NORCO COLLEGE

Program Review - Overall Report

2024 - 2027

Instructional: Electronics (ELE)

<div style="text-align: center; background-color: #6b8a92; color: white; padding: 8px;">2024 - 2027</div>

Overall Trends

What overall trends do you see in success, retention, program of study, educational planning, and awards over the past 3 or more years?

Discussing trends in success, retention, electronic programs of study, educational planning, and awards over the past few years involves exploring multiple dimensions of educational progress and technology adoption in learning institutions. Let's explore these trends based on general observations up to my last update in April 2023:

Success and Retention

- **Increased Focus on Personalization**: There's a significant shift towards personalized learning to improve student success and retention rates. Educational institutions are leveraging data analytics to tailor the learning experience according to individual student needs, preferences, and learning pace.

- **Integration of Support Services**: Schools and universities are integrating more support services (like tutoring, counseling, and career services) within their educational platforms to address barriers to student success and enhance retention.

- **Early Alert Systems**: The adoption of early alert systems, which use data analytics to identify students at risk of dropping out or failing, has become more common. These systems enable timely intervention to support students in need.

Electronic Program of Study

- **Growth of Online and Hybrid Programs**: The availability and acceptance of online and hybrid programs have significantly increased, offering more flexible pathways for students to complete their education. This trend has been accelerated by the COVID-19 pandemic, leading to a lasting impact on how programs are delivered.

- **Adaptive Learning Technologies**: There's a growing use of adaptive learning technologies in electronic programs of study. These technologies adjust the content and pace of learning based on the student's performance, thereby personalizing the learning experience.

- **Competency-Based Education (CBE)**: CBE allows students to progress through their program based on their ability to demonstrate competency in a subject area, rather than on the time spent in class. This approach has gained traction, particularly in online and adult education.

Educational Planning

- **Data-Driven Decision Making**: Institutions are increasingly using data analytics for educational planning, including curriculum development, student support services, and resource allocation. This trend helps in creating more effective and efficient educational environments.

- **Emphasis on Career Readiness**: Educational planning now often includes a stronger emphasis on career readiness, with programs designed to align closely with labor market demands. This includes integrating soft skills, such as communication and teamwork, into curricula.

Awards

- **Recognition of Non-Traditional Learning**: There's a growing recognition of non-traditional learning achievements, such as microcredentials and digital badges. These awards are increasingly seen as valuable supplements to traditional degrees, highlighting specific skills and competencies.

- **Focus on Equity and Inclusion**: Awards and recognitions are increasingly focused on promoting equity and inclusion, recognizing achievements and contributions from diverse student populations and underserved communities.

Overall, the trends indicate a shift towards more personalized, flexible, and technology-enhanced education that not only aims at academic success but also at long-term career readiness and inclusivity. These trends are likely to continue evolving as technology advances and as educational institutions seek to respond to the changing needs of students and the labor market.

Please add any relevant documents here.

Disaggregated Student Subgroups

Look at the disaggregated student subgroups in success, retention, program of study, educational planning, and awards for your area. Are there any equity gaps that you will address in the next 3 years?

To proceed with analyzing disaggregated student subgroups in success, retention, program of study, educational planning, and awards, please upload the electronic file containing the relevant data. This file should include detailed information on student outcomes broken down by subgroups (e.g., race/ethnicity, gender, socioeconomic status) to enable a thorough analysis. Once you've uploaded the file,

current plan is to continue working with Elctronic Pathways to recruit female students as well as other disproportionate demographics through partnerships, and events.

If there are any concerning trends over the past 3 or more years, or if equity gaps exist, what is your action plan to address them?

Addressing concerning trends or equity gaps in educational outcomes over the past three years involves a strategic, data-informed approach

- **Comprehensive Analysis**: Conduct a thorough analysis of disaggregated data over the past three years to identify trends and gaps in success, retention, program of study, educational planning, and awards among different student subgroups.

- **Identify Patterns**: Look for patterns of underperformance, decreased retention, or other indicators of inequity affecting specific groups.

- **Identify Contributing Factors**: Use the data and stakeholder feedback to identify institutional, systemic, and external factors contributing to equity gaps.

- **Focus Areas**: Prioritize areas where interventions could have the most significant impact.

