# MECHANICAL ENGINEERING & TECHNOLOGY

Jason Durfee (jdurfee@ewu.edu), Chair
department web page (https://www.ewu.edu/cstem/ment/)

## Faculty

Philip Appel, Heechang Bae, Kevin Chumbley, Jason Durfee, Robert Gerlick, Hessam Gharavi, Awlad Hossain, Ryan Kelley, Troy Krumrey, Kyle Larsen, Jennifer Leaf, James McCuistion, Matthew Michaelis, Benjamin Parrish, Kevin Ratigan, Hani Saad.

## Degrees

BS–Applied Technology (http://catalog.ewu.edu/stem/me-t/technology-applied-technology-option-bs/)
BS–Construction Management Technology (http://catalog.ewu.edu/stem/me-t/technology-construction-management-option-bs/)
BS–Mechanical Engineering (http://catalog.ewu.edu/stem/me-t/mechanical-bs/)
BS–Mechanical Engineering Technology (http://catalog.ewu.edu/stem/me-t/mechanical-engineering-technology-bs/)
BS–Manufacturing Technology, DFM Option (http://catalog.ewu.edu/stem/me-t/technology-design-option-bs/)
BS–Manufacturing Technology, Process Option (http://catalog.ewu.edu/stem/me-t/technology-manufacturing-option-bs/)

Minor–Applied Technology (http://catalog.ewu.edu/stem/me-t/applied-technology-minor/)
Minor–Construction Management (http://catalog.ewu.edu/stem/me-t/construction-management-minor/)
Minor–Geotechnical Engineering (http://catalog.ewu.edu/stem/me-t/geotech-minor/)
Minor–Manufacturing (http://catalog.ewu.edu/stem/me-t/manufacturing-minor/)
Minor–Mechanical Engineering (http://catalog.ewu.edu/stem/me-t/mechanical-minor/)

Required courses in these programs of study may have prerequisites. Reference the course description section for clarification.

**Pre-Construction Management Technology**

Eligible to declare a pre-major: Running Start, Freshman, Sophomores, Transfer Students <90 credits, Changing Majors <90 credits, Double Majors <90 credits.

Eligible to declare a major: Juniors, Transfer Students ≥90 credits, Changing Majors ≥90 credits, Double Majors ≥90 credits, Post Baccalaureate.

Threshold: when student has completed the following they can declare major and be assigned to a departmental advisor.

Must be completed with a grade ≥C.

| | |
|---|---|
| ENGL 201 | COLLEGE COMPOSITION: ANALYSIS, RESEARCH AND DOCUMENTATION (≥C) |
| MATH 142 | PRECALCULUS MATH II (≥C) |
| METC 110 | ENGINEERING GRAPHICS (≥C) |
| PHYS 131<br>& PHYS 161 | INTRODUCTORY PHYSICS I<br>and MECHANICS LABORATORY (≥C) |

**Pre-Manufacturing Technology, DFM Option**

Eligible to declare a pre-major: Running Start, Freshman, Sophomores, Transfer Students <90 credits, Changing Majors <90 credits, Double Majors <90 credits.

Eligible to declare a major: Juniors, Transfer Students ≥90 credits, Changing Majors ≥90 credits, Double Majors ≥90 credits, Post Baccalaureate.

Threshold: when student has completed the following they can declare major and be assigned to a departmental advisor.

Must be completed with a grade ≥C.

| | |
|---|---|
| ENGL 201 | COLLEGE COMPOSITION: ANALYSIS, RESEARCH AND DOCUMENTATION (≥C) |
| MATH 142 | PRECALCULUS MATH II (≥C) |
| METC 110 | ENGINEERING GRAPHICS (≥C) |
| MNTC 301 | METALLIC PROCESSES (≥C) |
| PHYS 131<br>& PHYS 132<br>& PHYS 161<br>& PHYS 162 | INTRODUCTORY PHYSICS I<br>and INTRODUCTORY PHYSICS II<br>and MECHANICS LABORATORY<br>and HEAT AND OPTICS LABORATORY (≥C) |

**Pre-Manufacturing Technology, Process Option**

Eligible to declare a pre-major: Running Start, Freshman, Sophomores, Transfer Students <90 credits, Changing Majors <90 credits, Double Majors <90 credits.

Eligible to declare a major: Juniors, Transfer Students ≥90 credits, Changing Majors ≥90 credits, Double Majors ≥90 credits, Post Baccalaureate.

Threshold: when student has completed the following they can declare major and be assigned to a departmental advisor.

Must be completed with a grade ≥C.

| | |
|---|---|
| ENGL 201 | COLLEGE COMPOSITION: ANALYSIS, RESEARCH AND DOCUMENTATION (≥C) |
| MATH 107 | MATHEMATICAL REASONING (≥C) |
| or MATH 141 | PRECALCULUS I |
| METC 110 | ENGINEERING GRAPHICS (≥C) |
| MNTC 301 | METALLIC PROCESSES (≥C) |
| PHYS 100 | PHYSICAL SCIENCE I (≥C) |

**Pre-Mechanical Engineering**

Declaring this major will guide you through the courses that must be completed to apply for the Mechanical Engineering major.

This is a competitive application process based upon your average GPA in the required courses. Students who apply with an average GPA in the required courses ≥3.3 or greater will be accepted while those with lower GPAs will be accepted if space is available. Acceptance into the Mechanical Engineering major is required for students to enroll in some of the 300 level and all of the 400 level Mechanical Engineering courses.

Must be completed with a grade ≥C unless otherwise noted.

| | |
|---|---|
| MATH 161 | CALCULUS I |
| & MATH 162 | and CALCULUS II |
| & MATH 163 | and CALCULUS III |
| PHYS 151 | GENERAL PHYSICS I |
| & PHYS 152 | and GENERAL PHYSICS II |
| & PHYS 153 | and GENERAL PHYSICS III |
| MENG 240 | STATICS |
| & MENG 241 | and STRENGTH OF MATERIALS |
| ENGL 201 | COLLEGE COMPOSITION: ANALYSIS, RESEARCH AND DOCUMENTATION |
| CHEM 171 | GENERAL CHEMISTRY I |
| & 171L | and GENERAL CHEMISTRY LABORATORY I |

**Pre-Mechanical Engineering Technology**

Declaring this major will guide you through the courses that must be completed to apply for the Mechanical Engineering Technology major.

This is a competitive application process based upon your average GPA in the required courses. Students who apply with an average GPA in the required courses of ≥3.0 will be accepted while those with lower GPAs will be accepted if space is available. Acceptance into the Mechanical Engineering Technology major is required for students to enroll in some of the 300 level and all of the 400 level Mechanical Engineering Technology courses.

