MECHATRONICS ENGINEERING TECHNOLOGY
MISSISSIPPI CURRICULUM FRAMEWORK

Mechanical Engineering (Program CIP: 14.1901)

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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.

Contents

Industry Credentials, Certifications, and Professional Licensure

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

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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 mechanical engineering program. A discussion was held to gather feedback concerning the trends and needs, both current and future, of their 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

2018- Office of Curriculum & Instruction, Mississippi Community College Board

2022- Office of Curriculum & Instruction, Mississippi Community College Board

PROGRAM DESCRIPTION

The **Mechanical Engineering** program is an Associate of Applied Science degree program with a one semester Advanced Technical Certificate option. Mechatronic technicians are responsible for assembling, installing, and maintaining/repairing machinery used in the manufacturing or industrial environment as well as troubleshooting, repair, and programming of automated systems. Graduates are prepared to enter the job market as entry level technicians.

Students receive training in mechatronics, robotics, process control, CNC/CAM, mechatronics troubleshooting, data acquisition and industrial communications programming.

SUGGESTED COURSE SEQUENCE

WORK READY CERTIFICATE

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1114 or IMM 1934	Manufacturing Basic Skills	4	2	4	90
MNT 1123	Industrial Electricity	3	1	4	75
MNT 1134	Industrial Control Systems	4	2	4	90
MNT 1142	Mechanical Power Transmission I	2	0	4	60
	All other electives approved by instructor per local community college policy	2			
	TOTAL	**15**			

WORK READY CERTIFICATE (ELECTRICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1123	Industrial Electricity	3			
MNT 1134	Industrial Control Systems	4			
MNT 1213	Programmable Logic Controllers	3			
	All other electives approved by instructor per local community college policy	5			
	TOTAL	**15**			

WORK READY CERTIFICATE (MECHANICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1113	Manufacturing Basic Skills	3			
MNT 1143	Mechanical Power Transmission	3			
MNT 1413	Blue Print Reading	3			
	All other electives approved by instructor per local community college policy	6			
	TOTAL	**15**			

CAREER CERTIFICATE REQUIRED COURSES

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1114 or IMM 1934	Manufacturing Basic Skills	4	2	4	90
MNT 1123	Industrial Electricity	3	1	4	75
MNT 1134	Industrial Control Systems	4	2	4	90
MNT 1142	Mechanical Power Transmission I	2	0	4	60
MNT 1213	Programmable Logic Controllers	3	2	2	60
MNT 1224	Fluid Power	4	3	2	75
MNT 1233	Electronic Motion Control	3	1	4	75
MNT 1242	Mechanical Power Transmission 2	2	0	4	60
	All other electives approved by instructor per local community college policy	5			
	TOTAL	**30**			

CAREER CERTIFICATE REQUIRED COURSES (ELECTRICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1123	Industrial Electricity	3			
MNT 1134	Industrial Control Systems	4			
MNT 1213	Programmable Logic Controllers	3			
MNT 1224	Fluid Power	4			
MNT 1233	Electronic Motion Control	3			
MNT 2114	Mechatronics Programming I	4			
	All other electives approved by instructor per local community college policy	10			
	TOTAL	**31**			

CAREER CERTIFICATE REQUIRED COURSES (MECHANICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 1113	Manufacturing Skills Basic	3			
MNT 1143	Mechanical Power Transmission	3			
MNT 1413	Blue Print Reading	3			
MNT 1213	Programmable Logic Controllers	3			
MNT 1224	Fluid Power	4			
MNT 1243	Mechanical Power Transmission 2	3			
MNT 2133	Mechatronics Troubleshooting and Repair	3			
	All other electives approved by instructor per local community college policy	10			
	TOTAL	**32**			

TECHNICAL CERTIFICATE REQUIRED COURSES

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 2114	Mechatronics Programming I	4	2	4	90
MNT 2123	Fundamentals of Instrumentation	3	2	4	90
MNT 2133	Mechatronics Troubleshooting and Repair	3	1	4	75
	All other electives approved by instructor per local community college policy	5			
	TOTAL	**15**			

