DEPARTMENT OF ENGINEERING
COLLEGE OF ARTS AND SCIENCES

Faculty

Jeannette Herring Russ (2002). Professor of Engineering and Department Chair. B.S., Mississippi State University; M.B.A., Colorado State University; Ph.D., Vanderbilt University; P.E.

Don Van (2001). Professor of Engineering and Director of Accreditation. B.S. and M.S., University of Illinois in Chicago; M.S. and Ph.D., New Jersey Institute of Technology; P.E., CEM.

Jay Bernheisel (2006). Professor of Engineering. B.S.M.E. and M.S.M.E., Rose-Hulman Institute of Technology; Ph.D., Northwestern University; P.E.

Georg Pingen (2010). Professor of Engineering. B.A., Samford University; B.S. and M.S., Washington University; Ph.D., University of Colorado at Boulder; P.E.

Randal S. Schwindt (2004). Professor of Engineering. B.S., Hardin-Simmons University; M.S., Texas A&M University; Ph.D., University of Illinois at Urbana-Champaign; P.E.

Staff


Ethan Wilding (2015). Lab Systems Engineer. B.S., University of Memphis; B.S.E., Union University; M.S., University of Tennessee.

Objectives

1. Graduates will make contributions through engineering practice, graduate school, or other professional pursuits.
2. Graduates will solve problems through inventive thinking.
3. Graduates will participate in continuing education.
4. Graduates will exemplify Christian principles and ethical standards.

Curriculum

Union offers the Bachelor of Science in Engineering, BSE, with concentrations in electrical and mechanical engineering. The curriculum is designed to expose students to a broad base of engineering knowledge and the basic science and math upon which that knowledge rests. In addition, the curriculum at Union includes a strong general education component that provides a greater understanding of the world in which engineering products will ultimately be used.

Because engineering courses build upon one another, the prerequisite sequences that exist in the curriculum must be closely followed. Incoming freshmen will ideally be ready to begin the calculus sequence in their first semester in order to satisfy the various prerequisites and complete the degree in four years.

The engineering major must complete all General Core Requirements to include CHE 111 and MAT 211. The major must also complete the BSE Specific Core comprised of MAT 212, 213, 314 (11 hours); MAT 208 or 315 (3); CSC 255 (3) or CHE 113 (2) plus at least 1 hr. of EGR Elective and PHY 231-32 (10).

The student with an acceptable bachelor's degree seeking the BSE as his second baccalaureate will complete CHE 111, MAT 211 and the BSE Specific Core as prerequisites to the major as well the major requirements described below.

The minor in engineering will benefit non-engineering students who are interested in applied science or fields that involve instrumentation and technology. It can also be useful for students who intend to pursue graduate work in related disciplines not offered at Union.

The minor in computational engineering science will benefit science, engineering, and mathematics students who are interested in the intersection of these three fields. It combines Union's existing strengths in these disciplines to offer an innovative program of study that introduces students to the field of computational modeling and simulations.

The Union BSE program is accredited by the EAC Accreditation Commission of ABET, www.abet.org. Accreditation is a consideration for professional licensure in many states and for admission to some engineering graduate schools. ABET does not accredit minors.

I. Major in Engineering—61 hours
A. Major core requirements—47 hours + a Concentration
   1. EGR 101, 105, 109, 210, 240, 261, 262
   2. EGR 330, 342, 360, 375, 391
   3. EGR 475, 491, 492, 498
B. Mechanical Engineering Concentration—14 hours
   1. EGR 320, 352, 355
   2. EGR 455, 456
C. Electrical Engineering Concentration—14 hours
   1. EGR 361, 365
   2. EGR 405, UL EEC Elective

II. Minor in Engineering—18 hours
EGR coursework to exclude EGR 391, 491, 492, and 498 (must include 6 upper level hours).

III. Minor in Computational Engineering Science—18 hours
A. EGR 109, 209, 325
B. CSC 255, 329
C. MAT 315, 360
D. If a student has taken all required courses but needs additional credits for the minor as the courses above count toward other degrees, students can (with advisor approval) count any other math, science, computer science, or engineering course that does not already fulfill a major/minor degree requirement.
Major in Engineering with Discipline-specific Honors

The discipline-specific honors program in engineering offers students an opportunity to go beyond the basic curriculum through taking engineering contract courses with expanded requirements, completing an original honors project, and attending colloquia sponsored by the Honors Community. Specific program requirements are outlined below, and additional details can be found on the engineering website.