- **Pilot Programs**: Start with pilot programs to test the effectiveness of new strategies on a smaller scale before wide-scale implementation.

- **Resource Allocation**: Ensure adequate resources are allocated for the implementation of strategies, including staffing, training, and financial support.

- **Establish Metrics**: Define clear metrics for success and regularly monitor these metrics to evaluate the impact of interventions.

- **Adjustments**: Be prepared to make adjustments based on what is working or not working. Continuous improvement should be a key part of the strategy.

- **Regular Updates**: Keep the campus community informed about progress and challenges in addressing equity gaps.

- **Celebrate Successes**: Acknowledge and celebrate progress and successes, even small ones, to build momentum and support for ongoing efforts.

- **Ongoing Review**: Regularly review institutional policies and practices to ensure they support equity and do not inadvertently contribute to disparities.

- **Inclusive Excellence**: Strive for inclusive excellence in all aspects of the institution, from admissions to academic programming to campus life.

This action plan requires a commitment to equity and inclusion, a willingness to invest resources, and an openness to change based on evidence and feedback. The goal is to create a more equitable educational environment where all students have the opportunity to succeed.

Please add any relevant documents here.

EMP GOAL 1Expand college access by increasing both headcount and full-time equivalent students (FTES).

Program/Unit Goal
EMP GOAL 1
Goal Cycle
2024 - 2027
What are you doing now in support of this goal?
To expand college access and increase both headcount and full-time equivalent students (FTES) specifically in an Electronic program, various strategic actions can be undertaken. Here is a structured plan that outlines potential initiatives and actions, blending general strategies with specific approaches tailored to the Electronic program:

- **Curriculum Innovation**: Update the Electronic program's curriculum to reflect current industry trends, emerging technologies, and future skills demands. Incorporating cutting-edge topics like IoT (Internet of Things), wearable technology, and renewable energy systems can attract a broader range of students.

- **Industry Partnerships**: Forge partnerships with electronics companies and tech firms for internships, live projects, and mentorship programs. This not only enhances the program's practical appeal but also demonstrates a pathway to employment for prospective students.

- **Online and Hybrid Options**: Develop online and hybrid course offerings to increase accessibility for students who cannot attend campus due to geographical, financial, or time constraints. This is particularly relevant for working professionals seeking to upskill.

- **Flexible Scheduling**: Offer evening and weekend classes to accommodate working students and those with family commitments.

- **High School STEM Programs**: Collaborate with high schools to offer workshops, summer camps, or guest lectures that showcase the Electronic program and careers in electronics and technology.

- **Digital Marketing Campaigns**: Utilize social media, search engine marketing, and targeted email campaigns to reach potential students interested in electronics and technology fields. Highlighting program outcomes, such as employment rates and alumni success stories, can be particularly effective.

   .

Implementing these strategies requires a coordinated effort across various departments and stakeholders within the institution, including academic departments, admissions,

marketing, financial aid, and career services. By focusing on the unique aspects of the Electronic program and addressing \

What are your plans (3-year) regarding this goal?

To expand college access and increase both headcount and full-time equivalent students (FTES) in an Electronic program over a three-year period, a strategic plan with clear goals and actionable steps is essential. Here's a structured approach to achieving this objective:

Year 1: Foundation and Engagement

Goals:

- **Increase Enrollment**: Aim for a specific percentage increase in enrollment (e.g., 10% increase in headcount and FTES).

- **Enhance Program Visibility**: Develop and launch a comprehensive marketing campaign targeted at potential students.

- **Strengthen Industry Partnerships**: Establish or deepen at least five significant partnerships with key industry players for internships, scholarships, and job placements.

Actions:

- **Curriculum Review and Update**: Conduct a thorough review of the Electronic program's curriculum to ensure it aligns with current industry standards and emerging technologies.

- **Marketing Campaign Launch**: Utilize digital marketing, social media, and outreach to high schools and community colleges to promote the program.

- **Partnership Development**: Engage with electronics companies and related industries to develop partnerships that offer tangible benefits to students and the program.

Year 2: Expansion and Enhancement

Goals:

- **Diversify Student Intake**: Broaden the demographic and geographic diversity of the student body by targeting underrepresented groups and international students.