TECHNICAL CERTIFICATE REQUIRED COURSES (ELECTRICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 2224	Mechatronics Programming 2	4			
MNT 2234	Mechatronics Special Projects	4			
MNT 2373	Servo Control Systems	3			
	All other electives approved by instructor per local community college policy	8			
	TOTAL	**19**			

TECHNICAL CERTIFICATE REQUIRED COURSES (MECHANICAL EMPHASIS)

			SCH Breakdown		
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours
MNT 2324	Power tools, Machining	4			
MNT 2234	Mechatronics Special Projects	4			
MNT 2354	Preventative Maintenance	4			
	All other electives approved by instructor per local community college policy	8			
	TOTAL	**20**			

COURSE ELECTIVES

			SCH Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	
*ELT 1144	AC/DC					
*ELT 1213	Electrical Power					
*SBA 1283	Industrial Instrumentation					
*CSC 2134	Programming 1 with C+++					
*CSC 2144	Programming 2 with C+++					
MNT 1153	Basic Industrial Robotics					
MNT 2384	Mechatronics Robotics					
MNT 2344	CNC/Computer Assisted Manufacturing					
MNT 2364	Industry 4.0 with Data Acquistion					
MNT 2314	Maintenance Welding and Metals					
MNT 2333	Computer Aided Design					
MNT 2214	Mechatronics Process Control					
MNT 2224	Mechatronics Programming 2					
MNT 2234	Mechatronics Special Projects					
SSP 100(2-3)	Smart Start 101	2-3				
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	1-3			3-9	45-135
	All other electives approved by instructor per local community college policy					
* These electives are recommend but can be changed to meet local industry needs.						

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: MNT 1114 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:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Complete a 10 hour OSHA Safety training program that includes the following topics at a minimum: OSHA 29CFR-1910 10 hour certification
    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 NC3 (1 Mechanical Systems)
    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 NC3(Precision Measurement Instrument Certification)
    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 70
      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
7. CPR American Heart Association or American Red Cross

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NC3 (1 Mechanical Systems)
NC3(Precision Measurement Instrument Certification)

OSHA 29CFR-1910 10 hour certification
American Heart Association or American Red Cross

Course Number and Name: MNT 1123 Industrial Electricity

Description: Principles and theories associated with AC and DC circuits used in the electrical trades. Includes the study of electrical circuits, laws and formulas, and the use of test equipment to analyze AC and DC circuits.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss and apply proper safety procedures for electrical maintenance including lockout/tagout NC3(1 Electricity)
    a. Define terms related to electrical lockout/tagout applications
    b. Determine correct application of lockout/tagout on electrical enclosures, panels, and switching devices
2. Basic Electrical Circuits NC3(1 Electricity)
    a. Define electricity
    b. Describe the two types of electrical current
    c. Describe the function of the 4 basic components of an electrical circuit
    d. Describe the function of an electrical schematic
3. Electrical Measurements NC3(1 Electricity), NC3 (504 Meter)
    a. Define voltage and give its unit of measurement
    b. Measure voltage in a circuit with DMM and oscilloscope
    c. Define series, parallel and combination circuits
    d. Define current and give its unit of measurement
    e. Measure current in a circuit with DMM and oscilloscope
    f. Define resistance and give its unit of measurement
    g. Measure resistance in a circuit
    h. Demonstrate measuring waveforms frequency using an oscilloscope
4. Circuit analysis NC3(1 Electricity)
    a. Define Ohm's law and give its importance
    b. Use Ohm's law to calculate the voltage, current, and resistance in a circuit
    c. Define Kirchhoff's Law
    d. Define electrical power and give its units for measurement
5. Inductance and Capacitance NC3(1 Electricity)
    a. Define electromagnetism
    b. Define inductance and give its unit of measurement
    c. Describe the effect of an inductor on a DC and an AC circuit
    d. Define capacitance and give its unit of measurement
    e. Describe the effect of a capacitor in a DC and an AC circuit
6. Transformers NC3(1 Electricity)
    a. Describe the function of a transformer
    b. Calculate the output voltage of a transformer
    c. Calculate the size a transformer based on input voltage, output voltage, and load
7. National Electric Code
    a. Calculate the size a conductor based on load
    b. Describe the importance of proper grounding

c. Locate information in the NEC

8. 3-phase electricity
    a. List the two types of three-phase power distribution configurations
    b. Describe how to reverse the rotation direction of a three-phase motor
    c. Operate a DMM to determine the voltage at a three-phase disconnect

