## Overview

The Mechanical Electrical Technology Department teaches courses in the design, installing, operating and maintenance of heating, ventilating, air conditioning, and refrigeration systems. The Mechanical-Electrical Department is committed to providing educational opportunities for current and future workforce needs. We strive to maintain the highest educational standards in the Air Conditioning, Heating, Ventilation, Refrigeration, Environmental Control, Building Automation, Renewable and Sustainable Energy, as well as Energy Efficiency and Management.

### Career Options

The Mechanical-Electrical Technology program provides instruction in design, installation, operation, repair, and maintenance of a wide range of mechanical and electrical equipment from small residential equipment to large commercial and industrial facilities. Systems covered include heating, ventilating, air conditioning, and refrigerating (HVAC/R).

### Associate Degree

#### A.S. in Mechanical-Electrical Technology

**MET Program Information**

The Mechanical-Electrical Technology (MET) program provides instruction in design, installation, operation, repair, and maintenance of a wide range of mechanical and electrical equipment from small residential equipment to large commercial and industrial facilities. The entire spectrum of mechanical and electrical systems is covered including energy management, mechanical system commissioning, indoor air quality, building automation systems, refrigerant recovery and management, electrical controls, pneumatic controls, electronic controls, instrumentation, and heat pumps. These systems include heating, ventilating, air conditioning, and refrigerating (HVAC/R).

Students will learn the theory and fundamentals of mechanical equipment and be exposed to hands-on training in sophisticated training laboratories. Laboratory equipment that students will work with include a water cooled chiller, cooling towers, steam and hot water boilers, thermal energy storage system, heat reclaim system, power management system, packaged and split system air conditioners, furnaces, and high, medium, and low temperature refrigeration systems. Students will also configure, program, and commission several Direct Digital Control (DDC) Systems, pneumatic systems, variable frequency drive (VFD), and programmable logic controllers (PLC), and work directly on the operating systems in the laboratory facility.

The program includes both day and evening lecture and laboratory class sections. Classes are conducted as both lecture and laboratory. Effective writing, verbal communication, electronic communication, sketching, drafting, mechanical calculations, and computer skills are emphasized across the curriculum.

**Recommended High School Preparation**

Completion of college preparatory English and general mathematics courses is highly desirable but not required. Courses in drafting, algebra, and computer fundamentals will be beneficial.

**Program Costs**

In addition to normal student expenses such as tuition and textbooks, MET students must purchase safety glasses for use in laboratory and shop classes. If this fee creates a financial burden, students should consult the Financial Aid Office for possible assistance.

**Catalog Date:** June 1, 2020

### Degree Requirements

<table>
<thead>
<tr>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET 360</td>
<td>Mechanical Systems Maintenance</td>
<td>1.5</td>
</tr>
<tr>
<td>MET 256</td>
<td>Fundamentals of Instruments and Electricity</td>
<td>1.5</td>
</tr>
<tr>
<td>MET 257</td>
<td>Fundamentals of Workplace Success</td>
<td>1.5</td>
</tr>
<tr>
<td>MET 351</td>
<td>Basic Mechanical Systems</td>
<td>5</td>
</tr>
<tr>
<td>MET 352</td>
<td>Mechanical Systems Calculations</td>
<td>3</td>
</tr>
<tr>
<td>MET 361</td>
<td>Refrigeration Systems</td>
<td>3</td>
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<td>MET 362</td>
<td>Refrigeration Systems Calculations</td>
<td>3</td>
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<tr>
<td>MET 363</td>
<td>Refrigerant Transition and Recovery Processes and Procedures</td>
<td>1.5</td>
</tr>
<tr>
<td>MET 364</td>
<td>Electrical Controls</td>
<td>3</td>
</tr>
<tr>
<td>MET 368</td>
<td>Heat Pump Operation and Maintenance</td>
<td>3</td>
</tr>
<tr>
<td>MET 371</td>
<td>Heating and Power Machinery</td>
<td>3</td>
</tr>
<tr>
<td>MET 372</td>
<td>Power Machinery, Heating and Air Conditioning Calculations</td>
<td>3</td>
</tr>
<tr>
<td>MET 373</td>
<td>Piping, Electrical, and Sheet Metal Drafting</td>
<td>3</td>
</tr>
<tr>
<td>MET 374</td>
<td>Automatic Control Systems I</td>
<td>3</td>
</tr>
<tr>
<td>MET 381</td>
<td>Air Conditioning</td>
<td>3</td>
</tr>
</tbody>
</table>
The Mechanical-Electrical Technology Associate in Science (A.S.) degree may be obtained by completion of the required program, plus general education requirements, plus sufficient electives to meet a 60-unit total. See SCC graduation requirements.

