INDUSTRIAL MAINTENANCE
MISSISSIPPI CURRICULUM FRAMEWORK

Industrial Mechanics and Maintenance Technology (Program CIP: 47.0303)
Electro-Mechanical Technology (Program CIP: 15.0499)

Initial Board March 2023

Final Board May 2023

Published by:
Mississippi Community College Board
Division of Workforce, Career, and Technical Education
3825 Ridgewood Road
Jackson, MS 39211
Phone: 601-432-6155
Email: curriculum@mccb.edu

1

Faculty Writing Team Members

William "Bill" Fitts, Holmes Community College, Ridgeland, MS
Frederick Jefferson, Hinds Community College, Raymond, MS
Mark Myles, Mississippi Delta Community College, Moorhead, MS
Jimmy Whitehead, Itawamba Community College, Fulton, MS
Earnest Bell, Coahoma Community College, Clarksdale, MS
Stanley Bishop, Meridian Community College, Meridian, MS
Max Dickerson, Meridian Community College, Meridian, MS
Nettie Coggin, Holmes Community College, Grenada, MS
Ben Harris, East Mississippi Community College, Mayhew, MS
Patricia Corrigan, East Mississippi Community College, Mayhew, MS
David Roberts, Hinds Community College, Pearl, MS
Ashley Brown, Itawamba Community College, Fulton, MS
Brian Warren, Northeast Mississippi Community College, Booneville, MS
Mason Smith, Northeast Mississippi Community College, Booneville, MS
Derek Devaughn, Northeast Mississippi Community College, Booneville, MS
Earl Walker, Coahoma Community College, Clarksdale, MS
Tyler Whitehead, Northeast Mississippi Community College, Booneville, MS
Rodney Edwards, East Mississippi Community College, Mayhew, MS
Micheal Stevenson, Mississippi Delta Community College, Moorhead, MS
Jeffrey Hoovler, Hinds Community College, Raymond, MS

Administrator Writing Team Members

Dr. Lori Smith, Meridian Community College, Meridian, MS
Dr. Luke Jones, Holmes Community College, Ridgeland, MS
Jason Mattox, Northeast Mississippi Community College, Booneville, MS
Jason Webb, Hinds Community College, Raymond, MS
Suzanne Thompson, Mississippi Delta Community College, Moorhead, MS
Dylan Baldwin, Itawamba Community College, Fulton, MS

Business and Industry Contributing Members

Jake Calgaro, G-W Goodheart-Willcox Publisher, Chicago, IL
Jimmie Bowling, Goodyear, Cleveland, MS
Scott Basden, Nissan North America, Canton, MS
Van Robinson, Milwaukee Tool, Jackson, MS
Ricky Edmonds, CBRE, Canton, MS

Office of Curriculum and Instruction Team Members

Scott Kolle, Ph.D., Director of Curriculum, Mississippi Community College Board
Sheriece Robinson, Ed.D., Curriculum Specialist, Mississippi Community College Board

The Office of Curriculum and Instruction (OCI) was founded in 2013 under the Division of Workforce, Career, and Technical Education at the Mississippi Community College Board (MCCB). The office is funded through a partnership with The Mississippi Department of Education (MDE), who serves as Mississippi's fiscal agent for state and federal Career and Technical Education (CTE) Funds. The OCI is tasked with developing statewide CTE curriculum, programming, and professional development designed to meet the local and statewide economic demand.

For information, please contact curriculum@mccb.edu.

Contents

INDUSTRY CREDENTIALS, CERTIFICATIONS, AND PROFESSIONAL LICENSURE

See the "Industry Credentials, Certifications, and Professional Licensure"
https://www.mccb.edu/assessment

INDUSTRY JOB PROJECTION DATA

A summary of occupational data is available from the Mississippi Department of Employment Security.
https://mdes.ms.gov/information-center/labor-market-information/

ARTICULATION

Check with the local community college CTE administration for articulation agreements.

DUAL ENROLLMENT

See the "Procedures Manual for Dual Enrollment and Accelerated Programs"
http://www.mississippi.edu/cjc/dual_enrollment.asp

RESEARCH ABSTRACT

In the fall of 2022, the Office of Curriculum and Instruction (OCI) met with the different industry members who made up the advisory committees for the Industrial Maintenance Technology program. A discussion was held to gather feedback concerning the trends and needs, both current and future, of the field. Program faculty, administrators, and industry members were consulted regarding industry workforce needs and trends. Industry advisory team members from the college involved with this program were asked to give input related to changes to be made to the curriculum framework.

REVISION HISTORY

2010-Research & Curriculum Unit, Mississippi State University
2014-Office of Curriculum & Instruction, Mississippi Community College Board
2017-Office of Curriculum & Instruction, Mississippi Community College Board
2022- Office of Curriculum & Instruction, Mississippi Community College Board

PROGRAM DESCRIPTIONS

The **Industrial Mechanics and Maintenance Technology** curriculum includes a program of study for a career certificate (30 semester credit hours), technical certificate (45 semester credit hours), and an Associate of Applied Science Degree (60 semester credit hours). This program is designed to prepare students for entry-level employment as multi-craft maintenance technicians. Industrial maintenance trade technicians are responsible for assembling, installing, and maintaining and repairing machinery used in the manufacturing or industrial environment. Students receive basic instruction in a wide variety of areas including safety, machinery maintenance and troubleshooting/service, blueprint reading, basic machining operations, fundamentals of piping and hydrotesting, and fundamentals of industrial electricity. Elective courses were added in an effort to allow colleges to customize the state-wide curriculum framework to meet the needs of the local economy.
Upon the completion of the career certificate program of study, students will be prepared to complete certifications recognized by their local industry.

The **Electro-Mechanical Technology** curriculum includes a program of study for a career certificate (30 semester credit hours), technical certificate (45 semester credit hours), and an Associate of Applied Science Degree (60 semester credit hours). Graduates are prepared to enter the job market in many different areas or continue their education at a four-year institution.

Students receive basic instruction in a wide variety of areas including safety, machinery maintenance, troubleshooting/service, blueprint reading, basic machining, fundamentals of industrial electricity, CAD, fluid power, Industrial Controls and PLC programming.

SUGGESTED COURSE SEQUENCE

CIP 47.0303: INDUSTRIAL MECHANICS AND MAINTENANCE TECHNOLOGY –WORK READY CERTIFICATE

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 1113	Industrial Maintenance Core and Safety*	3	2	2	60	30	30
IMM 1214	Introduction to Industrial Maintenance	4	2	4	90	30	60
	All other electives approved by instructor per local community college policy	8					
	TOTAL	**15**					

CIP 47.0303: INDUSTRIAL MECHANICS AND MAINTENANCE TECHNOLOGY CAREER CERTIFICATE REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 1113	Industrial Maintenance Core and Safety*	3	2	2	60	30	30
IMM 1214	Introduction to Industrial Maintenance	4	2	4	90	30	60
IMM 1153	Electrical Industrial Maintenance I**	3	1	4	75	15	60
IMM 1163	Electrical Industrial Maintenance II***	3	1	4	75	15	60
IMM 1243	Mechanical Industrial Maintenance I	3	1	4	75	15	60
IMM 1253	Mechanical Industrial Maintenance II****	3	1	4	75	15	60
	All other electives approved by instructor per local community college policy	11					
	TOTAL	**30**					

** CTE 1143 Fundamentals of Construction and Manufacturing can be taken in lieu of IMM 1113*

******* ELT 1213 Electrical Power or IMM 1814 Industrial Electricity Level I can be taken in lieu of IMM 1153*

******** ELT 1123 Commercial Wiring or IMM 1824 Industrial Electricity Level II can be taken in lieu of IMM 1163 ******** ROT 2613 Mechanical Drive Systems can be taken in lieu of IMM 1253*

There are three technical certificates: Industrial Maintenance Concentration, Advanced Manufacturing Technician Concentration, and Electro-Mechanical Technology.

CIP 47.0303 INDUSTRIAL MAINTENANCE CONCENTRATION TECHNICAL CERTIFICATE REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 2214	Advanced Electrical Industrial Maintenance	4	2	4	90	30	60
IMM 2224 **or** IMM 2424	Advanced Mechanical Industrial Maintenance **or** Solid State Motor Controls	4	2	4	90	30	60
IMM 2613 **or** ELT 2613	Programmable Logic Controllers	3	2	2	60	30	30
	All other electives approved by instructor per local community college policy	4					
	TOTAL	**15**					

CIP 47.0303 ADVANCED MANUFACTURING TECHNICIAN CONCENTRATION TECHNICAL CERTIFICATE REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 2613 **or** ELT 2613	Programmable Logic Controllers	3	2	2	60	30	30
IMM 2623 **or** ELT 2623	Advanced Programmable Logic Controllers	3	2	2	60	30	30
IMM 2424 **or** ELT 2424 **or** IMM 2433	Solid State Motor Controls or Solid State Motor Controls or Electronic Motion Control	4	2	4	90	30	60
	All other electives approved by instructor per local community college policy	5					
	TOTAL	**15**					

CIP 47.0303 ELECTRO-MECHANICAL TECHNOLOGY TECHNICAL CERTIFICATE REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 2124	Power Tools, Machining, & Materials	4	1	4	75	15	60
IMM 2513*	Programmable Logic Controller - Multi-Platform	3	1	4	75	15	60
IMM 2114	Equipment Maintenance, Troubleshooting, & Repair	4	1	4	75	15	60
IMM 2433	Electronic Motion Control	3	1	4	75	15	60
	All other electives approved by instructor per local community college policy	1					
	TOTAL	**15**					

*IMM 2613 and IMM 2623 may substitute IMM 2513

SUGGESTED COURSE SEQUENCE

CIP 15.0499 ELECTRO-MECHANICAL TECHNOLOGY CAREER CERTIFICATE REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 1934 **or** IMM 1214	Manufacturing Basic Skill **or** Introduction to Industrial Maintenance	4	2	4	90	30	60
IMM 1113 **or** ELT 1233 **or** CTE 1143	Industrial Maintenance NCCER Core and Safety **or** Fundamentals of Construction and Manufacturing **or** Fundamentals of Construction and Manufacturing	3	2	2	60	30	30
IMM 1153 **or** IMM 1814 **or** ELT 1213	Electrical Industrial Maintenance Level I **or** Industrial Electricity Level I **or** Electrical Power	4	2	4	90	30	60
IMM 1474	Fluid Power	4	2	4	90	30	60
IMM 1824 **or** IMM 1163 **or** ELT 1123	Industrial Electricity Level II **or** Electrical Industrial Maintenance Level II **or** Commercial Wiring	4	2	4	90	30	60
IMM 1484	Industrial Control Systems	4	2	4	90	30	60
DDT 1313 **or** IMM 1133	Computer Aided Design I **or** Industrial Maintenance Blueprint Reading	3	2	2	60	30	30
	All other electives approved by instructor per local community college policy	4	1	4	75	15	60
	TOTAL	**30**					

CIP 15.0499 ELECTRO-MECHANICAL TECHNOLOGY TECHNICAL CERTIFICATE
REQUIRED COURSES

			SCH Breakdown			Clock Hour Breakdown	
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab
IMM 2513*	Programmable Logic Controller - Multi-Platform	3	1	4	75	15	60
IMM 2114	Equipment Maintenance, Troubleshooting, & Repair	4	1	4	75	15	60
IMM 2433	Electronic Motion Control	3	1	4	75	15	60
	All other electives approved by instructor per local community college policy	5					
	TOTAL	**15**					

*IMM 2613 and IMM 2623 may substitute IMM 2513

Course Electives

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
IMM 1143	Commercial Industrial Wiring	3	2	2	60
IMM 1173	Motor Maintenance and Troubleshooting	3	2	2	60
IMM 1194	Electrical Level I	4	2	4	90
IMM 1214	Introduction to Industrial Maintenance	4	2	4	90
IMM 1224	Power Tool Applications	4	1	6	105
IMM 1234	Precision Machining Operations	4	2	4	90
IMM 1273	Industrial Maintenance E&I Level I (Part I)	3	2	2	60
IMM 1283	Industrial Maintenance E & I Level I (Part II)	3	2	2	60
IMM 1313	Principles of Hydraulics and Pneumatics	3	2	2	60
IMM 1323	Motor Control Systems	3	2	2	60
IMM 1373	Robotic Controls and Applications	3	2	2	60
IMM 1383	Industrial Robotics	3	2	2	60
IMM 1514	Equipment Installation and Alignment	4	1	6	105
IMM 1524	Preventive Maintenance and Service of Equipment	4	1	6	105
IMM 1614	Principles of Plumbing and Hydro Testing	4	2	4	90
IMM 1713	Methods of Layout	3	0	6	90
IMM 1723	Structural Repair	3	0	6	90
IMM 1734	Maintenance, Welding and Metals	4	1	6	105
IMM 191(1-4)	Special Project in Industrial Maintenance Mechanic	1-4	0	2-8	30-120
IMM 192(1-6)	Supervised Work Experience in Industrial Maintenance Mechanics	1-6	0	3-18	45-270
IMM 2214	Advanced Electrical Industrial Maintenance	4	2	4	90

IMM 2224	Advanced Mechanical Industrial Maintenance	4	2	4	90
IMM 2443	NCCER Pipefitting Level I	3	2	2	60
IMM 2623	Advanced Programmable Logic Controllers	3	2	2	60
IMM 2714	CNC Computer Assisted Manufacturing	4	2	4	90
IMM 2723	Maintenance Reliability	3	2	2	60
IMM 2814	Mechatronics Programming I	4	2	4	90
IMM 2824	Mechatronics Robotics	4	2	4	90
IMM 2833	Mechatronics Process Control	3	2	2	60
IMM 2844	Mechatronics Programming II	4	2	4	60
IMM 2854	Mechatronics Troubleshooting and Repair	4	2	4	90
IMM 2863	Data Acquisition and Communications	3	1	4	75
WBL 191(1-3) WBL 192(1-3) WBL 193(1-3) WBL 291(1-3) WBL 292(1-3) WBL 293(1-3)	Work Based Learning I-VI	4	2	4	90
SSP 100(2-3)	Smart Start	2-3			
	All other electives approved by instructor per local community college policy				

General Education Core Courses

To receive the Associate of Applied Science degree, a student must complete all of the required coursework found in the Career Certificate option, Technical certificate option, and a minimum of 15 semester hours of General Education core. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester or provided primarily within the last semester. Each community college will specify the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science degree at their college. The Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) Section 9 Standard 3 of the *Principles of Accreditation: Foundations for Quality Enhancement*[1] describes the general education core.

Section 9 Standard 3:

3. The institution requires the successful completion of a general education component at the undergraduate level that

   a) is based on a coherent rationale.

   b) is a substantial component of each undergraduate degree program. For degree completion in associate programs, the component constitutes a minimum of 15 semester hours of the equivalent; for baccalaureate programs, a minimum of 30 semester hours or the equivalent.

   c) ensures breadth of knowledge. These credit hours include at least one course from each of the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics. These courses do not narrowly focus on those skills, techniques, and procedures specific to a particular occupation or profession.

General Education Courses

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
	Humanities/Fine Arts	3						
	Social/Behavioral Sciences	3						
	Math/Science	3						
	Academic electives	6						
	TOTAL	**15**						

[1] Southern Association of Colleges and Schools Commission on Colleges. (2017). *The Principles of Accreditation: Foundations for Quality Enhancement*. Retrieved from http://www.sacscoc.org/2017ProposedPrinc/Proposed%20Principles%20Adopted%20by%20BOT.pdf

COURSE DESCRIPTIONS

Course Number and Name: IMM 1113 Industrial Maintenance Core and Safety

Description: This course includes basic safety, introduction to construction math, introduction to hand and power tools, blueprint drawings, and employability and communications.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

Basic Safety

1. Explain the idea of a safety culture and its importance in the construction crafts.
2. Identify causes of accidents and the impact of accident costs.
3. Explain the role of OSHA in job-site safety.
4. Explain OSHA's General Duty Clause and 1926 CFR Subpart C.
5. Recognize hazard recognition and risk assessment techniques.
6. Explain fall protection, ladder, stair, and scaffold procedures and requirements.
7. Identify struck-by hazards and demonstrate safe working procedures and requirements.
8. Identify caught-in-between hazards and demonstrate safe working procedures and requirements.
9. Define safe work procedures to use around electrical hazards.
10. Demonstrate the use and care of appropriate personal protective equipment (PPE).
11. Explain the importance of hazard communications (HazCom) and material safety data sheets (MSDSs).
12. Identify other construction hazards on your job site, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.