Must be completed with a grade ≥C unless otherwise noted.

| | |
|---|---|
| MATH 141 | PRECALCULUS I |
| & MATH 142 | and PRECALCULUS MATH II |
| & MATH 161 | and CALCULUS I |
| & MATH 162 | and CALCULUS II |
| PHYS 131 | INTRODUCTORY PHYSICS I |
| & PHYS 132 | and INTRODUCTORY PHYSICS II |
| & PHYS 133 | and INTRODUCTORY PHYSICS III |
| or PHYS 151 | GENERAL PHYSICS I |
| | and GENERAL PHYSICS II |
| & PHYS 152 | and GENERAL PHYSICS III |
| & PHYS 153 | |
| ENGL 201 | COLLEGE COMPOSITION: ANALYSIS, RESEARCH AND DOCUMENTATION |
| CHEM 171 | GENERAL CHEMISTRY I |
| & 171L | and GENERAL CHEMISTRY LABORATORY I |

## Undergraduate Programs

Students studying in the Department of Mechanical Engineering & Technology (APTC, CMTC, DNTC, MNTC, MENG, METC, TECH) may select from a broad number of disciplines that include Mechanical Engineering, Mechanical Engineering Technology, Construction, Design and Manufacturing. The primary goal of the Department of Mechanical Engineering & Technology is to provide students with the technical background required for careers in business and industry. Coursework within each program offers experiences in many areas of engineering and design that enhance the preparation of our graduates.

**General Admissions Information for Engineering & Design**

Students entering the Bachelor of Science degree in the Engineering programs as juniors should have completed one year of physics as well as most of their mathematics. Failure to complete the mathematics and physics requirements before the junior year likely will delay graduation.

**Faculty and Facilities**

The Department of Mechanical Engineering & Technology faculty, facilities, and equipment reflect a commitment to maintaining program relevance. Computer-assisted drafting and manufacturing, networking, signal processing, microprocessors, power systems, digital communication, electronics, integrated circuits design, graphic design/web design, robotics, thermodynamics, fluid dynamics, heat transfer and materials processing laboratories and a variety of other engineering/engineering technology laboratories are constantly being updated with new equipment. Articulation and research with industry have resulted in programs that address the latest trends in industry. These efforts have consistently offered graduates excellent job placement and employment opportunities.

**Engineering & Design Departmental Scholarship Information**

The department awards two scholarships annually: the M. W. Consulting Engineering Scholarship and Aaron G. Mertens memorial scholarship. These scholarships are awarded to our majors based on academic qualifications and need.

**Department Overload Policy**

Mechanical Engineering & Technology undergraduate students who wish to enroll in more than 18 credit hours during a quarter must obtain overload permission from their general or department advisor. Requests for 19 or more credit hours are generally approved only for those with a **GPA ≥3.0 in their major courses**. The normal limit is 20 credits except in exceptional cases. Additional per credit fees are assessed for students enrolled in more than 18 credits per quarter.

# Applied Technology Courses

**APTC 301. INTRODUCTION TO ROUTING AND SWITCHING. 4 Credits.**
**Notes:** this class prepares students to take the following exam(s): Interconnecting Cisco Networking Devices, Part 1 (ICND1).
**Pre-requisites:** a two year A.A.S or A.A.T Transfer Degree in IT or equivalent or permission of instructor.
This course provides students the knowledge and skills related to network fundamentals, LAN switching technologies, routing technologies, infrastructure services and infrastructure maintenance.

**APTC 302. NETWORK SERVER CONFIGURATION. 4 Credits.**
**Notes:** preparation for DCICN and DCICT Cisco exams.
**Pre-requisites:** APTC 301 ≥C or passing score for Cisco CCENT exam (within three years of the quarter of the class offering.)
This course provides students the knowledge of data center infrastructure, data center networking concepts and data center storage networking. Students will also learn about fundamental data center technologies including unified computing, data center network virtualization, Cisco data center networking technologies, data center automation and orchestration and Application Centric Infrastructure.

**APTC 303. NETWORK ADMINISTRATION. 4 Credits.**
**Notes:** preparation to take the following exam(s): Interconnecting Cisco Networking Devices: Accelerated (CCNAX).
**Pre-requisites:** APTC 301 ≥C.
This course provides students with the knowledge and skills related to network fundamentals, LAN switching technologies, IPv4 and IPv6 routing technologies, WAN technologies, infrastructure security and infrastructure management.

**APTC 399. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** CMTC 399, DNTC 399, MNTC 399, TECH 399.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Directed Study.

**APTC 401. NETWORK DIAGNOSIS AND MAINTENANCE I. 4 Credits.**
**Notes:** preparation for the DCUCI, DCII, and DCVAI Cisco exams.
**Pre-requisites:** APTC 302 ≥C.
This course provides students the knowledge of implementing Cisco data center technologies including unified computing, unified computing maintenance and operations, automation, unified computing security and unified computing storage. Knowledge of implementing Cisco data center infrastructure including key protocols, routing and switching protocols, maintenance, management, operations, security and storage is included.

**APTC 402. NETWORK DIAGNOSIS AND MAINTENANCE II. 4 Credits.**
**Notes:** preparation to take the following exam(s): Designing Cisco Data Center Infrastructure (DCID) and Troubleshooting Cisco Data Center Infrastructure (DCIT).
**Pre-requisites:** APTC 401 ≥C.
This course provides students the knowledge of Cisco data center infrastructure design pertaining to deployment requirements and options for network connectivity, infrastructure, storage network, compute connectivity and compute resource parameters. A focus on troubleshooting of Cisco data center infrastructure is included.

**APTC 403. ADVANCED ROUTING AND SWITCHING. 4 Credits.**
**Notes:** preparation for the ROUTE, SWITCH, and TSHOOT Cisco exams.
**Pre-requisites:** APTC 303 ≥C.
This course enables students to learn advanced IP addressing and routing in implementing scalable and highly secure Cisco routers that are connected to LANs, WANs and IPv6. Students learn how to plan, configure and verify implementation of enterprise switching solutions that use the Cisco Enterprise Campus Architecture. Topics on maintenance and troubleshooting are covered in this course.

**APTC 421. NETWORK SECURITY PROTOCOLS. 4 Credits.**
**Notes:** preparation for the IINS Cisco exam.
**Pre-requisites:** APTC 303 ≥C.
This course provides students the knowledge of secure network infrastructure, understanding core security concepts, managing secure access, VPN encryption, firewalls, intrusion prevention, web and email content security and endpoint security. A focus on installation, troubleshooting, and monitoring of a secure network utilizing technologies Cisco uses to maintain integrity, confidentiality and availability of data and devices is included.

**APTC 439. TOPICS IN APPLIED TECHNOLOGY. 6 Credits.**
**Notes:** An authorized elective substitution for APTC 495. This 6 credit course is only offered during the summer quarter.
**Pre-requisites:** TECH 331, TECH 462: all with grades ≥C, and junior standing.
This course explores topics in applied technology that are beyond the scope of the regular program course curriculum. It allows for a more in-depth coverage through lecture, discussion, research, and explorations of applied technology in the world as students prepare to enter the work force.

