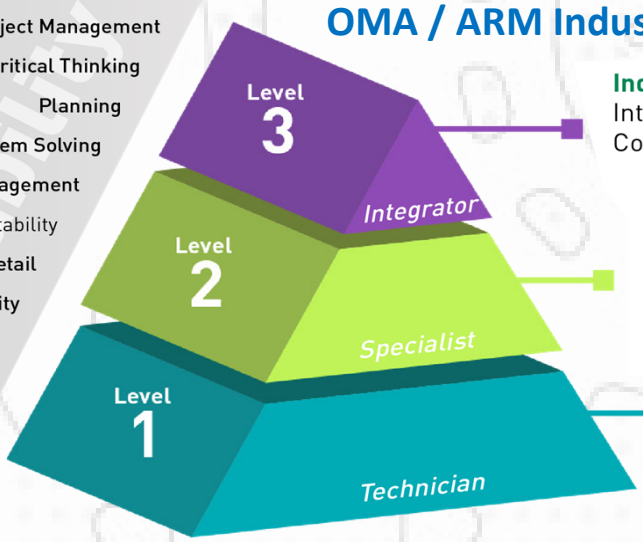
OMA / ARM Industrial Robotics & Automation Pathway

Employability
- Project Management
- Critical Thinking
- Planning
- Problem Solving
- Time Management
- Adaptability
- Attention to Detail
- Techical Learning Ability
- Interpersonal
- Communications
- Technology Aptitude
- Teaming
- Safety



Industry 4.0
Integration
Connectivity

ARM
ADVANCED ROBOTICS FOR MANUFACTURING

Industry 4.0 Integrator
Systems Designer
Process Engineer
Integration Specialist
Operations/Maintenance Supervisor

Advanced
Processes
Programming
Interoperability

Mechatronics Specialist
Automation Specialist
Robotics Specialist
Applications Engineer
Systems Operator

Fundamentals
Technical Expertise
Micro-certifications

Electromechanical Technician
Production Technician
Industrial Maintenance Technician
Operator

Integrated I4.0, Embedded Credentials: Roles & Skills Matrix for Advanced Manufacturing in Ohio

Level 3: Robotics Integrator

Advanced Product ID	HMI	Advanced Robotics	Advanced PLC	Smart Maintenance	Cyber Security
Vision Technology II Near Field Communications RFID II Potential & Impact	Manufacturing Processes Programming Creating Visual Awareness Recipe Creation Data Acquisition	Collaborative Robots Augmented Reality IRA Safety Standards Integration of PLC's w/Robotics Virtual Commission	Sensors III OPCUA w/MES & PLC I/O Condition Monitoring Advanced Networking & Connectivity	Predictive Maintenance Data Analysis LEAN & Visual Awareness Top Floor- Shop Floor Communication	Data Corruption: Understanding Risks & Consequences Preventing Cyber Attacks

Level 2: Robotics Specialist

Product ID Fundamentals	Applied Fluid Power	Applied Mechanical Systems	Applied PLC	Applied Robotics	Applied Industry 4.0
Vision Technology 1 RFID 1 Bar Coding 1	Maintenance & Troubleshooting Energy Efficiency Vacuum Technology	Gear Drives Bearings & Gaskets, Seals Clutches & Brakes Ball Screws and Linear Bearings	Sensors II PLC Technology II Basic Networking CoDeSys	Programming & Editing Maintenance & PM Welding Material Handling Palletizing	Introduction to MES Introduction to HMI Introduction to Data Safety Introduction to 3D Modeling

Level 1: Robotics Technician

Electricity Fundamentals	Fluid Power Fundamentals	Mechanical Systems	PLC Fundamentals	Robotics Fundamentals	Industry 4.0 Fundamentals
Electricity AC Electricity DC	Basic Hydraulics Basic Pneumatics	Mechanical Drive Systems Components & Calculations Belts, Chains, & Lubrication Maintenance & Installation of components	Sensors I PLC Technology 1	Introduction to Robotics	Introduction to Industry 4.0

OMA Automation & Robotics Task Force

Leveraging Ohio's Existing Assets, State Funding, and Infrastructure

(Click for More Info on Ohio's FANUC Assets)

Credentials, Equipment, and Curricula Supplied by Today's Leaders in Automation:

FANUC · Rockwell Automation · Allen-Bradley · LINCOLN ELECTRIC · Parker · stratasys · COGNEX

Integration, Interoperability, & Implementation by: APT MANUFACTURINGsolutions · IST Integrated Systems Technologies

Pathway Table of Contents:

Page:	Contents:
1	OMA/ARM Pathway Level 1, Level 2, Level 3 Outcomes
2	Sample ODE Courses for ARM Program
3-4	Level 1: Technician Pathway Sample with Credentials
5-6	Level 2: Specialist Pathway Sample with Credentials
7-9	Employment / Job Outcomes & Opportunities in Ohio
10-12	FANUC/Rockwell Connected Smart Manufacturing (CSM) Trainer

Example ODE Courses Selected for ARM Pathway

ODE CTE Course: (Approximately 230 hours each)	CTE CTAG and TAG Numbers	Possible Vendor-Neutral Industry Credentials	Topics Covered (Use a systems approach)
Manufacturing Operations (175003)	CTMET004 Manufacturing Processes (TAG OET010)	**Non-Vendor Specific:** • Occupational Safety and Health Administration (OSHA) 10 • NIMS Basic Mechanical Systems: Level 1 • NIMS Basic Pneumatic Systems: Level 1 • NIMS Basic Hydraulics: Level 1 **Vendor Specific:** • Parker Hannifin: Industrial Pneumatic Technology • Parker Hannifin: Industrial Hydraulic Technology	-Fundamentals of Manufacturing and Engineering Safety, LOTO, Blueprint Reading, etc.
Computer Integrated Manufacturing (175006)	CTMET005 Computer Aided Design/Drafting (TAG OET012)	**Non-Vendor Specific:** • NIMS CNC Mill Programming Setup & Operations **Vendor Specific:** • FANUC HandlingTool Operations and Programming • NOCTI Certified Robot -- Operator 1 • FANUC 2D iRVision Operations and Programming • Cognex Introduction to Insight • Lincoln/Miller/FANUC ArcTool Operations and Programming • Allen Bradley Rockwell Automation PLCs • FANUC CNC Turning Center Programming, Setup, Ops • FANUC CNC Milling Center Programming, Setup, Ops	CIM-Focused on Robotics: -Cover/Touch on CAD (3d modeling and Roboguide) -Cover/Touch on CNC. -Mention PLCs in relation to Robotics Systems approach, how are the two connected? -Basics on Industry 4.0
Digital Electronics (175007)	CTEET002 Digital Electronics (TAG OET002)	**Non-Vendor Specific:** • NIMS Electrical Systems: Level1	DC and AC Electrical fundamentals, - Digital electronics, truth tables, drives, sensors, motors, VFD -Basics on Industry 4.0
Industrial Robotics (176025) this CTAG will likely be removed. There is also 175004 Robotics	CTEET003 Programmable Logic Controllers (TAG OET022)	**Vendor Specific:** • FANUC HandlingTool Operations and Programming • NOCTI Certified Robot -- Operator 1 • FANUC 2D iRVision Operations and Programming • Cognex Introduction to Insight • Lincoln/Miller/FANUC ArcTool Operations and Programming • Allen Bradley Rockwell Automation PLCs	-Focus on PLCs -Cover/Touch on robotics in relation to PLCs (systems approach, how are the two connected? -Basics on Industry 4.0
ODE CTE Course— *Interoperability	Capstone Class	Credentials that apply to capstone project and topics covered	-Combine topics from 4 CTAG classes to make capstone class. -Utilize a systems approach: Advanced topics in Robotics, Vision, PLCs, integration,

Start Lvl 1

Level 1—Technician Sample Pathway: Fundamentals

Course / Topic

Industry Credential / Micro Credential Outcome:

Fundamentals of Engineering & Manufacturing

(Estimated 186 Contact Hours)

Safety Fundamentals 15 Contact Hours	**OSHA 10 Training** 10 Contact Hours
Safety: Lockout/Tagout 9 Contact Hours	**Employability** 15 Contact Hours
Math for Technicians I 14 Contact Hours	**Math for Technicians II** 14 Contact Hours
Mechanical Blueprint Reading 18 Contact Hours	**Hand Tools** 26 Contact Hours
Power Tools 9 Contact Hours	**Mechanical Fasteners** 18 Contact Hours
Measurement & Quality 15 Contact Hours	**Lubrication for Technicians** 23 Contact Hours

Occupational Safety and Health Administration (OSHA) 10

ODE CTE Approved—1 Pt

Click Course Topics & Credentials for More Info!

When the Fundamentals of Engineering curriculum material is combined with the content standards required in the selected ODE Career Tech courses, the students will be on track to complete the:

Ohio Manufacturing Foundations Certificate

Fundamentals / Basic Mechanical

(Estimated 60 Contact Hours)

	Basic Machines 15 Contact Hours	
Machine Statics & Dynamics 15 Contact Hours		**Machine Shafts & Keys** 15 Contact Hours
	Machine Bearings 15 Contact Hours	

NIMS Basic Mechanical Systems: Level 1

Micro Credential

Fundamentals / Basic Electrical

(Estimated 107 Contact Hours)

	Electrical Circuits 21 Contact Hours	
Resistors & Conductors 15 Contact Hours		**LCR Circuits** 15 Contact Hours
Motors & Generators 15 Contact Hours		**Oscilloscope & Multi Meter** 41 Contact Hours

NIMS Electrical Systems: Level 1

Micro Credential

Level 1—Technician Sample Pathway: Fundamentals

Course / Topic

Student Achieved Industry Credential / Micro Credential:

Fundamentals of Robotics

FANUC HandlingTool
65 Student Contact Hours
Train the Trainer @ FANUC

And

FANUC HandlingPro Simulation
24 Student Contact Hours
Train the Trainer @ FANUC

FANUC HandlingTool Operation & Programming
ODE CTE Approved—6Pts
ODE Course: CIM & Robotics
TechCred

NOCTI FANUC Certified Robot—Operator 1
Nationally Recognized
NOCTI

Advanced Robotics—Vision Systems

FANUC 2D iRVision
24 Student Contact Hours
Train the Trainer @ FANUC

And / Or

Cognex Vision Systems
32 Student Contact Hours
Train the Trainer @ Cognex

FANUC 2D iRVision Operation & Programming
TechCred
NOCTI

Cognex Vision Introduction to Insight

Advanced Robotics—Robotic Welding

Lincoln / FANUC Robot Welding
65 Student Contact Hours
Train the Trainer @ Lincoln/FANUC

And / Or

Miller / FANUC Robot Welding
65 Student Contact Hours
Train the Trainer @ Miller/FANUC

FANUC ArcTool Operations and Programming
ODE Course: CIM & Robotics
TechCred

Fundamentals of Programmable Logic Controllers

Rockwell / Allen Bradley PLCs
120 Student Contact Hours
Train the Trainer @ Rockwell

Rockwell Allen Bradley PLCs: Intro to Automation
ODE CTE Approved—6Pts
ODE Course: CIM & Robotics
TechCred

Fundamentals of Motion Control: Pneumatics

Parker Pneumatics
30 Student Contact Hours
Train the Trainer @ Parker

Parker Hannifin: Industrial Pneumatic Tech
ODE Course: Manufacturing Operations

NIMS Basic Pneumatic Systems: Level 1
Micro Credential

Fundamentals of Motion Control: Hydraulics

Parker Hydraulics
45 Student Contact Hours
Train the Trainer @ Parker

Parker Hannifin: Industrial Hydraulic Tech
ODE Course: Manufacturing Operations
TechCred

NIMS Basic Hydraulic Systems: Level 1
Micro Credential

Fundamentals of CNC: Machining & Turning

FANUC CNC Turning
30 Student Contact Hours
Train the Trainer @ FANUC

FANUC CNC Turning Center Programming, Setup, and Operation
ODE CTE Approved—4Pts
ODE Course: CIM
TechCred

FANUC CNC Machining
30 Student Contact Hours
Train the Trainer @ FANUC

FANUC CNC Machining Center Programming, Ops
ODE CTE Approved—4Pts
ODE Course: CIM
TechCred

NIMS Basic Machining: Level 1
Micro Credential

Fundamentals of Interoperability / Capstone

Intro to Interoperability: *Robot to PLC*
20 Student Contact Hours
Instructor Training @ LCCC / APT

Intro to Interoperability: *Robot to CNC*
15 Student Contact Hours
Instructor Training @ LCCC / APT

Job Or More Classes

Pathway Total: 757-854 Contact Hours
Jobs Available: Click Here

Level 1 Technician Credential Pathway Summary

- 12 Industry Credentials & 5 Micro Credentials
- 39 ODE Industry Credential Graduation Points
- College Credits: 13
- CTAG: CTEET003 PLCs: 3 Semester Hours
- CTAG: CTMET004 Manufacturing Processes: 3 Semester Hours
- CTAG: CTMET005 CADD: 3 Semester Hours
- CTAG: CTEET002 Digital Electronics: 3-4 Semester Hours
- Potential: ARM Level 1 Technician Credential

Start Lvl 2

Level 2—Specialist Sample Pathway: Fundamentals

Course / Topic

Advanced Mechanical

(Estimated 90 Contact Hours)

Belt Drives 15 Contact Hours	**Chain Drives** 15 Contact Hours
Machine Shafts Couplings 15 Contact Hours	**Gear Drives** 15 Contact Hours
Machine Speed Reducers 15 Contact Hours	**Electric Brakes** 15 Contact Hours

Advanced Electrical

(Estimated 246 Contact Hours)

Overcurrent Protection/Monitoring 15 Contact Hours	**Relay, Timers, Time Delay Relay** 15 Contact Hours
Transformers 15 Contact Hours	**Electric Motors** 21 Contact Hours
Electro Magnetic Motor Starters 15 Contact Hours	**Solid State Reduced Starters** 15 Contact Hours
Variable Frequency Drives (VFDs) 15 Contact Hours	**Pilot Devices** 15 Contact Hours
DC Motor Control 15 Contact Hours	**DC Power Supplies** 17 Contact Hours
Single & Three Phase Power 20 Contact Hours	**Electronic Timers** 15 Contact Hours
Thyristor Electric Motor Drives 23 Contact Hours	**Stepper Motor Drivers** 15 Contact Hours

Servo Motor Drives
15 Contact Hours

Advanced Motion Control

Parker Electro Hydraulic 24 Contact Hours	**Parker Electro Pneumatic** 24 Contact Hours

CAD & Additive Manufacturing (3D Printing)

Stratasys FDM & Polyjet
45 Contact Hours

Industry Credential / Micro Credential Outcome:

Start: OJT or Apprenticeship

24 Hours a Week

NIMS Electrical Control Systems: Level 1

Micro Credential

Stratasys FDM & PolyJet 3D Printing

SME Certified Additive Manufacturing – Fundamentals

ODE CTE Approved—3Pts

Level 2—Specialist Sample Pathway: Fundamentals

Course / Topic

Industry Credential / Micro Credential Outcome:

Advanced PLCs Specialist Foundation:

Studio 5000 Logix Lvl 1: *ControlLogix* Fundamentals & Troubleshooting
36 Contact Hours (CCP299)

OR

Studio 5000 Logix Lvl 1: *CompactLogix* Fundamentals & Troubleshooting
36 Contact Hours (CCP298)

Rockwell Motion Control Fundamentals
24 Contact Hours (CCN130)

&

EtherNet/IP Configuration and Troubleshooting
24 Contact Hours (CCP183)

Allen Bradley ControlLogix: Fundamentals & Troubleshooting

Micro Credential

TechCred

Advanced PLCs Specialist—Programming:

Studio 5000 Logix Lvl 2: *Ladder Logic Programming*
16 Contact Hours (CCP151)

Studio 5000 Logix Lvl 3: Project Development
32 Contact Hours (CCP143)

Allen Bradley Studio 5000 Logix Designer Level 2: Basic Ladder

Micro Credential

TechCred

Allen Bradley Logix5000 Programmer Certificate

TechCred

Advanced PLCs Specialist—Maintenance:

Studio 5000 Logix Lvl 3: Ladder Logic Interpretation
16 Contact Hours (CCCL21)

Allen Bradley Logix5000 Maintainer Certificate

TechCred

Advanced Robotics—Programming & Vision:

FANUC Robotics: Advanced Teach Pendant Programming
40 Contact Hours

&

Cognex Advanced InSight Programming
16 Contact Hours

FANUC Advanced Teach Pendant Programming

TechCred

Advanced Robotics—Maintenance & Safety:

FANUC Robotics: Mechanical Robot Disassembly/Reassembly
24 Contact Hours

FANUC Robotics: Electrical Controller Maintenance
32 Contact Hours

FANUC Dual Check Safety
24 Contact Hours

FANUC Mechanical Disassembly/Reassembly

TechCred

FANUC Electrical Maintenance with R-30iB Controller

TechCred

FANUC Dual Check Safety V7.50 & Newer

TechCred

Job Or More Classes

Level 2 Technician Credential Pathway Summary:

- 8 Industry Credentials
- 3 Micro Credentials
- 689 Contact Hours
- 600 - 1200 OJT or Pre Apprenticeship Hours
- Education Outcomes: Associates Degree

Potential: ARM Level 2 Specialist Credential

Employment Outcomes and In Demand Jobs in Ohio

All In-Demand Occupations

Listed According to Job Openings

All Data and Job Titles Compiled from ODJFS for Automation Pathway
Additional Job Titles can be added / identified working with OMA

Listed below are all in-demand occupations across the state of Ohio, sorted by the occupation's total annual job openings. Entry into these occupations requires varying levels of education, on-the-job-training and relevant work experience. Discuss these options with your OhioMeansJobs Center's workforce specialist.