Introduction to Construction Math & Industrial Math

1. Add, subtract, multiply, and divide whole numbers, with and without a calculator.
2. Use a standard ruler, a metric ruler, and a measuring tape to measure.
3. Add, subtract, multiply, and divide fractions.
4. Add, subtract, multiply, and divide decimals, with and without a calculator.
5. Convert decimals to percentages and percentages to decimals.
6. Convert fractions to decimals and decimals to fractions.
7. Explain what the metric system is and how it is important in the construction trade.
8. Recognize and use metric units of length, weight, volume, and temperature.
9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

Introduction to Hand Tools

1. Recognize and identify some of the basic hand tools and their proper uses in the construction trade.
2. Visually inspect hand tools to determine if they are safe to use.

3. Safely use hand tools.

Introduction to Power Tools

1. Identify power tools commonly used in the construction trades.
2. Use power tools safely.
3. Explain how to maintain power tools properly.

Basic Rigging

1. Identify and describe the use of slings and common rigging hardware.
2. Describe basic inspection techniques and rejection criteria used for slings and hardware.
3. Describe basic hitch configurations and their proper connections.
4. Describe basic load-handling safety practices.
5. Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

Basic Communication Skills

1. Interpret information and instructions presented in both verbal and written form.
2. Communicate effectively in on-the-job situations using verbal and written skills.
3. Communicate effectively on the job using electronic communication devices.

Basic Employability Skills

1. Explain your role as an employee in the construction industry.
2. Demonstrate critical thinking skills and the ability to solve problems using those skills.
3. Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.
4. Define effective relationship skills.
5. Recognize workplace issues such as sexual harassment, stress, and substance abuse.

Introduction to Materials Handling

1. Define a load.
2. Establish a pre-task plan prior to moving a load.
3. Use proper materials-handling techniques.
4. Choose appropriate materials-handling equipment for the task.
5. Recognize hazards and follow safety procedures required for materials handling.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1133 Industrial Maintenance Blueprint Reading

Description: Blueprints, schematics, and plans used in industrial maintenance including instruction in nomenclature, different views, and symbols and notations.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Identify, describe, and apply the use of an architect's scale when working with drawings.
   a. Identify and distinguish the scale used on a blueprint.
   b. Apply the use of the architect's scale.
2. Identify, describe, and define basic nomenclature used in drawings.
   a. Identify common symbols, lines, and other notations found on a drawing.
   b. Define the terms *dimension* and *tolerance* as applied to drawings.
3. Identify, describe, and apply auxiliary views, finished, materials, section lines, and cutting plane lines.
   a. Identify, distinguish, and apply primary and secondary auxiliary views on a drawing.
   b. Identify, describe, and apply surface finished shown on a blueprint.
   c. Identify materials used as indicated by section lines, and demonstrate correct selection.
   d. Describe and apply the use of the cutting plane line.

Course Number and Name: IMM 1143 Commercial Industrial Wiring

Description: Instruction and practice in the installation of commercial and industrial electrical services including the types of conduit and other raceways, NEC code requirements, and three-phase distribution networks.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Apply general safety rules and current NEC and local codes.
    a. Explain and demonstrate safety rules and regulations for working near or on load centers and safety switches.
    b. Explain and demonstrate the ability of safe lifting and work habits.
    c. Identify the code requirements for industrial and commercial locations.
2. Install and maintain raceways, conduit, and fittings.
    a. Identify types of raceways, conduit, and fittings.
    b. Apply usage of raceways, conduit, and fittings as required by electrical codes.
    c. Demonstrate the use of mechanical and hydraulic conduit benders to make specified bends to different sizes and types of conduit.
    d. Identify other types of raceways and their associated bodies.
3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes.
    a. Explain the codes NEC and local codes) for the installation of a three-phase service entrance.
    b. Explain safety precautions to be used when installing a three-phase service entrance.
    c. Construct a sketch to install a three-phase service entrance.
    d. Explain terms associated with a three-phase service entrance from codes and industry terminology.
    e. Identify components of a three-phase service entrance.
4. Prepare a job estimate including supplies and labor costs.
    a. Compute the local labor cost for a given job.
    b. Determine amount of supplies for a given job.
    c. Compute the cost of supplies for a given job.
    d. Justify in writing the total cost for a given job.

Course Number and Name: IMM 1153 Electrical and Instrumentation Level I

Description: This course includes Industrial Safety, Introduction to the National Electric Code®, Electrical Theory, Alternating Current, E&I Test Equipment, and Flow, Pressure, Level, and Temperature.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

INDUSTRIAL SAFETY FOR E & I TECHNICIANS

1. Demonstrate safe working procedures in an industrial environment.
2. Explain the purposes of OSHA and NFPA 70E and how they promote safety on the job.
3. Recognize electrical/energy hazards and describe how to avoid or minimize them in the workplace.
4. Explain safety issues concerning lockout/tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems.
5. Recognize and apply safe working practices.

INTRODUCTIONTOTHE NATIONAL ELECTRICAL CODE®

1. Explain the purpose and history of the National Electrical Code® (NEC®).
2. Describe the layout of the NEC®.
3. Explain how to navigate the NEC®.
4. Describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA).
5. Explain the role of nationally recognized testing laboratories.

ELECTRICAL THEORY

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.
6. Use Kirchhoff's current law to calculate the total and unknown currents in parallel and seriesparallel circuits.
7. Use Kirchhoff's voltage law to calculate voltage drops in series, parallel, and series-parallel circuits.
8. Use the formula for Ohm's law to calculate voltage, current, and resistance.

ALTERNATING CURRENT

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.

8. Explain the relationship between voltage and current in the following types of AC circuits: RL circuit, RC circuit, LC circuit, and RLC circuit
9. Explain the following terms as they relate to AC circuits: True power, Apparent power, Reactive power, Power factor
10. Explain basic transformer action.

E & I TEST EQUIPMENT

1. Identify and explain the purposes of test instruments commonly used to test and troubleshoot E & I equipment.
2. Explain how to read and convert from one scale to another using the above test equipment.
3. Explain the importance of proper meter polarity.
4. Define frequency and explain the use of a frequency meter.
5. Explain the difference between digital and analog meters.

FLOW, PRESSURE, LEVEL, ANDTEMPERATURE

1. Identify and describe methods of flow measurement.
2. Identify and describe methods of pressure measurement.
3. Identify and describe methods of temperature measurement.
4. Identify and describe methods of level measurement.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1163 Electrical and Instrumentation Level II

Description: This course includes process mathematics, hand bending, tubing, clean purge, and test tubing and piping systems, instrument drawings and documents (part one), conductors and cables, and conductors terminations and splices.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes

PROCESS MATHEMATICS

1. Identify different units of pressure measurement.
2. Convert measured values in the English system, using common conversion factor tables, to equivalent SI values.
3. Perform the basic mathematical operations necessary in instrumentation.
4. Square numbers and find the square root of numbers.
5. Perform the mathematical conversions necessary for instrumentation measurements.

HAND BENDING

1. Identify the methods for hand bending and installing conduit.
2. Calculate conduit bends.
3. Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
4. Cut, ream, and thread conduit.

TUBING

1. Identify the different kinds of tubing and describe the properties and common uses for each kind.
2. Explain the purpose for tubing standards and specifications.
3. Describe the proper handling and storage of tubing.
4. Cut tubing using the proper tools, cutting methods, and safety procedures.
5. Bend tubing using the proper tools, bending methods, and safety procedures.
6. Identify and select proper tubing fittings for selected instrumentation applications.
7. Flare tubing using the proper tools, flaring methods, and safety procedures.
8. Make and remake a compression fitting.

CLEAN, PURGE, ANDTEST TUBING AND PIPING SYSTEMS

1. Identify cleaning, flushing, and purging procedures.
2. Describe the general cleaning and purging requirements for piping and tubing.
3. Perform the appropriate cleaning and flushing methods until required cleanliness has been achieved.
4. Describe and select pressure and leak testing methods for piping/tubing systems.
5. Identify precautions associated with testing piping/tubing systems.
6. Perform pressure leak tests per approved procedures.
7. Prepare required test documentation.

INSTRUMENT DRAWINGS AND DOCUMENTS, PART ONE

1. Identify and describe standard Instrument Society of America (ISA) instrument symbols and abbreviations.
2. Read and interpret instrument indexes.
3. Read and interpret general instrument specifications.
4. Read and interpret general notes and details included on instrument drawings and documents.
5. Read and interpret installation detail drawings.
6. Read and interpret location drawings.

CONDUCTORS AND CABLES

1. From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses.
2. Determine the allowable ampacity of a conductor for a given application.
3. Identify the NEC® requirements for color coding of conductors.
4. Install conductors in a raceway system.

CONDUCTORS TERMINATIONS AND SPLICES

1. Describe how to make a sound conductor termination.
2. Prepare cable ends for terminations and splices and connect the ends using lugs or connectors.
3. Train cable at termination points.
4. Describe the *National Electrical Code*® (NEC®) requirements for making cable terminations and splices.
5. Demonstrate crimping techniques.
6. Select the proper lug or connector for the job.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1173 Motor Maintenance and Troubleshooting

Description: This course includes the principles and practice of electrical motor repair.Topics on the disassembly/assembly and preventive maintenance of common electrical motors are discussed.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Student Learning Outcomes:

1. Apply general safety and safety requirements for working with electric motors.
    a. Apply principles of safety in the use and repair of electrical motors.
    b. Describe safety procedures to utilize during connecting, operating, and repairing of electrical motors.
    c. Practice lockout/tagout procedure.
2. Use instruments and tools in maintaining, troubleshooting, and operating electrical motors.
    a. Identify, describe, and demonstrate the use of instruments and tools used to maintain, troubleshoot, and repair motors to include mega-ohm meters, volt-amp meters, and multimeters.
    b. Describe the procedures for the maintenance, testing, and/or repair of instruments and tools.
3. Troubleshoot and perform basic maintenance on electrical motors.
    a. List and describe functions of the major parts and windings of single-phase motors.
    b. List and describe the functions of split-phase, capacitor start, capacitor start-capacitor run, and permanent split capacitor electric motors.
    c. Describe and list the functions of a shaded pole and repulsion/induction electric motors.
    d. List and describe functions of major parts and windings of three-phase motors to include squirrel cage induction, synchronous, and wound rotor motors.
    e. List and describe functions of the major parts and windings of DC motors to include series, shunt, and compound wound motors.
    f. Develop a preventive maintenance program for electric motors.

Course Number and Name: IMM 1194 Electrical Level I

Description: Instruction in terminology and basic principles of electricity, use of test equipment, safety practices for working around and with electricity, and basic electrical procedures. [May be taught as a 90-contact-hour lab in open-entry–open-exit Career programs]

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for electrical maintenance including lockout/tagout.
    a. Define terms related to electrical lockout/tagout applications.
    b. Determine correct application of lockout/tagout on electrical enclosures, panels, and switching devices.
2. Apply basic terminology and principles associated with electricity.
    a. Define terms related to electrical applications.
    b. Practice safety precautions and procedures associated with electricity.
    c. Identify and describe the use of fuses, ground-fault interrupters, breakers, and other safety devices associated with electrical circuits.
    d. Apply Ohm's law to calculate circuit parameters including voltage, current, resistance, and power.
    e. Discuss the effect of wire size on current and voltage in a circuit.
3. Interpret and apply the National Electrical Code.
    a. Define and use symbols, abbreviations, and terminology found in industrial electrical work on prints and drawings.
    b. Calculate amperage for a given circuit.
    c. Calculate a service size and neutral.
4. Perform electrical jobs associated with industrial mechanics.
    a. Measure current, voltage, and resistance in a circuit.
    b. Test a circuit for continuity.
    c. Tag out, disconnect, and reconnect an electric motor.
    d. Perform preventive maintenance on an electric motor (disassemble, clean and inspect, repair mechanical components, lubricate, and reassemble).
    e. Check and service a battery, including recharging.
    f. Demonstrate the ability to correctly size and bend conduit.
    g. Discuss and define different types of raceways, cables and conductors

Course Number and Name: IMM 1214 Introduction to Industrial Maintenance

Description: This course includes basic tools of the trade, fasteners and anchors, oxyfuel cutting, gaskets and packing, craft-related mathematics, construction drawings, pumps and drivers, introduction to valves and test equipment, material handling, mobile and support equipment, and lubrication.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Note: Colleges have the option of offering IMM 1273 Industrial Maintenance Electrical and Instrumentation Level I (Part I) and IMM 1283 Industrial Maintenance Electrical and Instrumentation Level I (Part II).
Successful completion of these courses equates to the completion of IMM 1214 Introduction to Industrial Maintenance.

Student Learning Outcomes:

ORIENTATION TO THE TRADE

1. Describe the types of work performed by industrial maintenance craftworkers.
2. Identify career opportunities available to industrial maintenance craftworkers.
3. Explain the purpose and objectives of an apprentice training program.
4. Explain the responsibilities and characteristics of a good industrial maintenance craftworker.
5. Explain the importance of safety in relation to industrial maintenance craftworkers.
6. Explain the role of NCCER in the training process.

TOOLS OF THE TRADE

1. Explain the purpose of each of the tools commonly used by industrial maintenance craftworkers.
2. Describe how to maintain each of the tools used by industrial maintenance craftworkers.
3. Demonstrate the proper use and basic maintenance of selected industrial maintenance tools.

FASTENERS AND ANCHORS

1. Identify and explain the use of threaded fasteners.
2. Identify and explain the use of non-threaded fasteners.
3. Identify and explain the use of anchors.
4. Select the correct fasteners and anchors for given applications.
5. Install fasteners and anchors.

OXYFUEL CUTTING

1. Identify and explain the use of oxyfuel cutting equipment.
2. State the safety precautions for using oxyfuel equipment.
3. Set up oxyfuel cutting equipment.
4. Light and adjust an oxyfuel torch.
5. Shut down oxyfuel cutting equipment.
6. Disassemble oxyfuel cutting equipment.
7. Change empty cylinders.
8. Perform oxyfuel cutting: Straight line and square shapes, Piercing and slot cutting, Bevels, and Washing

9. Apply a rosebud flame to remove frozen components (also for preheat and expanding larger fittings).
10. Operate a motorized, portable oxyfuel gas cutting machine.

GASKETS AND PACKING

1. Identify the various types of gaskets and explain their uses.
2. Identify the various types of gasket materials and explain their applications.
3. Lay out, cut, and install a flange gasket.
4. Describe the use of O-rings.
5. Explain the importance of selecting the correct O-ring for an application.
6. Select an O-ring for a given application and install it.
7. Describe the uses and methods of packing.

CRAFT-RELATED MATHEMATICS

1. Identify and explain the use of special measuring devices.
2. Use tables of weights and measurements.
3. Use formulas to solve basic problems.
4. Solve area problems.
5. Solve volume problems.
6. Solve circumference problems.
7. Solve right triangles using the Pythagorean theorem.

CONSTRUCTION DRAWINGS

1. Explain the basic layout of a blueprint.
2. Describe the information included in the title block of a blueprint.
3. Identify the types of lines used on blueprints.
4. Identify common symbols used on blueprints.
5. Understand the use of architect's and engineer's scales.
6. Demonstrate the use of an architect's scale.

PUMPS AND DRIVERS

1. Identify and explain centrifugal pumps.
2. Identify and explain rotary pumps.
3. Identify and explain reciprocating pumps.
4. Identify and explain metering pumps.
5. Identify and explain vacuum pumps.
6. Explain net positive suction head and cavitation.
7. Identify types of drivers.

