary physical systems using analytical, finite difference and finite element methods. Numerical techniques using computer programs are emphasized.

C E 319.3
Hydrology and Hydrogeology
2(3L-1.5P)

Prerequisite(s): MATH 224, GEO E 218 and C E 225 (taken).

This course will introduce the student to the hydrologic cycle, emphasizing the three components of the cycle; firstly the climatological elements of precipitation and evaporation, secondly, the unsaturated zone including infiltration, evapotranspiration and downward percolating soil moisture, and finally subsurface flow systems and hydrogeologic processes.

C E 321.3
Structural Systems and Materials
2(3L-1.5P)

Prerequisite(s): C E 212, 311 and 317.

The behaviour and applications of basic forms of structural systems are reviewed, including beam and column systems, arches and cable systems, trusses, braced systems and rigid frames. Limit States design principles in accordance with the National Building Code of Canada (NBCC) are introduced as a means of dealing with uncertainty in design. The estimation of building loads is covered, including dead and live loads, snow and rain loads, and loads due to wind. An introduction is also given to the characteristics of common structural materials, including steel, reinforced concrete and wood.

C E 327.3
Sanitary/Environmental Engineering I
2(3L-1.5P)

Prerequisite(s): CHEM 111 and C E 225.

Fundamental topics in the discipline of sanitary/environmental engineering are introduced. Topics covered include the design of municipal water distribution and wastewater collection systems; an introduction to water chemistry and water quality assessment; and design of physical and chemical water treatment processes. A brief overview of municipal solid waste management systems is also presented.

C E 328.3
Introduction to Geotechnical Engineering
1(3L-1.5P)

Prerequisite(s): GEO E 218, C E 225 (taken) and G E. 213 (taken).

Classification systems and a review of phase relationships are provided. The fundamental concepts of effective stress as applied to volume change, shear strength and consolidation are emphasized. Both steady state and transient seepage analyses are used to develop concepts of pore water pressures that are incorporated into volume change and shear strength analyses. Concepts of stress state as applied to saturated and unsaturated soils form an integral part of understanding soil behavior. An introduction to foundation engineering that provides a survey of lateral earth pressure, bearing capacity of shallow and deep foundations, settlement and slope stability are provided. This course does not provide students with a facility for design in foundation engineering. However, it will furnish a basic grounding in the fundamentals of soil mechanics for application to more advanced courses.

C E 329.3
Transportation Engineering
2(3L-1.5P)

Prerequisite(s): C E 316.

This course introduces the civil engineering student to planning, design, operation and management of air and road transportation systems.

C E 414.3 (First offered 2002-2003)
Sanitary/Environmental Engineering II
1(3L-1.5P)

Prerequisite(s): C E 327.

Additional topics in the discipline of sanitary/environmental engineering are introduced. Topics covered include the design of primary wastewater treatment systems; introduction to biological processes and waste degradation; design of biological wastewater treatment processes; and tertiary wastewater treatment. An introduction to sludge processing and air pollution is also presented.

C E 415.3
Structures for Water Management
1(3L-1.5P)

Prerequisite(s): C E 315.

A design course in which the basics of fluid mechanics (hydrostatics, continuity, energy and momentum) are applied to hydraulic design. The concrete gravity dam and spillway structures are used to introduce the basic aspects of hydraulic structure design with respect to forces and hydraulic analysis, including the important topic of energy dissipation. Other structures, such as those used for flood control, irrigation, hydropower, navigation, water supply, land and highway drainage, wildfowl habitat preservation, and water-based recreation, are also considered.

C E 416.3
Geotechnical Engineering Practice
1(3L-1.5P)

Prerequisite(s): C E 328 (or 326).

Covers the basics of foundation engineering. Methods of design and construction of earth retaining structures and anchors are presented. The stability analysis of open excavations is included. The design and construction of shallow foundations based on bearing capacity and settlement analysis are considered along with the design and installation of pile foundation. Methods of design of driven displacement piles, auguered in place piles and cast in place piles are described. A theme of job site safety runs throughout the course.

C E 417.3
Pavement Materials and Design
1(3L-1.5P)

Prerequisite(s): C E 311 (or 313) and 328 (or 326).

Presents methods used to design, build, and predict the performance of road structures. The course draws heavily upon a material science and mechanics framework to quantify the effects of alternative materials, traffic loading and environmental loading on road performance. Road structural design, materials specification, construction, rehabilitation, and maintenance of flexible and rigid pavements are presented in the overall context of effective road asset management.

C E 418.3
Design in Reinforced Concrete
1(3L-3P)

Prerequisite(s): C E 321 (or 322) (taken).

An introduction to the analysis and design of reinforced concrete structural members. Limit States and ultimate strength methods for beams and one-way slabs (singly and doubly reinforced) in flexure and shear. Introduction to the development of reinforcement. Design of short beam-columns. Deflection, cracking and vibration control. Design of footings.

C E 419.3 (Last offered 2001-2002)
Environmental and Sanitary Engineering Fundamentals
1(3L-1.5P)

Prerequisite(s): C E 325 (taken).

The microbiological, chemical, and physical aspects of water quality are introduced. The unit operations and processes of coagulation, flocculation, sedimentation, softening, filtration, disinfection, taste and odour control and other treatment methods are introduced. Characteristics of waste waters, stream pollution, aerobic and anaerobic treatment are discussed, as are disposal methods for liquids and sludges.

C E 420.3
Project Engineering
2(3L-1.5P)

Prerequisite(s): G E 348, and 90 credit units of university study towards the B.E. degree.

An introduction to the engineering and construction industries: the engineer's role in industry, construction and the economy. Deals with various aspects of engineering including, work plans and related studies. It also deals with the marketing of engineering services. It discusses control on construction projects and methods of ensuring quality. Construction tendering is covered in detail, including the preparation of instructions to bidders, General and supplementary conditions, specifications, receiving tenders and awarding contracts. Bidding and estimating is also discussed. Computerized precedence network scheduling using various software packages is demonstrated. This course includes discussions on construction claims, professional liability, arbitration and the use of courts to settle disputes.

C E 461.3 (Last offered 2001-2002)
Structural Engineering Systems Design
2(3L-1.5P)

Prerequisite(s): C E 322 (taken).

Use of the National Building Code to determine the design loads acting on a structure. Procedures for evaluating the governing design loads acting on structural members are introduced. Design of selected structural components for a steel manufacturing building are discussed. Designs are performed in the practica using Limit States Design Specifications.

C E 463.3
Advanced Structural Analysis
2(3L-1.5P)

Prerequisite(s): C E 317.

Deals with advanced techniques for the analysis of determinate and indeterminate structures, including energy-based methods, moment distribution method with joint translation, influence lines, non-prismatic members. Computer analysis based on the stiffness formulation is presented for space frames. Finite element analysis is introduced for plate-like elements loaded in their own plane. Emphasis is placed on basic analytical techniques, followed by computer verification.

C E 464.3
Water Resources Engineering
2(3L-1.5P)

Prerequisite(s): G E 348 and C E 315 (taken).

Includes the consideration of water resource systems and their management, establishment of the various data needs for water resource systems analysis, the use of economics as a decision-making tool in water resources engineering and conceptual design of a number of components of a water resource system. While focussed on the engineering aspects of water resource management, the student is also exposed to some of the broader issues which impact management decisions for the resource (e.g., social, environmental, legal). An introduction is also provided to the basic principles of planning and to the use of reservoirs in water resource systems.

C E 465.3 (Last offered 2001-2002)
Environmental Control Engineering
2(3L-1.5P)

Prerequisite(s): C E 419 (or equivalent).

Environmental Impact Assessment (EIA) processes are presented and a number of Environmental Impact Studies (EIS) are reviewed. Waste management problems associated with waste disposal sites, spills, mine tailings and power generation are discussed. Techniques in instrumentation, monitoring and assessment are presented. Methods for the design of waste management systems are reviewed.

C E 466.3
Modeling of Earth Structures
2(3L-1.5P)

Prerequisite(s): C E 328 (or 326).

Design of earth embankments, especially those used for reservoir retention, encompasses virtually every aspect of soil mechanics and geotechnical engineering. Design and construction techniques for embankment foundations which will not permit excessive seepage, settlement or failure are investigated. Protection of slopes from erosion and embankment stability are discussed, as is the control of seepage through and below the embankment. Instrumentation of earth dams to ensure their safety and check on their performance is also presented.

C E 467.3
Transportation and Regional Development
2(3L-1.5P)

Prerequisite(s): C E 329 (or 227) and G E 348; or permission of the Department Head.