Occupation Title	Starting Wage	Median Annual Wage	Education Level	On-the-Job Training	Relevant Work Experience	Annual Job Openings*
General and Operations Managers	$50,180	$98,760	Bachelor's degree	None	5 years or more	5,791
Related Job Titles: Director of Operations; Plant Manager; Plant Superintendent; Vice President of Operations						
Machinists	$29,610	$42,650	High school diploma or equivalent	Long-term on-the-job training	None	2,854
Related Job Titles: Gear Machinist; Journeyman Machinist; Machine Operator; Machine Repair Person; Machinist Maintenance; Machinist Maintenance Specialist; Production Machinist; Set-Up Machinist; Tool Room Machinist						
Assemblers and Fabricators, All Other[2]	‡	$30,690	High school diploma or equivalent	Moderate-term on-the-job training	None	2,726
Related Job Titles: Action Finisher; Action Installer; Ager						
Industrial Machinery Mechanics	$35,520	$52,865	High school diploma or equivalent	Long-term on-the-job training	None	1,861
Related Job Titles: Industrial Mechanic; Loom Fixer; Machine Adjuster; Maintenance Mechanic; Maintenance Technician; Master Mechanic; Mechanic						
Maintenance and Repair Workers, General	$27,040	$40,767	High school diploma or equivalent	Moderate-term on-the-job training	None	5,895
Related Job Titles: Maintenance Technician; Maintenance Mechanic; Maintenance Electrician; Maintenance Supervisor; Maintenance Engineer; Process Technician; Equipment Engineering						

*Statewide "Annual Job Openings" occupational projections - Bureau of Labor Market Information
§ - "Relevant Work Experience" data unavailable | ‡ - "Starting Wage" data unavailable
[1] - Wage was calculated by multiplying the hourly wage by 2,080 to approximate an annual wage | [2] - National wage is displayed as the state wage data is unavailable

Return to Pathway

Occupation Title	Starting Wage	Median Annual Wage	Education Level	On-the-Job Training	Relevant Work Experience	Annual Job Openings*
FL Sup/Mgrs of Mechanics/Installers/Repairers	$41,110	$64,666	High school diploma or equivalent	None	Less than 5 years	1,499
Related Job Titles: Facilities Manager; Facility Maintenance Supervisor; Maintenance Foreman; Maintenance Manager; Maintenance Planner; Maintenance Supervisor; Production Crew Supervisor						
Mul ple Machine Tool Se ers, Operators, and Tenders, Metal and Plas c	$25,370	$35,828	High school diploma or equivalent	Moderate-term on-the-job training	None	1,427
Related Job Titles: Cell Technician; CNC Machine Setter; CNC Machinist; CNC Operator; Die Setter; Machine Operator; Machine Technician; Machinist Operator; Set-Up Person						
Computer-Controlled Machine Tool Oper., M/P	$30,010	$41,630	High school diploma or equivalent	Moderate-term on-the-job training	None	1,325
Related Job Titles: Brake Press Operator; Computer Numerical Control Lathe Operator; Computer Numerical Control Machine Operator; Computer Numerical Control Machinist; Computer Numerical Control Operator (CNC Operator); Machine Operator Machine Set-Up, Operator Machinist						
Mechanical Engineers	$56,120	$79,268	Bachelor's degree	None	None	1,165
Related Job Titles: Design Engineer; Product Engineer; Mechanical Design Engineer; Process Engineer; Equipment Engineer; Design Maintenance Engineer; Systems Engineer; Chassis Systems Engineer						
Industrial Engineers	$58,460	$82,573	Bachelor's degree	None	None	1,102
Related Job Titles: Process Engineer; Engineer Operations; Engineer; Engineering Manager; Manufacturing Specialist; Plant Engineer; Supply Chain Engineer; Tool Engineer; Production Engineer						
Industrial Production Managers	$64,770	$102,510	Bachelor's degree	None	5 years or more	738
Related Job Titles: Area Plant Manager; General Production Manager; Manufacturing Coordinator; Manufacturing Manager; Plant Manager Plant; Senior Manager; Product Line Manager; Production Control Manager; Production Manager; Sub Plant Manager						
Installation, Maintenance, and Repair Workers, All Other[1]	$25,430	$39,333	High school diploma or equivalent	Moderate-term on-the-job training	None	592
Related Job Titles: AMF Mechanic; Angle Furnaceman; Anglesmith; Anode Worker; Anvil Worker; Anvilsmith; Armorer Assembled Wood Products; Auto Dismantler						
Engineers, All Other[1]	$52,550	$91,478	Bachelor's degree	None	None	527
Related Job Titles: Application Engineer; Commercial Engineer; Consulting Engineer; Design Engineer; Director Engineering; Distribution Engineer; Engineering Analyst						
Manufacturing Engineers[1]	$52,550	$91,478	Bachelor's degree	None	None	527
Related Job Titles: Manufacturing Engineer; Manufacturing Director; Manufacturing Engineering Manager; Process Engineer; Facility Engineer; Plant Engineer						
Robotics Engineers[1]	$52,550	$91,478	Bachelor's degree	None	None	527
Related Job Titles: Associate Professor of Automation; Engineer; Automation Engineer; Plant Floor Automation Manager						

Return to Pathway

Occupation Title	Starting Wage	Median Annual Wage	Education Level	On-the-Job Training	Relevant Work Experience	Annual Job Openings*
Machine Feeders and Offbearers	$20,240	$32,468	No formal educational credential	Short-term on-the-job training	None	520
Related Job Titles: Material Handler; Dryer Feeder; Feeder; Tipper; Lug Loader; Machine Feeder; Offbearer						
Electrical Engineers	$56,130	$85,756	Bachelor's degree	None	None	446
Related Job Titles: Electrical Design Engineer; Project Engineer; Electrical Controls Engineer; Test Engineer; Hardware Design Engineer; Broadcast Engineer; Circuits Engineer; Electrical and Instrument; Maintenance Supervisor (E and I Maintenance Supervisor); Electrical Project Engineer						
Sales Engineers	$57,640	$89,646	Bachelor's degree	Moderate-term on-the-job training	None	377
Related Job Titles: Account Executive; Account Manager; Customer Engagement Manager; Product Manager; Product Sales Engineer; Sales Engineer of Engineered Products; Senior Sales Engineer; Technical Sales Engineer						
Maintenance Workers, Machinery	$30,430	$46,836	High school diploma or equivalent	Long-term on-the-job training	None	278
Related Job Titles: Maintenance Technician; Mechanic; Maintenance Mechanic; Machine Repairer; Maintainer; Maintenance Worker; Industrial Maintenance Millwright; Oiler; Maintenance Electrician; Maintenance Machinist						
Industrial Engineering Technicians	$38,840	$56,096	Associate's degree	None	None	275
Related Job Titles: Project Engineer; Engineering Technician; Industrial Engineering Technician; Methods Engineer; Manufacturing Technician; Production Staff Worker; Industrial Engineering Analyst; Process Documentation and Methods Analyst; Process Engineer; Plant Engineer						
Electronics Engineers, Except Computer	$59,560	$97,936	Bachelor's degree	None	None	258
Related Job Titles: Design Engineer; Engineer; Test Engineer; Electronics Engineer; Product Engineer; Engineering Manager; Electrical Design Engineer; Integrated Circuit Design Engineer (IC Design Engineer); Evaluation Engineer; Research and Development Engineer						
Numerical Tool and Process Control Programmers	$36,170	$50,512	Postsecondary non-degree award	Moderate-term on-the-job training	None	247
Related Job Titles: CAD CAM Programmer(Computer-Aided Design Computer-Aided Manufacturing Programmer); CNC Process Control Programmer; Computer Numerical Control Programmer (CNC Programmer); Machinist; Manufacturing Engineer; Metal Numerical Control Programmer; Mold Maker Numerical Control Numerical Control Programmer (NC Programmer)						
Mechanical Engineering Technicians	$40,570	$55,185	Associate's degree	None	None	218
Related Job Titles: Engineering Technician; Mechanical Designer; Research and Development Technician; Engineering Lab Technician; Equipment Engineer; Process Technician; Design Engineer; Designer; Engineering Technical Analyst; Lab Technician						
Electrical and Electronic Engineering Technicians	$39,150	$62,984	Associate's degree	None	None	203
Related Job Titles: Electrical Design Technician; Electrical Engineering Technician; Electrical Power Station Technician; Electronic Instrument Testing Technician; Lighting Engineering Technician; Programmable Logic Controller Programmer; Semiconductor Development Technician						
Electrical/Electronics Repair, Comm/Indus Equip.	$39,990	$59,098	Postsecondary non-degree award	Long-term on-the-job training	None	200
Related Job Titles: Control Technician; Electronics Technician; Industrial Electrician; Electrical Technician; Electrician; Electrical and Instrument Technician (E&I Tech); Instrument and Electrical Technician (I&E Tech); Electrical and Instrument Mechanic						
Electro-Mechanical Technicians	$39,800	$57,550	Associate's degree	None	None	35
Related Job Titles: Electro-Mechanical Technician (E/M Technician); Electronic Technician; Test Technician; Tester; Mechanical Technician; Product Test Specialist; Electro-Mechanic; Electronic Instrument Technician						

FANUC America

Connected Smart Manufacturing

CSM™

IIoT • Industry 4.0 • Analytics

Modern Manufacturing Technology Featuring Full Integration and Intelligence

FANUC

CONNECT 4.0 CERTIFIED EDUCATION

Rockwell Automation

*i*CSMT

Industrial Connected Smart Manufacturing Controls Integration

Each station is built as a fenceless system. There is an area scan located on each machine, as people approach the robot it will slow down to a safer speed and eventually stop until the person has backed away. Manual functions, moving, and teaching of the robot through the use of the robot teach pendant is still available while within the area scan protection zone.

OP 20 is equipped with an industrial Keyence Laser that can be programmed as part of the full system or it can be taken into the classroom and taught as an individual piece of equipment. The laser is an engraver that trainees can use to personalize the product by adding script, pictures, dates, bar codes, or QR codes. The laser also includes an integrated verification camera system used to grade the quality of the bar code. The laser enclosure has an easy to open front door to hand load and unload for individual teaching. Each station can also be used for teaching new programming, existing changes, and troubleshooting.

The *i*CSMT is outfitted with industrial grade components that the trainees will see when they get their full-time job in the industry. We have partnered with and are utilizing a Rockwell Automation PLC, Programmable Safety Controller, and an I/O link master block to interface and control the sensors, system stack light and pneumatic manifold. We have designed and built in additional I/O capabilities and capacities on the Robot, PLC, pneumatic manifold, and the I/O Link so that the institution has the ability to add to this system as desired.

APT Manufacturing

APT Manufacturing Solutions was founded in January of 1996. Since inception, APT has been on the cutting-edge of technology, utilizing state-of-the-art manufacturing methods, software, and processes. After 20 years our reputation precedes us; established by building long-term relationships with our customers and providing them superior service. APT currently has customers throughout the United States, as well as in Canada, Israel, Mexico, and Europe.

We are one of the largest diversified manufacturing companies in our area with well over 100 employees. We are also proud to be one of the largest FANUC integrators in North America. Our 75,000 square foot building is a controlled atmosphere with heating and air conditioning in order to adhere to the highest standards of quality.

We are one of the largest diversified manufacturing companies in our area and are committed to industrial education solutions. We are also proud to be one of the largest FANUC integrators in North America. We have been developing industrial solutions since 1995 and have collaborated with FANUC America on their most advanced robotic training equipment and industry 4.0 connectivity.

RIA CERTIFIED Robot Integrator

Automated with Rockwell Automation
Allen-Bradley · Rockwell Software

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001

DC Motor Control

15 hours of instruction

Description

DC Motor Control (EA16) delivers hands-on skills in installing, operating and troubleshooting DC drives used in electric motor circuits. An add-on to Electromagnetic Motor Starters (EA07), EA16 covers eight additional skills including operating SCR and PWM speed controllers, DC drives and braking controls. The skills-based curriculum presents hands-on activities using industrial-grade components.

Course Outline

- Demonstrating DC Drive Principles
- Connecting and Operating a SCR Speed Controller
- Connecting and Operating a PWM Speed Controller
- Connecting, Setting-up, and Operating a DC Drive
- Connecting and Operating Braking Controls • Testing a DC Drive
- Troubleshooting a DC Drive
- Performing Preventative Maintenance

Return to Flow Chart

DC Power Supplies

17 hours of instruction

Description

DC Power Supplies delivers hands-on skills in operating industrial-grade bridge rectifiers, transformers and test equipment. The skills-based curriculum builds on the concepts learned in the prerequisite test instruments courses: Oscilloscope (EB01A) and Digital Multimeter (EB01B). DC Power Supplies presents eleven additional skills using bridge rectifiers, diode rectifiers and low-voltage transformers.

Course Outline

- Power Supply Block Diagram
- Schematic Symbols
- Testing a Transformer
- Locating Diodes and Symbols
- Testing a Diode
- Drawing a Half-Wave Rectifier
- Connecting and Operating a Half-Wave DC Power Supply
- Confirming Full-Wave DC Power Supply Operation
- Connecting and Operating a Full-Wave DC Power Supply
- Confirming Single-Phase Bridge Rectifier Operation
- Connecting and Operating Single-Phase Bridge Rectifier

Return to Flow Chart

Electric Motors

21 hours of instruction

Description

Electric Motors (EA04) guides students through handson activities using common industrial motors, including three-phase, split-phase and capacitor-start motors. From wiring motor circuits to preventive maintenance and troubleshooting, students gain practical experience in all aspects of industrial motor operation, including connecting and operating a three-phase motor, troubleshooting a capacitorstart motor and testing motors with adjustable loads.