INTRODUCTION TO VALVES

1. Identify types of valves that start and stop flow.
2. Identify types of valves that regulate flow.
3. Identify valves that relieve pressure.
4. Identify valves that regulate the direction of flow.
5. Explain how to properly store and handle valves.
6. Explain valve locations and positions.

INTRODUCTION TO TEST EQUIPMENT

1. Explain the operation of and describe the following pieces of test equipment: Tachometer, Pyrometers, Multimeters, Automated diagnostics tools, Wiggy, voltage tester, Stroboscope
2. Explain how to read and convert from one scale to another using the above test equipment.
3. Define frequency and explain the use of a frequency meter.

MATERIAL HANDLING AND HAND RIGGING

1. Identify and describe the uses of common rigging hardware and equipment.
2. Inspect common rigging equipment.
3. Select, use, and maintain special rigging equipment, including: Jacks, Block and tackle, Chain hoists, and Come-alongs

4. Tie knots used in rigging.
5. Use and understand the correct hand signals to guide a crane operator.
6. Identify basic rigging and crane safety procedures.

MOBILE AND SUPPORT EQUIPMENT

1. State the safety precautions associated with the use of motor-driven equipment in industrial plants.
2. Explain the operation and applications of the following motor-driven equipment commonly used in industrial plants: Portable generators, Air compressors, Aerial lifts, Forklifts, and Mobile cranes.
3. Operate and perform preventive maintenance on the following equipment: Portable generators, Air compressors, and Aerial lifts.

LUBRICATION

1. Explain OSHA hazard communication as pertaining to lubrication.
2. Read and interpret a material data safety sheet (MSDS).
3. Explain the EPA hazardous waste control program.
4. Explain lubricant storage.
5. Explain lubricant classification and film protection.
6. Explain properties of lubricants and greases.
7. Explain how to select lubricants.
8. Identify and explain types of additives.
9. Identify and explain types of lubricating oils.
10. Identify and use lubrication equipment to apply lubricants.
11. Read and interpret a lubrication chart.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1224 Power Tool Applications

Description: Instruction in terminology and basic principles of power tools equipment, safety practices for working around and with power tools, and basic power tool procedures.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	105

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate the safe and proper use of hand power tools.
    a. Inspect, adjust, and operate hand power drills in a safe and proper manner.
    b. Inspect, adjust, and operate hand cut-off saws in a safe and proper manner.
    c. Inspect, adjust, and operate side grinders in a safe and proper manner.
    d. Inspect, adjust, and operate pneumatic chipping hammers in a safe and proper manner.
    e. Inspect, adjust, and operate impact wrenches in a safe and proper manner.
2. Demonstrate the safe and proper use of a bench grinder.
    a. Inspect, set up, and adjust a bench grinder for safe and proper use.
    b. Sharpen twist steel drill bit.
    c. Sharpen lathe tool bits.
    d. Grind angles on metal.
3. Demonstrate the safe and proper use of a drill press.
    a. Inspect, set up, and adjust a drill press for safe and proper operation.
    b. Locate and drill holes in metal to specifications.
    c. Ream holes to specifications.
4. Demonstrate the safe and proper use of a pipe threading machine.
    a. Inspect, set up, and adjust a pipe threading machine for safe and proper operations.
    b. Cut pipe to length and thread various diameters of pipe.
5. Demonstrate the safe and proper use of a cut-off saw.
    a. Inspect, set up, and adjust a cut-off saw for safe and proper operation.
    b. Service a cut-off saw blade to include removal, welding, installation, and tensioning.
    c. Select a cut-off saw blade for a given job.
    d. Cut metal to length with a cut-off saw.
    e. Cut angles on metal with a cut-off saw.

Course Number and Name: IMM 1234 Precision Machining Operations

Description: This course includes instruction related to the safe and proper use of various precision tools. The course also includes instruction in the use of drill presses, engine lathes, and milling machines.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate the safe and proper use of an engine lathe.
    a. Inspect, set up, and adjust an engine lathe.
    b. Turn metal stock to a given diameter.
    c. Turn metal stock to a given bevel, taper, and/or angle.
    d. Cut external and internal threads to specifications.
2. Demonstrate the safe and proper use of a milling machine.
    a. Inspect, set up, and adjust a milling machine.
    b. Cut a keyway to given specifications and tolerance.
    c. Plane metal surfaces to a given specification and tolerance.
3. Demonstrate the safe and proper use of a surface grinder.
    a. Inspect, set up, and adjust a surface grinder.
    b. Grind a flat plate to a given tolerance.
    c. Fabricate and/or grind a machine tool.
4. Demonstrate the proper use of a drill press.
    a. Inspect, set up, and adjust a drill press.
    b. Drill a hole to specification

Course Number and Name: IMM 1243 Mechanical and Industrial Maintenance I

Description: This course includes advanced trade math, precision measuring tools, installing bearings, and installing couplings.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

Advanced Trade Math

1. Use tables of equivalents.
2. Perform right angle trigonometry.
3. Calculate take-outs using trigonometry.
4. Calculate weights of objects.

Precision Measuring Tools

1. Use a level.
2. Use a feeler gauge.
3. Use calipers.
4. Use a micrometer.
5. Use a dial indicator.
6. Use a protractor.
7. Use gauge blocks.
8. Use speed measurement tools.
9. Use a pyrometer.
10. Describe the functions of thermal imaging, vibration analysis, and acoustic vibrations.

Installing Bearings

1. Remove bearings.
2. Troubleshoot bearing failures.
3. Install bearings.

Installing Couplings

1. Identify and explain coupling types.
2. Install couplings.
3. Remove couplings.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1253 Mechanical and Industrial Maintenance II

Description: This course includes advanced setting baseplates and pre-alignment, conventional alignment, installing belt and chain drives, and installing mechanical seals.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

Setting Baseplates and Pre-alignment

1. Establish baseplate and soleplate locations.
2. Install baseplates and soleplates.
3. Identify the proper anchor bolts for installation.
4. Field-verify a plate installation.
5. Set driven equipment.
6. Set a driver.

Conventional Alignment

1. Explain types of misalignment.
2. Align couplings using feeler gauge, straightedge, and dial indicator methods.
3. Identify and eliminate coupling stress.

Installing Belt and Chain Drives

1. Identify belt drive types.
2. Install a belt drive.
3. Identify chain drive types.
4. Install a chain drive.

Installing Mechanical Seals

1. Identify types of mechanical seals and explain their applications.
2. Safely and accurately remove and inspect mechanical seals.
3. Safely and accurately install mechanical seals.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1273 Industrial Maintenance Electrical and Instrumentation Level I

Description: This course includes basic tools of the trade, fasteners and anchors, oxyfuel cutting, gaskets and packing, and craft-related mathematics.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

ORIENTATION TO THE TRADE

1. Describe the types of work performed by industrial maintenance craftworkers.
2. Identify career opportunities available to industrial maintenance craftworkers.
3. Explain the purpose and objectives of an apprentice training program.
4. Explain the responsibilities and characteristics of a good industrial maintenance craftworker.
5. Explain the importance of safety in relation to industrial maintenance craftworkers.
6. Explain the role of NCCER in the training process.

TOOLS OF THE TRADE

1. Explain the purpose of each of the tools commonly used by industrial maintenance craftworkers.
2. Describe how to maintain each of the tools used by industrial maintenance craftworkers.
3. Demonstrate the proper use and basic maintenance of selected industrial maintenance tools.

FASTENERS AND ANCHORS

1. Identify and explain the use of threaded fasteners.
2. Identify and explain the use of non-threaded fasteners.
3. Identify and explain the use of anchors.
4. Select the correct fasteners and anchors for given applications.
5. Install fasteners and anchors.

OXYFUEL CUTTING

1. Identify and explain the use of oxyfuel cutting equipment.
2. State the safety precautions for using oxyfuel equipment.
3. Set up oxyfuel cutting equipment.
4. Light and adjust an oxyfuel torch.
5. Shut down oxyfuel cutting equipment.
6. Disassemble oxyfuel cutting equipment.
7. Change empty cylinders.
8. Perform oxyfuel cutting: Straight line and square shapes, Piercing and slot cutting, Bevels, and Washing
9. Apply a rosebud flame to remove frozen components (also for preheat and expanding larger fittings).
10. Operate a motorized, portable oxyfuel gas cutting machine.

GASKETS AND PACKING

1. Identify the various types of gaskets and explain their uses.
2. Identify the various types of gasket materials and explain their applications.
3. Lay out, cut, and install a flange gasket.
4. Describe the use of O-rings.
5. Explain the importance of selecting the correct O-ring for an application.
6. Select an O-ring for a given application and install it.
7. Describe the uses and methods of packing.

CRAFT-RELATED MATHEMATICS 1. Identify and explain the use of special measuring devices.

2. Use tables of weights and measurements.
3. Use formulas to solve basic problems.
4. Solve area problems.
5. Solve volume problems.
6. Solve circumference problems.
7. Solve right triangles using the Pythagorean theorem.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1283 Industrial Maintenance Electrical and Instrumentation Level I Part II

Description: This course includes construction drawings, pumps and drivers, introduction to valves and test equipment, material handling, mobile and support equipment, and lubrication.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

CONSTRUCTION DRAWINGS

1. Explain the basic layout of a blueprint.
2. Describe the information included in the title block of a blueprint.
3. Identify the types of lines used on blueprints.
4. Identify common symbols used on blueprints.
5. Understand the use of architect's and engineer's scales.
6. Demonstrate the use of an architect's scale.

PUMPS AND DRIVERS

1. Identify and explain centrifugal pumps.
2. Identify and explain rotary pumps.
3. Identify and explain reciprocating pumps.
4. Identify and explain metering pumps.
5. Identify and explain vacuum pumps.
6. Explain net positive suction head and cavitation.
7. Identify types of drivers.

INTRODUCTION TO VALVES

1. Identify types of valves that start and stop flow.
2. Identify types of valves that regulate flow.
3. Identify valves that relieve pressure.
4. Identify valves that regulate the direction of flow.
5. Explain how to properly store and handle valves.
6. Explain valve locations and positions.

INTRODUCTION TO TEST EQUIPMENT

1. Explain the operation of and describe the following pieces of test equipment: Tachometer, Pyrometers, Multimeters, Automated diagnostics tools, Wiggy, voltage tester, Stroboscope
2. Explain how to read and convert from one scale to another using the above test equipment.
3. Define frequency and explain the use of a frequency meter.

MATERIAL HANDLING AND HAND RIGGING

1. Identify and describe the uses of common rigging hardware and equipment.
2. Inspect common rigging equipment.
3. Select, use, and maintain special rigging equipment, including: Jacks, Block and tackle, Chain hoists, and Come-alongs
4. Tie knots used in rigging.
5. Use and understand the correct hand signals to guide a crane operator.

6. Identify basic rigging and crane safety procedures.

MOBILE AND SUPPORT EQUIPMENT

1. State the safety precautions associated with the use of motor-driven equipment in industrial plants.
2. Explain the operation and applications of the following motor-driven equipment commonly used in industrial plants: Portable generators, Air compressors, Aerial lifts, Forklifts, and Mobile cranes
3. Operate and perform preventive maintenance on the following equipment: Portable generators, Air compressors, and Aerial lifts

LUBRICATION

1. Explain OSHA hazard communication as pertaining to lubrication.
2. Read and interpret a material data safety sheet (MSDS).
3. Explain the EPA hazardous waste control program.
4. Explain lubricant storage.
5. Explain lubricant classification and film protection.
6. Explain properties of lubricants and greases.
7. Explain how to select lubricants.
8. Identify and explain types of additives.
9. Identify and explain types of lubricating oils.
10. Identify and use lubrication equipment to apply lubricants.
11. Read and interpret a lubrication chart.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1313 Principles of Hydraulics and Pneumatics

Description: Instruction in basic principles of hydraulics and pneumatics and the inspection, maintenance, and repair of hydraulic and pneumatic systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and discuss basic principles of hydraulics as related to industrial maintenance.
    a. Identify the basic components of a hydraulic system, including fluids, filters, pumps, lines, control valves, cylinders, motors, and so forth.
    b. Interpret schematics of hydraulic systems.
    c. Differentiate between open and closed hydraulic systems.
    d. Practice safety precautions and procedures associated with hydraulic systems.
2. Inspect, maintain, and repair hydraulic systems.
    a. Evaluate hydraulic pumps for pressure and flow.
    b. Inspect hydraulic valves for leakage and proper actions.
    c. Inspect hydraulic cylinders for leakage and proper operations.
3. Describe and discuss basic principles of pneumatics as associated with industrial maintenance.
    a. Identify the components of a pneumatic system, including compressor, lines, control valves, gauges, filters, attachments, cylinders, and motors.
    b. Interpret schematics of pneumatic systems.
    c. Practice safety precautions and procedures associated with pneumatic systems.
4. Inspect, maintain, and repair pneumatic systems.
    a. Perform scheduled preventive maintenance on an air compressor.
    b. Evaluate pneumatic equipment and devices for leakage and proper operation.

Course Number and Name: IMM 1323 Motor Control Systems

Description: This course includes the Installation of different motor control circuits and devices. Emphasis is placed on developing the student's ability to diagram, wire, and troubleshoot the different circuits and mechanical control devices.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Install different control circuits and devices.
    a. Diagram and wire a two-wire and three-wire motor control circuit with indicating pilot lights.
    b. Diagram, wire, and troubleshoot an on-delay and off-delay timer circuit.
    c. Diagram and wire multi-control manual station.
    d. Diagram and wire a "hands-off-automatic" control station.
    e. Diagram and wire a jog-forward/jog-reverse control.
2. Troubleshoot different control circuit and devices.
    a. Troubleshoot a two-wire and three-wire motor control circuit with indicating pilot lights.
    b. Troubleshoot an on-delay and off-delay timer circuit.
    c. Troubleshoot a multi-control manual station.
    d. Troubleshoot a "hands-off-automatic" control station.
    e. Diagram and wire a jog-forward/jog-reverse control.

Course Number and Name: IMM 1373 Robotic Controls and Applications

Description: This course is designed to introduce the student to industrial robots. Topics to be covered include robotics history, industrial robot configurations, operation, and basic programming and how they relate to industry.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe the various major components of all robots.
    a. Explain the axes of movement.
    b. Label each major component.
    c. Identify four general types of work envelopes.
    d. Discuss three general forms of robot actuation.
    e. Identify different types of input devices used with robot controllers.
    f. Describe the characteristics of a robot that distinguish it from other types of automated machinery.
2. Demonstrate safety procedures used in the automated environment.
    a. Apply safety rules for personal and general shop safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding.
    b. Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment.
    c. Apply general safety rules associated with working on various robotics systems.
    d. Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of firefighting devices.
3. Demonstrate the ability to operate robots.
    a. Evaluate robot performance.
    b. Apply basic programming skills.
    c. Identify and discuss end effectors.
    d. Identify and discuss visual and tactile sensors.
    e. Demonstrate basic troubleshooting techniques.

Course Number and Name: IMM 1383 Industrial Robotics

Description: This course teaches the operating systems and advanced programming methods of industrial robots. Actual industrial-grade robots are used to train the student in the areas of operation, maintenance, troubleshooting, service procedures, and robotics applications.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate the ability to integrate a robot into a process affiliated with the electrical industry.
    a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot's work envelope.
    b. Demonstrate the improvement of the efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth.
2. Demonstrate the ability to integrate peripheral equipment.
    a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.
    b. Interface contact and noncontact sensors into robotics work cell.
3. Demonstrate the ability to troubleshoot and maintain a robotics work cell.
    a. Locate and isolate faults in robotics applications.
    b. Demonstrate the use of test equipment and troubleshooting logic to repair faults.
    c. Perform routine maintenance procedures on robots with the use of checklists and service equipment (null servo valves, zero encoders, calibrate potentiometers, etc.).

