COLLEGE OF ENGINEERING

Gellersen Center

Kraig J. Olejniczak, Ph.D., P.E., Dean

Mission. The mission of the College of Engineering is to educate qualified and motivated individuals in a strong undergraduate environment who, upon graduation, are prepared for lifelong learning and the pursuit of professional excellence by ethically and creatively applying scientific knowledge to benefit society.

Vision. The vision of the College of Engineering is to be the finest undergraduate engineering college at a comprehensive university developing the leaders for tomorrow.

Objectives. Engineering is the art of applying scientific and practical knowledge to the solution of problems for the benefit of society. The curriculum integrates scientific and engineering principles, practical laboratory and computer experiences, engineering design experiences culminating in a major design project, and liberal learning in the tradition of Christian church-related colleges and universities. Special emphasis is given to communication skills, the humanities, and the social sciences. Students are enriched by participation in the academic, social, cultural, and spiritual life that is central to the Christian academic tradition at Valparaiso University. Graduates are prepared both for direct entry into the practice of engineering and for graduate school.

The Academic Program. Bachelor of Science degrees may be earned in civil, computer, electrical, and mechanical engineering. The goals of each of these programs are to build a strong foundation in mathematics, the natural and engineering sciences, and to provide an introduction to engineering design during the early portion of the program. This is followed by courses with increased emphasis on engineering applications, design, teamwork, and interdisciplinary activity. Instruction in engineering design is integrated throughout the curriculum so that students advance toward higher levels of competence culminating in a senior design project which emphasizes formulation of problem statements and criteria, consideration of alternatives, and communication of results.

The laboratory program provides for first-

hand observation of physical phenomena, experience in data collection and analysis, verification of designs, written and oral communication, and teamwork. The use of computers in both the classroom and laboratory is fully integrated into the curriculum starting in the first semester.

History. Civil engineering courses were taught at Valparaiso University beginning in 1859. Sisters Ethel and Merle McCall were the first women engineering graduates each receiving civil engineering degrees in 1915. Full four-year programs were established in 1920, with offerings in Civil, Electrical and Mechanical Engineering. During World War II, with the shortage of male students, the program was temporarily reduced to two years at Valparaiso University followed by two years at Purdue University.

After the war, four-year engineering programs were reinstated on campus through the initiative of students who raised funds and then designed and built a new engineering laboratory building. The first post-World War II degrees were offered in 1951 in Civil, Electrical and Mechanical Engineering. The Indiana Delta Chapter of Tau Beta Pi, the national engineering honor society, was chartered in 1963.

In 1968 the College of Engineering moved to the newly-constructed Gellersen Engineering and Mathematics Center. This facility was provided through the generosity of the late William A. Gellersen of Oakland, California. The building, located on the eastern edge of the campus, contains faculty offices, classrooms and laboratories for the College of Engineering and the Department of Mathematics and Computer Science.

The optional cooperative education program was initiated in 1983 and the first group of cooperative education students graduated in 1986.

College Organization. Administratively, the College is an instructional unit under the direction of the Dean of Engineering. The individual programs in Civil Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering are directed by the faculties of the three engineering departments under the leadership of Department Chairs. The Freshman Engineering Coordinator reports to the Dean.

Accreditation. Bachelor of Science degree programs in Civil Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET).

Admission Requirements. The requirements for admission of first-year students to the College are listed on pages 251-252 of this catalog. Students who do not meet the mathematics and science requirements for admission to the College of Engineering may be admitted to the Pre-Engineering Program in the College of Arts and Sciences as described on page 53. Upon satisfactory completion of the required mathematics and science courses, they may request admission to the College of Engineering.

Transfer Students. Academic work taken at other institutions is evaluated for advanced standing by the Registrar. The appropriate department chair then determines which credits apply toward the major and a Statement of Equivalence form is completed. Transfer students are urged to communicate with the chair of the department in which they hope to major prior to formally applying for admission to obtain a preliminary assessment of the duration of their course of study.

Computers. Computers are very important tools for the professional practice of engineering. For engineering students, having their own computer is as important as having their own textbooks and calculator. All engineering students are required to have an approved personal computer available for use in their residence.

In addition to their own computer, students have direct access to a wide variety of computing environments, e-mail, and the Internet on the campus computer network. Network-connected computers for general student use are located in Gellersen Center, Schnabel Hall, the Christopher Center and most residence halls. In addition, work stations and personal computers containing software for engineering design, analysis, and simulation are located in various engineering laboratories. Residence halls have network access from individual rooms. ISP or dial-up access is available from off-campus locations.

The Freshman Program. First year engineering students begin their program of study with a schedule of courses that is

consistent for all engineering majors. Work in a selected major begins in the second semester. The Freshman Engineering Coordinator serves as the academic advisor for all first-semester freshman engineering students.

The GE 100 Fundamentals of Engineering course is an integral part of the first-semester program. The course focuses on the fundamental concepts of engineering, drawing on topics from each discipline and showing the interdisciplinary nature of the profession.

A typical class will begin with a lecture, move on to a case study, and end with a hands-on project or demonstration. Student mentors (i.e., upper-division engineering students) will aid in guiding the projects.

Freshmen will also participate in an Engineering Seminar, which features alumni and campus speakers to help the freshmen better understand the possibilities available in engineering and other sessions to improve student survival skills.

Student Advisement. The Freshman Engineering Coordinator is the academic advisor for first-semester students. When a major is declared, the student is assigned to an academic advisor from that department's faculty. Majors are usually declared in the second semester of the freshman year.

Herman and Helen Hesse Learning Resource and Assessment Center. The Hesse Learning Resource and Assessment Center is an academic support program for students in the College of Engineering. Using peer tutors, it provides free one-on-one tutoring and group study sessions in math, science, and engineering courses for all engineering students. In conjunction with other campus-wide services, it also provides academic counseling, study-skill advising, assistance with technical writing, and group help sessions. The Center also assists in assessing outcomes of the College's educational programs. Located in Gellersen Center, it is open on all days when classes are in session.

Senior Project. All students in their senior year are required to complete a major design project. Students are organized into teams to plan, organize, execute, present, and document multidisciplinary design projects under the supervision of a faculty advisor.

Placement. The Career Center arranges on-campus interviews with a variety of employers who are interested in hiring graduates. Comprehensive services are also available to assist students seeking employment opportunities with organizations which do not interview on campus. Assistance is also available within and outside the College of Engineering for students wishing to find graduate study opportunities, cooperative education positions, summer employment, or part-time employment during the school year. Resource libraries provide information on employment and graduate school opportunities throughout the United States.

Professional Licensure. Licensure of those who wish to practice professional engineering is required by law in each of the states and the District of Columbia. The purpose of the law is to assure the general public that those professing to practice engineering have been examined and accepted by a State Board of Examiners. Graduate engineers will be able to more fully practice engineering if they are licensed as a Professional Engineer (PE). Licensing requires passing the Fundamentals of Engineering (FE) Examination typically followed by four years of engineering experience, after which the candidate can sit for the PE Examination. Senior engineering students are provided with information about the licensing process and an invitation, which they are urged to accept, to take the FE Examination during their senior year.

Student Professional and Service Organizations. To heighten student interest in the profession of engineering and in activities of the College of Engineering student body, the College provides general interest programs for all engineering students and sponsors social and recreational activities. Upon selecting a major, students are encouraged to join the student chapter of the related professional society. The American Society of Civil Engineers (ASCE), the Institute of Electrical and Electronics Engineers (IEEE), the American Society of Mechanical Engineers (ASME), and the Society of Women Engineers (SWE) all have active student chapters on campus. In addition, there is the club of the Society of Automotive Engineers (SAE). Junior and senior students who have distinguished themselves by high

scholarship, exemplary character, unselfish activity, and breadth of interest in their profession may be elected to membership in Tau Beta Pi, the national engineering honor society.

In alignment with the University's and College of Engineering's mission statements, the Engineers Without Borders™ (EWB) - Valparaiso Chapter was formed in the spring of 2002. EWB is a non-profit organization that was established to help developing areas worldwide with their engineering needs, while involving and training globally responsible engineering students.

As stated on the EWB-USA web site, "EWB projects involve the design and construction of water, wastewater, sanitation, energy, and shelter systems. These projects are initiated by, and completed with, contributions from the host community, which is trained to operate the systems without external assistance. In this way, EWB-USA ensures that its projects are appropriate and self-sustaining. The projects are conducted by groups of students under the supervision of faculty and professional engineers from partnering engineering firms. By involving students in every step of the EWB-USA process, the program maximizes their learning and awareness of the social, economics, environmental, political, ethical, and cultural impacts of engineering projects."

SPECIAL PROGRAMS OF THE COLLEGE OF ENGINEERING

Cooperative Education. The Cooperative Education Program provides a special five-year program for personal and career development which integrates classroom theory with career-related work experience. Employment in a salaried position allows students to gain valuable experience, to test career interests and to apply classroom knowledge in an environment related to their professional degree areas. The cooperative education student acquires engineering experience through a planned and supervised program which provides alternating periods of full-time campus study and full-time off-campus employment with one of over 100 co-op partners throughout the United States. The initial work assignment normally starts during the summer after the sophomore year. Academic credit is earned for each work period. Students typically complete four or five summer and semester work sessions with the same employer. The Cooperative Education Program enhances the graduating engineer's placement status, and some employers count the time served as a cooperative education student toward fringe benefits provided to employees.