Course Outline

- Connecting and Operating a Split-Phase Motor
- Connecting and Operating a Capacitor-Start Motor
- Connecting and Operating a Shaded-Pole Motor
- Connecting and Operating a DC Motor
- Connecting and Operating a Three-Phase Motor
- Performing Visual Inspection
- Lubricating Motors
- Performing DMM and Motor Megger Tests
- Troubleshooting a Split-Phase Motor
- Troubleshoot A CapacitorStart Motor
- Troubleshooting a ShadedPole Motor
- Troubleshooting A DC Motor
- Troubleshooting A ThreePhase Motor
- Testing Motors With Adjustable Loads

Return to Flow Chart

Electro Magnetic Motor Starters

15 hours of instruction

Description

Electromagnetic Motor Starters (EA07) guides students through hands-on activities using industrial motor controls. From wiring motor control circuits to troubleshooting, students gain practical experience in all aspects of industrial motor control, including testing and resetting overload protection, operating a threephase reversing starter and troubleshooting a three-phase motor control circuit.

Course Outline

- Connecting a Control Relay Seal-In Circuit
- Connecting, Adjusting, And Operating a Single Magnetic Starter
- Testing and Resetting Overload Protection
- Connecting, Adjusting, and Operating a Three-phase Reversing Starter
- Connecting and Operating a Magnetic Starter for Jogging
- Troubleshooting a Threephase Motor Control Circuit
- Troubleshooting a Reversing Three-phase Motor Control Circuit
- Performing Preventive Maintenance on Magnetic Starters

Return to Flow Chart

Electronic Timers

15 hours of instruction

Description

In the Electronic Timers (EB04) course, students work with industrial-grade timer devices used extensively in time-delay relays, motor drives and digital circuits. Students acquire skills including connecting and operating a 555 timer, verifying an astable timer circuit and connecting and operating an electronic pulse train. The skills-based curriculum builds on the concepts learned in the prerequisite course, Thyristor Electric Motor Drives (EB03). Electronic Timers (EB04) presents seven additional skills with a timer Flexponent™ panel.

Course Outline

- Locating Timer Pins
- Verifying a Monostable Timer Circuit
- Connecting and Operating a 555 Timer in Monostable (One-Shot) Mode
- Verifying an Astable Timer Circuit
- Connecting and Operating a 555 Timer in Astable (Multi vibrator) Mode
- Verifying a Pulse Train Circuit
- Connecting and Operating an Electronic Pulse Train

Return to Flow Chart

Overcurrent Protection/Monitoring

15 hours of instruction

Description

Electric Circuit Protection and Monitoring (EA02) delivers hands-on skills in the methods and devices used to protect industrial electric circuits. The skills-based curriculum presents hands-on activities using industrial-grade components.

Course Outline

- Drawing and Reading Circuit Protection Symbols
- Sizing Fuses
- Installing Fuses
- Testing and Replacing Fuses
- Performing Preventive Maintenance and Troubleshooting Fuse Blocks
- Sizing Circuit Breakers
- Testing and Resetting a Circuit Breaker
- Sizing and Installing an Overload Heater
- Adjusting and Testing the Overload Relay
- Installing and Setting Up a Three-Phase Monitor

Return to Flow Chart

Pilot Devices

15 hours of instruction

Description

Pilot Devices (EA09) delivers hands-on skills in installing, operating and troubleshooting pilot devices used in electric control circuits. Pilot Devices (EA09) is an add-on to Electromagnetic Motor Starters (EA07), covering ten additional skills including connecting and operating photoelectric sensors with fiber optics, capacitive and inductive proximity switches, limit switches, pressure switches, liquid level switches, and magnetic reed switches.

Course Outline

- Connecting and Operating a Photoelectric Detector
- Connecting and Operating a Photoelectric Sensor with Fiber Optics
- Connecting and Operating a Capacitive Proximity Switch
- Connecting and Operating an Inductive Proximity Switch
- Connecting and Operating a Limit Switch
- Connecting and Operating a Pressure Switch
- Connecting and Operating a Liquid Level Switch
- Connecting and Operating a Magnetic Reed Switch
- Troubleshooting Pilot Devices
- Performing Preventive Maintenance

Return to Flow Chart

Relays, Timers, Time Delay Relay

15 hours of instruction

Description

Relays, Timers and Time Delay Relays (EA08) features hands-on skills in installing, programming and maintaining control devices used in industrial electric circuits. Relays, Timers and Time Delay Relays (EA08) is an add-on to Electromagnetic Motor Starters (EA07), covering eight additional skills using a digital relay and an electronic timer mounted on the two included Flexponent™ panels.

Course Outline

- Connecting, Programming, and Operating Analog OnDelays and Off-Delay Relays
- Using Analog Relays and Motors
- Connecting, Programming, and Operating Digital Interval, Repeat Cycle, and One Shot Relays
- Using Digital Relays and Motors
- Connecting and Operating Electric Timers
- Using Electric Timers and Motors
- Troubleshooting Relays
- Performing Preventive Maintenance on Relays

Return to Flow Chart

Servo Motor Drives

15 hours of instruction

Description

Servo Motor Drives (EB06) guides students through six additional skills with an industrial grade servo motor and drive mounted on a Flexponent™ panel. Using precision servo motor systems found in CNC machines, robotic and hydraulic systems, students learn closed-loop servo motor control and system feedback principles while acquiring skills including installing and troubleshooting servo motor drives.

Course Outline

- Demonstrating ClosedLoop Servo Motor Control Principles
- Demonstrating Closed-Loop Servo Motor Principles
- Demonstrating Servo System Feedback Device Principles
- Demonstrating Analog and Digital Servo Motor Drive Principles
- Installing, Connecting and Monitoring a Basic Servo Motor Drive
- Testing and Troubleshooting a Basic Servo Motor Drive

Return to Flow Chart

Single & Three Phase Power

20 hours of instruction

Description

Single-phase and Three-phase Power Supplies builds on the concepts learned in the prerequisite course: DC Power Supplies (EB02A). The skillsbased curriculum presents thirteen additional skills using three new Flexponent™ panels covering industrial-grade bridge rectifiers, transformers and test equipment.

Course Outline

- Drawing Filter Schematic Diagrams
- Connecting and Operating a Power Supply
- Drawing Zener Schematic Symbols
- Connecting and Operating a Zener Diode Voltage Regulator
- Locating an IC Voltage Regulator
- Connecting and Operating a DC Power Supply with an IC Voltage Regulator
- Connecting and Operating a Bleeder Resistor
- Connecting and Operating a Volt age Divider
- Troubleshooting a DC Power Supply
- Confirming Three-Phase Bridge Rectifier Operation
- Testing a Three-Phase Bridge Rectifier
- Connecting and Operating a Three-Phase Bridge Rectifier
- Troubleshooting a Three-Phase Bridge Rectifier

Return to Flow Chart

Solid State Reduced Starters

15 hours of instruction

Description

Solid-State Starters (EA11) guides trainees through installing, operating and troubleshooting solid-state starters used in electric motor circuits. Solid-State Starters (EA11) is an add-on to Electromagnetic Motor Starters (EA07), covering five additional skills. The skills-based curriculum presents hands-on activities using industrial-grade components.

Course Outline

- Applying Solid-State Principles
- Connecting and Operating a Solid-State Starter
- Adjusting a Solid-State Starter
- Testing Solid-State Starters
- Troubleshooting Solid-State Starters

Return to Flow Chart

Stepper Motor Drives

15 hours of instruction

Description

Stepper Motors and Drives delivers hands-on skills using stepper motor systems found in robots, precision linear positioning devices, CNC machines and other devices that provide motion control with calculated accuracy. Students acquire skills including confirming stepper motor step angle and troubleshooting stepper motor drives. The skills-based curriculum builds on the concepts learned in the prerequisite courses in the Industrial Power Electronics series, presenting seven additional skills with an industrial-grade stepper motor and drive.

Course Outline

- Identifying Detent Torque
- Confirming Stepper Motor Step Angle
- Demonstrating Stepper Motor
- Principles
- Confirming Stator Winding Connections
- Demonstrating Unipolar Stepper Motor Drive
- Installing, Connecting and Monitoring a Basic Stepper Motor Drive
- Testing and Troubleshooting a Basic Stepper Motor and Drive

Return to Flow Chart

Thyristor Electric Motor Drives

23 hours of instruction

Description

Thyristor Electric Motor Drives brings students in contact with the same industrial grade components used in industrial electric motor drives. Students learn SCR control and PWM principles while acquiring skills including operating fullwave SCR DC motor drives, DIAC-controlled TRIAC AC motor drives and Schmitt Trigger controlled TRIAC AC motor drives.

Course Outline

- Locating an SCR and Drawing the Schematic Symbol
- Testing an SCR
- Connecting & Operating an SCR
- Confirming Full-Wave SCR Control
- Connecting & Operating a FullWave SCR DC Motor Drive
- Troubleshooting a Full-Wave SCR DC Motor Drive
- Locating the TRIAC and Drawing the TRIAC Symbol
- Testing a TRIAC
- Demonstrating TRIAC Control Principles
- Locating a DIAC and Drawing the Schematic Symbol
- Connecting & Operating a DIAC Controlled TRIAC AC Motor Drive
- Connecting and Operating a Schmitt Trigger-Controlled TRIAC AC Motor Drive

Return to Flow Chart

Transformers

15 hours of instruction

Description

Transformers (EA03) delivers hands-on skills in installing, operating, and troubleshooting transformers. Students learn about transformer principles and to read transformer symbols. Transformers (EA03) covers eight skills including inspecting, servicing, and sizing transformers, connecting a transformer for buck and boost operation, and in delta and wye

Course Outline

- Applying Transformer Principles
- Drawing and Reading Transformer Symbols
- Installing a Control Transformer
- Troubleshooting Transformers
- Connecting a Transformer as an Auto Transformer for Buck and Boost Operation
- Connecting Transformers in Delta and Wye
- Inspecting and Servicing a Transformer
- Sizing a Transformer

Return to Flow Chart

Variable Frequency Drives (VFDs)

15 hours of instruction

Description

Variable Frequency Drives (EA12) delivers comprehensive coverage of installing, operating and troubleshooting variable frequency drives (VFDs) in motor control circuits. Variable Frequency Drives (EA12) is an add-on to Electric Motors (EA04), covering six additional skills. The skills-based curriculum presents hands-on activities using an industrial-grade Mitsubishi VFD.

Course Outline

- Applying VFD Principles
- Connecting and Operating a Variable Frequency Drive
- Adjusting VFD Operating Parameters
- VFD Protection Parameters and Inputs/Outputs
- Troubleshooting the VFD
- Understanding Additional VFD Features

Return to Flow Chart

Belt Drives

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Demonstrating Belt Drive Ratio Principles
- Installing Belt Drives
- Aligning a Belt Drive
- Belt Tensioning
- Installing Adjustable Speed Sheaves
- Installing Positive Drive Systems
- Belt Troubleshooting & Maintenance

Return to Flow Chart

Chain Drives

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Demonstrating Roller Chain & Sprocket Principles
- Sizing Chain
- Installing & Aligning Sprockets
- Installing Chain Drives
- Adjusting Slack
- Troubleshooting & Maintenance

Return to Flow Chart

Electric Brakes

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Operating Electric Brakes
- Installing Electric Brakes
- Maintaining & Troubleshooting Electric Brakes

Return to Flow Chart

Gear Drives

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Demonstrating Gear Measurement Principles
- Installing a Worm Gear Drive
- Installing a Spur Gear Drive
- Measuring Backlash
- Installing a Helical Gear Drive
- Installing a Bevel Gear Drive
- Maintaining & Troubleshooting Gear Drives

Return to Flow Chart

Machine Shafts Couplings

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Identifying Shaft Couplings
- Correcting Soft Foot
- Aligning Shafts
- Aligning Rims & Faces
- Connecting Chain Couplings
- Connecting Universal Joints

Return to Flow Chart

Machine Speed Reducers

15 hours of instruction

Description

The JobMaster Mechanical Training series is a robust, stand-alone mobile training station providing comprehensive training in mechanical power transmission.

A true all-in-one trainer, the Mechanical Training Bench features industrial-strength components housed in a heavy duty mobile framework with a customized modular drawer storage system. Designed for two students per side, the trainer features bearings, belt drives, chain drives, gear drives and more. JobMaster courses are entirely skill-based, consisting of individual exercises that reproduce essential tasks performed by maintenance technicians, equipment operators, and machine repairmen.

Course Outline

- Demonstrating Basic Speed Reducer Principles
- Selecting a Speed Reducer
- Maintaining & Troubleshooting Speed Reducers

Return to Flow Chart

Parker Electro Hydraulic

24 hours of instruction

Description

Learn the skill of Open and Closed loop control exactly as you would in the real world. Automatic control of hydraulic systems has evolved into an increasingly superior alternative for many industrial applications. Advances in hydraulic hardware and electronics have combined to make the design and installation of these systems more intuitive, reliable, cost effective, repeatable and user friendly.

Controlling the position of a cylinder is one of the more demanding hydraulic motion control techniques. The electrohydraulic module is intended to develop a solid background in controlling the position of a cylinder, along with references to controlling velocity, pressure, force and combinations thereof.

Course Outline

- Electrohydraulic Valve
- LVDT (linear variable differential transformer)
- PC Board Input/Output Connections
- "On Board" Driver Card Current and Bias Options
- "On Board" Driver Card Electronic Limits
- "On Board" Driver Card Deadband Compensators
- Open Loop Operation with Cylinder
- Proportional Valve Characteristics
- Open Loop Operation with a Motor
- Closed Loop Operation with a Cylinder

Return to Flow Chart

Stratasys FDM & Polyjet

45 hours of instruction

Description

Additive manufacturing plays a key role across industries, but there is a widening gap between the technology and the number of skilled workers who can drive it. As a certification institution, you will prepare the workforce of tomorrow by offering a professional proficiency credential in additive manufacturing technologies, industries and applications, FDM and PolyJet materials, key technology specifications, design considerations from CAD to CAM, fabrication considerations and post-processing methods.

Course Outline

- Overview of Additive Manufacturing
- Additive Manufacturing Technologies
- Industries and Applications Using Stratasys
- Stratasys Materials and Material Properties
- Stratasys Technology and Key Specifications
- Design Considerations – From CAD to CAM
- Fabrication Considerations
- Post Processing
- Ability to define and understand benefits of 3D printing
- Understanding of ASTM key additive technologies
- Understanding of 3D printing industries and applications
- Knowledge of Stratasys technology
- Material testing standards and Stratasys materials
- Additive design and fabrication considerations
- Basic post-processing for FDM and PolyJet

Return to Flow Chart

Basic Machines

15 hours of instruction

Description

Mechanical Training Level 1 Bundle includes the tabletop working surface for mechanical training and curriculum for Basic Machines, Machine Statistic & Dynamics, Shafts & Keys, Bearings. The single bench setup for two students or double bench setup for four students includes all the hardware and curriculum for the four learning modules.

Course Outline

- Measurement
- Torque
- Work
- Power
- Horsepower
- Friction
- Velocity
- Acceleration
- Mass and Inertia

Return to Flow Chart

Machine Bearings

15 hours of instruction

Description

Mechanical Training Level 1 Bundle includes the tabletop working surface for mechanical training and curriculum for Basic Machines, Machine Statistic & Dynamics, Shafts & Keys, Bearings. The single bench setup for two students or double bench setup for four students includes all the hardware and curriculum for the four learning modules.

Course Outline

- Identifying Bearing Types
- Reading Bearing Dimensions
- Mounting Bearing Housings
- Reading a Tolerance Chart
- Bearing Troubleshooting and Failure Analysis

Return to Flow Chart

Machine Shafts & Keys

15 hours of instruction

Description

Mechanical Training Level 1 Bundle includes the tabletop working surface for mechanical training and curriculum for Basic Machines, Machine Statistic & Dynamics, Shafts & Keys, Bearings. The single bench setup for two students or double bench setup for four students includes all the hardware and curriculum for the four learning modules.