Student Learning Outcomes

Upon completion of this program, the student will be able to:

- apply problem-solving and analytical thinking skills in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- utilize tools and equipment in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- demonstrate an understanding of the requirements of the Federal Refrigerant Transition and Recovery Certification license examination.
- recognize the importance of proper handling of refrigerants and the environmental impact of improper refrigerant management.
- operate and troubleshoot both a water boiler and low pressure steam boiler system, pumping and piping systems, and related heating equipment.
- design a heating-cooling system for a residential and commercial application from concept to finish.
- explain the operation of chilled water systems, air distribution, variable air volume systems, thermal storage, cooling towers, and energy management.
- explain the concepts related to absorption air conditioning systems, helical-rotary, and centrifugal water chillers.
- demonstrate an understanding of electrical circuits and controls.
- design an electrical control schematic and troubleshoot various electrical equipment.
- utilize freehand sketching and drafting skills for use in field applications.
- demonstrate an understanding of the different types, applications, and proper use of instruments to measure and record temperature, humidity, flow, light, sound, velocity, pressure, combustion emissions, air quality, voltage, level, force, and vibration.
- analyze complex systems of the automatic controls industries.
- design and program Variable Frequency Drives, Programmable Logic Control systems, Direct Digital Control systems, and Pneumatic Control systems.
- explain the theory and demonstrate practical skill sets required of an entry level Building Automation Systems Technician.
- analyze manufacturer’s data of equipment performance and economic factors related to heating, cooling, and refrigeration equipment, and estimate the cost of a refrigeration system installation including materials, labor, and profit.
- solve problems involving heat transfer, heating and cooling loads, air distribution, and psychrometrics of air.
- evaluate and determine the need for periodic equipment maintenance and demonstrate an understanding of a maintenance contract.

Career Information

Upon completion of the MET program, students may find employment in the following industry sectors: government (federal, state, county, and city agencies), health care, commercial air conditioning and refrigeration service/repair, utilities, construction, facilities management, engineering, high technology, food production, and manufacturing. Typical job titles include: stationary engineer, air conditioning and refrigeration technician, maintenance mechanic, boiler operator, automatic control technician, wholesale and manufacturer’s sales representative.

Certificates of Achievement

Mechanical Systems Technician Certificate

The Mechanical Systems Technician Certificate of Achievement provides entry level instruction in design, installation, repair, and maintenance of a wide range of mechanical and electrical equipment from small residential equipment to light commercial buildings. The entry level skills covered included fundamental mechanical and electrical systems including indoor air quality, refrigerant recovery and management, electrical controls, and heat pumps.

Students will learn the theory and fundamentals of mechanical equipment and be exposed to hands-on training in sophisticated training laboratories. Laboratory equipment that students will work with includes high, medium, and low temperature refrigeration systems and electrical systems.

The program includes both day and evening lecture and laboratory class sections. Classes are conducted as both lecture and laboratory. Effective writing, verbal communication, electronic communication, mechanical calculations, and computer skills are emphasized across the curriculum.

Recommended High School Preparation

Completion of college preparatory English and general mathematics courses is highly desirable but not required. Courses in drafting, algebra, and computer fundamentals will be beneficial.

Program Costs

In addition to normal student expenses such as tuition and textbooks, MET students must purchase safety glasses for use in laboratory and shop classes. If this fee creates a financial burden, students should consult the Financial Aid Office for possible assistance.

Catalog Date: June 1, 2020

Certificate Requirements

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<tr>
<td>MET 352</td>
<td>Mechanical Systems Calculations</td>
<td>3</td>
</tr>
<tr>
<td>MET 361</td>
<td>Refrigeration Systems</td>
<td>3</td>
</tr>
</tbody>
</table>
Student Learning Outcomes

Upon completion of this program, the student will be able to:

- evaluate and determine the need for periodic equipment maintenance, and demonstrate an understanding of a maintenance contract.
- apply problem-solving and analytical thinking skills in the maintenance, operation, testing, troubleshooting and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- utilize tools and equipment in the maintenance, operation, testing, troubleshooting and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- demonstrate an understanding of the industry required Federal Refrigerant Transition and Recovery Certification license examination.
- recognize and demonstrate the importance of proper handling of refrigerants and the environmental impact of improper refrigerant management.
- explain the basic concepts of electrical circuits and control theory.
- design an electrical control schematic and troubleshoot various electrical equipment.
- utilize freehand sketching and drafting skills for field applications.
- analyze manufacturer’s data of equipment performance and economic factors related to heating, cooling, and refrigeration equipment.
- solve problems involving heating-cooling loads, heat transfer, air distribution, and psychrometrics of air.

Career Information

Upon completion of the Mechanical Systems Technician Certificate of Achievement, students will be qualified for employment in the following industry sectors: government (federal, state, county, and city agencies), health care, utilities, construction, engineering, high technology, food production, and manufacturing. Typical jobs titles include: utility engineer, maintenance mechanic, air conditioning and refrigeration technician, and wholesale and manufacturer’s sales representative.

Mechanical-Electrical Technology Certificate

MET Program Information

The Mechanical-Electrical Technology (MET) program provides instruction in design, installation, operation, repair, and maintenance of a wide range of mechanical and electrical equipment from small residential equipment to large commercial and industrial facilities. The entire spectrum of mechanical and electrical systems is covered including energy management, mechanical system commissioning, indoor air quality, building automation systems, refrigerant recovery and management, electrical controls, pneumatic controls, electronic controls, instrumentation, and heat pumps. These systems include heating, ventilating, air conditioning, and refrigerating (HVAC/R).

Students will learn the theory and fundamentals of mechanical equipment and be exposed to hands-on training in sophisticated training laboratories. Laboratory equipment that students will work with include a water cooled chiller, cooling towers, steam and hot water boilers, thermal energy storage system, heat reclaim system, power management system, packaged and split system air conditioners, furnaces, and high, medium, and low temperature refrigeration systems. Students will also configure, program, and commission several Direct Digital Control (DDC) Systems, pneumatic systems, variable frequency drive (VFD), and programmable logic controllers (PLC), and work directly on the operating systems in the laboratory facility.

