

# ATSM-2816: SPECIAL TOPICS: SHEET METAL: ELECTRICITY

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## Cuyahoga Community College

**Viewing: ATSM-2816 : Special Topics: Sheet Metal: Electricity**

**Academic Term:**

Fall 2019

**Subject Code**

ATSM - Applied Ind Tech- Sheetmetal

**Course Number:**

2816

**Title:**

Special Topics: Sheet Metal: Electricity

**Catalog Description:**

Course covering basic electricity and magnetism required for servicing HVAC equipment in residential and light commercial buildings. Automatic controls used to maintain temperature and humidity is included. Various motor types and motor phases along with service and shop exercises and application are integrated.

**Credit Hour(s):**

3

**Lecture Hour(s):**

3

## Requisites

**Prerequisite and Corequisite**

Departmental approval and/or a union sheet metal apprentice or a union sheet metal journeyman.

## Outcomes

**Course Outcome(s):**

Discuss the basics of electricity and magnetism with respect to currents, electrical formulas and components including equipment and functions.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. List and define the terms related to electricity and magnetism.
2. Explain the purpose of electricity and magnetism with respect to the Heating Ventilation and Air Conditioning HVAC technician.
3. Discuss electrical theory in terms of Ohm's Law with respect to voltage, amperage resistance and applications.
4. Differentiate between alternating and direct current.
5. Apply basic math concepts to calculate various voltages, amperes and resistances.
6. Explain how wire size affects the operation of electrical components and equipment.
7. Differentiate between conductors and insulators.
8. Describe the function of a transformer and explain the operation of its individual components.
9. Explain how transformers are sized to ensure proper amp draw of respective equipment.

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**Course Outcome(s):**

Discuss the automatic controls used to maintain temperature and humidity of various room sizes related to residential and commercial applications and identify the safety devices protecting equipment and respective components.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. List and define the terms related to automatic controls.
2. Explain the function of temperature controls and describe the different applications.
3. List the different types of automatic controls used for temperature managements.
4. Describe how electronic controls are used to govern system overshoot and temperature swing.
5. Differentiate between high and low voltage controls.
6. Name two ways motors are protected from high voltage in order to prevent fire or equipment failure.
7. Describe the function and application of pressure sensitive controls.
8. Explain how pressure transducers interface with microprocessors by converting sensed pressure into electronic signals.

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**Course Outcome(s):**

Identify the different types of motors used in the HVAC industry, describe the respective components of each and list and describe the application in the various operations of related equipment.

**Essential Learning Outcome Mapping:**

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

**Objective(s):**

1. List and define the terms related to electric motors and electric motor applications.
2. Describe the different types of open single phase motors.
3. Explain how different speeds are obtained in a single phase application.
4. Explain how electrical frequency is used to control operational speed in a 3-phase motor.
5. Describe the cooling process use for maintaining operating temperature in hermetic systems.
6. Discuss the importance of proper terminal connections in different motor applications..
7. Describe the operation of high efficiency motors and explain the rating process used.

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**Methods of Evaluation:**

class participation; quizzes; test;

Student must demonstrate the ability to perform shop projects in accordance with proficiency in accordance with current electrical standards.

**Course Content Outline:**

1. Electricity and magnetism
  - a. Terminology
    - i. Electricity
    - ii. Voltage
    - iii. Capacitance
    - iv. Resistance
    - v. Magnetism
    - vi. Watts
    - vii. Solenoid
  - viii. Conductor
  - ix. Insulator
  - x. Sine wave
  - xi. Current
  - xii. Multi meter
  - xiii. Ohm's Law
  - xiv. Transformer
  - xv. Service technician
  - xvi. Amp draw
  - xvii. Phase
  - xviii. EMF
  - xix. AWG
  - xx. Series

- xxi. Parallel
- xxii. Semi-conductor
- b. Purpose of electricity/magnetism/service
  - i. Primary service call
    - 1. Equipment malfunction
    - 2. Excessive energy use
    - 3. Maintenance
  - ii. Malfunction
    - 1. Motor
    - 2. Contacts
    - 3. Thermostat
    - 4. Relay switch
    - 5. Safety controls
    - 6. Refrigeration cycle
- c. Ohm' Law
  - i. Voltage = Amperage x Resistance
  - ii. Amperage = Voltage/Resistance
  - iii. Resistance = Voltage/Amperage
  - iv. Applications
    - 1. Series circuit
    - 2. Parallel circuit
- 1. Alternating versus Direct current
  - a. AC
    - i. Single phase
    - ii. 3 phase
    - iii. Sine wave
    - iv. General use
      - 1. Residences
      - 2. Common appliances
      - 3. Standard equipment
      - 4. 24v-480v
  - b. DC
    - i. Communications
    - ii. Control circuits
    - iii. Electronically commutated motor
- 1. Math concepts
  - a. Basic whole numbers
    - i. Addition
    - ii. Subtraction
    - iii. Multiplication
    - iv. Division
  - b. Fractions
  - c. Decimals
  - d. Conversions
  - e. Applications
    - i. Ohm's Law
      - 1. Voltage
      - 2. Amperes
      - 3. Resistance
    - ii. Wattage
      - 1. BTU conversion
      - 2. potential difference
- 1. Wire size
  - a. Sizes
    - i. 18 gauge
    - ii. 16 gauge
    - iii. 14 gauge
    - iv. 12 gauge
    - v. 10 gauge

