Academic Offerings

This section contains descriptions of programs, majors, minors, areas of concentration, fields of specialization, and courses. Semesters following course titles indicate when each course is normally offered. On rare occasions, a course may not be available when indicated because of low enrollment or unexpected staffing changes.

Courses listed as Fall Odd and Spring Even are scheduled to be offered during the 2011-2012 academic year. i.e., fall 2011-2012 is Fall Odd, spring 2011-2012 is Spring Even.

Engineering

The mission of the engineering department is based on an awareness of a calling that Christian engineers have as God's covenant people to bring every area of life under the lordship of Christ. Therefore, the Dordt College Engineering Program seeks to provide serviceable insight in the field of engineering from a distinctively Christian perspective; in a manner that demonstrates the unity of creation and rejects the classic polarizations between technical and humanities, vocational and liberal arts, or natural and spiritual; while demonstrating the highest possible quality of undergraduate teaching that we understand to be, most fundamentally, the enabling for Christian discipleship. In harmony with this mission, the general program objectives are as follows:

Religious Orientation: The Dordt College Engineering program seeks to guide students as they develop a Christian worldview, so that graduates of the engineering program will recognize that they are empowered by the spirit of Christ in order to responsibly serve the Creator, fellow humans, and the entire creation through their calling as an engineer.
Creational Structure: The engineering program will seek to provide a cohesive curriculum of diverse courses, so that graduates are prepared for life-long learning in any area of the natural sciences, social sciences, and humanities. The program will also provide students with the passion and competencies necessary for successful service as engineers in either graduate school or industry.
Creational Development: The program and curriculum will highlight the various aspects of human responsibility and involvement in the process of dynamically unfolding the creation. Graduates from the Dordt College Engineering program will reflect a desire to responsibly unfold the potential of creation through science and technology in stewardly ways. Graduates will be able to articulate the historical and philosophical roots and problems associated with Western science and technology, and demonstrate the ability to critically assess how the spirits of the age impact technological direction.
Contemporary Response: The engineering program will enable students to convert their insights and competencies into committed action in service to God and their neighbor. A student of the Dordt Engineering program will acquire the tenacity and perseverance necessary for engineering service. A Dordt engineering graduate will be able to articulate a vision for a community of Kingdom-committed citizens who become a light in the world by developing normative technological models and living normative lives. Graduates will recognize the need for bringing the Gospel of redemptive healing to technology and seek to develop technology in ways that reflect a love that desires the well-being (social, economic, ecological, etc.) of all of God's creatures.

The following specific curricular outcomes serve to facilitate the achievement of the general objectives described above.
1. **Educational Breadth and Worldview Development:** Students will receive a broad based education that educates the whole person for life-long learning and service and enables the engineering student to develop his or her Christian worldview.

2. **Obedience and Responsibility:** Students will be able to articulate a vision for the communal task of building models of normative technology with respect to fiduciary, ethical, juridic, economic, social, lingual, aesthetic, cultural, and analytical aspects of the creation.
3. **Teamwork:** Students will develop an ability to engage in the communal task of engineering by participating in group design projects and other engineering related activities that require professional interaction beyond the classroom.
4. **Problem Solving and Critical Thinking:** Students will develop the capacity for critical thinking and demonstrate an ability to identify, formulate and solve problems.
5. **Communication:** Students will be able to effectively express ideas and information through public speaking, writing, and graphical forms of communication.
6. **Societal and Historical Context:** Students will have an understanding of contemporary issues within the broader context of historical, cultural, and societal development; a knowledge that will help students to know their place and task in the dynamic unfolding of creation in time, what has been called *the cultural mandate.*
7. **Engineering Design:** Students will develop the ability to holistically design systems, components, or processes, giving consideration to the fiduciary, ethical, juridic, economic, social, lingual, aesthetic, formative, and analytical norms for design.
8. **Engineering, Math, and Science Fundamentals:** Students will demonstrate an ability to apply foundational knowledge in mathematics, science, and engineering, and gain an appreciation for the numerical and spatial aspects of the creation.
9. **Engineering Skills and Tools**: Students will have the ability to use the techniques, skills, and modern engineering tools (e.g. computational tools) necessary for professional engineering practice.
10. **Experimental Design and Analysis:** Students will have the ability to design and conduct experiments as well as to analyze and interpret data.

Every student in the engineering major will be assigned an engineering faculty member as his or her academic advisor.

The engineering major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). To earn an ABET accredited Bachelor of Science in Engineering degree, students must successfully complete the major requirements outlined below.