Introduction to transportation technology and its impact upon urban and regional development. Topics include transit technology, highway technology, transportation in Northern Canada, urban transportation planning, transportation economics and regulation, and current issues in transportation.

C E 468.3 (First offered 2002-03)
Design of Waste Management Systems
2(3L-1.5P)

Prerequisite(s): C E 319, 327 and 328 OR permission of the Department Head.

The course contains four principal components; characterization of solid waste streams (municipal mine tailings/was rock, agricultural and industrial); an introduction to contaminant transport process in ground water; a review of the design elements of containment systems; and finally discussion of case studies of containment system.

C E 469.3 (First offered 2002-2003)
Natural and Engineered Water Systems
2(3L-1.5P)

Prerequisite(s): C E 315, 319 and 327.

Provides the student with an opportunity to appreciate water in the natural environment and the integration of the built and natural environments. Although based on an engineering approach, the course exposes the student to multi-disciplinary water resource management, particularly in respect of the biologic and water quality aspects of water resource systems. Specifically, the course will address the topics of stormwater management including best management practices, water quality modeling in streams, environmental hydraulics (including the mixing of effluents near outfalls in rivers and lakes), ecohydraulics and natural channel design, and erosion control in the context of erosion impacts on natural water systems.

C E 470.3 (First offered 2002-2003)
Design in Structural Steel
2(3L-3P)

Prerequisite(s): C E 321.

An introduction to the design of structural steel members and connections. Limit States design principles, in conformance with the Canadian steel design Standard CSA-S16.1, are used as the basis for design. Types of members and components include tension and flexural members, columns and beam columns, and bolted and welded connections. Emphasis is placed on basic design procedures, followed by the use of computer-based verification.

C E 495.3 (Last offered 2001-2002)
Project
1&2(1S-2P)

Prerequisite(s): G E 390. Students must be in the final year of their program.

Each student must initiate and complete a project and submit a report written in good literary style. The project may deal with an original laboratory or field investigation with which the student was personally involved, or a case study of the design and/or construction and/or operation of a particular project or structure with which the student was personally involved. An original design problem of a nature not specifically considered in course work may also make a suitable project topic. The topic will be presented orally at a seminar attended by fellow students and members of the Civil Engineering faculty.

C E 495.6 (First offered 2002-2003)
Capstone Project
1&2(1L-1.5P)

Prerequisite(s): Must be in graduating year, or permission of the Department Head.

A final design course in which advanced principles of design are learned by application to a suitable civil engineering project. The course, which builds upon the foundation established in C E 395, focuses on approaches to be taken in defining complex problems (including the outlining of project objectives and scope), acquisition of suitable data resources, generation of alternative solutions, methods for selecting design alternatives and project implementation. Design philosophy and methods are discussed and explored in the context of the particular assignment given for the current year. The course requires that the students work in groups to achieve the desired outcome. Group interaction and performance is monitored throughout. Guest lectures from various industrial and other representatives will be provided to enhance the student's design experience.

GEOLOGICAL ENGINEERING

GEO E 218.3
Engineering Geology
1(3L-1.5P)

Introduction to engineering geology, engineering geomorphology, airphotos and airphoto interpretation. Emphasis will be placed on the surficial geology of the Canadian Prairies.

GEO E 315.3
Rock Mechanics
2(3L-1.5P)

Prerequisite(s): G E 213; GEO E 218 (or 213).

Corequisite(s): C E 328 (or 326).

Physical properties of rock. Rock stress-deformation behaviour and failure. Laboratory and *in situ* testing.

GEO E 335.3 (Last offered 2001-2002)
Seismology, Radar and Electrical Methods
2(3L-3P)

Prerequisite(s): CMPT 116 (or 122); MATH 223 and 224, or 225 and 226; E E 201 (or G E 212) or PHYS 227.

Basic theory of seismic, radar and electrical methods. The application of geophysical measurements in geological engineering, groundwater and prospecting problems.

Note: This course is also offered as GEOL 335 by the College of Arts and Science. Students with credit for GEO E 333 or GEOL 335 may not take this course for credit.

GEO E 378.3 (First offered 2001-2002)
Engineering Geological Mapping
3(P)

Prerequisite(s): GEOL 224, 243, 258, C E 328 and GEO E 315.

Introduction to field methods in geological engineering: mapping, discontinuity surveys, analysis and design. A two-week field camp immediately preceding first term in the final year of the GEO E program.

GEO E 411.3 (Last offered 2001-2002)
Well-Logging
1(3L)

Prerequisite(s): GEOL 121 or 110 (or GEO E 118); MATH 223 and 224, or 225 and 226; G E 212 or PHYS 227.

Discussion of the types of geophysical measurements that are made in boreholes with emphasis on the physical principles and problems involved in evaluation of geological formations.

Note: This course is also offered as GEOL 411 by the College of Arts and Science. Students with credit for GEOL 411 may not take this course for credit.

GEO E 412.3 (First offered 2002-2003)
Reservoir Mechanics
2(3L-1.5P)

Prerequisite(s): C E 319 (or 324) or M E 335.

Corequisite(s): GEOL 463.

Fluid flow in hydrocarbon reservoirs; material balance equations; oil and gas well testing; water influx and steam soak; fractional and segregated flow of immiscible fluids.

GEO E 414.3
Rock Mechanics Design
2(3L-1.5P)

Prerequisite(s): GEO E 315.

Applications of rock mechanics to design in civil and mining engineering.

GEO E 466.3
Petroleum Geomechanics
2 (3L-1.5P)

Prerequisite(s): 90 credits in the Civil or Geological Engineering programs or permission of the Department Head.

Geomechanical, geotechnical and petrophysical problems of interest to the petroleum industry: petroleum well drilling, borehole breakouts, wellbore stability, hydrofracture, settlement and consolidation due to oil withdrawal.

GEO E 475.3
Advanced Hydrogeology
1(3L-1.5P)

Prerequisite(s): GEOL 478 or BIORE 360.

Regional groundwater flow; petroleum hydrogeology; fluid migration in basins; surface-water groundwater interaction; introduction to groundwater modelling.

GEO E 479.2 (Last offered 2001-2002)
Field Survey and Design
3(P)

Prerequisite(s): GEO E 379.

A series of visits to sites of geological engineering interest immediately preceding the first term of fourth year; case history material provided; field diaries maintained; individual data analysis and/or design projects based on site visits and case history material.

GEO E 495.6
Design Project
1&2(1L-3P)

Prerequisite(s): G E 300 (or 390). Students must be in graduating year or have permission of the Program Coordinator.

Each student must plan and complete a project and submit a written engineering report. The project may involve original laboratory investigations and/or field case history studies and/or computer design problems. Results are presented orally at a seminar.

COMMERCE

COMM 102.3
Introduction to Business Management
1/2(3L)

Examines the processes of management including environment and business analysis, planning, decision making, execution, and performance measurement.

COMPUTER SCIENCE

CMPT 116
Computing I
1(3L-1.5T)

Prerequisite(s): Mathematics B30.

Gives the fundamentals of programming, including functions, procedures and arrays. It introduces object-oriented programming and GUI components. Also some basic numerical methods and engineering applications are presented.

Note: Students who have credit for this course may not receive credit for CMPT 111 or 112.

CMPT 117
Computing II
2(3L-1.5T)

Prerequisite(s): CMPT 116 (or 122).

Continues the development of programming skills started in CMPT 116, with an emphasis on object-oriented programming. Data structures for the storage and efficient retrieval of information will be studied and analyzed, in particular stacks, queues, linked lists and simple binary trees. Examples and exercises will be drawn from engineering applications and numerical methods.

Note: Students who have credit for CMPT 123 may not take this course for credit.

For descriptions of other Computer Science courses, see the College of Arts and Science section of the *Calendar.*

ELECTRICAL ENGINEERING

E E 201.3
Electric and Magnetic Circuits II
1(3L-1.5P)

Prerequisite(s): MATH 124 and E P 155.

Topics include magnetic fields, series and parallel magnetic circuits; electromagnetic induction, self and mutual inductances, transients in R-L circuits; generator and motor actions; waveform and frequency, average and rms values; voltage drops in R, L and C circuits; phasor representations of sinusoidal quantities; single phase series and parallel ac circuits; apparent, real and reactive powers, complex power, power factor; ammeters, voltmeters, wattmeters, and multimeters, impedance and frequency measurements.

E E 212.3
Passive AC Circuits
2(3L)

Prerequisite(s): MATH 124 and E E 201.

