# Mechanical Engineering, B.S.

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# About

- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Mechanical Engineering, Honors

Mechanical Engineers apply the principles of solid mechanics, thermal fluid sciences, dynamics and control, material science and manufacturing science to the analysis and design of systems of all types. In applying this technical knowledge to fields such as energy systems, nanomanufacturing and robotics, the mechanical engineer must consider economic constraints and the social and ecological implications of solutions imposed. The mechanical engineering curriculum offers the student an opportunity to pursue educational objectives within the framework of this broad theme.

## Mission Statement

We are committed to providing a rigorous educational experience in the discipline of mechanical engineering, graduating well-rounded leaders and life-long learners, who aspire to achieving professional excellence. We are *equally* committed to the discovery, dissemination, advancement and application of cutting-edge research. Inspired by the Augustinian tradition, we value an inclusive and diverse community in which we prepare our students to demonstrate the highest ethical conduct and contribute to the well-being of humankind.

## Program Educational Objectives

Our graduates will:

- Be valued members of their organizations because of their skills and abilities as mechanical engineers;
- Solve complex technical problems and/or design systems that are useful to society by applying the fundamental scientific principles that underpin the mechanical engineering profession;
- Advance in their chosen career paths by utilizing technical, leadership, communication, and interpersonal skills, with the highest ethical standards;
- Apply their knowledge and skills to successfully practice professions of their choice;
- Demonstrate professional and personal growth by pursuing or successfully completing an advanced degree, professional development courses, and/or engineering certification;
- Be actively engaged in service to their professions and communities, consistent with the tradition of St. Augustine.

The first year of the mechanical engineering program is devoted to laying a foundation of mathematics, physical science, and the general engineering sciences. The final three years are devoted primarily to mechanical engineering topics. The required courses span the field of mechanical engineering, and electives provide the opportunity to pursue specific areas of mechanical engineering in greater depth through technical concentrations which include Mechanics and Materials, Thermal/Fluid Systems, and Dynamic Systems. A student opting for a technical concentration will first take an elective in the junior year which corresponds to their selected technical concentration. Each student will then customize the

program of study by choosing four courses (12 credit hours) of technical electives in the senior year. To complete the technical concentration, two of these mechanical engineering technical electives must be selected from the designated set of concentration classes. In addition, the student must take the senior laboratory course from their technical concentration. A student who completes a technical concentration will have the concentration indicated on the final transcript. Students who do not opt for a concentration will still take a junior year restricted elective and a senior lab; the four senior year mechanical engineering electives can be chosen freely from all offerings.

The engineering design process is emphasized throughout the program and culminates with a senior year project that requires a synthesis of basic principles learned in previous courses.

Throughout the curriculum the technical courses are balanced by a careful selection of humanities courses to ensure that the effects of technology on society are given due consideration in design.

A faculty advisor is assigned to each student at the beginning of their first-year to provide academic and career guidance for the remainder of the student's years in the program until graduation. The advisor should be consulted regarding such topics as electives, minors or concentrations, graduate studies, undergraduate research, and completion of degree requirements for graduation.

**Program:** Engineering
**Type:** Bachelor of Science

# Freshman Year

**First Semester**

| Course | Title | Credits |
|---|---|---|
| ACS 1000 | Ancients | 3 |
| THL 1000 | Faith, Reason, and Culture | 3 |
| CHM 1103 | General Chemistry Lab I | 1 |
| CHM 1151 | General Chemistry I | 4 |
| MAT 1500 | Calculus I | 4 |
| EGR 1200 | Engineering Design Cornerstone | 3 |
| EGR 1001 | Career Compass IA | 0.5 |

**Second Semester**

| Course | Title | Credits |
|---|---|---|
| ACS 1001 | Moderns | 3 |
| MAT 1505 | Calculus II | 4 |
| PHY 2400 | Physics I Mechanics | 3 |
| ME 1201 | Intro to Comp Aid Design&Draft | 1 |
| ME 1205 | Computer Program for Mech Engr | 3 |
| | Elective | 3 |
| EGR 1002 | Career Compass IB | 0.5 |