- vi. 8 gauge
- vii. 6 gauge
- viii. 4 gauge
- ix. 2 gauge
- b. AWG
  - i. Standardized wire system
  - ii. Establish wire diameter
- c. Wire size effects
  - i. Amperage
  - ii. Voltage
- d. Effects on components
  - i. Overheating
  - ii. Fire potential
  - iii. Component failure
- e. Effects on equipment
  - i. Increased operating cost
  - ii. Shorter life span
  - iii. Excessive energy use
- 2. Conductors vs insulator
  - a. Conductors
    - i. Wire
    - ii. Copper
    - iii. Aluminum
    - iv. Silver
    - v. Gold
    - vi. Mercury
  - b. Applications
    - i. Circuit boards –gold
    - ii. General use-copper
    - iii. Thermometers-mercury
    - iv. Circuit breaker –silver
    - v. Contacts-silver
- 1. Insulators
  - a. Glass
  - b. Rubber
  - c. Plastic
  - d. uses
    - i. Prevent grounding
    - ii. Heat control
    - iii. Safety
- 2. Transformers
  - a. Function
    - i. Voltage reduction
    - ii. Voltage increase
  - b. Types
    - i. Step up
    - ii. Step down
  - c. Component
    - i. Coil
      - 1. Primary
      - 2. Secondary
    - ii. Core
  - d. Component operation
    - i. Applied
    - ii. Induced
    - iii. Magnetic field generator
- 3. Transformer size
  - a. Rating equals volts times amps (V) (A)
  - b. Range 10 to 75 VA

- c. Purpose
  - i. Adequate voltage
  - ii. Equipment protection
  - iii. Overload protection
- 1. Automatic controls
  - a. Terminology
    - i. Thermocouple
    - ii. Transducer
    - iii. Control bulb
    - iv. Sensed pressure
    - v. Operational device
    - vi. Safety control
    - vii. Automatic re-set
    - viii. Manual re-set
    - ix. System lag
    - x. System overshoot
    - xi. Temperature swing
    - xii. Thermostat
    - xiii. Heat anticipator
    - xiv. Bi metal
    - xv. Snap disc
    - xvi. Thermopile
    - xvii. Limit switch
    - xviii. Regulator
    - xix. Relay
    - xx. contactor
  - b. Temperature control: function and application
    - i. Function
      - 1. Temperature management
      - 2. Safety device
      - 3. Humidity
    - ii. Application
      - 1. Thermostat
      - 2. Refrigeration
      - 3. Heating
      - 4. HVAC equipment
  - c. Automatic control types
    - i. Electrical
      - 1. High voltage
      - 2. Low voltage
    - ii. Mechanical
      - 1. Water pressure regulator
      - 2. Gas regulator
- 1. Electro mechanical
  - a. Relay
  - b. Contactor
- 2. Electronic
  - a. Digital thermostat
  - b. Control board
- 3. Pneumatic
  - a. System sequence
    - i. Air compressor
    - ii. Dryer
    - iii. Thermostat
    - iv. Actuator
  - b. Early control system
- 4. Electronic controls

- a. System overshoot
  - i. Heat anticipator
  - ii. Prevention control
- b. Temperature swing
  - i. Upper and lower limits
  - ii. Tolerance
  - iii. Room comfort and efficiency
- 5. Voltage controls: high and low
  - a. High voltage
    - i. Industrial application
    - ii. Safety
    - iii. Equipment durability
    - iv. Less accurate
  - b. Low voltage
    - i. Residential
    - ii. Light commercial
    - iii. Greater accuracy
    - iv. Efficient
    - v. Economical
- 6. Motors: high voltage protection
  - a. B metal
    - i. Brass
    - ii. Steel
    - iii. Snap disc
  - b. Safety
    - i. Overheating
    - ii. Fire
  - c. Equipment protection
    - i. Motors
    - ii. Compressors
- 7. Pressure sensitive controls
  - a. Function
    - i. Low pressure
      - 1. Refrigerant controls
      - 2. Compressor protection
      - 3. Safety
    - ii. High pressure
      - 1. High temperature protection
      - 2. Overcharging prevention
  - b. Application
    - i. Residential air conditioning systems
    - ii. Residential furnace
    - iii. Commercial
- 8. Pressure transducers
  - a. Microprocessor interface
    - i. Human interface module
    - ii. Digital read/signaling
  - b. Conversion process
    - i. Sensed pressure to electronic signal
    - ii. Alarm system
    - iii. Operating status report

## Resources

John Tomczyk. . *Refrigeration and Air Conditioning Technology*. . 8th Edition. Cengage: Boston, MA, , 2017.

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Russell Smith. *Electricity for Refrigeration, Heating, and Air Conditioning*. . 10th Edition. Cengage: Boston, MA, 2018.

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**Resources Other**

**Additional Resource**

<https://www.supercoolsliderule.com/>

<http://www.ahrinet.org/>

- **RESOURCES:**
- **Refrigeration and Air Conditioning Technology, 8<sup>th</sup> Edition**
- **Electricity for Refrigeration, Heating, and Air Conditioning, 10<sup>th</sup> Edition**

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