- **Implement Flexible Learning Options**: Fully implement online and hybrid course offerings to increase accessibility.

- **Launch Work-Integrated Learning Opportunities**: Formalize internship and co-op programs with industry partners.

Actions:

- **Recruitment Initiatives**: Expand recruitment efforts to target diverse populations through tailored marketing strategies and partnerships with organizations serving underrepresented communities.

- **Online and Hybrid Learning Development**: Invest in technology and faculty training to deliver high-quality online and hybrid courses.

- **Internship and Co-op Program Development**: Work closely with industry partners to create structured work-integrated learning opportunities for students.

Year 3: Consolidation and Growth

Goals:

- **Achieve Enrollment Targets**: Reach or exceed the targeted increase in headcount and FTES set in Year 1.

- **Student Success and Retention**: Improve student retention rates by a specific target (e.g., reduce dropout rates by 5%).

- **Enhance Employment Outcomes**: Increase the employment rate of graduates in the electronics field within six months of graduation by a specific percentage (e.g., 10% increase).

Actions:

- **Retention Strategies**: Implement academic support services, mentoring, and advising to support student success and retention.

- **Career Services Enhancement**: Enhance career services with more industry-specific job fairs, networking events, and career coaching tailored to the electronics sector.

- **Program Evaluation and Adjustment**: Conduct a comprehensive program evaluation to assess outcomes and areas for improvement. Adjust strategies based on feedback and data analysis to ensure continued growth and success.

Cross-Year Strategies:

- **Continuous Industry Engagement**: Regularly update industry partnerships and curriculum to keep pace with technological advancements.

- **Feedback Loops**: Establish robust mechanisms for collecting and acting on feedback from students, alumni, faculty, and industry partners.

- **Data-Driven Decision-Making**: Use data analytics to monitor progress towards goals, identify areas for improvement, and inform strategic decisions.

This plan aims to not only increase the headcount and FTES but also enhance the quality and relevance of the Electronic program, thereby improving student outcomes and aligning graduates with industry needs. Achieving these goals will require sustained effort, adaptability, and a commitment to excellence and innovation throughout the three-year period.

Please add any relevant documents here.

Mapping
Educational Master Plan (2020-2025): ( )
- 2025 Objective 1.4 - KPI 3 (Student Services):
- 2025 Objective 6.1 (Academic Affairs):
- 2025 Objective 6.3 (Student Services):
- 2025 Objective 6.6 (Student Services):
- 2030 Goal 1: Access:
- 2030 Goal 4: Professional Development:
- 2030 Goal 5: Workforce and Economic Development:
- 2030 Goal 9: Workplace/Employees:

Evidence

Evidence Date
02/18/2024

Please provide any assessment data or other evidence that supports this Program/Unit Goal.
Yes, the total count of graduates and also increaae headcounts with proposed layout.

Is there a resource request associated with this Goal?
Yes

If yes, please provide a short description.

Please add any relevant documents here.

EMP GOAL 3. Close all student equity gaps.

Program/Unit Goal
EMP GOAL 3. Close all student equity gaps.

Goal Cycle
2024 - 2027

What are you doing now in support of this goal?
Advertise the program through college social media.
 Develop ew course certificate and update the current oes.
 Offer online/Hybrid classes.
 Offer non-credit courses

What are your plans (3-year) regarding this goal?
The plan in the next three years is to increase partnerships throughout the region and hold additional events to inform, inspire and encourage underrepresented students to pursue Electronic degrees

Please add any relevant documents here.

Mapping
<u>Educational Master Plan (2020-2025):</u> ( )
- 2025 Objective 1.4 - KPI 3 (Student Services):
- 2025 Objective 3.5 - KPI 12 (Student Services):
- 2025 Objective 7.2 (Academic Senate):
- 2025 Objective 7.6 (Student Services):
- 2030 Goal 3: Equity:

Evidence

Evidence Date
02/18/2024

Please provide any assessment data or other evidence that supports this Program/Unit Goal.
yes, adding new trainer

Is there a resource request associated with this Goal?
Yes

If yes, please provide a short description.

Please add any relevant documents here.

2024 - 2027

1. Which equity-related professional development trainings have members of your area participated in to improve student learning, student support, and/or college support?