Internships. The engineering internship program is an optional program in which all engineering students in good standing, except those participating in the Cooperative Education Program, may participate in during their summer breaks. Participation is limited to the summer between the freshman and sophomore years through the summer between the junior and senior years. Students interested in this program can earn up to three credit hours of academic credit for their participation in the program.

Interdisciplinary Studies. Programs can be arranged to meet special needs or interests of students studying engineering at Valparaiso University. Students interested in career fields such as electromechanical, biomedical or chemical engineering or medicine can enrich their engineering programs by careful selection of electives. These programs involve replacing technical and free electives with courses from other disciplines. Each student plans a program of study in consultation with a faculty advisor and must secure approval of the Dean of Engineering. Upon graduation the student receives a Bachelor of Science degree in Civil, Computer, Electrical, or Mechanical Engineering.

Double Degree Program. Some students wish to obtain a Bachelor of Arts or Bachelor of Science degree in the College of Arts and Sciences or the College of Business Administration in addition to their degree in engineering. In general, this will require an additional year or more of study. To earn two degrees, students must earn 162 credit hours and attain a grade point average of at least 2.00 as well as complete all other graduation requirements for each degree. Students desiring double degrees must have their schedules approved by the Deans of both colleges involved. Further information may be obtained from the Deans.

Majors and Minors. An engineering student may earn a major or minor in other colleges of the university by satisfying catalog course and credit requirements for the major or minor. Each major or minor will

require at least one course of at least three credits above any and all course work presented for the engineering degree. The use of engineering courses that are cross-listed or have equivalent course content with courses required for the major or minor is established by official action of the other college. The major or minor will be noted on the student's official academic record.

Departmental Minors. An engineering student seeking further breadth in their plan of study may earn one or more minors within the College of Engineering. The following minors are available: civil engineering, digital systems design, electrical engineering, and mechanical engineering. See the requirements for each in their respective departmental listing.

Engineering Minor. The engineering minor offers non-engineering students an introduction to areas of engineering. This minor is especially appropriate for students with an interest in pursuing a career in an engineering-related field. The Freshman Engineering Coordinator will serve as advisor. This minor would be of interest to science students who need an approved minor to graduate (see page 48).

A minimum of 18 credit hours of engineering courses is required for this minor. Of these, at least 9 credits must be from 200-level or higher courses. GE 100 may not be included, and credit will not be given for both CE 334 and ME 373, for both ECE 261 and ECE 281, and for both CE 212 and ME 252. Students must satisfy course prerequisites. The course of study must be approved by the advisor.

Manufacturing Management Minor. An interdisciplinary minor in Manufacturing Management is offered jointly by the College of Engineering and the College of Business Administration (see page 238 for requirements).

Honors College. Students invited to participate in the program of Christ College take all required engineering courses as well as courses required in the honors program. Because Christ College courses replace certain non-engineering courses, the College of Engineering-Christ College combination normally requires only four years for completion. Christ College courses provide an enriched program in the humanities and satisfy General Education Requirements for the engineering program. Academic advisors are assigned for both the College of Engineering and Christ College. Engineering students invited to join Christ College are strongly urged to accept the invitation. Additional information is available from the Dean of Engineering.

International Experiences. Various optional programs are available through which engineering students may obtain improved understanding of and appreciation for the history, geography, language, culture and engineering practices of other nations. In addition to the study opportunities described on pages 12-13 and 20-25 of this catalog, engineering students are permitted to arrange an international cooperative education assignment.

Valparaiso International Engineering Program (VIEP-German). VIEP-German is a five-year program that combines a major in one of the four engineering fields with a major or minor in German. The program allows students to gain multi-cultural experience and German language proficiency along with technical engineering skills and prepares them for careers with one of many German research and manufacturing firms located in the United States. Students are required to fulfill all requirements for one of the four engineering majors; take one German course per semester beginning, at the latest, in the third semester; participate in Valparaiso University's Study Abroad Program in Reutlingen, Germany in the seventh semester; enroll in at least one German-language engineering, science, or mathematics course while in Reutlingen; work in a cooperative education placement in Germany during the eighth semester and the ensuing summer; and reside in the Kade-Duesenberg German House and Cultural Center for at least two semesters. VIEP-German is coordinated jointly by the College of Engineering and the Department of Foreign Languages and Literatures. Students who wish to enroll in VIEP-German should see their engineering advisor and a German instructor as early in the freshman year as possible.

ACADEMIC POLICIES

Graduation Requirements. Students must complete one of the prescribed engineering curricula as described in the departmental listings. These prescribed

courses satisfy the curriculum requirements of the Accreditation Board for Engineering and Technology. The evaluation of advanced standing of transfer students in the Statement of Equivalence is based on meeting these requirements. The Department Chair or Freshman Engineering Coordinator may waive the requirement for GE 100 and/or GE 199. The requirement will be replaced with a free elective.

In addition to other requirements set forth on pages 262-264 of this catalog, the student's grade point average must meet the following minimums for all work taken at Valparaiso University:

1. A cumulative GPA of 2.00 in all work.
2. A cumulative GPA of 2.00 in mathematics and science. Computer science courses are included in the engineering major for Computer Engineering majors and in the mathematics and science for non-Computer Engineering majors.
3. A cumulative GPA of 2.00 in the engineering major. This includes courses identified with the student's departmental prefix (i.e., CE, ECE, and ME respectively) and all general engineering courses (GE).

Academic Deficiency. Students whose cumulative resident grade point average in any of the four categories listed above under Graduation Requirements falls below 2.00 are considered academically deficient. Such students may be denied the privilege of continuing their studies by being suspended from the College of Engineering unless they succeed in improving the quality of their work to the satisfaction of the faculty during the following semester. These students are considered to be on probation and may be required by their department to take certain prescribed courses and meet specific standards in order to continue their enrollment in the college. It is the policy of the College of Engineering that suspended students may not request reinstatement for one calendar year.

Guest Policy. A student not pursuing an engineering major or minor may take one engineering course per semester or summer session on the written recommendation of the Freshman Engineering Coordinator or a Department Chair and with the approval of the Dean of Engineering. Students who have been suspended from the College of Engineering and are presently enrolled in one of the other colleges may not enroll in an engineering course unless they have completed the course at an earlier date with an unsatisfactory grade (C- or lower). Courses that are cross-listed with departments in the other colleges and taken while on academic suspension may not be used to satisfy College of Engineering degree requirements.

Admission to Courses on a Satisfactory/Unsatisfactory Basis. The general policies for admission to courses on an S/U basis are found on page 259. Except for courses that are graded only on an S/U basis, the only S/U graded courses that may be used to satisfy specific degree requirements are academic area studies electives, physical education, and free electives. Courses that are not used to satisfy degree requirements may be taken on an S/U basis.

General Engineering

Barbara Engerer, Freshman Engineering Coordinator

See page 50 for the number of credit hours that may be applied toward a degree in the College of Arts and Sciences.

GE 100. Fundamentals of Engineering.
2+2, Cr. 3. This is an introductory studio-lab course that focuses on the fundamental concepts of engineering. Topics are drawn from principles of civil, computer, electrical, and mechanical engineering and show the interdisciplinary nature of the profession. Foundational skills such as problem solving, engineering communication, and teamwork are included. Students will participate in hands-on activities during most class periods.

GE 109. Mechanics-Statics.
Cr. 3. A course in the resolution and composition of forces and moments as applied to the free body diagram. Topics include principles of equilibrium, first and second moments of areas, study of trusses, frames and machines, friction. Prerequisites: MATH 131 and PHYS 141.

GE 199. Engineering Seminar.
Cr. 0. this seminar includes topics in engineering opportunities, student success skills, and career planning.

GE 290. Issues in Technology.
Cr. 3. Introduction to problem solving, decision making and risk assessment as they relate to the technical decision-making process. Engineering

measurements will be explored in the laboratory using conventional and computer-based data acquisition systems. Utilizing case studies, the relevant technical and nontechnical decisions associated with issues and projects will be explored. Not open to engineering majors.

GE 301. Principles of Engineering Practice.
Cr. 3. A discussion of engineering practice including topics such as engineering economics, management, professional ethics, and safety. Student will participate on multidisciplinary teams. Prerequisite: junior standing.

GE 386. Internship in Engineering.
Cr. 1. A summer engineering work experience with a pre-selected and approved employer. Requires satisfactory work performance and submission of a final report in approved format. Students may repeat for a maximum of three work sessions. Grading will be on an S/U basis. Prerequisites: student must be in good standing in the College of Engineering and have approval of the respective Department Cooperative Education Coordinator.

GE 481. Cooperative Education I.
Cr. 2. The application of theoretical and experimental engineering concepts in a business, consulting, industrial or government setting. Emphasis is placed on involvement in real-world engineering projects requiring analysis, design and investigative skills. Requires satisfactory work performance at a pre-selected employer and the submission of reports in a format approved by each department. This course is graded S/U only for civil and mechanical engineering majors. Prerequisite: approval of the respective Department Cooperative Education Coordinator.