# Sophomore Year

**First Semester**

| Course | Title | Credits |
|---|---|---|
| MAT 2500 | Calculus III | 4 |
| ME 2100 | Statics | 3 |
| ME 2505 | M.E. Analysis & Design | 4 |
| PHY 2402 | Physics II Elec & Magnet | 3 |
| PHY 2403 | Phy Lab for Engineering | 1 |
| EGR 2003 | Career Compass IIA | 0.5 |

**Second Semester**

| Course | Title | Credits |
|---|---|---|
| MAT 2705 | Diff Equation with Linear Alg | 4 |
| ME 2900 | ME Laboratory I | 1 |
| ME 3100 | Thermodynamics | 3 |
| ME 2103 | Mechanics of Materials | 3 |
| ME 2101 | Dynamic Systems I | 3 |
| COM 1102 | COM Foundations for Engrs | 3 |
| EGR 2004 | Career Compass IIB | 0.5 |

# Junior Year

**First Semester**

| Course | Title | Credits |
|---|---|---|
| ECE 2030 | Electric Circuits Fundamentals | 3 |
| ECE 2031 | Elect Circuit Fundamentals Lab | 1 |
| ME 3102 | Dynamic Systems II | 3 |
| ME 3402 | Solid Mechanics & Design I | 3 |
| ME 3600 | Fluid Mechanics | 3 |
| ME 3950 | Heat Transfer I | 3 |
| EGR 3005 | Career Compass IIIA | 0.5 |

**Second Semester**

| Course | Title | Credits |
|---|---|---|
| ME 3300 | Materials Science I | 3 |
| ME 3333 | Manufacturing Engineering | 3 |
| ME 3900 | ME Laboratory II | 1 |
|  | Elective - Restricted ME | 3 |
|  | Elective | 3 |
|  | Elective | 3 |
| EGR 3006 | Career Compass IIIB | 0.5 |

# Senior Year

**First Semester**

| Course | Title | Credits |
|---|---|---|
| ME 5005 | Capstone Design I | 2 |
| | Elective - ME/Concentration | 3 |
| | Elective - Career/ME | 3 |
| | Elective - Restricted ME Lab | 1 |
| | Elective | 3 |
| | Elective | 3 |

**Second Semester**

| Course | Title | Credits |
|---|---|---|
| ME 5006 | Capstone Design II | 2 |
| | Elective - ME/Concentration | 3 |
| | Elective - Career/ME | 3 |
| | Elective | 3 |
| | Elective | 3 |

# Category Descriptions

## Elective

Credits: 3

Electives are subject to change. Electives may be added to this list at the discretion of the College of Engineering.

Select one course from each of the elective groups below.

# One Theology or Philosophy Elective

Select one theology or philosophy course (3 or more credits) from the list below:

- Theology (THL) course or course with CTHL (Core Theology) attribute, at the 2000 level or above
- Philosophy (PHI)
- Peace and Justice (PJ)
- ETH 2050 - The Good Life: Ethics & Cont Prob
- EGR 2930 - Catholic Social Teaching for EGRs
- Any Humanities or Social Science course with a PJ (Peace and Justice) attribute

# One Upper Level Theology Elective

Select one upper level theology course (3 or more credits) from the list below:

- Theology (THL) course at the 2000 level or above
- Course with CTHL (Core Theology) attribute at the 2000 level or above

# One Humanities and Social Science Elective

Select one humanities or social science course (3 or more credits) from the list below:

## Humanities:

- Arab & Islamic Studies
- Art History
- Classical Studies
- Communications
- Ethics
- English - ENG 1050, 1975, 2100-9999
- Global Interdisciplinary Studies
- History
- Honors Program (eligible students only)
- Humanities
- Modern Languages (except speaking courses in native language)
- Philosophy
- Theatre
- Theology (2000 and above or course section with CTHL Core Theology attribute)