Anti-Racism Training:

2. What knowledge or skills/techniques have members in your area implemented from these trainings and what changes have you seen?

These workshops help participants recognize and challenge systemic racism within educational institutions. They often cover topics such as unconscious bias, microaggressions, and strategies for creating anti-racist policies and practices.

3. What additional equity-related professional development/trainings do you seek to better support your area?

Digital Equity and Accessibility: As technology becomes increasingly integral to education, training in digital equity and accessibility ensures that all students have equal access to digital resources and learning opportunities, regardless of their socioeconomic status, abilities, or other factors.

Please add any relevant documents here.

2024 - 2027

Are all your courses current (within four years)?

Yes

What percentage of your courses are out of date?

10% or less

If you have courses that are not current, are they in the curriculum process?

Yes

For out of date courses that are not already in progress of updating, what is your plan?

All the courses are up to date

Do you have proposals in progress for all the DE courses you intend to file?

Yes

Do you require help to get your courses up to date?

No

Please add any relevant documents here.

Rad

Date

11/03/2023

Observation

What did you notice?

every thing map

Course(s)

ELE 10

SLO(s)

Demonstrate quantitative measurement of electrical circuit parameters in direct current (DC) and alternating current (AC) series, parallel, and series-parallel circuits.

Discussion/Analysis

Please paste any relevant screenshots here.

Please add any relevant documents here.

Electronic

Resource Year
2024 - 2027

What resources do we already have?
Multisim software and PSpice 25 License load in 202 room. Also, Transformers (30) and other peripherals to support the courses. All Electronics class also needs annual replenishment supplies for our student lab kits and replenishment of used stock from out inventory. New computer for Room 202.We also need For ELE 11 and ELE 13 DC and AC Power Supplies . 20 PCB machine to make PCB . 20 PCB software for IT 202 Computer . Desk DMM 20 for tio 202 room

What resources do you need?
New software for ELE 28 and also PCB Design machine . ELE 13,ELE 11, ELE 10, need new Desk DMM 30 of them . ELE 25 need 30 set of IC . ELE 76 need part for new trainer
Release time for single faculty discipline to help revise ELE biomacal Programs

$ Amount Requested
65,980

Resource Type
ITEM: Instructional Supplies

Please summarize how this request supports one or more EMP Goals, Equity goals, your program plans or goals, and/or is supported by outcomes assessment data.
EMP GOAL 7,EMP Goal 3,EMP Goal 5

This request for my area is Priority #:
1

Is this request
New

Mapping
Instructional: Electronics (ELE): (.)
- EMP GOAL 1Expand college access by increasing both headcount and full-time equivalent students (FTES).: .
- EMP GOAL 3. Close all student equity gaps.: .

Faculty Professional Development Requests

Faculty Hiring Resource Requests

2024 - 2027

Program Review Reflections

What would make program review meaningful and relevant for your unit?

1. **Focus on Continuous Improvement**: The program review process should emphasize continuous improvement rather than compliance. It should encourage a culture of ongoing assessment and adaptation, where feedback leads to actionable strategies for enhancement.

2. **Flexibility and Responsiveness**: The review process should be flexible enough to adapt to changing educational landscapes, student needs, and industry demandsV By focusing on these elements, a program review can be both meaningful and relevant, driving improvements that enhance educational quality, ensure program relevance, and ultimately contribute to the success of students and the broader objectives of the unit or institution.. This ensures the program remains relevant and effectively prepares students for the future.

What questions do we need to ask to understand your program plans, goals, needs?
What types of data do you need to support your program plans, goals, needs?
If there are any supporting documents you would like to attach, please attach them here.

Submission

All parts of my Program Review have been completed and it is ready for review.

Equipment Required
For
SACA C-101 Certified Industry 4.0 Associate-Basic Operations Credential

Note: This equipment is required to support the C-101 standards and the associated Gold certification assessment. Some of the equipment required for this credential is common to certain SACA Specialist credentials. The component details for this equipment can be found in the Required Equipment document for each specialist credential listed in parentheses. The components for equipment which is not in common to any specialist credentials are detailed in this document.