GE 482. Cooperative Education II.
Cr. 2. A continuation of GE 481. This course requires a satisfactory employer evaluation and reports in a format approved by each department. This course is graded S/U only for civil and mechanical engineering majors. Prerequisite: GE 481.

GE 483. Cooperative Education III.
Cr. 1. Application of the concepts of engineering in a business, consulting, industrial or government setting. It requires reports in a format approved by each department. This course is graded S/U only for civil and mechanical engineering majors. May be repeated for up to three credit hours. Prerequisite: approval of the respective Department Cooperative Education Coordinator.

GE 495. Special Problem.
Cr. 1-3. Selected students are permitted to work on a special problem under the supervision of a member of the faculty. Each student is required to keep a progress notebook and to turn in a final report in an approved format. Open only to students with permission of the faculty and approval of the Dean of Engineering.

GE 497. Senior Design Project I.
Cr. 3. The application of theoretical and experimental engineering concepts in the analysis and design of an engineering system. Students form teams to plan and organize a multidisciplinary project. Prerequisite: senior standing. Corequisite: GE 301.

GE 498. Senior Design Project II.
Cr. 2. A continuation of GE 497. Projects are built, tested, documented and reported. Prerequisite: GE 497.

Civil Engineering

Associate Professors Aljobeh, Weiss (Chair); Assistant Professors Hagenberger, Leitch, Polito.

Mission. The mission of the Civil Engineering Department is to provide the highest quality of technical education which is grounded in the arts and sciences by faculty dedicated to challenging teaching and extraordinary care for individual students. The department will strive to develop graduates who will be effective members of engineering teams, managers of engineering projects, and serve as leaders in the civil engineering discipline and within the broader community of church and society.

Program Educational Objectives. The educational objectives of the Civil Engineering Program include the following:

1. Graduates shall possess a sound understanding of civil engineering concepts and the interrelation of these concepts with technical and nontechnical issues in business and society.
2. Graduates shall possess a desire for and an appreciation of the importance of a commitment to lifelong learning as a means of professional development.
3. Graduates shall possess effective written and oral communication skills.
4. Graduates shall possess the ability to function effectively as team members.
5. Graduates shall have the desire and the ability to actively contribute to the discipline of civil engineering and/or society as a whole.

"Civil engineering is the profession in which a knowledge of the mathematical and physical sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind in creating, improving and protecting the environment, in providing facilities for community living, industry, transportation, and in providing structures for the use of mankind."

--American Society of Civil Engineers

The Civil Engineering Program is designed to prepare the graduate to enter the practice of engineering or to pursue graduate study. The program is broad in scope requiring students to complete course work in five major branches of civil engineering (i.e., environmental, geotechnical, structural, transportation, and water resources engineering). Additional depth in one or several branches can be obtained through appropriate electives. The program emphasizes the importance of effective communication (e.g., written and oral); the ability to work in teams; the importance of ethical and professional responsibility; the need to be lifelong learners; and the need to hold paramount the safety, health, and welfare of the public.

Design is an important component of the Civil Engineering Program. This includes distinguishing between analysis and design, exposing students to various design methodologies, and requiring students to develop and evaluate (e.g., using economical, social, safety, and engineering criteria) alternative solutions to realistic engineering problems. The design experience (i.e., individually and in teams) is spread throughout the program and is incorporated into both classroom and laboratory exercises. In the sophomore year, students are introduced to fundamental aspects of the design process in the mechanics of materials and transportation courses. In the junior year, additional aspects of the design process and use of building codes are introduced in courses in structural design, soil and foundation engineering, and the sequence in environmental engineering. In the senior year, students are exposed to the design process in structural courses and electives. The design experience culminates with a major comprehensive design project in which students, working in teams, bring together their accumulated knowledge of design and analysis to solve a realistic engineering problem.

Laboratory work is designed to develop written communication skills, ability to analyze and interpret experimental data, self-confidence, and to aid in the interpretation and application of classroom theory. The majority of introductory courses in the five branches of civil engineering require a laboratory component. In addition, field exercises in surveying are an essential component of a student's education. The civil engineering department has modern, well-equipped laboratories in materials engineering, fluid mechanics, soil mechanics, and environmental engineering.

Graduation Requirements. The following courses and electives are required to earn the Bachelor of Science in Civil Engineering degree. A typical plan of study for each semester is published in the *Student Guide to University Life.*

CORE 110 The Human Experience	5 Cr.
CORE 115 The Human Experience	5 Cr.
CHEM 115 Essentials of Chemistry	4 Cr.
CHEM 116 Applications of Chemistry in Engineering	4 Cr.
ENGL 300 Introduction to Professional Writing	3 Cr.
MATH 131 Analytic Geometry and Calculus I	4 Cr.
MATH 132 Analytic Geometry and Calculus II	4 Cr.
MATH 234 Differential Equations and Linear Algebra	4 Cr.
PE 100 Healthy Lifestyles	1 Cr.
PHYS 141 Mechanics and Heat	3 Cr.
PHYS 141L Experimental Physics I	1 Cr.
THEO 200 The Christian Tradition	3 Cr.
Foreign Language/Diversity Elective	3-4 Cr.
Humanities, Social Science, or Theology Elective	6 Cr.
Mathematics/Science Elective	4 Cr.
Career Enhancement Elective	6 Cr.
Engineering Science Elective	3 Cr.
GE 100 Fundamentals of Engineering	3 Cr.
GE 109 Mechanics-Statics	3 Cr.
GE 199 Engineering Seminar	0 Cr.
GE 301 Principles of Engineering Practice	3 Cr.
CE 151 Construction Surveying	3 Cr.
CE 202 Statistical Applications in Civil Engineering	3 Cr.
CE 212 Materials Engineering	3 Cr.
CE 215 Mechanics of Materials	3 Cr.
CE 253 Transportation	3 Cr.
CE 315 Structural Analysis I	3 Cr.
CE 316 Structural Design I	3 Cr.
CE 320 Soil Mechanics	4 Cr.
CE 322 Soil and Foundation Engineering	3 Cr.
CE 332 Hydrology	3 Cr.
CE 334 Fluid Mechanics	4 Cr.
CE 364 Environmental Engineering I	4 Cr.
CE 417 Structural Design II	3 Cr.
CE 465 Environmental Engineering II	3 Cr.

CE 472 Project and Construction Management . 3 Cr.
CE 494 Senior Design Project . . . . . 3 Cr.
Civil Engineering Electives . . . . . 9 Cr.

Total required for graduation . . . . . 132 Cr.

Career Enhancement Electives. These six credits must be consistent with the student's written statement of career goals. Approval by the department chair is required.

Civil Engineering Electives. These nine credits are to be selected from the array of civil engineering electives provided. Courses which fulfill civil engineering elective requirements are indicated with a superscript [c].

Cooperative Education. Students may request to substitute up to six credits of GE 481 through GE 483 for the career enhancement electives.

Engineering Science Elective. The engineering science elective requirement may be met by taking one of the following courses: ECE 221, ECE 281, ME 209, ME 270, ME 462, ME 463, or ME 468.

Foreign Language/Diversity Elective. Students will take three credits from either a foreign language course at the 102 level or above or from a course on the diversity list found on pages 310-311.

Humanities, Social Science, Theology Electives. Students will take six credits from the approved list of Humanities courses, Social Science courses or Theology courses. Courses may be from the same area or from different areas. See pages 311-312 for Humanities and Social Science courses.

Mathematics/Science Elective. These four credits will be satisfied by MATH 253, PHYS 142 and 142L, BIO 171, BIO 172, BIO 210, or CHEM 221.

Civil Engineering Minor. A minor in civil engineering is available to students majoring in computer, electrical, or mechanical engineering. A minimum of 18 credit hours in civil engineering, excluding CE 202, is required. GE 109 may be counted as part of the 18 credits. A concentration of at least two CE courses in water resources, structural, geotechnical, construction, environmental, or transportation engineering is required. At least nine credits must be at the 300 level or above. Mechanical engineering majors may not use CE 334 as part of the minor. The civil engineering department chair must approve the plan of study.

CIVIL ENGINEERING

See page 50 for the number of credit hours that may be applied toward a degree in the College of Arts and Sciences.

CE 151. Construction Surveying.
2+3, Cr. 3. A study of the science and art of relative spatial measurements for engineering purposes. Special emphasis is placed on the theory of errors, use of surveying instruments, and field practice in transit-tape traversing, leveling and route surveying. Engineering graphing techniques and CAD software are introduced. Students are also instructed in public speaking and required to give one or more oral presentations.

CE 202. Statistical Applications in Civil Engineering.
Cr. 3. An introduction to the primary statistical and probabilistic models used in the collection and interpretation of civil engineering data. The focus is on summary techniques, regression models, application of the Central Limit Theorem, confidence intervals, and recurrence intervals. Monte Carlo simulation techniques are used to estimate the failure likelihood of a civil engineering system. Prerequisite: MATH 132 or MATH 152.