Application Requirements

• At least three full semesters, preferably four, must remain before graduation.
• The applicant must first meet with the Chair of the Engineering Department. If approval to proceed is granted at the departmental level, the student must submit an application to the Office of the Director of the Honors Community.

Admission Requirements

• Students must have a cumulative GPA of at least 3.5, as well as a GPA of at least 3.5 in engineering courses.
• Students must have completed at least ten credit hours of sophomore-level engineering courses. Transfer students must have completed at least two engineering courses at Union.

Progression Requirements

• Students must maintain a GPA of 3.5 overall and in engineering courses.
• Students must complete each honors contract course with a grade of B or better and achieve satisfactory completion of the honors contract for each course.

Curriculum Requirements

• Students must take at least 12 credits of honors contract courses.
  – For electrical engineering concentration students, typical honors contract courses include EGR 361 (4 credits), EGR 405 (4 credits), EGR 475 (4 credits), and EGR 498 (1 credit).
  – For mechanical engineering concentration students, typical honors contract courses include EGR 320 (3 credits), EGR 355 (4 credits), EGR 475 (4 credits), and EGR 498 (1 credit).
• Students must complete an honors project that is distinctly different from the senior design project. The honors project will be either a research project or a humanitarian engineering design project, with specific requirements to be determined in conjunction with the student’s departmental honors advisor. It is expected that a typical honors project will require roughly 250-300 hours of work.
• Students in their junior and senior years must satisfy Honors colloquium requirements as determined and published by the directors of the Honors Community.

Assessment of Majors

Assessment of majors culminates with the Fundamentals in Engineering (FE) exam taken during the senior year. The test, prepared by the National Council of Examiners for Engineering and Surveying, is administered by the State of Tennessee as the first step toward becoming a licensed professional engineer.

Student Award

The Service through Engineering Award is given by the faculty of the Department of Engineering to the senior who best exemplifies the use of engineering knowledge in service to society.

Course Offerings in Engineering (EGR)

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>101. Introduction to Engineering Design and Analysis</td>
<td>2</td>
<td>F, W, S</td>
</tr>
<tr>
<td>Provides an overview of the engineering profession, including technical and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>legal responsibilities, the design and analysis method, and application of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the engineering process to problem solving.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>105. Solid Modeling</td>
<td>3</td>
<td>F</td>
</tr>
<tr>
<td>Graphical communication methods through one of the widely used software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>packages–ProE; covers 2-D projections and views, 3-D surface and solid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>modeling, and general concepts such as object dimensions and tolerances.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>109. Introduction to Matlab and Computer Programming</td>
<td>2</td>
<td>S</td>
</tr>
<tr>
<td>Pre- or Corequisite: MAT 211.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduces computer programming using Matlab as a high-level programming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>language and as an engineering computational tool. Includes general</td>
<td></td>
<td></td>
</tr>
<tr>
<td>computer programming principles and structures and the unique features of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matlab, such as vector and matrix operations, with application to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>engineering.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>209. Survey of Computational Engineering</td>
<td>1</td>
<td>S—Odd Years</td>
</tr>
<tr>
<td>Using tutorials, an introductory exposure to the broad analysis and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>optimization capabilities offered by modern engineering software packages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>will be provided. In particular, structural and thermal simulation and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>optimization will be explored with Creo Simulate and structural, thermal,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fluid, and multi-physics simulations will be explored with COMSOL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiphysics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>210. Materials Engineering</td>
<td>3</td>
<td>S</td>
</tr>
<tr>
<td>Prerequisites: CHE 111, PHY 231.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examines the structure of material at the atomic level, including how</td>
<td></td>
<td></td>
</tr>
<tr>
<td>physical, thermal, and mechanical properties affect the behavior of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>materials.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
240. Mechanical Engineering Fundamentals I: Mechanics (3) F
Prerequisites: MAT 212; PHY 231.
Introduces vector analysis of forces and torques. Examines rigid bodies and determinate structures at equilibrium. Covers kinematics of a particle and of a rigid body. Presents kinetic analysis using force-acceleration, work-energy, and impulse-momentum techniques.