**APTC 490. SENIOR CAPSTONE: PRODUCTION LAB. 4 Credits.**
**Cross-listed:** TECH 490, CMTC 490, DNTC 490, MNTC 490.
**Notes:** the course will simulate a real world design team concept by utilizing a design group that contains members of different program majors.
**Pre-requisites:** senior standing.
**Satisfies:** a university graduation requirement–senior capstone.
The course simulates the real world situation that graduates face. Students will work in teams to apply techniques of production management, product design/development, plant layout, scheduling, cost accounting, assembly, inspection and quality control to produce a product. Learning to deal with the team dynamics is a valuable learning process. Each student team produces a new product and a final written report to demonstrate how the process and goals of the course have been realized.

**APTC 491. SENIOR PROJECT. 4-6 Credits.**
**Cross-listed:** TECH 491, CMTC 491, DNTC 491, MNTC 491.
**Pre-requisites:** senior standing.
Independent and/or group study and implementation of a design and development project. (variable time).

**APTC 495. INTERNSHIP. 1-15 Credits.**
**Cross-listed:** TECH 495, CMTC 495, DNTC 495, MNTC 495.
**Notes:** Graded Pass/Fail. This course may be repeated.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean.
A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.

**APTC 496. EXPERIMENTAL COURSE. 1-6 Credits.**
**Cross-listed:** TECH 496, CMTC 496, DNTC 496, MNTC 496.
Experimental Course.

**APTC 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Cross-listed:** TECH 497, CMTC 497, DNTC 497, MNTC 497.
Workshop, short course, conference, or seminar.

**APTC 498. SEMINAR. 1-6 Credits.**
**Cross-listed:** TECH 498, CMTC 498, DNTC 498, MNTC 498.
Seminar.

**APTC 499. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** TECH 499, CMTC 499, DNTC 499, MNTC 499.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

# Construction Management Technology Courses

**CMTC 235. CONSTRUCTION MATERIALS AND TECHNIQUES. 5 Credits.**
**Notes:** METC 102 may be waived by the instructor if you have two years of high school drafting.
**Pre-requisites:** METC 102, METC 110 or MENG 217, all with grades ≥C.
This course introduces various materials and techniques used in construction. Students gain an understanding of the fundamental principles of structural, physical and long-term performance of some of these materials through lecture and lab experiments. Students also gain an understanding of some of the mechanical and non-mechanical properties of various materials, common construction methods and knowledge of material properties and applications in construction.

**CMTC 236. CONSTRUCTION MATERIALS AND TECHNIQUES II. 5 Credits.**
**Pre-requisites:** CMTC 235.
This course introduces various materials and techniques used in construction for internal and external finishing. Students gain an understanding of the fundamental principles of structural, physical, and long-term performance of some of these materials and techniques through lecture and lab experiments. Students also gain an understanding of common construction methods and knowledge of mechanical systems and their application in construction.

**CMTC 305. CONSTRUCTION ESTIMATING. 4 Credits.**
**Pre-requisites:** CMTC 235 and MATH 142, MATH 161 or MATH 162; all ≥C.
This course provides students with the ability to estimate construction costs by reading and interpreting technical drawings. Primary focus is on calculating materials, labor and equipment cost for both residential and commercial building projects. Students generate quantity takeoffs for specific building projects.

**CMTC 320. NON-METALLIC PROCESSES. 5 Credits.**
**Pre-requisites:** METC 110; junior/senior status or permission of instructor.
Survey of non-metallic materials (such as woods, plastics, and ceramics) and the industrial processes utilized to convert raw materials into finished products. Course includes characteristics and properties of non-metallic materials and utilization of industrial tools and processing equipment.

**CMTC 335. ARCHITECTURE. 4 Credits.**
**Notes:** four hour lecture per week.
**Pre-requisites:** METC 110 or MENG 217, with a grade ≥C.
Design, layout, and development of residential dwellings and large structures.

**CMTC 345. SOILS/SURVEYING. 4 Credits.**
**Pre-requisites:** MATH 142, MATH 161 or MATH 162; with a grade ≥C.
This course introduces soil mechanics and site surveying. Through lecture and field work the course examines characteristics and compositions of soil, soil classification systems and the strength of soil masses. Students practice fundamentals of construction surveying, including taping, leveling, angular measurement, traversing, topographic surveying, building layout and grade staking.

**CMTC 354. BUILDING CODES. 4 Credits.**
**Pre-requisites:** ENGL 201 with a grade ≥C.
Building Codes is a comprehensive course pertaining to International Building Codes (IBC). Emphasis is placed on code requirements for both commercial and residential applications to include structural, mechanical, plumbing, fire, fuel gas and private sewage code requirements.

**CMTC 399. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 399, DNTC 399, MNTC 399, TECH 399.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Directed Study.

**CMTC 439. TOPICS IN CONSTRUCTION. 6 Credits.**
**Notes:** An authorized elective substitution for CMTC 495. This 6 credit course is only offered during the summer quarter.
**Pre-requisites:** TECH 331, TECH 462: all with grades ≥C, and junior standing.
This course explores topics in construction that are beyond the scope of the regular program course curriculum. It allows for a more in-depth coverage through lecture, discussion, and explorations of the construction world as students prepare to enter the work force.

**CMTC 490. SENIOR CAPSTONE: PRODUCTION LAB. 4 Credits.**
**Cross-listed:** APTC 490, TECH 490, DNTC 490, MNTC 490.
**Notes:** the course will simulate a real world design team concept by utilizing a design group that contains members of different program majors.
**Pre-requisites:** senior standing.
**Satisfies:** a university graduation requirement–senior capstone.
The course simulates the real world situation that graduates face. Students will work in teams to apply techniques of production management, product design/development, plant layout, scheduling, cost accounting, assembly, inspection and quality control to produce a product. Learning to deal with the team dynamics is a valuable learning process. Each student team produces a new product and a final written report to demonstrate how the process and goals of the course have been realized.

**CMTC 491. SENIOR PROJECT. 4-6 Credits.**
**Cross-listed:** APTC 491, TECH 491, DNTC 491, MNTC 491.
**Pre-requisites:** senior standing.
Independent and/or group study and implementation of a design and development project. (variable time).

**CMTC 495. INTERNSHIP. 1-15 Credits.**
**Cross-listed:** APTC 495, TECH 495, DNTC 495, MNTC 495.
**Notes:** Graded Pass/Fail. This course may be repeated.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean.
A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.

**CMTC 496. EXPERIMENTAL COURSE. 1-6 Credits.**
**Cross-listed:** APTC 496, TECH 496, DNTC 496, MNTC 496.
Experimental Course.

**CMTC 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 497, TECH 497, DNTC 497, MNTC 497.
Workshop, short course, conference, or seminar.