Basic concepts in AC circuits, power factor, real, reactive and complex power. Loop and nodal analysis, circuit theorems and their application in AC circuits. Wye-delta transformation, series and parallel resonance, circuit response to variable frequencies. Circuit representation of transformers, utilization of the per unit system, Polyphase system, three phase 3-wire and 4-wire systems, star and wye connections, balanced and unbalanced three phase systems, power measurement in three phase systems.

E E 214.3
System Modelling and Network Analysis
2(3L)

Prerequisite(s): MATH 124 and E E 201.

Deriving differential equations for electrical and mechanical systems, solving differential equations for initial conditions and a step input, the Laplace transform, Second Order Systems, solving transient response by the Laplace transform, Simulation with Matlab/Simulink, Frequency Response, Passive Filters, Network Synthesis, Two-Port Networks.

E E 216.3
Probability, Statistics and Numerical Methods
1(3L)

Prerequisite(s): MATH 124.

Tabular and graphical representation of data, Probability, Random variables and discrete probability distributions, Continuous probability distributions, expectation, confidence interval, Testing of hypotheses, Method of least squares, Software packages for statistical analyses. Numerical Methods: Random numbers and random sampling, Interpolation and spline functions, Solutions of equations in one variable, solutions of systems of linear equations, Numerical differentiation and numerical integration, Solutions of differential equations, Fast Fourier Transform, Optimization.

E E 221.3
Analog Electronics
1(3L)

Corequisite(s): E E 201 (or G E 212).

Introduction to solid state electronics. Emphasis is on circuit design concepts with extensive discussion on diodes and diode circuits and on bipolar junction transistors (BJT) and field effect transistors (FET) as amplifiers and as switches.

E E 232.3
Digital Electronics
2(3L)

Prerequisite(s): E E 221.

An introduction to digital logic including combinational and sequential logic devices and circuits. Covers the range from the fundamentals of Boolean algebra and the binary number systems to combinational and sequential circuit functional blocks such as adders, multiplexers, counters and state machines. Some coverage is also given to electronic characteristics of real logic devices and field programmable gate arrays (FPGA).

E E 271.3
Materials and Heat Transport in Electrical Engineering
1(3L)

Prerequisite(s): CHEM 111 and E P 155.

Basic concepts in materials science, crystals, kinetic theory, heat capacity, thermal fluctuations, Boltzmann equation, x-ray diffraction, crystal imperfections, solid solutions, alloys, mechanical properties, electrical properties, thermal properties, heat transport by thermal conduction, radiation and convection; and applications of these concepts in electrical engineering. Practicum and design based on these topics.

E E 292.2
Electrical Engineering Laboratory I
2(3P)

Corequisite(s): E E 212, 216 and 232.

Experiments related to Passive AC circuits, Analog Electronics and Digital Electronics. Introduction to Electrical Engineering laboratory equipment and experimental methods.

E E 301.3 (First offered 2001-2002)
Electricity, Magnetism and Fields
1(3L)

Prerequisite(s): E E 201 and E E 212.

Review of vector calculus, static electric and magnetic field theory and its extension into time varying E and M fields, interaction between fields and materials, transmission line, wave guide and antenna fields.

E E 311.3
Electronics
1(3L-1.5P)

Prerequisite(s): E E 201 (or G E 212).

An introductory service course in electronics. Topics include Thevenin's theorem, Norton's theorem, operational amplifiers, filters, an introduction to diodes, BJT, FET, diode circuits, and electronic amplifiers. Digital electronics, Boolean algebra, shift registers, and memory devices.

Note: Electrical Engineering students may not take this course for credit.

E E 314.3
Electrical Power Systems
1(3L-1.5P)

Prerequisite(s): E E 201 (or G E 212) and MATH 224.

An introduction to three-phase power circuits and fundamentals to dc, ac induction type and synchronous machines.

Note: Electrical Engineering students may not take this course for credit.

E E 323.3
Electronic Instrumentation
1(3L)

Prerequisite(s): E E 221 and E E 232.

Topics include: operational amplifer circuits, such as instrumention amplifier, active filters, and precision rectifers; noise sources and noise reduction techniques; transducers; virtual instrumentation; analog and digital interfacing such as A/D converters, D/A converters, sample and hold circuits, and digital instrumentation buses.

E E 331.3
Microprocessor Hardware and Software
1(3L)

Prerequisite(s): E E 232.

Covers the architecture and operation of microprocessors and memory devices, linking together of logic devices. The assembler language is introduced to program low level functionality of microprocessors.

E E 332.3
Real Time Computing
2(3L)

Prerequisite(s): E E 232 and 331.

The functional blocks studied in E E 331 are used to describe the architecture and operation of microprocessors and memory

devices. In addition, the course covers the linking together of logic devices and interfacing digital logic with analog inputs and outputs. The course also covers embedded processor systems (micro-controller) and application specific I/O interfacing techniques.

E E 341.3
Electric Machines I
2(3L)

Prerequisite(s): E E 212.

Basic concepts of transformers: transformer on no-load, equivalent circuit, transformer tests, transformer performance, three-phase transformers. Direct current machines: field excitation, commutation, armature windings, armature reaction, saturation curve, voltage buildup in a dc generator, steady-state operating characteristics of dc generators, dc motors, speed regulation of dc motors, steady-state operating characteristics of dc motors, torque-speed characteristics of dc motors, starting of dc motors, losses and efficiency of dc machines. Three-phase induction motors: synchronous speed and slip, rotating magnetic field, equivalent circuit of an induction motor, no load and locked rotor tests, torque-slip curve of an induction motor, losses and efficiency, starting of induction motors, speed control of induction motors, single-phase induction motors.

E E 342.3
Power Systems I
1(3L)

Prerequisite(s): E E 212.

This course covers generation of energy, components of a modern power system, three-phase systems; voltage, current and power calculations, per-unit system, modelling of transformers, single-line diagrams, Inductance and capacitance calculations of single- and three-phase lines, transmission lines; modeling, steady-state operation and compensation, power system controls; local and central controls.

E E 344.3
Power Electronics
2(3L)

Prerequisite(s): E E 323.

Corequisite(s): E E 341.

Introduction to switching devices: volt-ampere characteristics of BJTs, thyristors, GTOs, IGBT and MOSFETS, switching losses. Average, rms and peak current and voltage ratings of power electronic devices. Commutation of power electronic devices; analyses of uncontrolled and controlled converter circuits, single-phase and three-phase AC-DC converters, DC drives. Principle of DC to DC conversion: analyses of boost and buck choppers. Principle of DC to AC conversion, application of inverters, analysis of inverter circuits, voltage control in inverter circuits, reduction of output harmonics in inverters. Snubber circuits. Emphasis will be placed, throughout the course, on the utilization of software application packages.

E E 351.3
Spectrum Analysis and Discrete Time Systems
1(3L)

Prerequisite(s): Math 223, 224 and E E 214.

This course reviews input/output relationship from the perspective of linear differential equations and introduces convolution integrals as a general solution. Mathematical concepts of spectrum, the Fourier series for periodic signals and the Fourier transform for aperiodic signals, are covered to understand the spectrum of signals based on continuous time. Then, starting from sampling and related phenomena, discrete time base is introduced leading toward difference equations and the z-transform. Following the full discussion of the z-transform, basic concepts of DSP and the use of FFT are briefly covered.

E E 352.3
Communication Systems
2(3L)

Prerequisite(s): E E 351.

The course provides an introduction to communication systems beginning with digital signal representation and digital transmission. Frequency translation and amplitude modulation are discussed including the variants of DSB, SSB, VSB and QAM.

E E 362.3
Digital Signal Processing I
2(3L)

Prerequisite(s): E E 351.

Representation of signals and systems in discrete time functions and in z-transform, digital system response by difference equations, digital filters, convolution and correlation, frequency analysis, discrete time Fourier transform (DFT).

E E 372.3
Electronic Devices
1(3L)

Prerequisite(s): E E 201 and 271.

Quantum physics, Schrödinger equation, quantized energy levels, quantum numbers, photons, bonding, energy bands, electron statistics, semiconductor basics, extrinsic semiconductors, pn junction, pn junction characteristics and models, bipolar junction transistor (BJT), junction field effect transistor (JFET), metal-oxide-semiconductor transistor (MOST), enhancement and depletion MOSFETs, BJT, JFET and MOS transistor equations, biasing, amplifier circuits and small signal parameters and models

E E 391.3
Electrical Engineering Laboratory II
1(6P)

Corequisite(s): E E 301, 323, 331, 341 and 351.

Laboratory experiments and exercises of design software packages for the corequisite courses.