250. Mechanical Engineering Fundamentals II: Thermo-fluid Dynamics I (4) S
Prerequisite: PHY 232; Pre- or Corequisites: EGR 109; MAT 314.
Introduces macroscopic concepts of thermodynamics, including first and second laws, properties of a pure substance, and energy analysis; also introduces hydrostatics and fluid dynamics, including pressure distribution, relations for fluid particles, and development of conservation theorems. Includes weekly lab.

261. Electrical Engineering Fundamentals I: Digital Logic (3) F
Basic principles of logic design, including Boolean algebra, number systems, combinational and sequential logic, and programmable logic devices. Introduces computer simulation techniques for logic circuits. Credit toward the engineering major or minor will not be granted for both EGR 261 and CSC 160.

262. Electrical Engineering Fundamentals II: Electric and Electronic Circuits (4) S
Prerequisites: PHY 232; MAT 212; Pre- or Corequisite: EGR 109.
Fundamental concepts of circuits and electronics, including basic concepts, theorems, and laws of dc and ac circuits. Introduces power sources, passive circuit devices, op amps, and selected semiconductor devices. Includes weekly lab.

320. Mechanics of Materials (3) S
Prerequisites: EGR 210, 240; MAT 314.
The relationship between internal stresses and changes of form produced by external forces acting on solid bodies; also covers normal and shear stresses, strain, elasticity and plasticity, deformations, and loading.

325. Computational Analysis of Structures – Finite Element Methods (3) S – Even Years
Pre-requisites: EGR 109, MAT 212
Finite element methods will be introduced as a means to solve physical phenomena governed by partial differential equations through 1-D and 2-D examples from structural analysis, which will be implemented in Matlab, providing students with a “behind-the-scenes” glimpse of Computational Engineering. Further, this course will explore the most common mistakes made by users of Finite Element Methods in order to teach students how to recognize and avoid those mistakes.

330. Engineering Economy (3) S
Prerequisite: 7 EGR credit hours at the 200 level.
Presents basic principles of economic analysis related specifically to the realm of engineering; covers methods of developing engineering alternatives to capital investment projects using economic and financial principles.

342. Engineering Experimental Methods (3) F
Prerequisite: 7 EGR credit hours at the 200 level.
Teaches computer-based tools for engineering data analysis and experimental design; includes probability, statistical analysis, measurement errors, and graphical presentation methods.

352. Mechanical Engineering Laboratory (1) S
Prerequisite: EGR 342.
Demonstrates laboratory experimentation as a design and modeling tool. Emphasizes design of experiments and communicating engineering results. Includes planning, executing, and reporting on an area chosen by the students.

355. Thermo-fluid Dynamics II (4) F
Prerequisites: EGR 250; MAT 314.
Covers the 2nd law of thermodynamics, reversible/irreversible processes, entropy, steady-state devices, power and refrigeration cycles, conduction, convection, and radiation heat transfer, as well as an application of the Navier-Stokes equations to internal and external viscous fluid flows. Includes weekly lab.

360. Modeling and Analysis of Linear and Dynamical Systems (3) F
Prerequisites: EGR 240, 262; MAT 314.
Presents analysis of linear time-invariant (LTI) systems using time-domain and frequency-domain techniques. Electrical and mechanical system dynamics are characterized and modeled using differential equations, impulse response, and Laplace and Fourier techniques. Includes extensive use of Matlab.

361. Digital Electronics (4) S
Prerequisite: EGR 261 or CSC 160
Design and simulation techniques for digital systems, including optimal state assignment and state reduction for sequential circuits, circuit fault analysis, and higher level conceptual modeling. Covers system level topics such as computer organization and design test techniques. Includes weekly lab.

365. Electromagnetics (3) F
Prerequisites: EGR 262, MAT 314
An introduction to engineering applications of electric and magnetic fields through the solution of Maxwell’s equations in free space and in materials subject to various boundary conditions. Topics include transmission lines, transmission line circuits, the wave equation, wave propagation in unbounded regions, wave reflection and transmission, and antennas.