Course Outline

- Measuring and Verifying Shafts
- Demonstrating Shaft Expansion Principals
- Measuring Eccentricity and Shaft Runout
- Demonstrating Shaft Key Principals
- Preparing a Key from Keystock
- Shaft Troubleshooting and Failure Analysis

Return to Flow Chart

Machine Statics and Dynamics

15 hours of instruction

Description

Mechanical Training Level 1 Bundle includes the tabletop working surface for mechanical training and curriculum for Basic Machines, Machine Statistic & Dynamics, Shafts & Keys, Bearings. The single bench setup for two students or double bench setup for four students includes all the hardware and curriculum for the four learning modules.

Course Outline

- Identify Stress, Strain and Combined Stresses
- Identify Material Fatigue and Fatigue Stress Points
- Identify Fatigue and Failure and Failure Modes

Return to Flow Chart

Employability

15 hours of instruction

Description

Employability offers Industry and Career Skills in a module that aims to prepare high school and college students to apply for, and succeed in their first job.

Developed with employability experts at SkillsUSA, the module covers job application topics such as setting career goals, résumé preparation and interview skills. It provides training on core employee skills such as time management, teamwork, communication, conflict resolution, work ethics and more

Course Outline

- Time-Management Techniques
- Personal Qualities Desirable for the Workplace
- Interpersonal Communication
- Conflict Resolution
- Teamwork
- Problem-Solving Techniques
- Decision-Making Skills
- Business and Personal Ethics
- Business Etiquette and Ethical Computer Behavior
- Employer-Employee Relationships
- Proper Communication with Diverse Populations
- Career Goals
- Resumes and Cover Letters
- Job Applications
- Potential Employer Interviews
- Interviewing Skills

Return to Flow Chart

Hand Tools

26 hours of instruction

Description

Hand Tools play a key role in the everyday tasks of technicians. Hand Tools features skills-based curriculum delivered through seventeen activities in which students learn all aspects of using hand tools.

Hand Tools may be taught as a virtual module, delivered entirely online with interactive activities, or as a blended module with both virtual and hardware-based activities. A hardware package is available with all the tools covered in the activities.

Course Outline

- Shop Safety
- Rulers and Tape Measures
- How hand tools may be misused or abused
- Calipers and Feeler gauges
- Squares and Levels
- Knives
- Scribes and Punches
- Work Holding Devices
- Hammers
- Chisels
- Saws
- Pliers
- Cutters
- Files & Deburring Tools
- Drivers
- Hex Keys
- Wrenches
- Socket and Torque Wrenches

Return to Flow Chart

Lubrication for Technicians

23 hours of instruction

Description

Lubrication for Technicians conveys skills-based curriculum through virtual and hands-on activities.

Students learn about lubrication equipment, application methods lubrication schedules, special purpose greases, synthetic lubricants, packing bearings and more.

Course Outline

- Lubrication Fundamentals
- Lubrication Terms
- Identifying Lubricating Oils
- Identifying General Purpose Greases
- Identifying Special Purpose Greases
- Applying Lubricating Oils
- Applying Lubricating Greases
- Bearing Lubrication
- Setting Up a Lubrication Schedule
- Selecting Synthetic Lubricants
- Grease Guns
- Bearing Packers
- Grease Lubricators
- Drop Feed Oilers
- Electric Chain Oilers

Return to Flow Chart

Math for Technicians I

14 hours of instruction

Description:

Mathematics for Technicians I is designed to equip technicians with the math skills they are likely to need on a daily basis. Topics covered include arithmetic and algebra, types of numbers (whole numbers, fractions, and decimals), percentages, ratios and proportions, systems of measurement, geometry, and trigonometry

The curriculum conveys skills based math through nine virtual activities, providing students with fundamentals they will encounter in a variety of career and industrial environments.

Course Outline:

- Working with Arithmetic and Algebra
- Working with Whole Numbers
- Working with Fractions
- Working with Decimals
- Working with Percentages
- Working with Ratios and Proportions
- Working with Systems of Measurement
- Working with Geometry
- Working with Trigonometry

Return to Flow Chart

Math for Technicians II

14 hours of instruction

Description

Math for Technicians II applies advanced mathematics concepts to everyday tasks. Through interactive activities students learn about drive ratios, Ohm's Law, mechanical principles, and how these concepts apply in the engineering and industrial environments.

Course Outline

- Working with Conversion Formulas
- Applying Mechanical Principles
- Calculating Drive Ratios
- Calculating Speed Reducer Service Factor
- Using Ohm's Law in Series and Parallel Circuits
- Converting Binary, Binary Coded Decimal (BCD), Hexadecimal and Decimal Numbers
- Calculating Pressure, Force, Head and Flow
- Calculating Shim Requirements
- Selecting Pipe Size

Return to Flow Chart

Measurement & Quality

15 hours of instruction

Description

MMQC enables students to gain a solid foundation of knowledge and skill in performing measurements and calculations. Students use precision measurement tools, such as steel rule, tape measure, protractor, micrometer, height gauge, various calipers and dial indicators.

Students gain proficiency in reading mechanical drawings, in selecting the proper tools for inspecting parts and in preparing quality control/ inspection reports.

A separate hardware package is available with all the tools covered in the activities

Course Outline

- Accuracy, Precision and Measurement Tools
- Units of Measurement and Conversion
- Fractions, Decimals, and Rounding
- Scaled Measurement Tools
- Vernier, Dial, and Digital Calipers
- Micrometers
- Height Gauges and Dial Indicators
- Fixed Gauges
- Transfer Measurement Tools
- Statistical Analysis
- Statistical Process Control
- Nominal Dimensions and Tolerance
- Parts Inspection and Inspection Reports

Return to Flow Chart

Mechanical Blueprint Reading

18 hours of instruction

Description

Blueprint Reading delivers skills-based curriculum through virtual activities. Students learn all aspects of reading and interpreting blueprints in engineering and industrial environments, including views, tolerances, cutting planes, thread dimensions, and welding symbols.

Course Outline

- Identifying Lines and their Functions
- Single, Multiple and Auxiliary View
- Reading and Locating Blueprint Dimensions
- Determining Tolerances
- Identifying Thread Dimensions
- Identifying Tapers and Machine Surfaces
- Cutting Plane and Sections
- Geometric Dimensioning, Wear Limits and Assembly Drawings
- Identifying Welding Symbols
- Reading Plot Plans
- Reading Footing, Foundation and Floor Plans
- Reading Reinforced Concrete and Structural Steel Prints

Return to Flow Chart

Mechanical Fasteners

18 hours of instruction

Description

Mechanical Fasteners may be taught as a virtual module, delivered entirely online with interactive activities, or as a blended module with both virtual and hardware-based activities.

Through twelve activities, students identify and work with the many types of fasteners used in engineering and industrial environments. For blended lab applications, a separate hardware package is available with all the tools covered in the activities

Course Outline

- Screws and Bolts
- Threaded Fastener Selection
- Thread Standards
- Creating and Repairing Threads
- Nuts
- Torque Wrenches
- Bolt Extractor
- Washers
- Rivets
- Adhesives
- Hook and Loop Fasteners
- Cable Ties

Return to Flow Chart

OSHA 10 Training

10 hours of instruction

Description

If you're an entry-level worker, our OSHA 10-Hour Outreach General & Healthcare Industry course is your orientation to occupational safety and health. As part of OSHA's Outreach Training program to raise awareness about the safety measures under OSHA 29 CFR 1910, this course will help teach you how to improve workplace safety. You'll learn OSHA's best practices for reducing accidents and injuries, including fall protection, emergency evacuation plans, and the use of personal protective equipment. You'll also learn about the major hazards you might encounter in general industry work and solutions for recognizing, controlling, and protecting against them. This includes flammable and combustible substances, chemical and electrical hazards, and fire prevention

Course Outline

- Recognize the OSH Act, the functions and resources of OSHA
- Become aware of the OSHA inspection priorities and describe the inspection process
- Identify the rights and responsibilities of employers and employees under the OSH Act
- Discuss the major hazards associated with general industry work and how to avoid, protect or control them. This includes:
- Slips, trips, falls associated with walking and working surfaces
- Effective Egress and fire protection program
- Outline the general requirements for general safety standards
- Flammable and combustible liquids and gasses
- Hazards of chemicals
- Electrical hazards
- Recognize the value of personal protective equipment, usage and limitations
- Discuss the basic elements of a safety and health program

Return to Flow Chart

Power Tools

9 hours of instruction

Description

Power Tools play a key role in the everyday tasks of technicians. Power Tools delivers twelve skills-based activities, in which students learn all aspects of using power tools.

Power Tools may be taught as a virtual module, delivered entirely online with interactive activities, or as a blended module with both virtual and hardware-based activities. A separate hardware package is available with all the tools covered in the activities

Course Outline

- Shop Safety
- Power Drills
- Drill Presses
- Rotary Tools
- Jigsaws
- Reciprocating Saws
- Circular Saws
- Table Saws
- Bandsaws
- Sanders

Return to Flow Chart

Safety Fundamentals

15 hours of instruction

Description

Safety Fundamentals is one of the most important aspects of an industrial training program. This dedicated safety module explores all aspects of manufacturing and workplace safety with the objective of educating students about safety norms , procedures and laws.

Students will have a high level of regard for safety practices after completing this course

Course Outline

- Introduction to OSHA and Safety Responsibilities/
- Safety in the Workplace
- Personal Protective Equipment (PPE)
- Safety Procedures
- Production Team Training & Responsibilities
- Product Development
- Customer Service

Return to Flow Chart

Safety: Lockout/Tagout

9 hours of instruction

Description:

Lockout/Tagout procedures are critical in creating a safe work environment. Lockout Tagout delivers skills-based curriculum through virtual and hands-on activities. Students learn all aspects of lockout/ tagout procedures in industrial environments.

Through interactive activities, students learn about lockout devices, conducting energy control analysis, performing lockout/tagout and more

Course Outline:

- Acquiring Lockout/Tagout Basics
- Attaching Lockout Devices
- Completing and Attaching Tagout Devices
- Conduct energy control analysis
- Perform lockout/tagout procedure
- Perform lockout/tagout release

Return to Flow Chart

Electrical Circuits

21 hours of instruction

Description

Electrical Circuits (EA01A) introduces students to concepts including lockout/tagout and safety; connecting circuits and measuring electrical quantities like voltage and current. The skills-based curriculum includes a digital multimeter and five Flexponent™ panels.

Course Outline

- Lockout/Tagout
- Connecting a Basic Circuit
- Identifying Switches
- Connecting a Momentary Switch
- Connecting a Toggle Switch
- Identifying Sources of Electricity
- Measuring DC Voltage
- Constructing a Series Circuit
- Constructing a Parallel Circuit
- Applying DC Voltage Principles
- Testing an Electrolytic Cell
- Testing a Battery
- Testing a Thermocouple
- Testing a Solar Cell

Return to Flow Chart

LCR Circuits

15 hours of instruction

Description

LCR Circuits (EA01C) teaches the relationships between electrical properties such as inductance, capacitance and reactance. The skills-based curriculum builds on concepts learned in the prerequisite Resistors and Conductors (EA01B) course. Using the same components they will find in industrial environments, including relays, contactors, capacitors and inductors, students learn to determine capacitance, assemble an electromagnet, induce voltage and operate transformers.

Course Outline

- Discharge a Capacitor
- Testing a Capacitor
- Determining Capacitance
- Applying Capacitance Principles
- Applying Magnetic Principles
- Inducing a Magnetic Field
- Assembling an Electromagnet
- Applying Electromagnetic Principles
- Inducing Voltage
- Inducing DC Voltage
- Assembling and Operating Transformers

Return to Flow Chart

Motors & Generators

15 hours of instruction

Description

Motors and Generators (EA01D) delivers a complete understanding of phase relationships and the practical operation of motors and generators through activities including operating AC and DC generators, operating a series motor and demonstrating reactance and impedance. The skills-based curriculum builds on concepts learned in the prerequisite LCR Circuits (EA01C) course. Motors and Generators (EA01D) adds interactive content for eight additional hands-on activities using the Basic Power Electricity equipment.

Course Outline

- Operating a PMDC Motor
- Operating a DC Generator
- Operating an AC Generator
- Operating a Series Motor
- Reactance and Impedance
- Applying Phase Relationship Principles

Return to Flow Chart

Oscilloscope & Mutli Meter

41 hours of instruction

Description

Oscilloscope (EB01A) guides students through hands-on activities using industrialgrade test equipment. Students gain essential skills in the function and operation of an oscilloscope including identifying oscilloscope controls, adjusting probe compensation, and measuring AC voltage and frequency with an oscilloscope. The skills-based curriculum presents hands-on activities using an industrial grade oscilloscope as well as electrical components.

Using an industrial grade digital multimeter as well as components on the two included Flexponent™ panels, students gain essential skills in the function and operation of a digital multimeter. Digital Multimeter (EB01B) presents hands-on activities in a skills-based format covering safety, measuring voltage and resistance, testing grounds and more

Course Outline

- Reading the Oscilloscope Screen
- Identifying Oscilloscope Controls
- Setting Up and Operating the Oscilloscope
- Adjusting Probe Compensation
- Performing AC Voltage Calculations
- Measuring AC Voltage and Frequency
- Performing DC Voltage Calculations
- Measuring DC Voltage
- Digital Multimeter Safety
- DMM Controls and Features
- Locating and Reading DMM Icons and Symbols
- Reading the Liquid Crystal Display
- Setting Up the DMM for Reading AC Voltage
- Measuring AC Voltage
- Calculating & Converting AC Voltage
- Measuring DC Voltage
- Measuring Resistance
- Discharging a Capacitor
- Measuring Capacitance
- Testing Capacitors
- Measuring Current
- Measuring DC Millivolts
- Performing Continuity Tests
- Testing Grounds and Bonds
- Measuring Frequency

Return to Flow Chart

Resistors & Conductors

15 hours of instruction

Description

Resistors and Conductors (EA01B) teaches circuit troubleshooting and testing skills including measuring resistance, calculating wire size and determining losses in a wire. The hands-on activities use industrial-grade resistors, potentiometers, rheostats and coils

Course Outline

- Measuring Resistance
- Measuring Resistance in Series Circuits
- Measuring Resistance in Parallel Circuits
- Drawing and Reading Resistor Symbols
- Testing an Adjustable Resistor
- Measuring Wire Size
- Applying Resistance and Wire Size
- Calculating Wire Size
- Determining Losses in a Conductor

Return to Flow Chart

Engineering and Science Technologies Career Field
Manufacturing Operations
Subject Code: 175003
Outcome & Competency Descriptions

Course Description:
Students will learn the production processes applied across manufacturing operations. Students will be able to demonstrate a broad array of technical skills with an emphasis given to quality practices, measurement, maintenance and safety.

Strand 1. **Business Operations/21st Century Skills**
Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

Outcome 1.1. **Employability Skills:** Develop career awareness and employability skills (e.g. face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

Competencies
1.1.1. Identify the knowledge, skills, and abilities necessary to succeed in careers.
1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.
1.1.3. Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.
1.1.4. Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.
1.1.5. Develop strategies for self-promotion in the hiring process (e.g. filling out job applications, résumé writing, interviewing skills, portfolio development).
1.1.6. Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.
1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
1.1.8. Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.
1.1.9. Give and receive constructive feedback to improve work habits.
1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.
1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

Outcome 1.2. **Leadership and Communications:** Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

Competencies
1.2.1. Extract relevant, valid information from materials and cite sources of information.
1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal, and active listening skills to communicate effectively.
1.2.4. Use negotiation and conflict-resolution skills to reach solutions.
1.2.5. Communicate information (e.g. directions, ideas, vision, workplace expectations) for an intended audience and purpose.
1.2.6. Use proper grammar and expression in all aspects of communication.
1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
1.2.8. Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.
1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g. common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.
1.2.11. Write professional correspondence, documents, job applications, and résumés.
1.2.12. Use technical writing skills to complete forms and create reports.
1.2.13. Identify stakeholders and solicit their opinions.
1.2.14. Use motivational strategies to accomplish goals.