Engineering Major– Foundation: (common to all emphases) Chemistry 103; Mathematics 152, 153, 201, 204; Physics 201, 202; Engineering 103, 104, 202, 220, 299, 310, 379, 380, 390.

Students must select one of the following emphases:

Biomedical: Foundation; Engineering 204, 210, 212, 302, 362; three engineering electives; Biology 201, 202; two biology electives.

Civil and Environmental: Foundation; Engineering 210, 212, 300, 302, 317, 318, 319, 351, 352; Chemistry 104; one math-science elective; one engineering elective.

Computer: Foundation; Engineering 204, 304, 322, 323, 362, 363; Computer Science 110, 112, 202; Computer Science 311 or 305; Mathematics 212; two engineering electives.

Electrical: Foundation; Physics 203; Engineering 204, 304, 322, 323, 360, 362, 363; Computer Science 110; two math-science electives; one engineering elective.

Mechanical: Foundation; Engineering 210, 212, 300, 302, 303, 315, 317, 350, 362; two math-science electives; one engineering elective.

The engineering department provides suggestions and guides for selecting required electives. Students should consult their advisor for elective recommendations. Math-science elective courses can be selected from any of the following disciplines: agriculture, astronomy, biology, biotechnology, chemistry, computer science, earth science, environmental studies, mathematics or physics. Math-science courses required in the emphasis cannot also be used as elective options.

Engineering Science Major–

The engineering science major shares the same mission as the engineering major but puts greater emphasis on basic science and allows more flexibility in course selection. The engineering science major has not been examined nor accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. To earn a Bachelor of Arts degree in engineering science, students must successfully complete the major requirements outlined below.

Engineering Science Major Foundation: (common to all emphases) Chemistry 103; Mathematics 152, 153, 204; Physics 201, 202; Engineering 103, 104, 390.

Students must select one of the following emphases:

General: Foundation; 18 credits of natural science related courses not included in the foundation requirements; 18 additional credits of engineering course electives not included in the foundation requirements.

Agriculture: Foundation; 18 credits of agriculture related courses; 18 additional credits of engineering course electives not included in the foundation requirements.

Architecture: Foundation; Engineering 210, 212, 299, 302, 310, 317; Engineering 303 or 350; one course from Engineering 318, 319, 351, 352; Environmental Studies 151; Art 201, 202, 240; three courses from Art 207, 208, 209, 210.

Biology: Foundation; 18 credits of biology related courses; 18 additional credits of engineering course electives not included in the foundation requirements.

Business: Foundation; 18 credits of business administration or economics related courses; 18 additional credits of engineering course electives not included in the foundation requirements.

Chemistry: Foundation; 18 credits of chemistry related courses not included in the foundation requirements; 18 additional credits of engineering course electives not included in the foundation requirements.

Computer: Foundation; 18 credits of computer science related courses; 18 additional credits of engineering course electives not included in the foundation requirements.

Physics: Foundation; 18 credits of physics related courses not included in the foundation requirements; 18 additional credits of engineering course electives not included in the foundation requirements.

To ensure a coherent course sequence, students must have all the courses in their proposed program of study approved by the engineering department before declaring an Engineering Science major.

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103 Introduction to Engineering (3) .... Fall

An engineering foundations course that introduces students to Christian discipleship as expressed in the field of engineering. Students are exposed to design and analysis concepts in the various engineering sub-disciplines such as civil, electrical, mechanical, and biomedical engineering. Students are given the opportunity to learn about engineering by doing engineering as they participate in a project-based research and design activity. The design studio experience introduces concepts of graphical communication and develops basic skills in the use of a solid modeling software package. The course meets for two lecture periods and one design studio per week.

104 **Introduction to Engineering Design (3)** .... Spring
A continuation of the engineering foundations course that introduces students to Christian discipleship as expressed in the field of engineering. Students are exposed to design and analysis concepts in the various engineering sub-disciplines such as civil, electrical, mechanical, and biomedical engineering. Students are given the opportunity to learn about engineering by doing engineering as they participate in a project-based research and design activity. The design studio experience further develops the use of a solid modeling software in addition to exploring engineering analysis software. The course meets for two lecture periods and one design studio per week.

202 **Elements of Materials Science (4)** .... Spring
Studies the relationship between structure and properties of various materials, including metals, ceramics, polymers, and semiconductors. Students will learn how atomic and molecular arrangements, as well as manufacturing processes, influence the mechanical, electrical, and thermal properties of a material. Introductory topics in metallurgy in this course include the examination of effects of processing (heat treatment and manufacturing) and service environment on microstructure and properties. Laboratory explorations in materials engineering introduce concepts in experimental design and data analysis. Prerequisites: Chemistry 103; Physics 201.