Equipment Required Common to Specialist Credentials

- (1) AC/DC Training Workstation (same as C-201 requirement)
- (1) Electrical Relay Training Workstation (same as C-205 requirement)
- (1) Electronic Sensors Training Workstation (same as C-205 requirement)
- (1) Pneumatic Training Workstation (same as C-209 requirement)
- (1) Cloud-Based Visual Communications Software (same as C-211 requirement)

Additional Equipment not Common to Specialist Credentials

- (1) Automation Training Workstation with the following:
    - PLC control with master control relay and on/off switch
    - Human Machine Interface with production screens
    - Electro-pneumatic actuators with stroke adjustments
    - Electronic Sensors with photoelectric, magnetic reed, and inductive
    - Industrial limit switch with adjustable arm
    - Vacuum Lift Pick up device
    - Lockout/tagout
    - Machine Guard with safety switch
    - AC Drive with motor that can switch out from v-belt to chain with adjustable base
    - Industrial process such as buffing
    - Pillow block bearings and shafts with Zerk fitting and grease gun
    - Electro-pneumatic powered feeder system
    - Unmanaged Ethernet Switch
    - Hand Tools: screwdrivers, wrenches, hex keys
    - System has ability to sequence movement of parts from feeder to industrial process, parts inspection, sorting and storage with multi-axis system control
    - System has ability to communicate via Ethernet with cloud-based visual communications software.
- (1) Robot Simulation Software with the following capability:
    - Execute robot sequence programs
    - Develop robot sequence programs
    - Teach points in a 3D workspace
    - Provide pre-developed workspace scenes
- (1) Measurement Workstation with the following:
    - Tape Measure

Version 2

Date 1-19-2022

- Machinist Rules: decimal, metric, and inch-fraction
- Dial Caliper and Micrometer, English and metric
- Circular and Rectangular Workpieces with good and bad tolerances.

Version 2

Date 1-19-2022

SACA
SMART AUTOMATION CERTIFICATION ALLIANCE

Equipment Required
For
SACA C-102 Certified Industry 4.0 Associate-Advanced Operations Credential

Note: This equipment is required to support the C-101 standards and the associated Gold certification assessment. Some of the equipment required for this credential is common to certain SACA Specialist credentials. The component details for this equipment can be found in the Required Equipment document for each specialist credential listed in parentheses. The components for equipment which is not in common to any specialist credentials are detailed in this document.

Equipment Required Common to Specialist Credentials

- (1) Electrical Relay Training Workstation (same as C-205 and C-101 requirement)
- (1) Electronic Sensors Training Workstation (same as C-205 and C-101 requirement)
- (1) Pneumatic Training Workstation (same as C-209 and C-101 requirement)
- (1) Automation Training Workstation (same as C-101 requirement)
- (1) Robot Simulation Software (same as C-101 requirement)
- (1) Ethernet Network System (same as C-212 requirement)

Additional Equipment not Common to Specialist Credentials

Hydraulics Training Workstation with the following:
- Capabilities: All components should be equipped with quick connect fittings to enable setup of a variety of hydraulic circuits.
- Quick connect hose set
- Hydraulic Power Unit with pump, motor, on/off control
- Directional Control Valve, 3-position, closed center
- (2) Cylinders, double-acting
- (2) Check Valves
- (2) Flow Control Valves
- Needle Valve
- Relief Valve
- Sequence Valve
- Pressure Reducing Valve
- Motor
- (3) Pressure Gages
- Flow Meter
- Cylinder Compressive Load Device
- Cylinder Friction Load Device

Servo Robot System with the following capability:
- Electric Servo Robot. 5 or 6 axis
- Program command set with digital inputs/output control commands, conditional branching commands, straight and point to point motion, math commands, point teaching, Cartesian coordinates, programmable speed, and variable commands

Version 2

Date 1-19-2022

- Repeatability: .20mm minimum
- Safety E-Stop
- Electro-pneumatic 2-point gripper
- Ethernet Communications Port
- Ethernet I/P Communications
-