The program includes both day and evening lecture and laboratory class sections. Classes are conducted as both lecture and laboratory. Effective writing, verbal communication, electronic communication, sketching, drafting, mechanical calculations, and computer skills are emphasized across the curriculum.

Recommended High School Preparation

Completion of college preparatory English and general mathematics courses is highly desirable but not required. Courses in drafting, algebra, and computer fundamentals will be beneficial.

Program Costs

In addition to normal student expenses such as tuition and textbooks, MET students must purchase safety glasses for use in laboratory and shop classes. If this fee creates a financial burden, students should consult the Financial Aid Office for possible assistance.

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<td>MET 381</td>
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<tr>
<td>MET 383</td>
<td>Instrumentation</td>
<td>3</td>
</tr>
<tr>
<td>MET 384</td>
<td>Automatic Control Systems II</td>
<td>3</td>
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</table>
Student Learning Outcomes

Upon completion of this program, the student will be able to:

- apply problem-solving and analytical thinking skills in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- utilize tools and equipment in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- demonstrate an understanding of the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- commission an HVAC mechanical system and a Direct Digital Control (DDC) system.
- demonstrate an understanding of the techniques and practices of measuring and optimizing the energy efficiency of mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- apply knowledge of commissioning to better meet entry level and advanced employment standards.
- recognize the importance of proper handling of refrigerants and the environmental impact of improper refrigerant management.
- operate and troubleshoot both a water boiler and low pressure steam boiler system, pumping and piping systems, and related heating equipment.
- design a heating-cooling system for a residential and commercial application from concept to finish.
- explain the operation of chilled water systems, air distribution, variable air volume systems, thermal storage, cooling towers, and energy management.
- evaluate and improve air conditioning problem-solving skills.
- apply knowledge of how to measure and optimize the energy efficiency of mechanical systems to better meet entry level and advanced employment standards.
- demonstrate an understanding of electrical circuits and controls.
- design an electrical control schematic and troubleshoot various electrical equipment.
- utilize freehand sketching and drafting skills for use in field applications.
- utilize tools and equipment in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- apply problem-solving and analytical thinking skills in the maintenance, operation, testing, troubleshooting, and repair of heating, cooling, and refrigeration systems, accessories, and controls.
- recognize the importance of proper handling of refrigerants and the environmental impact of improper refrigerant management.
- operate and troubleshoot both a water boiler and low pressure steam boiler system, pumping and piping systems, and related heating equipment.
- design a heating-cooling system for a residential and commercial application from concept to finish.
- explain the operation of chilled water systems, air distribution, variable air volume systems, thermal storage, cooling towers, and energy management.
- evaluate and determine the need for periodic equipment maintenance and demonstrate an understanding of a maintenance contract.

Career Information

Upon completion of the MET program, students may find employment in the following industry sectors: government (federal, state, county, and city agencies), health care, commercial air conditioning and refrigeration service/repair, utilities, construction, facilities management, engineering, high technology, food production, and manufacturing. Typical job titles include: stationary engineer, air conditioning and refrigeration technician, maintenance mechanic, boiler operator, automatic control technician, wholesale and manufacturer’s sales representative.

Certificate

Commercial Building Energy Auditing and Commissioning Specialist Certificate

The Commercial Building Energy Auditing and Commissioning Specialist Certificate of Achievement is designed to meet the high industry demand for the unique skills needed to managing energy and the commissioning of new and existing facilities. The United States Green Building Council has proclaimed commissioning to be mandatory to achieve Leadership in Energy and Environmental Design (LEED) certification. This program will help students meet the Energy and Building Commissioning standards and is designed to help the student learn the information and skills necessary to begin working in the industry. Safety, environmental impact issues, indoor air quality, and equipment maintenance and operation will be emphasized throughout the program.

Catalog Date: June 1, 2020

Certificate Requirements

<table>
<thead>
<tr>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET 391</td>
<td>Mechanical Systems Commissioning</td>
<td>2.5</td>
</tr>
<tr>
<td>MET 392</td>
<td>Energy Management and Efficiency for HVAC Systems</td>
<td>2.5</td>
</tr>
<tr>
<td>MET 393</td>
<td>Commercial Building Energy Audits and Calculations</td>
<td>2.5</td>
</tr>
<tr>
<td>MET 396</td>
<td>Air and Water Balance of Mechanical Equipment</td>
<td>2.5</td>
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<tr>
<td>Total Units</td>
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<td>10</td>
</tr>
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</table>

Student Learning Outcomes

Upon completion of this program, the student will be able to:

- demonstrate an understanding of the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- apply knowledge of commissioning to better meet entry level and advanced employment standards.
- demonstrate an understanding of the techniques and practices of measuring and optimizing the energy efficiency of mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- apply knowledge of how to measure and optimize the energy efficiency of mechanical systems to better meet entry level and advanced employment standards.
- evaluate and improve air conditioning problem-solving skills.
- solve air conditioning system problems with the use of industry specific computer applications.