204 **Introduction to Microprocessors and Digital Circuits (4)** .... Spring
Digital circuits are covered, from simple logic gates through elementary microprocessor architecture. The course begins with elementary logic for binary systems, Boolean algebra, binary integer number formats and arithmetic, and combinational design. Intermediate topics include synchronous state machine design and register level concepts. The course concludes with topics in microprocessor architecture that include elementary assembly language and interfacing. Laboratory provides hands-on experience in logic design and microprocessor interfacing and includes two formal design projects. This course serves both computer science and engineering students. Prerequisite: Physics 116 or 202 or Engineering 103.

210 **Statics and Dynamics (4)** .... Fall
A mechanics course that examines the effects of forces and moments applied to rigid and deformable bodies in equilibrium. Students will analyze concentrated and distributed force systems applied to static particles, rigid bodies, trusses, frames, and machines. The course also studies the kinematics and kinetic analysis of particle systems and rigid bodies. Prerequisite: Physics 201.

212 **Mechanics of Materials (4)** .... Spring
A solid mechanics course that examines the stresses, strains, and deformations that develop when various loads (tension, compression, torsion, bending, or any combination of these loads) are applied to deformable bodies. Elements of structural design are introduced using safety factors and failure criteria for ductile materials. The mechanics lab provides hands-on experience applying and using strain gages and investigating beam loading. The mechanics design laboratory provides an introduction to experimental methods in structural analysis and an introduction to finite-element analysis (FEA) software. Prerequisite: Engineering 210.

220 **Linear Circuits and Electronics (4)** .... Fall
Assumes a prerequisite knowledge of DC electrical circuits, including the definitions of electrical quantities, circuit elements (sources, resistors, capacitors, inductors), understanding of Kirchhoff's laws and basic concepts in AC circuits such as frequency and phase. Topics in this course include: general linear circuit analysis including Norton's and Thevenin's theorems; superposition; nodal and loop analysis; natural and forced responses in RLC circuits; and sinusoidal steady state analysis. The course also gives introductions to operational amplifier circuits, single stage BJT transistor circuits, and steady-state balanced 3-phase power calculations. The lab includes a formal design project. Prerequisite: Engineering 104 or Physics 116 or 202; Corequisite: Mathematics 204. [Cross-listed: Physics 206]

281-283 Service-Learning (1-3) .... Fall, Spring, Summer
See page 161, Individual Studies

299 Thermodynamics (3) .... Spring
An introduction to thermodynamic principles, including work, heat, properties of pure substances, the first and second laws, entropy, and thermodynamic relations. Prerequisites: Physics 202; Mathematics 153.

300 Thermal-Environmental Systems (3) .... Fall
Applied engineering thermodynamics. A study of cycles and efficiencies, mixtures and solutions, chemical reactions, combustion thermodynamics, availability analysis, and thermal-fluid systems analysis. A lab-studio component will provide opportunity to complete projects and experimentation relating to combustion, emissions measurement, efficiency assessment, and indoor/outdoor air quality evaluation. Prerequisite: Engineering 299.

302 Fluid Mechanics and Hydraulics (4) .... Fall
A comprehensive, introductory course in fluid mechanics covering: hydrostatics; control volume approach to the continuity, momentum, and energy equations; dimensional analysis, similitude, and modeling; introductory boundary layer theory; fluid drag and lift; flow through conduits, pumps and compressors; and hydraulics and open channel flow. All students participate in team design projects involving design of water supply or sewage removal piping systems. The fluid systems and hydraulics laboratory will emphasize experimental design, technical communication skills, and report writing. Prerequisites: Physics 202; Mathematics 204.

303 Heat Transfer (4) .... Spring Odd
Studies of the three modes of heat transfer (conduction, convection, and radiation) with application to heat exchangers. Computer methods are used extensively for heat transfer design and analysis. A formal heat exchanger design project is included in this course. The thermo-systems and heat transfer laboratory will emphasize experimental design, technical communication skills, and report writing. Prerequisite: Engineering 302.

304 Embedded Microcontroller Systems (4) .... Spring
A course on the design of microcontroller-based systems and the associated software and hardware. Software issues such as modular design, interrupt-driven I/O, and design for reliability are covered. Hardware issues such as serial and parallel interfacing, bus structures, grounding and shielding, and D/A and A/D conversions are also studied. Lab exercises provide design experience using a particular microcontroller or a soft-processor foundation in an FPGA. Prerequisites: Engineering 204, 220; Computer Science 110 or 111; or by permission of instructor.