**CMTC 498. SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 498, TECH 498, DNTC 498, MNTC 498.
Seminar.

**CMTC 499. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 499, TECH 499, DNTC 499, MNTC 499.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

**DNTC 499. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 499, CMTC 499, TECH 499, MNTC 499.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

## Design Technology Courses

**DNTC 399. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 399, CMTC 399, MNTC 399, TECH 399.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Directed Study.

**DNTC 490. SENIOR CAPSTONE: PRODUCTION LAB. 4 Credits.**
**Cross-listed:** APTC 490, CMTC 490, TECH 490, MNTC 490.
**Notes:** the course will simulate a real world design team concept by utilizing a design group that contains members of different program majors.
**Pre-requisites:** senior standing.
**Satisfies:** a university graduation requirement–senior capstone.
The course simulates the real world situation that graduates face. Students will work in teams to apply techniques of production management, product design/development, plant layout, scheduling, cost accounting, assembly, inspection and quality control to produce a product. Learning to deal with the team dynamics is a valuable learning process. Each student team produces a new product and a final written report to demonstrate how the process and goals of the course have been realized.

**DNTC 491. SENIOR PROJECT. 4-6 Credits.**
**Cross-listed:** APTC 491, CMTC 491, TECH 491, MNTC 491.
**Pre-requisites:** senior standing.
Independent and/or group study and implementation of a design and development project. (variable time).

**DNTC 495. INTERNSHIP. 1-15 Credits.**
**Cross-listed:** APTC 495, CMTC 495, TECH 495, MNTC 495.
**Notes:** Graded Pass/Fail. This course may be repeated.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean.
A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.

**DNTC 496. EXPERIMENTAL COURSE. 1-6 Credits.**
**Cross-listed:** APTC 496, CMTC 496, TECH 496, MNTC 496.
Experimental Course.

**DNTC 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 497, CMTC 497, TECH 497, MNTC 497.
Workshop, short course, conference, or seminar.

**DNTC 498. SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 498, CMTC 498, TECH 498, MNTC 498.
Seminar.

## Manufacturing Technology Courses

**MNTC 208. SURVEY OF ELECTRICITY. 4 Credits.**
**Pre-requisites:** MATH 142 or MATH 161 or MATH 162; PHYS 100 or PHYS 110 or PHYS 121 or PHYS 131 or PHYS 151; with grades ≥C.
Introduces the student to direct current, alternating current (including residential wiring), and amplifying devices.

**MNTC 301. METALLIC PROCESSES. 5 Credits.**
**Pre-requisites:** MATH 142, MATH 161, MATH 162, METC 110 or MENG 217; all ≥C.
Metallic Processes is a comprehensive basic course in technical metals which is designed to survey metalworking materials and processes which have been developed by modern industry. The course provides opportunity to learn the theories and scientific principles basic to the application of metalworking tools and procedures.

**MNTC 320. NON-METALLIC PROCESSES. 5 Credits.**
**Pre-requisites:** MATH 142, MATH 161, MATH 162, METC 110, MENG 217 or; all ≥C.
Survey of non-metallic materials (such as woods, plastics, and ceramics) and the industrial processes utilized to convert raw materials into finished products. Course includes characteristics and properties of non-metallic materials and utilization of industrial tools and processing equipment.

**MNTC 399. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 399, CMTC 399, DNTC 399, TECH 399.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Directed Study.

**MNTC 402. MACHINE TOOL I. 5 Credits.**
**Pre-requisites:** MATH 142 or MATH 161 or MATH 162; MENG 217 and, MNTC 301; all with grades ≥C.
A comprehensive course in machine tool operations, both conventional and CNC. Course includes cutting operations, precision measurement, set up, and CNC programming.

**MNTC 404. COMPUTER NUMERICAL CONTROL. 5 Credits.**
**Pre-requisites:** MATH 142 or MATH 161 or MATH 162; MNTC 301, MNTC 402, MENG 217; all with grades ≥C.
This course provides the learner with experience utilizing CNC processes. Programming methods will include manual, CAM software and conversational languages.

**MNTC 406. WELDING TECHNOLOGY. 4 Credits.**
**Pre-requisites:** MATH 142 or MATH 161 or MATH 162, MNTC 301 ≥C or permission of the instructor.
Theory and practice of welding ferrous and non-ferrous metals. Practice in oxyacetylene, shielded metal arc and inert gas processes.

**MNTC 430. MACHINE TOOL II. 5 Credits.**
**Pre-requisites:** MATH 142 or MATH 161 or MATH 162; MNTC 301, MNTC 402, MNTC 404, MENG 217; all with grades ≥C.
Application and theory in the design, development and function of tooling, dies, molds, jigs, and fixtures. Laboratory experiences provide a problem solving approach to development of prototypes in both unit and mass production applications.

**MNTC 439. TOPICS IN MANUFACTURING. 5 Credits.**
**Notes:** An authorized elective substitution for MNTC 495. This course is only offered during the summer quarter.
**Pre-requisites:** TECH 331, TECH 462: all with grades ≥C, and junior standing.
This course explores topics in manufacturing that are beyond the scope of the regular program course curriculum. It allows for a more in-depth coverage through lecture, discussion, and explorations of the manufacturing world as students prepare to enter the work force.

**MNTC 490. SENIOR CAPSTONE: PRODUCTION LAB. 4 Credits.**
**Cross-listed:** APTC 490, CMTC 490, DNTC 490, TECH 490.
**Notes:** the course will simulate a real world design team concept by utilizing a design group that contains members of different program majors.
**Pre-requisites:** senior standing.
**Satisfies:** a university graduation requirement–senior capstone.
The course simulates the real world situation that graduates face. Students will work in teams to apply techniques of production management, product design/development, plant layout, scheduling, cost accounting, assembly, inspection and quality control to produce a product. Learning to deal with the team dynamics is a valuable learning process. Each student team produces a new product and a final written report to demonstrate how the process and goals of the course have been realized.

**MNTC 491. SENIOR PROJECT. 4-6 Credits.**
**Cross-listed:** APTC 491, CMTC 491, DNTC 491, TECH 491.
**Pre-requisites:** senior standing.
Independent and/or group study and implementation of a design and development project. (variable time).

**MNTC 495. INTERNSHIP. 1-15 Credits.**
**Cross-listed:** APTC 495, CMTC 495, DNTC 495, TECH 495.
**Notes:** Graded Pass/Fail. This course may be repeated.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean.
A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.

**MNTC 496. EXPERIMENTAL COURSE. 1-6 Credits.**
**Cross-listed:** APTC 496, CMTC 496, DNTC 496, TECH 496.
Experimental Course.

**MNTC 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 497, CMTC 497, DNTC 497, TECH 497.
Workshop, short course, conference, or seminar.