Career Information
Mechanical-Electrical Technology (MET) Courses

MET 250 Introduction to Mechanical-Electrical Technology

Units: 1
Hours: 18 hours LEC
Prerequisite: None.
Catalog Date: June 1, 2020

This introductory course is designed for potential heating, ventilation, and air conditioning/refrigeration (HVAC/R) career professionals such as stationary engineers, commercial refrigeration technicians, commercial HVAC/R control technicians, and residential air conditioning technicians. In this course, students will explore the available career opportunities, be introduced to the fundamentals of refrigeration and technical math associated with this field, and learn the requirements for a certificate in Commercial Building Energy Auditing and Commissioning Specialist, Mechanical-Electrical Technology, Mechanical Systems Technician, and completing the Associate in Science degree in Mechanical-Electrical Technology. A final grade of "C" or better is necessary to move on to MET 256, 257, 351, and 352.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- identify career opportunities in the heating, ventilation, and air conditioning/refrigeration industry.
- identify the basic components of a refrigeration system.
- describe the basic theory of heat transfer and how it is applied to a refrigeration system.
- perform a fundamental technical math calculation using unit cancellation.

MET 256 Fundamentals of Instruments and Electricity

Units: 1.5
Hours: 27 hours LEC
Prerequisite: MET 250 with a grade of "C" or better
Advisory: MET 257, MET 351 and MET 352 with a grade of "C" or better or concurrent enrollment in MET 257, MET 351 and MET 352.
Catalog Date: June 1, 2020

This course introduces the student to the fundamentals of electrical instruments and concepts required in commercial and industrial practice. Units of instruction include: fundamentals of electricity, Ohms law, use of voltmeters, ammeters, ohmmeters, series and parallel circuits, wiring diagrams, and electromagnetic theory. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain basic electrical concepts, such as ohms law, practical application of the theory of induction, and correct sizing of electrical conductors.
- explain when, why, and how to use voltmeters, ammeters, and ohmmeters.
- use mathematical concepts related to the study of electricity.

MET 257 Fundamentals of Workplace Success

Units: 1.5
Hours: 27 hours LEC
Prerequisite: MET 250 with a grade of "C" or better
Advisory: MET 256, MET 351 and MET 352 with a grade of "C" or better or concurrent enrollment in MET 256, MET 351 and MET 352.
Catalog Date: June 1, 2020

This course provides the student with basic workplace skills needed to enter the workforce as a machinery systems technician. Units of instruction include: teamwork, ethics, diversity, communication skills, writing e-mail messages, Internet websites, conflict resolution, critical thinking, problem solving, conflict resolution, career management, sexual harassment, and drug and alcohol use. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- define workplace success, proper attitudes, culture, politics, and attendance.
- exhibit understanding of workplace teamwork, diversity, accountability, quality, and work ethics.
- write cover letters and resumes for technical employment.

MET 294 Topics in Mechanical-Electrical Technology

Units: 0.5 - 4
Hours: 9 - 18 hours LEC
Prerequisite: None.
This is an individualized course developed in cooperation with industry to meet specialized training needs.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- understand and apply principles learned in mechanical-electrical technology.
- interpret refrigeration, heating, air conditioning, ventilation, or water-wastewater treatment data acquired in the laboratory.
- predict outcomes using the principles of mechanical-electrical technology.
- develop analytical reasoning and critical thinking skills as they relate to the study of mechanical-electrical technology.
- apply classroom study through application of planned, supervised, on-the-job experiences.

**MET 295 Independent Studies in Mechanical - Electrical Technology**

<table>
<thead>
<tr>
<th>Units:</th>
<th>1 - 3</th>
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</thead>
<tbody>
<tr>
<td>Hours:</td>
<td>54 - 162 hours LAB</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>None.</td>
</tr>
<tr>
<td>Catalog Date:</td>
<td>June 1, 2020</td>
</tr>
</tbody>
</table>

This course is designed to provide student's additional on-hands experience in the Mechanical Electrical Technology related disciplines. To be eligible for independent study, students must be currently enrolled in at least one Mechanical-Electrical Technology course. They must also discuss the study with a professor in this subject and secure approval.

**MET 351 Basic Mechanical Systems**

<table>
<thead>
<tr>
<th>Units:</th>
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</thead>
<tbody>
<tr>
<td>Hours:</td>
<td>54 hours LEC; 108 hours LAB</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>MET 250 with a grade of &quot;C&quot; or better</td>
</tr>
<tr>
<td>Advisory:</td>
<td>MET 256, MET 257 and MET 352 with a grade of &quot;C&quot; or better or concurrent enrollment in MET 256, MET 257 and MET 352.</td>
</tr>
<tr>
<td>Transferable:</td>
<td>CSU</td>
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<tr>
<td>Catalog Date:</td>
<td>June 1, 2020</td>
</tr>
</tbody>
</table>

This course is designed to introduce the student to the theoretical and practical applications of basic mechanical systems utilized in heating, ventilation, air conditioning, refrigeration, steam power generation, and the treatment of water for use in mechanical systems. Additional studies include fundamental laws of heat; theory of refrigeration and refrigerants; installation, operation, and testing of refrigeration units; and safe, efficient use of related hand, heat, and power tools. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- apply problem-solving skills to the maintenance, operation, and repair of mechanical systems.
- utilize tools and equipment in the maintenance, operation, and repair of mechanical systems.
- explain the theory and demonstrate practical applications of basic mechanical systems utilized in refrigeration, heating, cooling, steam power generation, and the treatment of water for use in mechanical systems.