CE 212. Materials Engineering.
2+3, Cr. 3. Study of the mechanical and physical properties of construction materials. Introduction to concrete mix design. Laboratory experiments include the measurement of strains and deflections using mechanical and electrical gages; behavior and failure of ductile and brittle materials subjected to axial or bending forces; introduction to creep, impact and stability of columns. A project is required, as well as written reports. Students are also instructed in public speaking and required to give one or more oral presentations. Prerequisite or corequisite: CE 215.

CE 215. Mechanics of Materials.
Cr. 3. (Also offered as ME 315 and PHYS 215.) Concepts of stress and strain, stress-strain relationships, states of plane stress and strain at a point; elementary analysis of stress distributions and deformations for axial loading of prismatic members, torsional loading of circular shafts and bending of beams, combined loading; plastic elastic action, and an introduction to statically indeterminate problems. Prerequisite: GE 109.

CE 253. Transportation.
Cr. 3. Introduction to transportation engineering with an emphasis on highway design. Topics include transportation demand and planning, parking and speed studies, human and vehicle design factors, environmental impact statements, horizontal and vertical alignment,

earthwork volumes, and design of flexible and rigid pavements. Prerequisite: CE 151 or consent of the instructor.

CE 290. Topics in Civil Engineering.
Cr. 2-4. Seven weeks or semester. The investigation of civil engineering topics of special interest. Prerequisites depend on topics offered. Offered upon sufficient demand.

CE 299. Sophomore Honor Studies in Civil Engineering.
Cr. 1-3. Independent study of an advanced topic in civil engineering. Available by invitation only. Prerequisite: approval by the Civil Engineering Department.

CE 315. Structural Analysis I.
Cr. 3. Application of fundamental analysis concepts to the behavior of civil engineering structures and structural components. Analysis of statically determinate and indeterminate structures using classical methods such as Slope Deflection, conjugate beam, and flexibility methods. Introduction to a typical structural analysis software program. Prerequisite: CE 215.

CE 316. Structural Design I.
Cr. 3. Principles of the design of steel structures. Design includes axial tension and compression members, flexural members, beam-columns, connections, and composite design. LRFD methods are used. Prerequisite: CE 315.

CE 320. Soil Mechanics.
3+3, Cr. 4. The study of index, mechanical and hydraulic properties of soils. Soil identification, compaction, shear strength, consolidation, vertical stress distribution, and flow through porous media. Principles of laboratory identification and testing of soils. Site investigation and in situ testing. Prerequisite: CE 215.

CE 322. Soil and Foundation Engineering.
Cr. 3. A continuation of CE 320. Lateral earth pressures, retaining wall design, elastic stress distribution, settlement, and bearing capacity of foundation systems. Sizing of shallow and deep foundation systems. Prerequisite: CE 320.

CE 332. Hydrology.
Cr. 3. Introduction to surface and ground water hydrology: hydrologic cycle, precipitation, evaporation, infiltration, ground water flow, well hydraulics, run-off, rainfall–run-off relationships, uniform flow in open channels, stream flow measurements, hydrologic routing, hydrologic modeling, hydrologic probability, and applications. Prerequisite: MATH 131.

CE 334. Fluid Mechanics.
3+3, Cr. 4. An examination of fluid properties, fluids at rest, and fluids in motion. Conservation of mass, and the energy and momentum principles are utilized along with dimensional analysis and similitude. Applications include pumps, flow in conduits, lift and drag, pipe networks, and hydraulic model studies. Integrated with the fluid mechanics per se are principles of mechanics-dynamics. Students are also instructed in public speaking and required to give one or more oral presentations. Prerequisites: MATH 132 and CE 215.

CE 364. Environmental Engineering I.
3+3, Cr. 4. Introductory study of water treatment and supply, wastewater collection and treatment common to rural and metropolitan areas. Laboratory principles and methods related to safety, sampling, data analysis, and measurement of selected physical, chemical, and biological characteristics of water and wastewater are introduced. Field trips are required. Prerequisites: CE 334 and CHEM 116.

CE 399. Junior Honor Studies in Civil Engineering.
Cr. 1-3. Independent study of an advanced topic in civil engineering. Available by invitation only. Prerequisite: approval by the Civil Engineering Department.

CE 415. Structural Analysis II.[c]
Cr. 3. Analysis of statically indeterminate structures using energy and/or matrix methods. Direct stiffness and flexibility methods are discussed as are a variety of applications in structural analysis software including response to time-dependent loading such as blasts, earthquakes, etc. Prerequisite: CE 315.

CE 417. Structural Design II.
Cr. 3. Principles of the design of reinforced concrete structures. Design includes flexural members, compression members, one-way slabs and footings. ACI Strength Design Method. Prerequisite: CE 315.

CE 418. Structural Design III.[c]
Cr. 3. Analysis and design of masonry structural system components. The use of appropriate specifications in design. Design projects may be required. Taught in alternate years. Prerequisite: CE 315.

CE 436. Water Resources Engineering.[c]
Cr. 3. Application of the principles of fluid mechanics to analysis and design of water resources projects. Topics include open-channel hydraulics, hydroelectric power, economic analysis, dams, spillways, river navigation, flood control, and water law. Prerequisite: CE 334 or ME 373.

CE 457. Traffic Engineering.[c]
Cr. 3. Fundamental traits and behavior of road users and their vehicles. Characteristics of a free-flowing traffic stream; capacity and level of service of urban and rural highways, signals and signalized intersection capacity; traffic speeds, volumes, signing and marking; accidents and

safety. Taught in alternative years. Prerequisite: CE 253 or consent of instructor.

CE 465. Environmental Engineering II.
Cr. 3. Introductory study of solid and hazardous waste management and air pollution control. Study of solid and hazardous waste properties, sources, composition, magnitude, and regulations. Engineered solid waste management functional elements will be introduced. Landfilling methods, including siting and modern landfill designs, will be studied. Introduction to air pollution sources, quality, meteorology, atmospheric dispersion modeling, and control methods. Field trips are required.

CE 466. Environmental Engineering Design.[c]
Cr. 3. A basic overview of remediation of contaminated soil and ground water at hazardous waste sites including development of site investigation plans, management of field investigations, environmental risk assessments, feasibility studies, innovative remedial design techniques, and case studies. Oral and written reports and field trips are required.

CE 472. Project and Construction Management.
Cr. 3. An introduction to professional practice issues such as contracts, addendums, bonds, design-build, bids, specifications, scheduling, and other legal issues. Students are also instructed in public speaking and required to give one or more oral presentations. Prerequisite: junior or senior standing.

CE 490. Topics in Civil Engineering.[c]
Cr. 2-4. Seven weeks or semester. The investigation of civil engineering topics of special interest. Prerequisites depend on topics offered. Offered upon sufficient demand. Prerequisite: junior standing or approval of the instructor.

CE 494. Senior Design Project.
2+2, Cr. 3. Student teams participate in the planning, analysis and design of integrated and realistic civil engineering projects. Knowledge gained in previous courses is used to incorporate the ethical, legal, societal, multicultural, economical, financial, aesthetic, and environmental aspects in the solution. In addition, the elements of management and communications are involved. The course may include field trips and lectures by practicing professionals. Oral and written reports are required.

CE 499. Senior Honor Studies in Civil Engineering.
Cr. 1-3. Independent study of an advanced topic in civil engineering. Available by invitation only. Prerequisite: approval by the Civil Engineering Department.

Electrical and Computer Engineering

Professors Hart, Kraft, Olejniczak; Associate Professors E. Johnson, D. Tougaw (Chair); Assistant Professors Freeman, Will; Instructor Budnik; Adjunct Assistant Professor Kempf.

The Department of Electrical and Computer Engineering offers two degree programs: Electrical Engineering and Computer Engineering. These two degrees share a fundamental theoretical background that is reflected by many common courses and shared laboratory facilities.

Digital design courses introduce the formulation of design problems and the use of computer-aided design tools. During the junior year, students refine these design elements while studying digital filter design, electronics, and the design of hardware to interface with embedded microprocessors. Students also participate in modest group design projects. During the senior year, students begin a systematic study of the design process and apply the design skills developed in earlier courses to an interdisciplinary capstone project which requires the consideration of realistic constraints, formal project management, the building and testing of a design prototype, and thorough documentation.

The department supports a diverse set of laboratory facilities. The electronics laboratory supports work in digital and analog systems. This large facility also includes equipment for power electronics. The digital systems laboratory is used to study digital filtering systems and advanced digital logic design. This laboratory also houses a hardware-in-the-loop simulator used for power systems studies. The computer laboratories contain a network of work stations, PCs, peripherals, and embedded microcontroller software and hardware development systems. Design teams use the project laboratory to build and test their prototypes.

ELECTRICAL ENGINEERING

Electrical Engineering Mission. The purpose of the Electrical Engineering Program is to educate qualified and motivated individuals in an exclusively undergraduate environment who, upon graduation, are prepared for lifelong learning and the pursuit of professional excellence in the field of electrical engineering, and who base their professional and personal decisions on the ethical, moral and social values which are central to Valparaiso University.