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NC3(1 Electricity)
NC3 (504 Meter)

Course Number and Name: MNT 1134 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:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Introduction NC3(1 Electricity)
    a. Describe the purpose of the Lockout / Tagout procedures used in industry
    b. Explain the importance of an equipment ground connection
    c. Describe the operation of 3-phase power
    d. Use a voltmeter to verify supply voltage
    e. Use a voltmeter to check a fuse
2. Control Transformers NC3(1 Electricity)
    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
3. 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 NC3(PLC-AB), NC3(PLC-S)
    e. Describe the six elements of control logic NC3(PLC-AB), NC3(PLC-S)
4. 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
5. Troubleshooting NC3(1 Electricity)
    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
6. 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

7. Automatic input devices NC3 (1PLC-sensors1)
    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
8. 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
9. Motor Braking
    a. Describe the function of braking in motor control
    b. List motor braking methods
10. Reduced voltage motor starting
    a. Describe reduced voltage motor starting methods
11. Industrial controls in Fluid power
    a. Describe solenoid operated valves
    b. Use the manual override to operate a cylinder
    c. Control a fluid power system using electrical controls
12. System Sequencing
    a. Demonstrate the ability to sequence a machine with both fluid power actuators and electric motors utilizing electric controls

National Coalition of Certification Centers

NC3(1 Electricity)
NC3 (1PLC-sensors1)
NC3(PLC-AB)
NC3(PLC-S)

Course Number and Name: MNT 1142 Mechanical Power Transmission I

Description: This course includes instruction and lab exercises related to motor mounting and alignment, key fasteners, and power transmission systems.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
2	0	4	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Mechanical Power Transmission Safety NC3 (1 Mechanical Systems)
    a. Demonstrate proper Lockout / Tagout
2. Machine Installation NC3 (1 Mechanical Systems)
    a. Demonstrate precision leveling technique
3. Motor Mounting NC3 (1 Mechanical Systems)
    a. Describe typical mounting used for electric motors
    b. Demonstrate the procedure to correct for a soft foot condition
4. Shaft speed measurement NC3 (1 Mechanical Systems)
    a. Demonstrate the use a tachometer to measure motor speed
    b. Use a stroboscope to measure motor speed
5. Keyseat Fasteners NC3 (1 Mechanical Systems)
    a. Describe the function of a Key Fastener
    b. Describe the 6 types of Keys
    c. Measure the actual size of a key and keyseat
6. Intro. To Shafts NC3 (1 Mechanical Systems)
    a. Identify a shaft size
    b. Describe the function of a shaft in power transmission
7. Intro. To Bearings NC3 (1 Mechanical Systems)
    a. Describe the function of a bearing
    b. Define three types of bearing loads
    c. Demonstrate ability to remove and install a variety of bearings
    d. Identify causes of failure of bearings
8. Intro. To Couplings NC3 (1 Mechanical Systems)
    a. Describe the function of a coupling
    b. Identify several different types of couplings
    c. Demonstrate ability to remove and install a coupling
9. Shaft Alignment NC3 (1 Mechanical Systems)
    a. Describe the purpose of shaft alignment
    b. Align two shafts in a power transmission system

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NC3 (1 Mechanical Systems)