E E 392.3 (First offered 2001-2002)
Electrical Engineering Laboratory III
2(6P)

Corequisite(s): E E 332, 342, 352, 362 and (344 or 372).

Laboratory experiments and exercises of design software packages for the corequisite courses.

E E 395.3 (First offered 2001-2002)
Electrical Engineering Design
2(1.5L-1.5P)

Prerequisite(s): E E 323.

Covers the "top down" approach applied to engineering design. The students will exercise the approach by designing, building and testing one or two projects. The course also includes aspects of manufacturing engineering and, project organization and control.

E E 402.3
Microwave Engineering
2(3L)

Prerequisite(s): E E 301.

Review of EM field theory, transmission line theory, Smith chart, impedance matching, microwave transmission lines, coaxial and wave guide components, resonators, microwave antennas.

E E 410.3 (Last offered 2001-2002)
Control Systems I
1(3L)

Prerequisite(s): E E 326 or MATH 338.

Deals with the basic aspects of feedback control systems including mathematical modeling of control elements and systems, stability assessment, time performance analysis, system compensation and design. Real and complex frequency domain techniques will be used and an introduction to state space methods given.

E E 419.3 (Last offered 2001-2002)
Electrical Engineering Laboratory IV
1(6P)

Prerequisite(s): E E 329.

Corequisite(s): E E 410 and three of E E 452, 453, 454, 455, 457, 489 and E P 356.

Experiments relating to Digital Systems III, VLSI, Instrumentation, Electrical Machines II, Power Systems II, Signals and Systems, E&M Field Theory and Control Systems I.

E E 431.3
Hardware Descriptive Language
2(3L)

Prerequisite(s): E E 232 and CMPT 117.

Discusses hardware descriptive language (HDL) and techniques to design application specific integrated circuits (ASICs) for specific applications such as digital filters and embedded controllers. HDL is a C like language allowing parallel processing description and timing control. The detailed syntax of HDL will be presented along with techniques for problem analysis and circuit synthesis using field programmable gate arrays (FPGA) and more advanced Embedded Arrays that includes a built-in CPU.

E E 432.3 (First offered 2002-2003)
VLSI Circuit Design
2(3L)

Prerequisite(s): E E 232 and 323.

A general introduction to VLSI design, simulation and testing. This includes CMOS cell design, logic simulation, circuit simulation and system design.

E E 438.6 (Last offered 2001-2002)
Engineering Design III
1&2(3P)

Prerequisite(s): E E 328 and 329.

Corequisite(s): A full complement of fourth year E E courses.

A continuation of E E 328. The emphasis in this course is on the application of the science of design. Students will be formed into working groups of two or three to design, in a top down fashion, a product or system. The students start from a layman's statement of what is needed and produce a requirement specification, block level design, bottom block design and a working unit. The students are also required to give a formal oral presentation of their year's work to a group of their peers.

E E 441.3 (First offered 2002-2003)
Power Systems II
1(3L)

Prerequisite(s): E E 342.

This course covers network calculations; loop and nodal equations; bus impedance and admittance matrices; network equations in matrix form; computer storage.; load flow studies; analysis of faulted power systems; symmetrical components; sequence networks; balanced and unbalanced faults; power system stability; swing equation; equal area criterion; and numerical solution of swing equation.

E E 442.3 (First offered 2002-2003)
Power Systems Operation and Control
2(3L)

Prerequisite(s): E E 342.

Corequisite(s): E E 341.

This course looks at economic dispatch; the lossless case; inequality constraints; consideration of transmission losses; unit commitment; system control; control loops; the automatic voltage regulator; automatic load frequency control of a single-area system; implementation using computers; system protection; subsystems and attributes; zones of protection; transducers; relay design; protection of lines; transformers; generators and busbars; and microprocessor-based relays.

E E 444.3 (First offered 2002-2003)
Electric Machines II
1(3L)

Prerequisite(s): E E 341.

This course deals with magnetic and magnetically coupled circuits, principles of electromechanical energy conversion, synchronous machines, brushless dc machines, Stepper motors, Reluctance motors, Permanent magnet machines, and Dynamic simulation of electric machines.

E E 445.3 (First offered 2002-2003)
Reliability Engineering
2(3L)

Prerequisite(s): E E 216.

This course covers basic reliability concepts; elements of probability and statistics; application of important distributions in reliability evaluation; reliability and availability assessment of series; parallel and complex systems; utilization of Monte Carlo simulation in system reliability evaluation; and Markov modelling in discrete and continuous systems.

E E 451.3 (Last offered 2001-2002)
VLSI Circuit Design
2(3L)

Prerequisite(s): E E 310 and 321; or E P 311 and 321.

A general introduction to VLSI design, simulation and testing. This includes CMOS cell design, logic simulation, circuit simulation and system design.

E E 452.3 (Last offered 2001-2002)
Instrumentation
1(3L)

Prerequisite(s): E E 320 and 321.

Intended for electrical engineering students, the material assumes a good working knowledge of transistors, operational amplifiers and digital logic devices. Topics include wide coverage of transduction and transducers, signal conditioning, noise sources, noise reduction techniques, and conversion between analog and digital domains.

E E 453.3 (Last offered 2001-2002)
Electrical Machines II
1(3L)

Prerequisite(s): E E 313.

This course deals with magnetic devices: stored energy and co-energy, calculation of forces; three-phase and single-phase induction motors; induction generator; nonsalient- and salient-pole synchronous machines; dynamic performance of synchronous machines; and induction motors.

E E 454.3 (Last offered 2001-2002)
Power Systems II
1(3L)

Prerequisite(s): E E 304 and 326.

Topics include: computer analysis of power systems; inputs and outputs of a load flow, power injection and flow equations; admittance and impedance matrices; sparsity techniques; Gauss Seidel and Newton Raphson load flow techniques; solution of unbalanced power systems; symmetrical components; balanced and unbalanced faults; power system stability; rotor dynamics; swing equation; synchronizing coefficient; equal area criterion; and step-by-step solution of the swing equation.

E E 455.3 (Last offered 2001-2002)
Signals and Systems II
1(3L)

Prerequisite(s): E E 315 and 326.

This course covers representation of signals and systems by discrete functions; convolution and z-transform methods; digital filters and digital system responses.

E E 456.3 (First offered 2002-2003)
Digital Communication
1(3L)

Prerequisite(s): E E 352.

Topics include: digital modulation methods; receiver synchronization; noise and bit error ratio in receivers; wireless and satellite communication systems; and spread spectrum communication.

E E 457.3 (Last offered 2001-2002)
Communication Electronics
1(3L)

Prerequisite(s): E E 321 and 325.

Covers devices and concepts used in conjunction with communications equipment. Extends the exposure into the megahertz frequency range where familiar devices require new understanding. This course can be taken by a student wanting to develop a strong instrumentation background as well as a student concentrating on the communications area.

E E 458.3 (First offered 2002-2003)
Communication Electronics
2(3L)

Corequisite(s): E E 352.

An introduction to devices and circuits commonly used in communications systems. Emphasis is on circuits extending into the radio frequency (RF) range, where familiar devices require a new understanding. Topics include resonant circuits, transformers, impedance matching concepts, transmission line hybrids, power amplifiers, frequency multipliers, phase locked loops, oscillators, and frequency synthesizers. This course is intended for students concentrating in the communications area.

E E 461.3 (First offered 2002-2003)
Digital Signal Processing II
1(3L)

Prerequisite(s): E E 362.

This course covers Finite impulse response linear phase filters, infinite impulse response filters, architecture of digital filters, DSP processors and special instruction sets, discrete Fourier transform DFT and fast Fourier transform FFT, and Finite register length effects.

E E 472.3 (First offered 2002-2003)
Optoelectronics and Photonics
2(3L)

Prerequisite(s): E E 372.

Topics include: physical optics, dielectric planar waveguides, optical fibers in optical communications, dispersion, bit-rate and bandwidth, semiconductor device principles, degenerate semiconductors, heterojunctions, light emitting devices, stimulated emission, Einstein coefficients for lasing devices, gas lasers, semiconductor lasers, new solid state lasers, emitters for optical communications, photodetectors, photodetectors for optical communications, photovoltaics, light modulation.

E E 480.3
Digital Control Systems
2(3L)

Prerequisite(s): E E 481 (or 410).

This course deals with specialized topics in feedback control. Topics include state-space modeling of control systems, digital computer simulation of control systems and digital computer stability analysis of multi-variable processes; controller synthesis using Nyquist criterion; direct digital control, z-transform methods for assessing stability of sampled data systems, and introduction to other topics in modern control theory.