Electrical Engineering Program Educational Objectives. The educational objectives of the electrical engineering program are to:

1. Prepare students to practice electrical engineering in such areas as digital systems design, electronics, embedded microcontrollers, software development, power systems, communication systems, or signal processing.
2. Prepare students to communicate effectively in a wide variety of situations using appropriate tools.
3. Prepare students to work effectively on teams in a variety of roles.
4. Prepare students to design electrical engineering systems using creativity, technical competence, and problem-solving skills.
5. Prepare students to assume their ethical and professional responsibilities to meet the needs of society.
6. Prepare students to function in a competitive business environment by understanding necessary economic and business practices.
7. Prepare students to appreciate the need for and to engage in continuous independent learning activities.

Graduation Requirements. The following courses and electives are required to earn the Bachelor of Science in Electrical Engineering degree. A typical plan of study for each semester is published in the *Student Guide to University Life.*

CORE 110 The Human Experience	5 Cr.
CORE 115 The Human Experience	5 Cr.
MATH 131 Analytic Geometry and Calculus I	4 Cr.
MATH 132 Analytic Geometry and Calculus II	4 Cr.
MATH 234 Differential Equations and Linear Algebra	4 Cr.
MATH 253 Calculus III	4 Cr.
PE 100 Healthy Lifestyles	1 Cr.
PHYS 141 (or 151) Mechanics and Heat	3 Cr.
PHYS 141L Experimental Physics I	1 Cr.
PHYS 142 (or 152) Electricity, Magnetism, Waves	3 Cr.
THEO 200 The Christian Tradition1	3 Cr.
Foreign Language/Diversity Elective	3-4 Cr.
Humanities, Social Science, Theology Elective	6 Cr.
Free Elective	3 Cr.
GE 100 Fundamentals of Engineering	3 Cr.
GE 199 Engineering Seminar	0 Cr.
GE 301 Principles of Engineering Practice	3 Cr.
GE 497 Senior Design Project I	3 Cr.
GE 498 Senior Design Project II	2 Cr.
ECE 110 Exploring Electrical and Computer Engineering	2 Cr.
ECE 111 Exploring Electrical and Computer Engineering Laboratory	1 Cr.
ECE 200 Computational Techniques for Electrical and Computer Engineers I	2 Cr.
ECE 201 Computational Techniques for Electrical and Computer Engineers II	2 Cr.
ECE 221 Digital Logic Design	3 Cr.
ECE 222 Advanced Logic Design	3 Cr.
ECE 251 Algorithms and Programming	3 Cr.
ECE 261 Linear Circuit Theory I	3 Cr.
ECE 262 Linear Circuit Theory II	3 Cr.
ECE 322 Embedded Microcontrollers	3 Cr.
ECE 340 Electronics I	3 Cr.
ECE 341 Electronics II	3 Cr.
ECE 360 Sampled Linear Systems	3 Cr.
ECE 365 Probability and Statistics for Electrical and Computer Engineers	3 Cr.
ECE 430 Electromagnetic Field Theory	3 Cr.
ECE 453 Communication Systems	3 Cr.
Mathematics/Science Electives	9 Cr.
Professional Electives	6 Cr.
Electrical Engineering Electives	12 Cr.
Total required for graduation	130 Cr.

Cooperative Education. Up to six credits of GE 481 through GE 483 may be used to satisfy the professional elective requirement if a minimum of six credits of cooperative education have been completed.

Electives. Specific recommendations regarding the selection of electives are available from the department and should be made in consultation with a departmental academic advisor.

Electrical Engineering Electives. Twelve credits must be taken by choosing four of the following eight courses: ECE 258, 372, 424, 429, 450, 452, 460, and 471. At least two of these courses must be chosen from the following core electrical engineering electives: ECE 372, 452, 460, and 471. Other courses may be used to satisfy this elective with the approval of the department faculty.

Foreign Language/Diversity Elective. Students will take three credits from either a foreign language course at the 102 level or above or from a course on the diversity list found on pags 310-311.

Humanities, Social Science, Theology Electives. Students will take six credits from the approved list of Humanities courses, Social Science courses, or Theology courses. Courses may be from the same area or from different areas. See pages 311-312 for Humanities and Social Science courses.

Mathematics/Science Electives. The mathematics/science elective requirement may be met by taking one of the following courses: ASTR 252, BIO 151, 152, 171, 172, 210, 250, or 270, CHEM 116, 122, 221, or 230, MATH 340, 366, 430 or 434, ECE 357, PHYS 250, 360, 381, 421, 430, or 440. Other choices may be made available by petition to the ECE department. An updated list of approved mathematics/science electives may be found on the College of Engineering web site.

Professional Electives. These courses are selected, in consultation with the advisor, to support the student's specific career goals. See the College of Engineering web site.

Electrical Engineering Minor. A minor in electrical engineering is available for students majoring in civil or mechanical engineering. A minimum of 19 credit hours is required. Courses must include ECE 110, 111, 200, 221, and 261. The remaining credits must be taken from the following courses: ECE 201, 222, 262, 322, 340, 341, 360, 372, 429, and 471.

COMPUTER ENGINEERING

Computer Engineering Mission. The purpose of the Computer Engineering Program is to educate qualified and motivated individuals in an exclusively undergraduate environment who, upon graduation, are prepared for lifelong learning and the pursuit of professional excellence in the field of computer engineering, and who base their professional and personal decisions on the ethical, moral and social values which are central to Valparaiso University.

Computer Engineering Program Educational Objectives. The educational objectives of the computer engineering program are to:

1. Prepare students to practice computer engineering in such areas as digital design, embedded systems, computer architecture, or software development.
2. Prepare students to communicate effectively in a wide variety of situations using appropriate tools.
3. Prepare students to work effectively on teams in a variety of roles.
4. Prepare students to design computer engineering systems using creativity, technical competence, and problem-solving skills.
5. Prepare students to assume their ethical and professional responsibilities to meet the needs of society.
6. Prepare students to function in a competitive business environment by understanding necessary economic and business practices.
7. Prepare students to appreciate the need for and to engage in continuous independent learning activities.

Graduation Requirements. The following courses and electives are required to earn the Bachelor of Science in Computer Engineering degree. A typical plan of study for each semester is published in the *Student Guide to University Life.*

CORE 110 The Human Experience	5 Cr.
CORE 115 The Human Experience	5 Cr.
MATH 131 Analytic Geometry and Calculus I	4 Cr.
MATH 132 Analytic Geometry and Calculus II	4 Cr.
MATH 234 Differential Equations and Linear Algebra	4 Cr.
MATH 253 Calculus III	4 Cr.
PE 100 Healthy Lifestyles	1 Cr.
PHYS 141 (or 151) Mechanics and Heat	3 Cr.
PHYS 141L Experimental Physics I	1 Cr.
PHYS 142 (or 152) Electricity, Magnetism, Waves	3 Cr.
THEO 200 The Christian Tradition	3 Cr.
Foreign Language/Diversity Elective	3-4 Cr.
Humanities, Social Science, Theology Elective	6 Cr.
GE 100 Fundamentals of Engineering	3 Cr.
GE 199 Engineering Seminar	0 Cr.
GE 301 Principles of Engineering Practice	3 Cr.
GE 497 Senior Design Project I	3 Cr.
GE 498 Senior Design Project II	2 Cr.
ECE 110 Exploring Electrical and Computer Engineering	2 Cr.
ECE 111 Exploring Electrical and Computer Engineering Laboratory	1 Cr.
ECE 200 Computational Techniques for Electrical and Computer Engineers I	2 Cr.
ECE 201 Computational Techniques for Electrical and Computer Engineers II	2 Cr.
ECE 221 Digital Logic Design	3 Cr.
ECE 222 Advanced Logic Design	3 Cr.
ECE 251 Algorithms and Programming	3 Cr.
ECE 252 Algorithms and Abstract Data Types	3 Cr.
ECE 261 Linear Circuit Theory I	3 Cr.
ECE 262 Linear Circuit Theory II	3 Cr.
ECE 322 Embedded Microcontrollers	3 Cr.
ECE 340 Electronics I	3 Cr.
ECE 341 Electronics II	3 Cr.
ECE 357 Algebraic and Discrete Structures I	3 Cr.

ECE 360 Sampled Linear Systems . . . . . 3 Cr.
ECE 365 Probability and Statistics for Electrical and Computer Engineers . . . . . 3 Cr.
ECE 424 Computer Architecture . . . . . 3 Cr.
ECE 430 Electromagnetic Field Theory . . . . . 3 Cr.
CS 257 Data Structures and Programming Languages . . . . . 4 Cr.
CS 347 Operating Systems and Networking . . . 4 Cr.
CS 358 Software Design and Development . . . . 4 Cr.
Mathematics/Science Elective . . . . . 3 Cr.
Professional Electives . . . . . 6 Cr.
Computer Engineering Elective . . . . . 3 Cr.

Total required for graduation 130 Cr.

Computer Engineering Elective. Three credits must be taken by choosing one of the following courses: ECE 429, 450, and 452.