Course Number and Name: MNT 1153 Basic Industrial Robotics

Description: This course provides a hands-on learning environment to develop and practice basic robotics safety, robotics systems, robotic operations and robotic programming.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Robotics Safety Fanuc Handling Tool and or ABB programming 1, NC3 (1Robotics)
    a. Apply safety rules when working with industrial robotics
    b. Demonstrate knowledge of industrial robot safety systems
1. Robot System Fanuc Handling Tool and or ABB programming 1, NC3 (1Robotics)
    a. Identify components of industrial robot systems
    b. Demonstrate ability to operate industrial robot teach pendant
3. Robot Operations Fanuc Handling Tool and or ABB programming 1, NC3 (1Robotics)
    a. Identify the axes of an industrial robot
    b. Demonstrate ability to jog robot in various coordinate systems
    c. Identify robot positional information
    d. Demonstrate knowledge cartesian coordinate system as it relates to industrial robots
    e. Demonstrate ability to change industrial robot reference point and cartesian coordinate system
    f. Demonstrate ability to change tool center point
4. Robot Programming Fanuc Handling Tool and or ABB programming 1, NC3 (1Robotics)
    a. Demonstrate ability to create industrial robot motion programs
    b. Demonstrate use of robot program instructions
5. Robot I/O Fanuc Handling Tool and or ABB programming 1, NC3 (1Robotics)
    a. Demonstrate use of industrial robot peripheral equipment
    b. Demonstrate use of I/O and robot programming

National Coalition of Certification Centers

NC3 (1Robotics)
Fanuc Handling Tool and or ABB programming 1

Course Number and Name: MNT 1213 Programmable Logic Controllers

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, installation and maintenance of PLCs.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Explain principles of PLCs NC3(PLC-AB), NC3(PLC-S)
    a. Identify components and operational principles of PLCs
    b. Differentiate between a PLC and a computer
2. Identify different types of PLC hardware NC3(PLC-AB), NC3(PLC-S)
    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 NC3(PLC-AB), NC3(PLC-S)
    a. Convert numbers from one system to another
    b. Explain logical operations using truth tables and ladder logic diagrams
4. Program different types of internal and discrete instructions NC3(PLC-AB), NC3(PLC-S)
    a. Demonstrate how to program examine on and off instructions
    b. Demonstrate how to program on-delay and off-delay instructions
    c. Demonstrate how to program up-counter and down-counter instructions
    d. Demonstrate how to program sequencer instructions for real-world output devices
    e. Demonstrate how to program latch and unlatch instructions
5. Troubleshoot and maintain different programmable controller systems NC3(PLC-AB), NC3(PLC-S)
    a. Identify and troubleshoot the power supply
    b. Identify and troubleshoot the inputs and outputs
    c. Identify and troubleshoot real-world inputs and outputs
6. Use program control instructions and subroutines to control program function NC3(PLC-AB), NC3(PLC-S)
7. Use math instructions to manipulate outputs of a program NC3(PLC-AB), NC3(PLC-S)
    a. Demonstrate the ability to enter and edit a PLC program that uses the add instruction
    b. Demonstrate the ability to enter and edit a PLC program that uses the multiply instruction
    c. Demonstrate the ability to enter and edit a PLC program that uses the divide instruction
    d. Demonstrate the ability to enter and edit a PLC program that uses a data move instruction
8. Program several types of high order instructions NC3(PLC-AB), NC3(PLC-S)
    a. Demonstrate the ability to program and set up an analog input card
    b. Demonstrate the ability to program and set up an analog output card

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NC3(PLC-AB)
NC3(PLC-S)

Course Number and Name: MNT 1224 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:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and discuss basic principles of pneumatics as related to industrial maintenance NC3(1 fluid power-pneumatics)
    a. Define pneumatics and give benefits and drawbacks to the system
    b. Describe and discuss 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. Demonstrate preventative maintenance on an air compressor
        ii. Demonstrate the ability to 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 NC3(1 fluid power-hydraulics)
    a. Define hydraulics and give benefits and drawbacks to the system
    b. Describe and discuss 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. Demonstrate the ability to 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

National Coalition of Certification Centers

NC3(1 fluid power-pneumatics)
NC3(1 fluid power-hydraulics)