**MET 352 Mechanical Systems Calculations**

<table>
<thead>
<tr>
<th>Units:</th>
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<tbody>
<tr>
<td>Hours:</td>
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<tr>
<td>Prerequisite:</td>
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<tr>
<td>Advisory:</td>
<td>MET 256, MET 257 and MET 351 with a grade of &quot;C&quot; or better or concurrent enrollment in MET 256, MET 257 and MET 351.</td>
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<tr>
<td>Transferable:</td>
<td>CSU</td>
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<tr>
<td>General Education:</td>
<td>AA/AS Area II(b)</td>
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This course focuses on building mathematical skills specific to the mechanical-electrical trades; problem solving using metric (SI) units and English and metric unit conversions; solution of word problems involving length, area, volume, weight, strength of materials, work, power, energy, and efficiencies; exponents, scientific notation, and roots; problem solving using graphs and tables; algebraic solutions to applied problems; freehand sketching employing multiview, isometric, and oblique drawing methods; and lettering and dimensioning. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- solve calculations related to Mechanical-Electrical Technology courses and mechanical systems using unit cancellation.
- demonstrate problem-solving abilities and practical analytical thinking skills.
- demonstrate freehand sketching and drafting skills for use in mechanical-electrical field applications.

**MET 360 Mechanical Systems Maintenance**

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<tr>
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<tbody>
<tr>
<td>Hours:</td>
<td>27 hours LEC</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>MET 351 with a grade of &quot;C&quot; or better</td>
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<tr>
<td>Transferable:</td>
<td>CSU (effective Summer 2020)</td>
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<td>Catalog Date:</td>
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</table>
This course introduces the student to maintenance concepts for basic mechanical systems. Units of instruction include coil maintenance, filter management, indoor air quality, lubrication, belts and drives, verifying operation, monitoring equipment, and maintenance contracts. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes
Upon completion of this course, the student will be able to:

- explain the theory and demonstrate practical applications of mechanical system maintenance.
- define the parts of a maintenance contract.
- analyze and determine the need for periodic equipment maintenance of various mechanical systems.

MET 361 Refrigeration Systems

<table>
<thead>
<tr>
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<tr>
<td>Hours:</td>
<td>36 hours LEC; 54 hours LAB</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>MET 351 with a grade of &quot;C&quot; or better</td>
</tr>
<tr>
<td>Advisory:</td>
<td>MET 352 with a grade of &quot;C&quot; or better. Concurrent enrollment in MET 362, MET 363, and MET 364.</td>
</tr>
<tr>
<td>Transferable:</td>
<td>CSU</td>
</tr>
<tr>
<td>Catalog Date:</td>
<td>June 1, 2020</td>
</tr>
</tbody>
</table>

This course is devoted to the study of residential and commercial refrigeration systems and equipment. Students learn about mechanical compression and refrigeration devices: their operating characteristics, common applications and typical servicing procedures, and related safety practices. Hand tools, power tools, and test instruments are used by the student in lab to repair and service refrigeration devices. Students gain additional experience by analyzing system performance with pressure-enthalpy diagrams. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes
Upon completion of this course, the student will be able to:

- apply problem-solving skills to the maintenance, operation, and repair of refrigeration systems.
- utilize tools and equipment in the maintenance, operation, and repair of refrigeration systems.
- demonstrate an understanding of the theory and practical applications of refrigeration equipment, accessories, and controls.

MET 362 Refrigeration Systems Calculations

<table>
<thead>
<tr>
<th>Units:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours:</td>
<td>54 hours LEC</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>MET 351 and 352 with grades of &quot;C&quot; or better</td>
</tr>
<tr>
<td>Advisory:</td>
<td>MET 361, MET 363, and MET 364 with a grade of &quot;C&quot; or better or concurrent enrollment in MET 361, MET 363, and MET 364.</td>
</tr>
<tr>
<td>Transferable:</td>
<td>CSU</td>
</tr>
<tr>
<td>Catalog Date:</td>
<td>June 1, 2020</td>
</tr>
</tbody>
</table>

This course focuses on mathematical problems involving English and metric (SI) units concerned with installation, operations, and maintenance of commercial and industrial refrigeration systems. Emphasis will be placed on basic heat transfer, loads, piping, equipment performance, and economic factors. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes
Upon completion of this course, the student will be able to:

- apply problem-solving skills to refrigeration equipment and systems.
- estimate the cost of a refrigeration system installation including materials, labor, and profit.
- analyze manufacturer’s data of equipment performance and economic factors related to refrigeration equipment.