Cooperative Education. Up to six credits of GE 481 through GE 483 may be used to satisfy the professional electives requirement if a minimum of six credits of cooperative education have been completed.

Electives. Specific recommendations regarding the selection of electives are available from the department and should be made in consultation with a departmental academic advisor.

Foreign Language/Diversity Elective. Students will take three credits from either a foreign language course at the 102 level or above or from a course on the diversity list found on pages 310-311.

Humanities, Social Science, Theology Electives. Students will take six credits from the approved list of Humanities courses, Social Science courses, or Theology courses. Courses may be from the same area or from different areas. See pages 311-312 for Humanities and Social Science courses.

Mathematics/Science Electives. The mathematics/science elective requirement may be met by taking one of the following courses: ASTR 252, BIO 151, 152, 171, 172, 210, 250, or 270, CHEM 116, 122, 221, or 230, MATH 340, 366, 430, or 434, PHYS 250, 360, 381, 421, 430, or 440. Other choices may be made available by petition to the ECE department. An updated list of approved mathematics/science electives may be found on the College of Engineering web site.

Professional Electives. These courses are selected, in consultation with the advisor, to support the student's specific career goals. See the College of Engineering web site.

Digital Systems Design Minor. This minor is available to qualified students who wish to document some background in computer hardware, but do not want to major in electrical engineering. The courses required for the completion of this minor are ECE 221, ECE 222, ECE 322 and two of the following: ECE 424, ECE 429, or ECE 450. The minor is available to any student, except those in the ECE department, who meets all of the prerequisites necessary to enroll in those courses that constitute the minor.

ELECTRICAL AND COMPUTER ENGINEERING COURSES

See page 50 for the number of credit hours that may be applied toward a degree in the College of Arts and Sciences.

ECE 110. Exploring Electrical and Computer Engineering.
Cr. 2. An introductory course emphasizing basic circuit analysis, characteristics of common electrical devices, computer tools including simulations, and problem-solving techniques. Prerequisite: MATH 131 or concurrent registration.

ECE 111. Exploring Electrical and Computer Engineering Laboratory.
0+3, Cr. 1. A complement to ECE 110, with emphasis on laboratory technique and the characteristics of electrical devices. Corequisite: ECE 110.

ECE 200. Computational Techniques for Electrical and Computer Engineers I.
Cr. 2. Introduction to the solution of electrical and computer engineering problems using computers. Important software packages such as LabVIEW, MATLAB and PSpice are used. The course is designed to complement ECE 261.

ECE 201. Computational Techniques for Electrical and Computer Engineers II.
Cr. 2. A continuation of ECE 200. Topics involve the solution of electrical and computer engineering problems using computers. The course is designed to complement ECE 262. Prerequisite: ECE 200.

ECE 221. Digital Logic Design.
2.5+1.5, Cr. 3. (Also offered as CS 220.) An introduction to digital logic concepts, including the analysis and design of combinational and sequential digital circuits.

ECE 222. Advanced Logic Design.
2.5+1.5, Cr. 3. A continuation of ECE 221 that includes the design of MSI and LSI digital circuits using a hardware description language (VHDL). Designs are also implemented in programmable logic devices (PALs, CPLDs). Prerequisite: ECE 221 with a minimum grade of C.

ECE 251. Algorithms and Programming.
Cr. 3. Introduction to the design of sequential and concurrent algorithms. Software engineering principles and practices relating to program design and implementation. Concurrence issues and practices for parallel algorithm design. Students cannot receive credit for both CS 157 and ECE 251.

ECE252. Algorithms and Abstract Data Types.
2+2, Cr. 3. A continuation of ECE 251 with emphasis on developing more skills in complex program development and data structures. Topics include stacks, queues and linked lists. Students design and write intermediate sized programs. Prerequisite: ECE 251 or CS 157.

ECE 261. Linear Circuit Theory I.
2.5+1.5, Cr. 3. A study of the fundamental methods and theorems of electric circuit analysis. Topics include steady-state and transient analysis of DC and AC circuits containing resistors, capacitors, inductors, and operational amplifiers. Prerequisite: MATH 131. Corequisite: ECE 200.

ECE 262. Linear Circuit Theory II.
2.5+1.5, Cr. 3. A continuation of ECE 261. Topics include power computations, transformers, frequency response, filters, Laplace transforms, and Fourier series. Prerequisite: ECE 261 with a minimum grade of C . Corequisite: ECE 201.

ECE 281. Fundamentals of Electrical Engineering.
2.5+1.5, Cr. 3. (Also offered as PHYS 281.)
A study of the fundamental methods of electrical circuit analysis with emphasis on computer-aided analysis. AC and DC circuits, operational amplifiers. Laboratory exercises emphasize measurement techniques and reinforce lecture material. Not applicable to a degree in electrical or computer engineering. Prerequisite: MATH 131.

ECE 290. Sophomore Project.
Cr. 1-3. An independent research, development, or design project done under the supervision of a faculty member. Prerequisite: sophomore standing.

ECE 299. Sophomore Honor Studies in Electrical and Computer Engineering.
Cr. 1-3. Independent study of an advanced topic in electrical engineering. Available by invitation only. Prerequisite: approval by the Electrical and Computer Engineering Department.

ECE 322. Embedded Microcontrollers.
2.5+1.5, Cr. 3. (Also offered as PHYS 322).
The application of microcontrollers in embedded system design, emphasizing the interaction of hardware and software design. Use of assembly language programming to interface external hardware to a microcontroller. Prerequisite: ECE 222 with a minimum grade of C.

ECE 340. Electronics I.
2.5+1.5, Cr. 3. An introduction to semiconductor theory and the design and analysis of electronic circuits. Topics include diodes, field-effect and bipolar transistors, CMOS logic circuits, single-state discrete transistor amplifiers, and multistage integrated-circuit amplifiers. Prerequisite: ECE 261 with a minimum grade of C.

ECE 341. Electronics II.
2.5+1.5, Cr. 3. Topics include power amplifiers, DC power supplies, data converters, feedback, oscillators, switched-capacitor circuits, and transistor memory units. Prerequisite: ECE 340.

ECE 357. Algebraic and Discrete Structures I.
Cr. 3. (Also offered as MATH 168.) An introduction to mathematical reasoning, algorithm analysis and the concepts that provide a mathematical foundation for computer science. Topics include a review of sets, relations, functions and matrices; proof techniques, including mathematical induction; counting techniques; difference equations; applications and elementary analysis of iterative and recursive algorithms. Prerequisite: ECE 251 .

ECE 360. Signals and Systems.
Cr. 3. Continuous and discrete systems and signals are considered in both time and frequency domains. Continuous-time linear systems topics include Fourier series, Fourier transforms, and Laplace transforms. Discrete-time topics include the discrete Fourier transform, the Z-transform, sampling, quantization, and discrete-time processing. Discrete and continuous filtering techniques are introduced. Prerequisite: ECE 262 with a minimum grade of C.

ECE 365. Probability and Statistics for Electrical and Computer Engineers.
Cr. 3. Basic discrete and continuous probability theory with applications, sampling, correlations and regression, and multiple random variables. Prerequisites: ECE 262 and MATH 253.

ECE 372. Energy Conversion and Transmission.
2.5+1.5, Cr. 3. A study of electromagnetic devices with emphasis on the principles and operating characteristics of transformers and transmission lines. Fundamentals of electric power system protection are also covered. Prerequisite: ECE 262.

ECE 390. Junior Project.
Cr. 1-3. An independent research, development, or design project done under the supervision of a faculty member. Prerequisite: junior standing.

ECE 399. Junior Honor Studies in Electrical and Computer Engineering.
Cr. 1-3. Independent study of an advanced topic in electrical engineering. Available by invitation only. Prerequisite: approval by the Electrical and Computer Engineering Department.

ECE 424. Computer Architecture.
Cr. 3. The description, organization, and design of computer elements to perform effectively. Instruction set design, caches, pipelining, and microprogramming. Prerequisite: ECE 222.

ECE 429. VLSI Design Principles and Tools.
Cr. 3. An introduction to the fundamental principles of CMOS digital integrated circuit design. Extensive use of CAD tools for layout and simulation. Techniques for speed and size trade-off are studied. Prerequisites: ECE 221 and 262 with minimum grades of C in both.

ECE 430. Electromagnetic Field Theory.
Cr. 3. The study of fundamental laws of static and dynamic electric and magnetic fields using vector methods. Topics include transmission lines, Maxwell's equations and electromagnetic radiation. Prerequisite: MATH 253.

ECE 450. Digital Communication Systems.
Cr. 3. Theory of interconnected digital systems including information flow control by packet and circuit-switching techniques and standards for communication between network nodes. Prerequisites: ECE 251 and ECE 262.

ECE 452. Digital Signal Processing.
2.7+1, Cr. 3. This course is an overview of the theory and techniques of the basic concepts of digital signal processing. Topics covered include design of FIR and IIR filters, construction of algorithms for real-time and off-line signal processing, relationships between analog and digital realizations, and real-time hardware considerations. Prerequisite: ECE 360.