Course Number and Name: MNT 1233 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:

Semester Hours	Lecture	Lab	Contact 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. Demonstrate the ability to 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. Apply preventative maintenance and troubleshooting techniques in motor control circuits

Course Number and Name: MNT 1242 Mechanical Power Transmission II

Description: This course includes instruction and lab exercises related to V belt drives, chain drives, gear drives, and multiple shaft systems.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
2	0	4	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Belt drives NC3 (1 Mechanical Systems)
    a. Describe the functions of the 3 basic components of a belt drive
    b. Calculate the pulley ratio of a belt drive system
    c. List 5 types of belt drives
    d. Install and align a belt drive system
    e. Adjust the belt tension of a belt drive system
2. Chain Drives NC3 (1 Mechanical Systems)
    a. Describe the functions of the 3 basic components of a chain drive
    b. Calculate the sprocket ratio of a chain drive system
    c. List 4 types of chains
    d. Install and align a chain drive system
    e. Adjust the chain tension of a chain drive system
    f. Demonstrate the ability to cut a chain to length and install using a master link
3. Gear drives NC3 (1 Mechanical Systems)
    a. Describe the function of the 3 components of a gear drive system
    b. Calculate the gear ration of a gear drive system
    c. List the 4 types of parallel shaft gears
    d. Install and align a spur gear system
    e. Measure and adjust gear backlash in a gear drive system
    f. Describe different types of gear drives
        i. Spur Gear
        ii. Bevel Gear
        iii. Worm Gear
        iv. Helical Gear
        v. Planetary Gear
    g. Install and align a bevel gear drive system in a gearbox
4. Multiple shaft systems NC3 (1 Mechanical Systems)
    a. Describe how to determine direction of rotation of a multiple shaft system
    b. Install and align a multiple shaft system
5. Gaskets NC3 (1 Mechanical Systems)
    a. Describe the function of a gasket
    b. Describe the function of sealant
    c. Assemble two parts with a gasket
6. Seals NC3 (1 Mechanical Systems)
    a. Describe 3 types of seals
    b. Demonstrate the ability to remove, identify, and install a lip seal
7. Linear drives NC3 (1 Mechanical Systems)
    a. Describe types of linear drives

vi. Screw
vii. Rack & Pinion
viii. Fluid

b. Demonstrate the ability to measure backlash / free play in a screw drive
c. Identify which drive is the most precise and explain why
d. Service and align a ball screw

8. Variable speed belt drives NC3 (1 Mechanical Systems)
    a. Describe how a variable speed belt drive works
9. Vibration analysis NC3 (1 Mechanical Systems)
    a. Describe sources of vibration in various drive systems
    b. Demonstrate the use a vibration meter to isolate the cause of a vibration

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NC3 (1 Mechanical Systems)

Course Number and Name: MNT 2114 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:

Semester Hours	Lecture	Lab	Contact 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. Demonstrate the ability to program of a variety of mechatronic devices given a sequence of operation
    d. Define discrete I/O handshaking and give an application
    e. Demonstrate the ability to work as a team, alter existing programs to allow for multiple station control for startup, and flexible manufacturing

Course Number and Name: MNT 2123 Fundamentals of Instrumentation

Description: This course provides students with a general knowledge of instrumentation principles as they relate to the electrical industry. This course includes instruction in the basis of hydraulics and pneumatics and the use of electrical circuits in the instrumentation process.