Outcome 1.3. **Business Ethics and Law:** Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

Competencies

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.
1.3.2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.
1.3.3. Use ethical character traits consistent with workplace standards (e.g. honesty, personal integrity, compassion, justice).
1.3.4. Identify how federal and state consumer protection laws affect products and services.
1.3.5. Access and implement safety compliance measures (e.g. quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], U.S. Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.
1.3.6. Identify deceptive practices (e.g. bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.
1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g. harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).
1.3.8. Verify compliance with computer, copyright, and intellectual property laws and regulations.
1.3.9. Identify potential conflicts of interest (e.g. personal gain, project bidding) between personal, organizational, and professional ethical standards.

Outcome 1.4. **Knowledge Management and Information Technology:** Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

Competencies

1.4.1. Use office equipment to communicate (e.g. phone, radio equipment, fax machine, scanner, public address systems).
1.4.2. Select and use software applications to locate, record, analyze, and present information (e.g. word processing, electronic mail, spreadsheet, databases, presentation, Internet search engines).
1.4.3. Verify compliance with security rules, regulations, and codes (e.g. property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to industry pathway.
1.4.4. Use system hardware to support software applications.
1.4.5. Use information technology tools to maintain, secure, and monitor business records.
1.4.6. Use electronic database to access and create business and technical information.
1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g. lists, calendars, address books).
1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.5. **Global Environment:** Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.

Competencies

1.5.1. Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent.
1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.
1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.
1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.
1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.
1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.
1.5.7. Use intercultural communication skills to exchange ideas and create meaning.
1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

Outcome 1.6. **Business Literacy:** Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

Competencies

1.6.1. Identify business opportunities.
1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g. risk vs. reward, reasons for success and failure).
1.6.3. Explain the importance of planning your business.

1.6.4. Identify types of businesses, ownership, and entities (i.e. individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit).
1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments, and interdepartmental interactions.
1.6.6. Identify the target market served by the organization, the niche that the organization fills, and outlook of the industry.
1.6.7. Identify the effect of supply and demand on products and services.
1.6.8. Identify the features and benefits that make an organization's product or service competitive.
1.6.9. Explain how the performance of an employee, a department, and an organization is assessed.
1.6.10. Describe the impact of globalization on an enterprise or organization.
1.6.11. Describe how all business activities of an organization work within the parameters of a budget.
1.6.12. Describe classifications of employee benefits, rights, deductions, and compensations.

Outcome 1.9. **Financial Management:** Use financial tools, strategies, and systems to develop, monitor, and control the use of financial resources to ensure personal and business financial well-being.

Competencies

1.9.1. Create, analyze, and interpret financial documents (e.g. budgets, income statements).
1.9.2. Identify tax obligations
1.9.3. Review and summarize savings, investment strategies, and purchasing options (e.g. cash, lease, finance, stocks, bonds).
1.9.4. Identify credit types and their uses in order to establish credit.
1.9.5. Identify ways to avoid or correct debt problems.
1.9.6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
1.9.7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
1.9.8. Identify income sources and expenditures.
1.9.9. Compare different banking services available through financial institutions.
1.9.10. Identify the role of depreciation in tax planning and liability.

Strand 2. **Electrical/Electronics**

Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

Outcome 2.1 **Electrical and Electronic Theory:** Explain electrical and electronic principles and theory.

Competencies

2.1.5. Compare alternating current (AC) and direct current (DC).

Outcome 2.2. **Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits.

Competencies

2.2.1. Compare conductors and insulators.
2.2.10. Analyze wiring schematics and diagrams for accuracy and function.

Outcome 2.3. **Codes and Regulations**: Explain and apply the National Electrical Code (NEC) and other building codes.

Competencies

2.3.1. Explain the role of Underwriters Laboratory (UL), Canadian Standards Association (CSA), and Intertek Testing Service/Edison Testing Laboratory (ITS/ETL).
2.3.2. Identify information in the National Electrical Code (NEC) and other applicable codes.
2.3.3. Apply applicable codes to installation of electrical equipment.

Outcome 2.8. **Power Supplies:** Provide power to electrical circuits.

Competencies

2.8.1. Identify the differences between transformer-powered supplies and line-connected supplies.
2.8.2. Select a battery based on composition, environment, and circuit characteristics.
2.8.3. Select and install filters.
2.8.4. Construct and install regulated power supplies.
2.8.5. Select and install fuses and circuit breakers.
2.8.6. Select and construct half-wave, full wave, and bridge rectifiers.
2.8.7. Select and install power conditioning, isolation transformers, surge suppressors, uninterruptible power supplies.

Strand 3. **Computer Integrated Manufacturing**

Learners apply the principles of computer integrated manufacturing related to computer numerical control, robotics, programmable logic controllers and power systems.

Outcome 3.4. **Power Technologies:** Install, maintain and troubleshoot power systems.

Competencies

3.4.1. Calculate the pressure and flow of a fluid and describe how it relates to the functioning of a hydraulic and pneumatic actuator.
3.4.2. Describe the relationship between force, pressure and power.
3.4.3. Calculate the efficiency of system components and energy loss due to friction, slippage, and leakage.
3.4.4. Determine the effect of energy storage on efficiency and size of power units.
3.4.5. Predict the performance of an actuator under meter-in and meter-out conditions.
3.4.6. Read and interpret hydraulic, pneumatic and vacuum schematics and model codes.

3.4.7. Select a fluid power system based on project needs (e.g. pressure, flow, temperature, dissipation, filtration, fluid, maintenance).
3.4.8. Explain the fundamental principles of pneumatics, hydraulics, and vacuum technology.
3.4.9. Troubleshoot power loss within a system.
3.4.10. Select an O-ring size, material, and oil capacity for a specified application.
3.4.11. Use directional and proportional controls.
3.4.12. Compare electromechanical, pneumatic and hydraulic actuation.
3.4.13. Perform general maintenance on pneumatics, hydraulics, and vacuum systems.
3.4.14. De-energize pneumatics, hydraulics, and vacuum systems.
3.4.15. Compare types and functions of compressors.

Outcome 3.5. Pumping Systems: Install, maintain, and troubleshoot pumps and pumping systems.

Competencies
3.5.1. Compare types of positive and nonpositive displacement pumps and their respective functions.
3.5.2. Calculate flow, head/pressure and efficiency.
3.5.3. Interpret pump curves.
3.5.4. Align precision and non-precision couplings.
3.5.5. Disassemble and assemble pumping stations.
3.5.6. Troubleshoot pump system failure conditions (e.g. cavitation).

Outcome 3.6. Mechanical Drives Systems: Install, maintain and monitor mechanical drives systems.

Competencies
3.6.1. Compare types of gears, couplings, belts and chains and describe their uses.
3.6.2. Perform shaft alignment on rotating equipment.
3.6.3. Select bearings for specific applications.
3.6.4. Calculate or obtain speed and torque ratios for belt and chain drives per design specifications.
3.6.5. Install and align power transmissions systems.

Strand 5. Pre-Engineering: Design and Development
Learners apply principles of design and development related to the design process, sketching and visualization, modeling, drafting, materials and production and process design.

Outcome 5.2. Sketching, Drawing, and Visualization: Conceptualize, sketch, and draw design projects and components.

Competencies
5.2.1. Compare technical sketching and drawing.
5.2.2. Sketch possible solutions to an existing design problem.
5.2.3. Apply tolerancing techniques when dimensioning.
5.2.4. Apply annotations on sketches and drawings.
5.2.5. Create sketches using integration sketching techniques and styles.
5.2.6. Apply coordinate systems (e.g. absolute, relative, user, cylindrical, Cartesian).

5.2.7. Sketch geometric forms and shapes.
5.2.8. Describe geometric constraints (e.g. geometric dimension and tolerancing [GD&T], run out, location, and form).
5.2.9. Select a view to graphically communicate a design solution.
5.2.10. Use reverse engineering to determine the strengths and weaknesses of a design.

Outcome 5.3. Computer-Aided Drafting and Modeling: Computer-aided Drafting and Modeling to illustrate the design of projects and components.

Competencies
5.3.1. Apply manufacturing processes to computer-aided modeling (e.g. casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).
5.3.2. Evaluate a sketch and generate a model utilizing three-dimensional modeling.
5.3.3. Compare conceptual, physical and mathematical design models used to check design.
5.3.4. Perform part manipulation during the creation of an assembly model.
5.3.5. Analyze assembly constraints and successfully construct an assembly drawing.
5.3.6. Use part libraries effectively during the assembly modeling process.
5.3.7. Employ subassemblies during the production of assemblies.
5.3.8. Verify drive constraints that simulate the motion of parts in assemblies.
5.3.9. Apply adaptive design concepts during the development of sketches, drawings, features, parts, and assemblies.
5.3.10. Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
5.3.11. Evaluate the accuracy of mass properties calculations.
5.3.12. Evaluate a model for design imperfections.
5.3.13. Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.
5.3.14. Create a sectional view drawing.
5.3.15. Illustrate the types of breaks and symbols used in drawing sectional views.
5.3.16. Produce a reverse-engineered drawing from a solid object.

Outcome 5.4. Materials: Select materials for design projects and components.

5.4.1. Compare advantages of materials used in manufacturing based on physical properties.
5.4.2. Identify the production processes used to create materials.
5.4.3. Determine the production processes used to create products from categories of materials (e.g. organic materials, metals, polymers, ceramics and composites).
5.4.4. Evaluate the types and magnitude of stresses and forces.
5.4.5. Analyze material properties by destructive and nondestructive tests.
5.4.6. Select materials for a given application based on specified criteria (e.g. cost, availability, manufacturability).

Outcome 5.5. Production and Process Design: Production, process design, and project management.

Competencies

5.5.1. Plan and apply manufacturing processes (e.g. casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).
5.5.2. Use process planning and improvement tools (e.g. flowcharts, diagrams, design for manufacturability [DFM]).
5.5.3. Identify the planning and process procedures for production (e.g. corrective preventive actions, audit documentation, Process Failure Mode Effect Analysis [PFMEA]).
5.5.4. Determine critical characteristics and establish quality controls.
5.5.5. Employ project scheduling techniques (e.g. critical path methodology [CPM], project evaluation and review technique [PERT]).
5.5.6. Identify criteria and constraints and determine how those will affect the design of the production process.
5.5.7. Estimate time, tooling, product packaging and material costs.
5.5.8. Monitor performance and compare to time, tool and material cost estimates.
5.5.9. Set capacity to account for fluctuation in demand.
5.5.10. Adjust the plan as necessary to respond to variations (e.g. process, demand, material).
5.5.11. Evaluate final solutions and communicate observations, processes and results.
5.5.12. Develop a packaging design that prepares a product for shipping.

Strand 6. Precision Machining

Learners apply principles of precision machining to measuring work pieces, drawing interpretation, inspection, bench work and layout, power saws, drilling machines, lathes and turning machines, milling machines and grinding machines.

Outcome 6.1. Measurement and Interpretation: Interpret drawings and documentation and perform measurements.

Competencies

6.1.1. Identify measuring tools and gradations used in precision machining and their purposes.
6.1.2. Identify typical measurements in precision machining (e.g. angles, diameter, hardness).
6.1.3. Identify measuring systems and convert between systems.
6.1.4. Identify information and symbols provided in drawings and specifications.
6.1.5. Measure and inspect work pieces according to product specifications.

Outcome 6.2. Layout and Planning: Plan a machining process.

Competencies

6.2.1. Determine product requirements, dimensions, and tolerances from drawing and specifications.
6.2.2. Determine process steps (e.g. cut, drill, turn, mill, grind, heat treat).
6.2.3. Plan individual process steps based on industry standards (e.g. manufacturer's specifications, machining standards).
6.2.4. Schedule machining equipment as required.

Outcome 6.8. **Maintenance:** Maintain tools and equipment in working condition.

Competencies

6.8.1. Identify equipment maintenance requirements in the equipment manufacturer's documentation.
6.8.2. Identify maintenance tasks required (e.g. inspecting, grinding, sharpening, dressing, lubricating, cleaning).
6.8.3. Verify measuring tool accuracy and recalibrate as needed.
6.8.4. Develop a preventive maintenance schedule.
6.8.5. Monitor equipment performance during use.
6.8.6. Repair or replace equipment and accessories as needed.

Strand 7. **Industrial Maintenance and Safety**

Learners apply principles of protection, prevention and mitigation to create and maintain safe working conditions at manufacturing sites. Knowledge and skills may be applied in all aspects of personal and site safety, including handling materials, using tools and equipment, working with and around electricity and using personal protective equipment.

Outcome 7.1. **Site Safety:** Handle materials, prevent accidents, and mitigate hazards.

Competencies

7.1.1. Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries, and labeling.
7.1.2. Identify and rectify or mitigate hazards associated with walking surfaces, working surfaces, and lighting.
7.1.3. Calculate example of load factors for constructing scaffolding, railings, ladders, and temporary structures.
7.1.4. Apply inspection, rejection criteria, hitch configurations, and load-handling practices to slings and rigging hardware.
7.1.5. Demonstrate proper use of American National Standards Institute (ANSI) hand signals.
7.1.6. Identify source of electrical and mechanical hazards and use shut down and established lock-out/tag-out procedures.
7.1.7. Identify and eliminate worksite clutter in accordance with standards for cleanliness and safety.
7.1.8. Identify procedures for handling, storage, and disposal of hazardous materials.
7.1.9. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms, and exits.
7.1.10. Select and operate fire extinguishers based on the class of fire.
7.1.11. Identify the components of a hazardous materials safety plan.
7.1.12. Create a hazardous materials safety plan.
7.1.13. Set up for ergonomic workflow.
7.1.14. Describe the interactions of incompatible substances when measuring and mixing chemicals.

Outcome 7.2. Personal Safety: Practice personal safety.

Competencies

7.2.1. Interpret personal safety rights according to the employee Right to Know plan.
7.2.2. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs, and reduces profits.
7.2.3. Select, use, store, maintain, and dispose of personal protective equipment (PPE) appropriate to job tasks, conditions, and materials.
7.2.4. Identify workplace risk factors associated with lifting, operating, and moving heavy objects and establish an ergonomics process.
7.2.5. Identify, inspect, and use safety equipment appropriate for task.
7.2.6. Use safe practices when working with electrical, mechanical, or other equipment.
7.2.7. Create and distribute training materials.
7.2.8. Safely operate manual, electrical-powered and pneumatic tools.

Engineering and Science Technologies Career Field
Robotics
Subject Code: 175004
Outcome & Competency Descriptions

Course Description
Students will apply the knowledge and skills necessary to program and operate robots, using the teach pendant as the main interface point. Students will learn robotic operations and system configurations. Students will code, compile and debug programs using the robotic programming language.

Strand 1. **Business Operations/21st Century Skills**
Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

Outcome 1.1. **Employability Skills:** Develop career awareness and employability skills (e.g. face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

Competencies
1.1.1. Identify the knowledge, skills, and abilities necessary to succeed in careers.
1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.
1.1.3. Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.
1.1.4. Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.
1.1.5. Develop strategies for self-promotion in the hiring process (e.g. filling out job applications, résumé writing, interviewing skills, portfolio development).
1.1.6. Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.
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1.1.8. Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.
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1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.
1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

Outcome 1.2. **Leadership and Communications:** Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

Competencies
1.2.1. Extract relevant, valid information from materials and cite sources of information.
1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal, and active listening skills to communicate effectively.
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1.2.8. Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.
1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g. common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.
1.2.11. Write professional correspondence, documents, job applications, and résumés.
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Outcome 1.3. **Business Ethics and Law:** Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

Competencies

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.
1.3.2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.
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1.3.8. Verify compliance with computer, copyright, and intellectual property laws and regulations.
1.3.9. Identify potential conflicts of interest (e.g. personal gain, project bidding) between personal, organizational, and professional ethical standards.