Course Number and Name: IMM 1474 Fluid Power

Description: Instruction in the basic principles of hydraulics and pneumatics and the inspection, maintenance and repair of hydraulic and pneumatic systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and discuss basic principles of pneumatics as related to industrial maintenance.
    a. Define pneumatics and give benefits and drawbacks to the system.
    b. Pneumatic safety
    c. Components of a Pneumatic System
        i. Describe the use and operation of pneumatic system components and give the schematic symbol of each.
    d. Pressure and flow
        i. List common units of measurement for pressure and flow.
        ii. Describe the difference between gauge and absolute pressure.
        iii. Define Pascal's law.
        iv. Calculate the extension and retraction forces of a pneumatic cylinder.
        v. Define Boyle's law.
    e. Speed control
        i. Describe the difference between meter-in and meter-out speed control and give advantages of each.
        ii. Describe the difference between pressure port and exhaust port speed control and give advantages of each.
    f. Pneumatic sequencing
        i. Describe methods of event sequencing in pneumatic systems.
    g. Vacuum Systems
        i. Describe methods of generating a vacuum using pneumatics and give an application.
    h. Maintenance
        i. Perform preventative maintenance on an air compressor.
        ii. Service an air drier
        iii. Describe methods of lubrication.
    i. Troubleshooting
        i. Describe and perform methods of identifying leaks.
        ii. Use a flowmeter to identify the source of an internal leak.
        iii. Use pressure gauges to identify a restriction in the system.
2. Describe and discuss basic principles of hydraulics as related to industrial maintenance.
    a. Define hydraulics and give benefits and drawbacks to the system.
    b. Hydraulic safety.
    c. Components of a hydraulic system.

i. Describe the use and operation of various types of hydraulic components and give the schematic symbol of each.

d. Pressure and flow
   i. Calculate extension and retraction forces of a cylinder.
e. Speed Control
   i. Describe the difference between meter-in and meter-out speed control and give advantages of each.
   ii. Define independent speed control.
   iii. Calculate cylinder speed given a flow rate.
f. Hydraulic Sequencing
   i. Describe methods of sequencing hydraulic circuits.
g. Accumulator Applications
   i. Describe how to use an accumulator to give auxiliary / emergency power in a hydraulic circuit.
   ii. Describe how to use an accumulator to compensate for leakage or temperature expansion in a hydraulic circuit.
h. Motor Braking
i. Describe how design a hydraulic motor braking circuit
i. Regeneration
   i. Describe regeneration and its uses in a hydraulic circuit.
   j. Maintenance
      i. Describe the importance of maintenance in a hydraulic system.
      ii. Change a hydraulic filter.
      iii. Monitor system temperature and how it affects performance.
k. Troubleshooting
   i. Use a flowmeter to check performance of a pump.
   ii. Use a flowmeter to identify an internal leak.
   iii. Use pressure gauges to identify a restriction in the system.

Course Number and Name: IMM 1484 Industrial Control Systems

Description: Instruction in the operation and function industrial control circuits and devices. Emphasis is placed on the student's ability to diagram, wire and troubleshoot a variety of circuits, control devices and actuators.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes

1. Control Transformers
   a. Describe the operation of a transformer and give its schematic symbol.
   b. Calculate the turns ratio of a transformer.
   c. Calculate the secondary voltage of a transformer given the input voltage and turns ratio.
   d. Test a control transformer using a meter.
   e. Size a control transformer given an application
2. Control Logic
   a. Describe the function of an indicator lamp and give its schematic symbol
   b. Describe the function of a pushbutton switch and give its schematic symbol.
   c. Describe the function of a selector switch and give its schematic symbol.
   d. Describe the function of a ladder diagram
   e. Describe the six elements of control logic.
3. Control Relays and Motor Starters
   a. Describe the function of a control relay and give its schematic symbols.
   b. Describe the function of a magnetic motor starter and how it differs from a control relay.
   c. Connect and operate a two wire motor control circuit.
   d. Connect and operate a three wire motor control circuit.
   e. Connect and operate a multiple operator station three wire motor control circuit.
4. Reversing Motor Control
   a. Describe the function of a reversing magnetic motor starter.
   b. Describe the function of an interlock.
   c. Connect a reversing motor control circuit with an interlock.
   d. Describe the function of automatic and manual modes.
   e. Describe the operation of a hand-off-automatic control circuit.
5. Timers
   a. Describe the function of an on-delay timer.
   b. Describe the function of and off-delay timer.
   c. Use a meter to test a time delay relay.
6. Motor Braking
   a. Describe the function of braking in motor control.
   b. List motor braking methods.
7. Reduced voltage motor starting

a. Describe reduced voltage motor starting methods.

Course Number and Name: IMM 1514 Equipment Installation and Alignment

Description: Instruction in pre-installation checks, assembly, location and layout of equipment, preparation of foundations and anchoring procedures, rigging and hoisting, and alignment and initial setup of equipment.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	105

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for equipment installation and alignment.
2. Perform pre-installation activities.
   a. Uncrate/unpackage components.
   b. Perform pre-installation checks for damage and missing components.
   c. Interpret assembly instructions provided by the manufacturer.
3. Perform assembly, location and layout, and foundation preparation activities.
   a. Assemble components of the equipment to be installed.
   b. Locate and lay out the position of the equipment to be installed.
   c. Prepare the foundation and mounting hardware for the equipment to be installed.
4. Perform rigging and hoisting activities for safe installation of equipment.
   a. Identify equipment and accessories used in rigging and hoisting.
   b. Practice safety procedures and precautions associated with rigging and hoisting.
   c. Determine safe working capacity of hoisting and lifting equipment.
   d. Estimate weight of load to be lifted.
   e. Demonstrate hand signals used in hoisting and moving equipment.
   f. Discuss the use of mobile power equipment in hoisting and moving including forklifts, cherry pickers, and cranes.
5. Install, align, and set up equipment.
   a. Rig and hoist equipment to specified location and layout.
   b. Discuss anchor equipment.
   c. Level equipment at location.
   d. Align shafts and bearings to specifications using dial indicators, feeler gauges, and laser shaft alignment systems.
   e. Perform final inspection and testing of installed equipment.

Course Number and Name: IMM 1524 Preventive Maintenance and Service of Equipment

Description: This course includes instruction in basic maintenance and troubleshooting techniques; use of technical manuals and test equipment; and inspection, evaluation, and repair of equipment.

Hour Breakdown

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	105

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures regarding preventative maintenance and service of equipment.
2. Perform preventive maintenance on equipment.
   a. Develop a preventive maintenance program for a given piece of equipment.
   b. Inspect and adjust belts, chains, and other moving parts.
   c. Lubricate a machine following manufacturer's recommendations.
3. Troubleshoot and repair equipment.
   a. Identify symptoms that indicate a machine is not operating properly (excessive noise, vibration, heat, speed, etc.).
   b. Determine the cause of the symptoms.
   c. Inspect machinery for broken or worn parts, and determine if replacement is needed.
   d. Prepare a report on time and costs involved in repairing equipment, including shutdown time for the machinery.
   e. Perform lockout-tagout procedures for broken equipment.
   f. Disassemble, inspect, repair, and reassemble equipment to specifications.
4. Perform maintenance and repair on HVAC systems or air compressor systems.
   a. Identify lubricants, and perform maintenance to manufacturer's specifications.
5. Discuss and apply proper safety procedures regarding preventative maintenance and service of equipment.
6. Perform preventive maintenance on equipment.
   a. Develop a preventive maintenance program for a given piece of equipment.
   b. Inspect and adjust belts, chains, and other moving parts.
   c. Lubricate a machine following manufacturer's recommendations.
7. Troubleshoot and repair equipment.
   a. Identify symptoms that indicate a machine is not operating properly (excessive noise, vibration, heat, speed, etc.).
   b. Determine the cause of the symptoms.
   c. Inspect machinery for broken or worn parts, and determine if replacement is needed.
   d. Prepare a report on time and costs involved in repairing equipment, including shutdown time for the machinery.
   e. Perform lockout-tagout procedures for broken equipment.
   f. Disassemble, inspect, repair, and reassemble equipment to specifications.
8. Perform maintenance and repair on HVAC systems or air compressor systems.

a. Identify lubricants, and perform maintenance to manufacturer's specifications.

Course Number and Name: IMM 1614 Principles of Plumbing and Hydro-Testing

Course Description: This course includes basic principles of plumbing to include installation and maintenance of many types of pipe systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

Introduction to the Plumbing Profession

1. Describe the history of the plumbing profession.
2. Identify the responsibilities of a person working in the plumbing industry.
3. State the personal characteristics of a professional.
4. Identify the stages of progress within the plumbing profession and its positive impact on society.
5. Identify how green technology is incorporated into plumbing.

Plumbing Safety

1. Describe the common unsafe acts and unsafe conditions that cause accidents.
2. Describe how to handle unsafe acts and unsafe conditions.
3. Explain how the cost of accidents and illnesses affects everyone on site.
4. Demonstrate the use and care of appropriate personal protective equipment.
5. Identify job-site hazardous work specific to plumbers.
6. Explain how to work safely in and around a trench.
7. Explain how to work safely in and around confined spaces.
8. Demonstrate the proper use of ladders.
9. Demonstrate how to maintain power tools safely.
10. Describe and demonstrate the lockout/tagout process.
11. Identify the benefits of a job safety analysis.

Tools of the Plumbing Trade

1. Identify plumbing tools.
2. Properly use plumbing tools.
3. Demonstrate proper maintenance and storage of hand and power tools.

Introduction to Plumbing Math

1. Add, subtract, multiply, and divide whole numbers.
2. Add, subtract, multiply, and divide fractions.
3. Add, subtract, multiply, and divide decimals.
4. Convert decimals to percentages and percentages to decimals.
5. Convert fractions to decimals and decimals to fractions.
6. Explain what the metric system is and how it is important in the plumbing trade.
7. Square various numbers and take square roots of numbers, with and without a calculator.
8. Identify the parts of a fitting and use common pipe-measuring techniques.
9. Use fitting dimension tables to determine fitting allowances and thread makeup.

10. Calculate end-to-end measurements using fitting allowances and thread makeup.
11. Identify the functions of a construction calculator.

Introduction to Plumbing Drawings

1. Identify various plumbing drawings and describe how the different views are used.
2. Identify the basic symbols used in schematic drawings of pipe assemblies.
3. Explain the types of drawings in a complete set of drawings and how they relate to each other.
4. Interpret plumbing-related information from a set of drawings.
5. Sketch an orthographic and isometric drawing.
6. Use an architect's scale to draw lines to scale and to measure lines drawn to scale.
7. Describe how code requirements apply to certain drawings.

Plastic Pipe and Fittings

1. Identify the various types of plastic pipe.
2. Identify the material properties, storage, and handling requirements of plastic pipe.
3. Identify the types of fittings and valves used with plastic pipe.
4. Identify the techniques used in hanging and supporting plastic pipe.
5. Properly measure, cut, and join plastic pipe.
6. Identify the hazards and safety precautions associated with plastic pipe.

Copper Tube and Fittings

1. Identify the various types of copper tube.
2. Identify the material properties, storage, and handling requirements of copper tube.
3. Identify the types of fittings and valves used with copper tube.
4. Identify the techniques used in hanging and supporting copper tube.
5. Properly measure, cut, and join copper tube.
6. Identify the hazards and safety precautions associated with copper tube.

Cast-Iron Pipe and Fittings

1. Select correct types of materials for cast-iron piping systems.
2. Identify types of fittings and their uses.
3. Select the appropriate personal protective equipment for cast-iron piping.
4. Correctly measure, cut, and join cast-iron pipe.
5. Select the correct hanger or support and spacing for the application.

Steel Pipe and Fittings

1. Identify the types of steel pipe.
2. Identify the material properties, storage, and handling requirements of steel pipe.
3. Identify the types of fittings and valves used with steel pipe.
4. Identify the techniques used in hanging and supporting steel pipe.
5. Properly measure, cut, and join steel pipe.
6. Identify the hazards and safety precautions associated with steel pipe.

Introduction to Plumbing Fixtures

1. Identify the basic types of materials used in the manufacture of plumbing fixtures.
2. Identify common types of sinks, lavatories, and faucets.
3. Identify common types of bathtubs and showers.
4. Identify common types of toilets, urinals, and bidets.
5. Identify and describe common types of drinking fountains and water coolers.
6. Identify common types of appliances connected by a plumber.

Introduction to Drain, Waste, and Vent (DWV) Systems

1. Explain how waste moves from a fixture through the drain system to the environment.
2. Identify the major components of a drainage system and describe their functions.
3. Identify the different types of traps and their components, explain the importance of traps, and identify the ways that traps can lose their seals.

4. Identify significant code and health issues, violations, and consequences related to DWV systems.

Introduction to Water Distribution Systems

1. Describe the process by which water is distributed in municipal, residential, and private water systems.
2. Identify the major components of a water distribution system, and describe the function of each component.
3. Explain the relationships between components of a water distribution system.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1713 Methods of Layout

Course Description: This course includes instruction related to the layout and development of various sheet metal problems using the principles of parallel line and triangulation development.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	0	6	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for layout of sheet metal.
2. Lay out and develop various sheet metal problems using the principles of parallel line and triangulation development.
    a. Lay out a rectangular, round, and transition sheet metal project.
3. Lay out and develop the following sheet metal problems using the principles of parallel line:
    a. Construct a rectangular straight duct (one-piece construction) plenum box.
    b. Construct a rectangular square throat and radius heel duct elbow.
    c. Round duct (miter 45°).
    d. Round saddle tap (miter) (same diameters)
    e. Round straight duct
    f. Flat S - hand and machine
    g. Bar S - (standing) - machine and hand
    h. Drive cleat - hand and machine
    i. Pittsburgh seam - hand and machine
4. Lay out and develop the following sheet metal problems using the principles of triangulation:
    a. Square to round (center taper) (boot box)
    b. Round duct taper (equal and taper)
    c. Rectangular duct transition
    d. Rectangular radius throat and radius heel duct elbow
5. Perform basic drawing skills.
    a. Measure blueprints using an architectural scale.
    b. Identify the basic symbols used on blueprints.
    c. Read and interpret notes on blueprints.
    d. Measure and transfer measurements using trammels.
    e. Draw circles and arcs with trammels.

Course Number and Name: IMM 1723 Structural Repair

Description: This course includes instruction related to estimating and making . repairs of wood, metal, and masonry structures.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	0	6	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for structural repair.
2. Identify and apply methods for making a specific structural repair.
    a. Identify specific materials used in structural repair according to specifications.
    b. Select materials needed to make a repair.
    c. Select tools needed to make a repair.
3. Construct structural repairs according to local specifications.
    a. Estimate expenses for a given project.
    b. Perform structural repairs for a specific project.

Course Number and Name: IMM 1734 Maintenance Welding and Metals

Description: This course includes different metals and their properties and in basic SMAW welding and oxy-fuel cutting and brazing. Components of this course are adopted from the NCCER Welding Level 1 Certification.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	105

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for welding.
2. Identify common metals, and discuss their properties.
    a. Identify the following metals commonly used in industrial machinery: cold rolled steel, hot rolled steel, stainless steel, titanium, aluminum, brass, copper, and cast iron.
    b. Discuss the properties of these metals as related to industrial maintenance.
3. Perform basic SMAW welding operations.
    a. Practice safety procedures for SMAW welding operations.
    b. Discuss the properties of electrodes commonly used in SMAW welding operations including E6010, E7018, stainless steel electrodes, and cast-iron electrodes.
    c. Set up SMAW welding equipment for a specific job.
    d. Prepare metal for SMAW welding.
    e. Demonstrate basic elements and techniques used in SMAW welding, including speed, position, joint preparation, arc gap, and so forth.
    f. Perform basic welding operations using SMAW welding equipment.
    g. Fabricate a welding project to specifications.
4. Perform basic oxy-fuel cutting, welding, and brazing operations.
    a. Practice safety procedures for oxy-fuel cutting and brazing operations.
    b. Set up oxy-fuel equipment for cutting.
    c. Set up oxy-fuel equipment for welding and brazing.
    d. Perform oxy-fuel cutting operations on mild steel.
    e. Perform oxy-fuel welding operations on mild steel.
    f. Silver-braze or solder copper fittings to a copper line.
    g. Heat metal for bending or component removal (bearings and races).