Hour Breakdown:

Semester Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Demonstrate a working knowledge of instrumentation as it pertains to the electrical industry
    a. Define terms associated with instrumentation
    b. Discuss basic theory of hydraulics, pneumatics, and electromagnetic controls
    c. Identify basic symbols used with hydraulics, pneumatics, and electromagnetic systems
2. Identify the type of instrumentation input and output devices, and describe their applications
    a. Describe control elements for pressure, flow, temperature, and level
    b. Identify the types of input and output devices
    c. Describe the input and output devices
3. Identify the types of electrical signals used in instrumentation
    a. Describe the transmission of information to include current, pressure, and frequency
    b. Explain the principles of the transmission information input and output
4. Describe fundamentals of electrical and electronic process controls
    a. Label a block diagram of an open loop system and a closed loop system
    b. Describe characteristics of an open loop and a closed loop system
5. Design a preventive maintenance program for instrumentation systems
    a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system
    b. Demonstrate the ability to sketch a piping and instrument drawing
6. Demonstrate the ability to install and calibrate various instrumentation devices

Course Number and Name: MNT 2133 Mechatronics Troubleshooting and Repair

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

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	1	4	75

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Overview
    a. Define Troubleshooting
    b. Define and describe 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: MNT 2214 Mechatronics Process Control

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

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Describe and apply the major elements of process technology [NC3 (2 Sensors 2)]
    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 [NC3 (2 Sensors 2)]
    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

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NC3 (2 Sensors 2)

Course Number and Name: MNT 2224 Mechatronics Programming II

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:

Semester Hours	Lecture	Lab	Contact Hours
4	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. Demonstrate the ability to 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. Demonstrate the ability to 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: MNT 2234 Mechatronics Special Project

Description: This course provides practical application of skills and knowledge gained in their Mechatronics Technician program of study. The instructor works closely with the student to ensure the selection of a project will enhance the student's learning experience.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
4	0	8	120

Prerequisite: Instructor Approved

Student Learning Objectives:

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

Course Number and Name: MNT 2314 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:

Semester Hours	Lecture	Lab	Contact 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. Demonstrate the ability to silver-braze or solder copper fittings to a copper line
    g. Demonstrate the ability to heat metal for bending or component removal (bearings and races)

Course Number and Name: MNT 2324 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:

Semester Hours	Lecture	Lab	Contact 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
    a. Inspect, adjust and operate side grinders in a safe and proper manner
    b. Identify, select, apply and maintain power cutting and threading tools
2. Demonstrate the safe and proper use of bench grinders
    a. Inspect, set-up and adjust a bench grinder for proper use
    b. Grind angles on metal
    c. De-burr metal using a bench grinder
3. Demonstrate the safe and proper use of a drill press
    a. Inspect, set-up and adjust a drill press for safe and proper use
    b. Locate, drill and ream holes in metal 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 use
    b. Cut and thread various lengths and diameters of pipe to specifications
5. Identify, select and process metals
    a. Identify the differences between iron, steel and alloy steel
    b. Identify the benefits and drawbacks of aluminum
    c. Demonstrate how to read an alloy number and identify the characteristics of that material
    d. Identify the appropriate material for a job

Course Number and Name: MNT 2333 Computer Aided Design I

Description: This course is designed to develop basic operating system and drafting skills on CAD.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Manage the operating system
    a. Examine the contents of storage devices
    b. List, erase, rename, and copy files on storage devices
    c. Examine, create, remove, and move files between folders and subfolders
    d. Access information services (e.g., Internet, e-mail, and networks)
2. Use the basic hardware of the CAD system
    a. Input data using keyboard and graphics tablet, or mouse
    b. Access files and/or symbols from the hard disk
    c. Store, retrieve, copy, and delete drawings and files
3. Draw a line using various point entry methods
    a. Draw a series of lines using absolute coordinates
    b. Draw a series of lines using relative
    c. Draw a series of lines using polar
    d. Draw a series of lines using direct distance entry
4. Manipulate drawing aids to increase accuracy and productivity
    a. Discuss grid mode
    b. Discuss snap mode
    c. Discuss polar tracking
    d. Discuss the mode
    e. Utilize object snap
    f. Discuss object snap tracking
    g. Utilize different object selection methods to be effective in the use of modify commands
5. Establish line standards and layer concepts
    a. Create layers in accordance to ANSI Standards regarding line type and line weight
    b. Manage layers
    c. Copy layers and line types between drawings
6. Create text styles and multiline text
    a. Revise text height
    b. Revise text fonts
    c. Utilize symbols
    d. Create single line text
    e. Create multiline text
    f. Check spelling
7. Utilize modify commands to improve efficiency
    a. Use the FILLET command to draw fillets, rounds and other radii
    b. Place chamfers and angled corners using the CHAMFER command
    c. Separate objects using BREAK command

d. Combine objects using the JOIN command
e. Edit objects using TRIM and EXTEND commands
f. Change objects using STRETCH and LENGTHEN commands
g. Edit the size of objects using the SCALE command
h. Use the EXPLODE command
i. Use the OFFSET command to create parallel lines