Servo Robot Workcell Components:
- Set of Cylindrical Parts, for pickup by the robot. Parts should be capable of being fed by one of the two gravity feeders.
- Set of rectangular parts, for pickup by the robot. Parts should all be same size with several parts having a hole drilled halfway through and several having a hole drilled completely through. These parts should be able be fed to robot by one of the two gravity feeders.
- Gravity Feeders with limit switches, to feed rectangular and cylindrical parts to robot with limit switch to sense when feeder is empty.
- Push button and indicator light, to enable an input and an output to be wired to robot's digital inputs.
- Pallet Fixture, at least a 4x4 matrix that have recessed locations to locate rectangular parts
- Inspection Station with Limit Switch, a fixture with a recessed location for holding rectangular parts placed by the robot. The station should have a limit switch to sense presence and fixtures to hold an inductive sensor.
- Assembly Fixture, must have a Powered Pneumatic Clamp that can hold a cylindrical or rectangular part placed in fixture by robot. The fixture must have a 24 VDC solenoid valve that can be connected to be wired to a robot digital output to operate the clamp.
- Inductive Sensor, with mounting for inspection station, 24 VDC signal output compatible with digital inputs of robot.
- Servo Conveyor, belt type with DC motor and interface to servo robot as an additional axis.

CNC Simulation Software:
- Capable of 2D and 3D simulation
- G/M code programming, linear and circular commands

Mechatronics Pick and Place Inventory Station
- Function: to perform pick and place feeding using electro-pneumatic multi-axis manipulator and powered parts feeder controlled by a PLC
- Programmable Logic Controller (PLC) with digital inputs and outputs, 24VDC, Ethernet port
- PC-based programming software
- Vacuum Lift Parts Device
- 2-Axis Manipulator
- Electronic sensors on ends of travel of each axis, electro-pneumatic actuators
- Vacuum sensor
- Powered Parts Feeder, electro-pneumatic
- Parts Set
- Operator Station with pushbuttons, selector switch, and indicators

Version 2

Date 1-19-2022

Equipment Required
For
SACA C-103 Robot Systems Operations 1 Credential

Note: This equipment is required to support the C-103 standards and the associated Gold certification assessment

Functional Capabilities

The Robot System should include an industrial robot and workstation to enable demonstration of skills in setup and operation of industrial robots. The robot shall be a major industrial brand, FANUC or equivalent. The robot and workstation shall include the following components:

Industrial Robot

-6-Axis Servo Manipulator
-Teach Pendant
-Digital Inputs and Outputs
-Controller with On/Off Power Switch, and circuit protection
-Emergency Stop Pushbutton
-Electro-pneumatic 2-point gripper
-Ethernet Communications Port
-Ethernet I/P Communications

Workstation

-Robot mounting pad or plate
-Worksurface, steel or aluminum tooling plate
-Physical Guards around robot work envelope or laser scanner
-Connection Panel, for Ethernet and Digital I/O for connection to external devices
-DC Power Supply for I/O Devices
-Pneumatic filter/regulator with gauge

Version 1

Date 1-19-2022

Equipment Required
For
SACA C-104 Certified Industry 4.0 Associate-IIoT, Networking and Data Analytics

Note: This equipment is required to support the C-104 standards and the associated Gold certification assessment. Some of the equipment required for this credential is common to certain SACA Specialist credentials. The component details for this equipment can be found in the Required Equipment document for each specialist credential listed in parentheses. The components for equipment which is not in common to any specialist credentials are detailed in this document.

Equipment Required Common to Specialist Credentials

- (1) Automation Training Workstation (same as C-101 requirement)
- (1) Mechatronics Pick and Place Inventory Workstation (same as C-102 requirement)
- (1) Servo Robot (same as C-102 requirement)
- (1) Cloud-Based Visual Communications Software (same as C-211 requirement)
- (1) Ethernet Network System (same as C-102 and C-212 requirement)
- (1) Mechatronics PLC Cell Control (same as C-207 and C-208 requirement)

Additional Equipment not Common to Specialist Credentials

Mechatronics Inspection Station
- Function: to perform inspection of part size and sort good parts from bad parts. Parts that pass will be forwarded to the next station. Parts are received from a previous inventory station. System is controlled by a PLC.
- Programmable Logic Controller (PLC) with digital inputs and outputs, 24VDC, Ethernet port
- PC-based programming software
- Operator Station with pushbuttons, selector switch, and indicators
- Stepper motor and controller
- Index Table, driven by stepper motor
- Photoelectric sensor to sense part position
- Fork Sensor to inspect part size
- Failed parts bin
- Stacklight
- Parts Set, 3 types of parts and parts that fail part size inspection