## Social Sciences:

- Criminology
- Economics
- Geography and the Environment - GEV 1002, 1500-3900, 4050-5300
- Humanities: HUM designated PSC
- Peace and Justice
- Political Science
- Public Administration
- Psychology
- Sociology
- Gender and Women's Studies

# One Science Elective

Select one science course (3 or more credits) from the list below:

- BIO >1200
- CHM >1151
- AST >2000
- PHY >2415

# One Ethics Elective

Any (3-credit) ETH > 2000 course from ethics department, or any course with Ethics (ETH) attribute, or an ethics course from the students minor (including NS 4200 & VSB 2007), or a course from other departments with a focus on ethical issues such as EGR 2001 and those with the word ethics in the title.

# One Statistics Elective

| Course | Title | Credits |
|---|---|---|
| STAT 4310 | Stat Methods | 3 |
| STAT 5700 | Probability | 3 |

# One Free Elective

Any three- or more credit course or any combination of one- and two-credit courses (adding up to three credits or more) from Villanova University.

## Elective - Restricted ME

Credits: 3

Electives are subject to change. Electives may be added to this list at the discretion of the College of Engineering.

If a concentration is chosen, students must take the appropriate courses in their concentration, including the below:

- Restricted ME Elective
- Restricted ME Lab
- Six credits from the approved list of courses for the concentration

| Course | Title | Credits |
|---|---|---|
| ME 3103 | Dynamic Systems III | 3 |
| ME 3403 | Solid Mechanics & Design II | 3 |
| ME 4850 | Thermal-Fluid System Design | 3 |

## Elective - ME/Concentration

Credits: 3

Electives are subject to change.  Electives may be added to this list at the discretion of the College of Engineering.

- If obtaining a concentration, both courses must come from that concentration. View all concentration electives below.
- Any ME 5000 through 8999 course for others.

Note: Graduate courses are subject to additional requirements. ME 5000 and ME 5001 require approval from the department chair and the advisor.

# Solid Mechanics Concentration Electives

| Course | Title | Credits |
|---|---|---|
| ME 5000 | Selected Topics in ME | 3 |
| ME 5001 | ME Undergraduate Research I | 3 |
| ME 5201 | Intro to Finite Elements | 3 |
| ME 5206 | Aircraft Design | 3 |
| ME 5500 | Biomechanics | 3 |
| ME 7000 | Advanced Engineering Analysis | 3 |
| ME 7002 | Continuum Mechanics | 3 |
| ME 7030 | Num Methods for Eng Simulation | 3 |
| ME 7040 | Intro to Fin Element Analysis | 3 |
| ME 7070 | Aero Vehicle Struc Analy & Des | 3 |
| ME 7250 | Nano/Microscale Mater Behavior | 3 |
| ME 7260 | Mechanic Behavior of Materials | 3 |
| ME 7270 | Polymer Engineering | 3 |
| ME 7280 | Additive Manufacturing | 3 |
| ME 7501 | Reinforced Comp Materials | 3 |
| ME 7502 | Fiber Composite Structures | 3 |
| ME 7550 | Biomechanics of Hard Tissues | 3 |
| ME 7560 | Biomechanics of Soft Tissues | 3 |
| ME 8040 | Adv Fin Element Analysis | 3 |
| ME 8200 | Elasticity & Stress Analysis | 3 |
| ME 8350 | Applied Fracture Mechanics | 3 |