Course Number and Name: IMM 1814 Industrial Electricity Level I

Description: Advanced skills and knowledge associated with electrical systems in an industrial setting. Content includes instruction in the National Electrical Code, electrical circuits, motors, and estimating expenses for a given project.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

Orientation to the Electrical Trade

1. Describe the apprenticeship/training process for electricians.
2. Describe various career paths/opportunities one might follow in the electrical trade.
3. Define the various sectors of the electrical industry.
4. State the tasks typically performed by an electrician.
5. Explain the responsibilities and aptitudes of an electrician.

Electrical Safety

1. Recognize safe working practices in the construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain electrical safety issues concerning lockout/tagout procedures, confined space entry, respiratory protection, and fall protection systems.
5. Develop a task plan and a hazard assessment for a given task and select the appropriate PPE and work methods to safely perform the task.

Introduction to Electrical Circuits

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement that are used to measure the properties of electricity.
4. Identify the meters used to measure voltage, current, and resistance.
5. Explain the basic characteristics of series and parallel circuits.

Electrical Theory

1. Explain the basic characteristics of combination circuits.
2. Calculate, using Kirchhoff's voltage law, the voltage drop in series, parallel, and series-parallel circuits.
3. Calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits.
4. Using Ohm's law, find the unknown parameters in series, parallel, and series-parallel circuits.

Introduction to the National Electrical Code®

1. Explain the purpose and history of the NEC®.
2. Describe the layout of the NEC®.
3. Demonstrate how to navigate the NEC®.
4. Describe the purpose of the National Electrical Manufacturers Association and the NFPA.
5. Explain the role of nationally recognized testing laboratories.

Device Boxes

1. Describe the different types of nonmetallic and metallic boxes.
2. Calculate the NEC® fill requirements for boxes under 100 cubic inches.
3. Identify the appropriate box type and size for a given application.
4. Select and demonstrate the appropriate method for mounting a given box.

Hand Bending

1. Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
2. Cut, ream, and thread conduit.

Raceways and Fittings

1. Identify and select various types and sizes of raceways and fittings for a given application.
2. Identify various methods used to fabricate (join) and install raceway systems.
3. Identify uses permitted for selected raceways.
4. Demonstrate how to install a flexible raceway system.
5. Terminate a selected raceway system.
6. Identify the appropriate conduit body for a given application.

Conductors and Cables

1. From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses.
2. Determine the allowable ampacity of a conductor for a given application.
3. Identify the NEC® requirements for color coding of conductors.
4. Install conductors in a raceway system.

Basic Electrical Construction Drawings

1. Explain the basic layout of a set of construction drawings.
2. Describe the information included in the title block of a construction drawing.
3. Identify the types of lines used on construction drawings.
4. Using an architect's scale, state the actual dimensions of a given drawing component.
5. Interpret electrical drawings, including site plans, floor plans, and detail drawings.
6. Interpret equipment schedules found on electrical drawings.
7. Describe the type of information included in electrical specifications.

Residential Electrical Services

1. Explain the role of the National Electrical Code® in residential wiring and describe how to determine electric service requirements for dwellings.
2. Explain the grounding requirements of a residential electric service.
3. Calculate and select service-entrance equipment.
4. Select the proper wiring methods for various types of residences.
5. Compute branch circuit loads and explain their installation requirements.
6. Explain the types and purposes of equipment grounding conductors.
7. Explain the purpose of ground fault circuit interrupters and tell where they must be installed.
8. Size outlet boxes and select the proper type for different wiring methods.
9. Describe rules for installing electric space heating and HVAC equipment.
10. Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
11. Explain how wiring devices are selected and installed.
12. Describe the installation and control of lighting fixtures.

Electrical Test Equipment

1. Explain the operations of and describe the following pieces of test equipment: (Voltmeter, Ohmmeter, Clamp-on Ammeter, Multimeter, Megohmmeter, Motor and Phase Rotation Testers)
2. Select the appropriate meter for a given work environment based on category ratings.
3. Identify the safety hazards associated with the various types of test equipment.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 1824 Industrial Electricity Level II

Description: Instruction in terminology and basic principles of electricity, use of test equipment, safety practices for working around and with electricity, and basic electrical procedures.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

Alternating Current

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.
8. Explain the relationship between voltage and current in the following types of AC circuits: (RL circuit, RC circuit, LC circuit, RLC circuit)
9. Explain the following terms as they relate to AC circuits: (True power, Apparent power, Reactive power, Power factor) 10. Explain basic transformer action.

Motors: Theory and Application

1. Define the following terms: (Controller, Duty cycle, Full-load amps, Interrupting rating, Thermal protection, NEMA design letter, Overcurrent, Overload, Power factor, Rated full-load speed, Rated horsepower, Service factor)
2. Describe the various types of motor enclosures.
3. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.
4. Define percent slip and speed regulation.
5. Explain how the direction of a three-phase motor is changed.
6. Describe the component parts and operating characteristics of a three-phase wound-rotor induction motor.
7. Describe the component parts and operating characteristics of a three-phase synchronous motor.
8. Describe the design and operating characteristics of various DC motors.
9. Describe the methods for determining various motor connections.
10. Describe general motor protection requirements as delineated in the National Electrical Code® (NEC®).
11. Define the braking requirements for AC and DC motors.

Electric Lighting

1. Describe the characteristics of light.
2. Recognize the different kinds of lamps and explain the advantages and disadvantages of each type:(Incandescent, Halogen, Fluorescent, High-intensity discharge --HID--)
3. Properly select and install various lamps in lighting fixtures.
4. Recognize and describe the installation requirements for various types of lighting fixtures:

(Surface-mounted, Recessed, Suspended, Track-mounted)

5. Recognize ballasts and describe their use in fluorescent and HID lighting fixtures.
6. Explain the relationship of Kelvin temperature to the color of light produced by a lamp.
7. Recognize basic occupancy sensors, photoelectric sensors, and timers used to control lighting circuits and describe how each device operates.

Conduit Bending

1. Describe the process of conduit bending using power tools.
2. Identify all parts of electric and hydraulic benders.
3. Bend offsets, kicks, saddles, segmented, and parallel bends.
4. Explain the requirements of the National Electrical CodeR (NECR) for bending conduit.
5. Compute the radius, degrees in bend, developed length, and gain for conduit up to six inches.

Pull and Junction Boxes

1. Describe the different types of nonmetallic and metallic pull and junction boxes.
2. Properly select, install, and support pull and junction boxes and their associated fittings.
3. Describe the National Electrical Code® (NEC®) regulations governing pull and junction boxes.
4. Size pull and junction boxes for various applications.
5. Understand the NEMA and IP classifications for pull and junction boxes.
6. Describe the purpose of conduit bodies and Type FS boxes.

Conductor Installations

1. Explain the importance of communication during a cable-pulling operation.
2. Plan and set up for a cable pull.
3. Set up reel stands and spindles for a wire-pulling installation.
4. Explain how mandrels, swabs, and brushes are used to prepare conduit for conductors.
5. Properly install a pull line for a cable-pulling operation.
6. Explain how and when to support conductors in vertical conduit runs.
7. Describe the installation of cables in cable trays.
8. Calculate the probable stress or tension in cable pulls.

Cable Tray

1. Describe the components that make up a cable tray assembly.
2. Explain the methods used to hang and secure cable tray.
3. Describe how cable enters and exits cable tray.
4. Select the proper cable tray fitting for the situation.
5. Explain the National Electrical Code® (NEC®) requirements for cable tray installations.
6. Select the required fittings to ensure equipment grounding continuity in cable tray systems.
7. Interpret electrical working drawings showing cable tray fittings.
8. Size cable tray for the number and type of conductors contained in the system.

Conductor Terminations and Splices

1. Describe how to make a good conductor termination.
2. Prepare cable ends for terminations and splices and connect using lugs or connectors.
3. Train cable at termination points.
4. Understand the National Electrical Code® (NEC®) requirements for making cable terminations and splices.
5. Demonstrate crimping techniques.
6. Select the proper lug or connector for the job.

Grounding and Bonding

1. Explain the purpose of grounding and bonding and the scope of NEC Article 250.
2. Distinguish between a short circuit and a ground fault.

3. Define the National Electrical Code® requirements related to bonding and grounding.
4. Distinguish between grounded systems and equipment grounding.
5. Use NEC Table 250.66 to size the grounding electrode conductor for various AC systems.
6. Explain the function of the grounding electrode system and determine the grounding electrodes to be used.
7. Define electrodes and explain the resistance requirements for electrodes using NEC Section 250.56.
8. Use NEC Table 250.122 to size the equipment grounding conductor for raceways and equipment.
9. Explain the function of the main and system bonding jumpers in the grounding system and size the main and system bonding jumpers for various applications.
10. Size the main bonding jumper for a service utilizing multiple service disconnecting means.
11. Explain the importance of bonding equipment in clearing ground faults in a system.
12. Explain the purposes of the grounded conductor (neutral) in the operation of overcurrent devices.

Circuit Breakers and Fuses

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the operation of a circuit breaker.
4. Apply the National Electrical Code® (NEC®) requirements for overcurrent devices.
5. Describe the operation of single-element and time delay fuses.

Control Systems and Fundamental Concepts

1. Describe the operating principles of contactors and relays.
2. Select contactors and relays for use in specific electrical systems.
3. Explain how mechanical contractors operate.
4. Explain how solid-state contactors operate.
5. Install contactors and relays according to the NEC® requirements.
6. Select and install contactors and relays for lighting control.
7. Read wiring diagrams involving contactors and relays.
8. Describe how overload relays operate.
9. Connect a simple control circuit.
10. Test control circuits.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 191(1-4) Special Project in Industrial Maintenance Mechanic

Description: Practical applications of skills and knowledge gained in other Industrial Maintenance Mechanics courses. The instructor works closely with the student to ensure that selection of a special project enhances the student's learning experiences. Variable credit is awarded on the basis of one semester hour per 30 contact hours

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
1	0	2	30
2	0	4	60
3	0	6	90
4	0	8	120

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Develop a written plan that details the activities and projects to be completed.
   a. Utilize a written plan which details the activities and projects to be done.
   b. Perform written occupational objectives.
2. Assess accomplishment of objectives.
   a. Prepare daily written assessment of accomplishment of objectives.
   b. Present weekly written report of activities done to the instructor.
3. Utilize a set of written guidelines for the special project.
   a. Develop and follow a set of written guidelines.

Course Number and Name: IMM 192(1-6) Supervised Work Experience in Industrial Maintenance Mechanics

Description: This course is a cooperative program between industry and education designed to integrate the student's technical studies with industrial experience. Variable credit is awarded on the basis of one semester hour per 45 internship hours.

Hour Breakdown:

Scheduled Hours	Lecture	Externship	Clock Hours
1	0	3	45
2	0	6	90
3	0	9	135
4	0	12	180
5	0	15	225
6	0	18	270

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Apply technical skills needed to be a viable member of the workforce.
    a. Prepare a description of technical skills to be developed in the supervised work experience.
    b. Develop technical skills needed to be a viable member of the workforce.
2. Apply skills developed in other program area courses and human relationship skills.
    a. Perform skills developed in other program area courses.
    b. Use proactive human relationship skills in the supervised work experience.
3. Apply and practice positive work habits and responsibilities.
    a. Perform assignments to develop work habits and responsibilities.
4. Work with the instructor and employer to develop written occupational objectives to be accomplished.
    a. Perform written occupational objectives in the supervised work experience.
5. Assess accomplishment of objectives.
    a. Prepare daily written assessment of accomplishment of objectives.
    b. Present weekly written reports of activities performed and objectives accomplished to the instructor.
6. Utilize a set of written guidelines for the supervised work experience.
    a. Develop and follow a set of written guidelines for the supervised work experience.

Course Number and Name: IMM 1934 Manufacturing Skills Basic

Description: Manufacturing Skills is the initial course designed to provide the student with the basic skills needed to be successful in a high-performance manufacturing environment. The course covers 5 major areas of knowledge that are considered critical for employment in a high-performance manufacturing company. The topics covered include: Basic Computer Literacy, Safety and CPR, Blueprint Reading, Precision Measurement, and an introduction to manufacturing improvement methods that covers Lean Manufacturing, Quick Changeover, 5S, Teamwork and Problem-solving.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Cover the OSHA Safety training program content (OSHA certification is left up to each community college)
    a. Introduction to OSHA
    b. Electrical
    c. Exit Routes, Emergency Action Plans, Fire Prevention Plans, and Fire Protection
    d. Flammable and Combustible Liquids
    e. Personal Protective Equipment
    f. Hazard Communication
    g. Machine Guarding
    h. Ergonomics
    i. Walking-Working Surfaces
    j. Lockout/Tag out Procedures
    k. Workplace violence
    l. Safety and Health Programs
2. Apply skills needed to read industrial blueprints.
    a. Read an orthographic drawing.
    b. Read various different types of drawings used in manufacturing such as isometric, auxiliary and sectional views.
    c. Determine dimensions from various mechanical drawings.
    d. Demonstrate the ability to recognize symbols used in different types of drawings.
3. Apply precision measurement skills.
    a. Recognize precision measuring instruments.
    b. Demonstrate the proper use and care of precision measuring instruments.
    c. Demonstrate the ability to measure accurately with English measurement scales.
    d. Demonstrate the ability to measure accurately with metric measurement scales.
    e. Apply precision measurement devices in simulated job tasks.
4. Apply techniques used in high-performance manufacturing.
    a. Demonstrate Teamwork and problem-solving skills.
    b. Describe High-Performance manufacturing procedures to include:
        i. Lean manufacturing
        ii. 5S
        iii. SMED
        iv. Identifying customers and their needs
        v. Quality control

vi. Understanding of ISO
vii. Value stream mapping

c. Research and present a manufacturing topic.

5. Apply basic interviewing skills.
   a. Perform interviewing skills.
   b. Create a resume for a job interview.
6. Perform basic computer literacy skills.
   a. Run a program from the desktop and the Start Menu.
   b. demonstrate how to operate a browser
   c. Enter a website by entering the URL.
   d. Demonstrate how to save a website URL as a favorite or bookmark.
   e. Demonstrate how to use a search engine
   f. Establish and use an email account
   g. Demonstrate how to create and save a word processing file.
   h. Create and save a spreadsheet file.
   i. Send, receive, save and open an attachment using an email account.

Course Number and Name: IMM 2114 Equipment Maintenance, Troubleshooting, and Repair

Description: This course includes maintenance and troubleshooting techniques, practice in the use of technical manuals and test equipment, and training in inspection/evaluation/repair of equipment.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	1	6	105

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures regarding maintenance, troubleshooting, and repair of equipment.
2. Perform preventive maintenance on equipment.
3. Troubleshoot and repair equipment.
4. Estimate expenses for a given project.

Course Number and Name: IMM 2124 Power Tools, Machining, and Materials

Description: This course is designed to provide fundamental skills associated with all mechanical maintenance courses. This course includes safety, powered hand and stationary tools, use of a calculator, test equipment familiarization and terminology.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Identify, select, apply and maintain common hand power tools used by industrial maintenance mechanics and technicians.
2. Demonstrate the safe and proper use of bench grinders.
3. Demonstrate the safe and proper use of a drill press.
4. Demonstrate the safe and proper use of a pipe threading machine.
5. Identify, select and process metals.

Course Number and Name: IMM 2214 Advanced Electrical Industrial Maintenance

Description: This course includes hazardous locations, electronic components, E & I drawings, motor controls, distribution equipment, transformer applications, and conductor selection and calculation.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

HAZARDOUS LOCATIONS

1. Define the various classifications of hazardous locations.
2. Describe the wiring methods permitted for branch circuits and feeders in specific hazardous locations.
3. Select seals and drains for specific hazardous locations.
4. Select wiring methods for Class I, Class II, and Class III hazardous locations.
5. Follow National Electrical Code® (NEC®) requirements for installing explosion-proof fittings in specific hazardous locations.