310 History of Science and Technology (3) .... Spring
Enables the student to examine from a Reformed, biblical perspective the narrative of scientific unfolding and technological development as two human activities that are manifest in all cultures. Emphasis is on the major paradigms and events that have shaped the development of science and technology in the West and most recently in North America. The course focuses on the historical activity of engineers and artisans, while investigating the interrelationship between scientific thought and technological development. Events and ideas such as the philosophical origins of Western science, the Copernican revolution, Enlightenment rationalism, the industrial revolutions, 20th century positivism, the Einsteinian revolution, and the modern systemization ethic are discussed. Prerequisites: CORE 140, 145, 200. [Cross-listed: CORE 312]

315 Machine Kinematics and Design (4) .... Spring Even
This senior-level design course focuses on the analysis and design of mechanisms and machine elements. In the first half of the course, students will analyze the motion of various mechanisms, such as slider cranks, gear trains, and cams. The second half of the course explores failure criteria for static and dynamic loading of machine elements. The design and integration of elements such as shafts, bearings, gears, springs, fasteners, clutches, and brakes will be addressed. Open-ended mechanical design projects will be the focus of the design studio component. Familiarity with computer software capable of solving iterative design problems is required. Prerequisites: Engineering 210, 212.

317 Structural Analysis (3) .... Fall
A study of the analysis and design of beams, trusses, and framed structures. Students will consider loads, shear, mo-

ment, and deflected shape diagrams. Deformation calculations, approximate methods, flexibility methods, moment distribution, and stiffness methods for analysis of continuous beams and frames will be considered. Influence lines for determinate and indeterminate beams will be introduced. Prerequisite: Engineering 212.

318 **Soil Mechanics and Foundation Design (4)** .... Fall
A study of the engineering principles relating to soil properties and foundation design. The material properties of soil including structure, index properties, permeability, compressibility, and consolidation will be explored. Methods of soil testing, identification, and remediation will be covered. Principles of settlement and stresses in soils will be considered. Slope stability, retaining walls, and bearing capacity of shallow foundations will be introduced. The soils lab will provide hands-on opportunities to determine water content, perform sieve analyses, and test liquid, plastic, and shrinkage limits. Soil classification, compaction, compression, and consolidation testing will be explored. Prerequisite: Engineering 212 or Construction Management 214. [Cross-listed: Construction Management 318]

319 **Environmental Engineering (3)** .... Spring Even
An introduction to water supply and wastewater treatment, solid waste management, hazardous waste disposal, pollution control equipment, and other topics relating to the engineer's role for ensuring clean air and providing clean water to communities. Methods and equipment for monitoring and testing air and water quality will be examined. Prerequisites: Chemistry 103; Mathematics 204.

322 **Electronics I (4)** .... Fall Even
A study of the flow of electricity in, and application of, semiconductor devices. Topics include basic signals and amplifier characteristics, operational amplifiers models and applications, diodes and applications, field effect transistors, bipolar junction transistors, and methods of amplification with single-transistor circuits. The laboratory includes a number of short design problems. Prerequisite: Engineering 220.

323 **Electronics II (4)** .... Spring Odd
A continuation of Engineering 322. Topics include biasing strategies for discrete and integrated circuit designs, current mirrors, differential and multistage amplifiers, frequency response, feedback, and stability. The laboratory includes construction of a kit, which introduces students to power output stages, tuned amplifiers, and demodulator circuits. The laboratory also includes a short design problem. Prerequisite: Engineering 322.

326 **Electromagnetic Theory (4)** .... Spring Odd
Review of vector calculus; divergence, curl, Gauss' and Stoke's theorems; electro- and magneto-statics; polarization; boundary conditions; Laplace and Poisson equations; magnetic vector potential; energy; Maxwell's equations for time varying fields; wave propagation; and Poynting's theorem. Prerequisites: Physics 203; Mathematics 201, 204. [Cross-listed: Physics 326]

341- **Special Topics in Engineering (3)** .... Occasional
348 Elective courses designed to treat particular topics in more detail than would be done in any of the above courses. Topics will depend on the mutual interest of students and staff.

350 **Sustainable Energy Systems Design (3)** .... Fall
A senior-level design course that focuses on designing for energy systems for conservation, sustainability, and efficiency. The course focuses on solar and renewable energy technologies for meeting residential, commercial, and industrial energy needs. An emphasis is placed on understanding energy utilization in buildings and the design of heating, ventilating, and air-conditioning systems. Topics of psychrometrics and indoor air quality will be addressed. Methods of auditing building energy loads and design principles of energy conservation are addressed. A variety of computer tools will be used extensively for system analysis. The laboratory and design studio component will involve community service projects and design projects relating to energy utilization and conservation. Prerequisites: Engineering 300, 302.