MET 363 Refrigerant Transition and Recovery Processes and Procedures

<table>
<thead>
<tr>
<th>Units:</th>
<th>1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours:</td>
<td>27 hours LEC</td>
</tr>
<tr>
<td>Prerequisite:</td>
<td>MET 351 with a grade of &quot;C&quot; or better</td>
</tr>
<tr>
<td>Advisory:</td>
<td>MET 361, MET 362, and MET 364 with a grade of &quot;C&quot; or better or concurrent enrollment in MET 361, MET 362, and MET 364.</td>
</tr>
<tr>
<td>Transferable:</td>
<td>CSU</td>
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<tr>
<td>Catalog Date:</td>
<td>June 1, 2020</td>
</tr>
</tbody>
</table>

This course focuses on the recovery and recycling of existing refrigerants, the transition to environmentally safe refrigerants, and the preparation for certification testing in refrigerant handling as mandated by the Clean Air Act, 40 CFR, part 82, subpart F and regulated by the Environmental Protection Agency (EPA). Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes
Upon completion of this course, the student will be able to:

- demonstrate the necessary skills to successfully take the HVAC/R industry required Federal Refrigerant Transition and Recovery Certification license examination.
- recognize the importance of proper handling of refrigerants.
- examine the environmental impact of improper refrigerant management.

MET 364 Electrical Controls
This course provides instruction in power and control circuits and devices used with refrigeration, heating, cooling, and pumping mechanical systems. Units of instruction include a study of electron theory, magnetism, induction, alternating current, direct current, resistance, and capacitance. Students will practice using electrical meters and test instruments in the laboratory. Electrical safety practices will also be covered. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- to explain an understanding of electrical theory, electrical circuits, circuit interpretation, and related electrical phenomenon.
- design an electrical control schematic for a refrigeration system.
- troubleshoot various electrical circuits.
- draw various types of refrigeration control circuits.

**MET 368 Heat Pump Operation and Maintenance**

| Units: | 3 |
| Hours: | 36 hours LEC; 54 hours LAB |
| Prerequisite: | MET 256, 351, and 352 with grades of "C" or better |
| Advisory: | MET 361, MET 362, and MET 363 with a grade of "C" or better or concurrent enrollment in MET 361, MET 362, and MET 363. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

This course provides instruction in basic refrigeration and heat pump theory, cooling and heating cycles, defrost cycles, controls, supplemental heat, flow control devices, and heat load calculations. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- explain basic refrigeration and heat pump theory.
- explain heat pump cooling and heating cycles.
- evaluate heat pump controls, defrost cycles, supplemental heat, and flow control devices.
- design a heating-cooling system for a residential application from concept to finish.

**MET 371 Heating and Power Machinery**

| Units: | 3 |
| Hours: | 36 hours LEC; 54 hours LAB |
| Prerequisite: | MET 351, 360, and 364 with grades of "C" or better |
| Advisory: | MET 372, MET 373, and MET 374 with a grade of "C" or better or concurrent enrollment in MET 372, MET 373, and MET 374. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

This course provides instruction on warm air furnaces, hydronic heating, hot water solar systems, and steam and power plant systems. Instruction includes pumps, pumping head calculations, combustion principles, steam and hot water boilers, warm air furnaces, boiler safety and operating controls, and boiler emissions. Laboratory activities include operation, testing, maintenance, and troubleshooting of warm air furnaces and steam/hot water heating systems. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- explain the theory and practice of heating and power machinery.
- operate and troubleshoot a low pressure steam boiler system and related heating equipment.
- describe pumps and piping systems.

**MET 372 Power Machinery, Heating and Air Conditioning Calculations**

| Units: | 3 |
| Hours: | 54 hours LEC |
| Prerequisite: | MET 361 and 362 with grades of "C" or better |
| Advisory: | MET 371, MET 373, and MET 374 with a grade of "C" or better or concurrent enrollment in MET 371, MET 373, and MET 374. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

This course focuses on mathematical problems involving English and metric (SI) units concerned with installation, operation, and maintenance of power machinery, and heating and air conditioning systems. Emphasis will be placed on heat transfer, heating and cooling loads, pipe and pump sizing, steam and hot water system performance, psychrometrics, and duct sizing calculations. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:
MET 373 Piping, Electrical, and Sheet Metal Drafting

Units: 3
Hours: 36 hours LEC; 54 hours LAB
Prerequisite: MET 360, 361, and 364 with grades of "C" or better
Advisory: MET 371, MET 372, and MET 374 with a grade of "C" or better or concurrent enrollment in MET 371, MET 372, and MET 374.
Transferable: CSU
Catalog Date: June 1, 2020

This course provides instruction in the design of mechanical and piping systems. Units of instruction include mechanical, electrical, and plumbing codes, recognition of standard symbols, computer aided drawing applications, and construction terms and specifications. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- demonstrate problem-solving skills involved in mechanical and electrical systems.
- demonstrate analytical thinking skills related to mechanical and electrical systems.
- solve problems required for the design of piping and ducting for mechanical and electrical systems.

MET 374 Automatic Control Systems I

Units: 3
Hours: 36 hours LEC; 54 hours LAB
Prerequisite: MET 361 and 364 with grades of "C" or better
Advisory: MET 371, MET 372, and MET 373 with a grade of "C" or better or concurrent enrollment in MET 371, MET 372, and MET 373.
Transferable: CSU
Catalog Date: June 1, 2020

This is the first of two courses (see MET 384) that focus on the study of controls and devices used in heating, ventilation, air conditioning, pumping, water treatment, and manufacturing systems. Units of instruction include control theory, final control devices, and pneumatic control systems. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- demonstrate how to calibrate a pneumatic thermostat.
- demonstrate how to program a Programmable Logic Controller.

