EET-2112: INDUSTRIAL ELECTRONICS

Cuyahoga Community College

Viewing: EET-2112 : Industrial Electronics

Board of Trustees:

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Academic Term:

Fall 2025

Subject Code

EET - Electrical/Electronic Engineer

Course Number:

2112

Title:

Industrial Electronics

Catalog Description:

Construction, theory of operation, performance characteristics relative to the application of DC motors, AC Single phase motors, AC single phase transformers, AC three phase transformers, AC three phase motors, specification and characteristics of power switching devices like triacs and silicon controlled rectifiers, Metal Oxide Semiconductor Field Effect Transistors (MOSFETS), power factor, opto-isolators, power supplies, linear and switch-mode regulators, Pulse Width Modulation (PWM), ground fault circuit interrupters (GFCI), relays, and safety.

Credit Hour(s):

3

Lecture Hour(s):

2

Lab Hour(s):

3

Requisites

Prerequisite and Corequisite

EET-1210 AC Electric Circuits.

Outcomes

Course Outcome(s):

Build and test a power supply.

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Explain the rectifying properties of a diode.
2. Measure the output voltage of a bridge rectifier.
3. Measure and explain ripple.
4. Determine the ripple factor.
5. Demonstrate soldering skills when constructing a power supply.
6. Demonstrate the importance of safety by always wearing safety glasses in a lab environment.
7. Demonstrate the safe use of tools that includes that includes but is not limited to, screw drivers, cutters, strippers, drills, soldering equipment.

Course Outcome(s):
Construct and measure parameters of a linear voltage regulator circuit.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Measure and explain regulation versus a changing load.
2. Measure and explain regulation versus a changing supply voltage.
3. Measure the output ripple voltage.
4. Calculate the ripple rejection ratio.
5. Measure the dropout voltage.
6. Measure the efficiency of a linear mode regulator.

Course Outcome(s):
Construct a switch-mode regulator circuit.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Measure and explain regulation versus a changing load.
2. Measure and explain regulation versus a changing supply voltage.
3. Measure the output ripple voltage.
4. Measure the switching frequency.
5. Measure the dropout voltage.
6. Explain why the efficiency of a switch mode regulator is higher than that of a linear regulator.
7. Measure the efficiency of a switch mode regulator.

Course Outcome(s):
Build and measure parameters that associate with electromechanical relays.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Explain the difference between normally opened (NO) contacts and normally closed contacts (NC).
2. Draw the symbols for NO and NC contacts and explain the meaning of Form A, Form B, Form C and relays that use multiple contacts (two Form A, 2FA, etc.).
3. Measure the pull-in and drop-out voltage and current.
4. Calculate and measure the transients associated with high-side switching.
5. Calculate and measure the transients associated with low-side switching.
6. Measure and explain the transient suppressing nature of a shunting diode.

Course Outcome(s):
Measure and calculate the transfer parameters of an opto-isolator.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Using a datasheet, determine the breakdown voltage from the LED side to the transistor/diode side.
2. Measure the current transfer ratio as a function of the LED current.
3. Explain the meaning of the output transistor being in the cutoff, active or saturation mode.
4. Give examples where opto-isolators are necessary.

Course Outcome(s):

Explain power factor correction and how the power factor is corrected (Power factor refers to the phase angle between voltage and current, not the method to obtain 360 degree conduction in a power supply).

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Explain what power factor is, why electric companies penalize enterprises with a poor power factor and why it raises the loss(es) in the power company's grid.
1. Convert series resistor and inductor (RL) circuits into parallel equivalent circuits.
2. Calculate the value of the capacitor that needs to be placed in parallel with an RL circuit to correct the power factor.
3. Verify the size of the component by recalculating circuit parameters using the specified value of the capacitor.

Course Outcome(s):

Explain and demonstrate the variable effective voltage and power that is afforded by the use of Pulse Width Modulation (PWM).

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Calculate the average DC voltage at various duty cycle percentages.
2. Calculate the AC RMS voltage at various duty cycle percentages.
3. Calculate the erffective voltage at various duty cycle percentages.
4. Explain why PWM which operates the switching device at full on mode (sometimes called saturation) and full off mode (sometimes called cutoff) is more efficient as compared to linear control devices.
4. Demonstrate PWM as applied to control the power to a device (like a motor).

Course Outcome(s):

Explain the operation and measure the controlled output of a Silicon Controlled Rectifier (SCR).

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Display the output waveform of an SCR with various firing angles.
2. Using a data sheet, determine the breakdown and break over voltages.
3. Using a data sheet, determine the rated current.
4. Explain the difference between a triac and SRC.
5. Display the waveform of a diac.
6. Demonstrate the SCR's ability to control power in an electrical circuit.
7. List the limitations of an SRC in an alternating Current (AC) circuit.

Course Outcome(s):
Demonstrate AC Circuit control using a triac.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Display the output waveform of a triac with various firing angles.
2. Using a data sheet, determine the breakdown and break over voltages.
3. Using a data sheet, determine the rated current.
4. Explain the difference between a triac and SRC.
5. Demonstrate the triac's ability to control power in an electrical circuit.

Course Outcome(s):
Characterizing and measuring Metal Oxide Semiconductor Field Effect Transistor (MOSFET) characteristics.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Using a data sheet, determine the threshold voltage for a MOSFET.
2. Measure the effective source to drain resistance (Rds on) for a fully conducting MOSFET.
3. Explain why the DC input resistance of a MOSFET is extremely high.
4. Explain and demostrate the Miller Effect and how it drastically reduces the input impedance of the MOSFET.
5. Explain and calculate the drain voltage of a gate-to-source voltage drive limited circuit.
6. Explain and calculate the drain voltage of load limited circuit.
7. Explain the meaning of Electrostatic Discharge (ESD) and how it can damage a MOSFET.
8. Determine the power dissipation of a MOSFET.