E E 481.3 (First offered 2002-2003)
Control Systems
1(3L)

Prerequisite(s): E E 214 and 351.

Topics include mathematical modeling of control elements and systems, performance analysis, stability assessment and system compensation. Both time domain and frequency domain techniques are used. Multi-variable processes are discussed using state space models. Discussion extends to the basic concepts of controller design, root locus method and frequency response method. Controller design methods specific to phase lead/lang compensator and PID controller are presented. MatLab control tools are used in computer simulation and in various analyses of control systems.

E E 482.3 (Last offered 2001-2002)
Power Electronics
2(3L)

Prerequisite(s): E E 313 and 321.

Introduction to SCRs, firing circuits for SCRs, analysis of controlled converter circuits, DC drives, analysis of chopper and inverter circuits, commutation methods for thyristor circuits, ac drives, applications of converters and inverters.

E E 483.3 (Last offered 2001-2002)
Electrical Machines III
2(3L)

Prerequisite(s): E E 453.

Design considerations of electrical machines; principles of electrical machines; machine structures; magnetic circuits; field and armature windings; magnetic materials; dielectric materials; waveform consideration, and commutation.

E E 484.3 (Last offered 2001-2002)
Signal Processing
2(3L)

Prerequisite(s): E E 455.

Implementation factors in digital signal processing including structural transposition, the effects of roundoff errors and processors designed for DSP applications.

E E 485.3 (Last offered 2001-2002)
Communication/Transmission
2(3L)

Prerequisite(s): E E 325 and 457.

Communication of data, voice and video signals in the presence of noise.

E E 486.3 (Last offered 2001-2002)
Microwave Engineering
2(3L)

Prerequisite(s): E E 321.

Review of EM field theory, transmission line theory, Smith chart, impedance matching, microwave transmission lines, coaxial and wave guide components, resonators, microwave antennas.

E E 487.3 (Last offered 2001-2002)
Microelectronics and Optoelectronics
2(3L)

Prerequisite(s): E E 317.

An introduction to the physics and technology of solid state electronic devices and optoelectronics including optical fibres.

E E 488.3 (Last offered 2001-2002)
Reliability Engineering
2(3L)

Prerequisite(s): G E 210 and E E 326.

Basic reliability concepts, elements of probability and statistical theory, application of important distributions, reliability and availability evaluation in series, parallel and complex systems, failure testing and the establishment of confidence levels.

E E 489.3 (Last offered 2001-2002)
Digital Systems III
2(3L)

Prerequisite(s): E E 320 or CMPT 321.

Synthesis of digital processing systems. The integration of acquisition, storage, central processing and peripheral processing devices. Fault detecting and diagnosing techniques. Diagnostic and system development equipment.

E E 491.3 (First offered 2002-2003)
Electrical Engineering Laboratory IV
1(6P)

Corequisite(s): E E 481 and two of E E 431, 441, 445, 461.

Electrical Engineering experimental laboratory and exercises of design software packages.

E E 495.6 (First offered 2002-2003)
Design Project
1&2(6P)

Corequisite(s): In graduating year or permission of the Department Head.

The emphasis in this course is on the application of a formal design process. Students will be formed into working groups of two or three to design, in a top down fashion, a product or system. The students start from a layman's statement of what is needed and produce a requirement specification, block level design and a working unit. Under special circumstances, feasibility studies may qualify as design projects. The students are also required to give a formal oral presentation of their year's work to a group of their peers.

ENGINEERING PHYSICS

E P 155.3
Electric and Magnetic Circuits I
2(3L-1.5P)

Prerequisite(s): G E 124 and MATH 110 (taken).

Topics include Coulomb's law, sources of dc potential, resistance, conductance, Ohm's law, power and energy, ammeters, voltmeters, voltage dividers, ohmmeter, Kirchhoff's laws, series and parallel circuits, circuit analysis techniques, Wheatstone bridge, electrostatic fields, dielectric materials, capacitance, series and parallel arrangement of capacitors, transients in R-C circuits.

E P 225.3
Waves, Fields and Optics
2(3L-1.5P)

Prerequisite(s): E P 155; MATH 223; MATH 238.

Corequisite(s): MATH 224 or MATH 226.

Offers an introduction to mechanical and electromagnetic wave phenomena including derivation of wave equations and wave velocities, energy and momentum carried by waves, wave reflection in terms of impedance mismatch, standing waves, and radiation of electromagnetic waves. This is

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followed by geometrical and physical optics.

E P 228.3
Computer Tools for Engineering Physics
2(3L-4P)

Prerequisite(s): CMPT116; G E 120; MATH 238 (or MATH 224 which may be taken as a corequistite)

Use of mathematical and software tools for modelling physical systems and for data analysis. Symbolic software is used for calculus, linear algebra, differential equations, and vector calculus. Curve fitting and Fourier techniques are also presented.

E P 271.3
Heat, Kinetic Theory and Thermodynamics
2(3L-1.5P)

Prerequisite(s): MATH 223 or 238; PHYS 251.

Calorimetry, thermal expansion, heat transfer and the empirical gas laws. Kinetic theory of gases: specific heats, Boltzmann distribution. Mean free path and transport phenomena. Zeroth, first and second laws of thermodynamics. Entropy and heat engines.

E P 311.3
Electronics 1
1(3L-4P)

Prerequisite(s): E P 228 or MATH 266; PHYS 227.

Corequisite: MATH 338.

Introduces analogue electronics. The course covers network analysis, AC circuits, the physics and operation of semiconductors, junction diodes, transistors, the design of amplifier circuits, small signal analysis, and operational amplifiers (op-amps).

E P 317.3
Applied Physics of Materials
1(3L)

Corequisite(s): PHYS 381.

The structure of solids and liquids and their mechanical, electric and magnetic properties.

E P 320.3
Discrete Linear Systems and Applied Information Theory
2(3L-3P)

Prerequisite(s): PHYS 227; MATH 224 or 238.

An introduction to discrete linear systems and applied information theory with strong emphasis on both analytic and computer-based solutions to practical physical problems in systems engineering and data analysis. Since any linear system can be described in terms of a filter, special stress is given to the subject of digital filtering.

E P 321.3
Electronics II
2(3L-4P)

Prerequisite(s): E P 311.

Introduces digital electronics and completes some analogure electronic topics not covered in E P 311. Analogue topics include transducers, feedback systems, modulators, frequency converters, amplifier configurations and design. The majority of the course covers digital electronics, including logic operation and implementation (AND, OR, NOT), binary numbers, Boolean algebra, memory elements, ROM, RAM, logic circuits (adders, counter, etc.), A/D and D/A converters, and simple microprocessors. Circuit design principles are emphasised and a major design project is undertaken.

E P 324.3
Mechanics IV
2(3L)

Prerequisite(s): G E 226 or PHYS 223.

Corequisite(s): MATH 338.

Covers three-dimensional rigid body dynamics and introduces fluid mechanics concepts such as the control-volume approach, the continuity equation, derivation of Bernoulli's equation, and conservation of momentum and energy in a fluid system.

E P 356.3
Electricity and Magnetism 2
2(3L)

Prerequisite(s): PHYS 227.

Corequisite(s): MATH 338 .

A review of static electric and magnetic field theory and its extension into time varying E and M fields; interactions between fields and materials; transmission line, wave guide and antenna fields.

E P 413.3
Instrumentation and Design
1(3L)

Prerequisite(s): E P 321.

Corequisite(s): E P 414.

A course in electronic instrumentation and in design of measuring equipment. Emphasis is placed on digital techniques for the measurement of physical parameters.

E P 414.3
Instrumentation Laboratory
1(4P)

Prerequisite(s): E P 321.

Corequisite(s): E P 413.

A number of laboratory exercises based on the material given in E P 413 are carried out. The aim of the laboratory is to introduce the student to the practical problems and challenges associated with microprocessor based instrumentation design.

E P 421.3
Optical Systems and Materials
1(3L-4P)

Prerequisite(s): E P 356; E P 225 or PHYS 341.

Topics covered are interference, diffraction (including Fourier methods), optical materials and frequency response, polarization systems and polarimetry, optical filtering and holography and a systems approach to geometric optics. The laboratory component provides experience for much of the material covered in lectures.

E P 424.3 (Last offered 2001-2002)
Design Laboratory
2(4P)

Prerequisite(s): E P 413 and 414.

A continuation of E P 414. The laboratory exercises will include serial interfacing, interrupts, the IEEE bus, correlation techniques for S/N improvement and design of a box-car integrating A/D system.

E P 425.3 (Last offered 2001-2002)
Engineering Physics Systems
2(3L)

Corequisite(s): PHYS 404.