MET 378 Geothermal Heat Pump Operation and Maintenance

Units: 3
Hours: 54 hours LEC
Prerequisite: MET 366, 351, and 352 with grades of "C" or better
Transferable: CSU
Catalog Date: June 1, 2020

This course provides instruction in basic geothermal heat pump theory, cooling and heating cycles, load calculations, cost analysis, open and closed water loop systems, system diagnostics, and solar applications. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- demonstrate an understanding of basic refrigeration and geothermal heat pump theory.
- explain geothermal heat pump cooling and heating cycles.
- demonstrate an understanding of how to evaluate geothermal heat pump controls, defrost cycles, supplemental heat, and flow control devices.
- design a heating-cooling geothermal heat pump system for a residential or light commercial application from concept to finish.

MET 381 Air Conditioning

Units: 3
Hours: 36 hours LEC; 54 hours LAB
Prerequisite: MET 371 and 372 with grades of "C" or better
Advisory: MET 382, MET 383, and MET 384 with a grade of "C" or better or concurrent enrollment in MET 382, MET 383, and MET 384.
Transferable: CSU
Catalog Date: June 1, 2020

This course provides instruction in the design, operation, and maintenance of commercial and industrial air conditioning systems. Instruction includes study of air distribution, variable air volume systems, refrigeration compressors, absorption air conditioning systems, helical-rotary and centrifugal water chillers, chilled water systems, thermal storage, cooling towers, and hot water solar systems, and energy...
management. Students will gain practical experience by operating commercial air conditioning systems. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- demonstrate the ability to check for correct refrigerant charge on a air conditioning systems.
- demonstrate the ability to replace a refrigerant compressor.
- analyze the amount of energy saved by utilizing a thermal storage system.

**MET 382 Air Conditioning Systems Calculations**

| Units: 3 |
| Hours: 54 hours LEC |
| Prerequisite: MET 372 with a grade of "C" or better |
| Advisory: MET 381, MET 383, and MET 384 with a grade of "C" or better or concurrent enrollment in MET 381, MET 383, and MET 384. |
| Transferable: CSU |
| Catalog Date: June 1, 2020 |

This course provides an introduction to the use of computer applications in solving problems concerned with the design, installation, and operation of air conditioning systems. Units of instruction include calculating heating and cooling loads, piping, air distribution, equipment selection, and psychrometric and economic analysis. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- evaluate and improve air conditioning problem-solving skills.
- solve air conditioning system problems with the use of industry specific computer applications.
- design commercial air conditioning systems.
- estimate commercial air conditioning systems.

**MET 383 Instrumentation**

| Units: 3 |
| Hours: 36 hours LEC; 54 hours LAB |
| Prerequisite: MET 371, 372, 373, and 374 with grades of "C" or better |
| Advisory: MET 381, MET 382, and MET 384 with grades of "C" or better or concurrent enrollment in MET 381, MET 382, and MET 384. |
| Transferable: CSU |
| Catalog Date: June 1, 2020 |

This course provides instruction in the theory and practice of using instruments for testing and analyzing the operation of refrigerating, air conditioning, mechanical, electrical, and building systems. Units of instruction include a study of measurement principles including temperature, humidity, flow, light, sound, velocity, pressure, combustion emissions, air quality, voltage, level, force, and vibration. Laboratory activities will emphasize the practical applications of sensors and measuring instruments. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- describe different types of instruments used to measure and record temperature, humidity, flow, light, sound, velocity, pressure, combustion emissions, air quality, voltage, level, force, and vibration.
- demonstrate skills in using measuring, indicating, and recording instruments for industrial mechanical and electrical systems.

**MET 384 Automatic Control Systems II**

| Units: 3 |
| Hours: 36 hours LEC; 54 hours LAB |
| Prerequisite: MET 371 and 374 with grades of "C" or better |
| Advisory: MET 381, MET 382, and MET 383 with a grade of "C" or better or concurrent enrollment in MET 381, MET 382, and MET 383. |
| Transferable: CSU |
| Catalog Date: June 1, 2020 |

This is the second of two courses (see MET 374) that focus on the study of controls and devices used in heating, ventilation, air conditioning, pumping, water treatment, and manufacturing systems. Units of instruction include electronic and direct digital controls, networks, interoperable systems, and programming of controllers. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

**Student Learning Outcomes**

Upon completion of this course, the student will be able to:

- describe electronic and direct digital controls.
- apply knowledge of automatic controls to better meet entry level and advanced employment standards.
- design and program a direct digital control system.
This course focuses on the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, renewable and sustainable energy, and water treatment. Units of instruction include energy conservation; developing and implementing a comprehensive commissioning plan; inspection and testing of control systems; mechanical equipment, and field devices and user interfaces to ensure that they are installed, programmed, and operated precisely as the design intends. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- apply knowledge of commissioning to better meet entry level and advanced employment standards.
- commission an HVAC mechanical system and a Direct Digital Control (DDC) system.