ELECTRIC COMPONENTS

1. Identify electronic system components.
2. Describe the electrical characteristics of solid-state devices.
3. Describe the basic materials that make up solid-state devices.
4. Describe and identify the various types of transistors and explain how they operate.
5. Describe and connect diodes, including light-emitting diodes (LEDs) and silicon-controlled rectifiers (SCRs).
6. Use a cross reference manual to find substitutes for electronic components.
7. Identify fuses used in electronic devices.
8. Identify the leads of various solid-state devices.
9. Describe integrated circuits.
10. Applicable pin numbers of integrated circuits.
11. Explain the purpose of logic gates.
12. Check diodes.

E&I DRAWINGS

1. Identify common types of electrical and instrumentation diagrams and drawings.
2. Read and interpret electrical diagrams used in instrumentation work: Wiring diagrams, Ladder diagrams, One-line Diagrams, and Motor controller diagrams
3. Read and interpret instrumentation diagrams: P&ID diagrams, Loop diagrams, and Raceway diagrams.
4. Draw a loop diagram for a given instrumentation loop.

MOTOR CONTROLS

1. Identify contactors and relays both physically and schematically and describe their operating principles.
2. Identify pilot devices both physically and schematically and describe their operating principles.
3. Interpret motor control wiring, connection, and ladder diagrams.
4. Select and size contactors and relays for use in specific electrical motor control systems.
5. Select and size pilot devices for use in specific electrical motor control systems.
6. Connect motor controllers for specific applications according to National Electrical Code® (NEC®) requirements.

DISTRIBUTION EQUIPMENT

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the purpose of switchgear.
4. Describe the four general classifications of circuit breakers and list the major circuit breaker ratings.
5. Describe switchgear construction, metering layouts, wiring requirements, and maintenance.
6. List National Electrical Code® (NEC®) requirements pertaining to switchgear.
7. Describe the visual and mechanical inspections and electrical tests associated with low-voltage and medium-voltage cables, metal-enclosed busways, and metering and instrumentation.
8. Describe a ground fault relay system and explain how to test it.

TRANSFORMER APPLICATIONS

1. Identify three-phase transformer connections.
2. Identify specialty transformer applications.
3. Size and select buck-and-boost transformers.
4. Calculate and install overcurrent protection for specialty transformers.
5. Ground specialty transformers in accordance with National Electrical Code® (NEC®) requirements.
6. Calculate harmonic derating of transformers.

CONDUCTOR SELECTION AND CALCULATIONS

1. Select electrical conductors for specific applications.
2. Calculate voltage drop in both single-phase and three-phase applications.
3. Apply National Electrical Code® (NEC®) regulations governing conductors to a specific application.
4. Calculate and apply NEC® tap rules to a specific application.
5. Size conductors for the load.
6. Derate conductors for fill, temperature, and voltage drop.
7. Select conductors for various temperature ranges and atmospheres.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 2224 Advanced Mechanical Industrial Maintenance

Description: This course includes temporary grounding, layout and installation of tubing and piping systems, machine bending of conduit, hydraulic controls, pneumatic controls, and motor-operated valves.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

TEMPORARY GROUNDING

1. Explain the purpose of temporary grounding.
2. Explain requirements associated with temporary grounding devices.
3. Identify and explain temporary grounding equipment.
4. Explain how to install and remove temporary grounding devices.

LAYOUT AND INSTALLATION OF TUBING AND PIPING SYSTEMS

1. Using prints, specifications, and visual inspections, determine the scope of the layout procedure.
2. Determine the proper methods for routing piping or tubing.
3. Apply fitter's math to measure and bend piping or tubing.
4. Cut piping or tubing.
5. Apply the appropriate calculations and bender to accurately bend piping or tubing to the proper angle in an offset.
6. Identify and state the usage of various piping and tubing supports.
7. Install various piping and tubing supports.
8. Identify and state the usage of various piping and tubing fittings, including: Flare tubing fittings, Compression tubing, Fittings, Threaded pipe fittings, and Pipe flanges

MACHINE BENDING OF CONDUIT

1. Describe the process of conduit bending using power tools.
2. Identify all parts of electric and hydraulic benders.
3. Bend offsets, kicks, saddles, segmented, and parallel bends.
4. Explain the requirements of the National Electrical Code® (NEC®) for bending conduit.
5. Compute the radius, degrees in bend, developed length, and gain for conduit up to six inches.

HYDRAULIC CONTROLS

1. Explain hydraulic system safety.
2. Explain the principles of hydraulics.
3. Identify hydraulic devices and symbols and explain their functions.
4. Explain a hydraulic system in a process application.

PNEUMATIC CONTROLS

1. Explain pneumatic system safety.
2. Explain the physical characteristics of gases.
3. Explain compressing gases.
4. Explain the pneumatic transmission of energy.
5. Explain the principles of compressor operation.
6. Identify and explain types of compressors.
7. Explain compressed-air treatment.
8. Identify and explain pneumatic system components and symbols.

MOTOR-OPERATED VALVES

1. State safety regulations associated with motor-operated valves (MOVs).

2. Explain the operating principles of various types of MOVs.
3. Identify applications of MOVs.
4. Set up a MOV.
5. Remove and replace a limit switch.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 2424 Solid State Motor Control

Description: This course includes principles and operation of solid state motor control. Additionally, the course includes the design, installation, and maintenance of different solid state devices for motor control.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Apply general safety and safety requirements for working on and around electrical motors.
    a. Apply principles of safety in the use of electrical motors.
        i. Describe safety procedures to utilize during connecting and operating electric motors.
    b. Troubleshoot solid state motor controls.
        i. Identify electronic and industrial symbols used to represent logic gates in solid state schematics.
        ii. Describe the operation of the different types of industrial and electronic logic gates.
        iii. Draw a solid state logic circuit to replace a manual control station.
        iv. Troubleshoot and repair/replace solid state devices to include memory devices, flip/flops, adjustable time delays, starting and stopping sequences, and looping.
    c. Operate AC and DC variable speed drives.
        i. Discuss the operation of a DC variable speed drive.
        ii. Discuss the operation of an AC variable speed drive.
        iii. Connect and operate a DC and AC variable speed drive.

Course Number and Name: IMM 2433 Electronic Motion Control

Description: This course explains applications and operating procedures of solid-state controls, reduced-voltage starters, and adjustable frequency drives as well as troubleshooting procedures.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Select and install solid-state relays for specific applications in motor control circuits.
2. Install non-programmable and programmable motor circuit protection.
3. Select and install electromechanical and solid-state timing relays for specific applications in motor circuits.
4. Recognize the different types of reduced-voltage starting motor controllers and describe their operation.
5. Connect and program adjustable frequency drives to control a motor.
6. Demonstrate the special precautions used when handling and working with solid-state motor controls.
7. Perform preventative maintenance and troubleshooting tasks in motor control circuits.
8. Troubleshooting
    a. Use a meter to test a manual switch.
    b. Use a meter to test a control relay.
    c. Use a meter to test a motor starter.
    d. Use a meter to test an overload relay.
    e. Use a meter to test the windings of a 3-phase motor.
    f. Use a meter to measure voltage in a circuit.
    g. Use a meter to measure voltage drop in a circuit.
    h. Use a clamp on ammeter to measure current in a circuit.
    i. Describe systems troubleshooting methods and give examples of each.
9. Automatic input devices (REMOVE PER HINDS & ADD TO IMM 2433)
    a. Mechanical switches.
        i. Describe the function of a limit switch and give its schematic symbol.
        ii. Describe the function of a float switch and give its schematic symbol.
        iii. Describe the function of a pressure switch and give its schematic symbol.
    b. Electronic Sensors
        i. Describe the function of an inductive proximity sensor and give its schematic symbol.
        ii. Describe the function of a capacitive proximity sensor and give its schematic symbol.
        iii. Describe the function of a photoelectric sensor and give its schematic symbol.
    c. Sequence control
        i. Describe the function of a sequence control circuit.

Course Number and Name: IMM 2443 Basic Pipefitting

Description: This course includes basic principles of piping and pipe fitting, and basic pipe fitting procedures for threaded pipe systems .

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

Orientation

1. Describe the types of work performed by pipefitters
2. Identify career opportunities available to pipefitters.
3. Explain the purpose and objectives of an apprentice training program.
4. Explain the responsibilities and characteristics of a good pipefitter.
5. Explain the importance of safety in relation to pipefitting.

Pipefitting Hand Tools

1. Describe the safety requirements that apply to the use of pipefitter hand tools.
2. Explain how to properly care for selected pipefitter hand tools.
3. Demonstrate how to safely and properly use selected pipefitter hand tools.
4. Identify tools and state their uses.
5. Use selected hand tools.

Pipefitting Power Tools

1. State the safety procedures that must be followed when working with power tools.
2. Cut pipe using a portable band saw.
3. Identify and explain the uses of portable grinders.
4. Explain the proper and safe operation of machines used in pipe joint preparation:
   a. Pipe threaders
   b. Portable power drives
   c. Pipe bevelers
5. Perform selected pipe joint preparation operations using power tools.

Laddrs and Scaffolds

1. Identify the different types of ladders and scaffolds used on a work site.
2. Describe how to safely use ladders and scaffolding.
3. Properly set up, inspect, and use stepladders, extension ladders, and scaffolding.

Piping Systems

1. Identify and explain the type of piping systems.
2. Identify piping systems according to color-coding.
3. Explain the effects and corrective measures for thermal expansion in piping systems.
4. Explain types and applications of pipe insulation.

Threaded Pipe Fabrication

1. Identify and explain the materials used in threaded piping systems.
2. Identify and explain pipe fittings.
3. Read and interpret screwed fitting joint drawings.
4. Identify and explain types of threads.
5. Determine pipe lengths between joints.
6. Thread and assemble piping and valves.
7. Calculate offsets.

* These student learning outcomes align to NCCER for the colleges wanting to offer NCCER as a certification.

Course Number and Name: IMM 2513 Programmable Logic Controllers Multi-Platform

Description: This course covers use of programmable logic controllers (PLCs) in modern industrial settings as well as the operating principles of PLCs and practice in the accelerated programming across multiple PLC platforms, installation and maintenance of PLCs.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Explain principles of PLCs.
2. Identify different types of PLC hardware.
3. Explain numbering systems, encoding / decoding, and logical operations.
4. Program different types of internal and discrete instructions.
5. Troubleshoot and maintain different programmable controller systems.
6. Use program control instructions and subroutines to control program function.
7. Use math instructions to manipulate outputs of a program.

Course Number and Name: IMM 2613 Programmable Logic Controllers

Description: This course includes of programmable logic controllers (PLCs) in modern industrial settings. This course also includes the operating principles of PLCs and practice in the programming, installation, and maintenance of PLCs.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Explain principles of PLCs.
    a. Identify components and operational principles of PLCs.
    b. Differentiate between a PLC and a computer.
2. Identify different types of PLC hardware.
    a. Identify and wire different types of input and output modules.
    b. Identify different types of PLC processor modules, memory capabilities, and programming devices.
3. Explain numbering systems, encoding/decoding, and logical operations.
    a. Convert numbers from one system to another.
    b. Explain logical operations using truth tables and ladder logic diagrams.
4. Program all types of internal and discrete instructions.
    a. Program examine on and off instructions.
    b. Program on-delay and off-delay instructions.
    c. Program up-counter and down-counter instructions.
    d. Program sequencer instructions for real-world output devices.
    e. Program latch and unlatch instructions.
5. Troubleshoot and maintain different programmable controllers systems.
    a. Identify and troubleshoot the power supply.
    b. Identify and troubleshoot the inputs and outputs (I/O) cards.
    c. Identify and troubleshoot real-world inputs and outputs.

Course Number and Name: IMM 2623 Advanced Programmable Logic Controllers

Description: Advanced PLC course that provides instruction in the various operations, installations, and maintenance of electric motor controls. Also, information in such areas as sequencer, program control, introduction to function blocks, sequential function chart, introduction to HMI, and logical and conversion instructions.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Program all types of high order instructions.
    a. Calculate and develop mathematical instructions to include addition, subtraction, multiplication, and division.
    b. Program and set up a chart for input and output sequencer combination.
    c. Program and set up an analog input and output card using PLC software.
    d. Explain the use of function block and sequential function blocks in a programmable logic controller.
    e. Demonstrate the ability to develop a basic Human to Machine Interface (HMI) project.
    f. Program and demonstrate how to set up a produce and consume tab/message.
2. Troubleshoot advanced PLC controls.
    a. Troubleshoot an analog input and output card.
    b. Troubleshoot communication devices used in networking.

Course Number and Name: IMM 2714 CNC Computer Assisted Manufacturing

Course Description: An introduction of computer numerical control (CNC) and computer assisted manufacturing (CAM) techniques and practices. Includes the use of the Cartesian coordinate system, programming codes and command, and tooling requirements for CNC/CAM machines

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite:
Instructor Approved

Student Learning Outcomes:

1. Discuss and apply general machine shop safety.
    a. Identify, discuss, and test safety procedures.
    b. Demonstrate safety procedures.
2. Describe CNC machining, uses, and applications of CNC program.
    a. Describe the capabilities and limitations of computer numerical control (CNC)/computer assisted manufacturing (CAM) equipment.
    b. Describe the Cartesian coordinate system as used in a CNC machine program.
    c. Describe the differences in absolute and incremental dimensioning as related to an ISO programming of a CNC machine.
    d. Describe procedures for CNC machine start-up.
3. Discuss commands for CNC machine codes.
    a. List and describe the purpose or function of the preparatory commands for a CNC machine (Gcodes).
    b. Explain the purpose or function of the miscellaneous commands used with a CNC machine (Mcodes).
    c. State the purpose of other alphabetical commands used in programming operations of a CNC machine.
4. Discuss tooling for CNC operations, and safely use CNC mill, CNC lathe, and CNC machine centers to project specifications.
    a. Describe the different types of tooling required for CNC mills, CNC lathes, and CNC machine centers.
    b. Select tooling required for a specific job on a CNC mill, CNC machine centers, and CNC lathe.
    c. Write and manually input program data.
    d. Execute programs for CNC mill, CNC lathe, and CNC machine center according to project specifications.