**MNTC 498. SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 498, CMTC 498, DNTC 498, TECH 498.
Seminar.

**MNTC 499. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 499, CMTC 499, DNTC 499, TECH 499.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

# Mechanical Engineering Courses

**MENG 199. DIRECTED STUDY. 1-5 Credits.**
Directed Study

**MENG 201. MATLAB. 4 Credits.**
**Pre-requisites:** MATH 141, MATH 142 or MATH 161 with a grade ≥C.
This course introduces the student to the application of basic MATLAB building blocks to engineering problems. Students will get a thorough introduction to data visualization, data analysis, symbolic calculations, numeric computations and other basic skills related to MATLAB.

**MENG 207. ELECTRICITY. 3 Credits.**
**Pre-requisites:** MATH 162, PHYS 133 or PHYS 153; and PHYS 163, which may be taken concurrently, all grades ≥C.
This course is intended to provide students with a basic understanding of electricity and its applications. In this course, basic concepts of current, voltage and resistance will be presented as well as basic circuit-analysis methods including inductor and capacitor.

**MENG 217. 3D PARAMETRIC COMPUTER AIDED DESIGN. 4 Credits.**
**Pre-requisites:** METC 110 or ≥C or High School AUTOCAD or permission of Instructor.
This course uses the computer to draft parametric models in three dimensions. File management methods, rapid prototyping and 2D drawing development techniques are discussed. (Four hours per week.)

**MENG 240. STATICS. 4 Credits.**
**Pre-requisites:** PHYS 151, PHYS 161, and MATH 161, all with grades ≥C.
Fundamentals of applied mechanics, equivalent force systems, equations of equilibrium, structures, three dimensional force systems and friction.

**MENG 241. STRENGTH OF MATERIALS. 4 Credits.**
**Pre-requisites:** MENG 240, MATH 162, PHYS 152, and PHYS 162, all with grades ≥C.
A study of the internal stresses, internal deformations and deflections of materials. Topics may include: shear and moment diagrams for beams, combined loading on beams, temperature stresses and torsional loading. (four hours lecture per week)

**MENG 242. DYNAMICS. 4 Credits.**
**Pre-requisites:** MENG 240 with grade ≥C.
Kinematics and kinetics of particles and rigid bodies using vector analysis; force mass acceleration, work and energy, impulse and momentum, translating and rotating coordinate system.

**MENG 300. LABORATORY ANALYSIS AND REPORTS. 5 Credits.**
**Pre-requisites:** PHYS 133 or PHYS 153; PHYS 163, MATH 162, ENGL 201, all with ≥C; or permission of instructor.
This course examines the different aspects of laboratory analysis and report writing. This includes description of engineering problems, analysis of data including error analysis and data interpretation, instrumentation and measurements. In addition, the application of spreadsheets for solving and analyzing engineering problems, creating technical graphs, trending and curve fitting and project management will be addressed.

**MENG 307. INDUSTRIAL CONTROLS AND INSTRUMENTATION. 5 Credits.**
**Pre-requisites:** MENG 207 or EENG 209 with a grade ≥C.
This course includes principles of instrumentation, sensors, motors and actuators, electrical power systems, relays, and basic control theory. Emphasis will be on discrete control systems and methods.

**MENG 353. INDUSTRIAL MATERIALS. 5 Credits.**
**Pre-requisites:** CHEM 121 or CHEM 171/HONS 171 with CHEM 171L; and ENGL 201; and MATH 142 or MATH 161/HONS 161 or MATH 162 or MATH 163; all ≥C.
Students in this course achieve a thorough understanding of engineering materials, their properties, responses and applications. Laboratory work includes destructive and non destructive testing and image analysis of microscopic structure of industrial materials.

**MENG 380. THERMODYNAMICS. 5 Credits.**
**Pre-requisites:** PHYS 152 and PHYS 162; MATH 162; MENG 300, all with grades ≥C. Declared Mechanical Engineering Major.
This course explores properties of materials, work, heat, conversion of energy, conservation of mass and energy transformation processes. Emphasis is on application of the first and second laws to engineering systems.

**MENG 382. FLUID MECHANICS. 5 Credits.**
**Notes:** laboratory work is included.
**Pre-requisites:** MENG 242; grades ≥C in all of the following, PHYS 152; PHYS 162, MATH 162; MENG 300; and a declared Mechanical Engineering major.
This course introduces the student to theory, concepts and applications of fluid mechanics. Topics include static and dynamic forces; conservation of mass, energy and momentum; flow in pipes and ducts; and fan and pump performance.

**MENG 385. ROBOTICS AND AUTOMATION. 5 Credits.**
**Notes:** three hours lecture, four hours laboratory per week.
**Pre-requisites:** MENG 201 or CSCD 255; MENG 307; all grades ≥C and a declared in Mechanical Engineering or Mechanical Engineering Technology major or permission of instructor.
This course covers various electrical and mechanical systems used in robotics and other automated industrial systems. It includes automated equipment programming and industrial planning as applied to automated systems.

**MENG 386. ENGINEERING NUMERICAL ANALYSIS. 5 Credits.**
**Pre-requisites:** PHYS 153; PHYS 163; MATH 163; and either MENG 201 or CSCD 255; and a declared Mechanical Engineering major.
This course covers a multitude of numerical approximation methods used to solve specific structural engineering problems and highlights the algorithms used in many common scientific software packages.

**MENG 398. SEMINAR. 1-5 Credits.**
Seminar

**MENG 399. DIRECTED STUDY. 1-5 Credits.**
**Pre-requisites:** junior standing; declared Mechanical Engineering major and permission of the instructor, department chair and college dean.
Independent Study.

**MENG 405. DESIGN OF MACHINE ELEMENTS. 5 Credits.**
**Pre-requisites:** MATH 162 and MENG 241 and MENG 353, with grades ≥C, and a declared Mechanical Engineering major.
This course covers the design of machine components and mechanisms and utilizes the concepts of engineering mechanics and strength of materials.

**MENG 407. HEATING, VENTILATING AND AIR CONDITIONING. 5 Credits.**
**Pre-requisites:** PHYS 132 or PHYS 152; PHYS 162, MENG 380 or METC 388 (may be taken concurrently), all with grades ≥C, and a declared Mechanical Engineering or Mechanical Engineering Technology major.
The study of the principles of Heating, Ventilating and Air Conditioning (HVAC) including the investigation of the basic calculations to determine heating and cooling loads and the study of the basic equipment design for HVAC.

**MENG 412. FUNDAMENTALS OF ENGINEERING. 2 Credits.**
**Pre-requisites:** senior standing; MENG 241 or METC 341; MENG 242 or METC 342; MENG 380 or METC 388; and declared into one of the following: Mechanical Engineering, Mechanical Engineering Technology; or permission of instructor.
This course reviews the fundamentals of engineering. It provides an overview of principles of the practice of engineering and assists students in preparation for the first steps in professional licensure.