Students are given lectures by design personnel in nuclear physics, and the areas of cybernetics, plasma physics and space and atmospheric physics. The students observe the research systems in operation and are required to undertake various system designs in these areas.

E P 431.3
Optical Systems and Materials 2
2(3L)

Prerequisite: E P 421.

A continuation of E P 421, aimed at the study of optical systems for imaging, anisotropic optical materials, the passage of electromagnetic waves through such materials, use of anisotropic materials for modulation of light, full electromagnetic information retrieval by polarimetry, lasers and holography, fiber optics and communications systems.

E P 495.6 (First offered 2002-2003)
Capstone Design Project
1&2(1.5L-3P)

Prerequisite(s): E P 317 and E P 356.
Corequisite(s): E P 413, 414 and 421.

This is a year-long design project incorporating all the steps and procedures used by professional engineers.

ENGINEERING PROFESSIONAL INTERNSHIP PROGRAM

EPIP 401.0
Internship Placement 1

EPIP 402.0
Internship Placement 2

EPIP 403.0
Internship Placement 3

EPIP 404.0
Internship Placement 4

GENERAL ENGINEERING

G E 110.3
Engineering I
1(3L-3P)

An introduction to engineering to develop various problem solving approaches, skills and competencies used by engineers, including common computer applications, charts and graphs, documentation, and drawing and sketching to develop visualization skills.

G E 120.3
Engineering II
2(3L-3P)

Prerequisite(s): G E 110.

Further development of problem solving skills begun in G E 110. An introduction to modeling physical systems, with an emphasis on developing a relatively non-mathematical conceptual understanding of force, pressure, rates, flow, accumulation, etc. and their application in practical engineering situations. The fundamentals and application of linear algebra are the focus in the first half of the course. The types of activities included within the various engineering disciplines are discussed to illustrate the range of engineering activity. Examples of open-ended, discipline-specific problems are included in the lab component of the course.

G E 124.3
Engineering Mechanics I
1(3L-1P-2T)

Prerequisite(s): Physics 30.

Introduction to statics. This course provides a basic introduction to forces as vectors, force equilibrium of particles, and force and moment equilibrium of rigid bodies. Problems involving friction and the analyses of simple trusses, frames and machines are also introduced. A series of problem laboratories and practical laboratories are designed to help the student apply the principles of statics to practical problems.

G E 125.3
Engineering Mechanics II
2(3L-1P-2T)

Prerequisite(s): G E 124 and MATH 110.

Corequisite(s): MATH 124

A continuation of Engineering Mechanics I. The equilibrium of bodies under distributed loads is presented as an introduction to centroids, centers of mass, and area moments of inertia. Particle dynamics is the subject of the majority of the course starting with the principles of particle translation under constant and non-constant acceleration. The kinetics of particles during translation, including force-acceleration, work-energy, and impulse-momentum are also applied to practical engineering applications. A series of problem laboratories and practical laboratories provide practical problems to assist in the assimilation of the principles covered.

G E 210.3
Probability and Statistics
1(3L-1.5P)

Prerequisite(s): A course in calculus (may be Calculus 30).

Introduces the student to the concepts of probability and statistics using examples from various fields of engineering.

G E 213.3
Mechanics of Materials
1/2 (3L-1.5P)

Prerequisite(s): G E 124 and G E 125 (taken).

Building upon the concepts introduced in the courses in statics and dynamics and the properties of engineering materials, this course will extend equilibrium analysis to deformable bodies. Emphasis will be placed on understanding and applying the three fundamental concepts of solid mechanics - equilibrium, constitutive relationships, and geometry of deformation (compatibility). The fundamentals will be introduced and reinforced in the context of specific behaviors, including axial tension and compression, pure bending, bending in combination with shear, and torsion of circular shafts. Transformation of stress in two dimensions will be introduced.

G E 226.3
Mechanics III
2(3L-1.5P)
Prerequisite(s): G E 125 and MATH 223 (taken).
A course in the mechanics (kinematics and kinetics) of plane motion. Velocity and acceleration for translational and rotational motion are treated. The force-acceleration, impulse-momentum, and work-energy methods for systems undergoing two-dimensional dynamics are discussed in detail.

G E 300.3
Oral and Written Communication
1/2(1L-2P)
Prerequisite(s): 45 credit units towards the B.E. degree
The course introduces the study and practice of pragmatic communication, with a focus on the rhetorical foundations of technical communication. It is designed to teach students to read analytically, to evaluate the demands of audience, context, and purpose, and to write and present technical and other information clearly and comprehensively. It will also deal with the role of communicative competence in establishing professional credibility with clients, co-workers, and superiors. Students will prepare and present a variety of oral and written messages typical of those encountered in professional practice, including reports, résumés, and correspondence, and will be involved in the evaluation and critical appraisal of each other's work.
Note: Students with credit for G E 390 cannot take G E 300 for credit.

G E 348.3
Engineering Economics
1/2(3L-1.5P)
Prerequisite(s): 45 credit units of university study towards the B.E. degree.
An introduction to engineering economics and decision analysis. Topics include: Fundamental economic concepts, cost concepts, time value of money operations, comparison of alternatives, depreciation and income tax, economic analysis of projects in the public and private sectors; break-even analysis, sensitivity and risk analysis, decision models.

G E 400.3
Rhetoric: Theory and Practice of Persuasion
1/2(3L)
Prerequisite(s) and Corequisite(s): A previous course in any humanities discipline.
A broad survey of the ancient discipline of rhetoric as it is currently understood and practised. Consideration of the nature, tradition, and theory of rhetoric, with an emphasis on developing skill in the use and detection of rhetorical devices and strategies in oral and written discourse.

G E 449.3
Engineering in Society
1/2(3L)
Prerequisite(s): G E 300 (or 390) and 90 credit units of university study towards the B.E. degree.
Designed to create an awareness of the diverse and often-contradictory impacts of science and technology on society. The consequences of current technological changes and those of the recent past are explored from a professional ethics point of view to illustrate the complexities of technological-societal interrelationships.

GEOLOGICAL ENGINEERING

See Civil Engineering.

GEOLOGY

For descriptions of Geology courses, see the College of Arts and Science section of the *Calendar.*

MATHEMATICS AND STATISTICS

MATH 110.3
Calculus I
For details, see the College of Arts and Science section of the *Calendar.*

MATH 124.3
Calculus II for Engineers
2(3L-1.5P)
Prerequisite(s): MATH 110.
Differentiation and integration of inverse trigonometric functions, exponential, hyperbolic and logarithmic functions with applications. Techniques of integration; applications to work, pressure, moments and centroids. Polar co-ordinates and parametric equations of plane curves; complex numbers.

MATH 223.3
Intermediate Calculus
1(3L-1P)
Prerequisite(s): MATH 110 and 124.
Vectors in two and three dimensions, vector calculus, space geometry, multiple integration and partial differentiation, line integrals and Green's Theorem.

MATH 224.3
Differential Equations
2(3L-1P)
Prerequisite(s): MATH 124.
Differential equations of first and second order, sequences and series, convergence, Taylor's Series and elementary series.

For descriptions of other Mathematics courses, see the College of Arts and Science section of the *Calendar.*

MECHANICAL ENGINEERING

M E 214.3
Introduction to Materials and Manufacturing
1(3L-1.5P)
Provides an introduction to the relations between the structure and properties in engineering materials. It deals with the basics of structure, strengthening and deformation mechanisms of steels.

M E 215.3
Fluid Mechanics I
2(3L-1.5P)
Prerequisite(s): G E 125 and MATH 223 (taken).
The basic principles of fluid mechanics are introduced. Fluid statics is approached from a differential formulation and Fluid Dynamics using a control volume method. The principles are applied to pressure measurements, flow in pipes and flow over submerged surfaces.

M E 227.3
Thermodynamics I
1(3L-1.5P)
Prerequisite(s): CHEM 111 and MATH 124 (taken).
The basic fundamental laws of thermodynamics involving compressible fluid flow, mass and energy transfers are developed. Problems are analyzed for closed and open systems using the concepts of heat and work and the basic laws. The course content is amplified by tutorials and laboratory experiments.

M E 229.3
Introduction to Engineering Design
2(1.5L-3P)
Prerequisite(s): G E 110; G E 125 (taken) and M E 214.
Introduces the mechanical engineering student to the concepts behind engineering design. Special seminars by practicing professionals supplement the course materials. Specific topics to be covered are: historical background, log books, scheduling, literature search, cost analysis, project management, CAD and CAM techniques, report writing, design ethics and legal responsibilities. Students are responsible for participating in and completing an applied design project.