MET 392 Energy Management and Efficiency for HVAC Mechanical Systems

This course focuses on the theory, techniques, and practices of analyzing all aspects of large commercial building operations and correlating a building envelope’s interaction with the mechanical systems. Students will review the concepts and principles of the design of commercial heating, ventilating, and air conditioning (HVAC) systems and direct digital controls (DDC). This course will introduce the economics of operating electrical and mechanical equipment, methods of acquiring HVAC equipment performance data through the use of portable data loggers and DDC control systems and using that data to improve operations and reduce energy consumption. Discussions will include current industry practices for energy conservation, utility rate schedules and rebate programs, overview of California Energy Code and LEED – Leadership in Energy and Environmental Design, and the U. S. Green Building Council rating system. Components of this course may be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain the techniques and practices of measuring and optimizing the energy efficiency of mechanical systems that are used in heating, ventilating, air conditioning, pumping, and water treatment.
- apply knowledge of how to measure and optimize the energy efficiency of mechanical systems to better meet entry level and advanced employment standards.
- measure and optimize the energy efficiency of an HVAC mechanical system, thermal storage system, and a Direct Digital Control (DDC) system.

MET 393 Commercial Building Energy Audits and Calculations

This course focuses on the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, renewable and sustainable energy, and water treatment. Units of instruction include energy conservation; developing and implementing a comprehensive commissioning plan; inspection and testing of control systems; mechanical equipment, and field devices and user interfaces to ensure that they are installed, programmed, and operated precisely as the design intends. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- develop and execute energy audits of large commercial buildings.
- explain the techniques and practices of modeling the energy efficiency of mechanical systems that are used in heating, ventilating, and air conditioning (HVAC).
- apply knowledge of an energy model documenting compliance with California’s Title 24 Energy Standards to better meet entry level and advanced employment standards.
- model and optimize the energy efficiency of complex HVAC mechanical systems, including a thermal storage system and energy efficiency measures such as daylighting.
- describe the capabilities and limitations of energy models and how to effectively use energy modeling.
- describe energy conservation techniques that can be applied to heating, ventilating and cooling, and equipment to optimize the utility costs and water consumption.
- use a Building Energy Performance Index (BEPI) and other techniques to track energy consumption.

MET 395 Water Treatment for Heating and Air Conditioning Equipment

This course focuses on the theory, techniques, and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, renewable and sustainable energy, and water treatment. Units of instruction include energy conservation; developing and implementing a comprehensive commissioning plan; inspection and testing of control systems; mechanical equipment, and field devices and user interfaces to ensure that they are installed, programmed, and operated precisely as the design intends. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain the techniques and practices of commissioning controls and mechanical systems that are used in heating, ventilation, air conditioning, pumping, and water treatment.
- apply knowledge of commissioning to better meet entry level and advanced employment standards.
- commission an HVAC mechanical system and a Direct Digital Control (DDC) system.
This course focuses on basic mechanical system water sides theories of corrosion, scaling, and algae-slime growth-corrosion inhibition, chemicals and feed-bleed-blowdown systems; scaling inhibition, chemicals, and feed-blowdown systems; algae inhibition and chemicals; testing methods, kits, and instruments; and water quality standards. Components of this course may be offered online. Students may be required to have access to a computer and the Internet and have some familiarity with a computer.

### Student Learning Outcomes

Upon completion of this course, the student will be able to:

- detect when a mechanical system needs water treatment.
- explain the importance of water treatment of mechanical systems.
- describe basic mechanical system water treatment tests.
- explain the more complex aspects of water treatment of mechanical systems.

### MET 396 Air and Water Balance of Mechanical Equipment

| Units: | 2.5 |
| Hours: | 36 hours LEC; 27 hours LAB |
| Prerequisite: | MET 381, 383, and 384 with grades of "C" or better; or four years of field experience in commercial HVAC design, installation, repair, or operation. |
| Advisory: | MET 391 and MET 392 with a grade of "C" or better or concurrent enrollment in MET 391 and MET 392. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

This course focuses on air and water flow theory; air and water systems and components; air flow measuring instruments, their calibration, and use; and typical water flow balance work. Components of this course will be offered online. Students will need to have access to a computer and the Internet and have some familiarity with a computer.

### Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain air and water balance related to mechanical heating, cooling, and refrigeration systems.
- explain how air and water balance is accomplished for mechanical heating, cooling, and refrigeration systems.
- describe the importance of air and water balance for mechanical heating, cooling, and refrigeration systems.
- explain how to determine when a mechanical heating, cooling, or refrigeration systems is out of balance.

### MET 495 Independent Studies in Mechanical-Electrical Technology

| Units: | 1 - 3 |
| Hours: | 54 - 162 hours LAB |
| Prerequisite: | None. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

Independent Study is an opportunity for the student to extend classroom experience in this subject, while working independently of a formal classroom situation. Independent study is an extension of work offered in a specific class in the college catalog. To be eligible for independent study, students must have completed the basic regular catalog course at Sacramento City College. They must also discuss the study with a professor in this subject and secure approval. Only one independent study for each catalog course will be allowed.

### Student Learning Outcomes

Upon completion of this course, the student will be able to:

- produce work independently on Mechanical-Electrical Technology topics.

### MET 499 Experimental Offering in Mechanical-Electrical Technology

| Units: | 0.5 - 4 |
| Prerequisite: | None. |
| Transferable: | CSU |
| Catalog Date: | June 1, 2020 |

### Faculty

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Business and Industry
(/academics/meta-majors/business-and-industry)
This program is part of the Business and Industry meta major.

BUSINESS AND INDUSTRY ➔ (/ACADEMICS/META-MAJORS/BUSINESS-AND-INDUSTRY)