**MENG 444. HEAT TRANSFER. 5 Credits.**
**Pre-requisites:** MATH 241, MATH 347, MENG 300, MENG 382, MENG 386; all with grades ≥C, and a declared Mechanical Engineering major.
This course provides a detailed calculus-based analysis of the heat transfer through solids, fluids and vacuums. Concepts include conduction, convection, and radiation heat transfer in one and two dimensions for steady and unsteady states.

**MENG 452. ENGINEERING ECONOMICS. 2 Credits.**
**Pre-requisites:** MATH 142 or MATH 161, with grades ≥C, and a declared Mechanical Engineering or Mechanical Engineering Technology major; junior standing; or permission of instructor.
This course focuses on the systematic evaluation of the economic benefits and costs of projects involving engineering design and analysis. Engineering economics quantifies the benefits and costs associated with engineering projects to determine whether they make (or save) enough money to warrant their capital investment.

**MENG 453. MATERIALS AND DESIGN. 5 Credits.**
**Notes:** four hour lecture, two hours lab per week.
**Pre-requisites:** MENG 241 with a grade ≥C or METC 341 with a grade ≥B; MENG 353 with a grade ≥C; and a declared Mechanical Engineering or Mechanical Engineering Technology major.
This course expands upon the concepts covered in the Industrial Materials class. Focus is on how materials and the design of products and the processes to make them are interrelated. Students explore processing and properties of materials such as glass, ceramics, polymers and metals other than steel.

**MENG 455. COMPOSITE MATERIALS. 5 Credits.**
**Pre-requisites:** MENG 201 and MENG 353, both with grades ≥C; and a declared Mechanical Engineering or Mechanical Engineering major.
This course covers basics of composite materials including manufacturing, design and applications. Students learn anisotropic and heterogeneous material systems; types of composite constituents; physical and mechanical properties; micro, macro and ply mechanics; composite design related to strength and different failure modes; and applications of composite beams, plates and stiffened panels.

**MENG 482. ADVANCED FLUID DYNAMICS. 5 Credits.**
**Pre-requisites:** grades ≥C in all of the following, MATH 347, MENG 217, MENG 382; and a declared Mechanical Engineering major.
Students apply fluid principles to various technical situations and utilize advanced methods to derive a solution. Topics covered may include Computational Fluid Dynamics (CFD), turbo machinery, compressible fluid flow, turbulence, thermo-fluid system design, and fan and pump performance.

**MENG 485. ADVANCED ROBOTICS AND AUTOMATION. 5 Credits.**
**Pre-requisites:** MENG 385 with a grade ≥C; and a declared Mechanical Engineering or Mechanical Engineering Technology major.
A study of the various electrical and mechanical systems used in advanced robotics and other automated systems. Topics include automated equipment, programming and industrial planning as applied to automated systems, robotic vision, cooperative robotics and service robots.

**MENG 486. PROGRAMMABLE LOGIC CONTROLLERS IN AUTOMATION. 5 Credits.**
**Notes:** five hours lecture per week.
**Pre-requisites:** MENG 207 or EENG 160; MENG 201 or CSCD 110 or CSCD 255, all with a grade ≥C.
A study of Programmable Logic Controllers used in industrial automation and advanced robotics. Course explores automated equipment, ladder logic programming and industrial planning as applied to automated systems.

**MENG 487. MECHATRONICS. 5 Credits.**
**Pre-requisites:** MENG 385 with a grade ≥C; and a declared major in Mechanical Engineering or Mechanical Engineering Technology or permission from instructor.
This course includes a study of process control in automation, including basic control concepts, open and closed loop systems, sensors, actuators, control methods. Practical applications with the use of common input sensors and output actuators are emphasized.

**MENG 490A. SENIOR CAPSTONE: DESIGN LABORATORY I. 2 Credits.**
**Pre-requisites:** MENG 217, MENG 241 or METC 341, MNTC 301, and ENGL 201, all with a grade ≥C; and senior standing, and a declared Mechanical Engineering or Mechanical Engineering Technology major.
**Satisfies:** a university graduation requirement–senior capstone.
This course simulates the industrial environment, where students work in teams to solve a real world problem from design to implementation. Team dynamics and project constraints are strictly monitored and each student's unique skills are utilized in different stages of the design process.

**MENG 490B. SENIOR CAPSTONE: DESIGN LABORATORY II. 3 Credits.**
**Pre-requisites:** MENG 490A with a grade ≥C.
**Satisfies:** a university graduation requirement–senior capstone.
See description for MENG 490A.

**MENG 491. SENIOR THESIS. 1-6 Credits.**
**Pre-requisites:** permission of instructor.
Independent and/or group study and implementation of a design and development project. (variable time)

**MENG 492. FINITE ELEMENT ANALYSIS. 5 Credits.**
**Pre-requisites:** MENG 201, MENG 217, MENG 241, all with grades ≥C; and a declared Mechanical Engineering major or permission of the instructor.
This course introduces the computational methods to solve engineering problems using the finite element approach. Modeling techniques for different engineering structures such as truss, beams, frames, two and three dimensional solids, and thin-walled structures are introduced in this course. Students solve a wide variety of engineering problems dealing with statics, dynamics, fluid mechanics, heat transfer and design and material selections using the state of art FEA software.

**MENG 493. SENIOR SEMINAR. 1 Credit.**
**Notes:** graded Pass/Fail.
**Pre-requisites:** senior standing or permission of instructor; and a declared Mechanical Engineering or Mechanical Engineering Technology major.
This course provides the students firsthand exposure to the latest technological advances directly from the manufacturer or researcher. This helps students in their lifelong learning and provides an opportunity to inquire about particular topics or fields of interest.

**MENG 495. INTERNSHIP. 1-6 Credits.**
**Notes:** Graded Pass/Fail. A minimum of 180 hours of work is required for students to complete the internship experience. Students working part-time over multiple quarters will have the credit hours divided across quarters to match the hours worked in each quarter.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean; and declared Mechanical Engineering major.
This course gives students applied field experience working in industry. Students will apply engineering principles to solve problems under the supervision of a practicing engineer.

**MENG 496. EXPERIMENTAL. 1-10 Credits.**

**MENG 499. DIRECTED STUDY. 1-10 Credits.**
**Pre-requisites:** permission of the instructor, department chair and college dean; senior standing; and a declared Mechanical Engineering major.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

# Mechanical Engineering Technology Courses

**METC 102. INTRODUCTION TO ENGINEERING GRAPHICS. 4 Credits.**
**Notes:** graded Pass/Fail.
This course offers an introduction to the fundamentals of technical drawing. It emphasizes the technical methods used to describe the size and shape of objects. This course will not satisfy elective requirements for a major or minor in Technology.

**METC 110. ENGINEERING GRAPHICS. 5 Credits.**
**Notes:** two years of high school drafting is highly recommended.
**Pre-requisites:** METC 102 or permission of instructor.
A study of the technical portion of the graphics language. This language, technical drawing, is used by engineers to communicate proposed designs and new ideas. Includes the theory and practice of descriptive geometry and the graphic representation of data.