ECE 453. Communication Systems.
Cr. 3. Methods of transmission of information by electrical signals through channels limited by bandwidth and additive noise. The characteristics of standard analog and digital modulation schemes such as AM, FM, PAM, PCM are investigated and related to their channel requirements. Prerequisites: ECE 360 and ECE 365.

ECE 460. Control System Design.
Cr. 3. A study of the application of feedback analysis and design in the frequency and time domains. Classical design is considered using root-locus and frequency response methods. Models derived from frequency response data are introduced. Introduction to modern control (state-space representation and pole placement) and Luenberger observers. Prerequisite: ECE 360.

ECE 471. Power Electronics.
2.7+1, Cr. 3. A course in the application and design of power semiconductor circuits. Topics include rectifiers, AC controllers, inverters and switched-mode power supplies. Prerequisite: ECE 262.

ECE 490. Topics in Electrical and Computer Engineering.
Cr. 1-3. The investigation of electrical engineering or computer engineering topics of special interest. Prerequisite: consent of the Chair of the Department.

ECE 499. Senior Honor Studies in Electrical and Computer Engineering.
Cr. 1-3. Independent study of an advanced topic in electrical engineering. Available by invitation only. Prerequisite: approval by the Electrical and Computer Engineering Department.

Mechanical Engineering

Professors Palumbo (Chair), Schoech, Steffen; Associate Professor Doria; Assistant Professors P. Johnson, Sevener; Instructor Duncan.

Mission. The Mechanical Engineering Department provides a program of professional studies grounded in engineering fundamentals and arts and sciences augmented by the development of interpersonal skills, experiential learning, and an appreciation of lifelong learning. Graduates are prepared to apply their knowledge to society's needs and help shape the future.

Program Educational Objectives. The educational objectives of the Mechanical Engineering Program are the following:

1. Prepare graduates for the practice of mechanical engineering in such areas as mechanical design, systems, manufacturing, experimentation, and energy conversion;
2. Prepare graduates to communicate in a wide variety of settings using appropriate methods;
3. Prepare graduates to work effectively on teams in a variety of roles;
4. Prepare graduates who have an understanding of and concern for ethical, safety, environmental, social, economic, global and lifelong learning issues faced by practicing engineers. Graduates will be committed to fairness, integrity and honesty, respect for human dignity, serving others, excellence, and growth;

5. Prepare graduates to be proficient in a laboratory setting. They will have good hands-on skills with mechanical/electrical hardware and data acquisition software. They will be able to design experiments and use uncertainty analysis tools;
6. Prepare graduates with a broad based education, which includes a strong liberal arts component to frame and focus their technical skills and enhance their quality of life.

Program Overview. The practice of mechanical engineering includes a wide variety of technical activities in the areas of energy conversion, automatic control of engineering processes, and the design, development and manufacture of mechanical components and systems. Mechanical engineering contributes to almost every aspect of our society.

The Mechanical Engineering Program prepares the individual for leadership roles on multidisciplinary teams that will address both technical and nontechnical issues. A curriculum solidly comprised of fundamental engineering course work and the humanities and social sciences is an essential element in the preparation process.

Courses are sequenced to build upon a firm foundation in mathematics, basic sciences, and engineering sciences. Courses progressively involve students in engineering design activities and culminate in a major interdisciplinary design experience during the final year of study. Alongside technical issues, design activities address economic, safety, environmental, sustainability, product development, and social factors.

Graduates of the Mechanical Engineering Program at Valparaiso University are qualified to enter industry as practicing engineers or to pursue advanced degrees.

Mechanical Engineering Laboratories. The Mechanical Engineering Program contains a significant laboratory component which is closely correlated with lecture courses. There are eight primary laboratory facilities within the department. Additional laboratory facilities support senior design projects. Personal computers with appropriate hardware and software are available in the laboratories for mechanical design, to acquire and analyze data, to control hardware, and to report results in graphic and tabular form.

The *Mechanical Measurements and Mechatronics Laboratory* complements instruction in the use of standard measurement equipment, calibration techniques, computer data acquisition and the study of mechanical and electrical systems.

The *Energy Systems Laboratory* provides the opportunity to study the laws governing work, heat, and energy conversion. This facility includes laboratory equipment such as an internal combustion engine, a supersonic nozzle, a solar collector, a heat pump, and a wind tunnel.

The *Automatic Control Laboratory* is used to conduct experiments with simulated process systems and the associated instrumentation to control these processes.

The *Manufacturing Process and Systems Laboratory* supports instruction in methods and theory of metal working, automation, product design and development, and the design, operation, and control of production systems. In addition to metal cutting, forming, welding, grinding and inspection equipment, this laboratory contains the Integrated Manufacturing and Design Facility with Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) software, Computer Numerical Control (CNC) machine tools, robots, and vision systems.

The *Materials Science Laboratory* contains equipment for conducting a variety of materials experiments including impact, tension, creep, cold working, hardness and nondestructive testing. Special emphasis is placed upon modification of material properties by heat treatment. Metallurgical specimens are prepared and examined.

The *Experimental Stress Laboratory* provides primary equipment for strain/stress analysis including electrical resistance strain gages and photoelasticity.

The *Vibrations Laboratory* contains mechanical and electrical vibration excitation and measuring devices along with equipment to perform modal analysis and sound measurement.

Graduation Requirements. The following courses and electives are required to earn the Bachelor of Science in Mechanical Engineering degree. A typical plan of study for each semester is published in the *Student Guide to University Life.*

CORE 110 The Human Experience	5 Cr.
CORE 115 The Human Experience	5 Cr.
CHEM 115 Essentials of Chemistry	4 Cr.
MATH 131 Analytic Geometry and Calculus I	4 Cr.

MATH 132 Analytic Geometry and Calculus II	4 Cr.
MATH 234 Differential Equations and Linear Algebra	4 Cr.
MATH 253 Analytic Geometry and Calculus III	4 Cr.
PE 100 Healthy Lifestyles	1 Cr.
PHYS 141 Mechanics and Heat	3 Cr.
PHYS 141L Experimental Physics I	1 Cr.
PHYS 142 Electricity, Magnetism and Waves	3 Cr.
THEO 200 The Christian Tradition	3 Cr.
Foreign Language/Diversity Elective	3-4 Cr.
Humanities, Social Science, Theology Elective	6 Cr.
Mathematics/Science Elective	3 Cr.
Free Elective	3 Cr.
GE 100 Fundamentals of Engineering	3 Cr.
GE 109 Mechanics-Statics	3 Cr.
GE 199 Engineering Seminar	0 Cr.
GE 301 Principles of Engineering Practice	3 Cr.
GE 497 Senior Design Project I	3 Cr.
GE 498 Senior Design Project II	2 Cr.
ECE 281 Fundamentals of Electrical Engineering	3 Cr.
ME 104 Computer-Aided Design	3 Cr.
ME 209 Mechanics-Dynamics	3 Cr.
ME 225 Computational Techniques for Mechanical Engineers	3 Cr.
ME 252 Materials Science	3 Cr.
ME 253 Manufacturing Processes	4 Cr.
ME 270 Thermodynamics I	3 Cr.
ME 315 Mechanics of Materials	3 Cr.
ME 332 Mechatronics	3 Cr.
ME 333 Mechanical Measurements Laboratory	4 Cr.
ME 362 Mechanisms	3 Cr.
ME 373 Fluid Mechanics	3 Cr.
ME 374 Heat Power Laboratory	1 Cr.
ME 376 Heat Transfer	3 Cr.
ME 463 Machine Design I	3 Cr.
ME 470 Thermodynamics II	3 Cr.
Mechanical Engineering Electives	12 Cr.
Total required for graduation	130 Cr.

Cooperative Education. GE 481 through GE 483 credits may be used to satisfy the Free Elective requirement. Courses GE 481-483 are graded S/U only.

Free Elective. Students are encouraged to select a course aligned with enhancing their life goals. A public speaking course is recommended for individuals who have not had a formal course in this subject. A speech course should be selected from COMM 140, 145, or 243.

Foreign Language/Diversity Elective. Students will take three credits from either a foreign language course at the 102 level or above or from a course on the diversity list found on pages 310-311.

Humanities, Social Science, Theology Electives. Students will take six credits from the approved list of Humanities courses, Social Science courses, or Theology courses. Courses may be from the same area or from different areas. See pages 311-312 for Humanities and Social Science courses.

Mathematics/Science Elective. This elective requirement may be met with a course from Biology, Chemistry, Mathematics, Computer Science, Physics, or IDS 205. A list of courses that fulfill the requirement is available in the Chair's Office.

Mechanical Engineering Electives. Twelve credits of mechanical engineering courses are to be selected to provide areas of individual study emphasis. Up to three credits may be substituted for students taking an approved technical concentration outside the College of Engineering. Only three hours of ME 499 course credits may be applied as an ME elective.

Courses which fulfill mechanical engineering elective requirements are indicated with a superscript [m].

Manufacturing Management Minor. This interdisciplinary minor is described on page 238.

Mechanical Engineering Minor. A minor in mechanical engineering is available for students majoring in civil, computer, or electrical engineering. A minimum of 19 credit hours is required. Courses must include GE 109, ME 209, ME 253 or 354, and ME 270. The remaining credits must be from ME courses at the 300 level or above. ECE 460 may be taken in place of ME 444. Civil engineering majors may not use ME 373 for the minor.