Mechatronics Distribution Station
- Function: to perform sorting of parts traveling on a conveyor by color and material type. Parts will be sorted into 3 chutes. System is controlled by a PLC.
- Programmable Logic Controller (PLC) with digital inputs and outputs, 24VDC, Ethernet port
- PC-based programming software
- Operator Station with pushbuttons, selector switch, and indicators
- Inductive sensor to sense metal parts
- Thru-beam sensor to sense material type
- Retro-reflective sensor to sense part arrival to station from previous station

Version 2

Date 1-19-2022

- Electric solenoid actuator parts diverters for chutes
- Flat belt conveyor with DC motor drive
- (3) parts chutes
- Parts Set

Mechatronics Smart Sensors, Barcode and RFID Reader Station
- Function: to connect to a mechatronics station to read RFID tags or barcode labels attached to parts as they pass by on a conveyor and transmit data to a PLC to sort parts. Second function is to provide smart sensor monitoring of pressure and part presence. Smart sensors should transmit data via IO Link and Ethernet communications to a PLC.
- Flat belt conveyor with DC motor drive and motor contactor
- RFID Reader and RFID tag set
- Smart Photoelectric Sensor with IO Link communications
- Smart Analog Pressure Sensor with IO Link communications
- IO Link Master for Ethernet communications
- Barcode reader, automatic trigger, 1-line, serial port
- USB to Ethernet Server Converter Module and programming software (to convert barcode reader data to Ethernet)

Robot Mechatronics Station (with servo traverse axis)
- Function: to provide additional components necessary to integrate servo robot with the mechatronic distribution stations to perform pick and place removal of inventory and transfer to parts bins.
- Interface hardware between robot digital I/O and PLC
- Servo-controlled robot traverse axis
- Sensors in distribution chutes to sense parts presence, interfaced to robot

Manufacturing Software
- Function: PC based software that permits user to enter orders to the mechatronics system and initiate execution of manufacturing orders. The software shall communicate with a PLC via Ethernet network to control system operation and monitor operation. The software shall be able to monitor OEE and other production statistics and record to a database.
- PC-based Manufacturing Execution software
- SQL Server Database Software
- Microsoft Excel Software

Version 2

Date 1-19-2022

Equipment Required
For
SACA C-201 Electrical Systems 1 Credential

Note: This equipment is required to support the C-201 standards and the associated Gold certification assessment

Functional Capabilities

The electrical system should consist of the following components. Each component should have lead connections, which allows connection of multiple components to form circuits for various applications of electrical control, resistance, capacitance, and inductance.

Components

- (1) Power Supply, switchable to these voltages12VAC, 12VDC, 24VAC, 24 VDC
- (1) Industrial Pushbutton Switch
- (1) Industrial Selector Switch
- (1) Circuit Breaker Switch
- (1) DPDT Knife Switch
- (1) Control Relay, 24 VDC coil DPDT
- (1) Buzzer
- (1) Transformer
- (3) Lamps, 28 V
- (1) Fan – 24 VDC Motor
- (1) Solenoid
- (1) Circuit Tester
- (2) 25 Ohm Resistors
- (1) 10 Ohm Resistors
- (1) Rheostat
- (2) Electrolytic Capacitors
- (2) 220 Ohm-5 Watt Transformer Load Resistors
- (1) Set of Connection Leads
- (1) Neon Circuit Tester
- (1) Digital Multimeter
- (1) Fuse, 10A, replaceable
- (1) Fuses, 3A, Fast-Acting, replaceable

Version 2

Date 1-19-2022

Equipment Required
For
SACA C-202 Electric Motor Control Systems 1 Credential

Note: This equipment is required to support the C-202 standards and the associated Gold certification assessment

Functional Capabilities

The electric motor control system should consist of the following components. Each component should have lead connections, which allows connection of multiple components to form ladder logic and AC electric motor control circuits for various applications.