351 **Reinforced Concrete Design (3)** .... Spring Even

Analysis and design of reinforced concrete beams, columns, one-way slabs, and frames. The design of members for axial load, flexure, shear, deflections, bond, and anchorage will be considered. Design will be based primarily on ACI strength design methods. Prerequisite: Engineering 202, 317.

352 **Structural Steel Design (3)** .... Spring Odd
A study of design and behavior of steel members and structures. The design of steel beams, columns, tension members, frames, trusses, and simple connections will be considered. Design will be based primarily on AISC specifications and manuals related to the load and resistance factor design method. Allowable stress design will be introduced. Prerequisites: Engineering 202, 317.

357 **Bioengineering (3)** .... Spring Odd
A study of the fundamental mass and energy transfer, sensory signals, and structural properties related to human physiology. Mathematical models for biological processes will be developed and applied to the design of health monitors, medical sensors, and prosthetic devices. The course will cover a broad range of biomechanical, bioelectrical, and biochemical topics as they relate to biomedical engineering applications. Prerequisites: Engineering 212, 220, 302.

360 **Introduction to Power System Analysis (4)** .... Fall Odd
An introduction to the design, planning, and operation of electric power utilities. Includes principles of economic dispatch and politics that impact design and operating strategies. Topics include power transmission lines, transformers, generators, system modeling, load flow analysis, faults, and system stability. Prerequisites: Engineering 220; Mathematics 201.

362 **Dynamic Systems and Process Control (4)** .... Fall
A study of the dynamics and automatic control of systems. Topics include dynamic system modeling, feedback, steady-state operation, transient response, root loci, state-space representation, frequency response, stability criteria, and compensation. A variety of system types are modeled and analyzed, including mechanical, electrical, hydraulic, pneumatic, thermal, and chemical systems. Structured modeling approaches using Laplace transform methods and state equations are explored. Design studio sessions provide an introduction to instrumentation and provide hands-on opportunities to apply controls theory. Prerequisites: Engineering 220; Mathematics 204; Physics 202.

363 **Introduction to Communication Systems (4)** .... Spring Even
A study of analog and digital communication systems performance and theory with applications in radio, satellite, telephone, computer networking, and radar systems. Topics include linear modulation (AM, SSB, etc.), exponential modulation (FM and PM), sampling theory, the discrete-time and discrete-frequency domains, and basic digital modulation methods such as *m*-ary PSK, DPSK, OFDM, etc. The topic of noise is considered at the most elementary level sufficient to distinguish the performance of various modulation methods in the presence of noise. Prerequisite: Engineering 220.

371-373 **Engineering Internship (3-9)** .... Fall, Spring, Summer
An off-campus experience that is intended to provide the engineering major with an opportunity to apply knowledge, principles, and skills gained in the classroom in an engineering workplace environment. Written and oral summary reports by participants bring reflection on the technical experience into subsequent classes. Graded on a pass/fail basis. Prerequisite: completion of six engineering courses or junior standing in the engineering program.

379 **Senior Design I (1)** .... Fall
The first of two project courses providing students with the opportunity to use, in an integrated manner, the knowledge and skills that have been acquired to this point in their education. This laboratory course is devoted entirely to the research, planning, analysis, and report writing required in the first phase of the senior design project. Students work in teams of two or three on a project of their mutual interest. Prerequisites: Engineering 302 or 304; senior standing.

380 **Senior Design II (4)** .... Spring
The second course devoted to senior design project activities. In-class topics will include general topics relating to

engineering design, such as engineering economics, technical writing, design aesthetics, project planning, engineering statistics, technical literature research, safety, and ergonomics. The lab portion of the course requires students to complete the design, experimentation, analysis, and communication components of their project. Work on the project, while culminating in this course, starts in Engineering 379 the previous semester. Teams confer weekly with members of the engineering department staff. Prerequisite: Engineering 379.

390 Technology and Society (3)..........Spring
An examination and critique of the relationship of technology to other areas of Western society. During the first half of the course students examine a Christian philosophy of technology and application is made to such problems as the role of the computer, technocracy, appropriate technology, and the historical two-cultures dualism. During its second half, the course focuses on the question of engineering ethics, with particular emphasis on such questions as safety and risk, professional responsibility and authority, whistle blowing, normative socio-economic structures, and morality in career choice. This course requires the student to write and orally present a significant research paper and to work in a small group on the design of one aspect of a technological business enterprise. Prerequisites: CORE 200; junior or senior standing. [Cross-listed: Computer Science 390, CORE 267]

391-393 Individual Studies (1-3) ....Fall, Spring, Summer
See page 161, Individual Studies