M E 251.3
Probability, Statistics and Analysis I
2(3L-1.5P)
Prerequisite(s): G E 120 and MATH 223 (taken).
Introduces some of the mathematical tools and engineering procedures to solve applied engineering problems. Topics include: linear algebra and applications to mechanical systems, vector calculus with applications to mechanical, fluids, and thermal systems, probability, statistics, and mean testing.

M E 313.3
Mechanics of Materials I
1(3L)
Prerequisite(s): G E 213; MATH 223 (taken), MATH 224 (taken) and M E 251 (taken).
General principles underlying the mechanics of materials are discussed and applied to the advanced strength analysis of common structural elements. Failure criteria and fracture mechanics are also considered.

M E 316.3
Dynamics and Vibrations
1(3L)
Prerequisite(s): G E 226, M E 251 (taken) and MATH 224 (taken).
Kinematics of rigid bodies and systems of rigid bodies using both stationary and moving coordinate systems. Three-dimensional kinetics. Introduction to vibration analysis. Introduction to Lagrangian dynamics. Discussion of design considerations, including numerical solution techniques, parameter estimation, and linkage synthesis. Cam-follower mechanisms.

M E 318.3
Mechanical Engineering Laboratory I
1(6P)
Prerequisite(s): M E 214 and 215.
Corequisite(s): M E 313 and (M E 327 or 335); or permission of the Department Head.
A general laboratory course demonstrating and further investigating engineering principles related primarily to material treated in the third year first term lectures. Considerable importance is placed on the development of student report writing capability.

M E 321.3
Advanced Engineering Analysis II
1(3L)
Prerequisite(s): M E 251 (or 371).
Partial differential equations of physical systems, concepts of wave propagation and heat transfer. Fourier series, Fourier and Laplace transforms, special functions. Solution techniques involving separation of variables and transform methods. Applications in mechanics, heat transfer, vibrations and electro-magnetism.

M E 323.3
Mechanics of Materials II
2(3L)
Prerequisite(s): M E 313.
The strength analysis of more complex structural elements is discussed. Also introduces the general principles of the mechanics of solids. Methods leading to computer aided analysis are emphasized.

M E 324.3
Engineering Materials
1(3L)
Prerequisite(s): M E 214.
Covers the iron-carbon diagram in detail. The processes taking place during heat treatment of steels are examined. Non-ferrous alloys, composites, and non-metallics are also covered. The subject of corrosion is introduced.

M E 327.3
Heat Transfer
1(3L)
Prerequisite(s): M E 215 and M E 227.
The basic concepts of the three major fields of heat transfer; conduction – basic laws and applications; convection – free and forced convection, internal and external flows, heat exchangers; radiation – laws of generation and exchange. Laboratory includes elementary heat exchanger design and computer simulation in the three modes of heat transfer.

M E 328.3
Mechanical Engineering Laboratory II
2(6P)
Corequisite(s): M E 323 and 327; or permission of the Department Head.
A general laboratory course demonstrating and further investigating engineering principles related primarily to material treated in the third year, second-term lectures with emphasis on written reports.

M E 330.3
Manufacturing Processes
2(3L)

Prerequisite(s): G E 213 and M E 214 (starting 2001 M E 324).

Corequisite(s): starting 2001 G E 226.

Introduction to the processes in which physical objects are manufactured. Topics include casting, machining, powder metallurgy, special treatment of steels, joining, molding of plastics and superplastics forming of non-ferrous alloys.

M E 335.3
Fluid Mechanics II
2(3L)

Prerequisite(s): MATH 224 (taken), M E 215 and M E 251 (taken).

The basic principles of fluid mechanics are developed using a differential control volume formulation, and then applied to the study of incompressible flow. The distinction is made between ideal and viscous fluids, and laminar and turbulent flow. Both integral and differential methods are used to study boundary layers, with both industrial and environmental applications.

M E 352.3
Engineering Analysis III
2(3L)

Prerequisite(s): M E 321.

The Laplace Transform as a tool in the solving of differential equations is introduced. First and second order initial value differential equations are examined in context with engineering terms and applications. Transient and frequency responses are examined. Modeling of mechanical and electro-mechanical systems is introduced. Using the mathematical models combined with computer techniques, design of linear systems is considered

M E 413.3
Machine Design I
1(3L)

Prerequisite(s): M E 214 and 323 (starting 2002 M E 316, 323, 324); or permission of the Department Head.

Deals with various machine design fundamentals and the use of integrated design software. Design for fatigue and consideration of fracture mechanics is emphasized. Topics include: the selection of fasteners, rolling element bearings, V-belts and roller chains and the design of coil and leaf springs, spur gears, clutches and breaks.

M E 417.3
Thermodynamics II
1(3L)

Prerequisite(s): M E 227; [starting 2002 M E 335 (taken)].

A second course in equilibrium thermodynamics. It focuses on the second law and the concept of entropy, which are used to study the conditions of thermal, mechanical and chemical equilibrium, with applications to power cycles, refrigeration cycles and reacting mixtures. The second law is next used to develop the concept of availability or energy. Finally, both the first and second laws are used to study one-dimensional compressible duct flow.

M E 418.3
Mechanical Engineering Laboratory III
1(6P)

Corequisite(s): M E 417 and 431; or permission of the Department Head.

The laboratory exercises give the student responsibility for planning and setting up laboratory experiments and for the preparation of written reports. The use of standard measuring procedures in Mechanical Engineering is also emphasized. These laboratory exercises include control systems, fatigue and tribology, CNC manufacturing, engines and compressors, and vibrations.

M E 423.3 (Last offered 2001-2002)
Machine Design II
2(3L-1.5P)

Prerequisite(s): M E 413 and 450 or permission of the Department Head.

Basic gear theory along with strength, wear, and efficiency considerations are employed in the design of helical and spur gear power transmission systems. Life prediction and selection of rolling element bearings and the design of journal bearings are also treated. Springs and flexible power drives are considered as well. Machines employing these various elements are designed in the laboratory.

M E 426.3 (Last offered 2001-2002)
Vibrations and Acoustics
2(3L)

Prerequisite(s): M E 316 and 321 (taken).

An introduction to vibration and acoustic analysis. Undamped, damped and forced vibrations of systems with one and more than one degree of freedom, vector and Lagrangian methods, determination of natural frequencies, shock and impact analysis; acoustics, properties, psycho-acoustics, instrumentation, standards, acoustics of walls, enclosures, rooms and barriers.

M E 431.3
Control Systems I
1(3L)

Prerequisite(s): M E 321 (taken), (starting 2002 M E 352, taken).

Transfer functions, transient and frequency responses, performance specifications, stability analyses, introduction to design (compensation).

M E 435.3 (Last offered 2001-2002)
Heat Transfer in Electrical Engineering
1(3L)

Prerequisite(s): M E 322 (taken).

The basic equations of conduction, convection and radiation heat transfer are considered. Applications are to steady and transient heat transfer problems with and without heat sources.

Note: Mechanical Engineering students cannot obtain credit for this course.

M E 441.3 (Last offered 2001-2002)
Control Systems II
2(3L)

Prerequisite(s): M E 431; or permission of the Department Head.

System stability, root locus and Nyquist stability criteria, feedback system performance, compensation, and design; some advanced methods in control systems analysis and design.

M E 450.3
Finite Element Analysis
1(3L-1.5P)

Prerequisite(s): M E 321 (taken) and 323.

The finite element concept is introduced using simple structural elements. The method is then generalized using weighted residual methods. Numerous engineering problems drawn mainly from solid mechanics are solved using finite element methods. It is shown how the finite element method might be used for fluid flow and heat transfer analysis.

M E 460.3
Automation and Robotics in Manufacturing
2(3L-1.5P)

Prerequisite(s): M E 316 and 330 (starting 2002 M E 229); or permission of the Department Head.

An introduction to production automation and robotic modelling. Topics include: flow line production, automated assembly systems and line balancing, industrial robotics, kinematics, dynamics and trajectory control of robots.

M E 461.3 (Last offered 2001-2002)
Instrumentation
2(3L-1.5P)

Prerequisite(s): M E 431; or permission of the Department Head.

Introduction to measurement systems followed by a study of transducers commonly used in engineering measurements, e.g., displacement, velocity, acceleration, force, pressure, flow, temperature nuclear radiation, signal processing, indicating and recording instrumentation.

M E 462.3 (Last offered 2001-2002)
Hydraulics and Fluid Power Control
2(3L-1.5P)

Prerequisite(s): M E 431; or permission of the Department Head.