Outcome 1.4. Knowledge Management and Information Technology: Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

Competencies

1.4.1. Use office equipment to communicate (e.g. phone, radio equipment, fax machine, scanner, public address systems).
1.4.2. Select and use software applications to locate, record, analyze, and present information (e.g. word processing, electronic mail, spreadsheet, databases, presentation, Internet search engines).
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1.4.4. Use system hardware to support software applications.
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1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g. lists, calendars, address books).
1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.5. Global Environment: Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.

Competencies

1.5.1. Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent.
1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.
1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.
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Outcome 1.6. Business Literacy: Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

Competencies

1.6.1. Identify business opportunities.
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1.9.1. Create, analyze, and interpret financial documents (e.g. budgets, income statements).
1.9.2. Identify tax obligations
1.9.3. Review and summarize savings, investment strategies, and purchasing options (e.g. cash, lease, finance, stocks, bonds).
1.9.4. Identify credit types and their uses in order to establish credit.
1.9.5. Identify ways to avoid or correct debt problems.
1.9.6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
1.9.7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
1.9.8. Identify income sources and expenditures.
1.9.9. Compare different banking services available through financial institutions.
1.9.10. Identify the role of depreciation in tax planning and liability.

Strand 2. **Electrical/Electronics**

Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

Outcome 2.1 **Electrical and Electronic Theory:** Explain electrical and electronic principles and theory.

Competencies

2.1.1. Describe the structure of atoms and their relationship to electricity.
2.1.2. Compare electrical and electromagnetic effect.
2.1.3. Explain methods of producing electrical current.

2.1.4. Explain how batteries store and disperse energy.
2.1.5. Compare alternating current (AC) and direct current (DC).
2.1.6. Define the units of measurement for voltage, current, power and resistance.
2.1.7. Describe the relationships between voltage, current, resistance and power in circuits.
2.1.8. Determine voltage, current, resistance and power in circuits using Ohm's Law, Kirchhoff's Law and Watt's Law.
2.1.9. Describe the purpose of grounding and common methods used for grounding.
2.1.10. Evaluate frequency and phase.
2.1.11. Identify methods of varying capacitance.
2.1.12. Calculate true power, apparent power, reactive power and power factor.
2.1.13. Determine impedance.
2.1.14. Compare peak (PK), root mean square (RMS) and average values.

Outcome 2.2. **Circuits:** Construct and analyze alternating current (AC) circuits and direct current (DC) circuits.

Competencies
2.2.8. Explain the uses of series, parallel and series-parallel circuits.
2.2.9. Construct and troubleshoot series, parallel and series-parallel circuits.
2.2.10. Analyze wiring schematics and diagrams for accuracy and function.

Outcome 2.3 **Codes and Regulations**: Explain and apply the National Electrical Code (NEC) and other building codes.

Competencies
2.3.1. Explain the role of Underwriters Laboratory (UL), Canadian Standards Association (CSA), and Intertek Testing Service/Edison Testing Laboratory (ITS/ETL).

Outcome 2.6 **Digital Electronics:** Create circuits to perform tasks and operations.

Competencies
2.6.6. Describe the purpose and operation of programmable logic devices (PLDs) and complex programmable logic devices (CPLDs).
2.6.7. Describe the purpose and use of asynchronous and synchronous counters.
2.6.9. Explain the purpose and use of a digital bus.
2.6.10. Explain the purpose and use of pulsers and logic probes.
2.6.11. Identify the numbering systems, codes, arithmetic operations, Boolean operations and simplification methods used in digital electronics.

Outcome 2.7 **Cabling and Wiring:** Connect components to construct low-voltage, data and communication systems using coaxial or fiber optic cables and twisted pair or balanced wires.

Competencies
2.7.1. Describe the types, purposes and uses of cables and wires.

2.7.2. Identify the construction, impedance characteristics, and use of cables and wires.
2.7.3. Explain how the characteristics of cables and wires cause impedance.
2.7.4. Select methods for splicing and terminating cables and wires.
2.7.5. Splice and terminate cables and wires.
2.7.6. Test cables and wires.

Outcome 2.8 Power Supplies: Provide power to electrical circuits.

Competencies
2.8.1. Identify the differences between transformer-powered supplies and line-connected supplies.
2.8.2. Select a battery based on composition, environment, and circuit characteristics.
2.8.4. Construct and install regulated power supplies.

Outcome 2.9. Motors and Power: Install motors, variable-frequency drives (VFD), and power wiring.

Competencies
2.9.9. Describe how programmable controllers can be used to control single speed motors and variable speed motor applications.

Strand 3. Computer Integrated Manufacturing
Learners apply the principles of computer integrated manufacturing related to computer numerical control, robotics, programmable logic controllers and power systems.

Outcome 3.1. Robotic Fundamentals: Apply robotics fundamentals.

Competencies
3.1.1. Identify the components of a robot system and explain their roles in the robot's operation cycle.
3.1.2. Maintain robot components and controllers.
3.1.3. Select type of industrial robot to meet specific applications.
3.1.4. Use job specifications to create programs for robot operations, sensors and feeder systems.
3.1.5. Plan, program and test a robot using teach pendant and simulation software.
3.1.6. Identify the robot's payload and identify the concepts of payload weight and moment of inertia to select an appropriate robot.
3.1.7. Use robot speed specifications to calculate estimated cycle times for sample tasks.
3.1.8. Direct robot to home position using absolute and incremental coordinates.
3.1.9. Compare robotic applications and processes (e.g. palletizing, vision, pick and place, welding).
3.1.10. Identify the robot's work envelope and apply the concepts of reach and articulation to evaluate whether a robot is suited to an application.
3.1.11. Analyze the performance and troubleshoot the operation of a robot.

Outcome 3.2. Robotics: Plan and operate robotics production processes.

Competencies
3.2.1. Perform controller startup and shutdown.

3.2.2. Operate a teach pendant and pendant menu.
3.2.3. Use coordinates and motion functions to execute robotic processes.
3.2.4. Identify and explain alarms, errors and recovery.
3.2.5. Select, display and run a robotic program (job).
3.2.6. Execute robotic programming including tool path commands.
3.2.7. Modify command positions (i.e. touching-up points).
3.2.8. Explain non-motion instructions (i.e. control instructions, arithmetic instructions and input/output instructions).
3.2.9. Compare robotic applications and processes (e.g. pick and place, welding).
3.2.10. Describe common end of arm tooling.
3.2.11. Select appropriate robot based on payload weight, moment and inertia.
3.2.12. Describe Cartesian space, the Right-Hand rule and how locations are represented in three-dimensional space.
3.2.13. Determine home position using absolute and incremental coordinates (e.g. fixed and floating zero).
3.2.14. Analyze the information contained in positional data.
3.2.15. Perform robot I/O analysis and manipulation.
3.2.16. Determine application suitability using work envelop, reach and articulation.

Outcome 3.7. Programmable Logic Controllers (PLCs): Program, install and monitor digital computers used for automation of electromechanical processes to perform tasks.

Competencies

3.7.1. Describe the use of Programmable Logic Controller (PLC) in manufacturing automation.
3.7.2. Identify programmable logic controller Programmable Logic Circuits (PLC) components.

Engineering and Science Technologies Career Field
Computer Integrated Manufacturing
Subject Code: 175006
Outcome & Competency Descriptions

Course Description
In this course, students will be introduced to all aspects of computer-integrated manufacturing. They will learn about robotics and automation, manufacturing processes, computer modeling, manufacturing equipment and flexible manufacturing systems.

Strand 1. **Business Operations/21st Century Skills**
Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

Outcome 1.1. **Employability Skills:** Develop career awareness and employability skills (e.g. face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

Competencies
1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.
1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.
1.1.3. Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.
1.1.4. Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.
1.1.5. Develop strategies for self-promotion in the hiring process (e.g. filling out job applications, résumé writing, interviewing skills, portfolio development).
1.1.6. Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.
1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
1.1.8. Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.
1.1.9. Give and receive constructive feedback to improve work habits.
1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.
1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

Outcome 1.2. **Leadership and Communications:** Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

Competencies
1.2.1. Extract relevant, valid information from materials and cite sources of information.
1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal, and active listening skills to communicate effectively.
1.2.4. Use negotiation and conflict-resolution skills to reach solutions.
1.2.5. Communicate information (e.g. directions, ideas, vision, workplace expectations) for an intended audience and purpose.
1.2.6. Use proper grammar and expression in all aspects of communication.
1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
1.2.8. Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.
1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g. common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.
1.2.11. Write professional correspondence, documents, job applications, and resumes.
1.2.12. Use technical writing skills to complete forms and create reports.
1.2.13. Identify stakeholders and solicit their opinions.
1.2.14. Use motivational strategies to accomplish goals.

Outcome 1.3. **Business Ethics and Law:** Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

Competencies

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.
1.3.2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.
1.3.3. Use ethical character traits consistent with workplace standards (e.g. honesty, personal integrity, compassion, justice).
1.3.5. Access and implement safety compliance measures (e.g. quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], U.S. Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.
1.3.6. Identify deceptive practices (e.g. bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.
1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g. harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).
1.3.8. Verify compliance with computer, copyright, and intellectual property laws and regulations.
1.3.9. Identify potential conflicts of interest (e.g. personal gain, project bidding) between personal, organizational, and professional ethical standards.

Outcome 1.4. **Knowledge Management and Information Technology:** Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

Competencies

1.4.1. Use office equipment to communicate (e.g. phone, radio equipment, fax machine, scanner, public address systems).
1.4.2. Select and use software applications to locate, record, analyze, and present information (e.g. word processing, electronic mail, spreadsheet, databases, presentation, Internet search engines).
1.4.3. Verify compliance with security rules, regulations, and codes (e.g. property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to industry pathway.
1.4.4. Use system hardware to support software applications.
1.4.5. Use information technology tools to maintain, secure, and monitor business records.
1.4.6. Use electronic database to access and create business and technical information.
1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g. lists, calendars, address books).
1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.5. **Global Environment:** Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.

Competencies

1.5.1. Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent.
1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.
1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.
1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.
1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.
1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.
1.5.7. Use intercultural communication skills to exchange ideas and create meaning.
1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

Outcome 1.6. **Business Literacy:** Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

Competencies

1.6.1. Identify business opportunities.
1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g. risk vs. reward, reasons for success and failure).
1.6.3. Explain the importance of planning your business.
1.6.4. Identify types of businesses, ownership, and entities (i.e. individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit).

1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments, and interdepartmental interactions.
1.6.6. Identify the target market served by the organization, the niche that the organization fills, and outlook of the industry.
1.6.7. Identify the effect of supply and demand on products and services.
1.6.8. Identify the features and benefits that make an organization's product or service competitive.
1.6.9. Explain how the performance of an employee, a department, and an organization is assessed.
1.6.10. Describe the impact of globalization on an enterprise or organization.
1.6.11. Describe how all business activities of an organization work within the parameters of a budget.
1.6.12. Describe classifications of employee benefits, rights, deductions, and compensations.

Outcome 1.9. **Financial Management:** Use financial tools, strategies, and systems to develop, monitor, and control the use of financial resources to ensure personal and business financial well-being.

Competencies
1.9.1. Create, analyze, and interpret financial documents (e.g. budgets, income statements).
1.9.2. Identify tax obligations
1.9.3. Review and summarize savings, investment strategies, and purchasing options (e.g. cash, lease, finance, stocks, bonds).
1.9.4. Identify credit types and their uses in order to establish credit.
1.9.5. Identify ways to avoid or correct debt problems.
1.9.6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
1.9.7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
1.9.8. Identify income sources and expenditures.
1.9.9. Compare different banking services available through financial institutions.
1.9.10. Identify the role of depreciation in tax planning and liability.

Strand 2. **Electrical/Electronics**

Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

Outcome 2.4 **Electronic Components:** Describe the functions and purposes of electronic components.

Competencies
2.4.3. Identify symbols for electronic components.

Outcome 2.5 Electronic Connections: Connect individual components into an electrical circuit.

Competencies
2.5.6. Combine components per wiring prints, schematics and block diagrams.

Outcome 2.6 Digital Electronics: Create circuits to perform tasks and operations.

Competencies
2.6.13. Design a schematic for a digital circuit.

Outcome 2.8 Power Supplies: Provide power to electrical circuits.

Competencies
2.8.1. Identify the differences between transformer-powered supplies and line-connected supplies.
2.8.2. Select a battery based on composition, environment, and circuit characteristics.
2.8.4. Construct and install regulated power supplies.

Outcome 2.9. Motors and Power: Install motors, variable-frequency drives (VFD) and power wiring.

Competencies
2.9.1. Identify types and components of single phase and three phase motors.
2.9.2. Interpret motor nameplate information and motor specifications.
2.9.3. Calculate motor loads.
2.9.4. Determine motor rotation needed for the installed load and explain the process for reversing rotation (i.e. three phase and single phase).
2.9.5. Interpret schematics and control diagrams for building a motor circuit.

Strand 3. Computer Integrated Manufacturing

Learners apply the principles of computer integrated manufacturing related to computer numerical control, robotics, programmable logic controllers and power systems.

Outcome 3.1. Robotic Fundamentals: Apply robotics fundamentals.

Competencies
3.1.1. Identify the components of a robot system and explain their roles in the robot's operation cycle.
3.1.3. Select type of industrial robot to meet specific applications.

Outcome 3.7. Programmable Logic Controllers (PLCs): Program, install, and monitor digital computers used for automation of electromechanical processes to perform tasks.

Competencies
3.7.1. Describe the use of Programmable Logic Circuits (PLC) in manufacturing automation.

Engineering and Science Technologies Career Field
Computer Integrated Manufacturing
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Strand 5. **Pre-Engineering: Design and Development**
Learners apply principles of design and development related to the design process, sketching and visualization, modeling, drafting, materials and production and process design.

Outcome 5.1. **The Design Process:** Use the engineering design process and quality assurance principles to analyze and solve design problems.

Competencies
5.1.1. Describe the role of research, development, and experimentation in design problem solving.
5.1.2. Conduct an investigation to identify customer needs, constraints, and criteria.
5.1.3. Develop multiple solutions and select an approach.
5.1.4. Develop a design proposal and make a model/prototype.
5.1.5. Evaluate and redesign a prototype using collected data.
5.1.6. Use process planning and improvement tools to manage the life cycle of a product.
5.1.7. Identify the potential concept and design flaws (e.g. concept model corrections, audit documentation using Design Failure Mode Effect Analysis [DFMEA]).
5.1.8. Compare design considerations for product recycling or disposal for the end of a product's life cycle.
5.1.9. Document progress and capture ideas during the development phase.

Outcome 5.2. **Sketching, Drawing, and Visualization:** Conceptualize, sketch, and draw design projects and components.

Competencies
5.2.1. Compare technical sketching and drawing.
5.2.2. Sketch possible solutions to an existing design problem.
5.2.3. Use tolerancing techniques when dimensioning.
5.2.4. Apply annotations on sketches and drawings.
5.2.5. Create sketches using integration sketching techniques and styles.
5.2.6. Apply coordinate systems (e.g. absolute, relative, user, cylindrical, cartesian).
5.2.7. Sketch geometric forms and shapes.
5.2.8. Describe geometric constraints.
5.2.9. Select a view to graphically communicate a design solution.

Outcome 5.3 **Computer-Aided Modeling:** Create models to illustrate the design of projects and components.