Course Number and Name: IMM 2723 Maintenance Reliability

Course Description: This course includes four major performance domains that are aligned to the Certified Maintenance Reliability Professional Certification. Domains include maintenance practices, preventive and predictive maintenance and analysis, and corrective maintenance.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

Maintenance Practices

1. Adhere to safety, health, and environmental standards and policies by taking personal responsibility in order to prevent injury or illness from exposure to hazards by successfully demonstrating the following:
   a. Blood borne pathogens
   b. Confined space entry
   c. Electrical safety
   d. Emergency response (ER) and evacuation
   e. Environmental compliance
   f. Ergonomics
   g. Eye protection
   h. Fall protection
   i. Fire safety
   j. HAZCOM/MSDS
   k. Hearing conservation
   l. Ladder safety
   m. Lockout/tagout procedures
   n. Personal protective equipment (PPE)
   o. Process safety management (PSM)
   p. Respiratory protection
   q. Rigging
   r. Safety system and devices
   s. Scaffolding
2. Inform production control personnel about the maintenance activity required in accordance with company protocol in order to adjust the operations schedules by successfully demonstrating the following:
   a. Lockout/tagout procedures
   b. Process overview
   c. Work permits
3. Perform the proper lockout/tagout procedures on equipment in accordance with applicable standards in order to ensure zero energy state prior to commencing maintenance work and minimize health, safety, and environmental hazards to employees and the community by successfully demonstrating the following:
   a. Lockout/tagout procedures
   b. Multiple energy sources
   c. Zero energy states

4. Perform a pre-use inspection on maintenance tools and equipment using established standards and guidelines in order to ensure safe operation and to extend the life of the tools and equipment by successfully demonstrating the following:
    a. Cranes and hoists
    b. Field machinery and tools
    c. Ladder safety
    d. Rolling stock/mobile equipment (e.g., mobile cranes, man-lift/scissor lift, fork lift)
    e. Shop machinery and tools
    f. Rigging equipment (e.g., slings, shackles, eyebolts, chains, hooks)
5. Use maintenance tools and equipment in accordance with manufacturers' specifications and established safety policies in order to ensure safety and efficiency by successfully demonstrating the following:
    a. Equipment and tool specifications
    b. Established equipment and tool-safety policies and procedures
6. Use measuring tools and equipment in a manner that will ensure accurate measurements in order to perform maintenance tasks properly by successfully demonstrating the following:
    a. Application of specific tools
    b. Basic math (e.g., fractions, addition, subtraction, multiplication, division)
    c. Calibration requirements for measurement tools (e.g., torque wrench, calipers, alignment tools)
    d. Conversion of appropriate measurement and engineering units
    e. Measurement principles (e.g., mass, force, motion, distance, acceleration, power, fluid, bulk)
    f. Measurement tools (e.g., rulers, gauges, tapes, micrometer, calipers, lasers)
7. Handle all maintenance materials and parts in accordance with established standards and procedures in order to prevent damage to the parts and equipment by successfully demonstrating the following: a. Company safety policies
    b. Material handling techniques and procedures
    c. Material storage procedures
    d. Original equipment manufacturers' (OEM) instructions
8. Maintain housekeeping by adhering to established site standards and by removing all maintenancerelated parts and waste in order to ensure a safe and orderly job site by successfully demonstrating the following:
    a. Facility and regulatory policies on housekeeping
    b. Hazards of improper housekeeping
    c. Proper organization and cleaning of job site
9. Document maintenance activities using the facility's maintenance management system in order to record history, assist with planning and scheduling, and support root-cause failure analysis by successfully demonstrating the following:
    a. Documentation systems (e.g., paper filing systems, computer filing systems, email)
    b. Maintenance planning and scheduling

Preventive and Predictive Maintenance

10. Use PF curve to demonstrate life cycle of equipment components from Design to Function Failure or end of life:
    a. Design
    b. Installation or repair
    c. Potential Failure
    d. Deterioration over time
    e. Functional Failure
    f. Correct before failure
11. Perform preventive and/or predictive maintenance according to the work plan in order to maximize mean time between failures by successfully demonstrating the following:

a. Company safety, health, and environmental policies
b. Equipment function and use
c. Predictive maintenance procedures
d. Preventive maintenance procedures
e. Work plan requirements

12. Apply predictive maintenance techniques by observing equipment performance and collecting ongoing performance data in order to maximize mean time between failures by successfully demonstrating the following:
    a. Company safety, health, and environmental policies
    b. Function of equipment
    c. Operation parameters for equipment, including baseline conditions
    d. Predictive maintenance techniques and technologies (e.g., oil samples, vibration readings, hermographic equipment, ultrasonic testing)
13. Lubricate equipment in accordance with the lubrication schedule and equipment specifications in order to ensure reliable performance and prevent damage by successfully demonstrating the following:
    a. Company safety, health, and environmental policies
    b. Equipment specifications
    c. Filtering systems
    d. Lubricant specifications
    e. Lubricating systems
    f. Lubrication principles
    g. Lubrication route
    h. Lubrication Failures
14. Perform alignment checks on rotating equipment (e.g., pumps, fans, blowers, turbines, gear boxes, compressors) in accordance with equipment specifications in order to ensure reliable performance and prevent damage by successfully demonstrating the following:
    a. Company safety, health, and environmental policies
    b. Equipment alignment techniques (e.g., laser, reverse, straight edge, rim and face)
    c. Equipment functions
    d. Thermal growth
    e. Operation principles for rotating equipment
    f. Alignment Failures
15. Perform checks on safety systems and devices in accordance with equipment design specifications in order to ensure reliable operation and protect employees by successfully demonstrating the following:
    a. Company safety, health, and environmental policies
    b. Consequences of bypassing safety systems
    c. Equipment design specifications
    d. Equipment functions (e.g., limit switches, photoelectric eyes)
    e. Operation of safety systems
16. Design a Preventive Maintenance standard that will maintain the design intent of the equipment with minimum skill and resource requirements:
    a. Company safety, health, and environmental policies
    b. Functions and Components list
    c. Failure Modes list
    d. Identifying the PM task
    e. Optimizing the task
    f. Promoting the task
    g. PM Scheduling
    h. PM effectiveness and efficiency

i. PM Analysis

Troubleshooting and Analysis

17. Task 1: Gather information relating to a maintenance request by reviewing the work order and/or interviewing operations personnel in order to determine the general nature of the problem by successfully demonstrating the following:
    a. Effective interpersonal relations
    b. Equipment and/or processes
    c. Recording Sequence of events
    d. Maintenance work order systems
18. Verify that the problem is valid by systematically testing and/or observing the equipment's performance, as conditions permit, in order to determine if a problem actually exists by successfully demonstrating the following:
    a. Function and use of the equipment
    b. Process indicators (e.g., gauges, annunciators, Human Machine Interface [HMI] displays)
19. Obtain appropriate technical documentation using facility resources in order to gain full understanding of designed operating parameters and/or sequences by successfully demonstrating the following:
    c. Facility resources (e.g., CMMS, technical library, engineering files)
    d. Operating parameters and sequences
    e. Technical documentation (e.g., schematics, P&ID, blueprints, O&M manuals, SOP, MSDS)
20. Investigate previous maintenance activities, as conditions require, by reviewing equipment history in order to identify information that will facilitate troubleshooting by successfully demonstrating the following:
    a. Facility maintenance record systems
    b. Facility preventative maintenance scheduling programs or systems
    c. Preventative maintenance techniques and theories (e.g., lubrication, seals and bearings, alignments)
21. Identify the cause of the problem using a systematic process of elimination in order to determine what is causing the malfunction by successfully demonstrating the following:
    a. Equipment and/or process design parameters
    b. Hazards involved with operating and/or maintaining specific process equipment
    c. Systematic troubleshooting and analysis

<u>Corrective Maintenance</u>

22. Verify troubleshooting analysis by disassembling and inspecting components using established procedures in accordance with applicable standards and guidelines in order to confirm that the identified corrective action is appropriate by successfully demonstrating the following:
    a. Common mechanical systems (e.g., lubrication, seals and bearings, alignment, power transmission, cams, cranks, pneumatics, hydraulics, thermodynamics, heat transfer, piping systems, steam systems)
    b. Correct use of tools and equipment, including measuring devices
    c. Equipment specifications
    d. Equipment and component functions
    e. Operation of equipment and components
    f. Results of troubleshooting analysis
    g. Specific equipment repair procedures, applicable standards, and guidelines
23. Repair the malfunction by performing required corrective maintenance tasks in accordance with best maintenance practices in order to return the equipment to the desired operating condition by successfully demonstrating the following:

a. Common mechanical systems (e.g., lubrication, seals and bearings, alignment, power transmission, cams, cranks, pneumatics, hydraulics, thermodynamics, heat transfer, piping systems, fabrication, steam systems)
b. Correct use of tools and equipment, including measuring devices
c. Equipment specifications
d. Equipment and component functions (e.g., pumps, fans, blowers, turbines, gear boxes, compressors, fasteners, motors, piping systems, gaskets/packing, drive systems, conveying systems)
e. Equipment and component operation
f. Specific equipment repair procedures, applicable standards, and guidelines

24. Monitor the equipment after it has been repaired while operating it under normal conditions in order to determine whether or not the repair was successful by successfully demonstrating the following:
    a. Equipment and component functions (e.g., pumps, fans, blowers, turbines, gear boxes, compressors, fasteners, motors, piping systems, gaskets/packing, drive systems, conveying systems)
    b. Equipment and component operation
25. Release repaired equipment for return to service using standard operating procedure in order to resume normal operation by demonstrating the following:
    a. Procedures for releasing equipment for return to service
26. Perform effective Root Cause Analysis post recovery to eliminate recurrence of Function Failure and to improve the time for Recovery:
    a. Record all sequence of events and important contributing facts
    b. Use factor tree to show the contributing factors
    c. Cause levels from Effect – Physical – Human - Systemic – Latent
    d. Countermeasure implementation
    e. Countermeasure effectiveness

Course Number and Name: IMM 2814 Mechatronics Programming I

Description: This course provides a hands-on learning environment to develop and practice the techniques used in programming and sequencing mechatronics systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Introduction to Mechatronics
    a. Define Mechatronics
    b. Explain why Mechatronics is important in the world today.
    c. Explain the importance of common applications of mechatronics in our everyday lives.
    d. Explain Mechatronics safety.
2. Mechatronic Systems
    a. List a variety of systems used in mechatronic systems and give an application.
3. Discuss the operation of a Mechatronic System
    a. Discuss why (in many cases) machines require a startup / shutdown procedure.
    b. Describe the function of Start, Stop, Emergency Stop and Reset controls.
    c. Describe the difference in manual and automatic modes.
    d. Give examples of how mechatronics systems are used in industry.
    e. Describe the function of an HMI and how it differs from traditional controls.
4. Programming of a Mechatronic System
    a. Describe the function of a programmed interlock
    b. Describe the function of a programmed fault detection/protection.
    c. Be able to program of a variety of mechatronic devices given a sequence of operation.
    d. Define discrete I/O handshaking and give an application.
    e. Working in a team, alter existing programs to allow for multiple station control for startup, and flexible manufacturing.

Course Number and Name: IMM 2824 Mechatronics Robotics

Description: This course provides a hands-on learning environment to develop and practice the techniques used in programming and troubleshooting robotic systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Safety
    a. Apply safety rules for personal and general safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding.
    b. Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment.
    c. Apply general safety rules associated with working on various robotics systems.
    d. Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of fire-fighting devices.
2. Robotic Components
    a. Explain the axis of movement
    b. Label each major component
    c. Identify four general types of work envelopes
    d. Discuss three general forma of robot actuation
    e. Identify different types of input devices used with robot controllers
    f. Describe the characteristics of a robot which distinguishes it from other types of automated machinery.
3. Robot Operation
    a. Evaluate robot performance
    b. Apply basic programming skills
    c. Identify and discuss end effectors
    d. Identify and discuss visual and tactile sensors
    e. Demonstrate basic troubleshooting techniques
4. Integrate a robot into a process
    a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot's work envelope.
    b. Demonstrate the improvement of efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, etc.
5. Integrate peripheral equipment
    a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells.
    b. Interface contact and non-contact sensors into robotics work cell.
6. Troubleshoot a robotic work cell
    a. Locate and isolate faults in robotics applications
    b. Demonstrate the use of test equipment and troubleshooting logic to repair faults.
    c. Perform routine maintenance procedures on robots with the use of checklists and service equipment.

Course Number and Name: IMM 2833 Mechatronics Process Control

Course Description: A study of the instruments and instrument systems used in chemical processing including terminology, primary variables, symbols, and control loops.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and apply the major elements of process technology.
    a. Define pressure and apply related measurements and processes used in the process industry.
    b. Define temperature and apply related measurements and processes used in the process industry.
    c. Define level and apply related measurements and processes used in the process industry.
    d. Define flow and apply related measurements and processes used in the process industry.
    e. Define analytical instrumentation and apply related measurements and processes used in the process industry.
2. Describe and explain the functions and components of process control.
    a. Identify and describe the various pieces of equipment used in instrumentation (transmitters; transducers; differential pressure cells; analog, pneumatic and digital instruments; etc)
    b. Describe valves used in instrumentation (globe, three-way, butterfly, etc.)
    c. Explain the functions and components of a control loop and contrast the differences between open and closed controls.
    d. Describe the relationship between measurement instruments and their role in the overall control loop process.
3. Describe and interpret the types of process industry drawings.
    a. Compare and contrast piping and instrument diagrams (P&IDs) and process flow drawings (PFDs)
    b. Describe the lettering and numbering standards based on ISA instrumentation symbols.
    c. Describe how to determine the instrument type from the symbol information.
    d. Describe the standards for line symbols.
4. Describe the role and function of advanced controls and controllers in process operations.
    a. Identify the different advanced controls and controllers and their primary function.
5. Explain the different practices related to process technicians' troubleshooting process instruments.
    a. Explain the importance of process knowledge in troubleshooting.
    b. Identify typical malfunctions found in primary sensing elements and transmitters.
    c. Explain the methods used for determining if a sensing/measuring device is malfunctioning.
    d. Demonstrate how to properly tune a PID control loop.

Course Number and Name: IMM 2844 Mechatronics Programming II

Course Description: This course provides a hands-on learning environment to develop and practice the techniques used in advanced programming and network integration of mechatronic systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Analog inputs and Outputs
    a. Integrate an analog sensor into an existing mechatronics system.
    b. Integrate an analog output device into an existing mechatronics system.
2. Networking
    a. Set up a network to allow data sharing between devices.
3. HMI Integration
    a. Create a HMI application to remote control a mechatronics station.
    b. Create a HMI application to remote control multiple mechatronics stations.
    c. Create a HMI application to provide fault warnings and troubleshooting information.
4. Vision Systems
    a. Set up and calibrate a vision system
5. Data Collection Systems
    a. Create a program for a flexible manufacturing system that builds a part based on information read from that part (bar code, data matrix, rfid).

Course Number and Name: IMM 2854 Mechatronics Troubleshooting and Repair

Course Description: This course provides a hands-on learning environment to develop and practice the techniques used in troubleshooting complex mechatronics systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Overview
    a. Define Troubleshooting
    b. Troubleshooting Steps
        i. Preparation
        ii. Observation
        iii. Define Problem Area
        iv. Identify Possible Causes
        v. Determine Most Probable Cause
        vi. Test and Repair
        vii. Follow-up
2. Troubleshooting Techniques
    a. Discuss various troubleshooting techniques and their application.
3. System Troubleshooting
    a. Demonstrate how to effectively troubleshoot and repair various machine issues.

Course Number and Name: IMM 2863 Data Acquisition and Communications

Course Description: This is a course in acquisition and communication of systems data in industrial automated applications.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Explain data communication components used in automatic systems.
    a. Identify characteristics and uses of various EIA standard data communication interfaces.
    b. Describe standard serial communications used in computers.
    c. Describe parallel communication interfaces.
    d. Explain Ethernet.
    e. Explain Controlnet.
    f. Explain CAN based networks.
2. Use data communication software PLC and a computer to connect a network.
    a. Configure a computer for serial or parallel communications.
    b. Perform data transfers between computers.
    c. Use communication test equipment to troubleshoot communications links.
3. Use computers and / or controllers for data acquisition.
    a. Interface sensors with computer or controller data acquisition using Ethernet.
    b. Configure software and computer for data acquisition from a PLC.

Course Number and Name: WBL 191(1-3), WBL 192(1-3), Work-Based Learning I, II, III, IV, V, and VI, WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), and WBL 293(1-3)

Description: A structured work-site learning experience in which the student, program area teacher, Work-Based Learning Coordinator, and worksite supervisor/mentor develop and implement an educational training agreement. Designed to integrate the student's academic and technical skills into a work environment. Includes regular meetings and seminars with school personnel for supplemental instruction and progress reviews. (1-3 sch: 3-9 hours externship)

Hour Breakdown:

Semester Credit Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor approved

Student Learning Outcomes:

1. Apply technical skills and related academic knowledge needed to be a viable member of the workforce
a. Apply technical skills needed to be a viable member of the workforce
b. Apply skills developed in other related courses in a work-based setting
c. Perform tasks detailed in an educational training agreement at the work setting

2. Apply general workplace skills to include positive work habits and responsibilities necessary for successful employment
a. Demonstrate pro-active human relationship skills in the work setting to include conflict resolution, team participation, leadership, negotiation, and customer/client service
b. Demonstrate time, materials, and resource management skills
c. Demonstrate critical thinking skills such as problem solving, decision making, and reasoning
d. Demonstrate acquiring, evaluating, organizing, maintaining, interpreting, and communicating information
e. Demonstrate positive work habits and acceptance of responsibilities necessary for successful employment

APPENDIX A: RECOMMENDED TOOLS & EQUIPMENT

CAPITALIZED ITEMS

Access to some tools and equipment may be provided by Machine Shop, Electrical, Plumbing/Pipefitting, Automotive, and Welding Program facilities.