375. Power Systems and Electrical Machines (3) F
Prerequisite: EGR 262.
Introduces the basic principles of power systems and electrical machines with an emphasis on 3-phase power, theory of machinery, and principles of machine operation. Topics include transformers, electro-mechanics, synchronous machines, induction motors, and DC motors and system-level topics such as power flow, faulty analysis, and economic operation.
405. Electronic Circuit Analysis and Design (4) F
Prerequisite: EGR 262.
Introduces fundamental principles of electronics, including
analysis and design techniques for circuits containing diodes,
field effect transistors, and bipolar junction transistors.
Includes weekly lab.

416. Physical Principles of Solid State Devices (3) S
Prerequisites: EGR 262; MAT 314.
Introduces concepts in material science and quantum physics,
including modern theory of solids, magnetic and optical
properties of materials, semi-conductors and semi-conductor
device, dielectric materials, and superconductivity.

455. Energy Conversion (3) S
Pre- or Corequisite: EGR 355.
Provides a comprehensive analysis of current energy systems,
including fossil power plants, nuclear plants, and other forms
of renewable energy sources; covers the Rankine cycle, steam
generators, combustion, and turbines; presents information on
the environmental impact of energy generation.

456. Machine and Mechanism Theory and Design (3) F
Prerequisite: EGR 360.
Covers design, selection, and evaluation of mechanisms for
various applications, including planar and spatial linkages,
cams, gears, planetary and non-planetary gear systems, linkage
synthesis, and linkage dynamics.

470. Heat Transfer (3) As Needed
Prerequisite: EGR 355.
The analysis of various heat transfer modes, including
conduction, natural and forced convection, and radiation;
introduces industrial applications of heat transfer such as heat
exchangers, waste heat recovery, and steam generators in a
nuclear plant or in a gas turbine electrical generator.

475. Control Theory and Design (4) S
Prerequisite: EGR 360.
Introduces analysis and design of linear control systems using
root locus and frequency response techniques; includes system
representation and control system characteristics. Includes weekly lab.

491. Major Project Design I (2) F
Prerequisite: 30 EGR credit hours and EGR 391.
Allows a student to work individually on a real-world
engineering problem assigned by either the instructor or a
sponsoring industry; requires the student to solve the problem
by applying the engineering design and analysis method;
involves oral and written presentations, where the written
presentation is in the form of a design portfolio that documents
a full engineering study of the project. This course must be
taken the last full academic year in the program.

492. Major Project Design II (3) S
Prerequisite: EGR 491.
 Allows a team of students to work on a real-world engineering
problem assigned by either the instructor or a sponsoring
industry; requires the student to solve the problem by
team effort via project management; involves oral written
presentations, where the written presentation is in the form
required for EGR 491. The oral presentation will be a publicly
announced event. This course must be taken the last full academic
year in the program.

498. Engineering Seminar (1) S
Prerequisite: 30 EGR credit hours.
Provides an opportunity for students to discuss professional
ethics and Christian conduct as engineers through case studies.
Includes also presentations by engineers from local industry on
current topics. This course must be taken the last full academic
year in the program.

499. Seminar (1-3) As Needed
To be used at the discretion of the department.

179-279-379-479. External Domestic Study Programs (1-3)
As Needed
All courses and their applications must be defined and
approved prior to registering.

179PF-279PF-379PF-479PF. External Domestic Study
Programs (Pass/Fail) As Needed
All courses and their applications must be defined and
approved prior to registering.

180-280-380-480. Study Abroad (1-4)
All courses and their application must be defined and approved
prior to travel.

180PF-280PF-380PF-480PF. Study Abroad Programs
(Pass/Fail) As Needed
All courses and their applications must be defined and
approved prior to travel.

195-6-7. Special Studies (1-4)
281-82-83. Cooperative Education I, II, III (Pass/Fail) As Needed
Offers students an opportunity to obtain a semester (or sec-
ond or third semester) of fulltime industrial experience while
still an undergraduate; allows students to participate in the
established program through which academic institutions
partner with engineering companies to provide students with
supervised, educational work experiences.

295-6-7. Special Studies (1-4)
Lower-level group studies which do not appear in the regular
department offerings.

395. Special Studies (3)
Upper-level group studies applicable to electrical engineering
which do not appear in the regular department offerings.

396-7. Special Studies (1-4)
Upper-level group studies which do not appear in the regular
department offerings.

495-6-7. Independent Study (1-4)
Individual research under the guidance of a faculty member.