8. Perform drafting functions on the CAD system
    a. Construct single-view and multi-view drawings
    b. Modify or edit an existing drawing
    c. Modify the existing system variables

Course Number and Name: MNT 2344 CNC/ Computer Assisted Manufacturing

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:

Semester Hours	Lecture	Lab	Contact 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: MNT 2354 Preventative Maintenance

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:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:
Preventive and Predictive Maintenance

1. 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
2. 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
3. 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, tshermographic equipment, ultrasonic testing)
4. 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

5. 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
6. 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
7. Design a Preventative 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

Course Number and Name: MNT 2364 Industry 4.0 with Data Acquisition

Description: This is a course to introduce and explain Industry 4.0 with data acquisition.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Discuss, define and explain the following[NC3 (1 Industry 4.0)]
   a. What is Industry 4.0
   b. How has these changes impacted industry, current and future employees, and other members of the manufacturing value chain.
   c. Give examples of the benefits and value of industry 4.0
   d. What is the 'interconnected world'
   e. Define important terms, theories, and ideas behind industry 4.0
   f. What is MES and related functionality.
   g. Explain the importance of data security [NC3 (2 Industry 4.0)]
2. Show the ability to complete the following
   a. Configuration of MES [NC3 (2 Industry 4.0)]
   b. Incorporate HMI applications to a production system [NC3 (2 Industry 4.0)]
   c. Utilize web services/ email push delivery [NC3 (2 Industry 4.0)]
   d. Configure VLANs to isolate data on an industrial Ethernet network
   e. Set firewall rules to isolate data on an industrial Ethernet network
3. Explain data communication components used in automation systems
   a. Identify characteristics and use of various EIA or IEEE 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
   g. Explain point-to-point wireless networks
4. Use data communication software PLC and a computer to connect a network
   a. Configure a computer for serial or parallel communications
   b. Perform data transfer between computers
   c. Use communication test equipment to troubleshoot communications links
5. Use computers and / or controllers for data acquisition
   a. Interface seniors with computer or controller data acquisition using Ethernet
   b. Configure software and computer for data acquisition from a PLC

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NC3 (1 Industry 4.0)
NC3 (2 Industry 4.0)

Course Number and Name: MNT 2373 Servo Control Systems

Description: This course is designed to teach servo components; velocity servos; positional servos; force, pressure, and torque servos; servo amplifiers; programmers; and servo analysis. Emphasis placed on servo trim and maintenance and the applications of servo systems.

Hour Breakdown:

Semester Hours	Lecture	Lab	Contact Hours
3	2	2	60

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Identify and discuss the components and characteristics of a servo system used in the electrical industry
    a. Identify the components of a basic servo system
    b. Identify servo as to control type and construction
    c. Demonstrate operating characteristics of a servo by conducting performance tests
    d. Explain servo construction, operation, and function
    e. Demonstrate the ability to mechanically and/or electrically null a servo
    f. Demonstrate the ability to test a servo motor
    g. Discuss differences between various types of feedback such as a resolver, incremental and an absolute encoder
2. Demonstrate the ability to construct and analyze open loop and closed loop systems
    a. Draw a block diagram of a closed loop servo system
    b. Identify and explain five control modes of a closed loop servo system
    c. List and describe transducers commonly used with angular, linear, and velocity control systems
    d. Construct and analyze open loop and closed loop velocity control systems
    e. Construct and analyze open loop and closed loop angular position control systems
    f. Construct and analyze open loop and closed loop linear position control systems
    g. Demonstrate the concepts of accuracy, error, gain, response, and stability of closed loop servo systems
3. Demonstrate the ability to troubleshoot and repair a servo control system used in the electrical industry
    a. Apply troubleshooting logic to solve electrical problems with a servo control system
    b. Apply troubleshooting logic to locate and repair a fault in a servo motor
    c. Construct and demonstrate an angular position control system as it relates to a simulated machine function
    d. Construct and demonstrate velocity control as it relates to a simulated machine function
    e. Construct and demonstrate linear position control as it relates to a simulated machine function