1. Emergency eyewash station (1)
2. Work bench with heavy duty mechanics vises (5)
3. Oxy-fuel burning table with dross pan and replaceable slats (1)
4. Work area protective screens (1 per welding booth)
5. Exhaust system (1)
6. Compressed air delivery system (compressor, lines and hoses, air regulator, quick connectors and adapters) (1)
7. Shielded metal arc welding machine (AC-DC) with cables and accessories (5)
8. Oxy-fuel welding, brazing, and cutting equipment with regulators, hoses, torch and tips, cart, and accessories (5)
9. Horizontal band saw – 10-in (1)
10. Radial arm drill press – 20-in. with accessories (vise, collets, hold-down clamps) (1)
11. Hydraulic press – 20-ton capacity (1)
12. Pedestal grinders (10- to 12-in.) (2)
13. Taper shank reamer set (1)
14. Adjustable hand reamer set – 1/8 in. – 1/2 in. by 64ths (1)
15. Tap and die set – high-speed steel – 3 by 20 through 13 by 12 (1)
16. Outside micrometer sets (outside) 0–6 in. (10)
17. Depth micrometers (0–6 in.) (2)
18. Vernier calipers (dial) (6-in.) (5)
19. Telescopic gage sets (2)
20. Hand tool sets (wrenches, sockets and socket accessories, screwdrivers, hammers, punches and chisels, pliers, Allen wrenches, feeler gauges, files, etc.) (5)
21. Portable metal cutting band saw (1)
22. Magnetic base drill (1)
23. Pipe threading machine (1)
24. Shop crane and dolly (2)
25. Chain hoist on portable A-frame or overhead trolley (2)
26. Hoisting accessories kit (pulleys, chains, wire robe, clamps, block and tackle, come-alongs, shackles and hooks, etc.) (1)
27. Hydraulic jacks (20-ton) (2)
28. Pipe and tubing bender (1)
29. Abrasive cut-off saw (1)
30. Four-wheel dolly – heavy duty (2)
31. Fiberglass stepladder (6 ft, 8 ft, 10 ft, 12 ft, 14 ft) (1 each)
32. Pipe cutting and beveling machine (1)
33. Mechanical maintenance trainers with accessories (2)
34. Part washing vat (1)
35. Eight-way puller sets (2)
36. Impact wrench with impact socket sets (2)
37. Stationary belt sander (1)
38. Hydro-testing equipment (1)
39. Dry blast parts cleaning cabinet (1)
40. TIG welders with accessories (5)
41. MIG welders with accessories (5)
42. Vertical bank saw, 14-in. (1)
43. Pneumatic oil pump (1)
44. Oil recovery system (1)

45. Plasma cutter (1)
46. Reciprocating saw (1)
47. Hammer drill (1)
48. Power miter, 12-in. (1)
49. Engine lathes, gear drive, (14 in. by 40 in.), with accessories (6)
50. Vertical milling machines, with accessories (3)
51. Surface grinder (1)
52. Vernier height gage (1)
53. Screw pitch gage set (1)
54. Bearing and shaft alignment system with accessories (1)
55. Hydraulic system trainers with accessories (2)
56. Pneumatic system trainers with accessories (2)
57. Mechanical maintenance trainers (2)
58. Machinist precision level (1)
59. Surface plate and stand (1)
60. Student computers with Internet access (10)
61. Printers (10)

*Other equipment items can be added when deemed appropriate by the community college industry craft committee or by industry/business training requirements.

NON-CAPITALIZED ITEMS

1. First aid kit (1)
2. 8-in. C-clamp (1)
3. 4 1/2-in. right angle grinders (2)
4. 9-in. right angle grinder (1 per program)
5. Safety glasses with side shields, safety goggles, and face shields and sanitizing cabinet (1 set including 1 pair of glasses for each student)
6. Leather jacket, cape, sleeves, or apron and leather gloves (4 sets)
7. Welding helmet (2 per welding machine)
8. Welding goggles (2 per oxy-fuel outfit)
9. Drill bit sets (1/16-in. to 12-in. diameter) (2)
10. Set, small hole saws, 3/8-in. to 2-in. sets (2)
11. Combination square set (5)
12. Set precision square set (5)
13. Scales 6-in. 4R graduation (12)
14. Drill point gages (5)
15. Radius gage sets (2)
16. Acme thread gage sets (5)
17. Center gages (10)
18. Spring caliper set – inside, outside, and hermaphrodite – 0 to 12 in. (1)
19. Dividers (10)
20. Torpedo levels (10)
21. Metal scribes (10)
22. Hand hacksaws (5)
23. Hand power drills – 3/8-in. and 1/2-in. (2)
24. Pipe wrench sets (6-in. to 18-in.) (2)
25. Electrical hand tool set (lineman's pliers, wire strippers, screwdrivers, needle-nose pliers, tool pouch, ruler) (5)
26. Drafting kits (T-square, triangles, curves, drafting board) (2)
27. Digital VOM (1)
28. Fiberglass extension ladder, 14 ft (1)
29. Safety harness for ladders (1)

30. Chain pipe vise on tripod (2)
31. Pipe stands (4)
32. Tubing cutter and flaring tool kits (2)
33. Chain-type pipe wrenches (2)
34. Adjustable wrench sets, 6 in. through 12 in. (5)
35. Lockout/Tagout station (1 set)
36. Chipping hammer (1)
37. Wire brushes (5)
38. Fuse puller (1)
39. Clamp-on amp meters (5)
40. Circular saws 73 (5)
41. Jig saw (1)
42. Keyway broach set (1)
43. Dial indicators with magnetic base (2)
44. "V" block set (1)
45. Steel parallel sets (2)
46. Inside micrometer sets (2)
47. Thread micrometers (2)
48. Pneumatic chipping hammers (2)
49. Sine bars (2)
50. 3/8-in. cordless drills with chargers (4)
51. Hand pipe cutter, 1/2-in. to 2-in. (1)
52. Midget tubing cutter (1)

*Other equipment items can be added when deemed appropriate by the community college industry craft committee or by industry/business training requirements.

APPENDIX B: CURRICULUM DEFINITIONS AND TERMS

1. Course Name – A common name that will be used by all community colleges in reporting students

2. Course Abbreviation – A common abbreviation that will be used by all community and junior colleges in reporting students

3. Classification – Courses may be classified as the following:
    a. Career Certificate Required Course – A required course for all students completing a career certificate.
    b. Technical Certificate Required Course – A required course for all students completing a technical certificate.
    c. Technical Elective – Elective courses that are available for colleges to offer to students.

4. Description – A short narrative that includes the major purpose(s) of the

5. Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course

6. Corequisites – A listing of courses that may be taken while enrolled in the course

7. Student Learning Outcomes – A listing of the student outcomes (major concepts and performances) that will enable students to demonstrate mastery of these competencies

8. The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:
9. The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
    a. Additional competencies and objectives within the course related to topics not found in the state framework, including activities related to specific needs of industries in the community college district
    b. Activities that develop a higher level of mastery on the existing competencies and suggested objectives
    c. Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed or revised
    d. Activities that include integration of academic and career–technical skills and course work, school-to-work transition activities, and articulation of secondary and postsecondary career–technical programs
    e. Individualized learning activities, including work-site learning activities, to better prepare individuals in the courses for their chosen occupational areas

10. Sequencing of the course within a program is left to the discretion of the local college. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors. Programs that offer an Associate of Applied Science Degree must include all of the required Career Certificate courses, Technical Certificate courses **AND** a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college.

11. In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

12. Adding new student learning outcomes to complement the existing competencies and suggested objectives in the program framework.
13. Revising or extending the student learning outcomes
14. Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change)

APPENDIX C: RECOMMENDED TEXTBOOK LIST

Recommended Textbook List		
Book Title	**Author(s)**	**ISBN**
Industrial Motor Controls	Stephen L. Herman	978-1-133-69180-8
Welding 5th Edition Level 1 Trainee Guide	NCCER	978-0-13-413110-8
Industrial Maintenance Electrical & Instrumentation Technician (Level 2) 3rd Edition	NCCER	978-0-13-614390-1
National Electrical Code Book 2020 Edition		978-145592970
National Electrical Code Book TABS		978-1950431311
Understanding National Electrical Code (Volume 1) (2020 Edition)		978-1950431076
Industrial Mechanics		978-0-8269-3712-4
Programmable Logic Controllers	Frank Petruzella	978-1-264-44684-1

APPENDIX D: CREDIT BY EXAMINATION

The following **NCCER** modules are aligned to courses listed below. Each module will serve as the state recommended exam to reward credit for prior learning experiences. Colleges have the local autonomy to create a college-level exam when awarding credit.

Course Number and Name	NCCER Credential and Module
CTE 1143 Fundamentals of Construction OR IMM 1113 Industrial Maintenance Core and Safety	NCCER Core Curriculum 1. Module 00101-09 Basic Safety 2. Module 00102-09 Introduction to Construction Math 3. Module 00103-09 Introduction to Hand Tools 4. Module 00104-09 Introduction to Power Tools 5. Module 00105-09 Introduction to Construction Drawing 6. Module 00106-09 Basic Rigging 7. Module 00107-09 Basic Communication Skills 8. Module 00108-09 Basic Employability Skills 9. Module 00109-09 Introduction to Materials Handling
IMM 1214 Introduction to Industrial Maintenance	NCCER Industrial Maintenance Electrical and Instrumentation Level 1 Modules Module 40101-07 Orientation to the Trade Module 40102-07 Tools of the Trade Module 40103-07 Fasteners and Anchors Module 40104-07 Oxyfuel Cutting Module 40105-07 Gaskets and Packing Module 40106-07 Craft-Related Mathematics Module 40107-07 Construction Drawings Module 40108-07 Pumps and Drivers Module 40109-07 Introduction to Valves Module 40110-07 Introduction to Test Equipment Module 40111-07 Material Handling and Hand Rigging Module 40112-07 Mobile and Support Equipment Module 40113-07 Lubrication
IMM 1273 Industrial Maintenance Electrical and Instrumentation Level I (Part I)	NCCER Industrial Maintenance Electrical and Instrumentation Level 1 Modules Module 40101-07 Orientation to the Trade Module 40102-07 Tools of the Trade Module 40103-07 Fasteners and Anchors Module 40104-07 Oxyfuel Cutting Module 40105-07 Gaskets and Packing Module 40106-07 Craft-Related Mathematics

IMM 1283 Industrial Maintenance Electrical and Instrumentation Level I (Part II)	NCCER Industrial Maintenance Electrical and Instrumentation Level 1 Modules 1. Module 40107-07 Construction Drawings 2. Module 40108-07 Pumps and Drivers 3. Module 40109-07 Introduction to Valves 4. Module 40110-07 Introduction to Test Equipment 5. Module 40111-07 Material Handling and Hand Rigging 6. Module 40112-07 Mobile and Support Equipment 7. Module 40113-07 Lubrication

IMM 1153 Electrical Industrial Maintenance I	NCCER Industrial Maintenance Elect rical and Instrumentation Level 2 Modules 1. Module 40201-08 Industrial Safety for E & I Technicians 2. Module 40202-08 Introduction to the national Electrical Code® 3. Module 40203-08 Electrical Theory 4. Module 40204-08 Alternating Current 5. Module 40205-08 E & I Test Equipment 6. Module 40206-08 Flow, Pressure, Level, and Temperature
IMM 1163 Electrical Industrial Maintenance II	NCCER Industrial Maintenanc e Electrical and Instrumentation Level 2 Modules 1. Module 40207-08 Process mathematics 2. Module 40208-08 Hand Bending 3. Module 40209-08 Tubing 4. Module 40210-08 Clean, Purge, and Test Tubing and Piping Systems 5. Module 40211-08 Instrument Drawings and Documents, Part One 6. Module 40212-08 Conductors and Cables 7. Module 40213-08 Conductors Terminations and Splices
IMM 1243 Mechanical Industrial Maintenance I	NCCER Maintenance Mechanic Level 3 Modules Module 32301-08 Advanced Trade Math Module 32302-08 Precision Measuring Tools Module 32303-08 Installing Bearings Module 32304-08 Installing Couplings
IMM 1253 Mechanical Industrial Maintenance II	NCCER Maintenance Mechanic Level 3 Modules Module 32305-08 Setting Baseplates and Pre-alignment Module 32306-08 Conventional Alignment Module 32307-08 Installing Belt and Chain Drives Module 32308-08 Installing Mechanical Seals

IMM 2214 Advanced Electrical Industrial Maintenance	NCCER Industrial Maintenance Electrical and Instrumentation Level 3 Modules Module 40301-09 Hazardous Locations Module 40302-09 Electrical Components Module 40303-09 E & I Drawings Module 40304-09 Motor Controls Module 40305-09 Distribution Equipment Module 40306-09 Transformer Applications Module 40307-09 Conductor Selection and Calculations
IMM 2224 Advanced Mechanical Industrial Maintenance or IMM 2443 NCCER Pipefitting Level I	NCCER Electrical and Instrumentation Level 3 Modules Module 40308-09 Temporary Grounding 1. Module 40309-09 Layout and Installation of Tubing and 2. Piping Systems 3. Module 40310-09 Machine Bending of Conduit 4. Module 40311-09 Hydraulic Controllers 5. Module 40312-09 Pneumatic Controls 6. Module 40313-09 Motor-Operated Valves
IMM 1614 Principles of Plumbing and Hydro- Testing	NCCER Plumbing Level I Modules Module 02101-12 Introduction to the Plumbing Profession Module 02102-12 Plumbing Safety 3. Module 02103-12 Tools of the Plumbing Trade
	4. Module 02104-12 Introduction to Plumbing Math 5. Module 02105-12 Introduction to Plumbing Drawings 6. Module 02106-12 Plastic Pipe and Fittings 7. Module 02107-12 Copper Tube and Fittings 8. Module 02108-12 Cast-Iron Pipe and Fittings 9. Module 02109-12 Steel Pipe and Fittings 10. Module 02110-12 Introduction to Plumbing Fixtures 11. Module 02111-12 Introduction to Drain, Waste, and Vent (DWV) Systems Module 02112-12 Systems Introduction to Water Distribution
IMM 1814 Industrial Electricity Level I	NCCER Electricity Level I Modules 1. Module 26101-11 Orientation to the Electrical Trade 2. Module 26102-11 Electrical Safety 3. Module 26103-11 Introduction to Electrical Circuits 4. Module 26104-11 Electrical Theory 5. Module 26105-11 Introduction to the National Electrical Code®

	6. Module 26106-11 Device Boxes 7. Module 26107-11 Hand Bending 8. Module 26108-11 Raceways and Fittings 9. Module 26109-11 Conductors and Cables 10. Module 26110-11 Basic Electrical Construction Drawings 11. Module 26111-11 Residential Electrical Services 12. Module 26112-11 Electrical Test Equipment
IMM 1824 Industrial Electricity Level II	NCCER Electricity Level II Modules 1. Module 26201-11 Alternating Current 2. Module 26202-11 Motors: Theory and Application 3. Module 26203-11 Electric Lighting 4. Module 26204-11 Conduit Bending 5. Module 26205-11 Pull and Junction Boxes 6. Module 26206-11 Conductor Installations 7. Module 26207-11 Cable Tray 8. Module 26208-11 Conductor Terminations and Splices 9. Module 26209-11 Grounding and Bonding 10. Module 26210-11 Circuit Breakers and Fuses 11. Module 26211-11 Control Systems and Fundamental Concepts

How to Decode a Module Number

NCCER module numbers are divided into three parts. This structure allows users to easily track training histories and revisions from one edition to the next.