Competencies
5.3.1. Apply manufacturing processes to computer-aided modeling (e.g. casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).
5.3.2. Evaluate a sketch and generate a model utilizing three-dimensional modeling.
5.3.3. Compare conceptual, physical, and mathematical design models used to check proper design.
5.3.4. Perform part manipulation during the creation of an assembly model.
5.3.5. Analyze assembly constraints and successfully construct an assembly drawing.

5.3.6. Utilize part libraries effectively during the assembly modeling process.
5.3.7. Employ subassemblies during the production of assemblies.
5.3.8. Verify drive constraints that simulate the motion of parts in assemblies.
5.3.9. Apply adaptive design concepts during the development of sketches, features, parts, and assemblies.
5.3.10. Translate a three-dimensional drawing or model into corresponding orthographic drawing views.
5.3.11. Evaluate the accuracy of mass properties calculations.
5.3.12. Evaluate a model for design imperfections.
5.3.13. Create and interpret auxiliary views, orthographic projections, isometric drawings, oblique drawings, and perspective drawings.
5.3.14. Create a sectional view drawing.
5.3.15. Illustrate the types of breaks and symbols used in drawing sectional views.
5.3.16. Produce a reverse-engineered drawing from a solid object.
5.3.17. Add technical elements (e.g. parts lists, titles, finishes, tolerances, specifications, hidden surfaces) to drawings.

Outcome 5.4 Materials: Select materials for design projects and components.

Competencies
5.4.1. Compare advantages of materials used in manufacturing based on physical properties.
5.4.2. Identify the production processes used to create materials.
5.4.3. Determine the production processes used to create products from categories of materials (e.g. organic materials, metals, polymers, ceramics and composites).
5.4.4. Evaluate the types and magnitude of stresses and forces.
5.4.5. Analyze material properties by destructive and nondestructive tests.
5.4.6. Select materials for a given application based on specified criteria (e.g. cost, availability, manufacturability).
5.4.7. Analyze the strength of a design using simulation modeling software (e.g. finite element analysis).
5.4.8. Use a material and develop a product.

Outcome 5.5 Production and Process Design: Identify and evaluate production and process design.

Competencies
5.5.1. Plan and apply manufacturing processes (e.g. casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping, 3-D printing).
5.5.2. Use process planning and improvement tools (e.g. flowcharts, diagrams, design for manufacturability [DFM]).
5.5.3. Identify the planning and process procedures for production (e.g. corrective preventive actions, audit documentation, Process Failure Mode Effect Analysis [PFMEA]).
5.5.4. Determine critical characteristics and establish quality controls.
5.5.5. Employ project scheduling techniques (e.g. critical path methodology [CPM], project evaluation and review technique [PERT]).

5.5.6. Identify criteria and constraints and determine how those will affect the design of the production process.
5.5.7. Estimate time, tooling, product packaging and material costs.
5.5.8. Monitor performance and compare to time, tool and material cost estimates.
5.5.9. Set capacity to account for fluctuation in demand.
5.5.10. Adjust the plan as necessary to respond to variations (e.g. process, demand, material).
5.5.11. Evaluate final solutions and communicate observations, processes and results.
5.5.12. Develop a packaging design that prepares a product for shipping.

Strand 6. Precision Machining

Learners apply principles of precision machining to measuring work pieces, drawing interpretation, inspection, bench work and layout, power saws, drilling machines, lathes and turning machines, milling machines and grinding machines.

Outcome 6.1. Measurement and Interpretation: Interpret drawings and documentation and perform measurements.

Competencies

6.1.1. Identify measuring tools and gradations used in precision machining and their purposes.
6.1.2. Identify typical measurements in precision machining (e.g. angles, diameter, hardness).
6.1.3. Identify measuring systems and convert between systems.
6.1.4. Identify information and symbols provided in drawings and specifications.

Outcome 6.2. Layout and Planning: Plan a machining process.

Competencies

6.2.1. Determine product requirements, dimensions, and tolerances from drawing and specifications.
6.2.2. Determine process steps (e.g. cut, drill, turn, mill, grind, heat treat).
6.2.3. Plan individual process steps based on industry standards (e.g. manufacturer's specifications, machining standards).
6.2.4. Schedule machining equipment as required.

Outcome 6.5 Turning: Turn materials.

Competencies

6.5.1. Identify the type of material and turning required in product specifications.
6.5.2. Select turning machine, bit, chucks, speeds, and cutting fluids.
6.5.3. Configure the turning equipment.
6.5.4. Prepare work pieces for turning.
6.5.5. Turn the materials.
6.5.6. Inspect the work to meet requirements.

Outcome 6.6 Milling: Mill materials.

Competencies

6.6.1. Identify the type of material and milling required in product specifications.

6.6.2. Select milling machine, bit, chucks, speeds and cutting fluids.
6.6.3. Configure the milling equipment.
6.6.4. Prepare work pieces for milling.
6.6.5. Mill the materials.
6.6.6. Inspect and deburr the work to meet requirements.

Outcome 6.8 Maintenance: Maintain tools and equipment in working condition.

Competencies
6.8.1. Identify equipment maintenance requirements in the equipment manufacturer's documentation.
6.8.2. Identify maintenance tasks required (e.g. inspecting, grinding, sharpening, dressing, lubricating, cleaning).
6.8.3. Verify measuring tool accuracy and recalibrate as needed.
6.8.4. Develop a preventive maintenance schedule.
6.8.5. Monitor equipment performance during use.
6.8.6. Repair or replace equipment and accessories as needed.

Outcome 6.9. Computer Numerical Control (CNC): Apply standard practices of CNC operations and part inspection.

Competencies
6.9.1. Maintain CNC milling/turning machine components and controllers.
6.9.2. Plan a CNC production process for jobs in a machining cell.
6.9.3. Create and edit CNC programs (e.g. G-code, computer-aided manufacturing [CAM]) for milling/turning machine operations according to job specifications, dimensions, and tolerances.
6.9.4. Create a tool setup sheet.
6.9.5. Work from a process sheet and part print.
6.9.6. Set up and operate CNC milling/turning machines.
6.9.7. Monitor the operations of a machining cell and troubleshoot problems that arise.
6.9.8. Verify part quality against job specifications.

Career-Technical Credit Transfer (CT)²
Electrical Engineering Technology Career-Technical Assurance Guide (CTAG)
June 22, 2019

The following courses, indicated by a Career-Technical Articulation Number (CTAN), are eligible for post-secondary credit and transfer among Ohio's public secondary career-technical institutions and state institutions of higher education. The SCTAI alignment document with ODE competencies and post-secondary learning outcomes are available on the ODHE website at https://www.ohiohighered.org/sctai/ctags.

CTEET001 - DC Circuits (OET001)	**Credits: 3 Semester Hours**

Advising Notes:
To access post-secondary college credit for this CTAN, **secondary students** must:
• Students must matriculate to an institution of higher education with an approved or comparable program within 3 years of completing the approved secondary program.
• Students must successfully complete the **ODE course DC Electronic Circuits (175105)** with a **qualifying cut score of 61 or higher** on the End-of-Course examination from an approved high school program.
• Students must include proof of laboratory component with their submission.
• Students must complete the **pre-requisite requirement for College Algebra** at the matriculating institution.
  o Students will not receive post-secondary credit for DC Circuits until this pre-requisite is satisfied.
To access college credit for this CTAN, **adult career-technical students** from Ohio Technical Centers must:
• Successfully complete an approved Electronics (CT)² program at an Ohio Technical Center.
• Complete the **pre-requisite requirement for College Algebra** at the matriculating institution
  o Students will not receive credit for DC Circuits until this pre-requisite is satisfied.
For CTAG credit, please consult the TAG Rubric for DC Circuits developed by the OETEA. This document will help both instructors and students understand the level to which the CTAG learning outcomes shall be taught and understood.
	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.

CTEET002 - Digital Electronics (OET002)	Credits: 4 Semester Hours
Advising Notes: To access post-secondary college credit for this CTAN, **secondary students** must: • Students must matriculate to an institution of higher education with an approved or comparable program within 3 years of completing the approved secondary program. • Students must successfully complete the **ODE course [Digital Electronics (175007)]** with a **score of 56 or higher** on the End-of-Course examination. • Students must include proof of laboratory component with their submission. **For CTAG credit, please consult the TAG Rubric for Digital Electronics developed by the OETEA. This document will help both instructors and students understand the level to which the CTAG learning outcomes shall be taught and understood.**	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.
CTEET003 - Programmable Logic Controllers (OET022)	**Credits: 3 Semester Hours**
Advising Notes: To access post-secondary college credit for this CTAN, **secondary students** must: • Matriculate to an institution of higher education with an approved or comparable program within 3 years of completing the approved secondary program. • Successfully complete **ODE Course [Industrial Robotics (176025)** • Submitted course work must include proof of a laboratory component. To access college credit for this CTAN, **adult career-technical students** from Ohio Technical Centers must fulfill the following conditions: • Successfully complete an approved $(CT)^2$ program at an Ohio Technical Center. **For CTAG credit, please consult the CTAG Rubric for Programmable Logic Controllers developed by the OETEA. This document will help both instructors and students understand the level to which the CTAG learning outcomes shall be taught and understood.**	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.

Each CTAN identifies the learning outcomes equivalent or common to those taught in introductory technical courses. To receive credit under these agreements, the career-technical programs and the state institutions of higher education must document that their course content matches the learning outcomes in the CTANs.

Return to Pathway Chart

Requirements and Credit Conditions:

General Notes and Student Guidance:

1. The receiving institution must have a comparable program, major, or courses for the CTANs listed in this document. Approved programs can be found here.

2. Credits apply to courses in the specified technical area at Ohio's public institutions of higher education, if the institution offers courses in the specific technical area. In the absence of an equivalent course, and when the institution offers the technical program, the receiving institution will guarantee to grant and apply an equivalent credit value of the Career-Technical Articulation Number (CTAN) toward the technical requirements of the specific degree/certificate program.

3. A career-technical student seeking credit under the terms of this CTAG must enroll in the college and submit the verification form within three years of completing a career-technical education course.

4. A career-technical student who meets all eligibility criteria will receive the credit hour value for the equivalent course(s) as offered at the receiving state institution of higher education.

5. The admission requirements of individual institutions and/or programs are unaffected by the implementation of $(CT)^2$ outcomes.

6. The transfer of credit through this CTAG will not exempt a student from the residency requirements at the receiving institution.

CTEET001 - DC Circuits (OET001)	Credits: 3 Semester Hours

General Course Description: A detailed study of direct current electric circuits and related bilateral devices. This course covers DC fundamentals, the systems that use them, and the basic sources of DC electricity. Conventional and computer circuit analysis will be used. Includes hands-on labs.

Credits: 3 Semester Hours

Learning Outcomes:

1. * Demonstrate an understanding of, and application for, electrical components and quantities
2. * Define voltage, current, electrical resistance and power
3. * Utilize Ohm's Law and Kirchhoff's Laws to analyze circuits.
4. * Determine resistance, current, voltage, and power for series circuits, parallel circuits, and series-parallel circuits.
5. * Apply circuit theorems such as superposition, Thevenin's and Norton's theorems to the analysis of circuits.
6. * Employ mesh and/or nodal analysis techniques to analyzing circuits.
7. * Demonstrate an understanding of the properties of capacitors and their behavior under DC conditions.
8. * Demonstrate an understanding of the properties of inductors and their behavior under DC conditions.

Asterisk Indicates Essential Learning Outcomes

CTEET002 - Digital Electronics (OET002)	Credits: 3-4 Semester Hours

General Course Description: Principles and applications of digital systems. Emphasis placed on the study of combinational and sequential logic from a systems approach. Actual ICs and Programmable logic devices (PLDs) are used, as well as digital diming diagrams and waveforms. Includes hands-on labs.

Credits: 3-4 Semester Hours

Learning Outcomes:

1. * Demonstrate an understanding of and application for number systems, operations, and codes.
2. * Identify various types of Logic Gates and explain their truth tables.
3. * Utilize Boolean Algebra to describe and simplify digital logic circuits.
4. * Apply DeMorgan's theorem to simplify combinational logic circuits.
5. * Design combination logic circuits to meet specified system requirements.
6. * Demonstrate an Understand of and applications for Encoders / Decoders.
7. * Demonstrate an understanding of and applications for multiplexers/demultiplexers.
8. * Demonstrate an understanding of and applications for adders, subtractors, and Arithmetic Logic Units (ALUs).
9. * Explain the types of, operation of, and applications for flip-flops and related devices.
10. * Demonstrate an understanding of and applications for counters.
11. * Demonstrate an understanding of and applications for shift registers.
12. * Utilize and explain the types of memory and storage in digital circuits.
13. * Explain the development of and applications for Integrated circuit technologies.

Return to Flow Chart

Asterisk Indicates Essential Learning Outcomes

CTEET003 Programmable Logic Controllers (PLC) (OET022)	Credits: 3 Semester Hours

General Course Description: This course includes the principles and application of Programmable Logic Controllers including ladder logic, program control, data manipulation, math instructions, sequencers, shift registers, networking, PLC-mechanism interfacing and human-machine interfacing. Students will install, program, and document PLCs used in a variety of applications. The course will include advanced control circuits, advanced design of ladder and wring diagrams to meet a given set of criteria, PLC programming, development of a human-machine interface, and data transfer in PLC networks. Includes hands-on lab.

Credits: 3 Semester Hours

Learning Outcomes:

1. * Recall the history of control systems and Programmable logic controllers (PLCs).
2. * Explain and describe the use of number systems.
3. * Demonstrate use of ladder logic programming devices.
4. * Employ ladder logic use in control circuit design.
5. * Use addressing to control Input/Output (I/O) modules.
6. * Demonstrate the use of relays, contacts, coils, and timers.
7. * Demonstrate counters and sequencers.
8. * Demonstrate fundamental PLC programming (e.g. comparators, block transfers, I/O forcing).
9. * Demonstrate data transfer in PLC networks.

Asterisk Indicates Essential Learning Outcomes

Return to Flow Chart

Electrical Engineering Technology Panel Participants

Ayodele Abatan	Miami University	SCTAI Panel Lead Expert
Dave Barth	Edison Community College	SCTAI Panel Expert
Roger Diamond	Lorain County Community College	SCTAI Panel Expert
Dexter Hulse	University of Cincinnati	SCTAI Panel Expert
Steve Tornero	Stark State College	SCTAI Panel Expert
Linda Beale	University of Toledo	Item Writer
Tommy Hager	Washington State Community College	Item Writer
Dan Pack	Cuyahoga Community College	Item Writer
Cyndi Brill	Ohio Department of Education	Program Specialist
Linda O'Conner	Ohio Department of Education	Program Specialist
John Wiseman	Ohio Department of Education	Program Specialist
Rob Speckert	Ohio Department of Higher Education	SCTAI Special Coach
Jamilah Tucker	Ohio Department of Higher Education	Director of Career Technical Transfer Initiatives
Anne Skuce	Ohio Department of Higher Education	Senior Associate Director, SCTAI
Misty McKee	Ohio Department of Higher Education	Assistant Director, SCTAI
Jessi Spencer	Ohio Department of Higher Education	Administrative Coordinator, SCTAI

Career-Technical Credit Transfer (CT)²
Mechanical Engineering Technology Career-Technical Assurance Guide (CTAG)
August 16, 2019

The following courses, indicated by a Career-Technical Articulation Number (CTAN), are eligible for transfer among (CT)² approved courses and state institutions of higher education.