**METC 340. STATICS. 5 Credits.**
**Pre-requisites:** MATH 142 or MATH 161; PHYS 131 or PHYS 151; all with grades ≥C.
A study of applied mechanics and the principles of statics dealing with forces and with the effects of forces acting upon rigid bodies at rest.

**METC 341. STRENGTH OF MATERIALS. 4 Credits.**
**Pre-requisites:** METC 340 or MENG 240, both with grades ≥C.
A study of the relationship that exists between externally applied forces and internally induced stresses in members and parts, including the relationship existing between these same externally applied forces and the resulting deformations. (four hours lecture per week)

**METC 342. DYNAMICS. 4 Credits.**
**Pre-requisites:** METC 340 or MENG 240 and MATH 162; all with grades ≥C.
This course is a study of the motion of rigid bodies and forces affecting their motion. Topics include kinematics and kinetic of motion, curvilinear motion, plane motion, work, energy and power, impulse and momentum. (four hours lecture per week)

**METC 384. ENERGY MANAGEMENT AND UTILIZATION. 5 Credits.**
**Pre-requisites:** MENG 380 or METC 388, both with grades ≥C.
The study of energy usage and energy management within industrial facilities. The development of Energy audit procedures including the energy saving calculations for industrial settings. Students will develop and explore the creation of industrial energy audits through the extensive use of case studies.

**METC 387. FLUID MECHANICS. 5 Credits.**
**Notes:** laboratory work is included.
**Pre-requisites:** PHYS 132 or PHYS 152; PHYS 162, MATH 162; MENG 300; all with grades ≥C, and a declared Mechanical Engineering Technology major.
This course introduces the student to theory, concepts and applications of fluid mechanics. Topics include static and dynamic forces; conservation of mass, energy and momentum; flow in pipes and ducts; and fan and pump performance.

**METC 388. THERMODYNAMICS AND HEAT TRANSFER. 5 Credits.**
**Pre-requisites:** PHYS 132 or PHYS 152; PHYS 162, MATH 162, MENG 300; all with grades ≥C; and a declared Mechanical Engineering Technology major.
This course introduces the student to theory, concepts and applications of thermodynamics and heat transfer. Topics include properties of materials, work, heat, conservation of mass and energy, energy transformation processes, and heat transfer via conduction, convection and radiation.

**METC 399. DIRECTED STUDY. 1-5 Credits.**
Directed Study.

**METC 415. DESIGN OF MACHINE ELEMENTS. 5 Credits.**
**Pre-requisites:** METC 341 or MENG 241; MENG 353, MATH 162; all with grades ≥C, and a declared Mechanical Engineering Technology major.
This course covers the design of machine components and mechanisms and utilizes the concepts of engineering mechanics and strength of materials.

**METC 417. ADVANCED PARAMETRIC DESIGN. 5 Credits.**
**Pre-requisites:** MENG 217; MATH 162; METC 341 or MENG 241, all with a grade ≥C; and a declared Mechanical Engineering or Mechanical Engineering Technology major.
Advanced techniques and best practices for parametric design of parts and assemblies. These advanced methodologies include design simulation and analysis including stress analysis, thermal analysis, flow analysis, vibration and motion studies, and design optimization.

**METC 456. ENGINEERING ETHICS, CONTRACTS AND PATENTS. 2 Credits.**
**Pre-requisites:** junior standing, ENGL 201 with a ≥C, and a declared Mechanical Engineering or Mechanical Engineering Technology major.
This course investigates the elements of professional engineering practice including their relationship to the law, to the public and the ethics of the profession. Topics covered range from ethics, contracts, patents, copyrights, sales agreements and engineering specifications to professionalism, licensing, intellectual property, liability, risk, reliability and safety.

**METC 468. QUALITY ASSURANCE AND INTRO TO LEAN. 5 Credits.**
**Pre-requisites:** PHYS 132 or PHYS 152; PHYS 162; MATH 162; MENG 300; all with grades ≥C; and a declared Mechanical Engineering or Mechanical Engineering Technology major.
Application and theory of quality control and continuous improvement systems. This includes statistical analysis, design of experiments, development and use of process control charts, sampling processes, time and motion studies, and introduction to other Lean tools.

**METC 490A. SENIOR CAPSTONE: DESIGN LABORATORY I. 2 Credits.**
**Pre-requisites:** METC 341 or MENG 241; MENG 217, MATH 162, MNTC 301 and ENGL 201, all with grades ≥C; and senior standing; and a declared Mechanical Engineering Technology major.
**Satisfies:** a university graduation requirement–senior capstone.
This course simulates the industrial environment, where students work in teams to solve a real world problem from design to implementation. Team dynamics and project constraints are strictly monitored and each student's unique skills are utilized in different stages of the design process.

**METC 490B. SENIOR CAPSTONE: DESIGN LABORATORY II. 3 Credits.**
**Pre-requisites:** METC 490A with a grade ≥C. Must be a declared Mechanical Engineering Technology major.
**Satisfies:** a university graduation requirement–senior capstone.
See description for METC 490A.

**METC 491. SENIOR PROJECT. 1-10 Credits.**
**Pre-requisites:** senior standing, a declared Mechanical Engineering Technology major and permission of the instructor and chair.
Independent and/or group study and implementation of a design and development project. (variable time).

**METC 495. INTERNSHIP. 1-5 Credits.**
**Notes:** Graded Pass/Fail. May be repeated for credit. A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean and a declared Mechanical Engineering Technology major.
This course gives students applied field experience working in industry. Students will apply engineering principles to solve problems under the supervision of a practicing engineer. A minimum of 180 hours of work is required for students to complete the internship experience. Students working part-time over multiple quarters will have the credit hours divided across quarters to match the hours worked in each quarter.

**METC 499. DIRECTED STUDY. 1-5 Credits.**
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

# Technology Courses

**TECH 197. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.**

**TECH 199. DIRECTED STUDY. 1-5 Credits.**

**TECH 297. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.**

**TECH 298. SEMINAR. 1-5 Credits.**

**TECH 330. TECHNOLOGY PROBLEM ANALYSIS AND DESIGN I. 4 Credits.**
**Pre-requisites:** ENGL 201 ≥C.
Development of advanced skills in technical problem analysis, planning, research, solution strategies, critical thinking and presentation. Computer-aided design tools such as CAD, project-planning software, spreadsheets, as well as imaging and publishing software are used. Emphasis is on consideration of interconnected systems.

**TECH 331. TECHNOLOGY PROBLEM ANALYSIS AND DESIGN II. 4 Credits.**
**Pre-requisites:** TECH 330 ≥C.
Development of student's synthesis, design, organizational, and learning skills through examination of current research and/or design topics in Technology.