Course Outcome(s):
Explain and measure the torque, RPM, electrical power input and mechanical power output from a Direct Current (DC) motor.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):
1. Measure and compare the differences in torque, RPM, electrical power input and mechanical power output from a shunt, series and compound wound DC motor.
2. Explain the concept of a locked rotor and how it can damage a DC motor.
3. Explain the difference between a permanent magnet and an electromagnetic field supply.
4. Explain the inverse relationship of field current and RPM.
5. Explain and count commutator segments and brushes.
6. Explain the purpose of a commutator.

Course Outcome(s):
Measure the parameters of a squirrel cage Alternating Current (AC) induction motor.

Essential Learning Outcome Mapping:
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Observe the torque, RPM, electrical power input and mechanical power output of a squirrel cage AC motor.
2. Measure the AC RMS voltage at various load points.
3. Explain the concept of a locked rotor and how it can damage a motor.
4. Identify the motor's stator and rotor.
5. Explain the concept of a rotating magnetic field.
6. Identify and explain the need for a starter winding and Centrifugal switch.

Course Outcome(s):

Measure the input and output power, apparent power and reactive power in an industrial transformer.

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Measure and explain why near perfect reactive loads connected to the secondary of the transformer do not dissipate power.
2. Construct a power triangle for inductive, capacitive and resistive loads.
3. Explain how the turns ratio affects the primary and secondary voltage relationship.
4. Explain how the turns ratio affects the primary and secondary current relationship.
5. Explain why the primary power must always be greater than the secondary power.

Course Outcome(s):

Explain and measure the phase relationships in the 3 phase power circuit.

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Determine the line voltage and phase voltage, line current and phase current relationship for a wye connected motor.
2. Determine the line voltage and phase voltage, line current and phase current relationship for a delta connected motor.
3. Determine the line voltage and phase voltage, line current and phase current relationship for a wye connected source.
4. Determine the line voltage and phase voltage, line current and phase current relationship for a delta connected source.
5. Measure and compare the electrical power input and mechanical power output of wye and delta configured motors at various load points.
6. Using software simulation program, display the the three waveforms and measure the difference in degrees between them.

Course Outcome(s):

Write a formal lab report.

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Use correct spelling and grammar.
2. Use equation editor when inserting an equation.
3. Follow the guidelines as specified in the formal lab report document.

Course Outcome(s):

Build and test the course project.

Essential Learning Outcome Mapping:

Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

Objective(s):

1. Demonstrate soldering skills.
2. Demonstrate safety skills when working with tools, soldering equipment and drills.
3. Test the project in accord with the instructions.

Methods of Evaluation:

1. Homework assignments
2. Reports based upon laboratory experiments
3. Laboratory work
4. Midterm exams
5. Final exam
6. Operational class project

Course Content Outline:

1. Concepts
    a. Safety
    b. Polyphase
    c. Electromechanical, electromagnetic
    d. Power Factor
    e. Standards (National electrical Code (NEC), etc.
    f. Switching voltage/current
    g. Power supplies
    h. Ripple
    i. Ripple factor
    j. Bridge rectifiers
    k. Half wave rectifiers
    l. Voltage regulators
    m. Ripple rejection ratio
    n. Ripple factor
    o. Dropout voltage
    p. Switch mode regulators
    q. Switch mode efficiency
    r. Switch mode frequency
    s. Relay pull-in current and voltage
    t. Relay dropout current and voltage
    u. Relay transients
    v. Relay contact naming convention
    w. Optical isolators
    x. Forward current transfer ratio
    y. Breakdown voltage
    z. SCR conduction angle
    aa. SCR brown voltage
    bb. SCR breakover voltage
    cc. Triac conduction angle
    dd. Triac breakdown voltage
    ee. Triac breakover voltage
    ff. Diac triggering diodes
    gg. Power factor correction
    hh. PWM
    ii. PWM effective voltage
    jj. PWM average voltage

   kk. MOSFET
   ll. Miller Effect
   mm. ESD
   nn. GFCI
   oo. DC motors
   pp. shunt, series and compound connections
   qq. Squirrel cage motors
   rr. Transformers
   ss. Turns ration
   tt. Reactive power
   uu. Apparent power
   vv. Three phase power systems
   ww. synchronizing to the grid
2. Skills
   a. Use safety equipment and procedures
   b. Using instrumentation to trouble shoot
   c. Use instrumentation to characterize components
   d. Soldering
3. Issues
   a. Personal safety equipment
   b. Locking out equipment
   c. Knowing what equipment not to repair
   d. Following standard practice
   e. Following practices local to the company

Resources

Boylestad. *Introductory Electric Circuit Analysis*. 14th ed. Pearson, 2023.

Jose' Gabriel Pinto. *Power Electronics and Power Control*. MDPI, 2020.

Boylestad & Nashelsky. *Electronic Devices and Circuit Theory*. 11th ed. Pearson, 2013.

Scarpino. *Motors for Makers*. 1st ed. Que Publishing, 2016.

Nahvi, Edminster. *Schaum's Outline of Electric Circuits*. 7th ed. McGraw-Hill, 2017.

Beaty, Santoso. *Handbook of Electric Power calculations*. 4th ed. McGraw-Hill, 2015.

Jones & Bartlet. *Ugly's Electric Motor and Control*. 3rd ed. Jones & Bartlet Learning, 2017.

Lab Volt Ltd. "Laboratory Experiments"

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