CTMET004 Manufacturing Processes (TAG course OET010)	**Credits: 3 Semester Hours**
Advising Notes: Students may access post-secondary credit for this CTAN by completing the following: • Successfully complete ODE course Manufacturing Operations (175003). • Matriculate to an institution of higher education with an approved or comparable course no later than 3 years after completing the approved secondary program. • Earn a passing score on the end of course exam. The score will be determined at the conclusion of field-testing at the end of the 2019-2020 academic year.	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.
CTMET005 Computer Aided Design/Drafting	**Credits: 3 Hours**
Advising Notes: In order to access post-secondary college credit for this CTAN, students must: • Matriculate to an institution of higher education with an approved or comparable program within 3 years of completing the approved program. • Successfully complete the **ODE course Computer Integrated Manufacturing (175006)** from an approved program and earn a qualifying score of 60 or higher on the end-of-course examination. **TAG course OET012**	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.
CTMET006 CNC Programming/Machining	**Credits: 3 Semester Hour**
Advising Notes: Students may access post-secondary credit for this CTAN by completing the following: • Successfully complete ODE course CNC (176007). • Matriculate to an institution of higher education with an approved or comparable course no later than 3 years after completing the approved secondary program. • Earn a passing score on the end of course exam. The score will be determined at the conclusion of field-testing at the end of the 2019-2020 academic year.	Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.

The CTAN identifies learning outcomes that are equivalent or common in introductory technical courses. For students to receive credit under these agreements, the career-technical secondary programs and the post-secondary institutions must document that their course content matches the learning outcomes in the CTAN.

Return to Pathway Chart

Requirements and Credit Conditions:

1. The receiving institution must have a comparable program, major, or courses that have been approved through submission to the Ohio Department of Higher Education $(CT)^2$ approval process for the CTANs listed in this document.
2. Credits apply to courses in the specified technical area at Ohio's public institutions of higher education, if the institution offers courses in the specific technical area. In the absence of an equivalent course, and when the institution offers the technical program, the receiving institution will guarantee to grant and apply an equivalent credit value of the Career-Technical Articulation Number (CTAN) toward the technical requirements of the specific degree/certificate program.
3. The applicant must provide proof to the receiving institution that she/he completed a course that has been approved through the $(CT)^2$ approval process and that she/he has passed the end-of-program assessment.
4. A career-technical student seeking credit under the terms of this CTAG must apply and be accepted to the college within three years of completing a career-technical education program.
5. A career-technical student who meets all eligibility criteria will receive the credit hour value for the comparable courses as offered at the receiving state institution of higher education.
6. The admission requirements of individual institutions and/or programs are unaffected by the implementation of $(CT)^2$ outcomes.
7. The transfer of credit, through this CTAG, will not exempt a student from the residency requirements at the receiving institution.

Public secondary career-technical students must complete a CTAN in the Engineering and Science Technology and Manufacturing Technology pathway to be eligible for credit under this CTAG. This pathway is outlined in the Ohio Department of Education's *Engineering and Science Technology and Manufacturing Career Field Technical Content Standards*.

CTMET004 (OET010) Manufacturing Processes | Credits: 3 Semester Hour

General Course Description: The focus of this course is to provide the student with an introduction to common major manufacturing processes. Students will study and gain practical experience in various manufacturing processes such as metrology, materials, heat-treating, machine operations, metal forming, extrusions, castings, welding, finishing, adhesion, fasteners, assembly, and applications of empirical data to determine speeds and feeds to optimize production efficiencies. Learning outcomes are achieved through various in-class and laboratory experiences.

Credits: 3 Semester Hours

Learning Outcomes:
Outcomes marked with an asterisk are essential and must be included in the course.

1. *Demonstrate an understanding of the interrelationships between material properties and manufacturing processes.
2. *Distinguish between different manufacturing processes such as forgings, extrusions, castings, forming, and finishing.
3. *Distinguish between different fabrication processes such as welding fasteners, and adhesives.
4. *Apply process parameters to optimize production efficiencies.
5. *Demonstrate appropriate safety procedures and methods in a manufacturing setting.
6. *Demonstrate proficiency in the use of measurement instruments.

Return to Flow Chart

CTMET005 CADD Computer Aided Drafting/Design (OET012)	Credits: 3 Semester Hours

General Course Description: This course introduces the student to the fundamental concepts used in creating computer-generated drawings using a commercial CAD software. Topics include coordinate systems, construction, text insertion, editing techniques, views, projections, display control inquiry techniques, dimensioning and use of part libraries in the creating of drawings and assemblies. Bill of materials will be generated from multi-sheet assemblies. Students will develop 3D objects using primitive solids and Boolean operations. Learning outcomes are achieved through various in class and laboratory experiences.

Learning Outcomes:

1. * Demonstrate proficiency of a commercial CAD system based on ASME (ANSI) Y14.5 or equivalent ISO standards.
2. *Create working drawings using orthographic projections, section views, and auxiliary views.
3. *Create detail drawings that include dimensions and tolerances.
4. *Create assembly drawings including bill of materials.
5. *Demonstrate a basic knowledge of 3D modeling.

Return to Flow Chart

Asterisk Indicates Essential Learning Outcomes

CTMET006 CNC Programming/Machining	Credits: 3 Semester Hour

General Course Description: This course introduces students to the fundamentals of manual programming for numerical control machines. Topics include CNC machine types, controls, safety, and coordinate measuring systems; speed and feed calculations; CNC tooling and fixturing; and programming CNC mills and lathes. Embedded CNC software is utilized for this course.

Credits: 3 Semester Hours
Learning Outcomes:
Outcomes marked with an asterisk are essential and must be included in the course.

1. *Explain and apply common formats and codes for manual programming.
2. *Create a manual CNC program.
3. *Explain and document setup procedures for CNC lathes and mills.
4. Troubleshoot a manual CNC program.
5. *Perform set-up procedures on a CNC machine.
6. *Make the part to print specifications.
7. Explain secondary manual programming techniques.
8. Explain and demonstrate height compensation, cutter compensation, and tooling offset.

Mechanical Engineering Technology Faculty Participation

Steven Sykes	Edison State Community College	Lead Expert
Ramona Anand	Lorain County Community College	Item Writer
Dave Barth	Edison State Community College	Exam Validator
John Hittepole	Edison State Community College	Exam Validator
Scott Laslo	Columbus State Community College	Item Writer
Robert Speckert	Miami University	Item Writer
Dan Wagner	North Central State College	Exam Validator

Allen Bradley-Rockwell PLC Train the Trainer

INSTRUCTOR: Drew Fuller, WCSCC RAMTEC

DATES: January 8th, 9th, & 10th
Three-day Instructor PLC Training
9:00AM – 3:00PM

LOCATION: Wayne County Schools Career Center
RAMTEC PLC Room
518 West Prospect Street
Smithville, OH 44677

COURSE OUTLINE:

Day 1 – Wednesday, Jan 8th

- Introductions and Facility tour. Review of safety procedures and emergency plans.

MICRO850

- Review Micro 850 books, PowerPoints, and CCW software.
- Review the supplied documentation that comes with the 850 workstation.
- Review the hardware configurations of the workstation.
- Students will be given a demonstration on a typical lesson and given time to work through the Communications Lab from the book.
- Students will be shown basic add-on hardware for enrichment to the course content such as sensors and lights.

Day 2 – Thursday, Jan 9th

INTRO TO AUTOMATION

- Review Intro to Automation books, PowerPoints, and Logix5000 software.
- Review the supplied documentation that comes with the Ferris Wheel workstation.
- Students will be given a demonstration on a typical lesson and given time to work through the Communications Lab from the book as a comparison to the lab on Day 1.
- Students will also be given time to gain experience with the demo station as it is typically expected to run with the supplied program.
- Students will be given extra content beyond what the course requirements expect, including; practice programming, lab exercises, and Rockwell manuals for troubleshooting and higher levels of equipment and software definition.

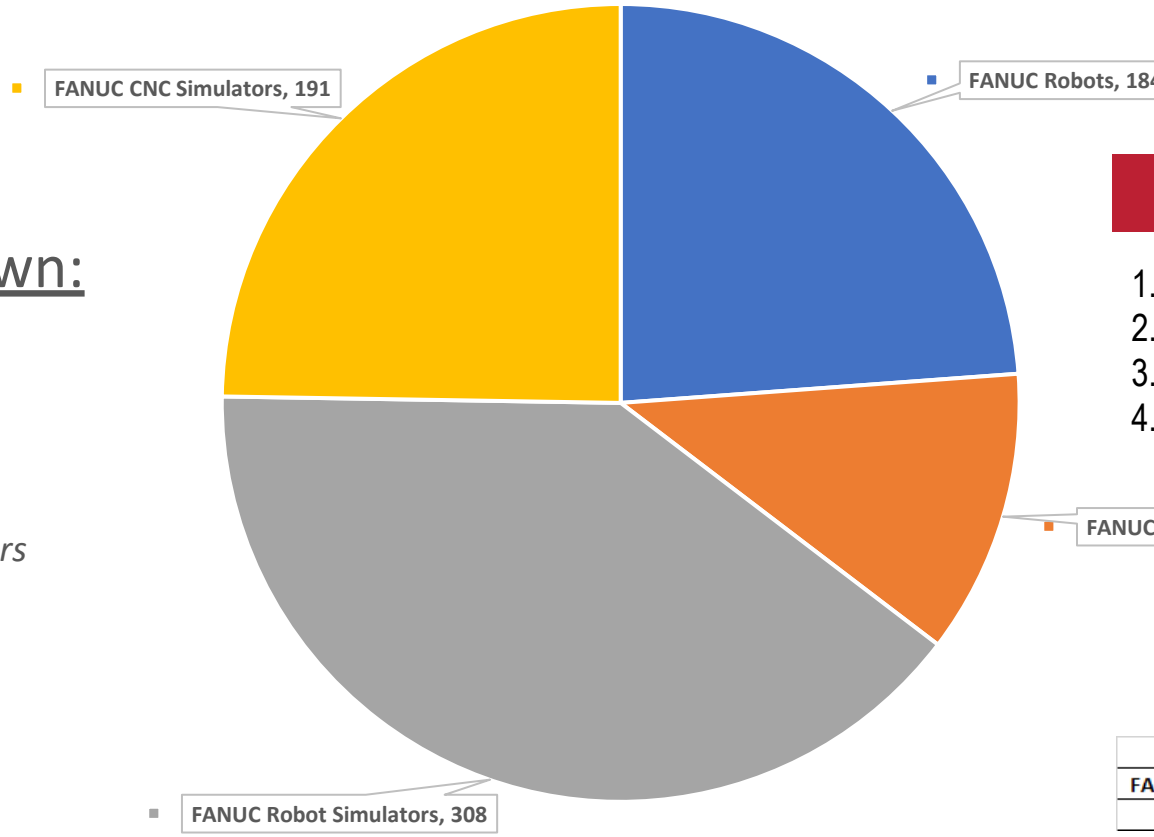
Day 3 – Friday, Jan 10th

AC/DC DRIVES

- Review AC/DC Drives books, PowerPoints, and add motor controls to the Logix5000 software.
- Review the supplied documentation that comes with the Ferris Wheel workstation as it pertains to the VFD.
- Students will be given a demonstration on a typical lesson and given time to work through a random lab from the book.
- Students will continue to work through higher levels of programming using IF-AND-OR-NOT-THEN logic.
- Time will be given for open discussions and questions for any RAMTEC related coursework.

I. Asset Mapping FANUC in Ohio: *EDU*

FANUC Robotics & CNC Technology Installations in Education in Ohio: High Schools, Career Centers, Community Colleges, Universities - 74 Total Institutions Consisting of:



Institution Breakdown:

- 24 RAMTEC Centers
- 21 High Schools
- 14 Community Colleges
- 15 Universities
  - ❖ *17 Ohio TechNet Centers*

Ohio | TechCred

Industry / Micro Credentials Achievable:

1. FANUC HandlingTool Operations & Programming*
2. FANUC 2D iRVision Operations & Programming
3. FANUC Machining, Setup, Operations, Programming*
4. FANUC Turning Setup, Operations, Programming*

14 Total ODE High School Graduation Points

RAMTEC

Breakdown of Assets at 24 RAMTECSites:

70	56	186	137
FANUC Robots	FANUC CNC	FANUC Robot Simulators	FANUC CNC Simulators
RAMTEC	RAMTEC	RAMTEC	RAMTEC

Integrated Systems Technologies

Return to Chart

I. Asset Mapping FANUC in Ohio: *Funding*

How was the foundation of FANUC robots and CNC assets funded to address entry level robotics and CNC training throughout education in Ohio?

STRAIGHT A FUND

RAPIDS Regionally Aligned Priorities in Delivering Skills

The U.S. Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT)

Local Industry Partnerships – Ex: Dana Corporation Donation to Owens Community College

C26 CTE State Equipment Funds

Post Secondary General Funds

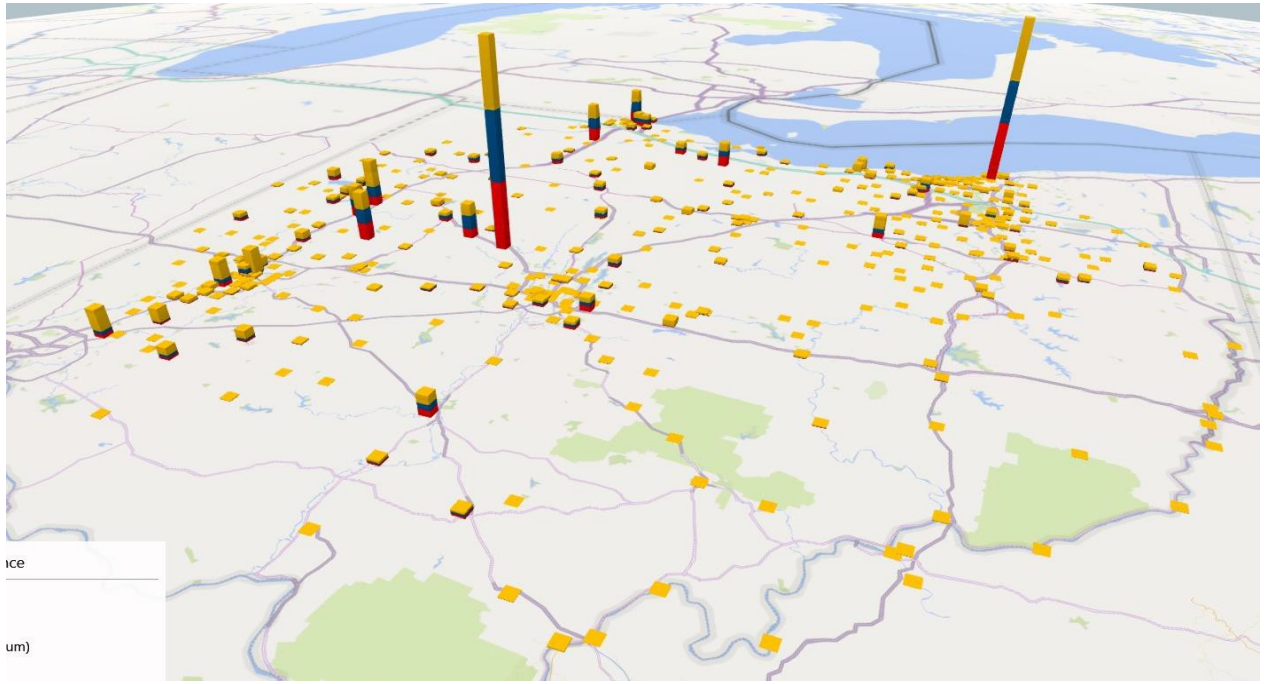
Return to Chart

I. Asset Mapping FANUC in Ohio: *Industry*

FANUC

FANUC America, Rockwell Automation, Cisco & Lincoln Electric in Ohio (Data Not Shown)

Today's Advanced Manufacturing is Integrated and Connected Smart Manufacturing ™



Ohio Industrial Install Base:	
CNC	More than 12,750 installations
Robot	More than 13,300 installations
Grand Total	More than 26,050 installations

Return to Chart

FANUC Rockwell Automation cisco LINCOLN ELECTRIC

IST Integrated Systems Technologies