**TECH 393. TECHNOLOGY WORLD CIVILIZATION. 4 Credits.**
**Cross-listed:** HONS 393.
**Pre-requisites:** ENGL 201 ≥C.
**Satisfies:** a university graduation requirement–global studies.
Students will investigate the issues surrounding technological change in discrete cultural settings with a historical perspective of the evolution of technology in a global context.

**TECH 395. CO-OP FIELDWORK. 1-5 Credits.**

**TECH 396. EXPERIMENTAL COURSE. 1-6 Credits.**

**TECH 397. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.**

**TECH 398. SEMINAR. 4 Credits.**

**TECH 399. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 399, CMTC 399, DNTC 399, MNTC 399.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Directed Study.

**TECH 403. COMPUTER-AIDED DESIGN AND PROJECT MANAGEMENT. 4 Credits.**
**Pre-requisites:** MATH 107, MATH 114, MATH 141, MATH 142, MATH 161, MATH 162, MATH 200 or MATH 208; ≥C.
The application of spreadsheets to solve engineering problems, technical graphs, trending and curve fitting. The introduction to the use of computer-aided scheduling of projects, critical path planning, project tracking and cost collection.

**TECH 452. ENGINEERING ECONOMICS. 4 Credits.**
**Notes:** this course cannot be substituted for MENG 452 in degrees that require that class.
**Pre-requisites:** MATH 107, MATH 114, MATH 141, MATH 142, MATH 161, MATH 162, MATH 200 or MATH 208; ≥C.
This course focuses on the systematic evaluation of the economic benefits and costs of projects involving engineering design and analysis. Engineering economics quantifies the benefits and costs associated with engineering projects to determine whether they make (or save) enough money to warrant their capital investment.

**TECH 454. ENVIRONMENTAL ENGINEERING. 4 Credits.**
**Pre-requisites:** PHYS 100, PHYS 110, PHYS 121, PHYS 131, PHYS 151; ENGL 201; MATH 107, MATH 114, MATH 141, MATH 142, MATH 161, MATH 162, MATH 200 or MATH 208; All ≥C.
This course explores ways to promote the design and manufacturing of environmentally sound products and processes. Benefits include environmentally-friendly products, more efficient operations and the good will of an informed public that expects a clean, healthy environment.

**TECH 456. ENGINEERING ETHICS, CONTRACTS AND PATENTS. 4 Credits.**
**Pre-requisites:** ENGL 201 ≥C.
This course investigates the elements of professional engineering practice including their relationship to the law, to the public and the ethics of the profession. Topics covered range from ethics, contracts, patents, copyrights, sales agreements and engineering specifications to professionalism, licensing, intellectual property, liability, risk, reliability and safety.

**TECH 458. QUALITY ASSURANCE. 4 Credits.**
**Notes:** this course cannot be substituted for METC 468 in degrees that require that class.
**Pre-requisites:** MATH 107, MATH 114, MATH 141, MATH 142, MATH 161, MATH 162, MATH 200 or MATH 208; ≥C.
Application and theory of quality control systems including development and use of process control charts, sampling, time and motion studies, and statistical analysis.

**TECH 462. INDUSTRIAL SAFETY ENGINEERING. 4 Credits.**
**Pre-requisites:** junior standing and ENGL 201 ≥C.
Fundamentals of safety, classification of hazards, accident statistics, organization problems, safety codes, machine guarding, mechanical, electrical and chemical hazards, ventilation, respiratory and safety devices. (4 hours lecture per week)

**TECH 490. SENIOR CAPSTONE: PRODUCTION LAB. 4 Credits.**
**Cross-listed:** APTC 490, CMTC 490, DNTC 490, MNTC 490.
**Notes:** the course will simulate a real world design team concept by utilizing a design group that contains members of different program majors.
**Pre-requisites:** senior standing.
**Satisfies:** a university graduation requirement–senior capstone.
The course simulates the real world situation that graduates face. Students will work in teams to apply techniques of production management, product design/development, plant layout, scheduling, cost accounting, assembly, inspection and quality control to produce a product. Learning to deal with the team dynamics is a valuable learning process. Each student team produces a new product and a final written report to demonstrate how the process and goals of the course have been realized.

**TECH 491. SENIOR PROJECT. 4-6 Credits.**
**Cross-listed:** APTC 491, CMTC 491, DNTC 491, MNTC 491.
**Pre-requisites:** senior standing.
Independent and/or group study and implementation of a design and development project. (variable time).

**TECH 495. INTERNSHIP. 1-15 Credits.**
**Cross-listed:** APTC 495, CMTC 495, DNTC 495, MNTC 495.
**Notes:** Graded Pass/Fail. This course may be repeated.
**Pre-requisites:** junior or senior status and permission of the instructor, department chair and dean.
A maximum of 5 credits may be earned toward electives for a Technology major. Students considering electives for a Technology minor should consult with their departmental advisor.

**TECH 496. EXPERIMENTAL COURSE. 1-6 Credits.**
**Cross-listed:** APTC 496, CMTC 496, DNTC 496, MNTC 496.
Experimental Course.

**TECH 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 497, CMTC 497, DNTC 497, MNTC 497.
Workshop, short course, conference, or seminar.

**TECH 498. SEMINAR. 1-6 Credits.**
**Cross-listed:** APTC 498, CMTC 498, DNTC 498, MNTC 498.
Seminar.

**TECH 499. DIRECTED STUDY. 1-5 Credits.**
**Cross-listed:** APTC 499, CMTC 499, DNTC 499, MNTC 499.
**Pre-requisites:** permission of the instructor, department chair and college dean.
Designed for students wanting to pursue a subject beyond the scope of regular courses.

**TECH 539. SPECIAL STUDIES TECHNOLOGY. 1-5 Credits.**

**TECH 595. INTERNSHIP. 1-5 Credits.**

**TECH 596. EXPERIMENTAL COURSE. 1-6 Credits.**

**TECH 597. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-6 Credits.**
**Notes:** only one workshop course for up to 3 credits may be used to fulfill graduate degree requirements.

**TECH 598. SEMINAR. 1-6 Credits.**

**TECH 599. INDEPENDENT STUDY. 1-6 Credits.**
**Notes:** may be repeated within the 6 credits allowed to fulfill the student's goals and needs in specific areas.
**Pre-requisites:** permission of the instructor, department chair and college dean.

**TECH 600. THESIS. 2-6 Credits.**
**Pre-requisites:** permission of the instructor, department chair and college dean.
Independent research study under the direction of a graduate adviser committee.

**TECH 601. RESEARCH REPORT. 2-6 Credits.**

**TECH 695. INTERNSHIP. 1-6 Credits.**
**Pre-requisites:** permission of the instructor, department chair and college dean.

**TECH 696. COLLEGE TEACHING INTERNSHIP. 1-5 Credits.**
**Pre-requisites:** permission of the instructor, department chair and college dean.
Teaching a lower-division college course under supervision of a regular faculty member. Includes course planning, arranging bibliographical and instructional aids, conferences with students, experience in classroom instruction and student course evaluation.