MECHANICAL ENGINEERING

See page 50 for the number of credit hours that may be applied toward a degree in the College of Arts and Sciences.

ME 104. Computer-Aided Design.
2.5+1.5, Cr. 3. A course in the theory and technique of engineering graphics related to the design process. Emphasis is placed on orthographic and isometric projections, oblique and section views, and dimensioning and tolerancing. The laboratory focuses on 3-D modeling strategies including line drawings, solid modeling, and parametric modeling using computer-aided design software.

ME 209. Mechanics-Dynamics.
Cr. 3. A study of individual particles and systems of particles in rectilinear and curvilinear motion in two and three dimensions. The course includes motion of a rigid body in translation, rotation, and general plane motion; forces involved in moving systems; use of work and energy relations; and impulse and momentum. Prerequisites: MATH 132 and GE 109.

ME 225. Computational Techniques for Mechanical Engineers.
Cr. 3. Problems in mechanical engineering are solved using numerical methods and MATLAB software. Topics in numerical methods include solution of nonlinear equations, fitting functions to data, integration, differentiation, interpolation of data, solution of ordinary differential equations, and multivariable uncertainty analysis using statistical methods. The graphical capabilities of MATLAB are used to generate engineering plots. The use of MATLAB as a programming language is developed. Corequisite: MATH 234.

ME 252. Materials Science.
2.5+1.5, Cr. 3. (Also offered as PHYS 252.) A study of structure-property-processing relationships of engineering materials related to their selection in design and manufacturing processes. Methods of controlling structure and mechanical properties of materials are studied with an emphasis on the strengthening mechanisms. Processes studied include solidification, phase transformation, and mechanical working of metals. Prerequisite: MATH 132 or MATH 152; corequisite: CHEM 115.

ME 253. Manufacturing Processes.
3+3, Cr. 4. (Also offered as ME 354.) A study of manufacturing emphasizing metal cutting and forming, operation planning, fabrication techniques and inspection. Statistical Process Control (SPC), application of machine tools and Computer Numerical Control (CNC) are introduced. Field trips to industrial facilities are arranged. Prerequisite: ME 104.

ME 270. Thermodynamics I.
Cr. 3. A study of the first and second laws of thermodynamics. Extensive use of these laws is made in analyzing processes and cycles. Additional topics covered are ideal gases, non-reactive gas and gas-vapor mixtures as well as other simple compressible substances. Prerequisites: MATH 132 and PHYS 141.

ME 315. Mechanics of Materials.
Cr. 3. (Also offered as CE 215 and PHYS 215.) Concepts of stress and strain, stress-strain relationships, states of plane stress and strain at a point; elementary analysis of stress distributions and deformations for axial loading of prismatic members, torsional loading of circular shafts and bending of beams, combined loading; plastic elastic action, and an introduction to statically indeterminate problems. Prerequisite: GE 109.

ME 332. Mechatronics.
2.5+1.5, Cr. 3. A study of digital logic design, actuators, sensors and controllers applied to the design of mechanical systems. Emphasis is placed on digital logic design, pneumatic components and circuits, programmable logic controllers, systems-level modeling and systems engineering principles. Prerequisite: ECE 281.

ME 333. Mechanical Measurements Laboratory.
3+3, Cr. 4. (Also offered as PHYS 333.) A study of fundamental concepts and physical principles involved in the science of measurement and design of experiments. Experiments involve calibration and testing (both static and dynamic) of primary elements, signal amplifiers, transducers and readout devices. Experimentation utilizes laboratory and industrial instruments. Extensive use is made of computer data acquisition and analysis. Corequisite: ME 225 or ECE 251; prerequisites: CORE 110, PHYS 142 and ME 270.

ME 354. Manufacturing Processes.
3+3, Cr. 4. (Also offered as ME 253.) See course description for ME 253. Open only to non-mechanical engineering majors in the Manufacturing Management Minor program. Prerequisite: MATH 122 or MATH 131.

ME 362. Mechanisms.
Cr. 3. Graphical and analytical approaches to kinematic analysis and synthesis of linkages, gears and cams. Linkage topics include displacement, velocity and acceleration analysis along with type, number and dimensional synthesis. Fundamentals of gears and gear trains are investigated. Cam sizing and application of motion programs to cam design are considered. Prerequisites: ME 209 and ME 225; corequisite: MATH 253.

ME 373. Fluid Mechanics.
Cr. 3. The basic conservation equations in control volume form are developed and used in engineering applications of fluid motion. Topics include fluid statics and the dynamics of both compressible and incompressible flows. Prerequisite: ME 209.

ME 374. Heat Power Laboratory.
0+3, Cr. 1. Experimental studies designed to reinforce theory presented in the areas of heat transfer, thermodynamics and fluid mechanics. Experiments deal with topics such as flow and heat transfer mechanisms, refrigeration and internal combustion engines. Prerequisites: ME 270, ME 333, and ME 373; corequisite: ME 376.

ME 376. Heat Transfer.
Cr. 3. The fundamentals of heat transfer by conduction, radiation and forced and free convection are developed and applied to engineering problems. Prerequisite: ME 270.

ME 444. Automatic Control.[m]
2.5+1.5, Cr. 3. Fundamentals of instrumentation and control with particular application to the process industries. System dynamics are analyzed using step, ramp and frequency response techniques. Laboratory experiments

involve system stability, controller selection and adjustment, numerical analysis techniques and system sequencing to achieve specific control objectives. Prerequisites: ME 333 and MATH 234.

ME 456. Manufacturing System Design.[m]
Cr. 3. A study of the application of Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), robots, machine vision, Computer Numerical Control (CNC) machine tools, and computers to the design of manufacturing systems, with emphasis on manned and flexible cells. Prerequisite: ME 253 or senior standing in ECE.

ME 457. Product and Production System Design.
2.5+1.5, Cr. 3. (Also offered as ME 458.) Product design/development and production system design are the focus of lectures and a semester-long laboratory experience in which a simple product and its production system are designed and produced. The design, operation, and control of production systems are studied with emphasis on manned and robot cellular manufacturing systems. Open only to non-mechanical engineering majors in the Manufacturing Management Minor program. Prerequisite: ME 253 or ME 354.

ME 458. Product and Production System Design.[m]
2.5+1.5, Cr. 3. (Also offered as ME 457.) See course description above. Prerequisite: ME 253.

ME 462. Vibrations.[m]
2.5+1.5, Cr. 3. Single and multiple degree of freedom systems and continuous media are analyzed with regard to natural frequencies, free, forced and damped vibrations. Practical aspects of vibration isolation, absorption, damping and noise measurement and reduction are considered. Analytical and experimental modal analysis techniques and finite-element analysis are presented. Prerequisites: MATH 234, ME 225, and ME 209.

ME 463. Machine Design I.
2.75+.75, Cr. 3. The application of specialized topics in mechanics of materials to the design and analysis of machine elements. Topics considered include combined stress, contact stress, stress concentration, fatigue, deflection and theories of failure. Stress principles are applied to springs, bolts, joints and general mechanical elements. Prerequisite: ME 315.

ME 464. Machine Design II.[m]
2.75+.75, Cr. 3. A comprehensive study in the design and analysis of belt and chain drives, gearing, gear trains, antifriction and journal bearings. Shaft critical speeds, dynamic balancing and machine dynamics are considered. Prerequisite: senior standing in mechanical engineering.

ME 468. Experimental Stress Analysis.[m]
2.5+1.5, Cr. 3. An introduction to experimental, theoretical, and computational methods for determining stress distributions in structures and machine components. Topics include photomechanics techniques, electrical resistance strain gages, finite-element analysis with a review of stress and strain at a point, and biaxial stress-strain relations. Prerequisite: ME 315.

ME 470. Thermodynamics II.
Cr. 3. Continuation of ME 270. Topics include combustion principles and cycle optimization using the second law of thermodynamics. Prerequisites: ME 270 and CHEM 115.

ME 475. Advanced Thermodynamics.[m]
Cr. 3. The study of advanced topical matter in the thermal sciences. Topics to be determined by instructor prior to course offering. Topics may include compressible fluid flow, computational fluid dynamics, gas turbines, or propulsion. Prerequisites: ME 270, ME 373, and ME 376.

ME 478. Heat Power Design.[m]
2+3, Cr. 3. A design-oriented course using a team approach. Open-ended problems are assigned which involve the synthesis of heat transfer, flow, and energy conversion components. Presentation of oral and written reports is an important part of the course. Prerequisites: ME 270, ME 373 and ME 376.

ME 490. Topics in Mechanical Engineering.[m]
Cr. 1-3. Seven weeks or semester. The investigation of mechanical engineering topics of special interest. Prerequisite: consent of the Chair of the Department. Offered upon sufficient demand.

ME 499. Undergraduate Research in Mechanical Engineering.[m]
Cr. 1-3. Independent study of an advanced topic in mechanical engineering. This course may be repeated for additional credit. Available by invitation only. Prerequisite: approval by the Mechanical Engineering Department.