# Dynamic Systems Concentration Electives

| Course | Title | Credits |
|---|---|---|
| ME 5000 | Selected Topics in ME | 3 |
| ME 5001 | ME Undergraduate Research I | 3 |
| ME 5201 | Intro to Finite Elements | 3 |
| ME 5205 | Flight Dynamics | 3 |
| ME 5206 | Aircraft Design | 3 |
| ME 5207 | Orbital Mechanics | 3 |
| ME 5411 | Mechatronics | 3 |
| ME 5421 | Introduction to Robotics | 3 |
| ME 5441 | Advanced System Modeling | 3 |
| ME 7000 | Advanced Engineering Analysis | 3 |
| ME 7030 | Num Methods for Eng Simulation | 3 |
| ME 7040 | Intro to Fin Element Analysis | 3 |
| ME 7060 | Multiphysics Sys Modelng & Sim | 3 |
| ME 7205 | Advanced Dynamics | 3 |
| ME 7206 | Dynamics of Rotating Machinery | 3 |
| ME 7207 | Simulation of Multibody System | 3 |
| ME 8000 | Adv. Engineering Analysis II | 3 |
| ME 8204 | Robotics:Analysis & Control | 3 |
| ME 8207 | Vibration Analysis | 3 |
| EGR 8301 | Control Systems Engineering | 3 |
| EGR 8302 | Digital Control | 3 |
| EGR 8304 | Nonlinear Control | 3 |
| EGR 8305 | System Identification | 3 |
| EGR 8306 | Nonlinear Dynamics | 3 |
| EGR 8308 | Feedforward Control | 3 |
| EGR 8310 | Optimization for Engineers | 3 |
| EGR 8311 | Machine Learning for Engineers | 3 |

# Thermal/Fluids Concentration Electives

| Course | Title | Credits |
|---|---|---|
| ME 5000 | Selected Topics in ME | 3 |
| ME 5001 | ME Undergraduate Research I | 3 |
| ME 5101 | Elements of Aerodynamics | 3 |
| ME 5102 | Compressible Fluid Flow | 3 |
| ME 5130 | Intro to Sustainable Energy | 3 |
| ME 5140 | Design of Gravity Water Ntwrks | 3 |
| ME 5201 | Intro to Finite Elements | 3 |
| ME 5206 | Aircraft Design | 3 |
| ME 5441 | Advanced System Modeling | 3 |
| ME 7000 | Advanced Engineering Analysis | 3 |
| ME 7002 | Continuum Mechanics | 3 |
| ME 7030 | Num Methods for Eng Simulation | 3 |
| ME 7038 | Intro-Computational Fluid Mech | 3 |
| ME 7040 | Intro to Fin Element Analysis | 3 |
| ME 7103 | Advanced Engrg Thermodynamics | 3 |
| ME 7140 | Thermal Energy Storage | 3 |
| ME 7150 | Sustainable Energy | 3 |
| ME 7240 | Constructal Theory and Design | 3 |
| ME 7600 | Thermal Mgmnt of Electronics | 3 |
| ME 7700 | Tran Phen in Bio Systems | 3 |
| ME 8038 | Adv Computational FluidDynamic | 3 |
| ME 8100 | Fund of Cond & Rad Heat Trans | 3 |
| ME 8103 | Advanced Fluid Mechanics | 3 |
| ME 8120 | Convection Heat Transfer | 3 |
| ME 8150 | Multiphase Flow & Heat Trans. | 3 |
| ME 8250 | Microscale Heat Transfer | 3 |
| EGR 7800 | Solar Therm. Energy Conversion | 3 |

## Elective - Career/ME

Credits: 3

One course from:

- ME 5000 through 8999
- Approved elective from other Engineering Department: CHE 5000-8999, CEE 4000-8999, ECE 5000-8999, EGR 7000-8999, SUSE 7000-8999
- Approved elective from hard sciences: AST 4000-8999, BIO 4000-8999, CHM 4000-8999, CSC 4000-8999, ENV 4000-8999, GEV 4000-8999, MAT 4000-8999, PHY 4000-8999, STAT 4000-8999
- Courses from student's completed minor or second major.

Note: Graduate courses are subject to additional requirements.

## Elective - Restricted ME Lab

Credits: 1

If a concentration is chosen, students must take the appropriate courses in their concentration, including the below:

- Restricted ME Elective
- Restricted ME Lab
- 6 credits from the approved list of courses for the concentration

| Course | Title | Credits |
|---|---|---|
| ME 4001 | Dynamic Systems Lab | 1 |
| ME 4002 | Solid Mechanics Lab | 1 |
| ME 4003 | Thermal Fluids Lab | 1 |