Course Number and Name: MNT 2384 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:

Semester Hours	Lecture	Lab	Contact Hours
4	2	4	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

1. Safety NC3 (1Robotics), Fanuc Handling Tool and or ABB programming 1
    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 NC3 (1Robotics), Fanuc Handling Tool and or ABB programming 1
    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 NC3 (1Robotics), Fanuc Handling Tool and or ABB programming 1
    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 NC3 (1Robotics)
    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 NC3 (1Robotics)
    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 NC3 (1Robotics)
    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

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NC3 (1Robotics)
Fanuc Handling Tool and or ABB programming [1]

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

47. Reciprocating saw (1)
48. Hammer drill (1)
49. Power miter, 12-in. (1)
50. Engine lathes, gear drive, (14 in. by 40 in.), with accessories (6)
51. Vertical milling machines, with accessories (3)
52. Surface grinder (1)
53. Vernier height gage (1)
54. Screw pitch gage set (1)
55. Bearing and shaft alignment system with accessories (1)
56. Hydraulic system trainers with accessories (2)
57. Pneumatic system trainers with accessories (2)
58. Mechanical maintenance trainers (2)
59. Machinist precision level (1)
60. Surface plate and stand (1)
61. Student computers with Internet access (10)
62. Printers (10)
63. Oscilloscope (5)
64. Network Analyzer
65. Document Process Calibrator
66. Thermal Imaging Camera
67. AC/DC Electrical Trainer (5)
68. Motor Control Trainers (5)
69. Megaohm Meter
70. Rotation Tester
71. Power Quality Analyzer
72. Shaft Laser Alignment Kit
73. Vibration Analysis Kit
74. Stroboscope (5)
75. Tachometer
76. PLC Trainer with Analog Capability (1 per every 2 students minimum)
77. PLC Programming Software (1 per computer)
78. Variable Frequency Drives with Motor (1 per every 2 students minimum)
79. Electronic Reduced Voltage Starter (1 per every 2 students minimum)
80. Mechatronics Training Systems (to include HMI, robot, vision system, RFID, barcode reader, etc.)
81. Industrial Grade Robotic Arm (1 per every 2 students minimum)
82. CNC Vertical Mill
83. CNC Turning Center
84. CNC Machining Center
85. Process Control Trainer (pressure, temperature, level and flow with both controllers and PLC) (1 per every 2 students minimum)
86. Computer aided design software
87. Large format printer
88. Scissor Lift
89. Ultrasonic Tester
90. Servo Motor Training System

*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

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

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

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

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

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

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

- 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:

- 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
- 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.

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

- Adding new student learning outcomes to complement the existing competencies and suggested objectives in the program framework.

- Revising or extending the student learning outcomes

- 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 CIP: 14.1901 Mechanical Engineering		
Book Title	**Author(s)**	**ISBN**
Fluid Power Hydraulics and Pneumatics 2nd edition	James R. Daines	9781605259314
High Performance Manufacturing 1st edition	MSSC	9780078614873
Electrical Motor Control for Integrated Systems 5th edition	Gary Rockis & Glen Mazur	9780826912268
Programmable Logic Controllers 5th edition	Frank Petruzella	9780073373843
Delmar's Standard Textbook of Electricity 6th edition	Steven L. Herman	9781285852706
Instrumentation and Process Control 6th edition	Franklyn W. Kirk	9780826934420
NCCER Welding Level 1 5th edition or AWS equivalent	NCCER	9780134163116