An introduction to the design of hydraulic circuits based on a load cycle analysis is presented. The operation of pumps, motors, actuators, valves, etc., is discussed in detail. Analysis of circuits and optimization of component choice or layout are considered.

M E 463.3
Advanced Structural Analysis
2(3L-1.5P)

Prerequisite(s): M E 450; or permission of the Department Head.

Governing equations for plates, membranes, shells and thin-walled beams. Applications to typical engineering problems. Elements of structural stability and dynamics. Some geometrically and materially nonlinear problems. Methods of numerical solutions, including the use of advanced FEM.

M E 464.3 (Last offered 2001-2002)
Materials in Engineering Design
2(3L-1.5P)

Prerequisite(s): M E 474; or permission of the Department Head.

Emphasizes materials engineering in the design process. It covers an overview of available engineering materials and their selection based on mechanical properties, surface durability and cost.

M E 465.3 (Last offered 2001-2002)
Selected Topics in Transport Processes
2(3L-1.5P)

Prerequisite(s): M E 327, 335 and 417 or permission of the Department Head.

Lectures focus on selected topics in transport processes including the following: aerodynamics, boiling heat transfer and two-phase flow, microgravity, numerical methods in fluid flow and heat transfer.

M E 467.3 (Last offered 2001-2002)
Applied Thermodynamics
2(3L-1.5P)

Prerequisite(s): M E 329 and 417.

The theory of compressible gas dynamics is applied to isentropic flow in nozzles and diffusers, frictional flow in gas pipelines, shock waves, and heat transfer in combustors. Design and performance comparisons are made between applications of gas and vapour power cycles in special and industrial cases. Axial flow blade designs in rotary compressor and turbines are developed and applications are analyzed.

M E 468.3
Thermal Energy Systems
2(3L-1.5P)

Prerequisite(s): M E 327, 329 (starting 2002 M E 335) and 417; or permission of the Department Head.

Energy conversion, thermal-fluid equipment selection, functional design, physical and economic modeling, simulation and optimization of life-cycle costs. System design examples will be taken from one or more of: air handling systems including fans and ducts, pumping systems with pumps and pipes, heat exchanger systems and large building thermal design.

M E 469.3
Computers in Mechanical Engineering
2(3L-1.5P)

Prerequisite(s): M E 321 or permission of the Department Head.

Introduces students to several aspects of the practice of incorporating or embedding computers in mechanical designs (Mechatronics). Included are the use of microcontrolers for data collection, sensing and control. The class emphasizes a hands on approach and communication within disparate design groups.

M E 471.3
Introduction to Aerodynamics
2(3L-1.5P)

Prerequisite(s): M E 215.

Corequisite(s): M E 335 or permission of the Department Head.

This course is an introduction to aerodynamics which explores the lift and drag performance of airfoils. Potential flow is used to develop the theory of flow over airfoils and wings, using both classical and numerical – e.g. vortex panel – methods. Boundary layer theory is used to explain the role of viscosity and the potential for flow separation. Numerical models are used to predict skin friction values. Finally, the development of shock waves for supersonic conditions is considered.

M E 472.3 (First offered 2002-2003)
Advanced Control Systems
2(3L-1.5P)

Prerequisite(s): M E 431 or permission of

the Department Head.

Topics include: frequency response, design and compensation using root-locus and frequency response methods, state-space approach, nonlinear systems, Liapunov stability methods, digital control systems, as well as case studies.

M E 473.3 (First offered 2002-2003)
Introduction to Computational Fluid Dynamics
2 (3L–1.5P)

Prerequisite(s): M E 321 and 335.

Introduces the student to the subject of Computational Fluid Dynamics, as well as numerical methods for predicting heat transfer. The course focuses on incompressible flow of a viscous fluid, including both diffusive and convective transport. Pressure solvers and turbulence models are also described. A comprehensive commercial CFD package is introduced to the students, as an example of the software used by engineers to perform numerical simulation of heat and fluid flow.

M E 474.3 (Last offered 2001-2002)
Behaviour of Engineering Materials
1(3L)

Prerequisite(s): M E 324 (taken).

Emphasizes the application of metallurgical principles to mechanical behaviour and design. Deformation processes are reviewed, failure criteria discussed, and fracture processes and mechanisms are described in detail. Creep and fatigue design procedures are examined together with the procedures of failure analysis. Corrosion of materials is discussed. Composites are introduced.

M E 475.3 (First offered 2002-2003)
Introduction to Mechatronics
2 (3L–1.5P)

Prerequisite(s): M E 431; or permission of the Department Head.

The objective of the course is to provide engineers with the tools necessary for managing the design and development of Systems requiring a multi-disciplinary approach. It deals with life cycle models and disciplines required for integration of complex industrial systems. The course will review and links selected topics from mechanical, electrical, electronics, software and control engineering. Problems considered would involve real-time computer aided control of nonlinear and multivariable systems.

M E 476.3 (First offered 2002-2003)
Multiphase Flow and Heat Transfer
1(3L–1.5P)

Prerequisite(s): M E 327 and M E 335; or permission of the Department Head.

The fundamental concepts of the flow of multiphase mixtures, momentum and energy equations for two- phase flow systems, convective boiling and condensation heat – transfer processes, applications in oil-gas transport and thermal control systems (terrestrial and non-terrestrial)

M E 477.3 (First offered 2002-2003)
Advanced Engineering Materials
2 (3L–1.5P)

Prerequisite(s): M E 324.

Corequisite(s): M E 330; or permission of the Department Head.

Provides students with an exposure to advanced materials not covered in the core M E materials courses. Emphases will be placed on topics relating to materials used in high temperature and other hostile environments. Other topics will include fracture toughness and crack growth. Engineering applications of non-metallic materials are considered

M E 483.3 (First offered 2002-2003)
Heat Transfer for Electrical Engineering
2(3L)

Prerequisite(s): MATH 224.

Introduction to the basics of thermodynamics and fluid mechanics. The basic equations of conduction, convection and radiation heat transfer are considered. Applications are to steady and transient heat transfer problems with and without heat sources.

Note: Mechanical Engineering students cannot obtain credit for this course.

M E 490.3 (First offered 2002-2003)
Design of Fluid Power Circuits
2(3L-1.5P)

Prerequisite(s): M E 335 and M E 431 or permission of Department Head.

This course is an introduction to the design of industrial and Fluid Power circuits. The operation and design of basic components are considered. A methodology to the design of industrial circuits is introduced and applied to industrial applications. Design criteria for closed loop applications are introduced.

M E 491.3 (First offered 2002-2003)
Thermal Systems Design
1(3L-1.5P)

Prerequisite(s): M E 327 and M E 335 or permission of the Department Head.

A design course involving the application of the fundamentals of thermodynamics. Topics may vary depending on the choice of design project, but would typically include psychrometrics, internal and external energy gains, heating and cooling loads, duct and piping design, overall thermal design specifications and system component design and selection.

M E 492.3 (First offered 2002-2003)
Materials in Engineering Design
1(3L-1.5P)

Prerequisite(s): M E 324 and M E 330; or permission of the Department Head.

Emphasizes materials engineering in the design process. It covers an overview of available engineering materials and their selection based on mechanical properties, surface durability and cost.

M E 493.3 (First offered 2002-2003)
Machine Design II
2(3L-1.5P)

Prerequisite(s): M E 413 or permission of Department Head.

This class is a continuation of Machine Design 1 with an emphasis on the use of integrated design software. Major topics will include the consideration of human factors, the use of optimization and probabilistic approaches in design. The application of modern design theories such as design for modularization, and design for maintenance and recycling will be presented. The final portion of the class will include case studies of actual designs.

M E 495.6
Industrial Design Project
1&2(1L-3P)

Prerequisite(s): M E 229 and 90 credit units of university study towards the B.E. degree in Mechanical Engineering; or permission of the Department Head.

The synthesis and design of mechanical engineering components and systems. Students work in groups as a design team on selected projects submitted by industry. Oral and written presentations are made by students during the term with a formal oral presentation and final written report at the end of the course. Evaluations of oral and written presentations are made by supervisors as well as other outside examiners. Lecture material covers design processes and methodologies as well as design aspects related to occupational health and safety. This material is augmented through seminars given by industrial design specialists based on their design experiences.

M E 498.3
Special Topics
1/2 (3L-1.5P)

These are courses offered occasionally by visiting faculty and in other special situations. Students interested in these courses should contact the Dean's Office for further information.

PHYSICS

For descriptions of Physics courses, see the College of Arts and Science section of the *Calendar.*