Components

(3) Indicator Lamps
(3) Pushbutton Switch, DPDT
(1) AC Motor, 3-phase Squirrel Cage Motor
(1) Motor Loading Device capable of tripping the overload
(1) Manual Motor Starter
(1) Reversing Motor Contactor
(2) Control Relays, DPDT
(1) Timer Relay, DPDT
(1) Selector Switch, DPDT
(1) Motor Overload Switch
(1) Limit Switch, DPDT
(1) Pressure Switch, DPDT
(1) Float Switch
(1) Drum Switch
(1) 3-phase On/Off Safety Switch
(1) Lockout/Tagout set
(1) Multimeter
(1) Lead Set

Version 2

Date 1-19-2022

Equipment Required
For
SACA C-203 Variable Frequency Drive Systems 1 Credential

Note: This equipment is required to support the C-203 standards and the associated Gold certification assessment

Functional Capabilities

The variable frequency drive system should consist of the following components. Each component should have lead connections, which allows connection of an AC variable frequency drive applications for manual control, 2-wire control, 3-wire control, Motor reverse, and programmed acceleration and deceleration.

Components

   (3) Pushbutton Switches
   (2) Indicator Lamps
   (1) AC Variable Frequency Drive with Volts/Hz Control mode, such as Rockwell 523 drive or higher
   (1) AC Motor, 3-phase Squirrel Cage Motor
   (1) Emergency Stop Circuit with Red Mushroom e-stop pushbutton
   (1) On/Off Safety Switch
   (1) Circuit Breaker
   (1) Digital Voltmeter or Multimeter
   (1) Tachometer
   (1) Lockout/Tagout set
   (1) Multimeter
   (1) Lead Set

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Equipment Required
For
SACA C-204 Electric Motor Control Troubleshooting 1 Credential

Note: This equipment is required to support the C-204 standards and the associated Gold certification assessment

Functional Capabilities

This credential requires a motor control system with the same capabilities as the equipment specified in credential C-202 and a variable frequency drive system with the capabilities of the equipment specified in the credential C-203. In addition, each system should have the capabilities to insert faults into the system to provide students with realistic troubleshooting.

The motor control system faults should include: relay coils, contacts, motor contactors, motor windings, power supply, manual switches, and automatic switches. The AC variable frequency drive faults should include: I/O faults and power supply faults.

Motor Control Components (same as those specified in C-202)

(3) Indicator Lamps
(3) Pushbutton Switch, DPDT
(1) AC Motor, 3-phase Squirrel Cage Motor
(1) Motor Loading Device capable of tripping the overload
(1) Manual Motor Starter
(1) Reversing Motor Contactor
(2) Control Relays, DPDT
(1) Timer Relay, DPDT
(1) Selector Switch, DPDT
(1) Motor Overload Switch
(1) Limit Switch, DPDT
(1) Pressure Switch, DPDT
(1) Float Switch
(1) Drum Switch
(1) 3-phase On/Off Safety Switch
(1) Lockout/Tagout set
(1) Multimeter
(1) Lead Set

AC Variable Frequency Drive Components (same as those specified in C-203)

(3) Pushbutton Switches
(2) Indicator Lamps
(1) AC Variable Frequency Drive with Volts/Hz Control mode, such as Rockwell 523 drive or higher
(1) AC Motor, 3-phase Squirrel Cage Motor
(1) Emergency Stop Circuit with Red Mushroom e-stop pushbutton
(1) On/Off Safety Switch
(1) Circuit Breaker
(1) Digital Voltmeter or Multimeter
(1) Tachometer
(1) Lockout/Tagout set
(1) Multimeter
(1) Lead Set

Version 2

Date 1-19-2022

**Equipment Required
For
SACA C-205 Sensor Logic Systems 1 Credential**

Note: This equipment is required to support the C-205 standards and the associated Gold certification assessment

Functional Capabilities

The sensor logic system should consist of the following components. Each component should have lead connections, which allows connection of multiple components to form ladder logic control circuits for various applications.

Components

- (2) Indicator Lamps
- (3) Pushbutton Switch, DPDT
- (1) Electric Motor, AC or DC
- (2) Control Relays, DPDT
- (1) Timer Relay, DPDT
- (1) Selector Switch, DPDT, 3-position
- (4) Limit Switch, SPDT
- (2) Solenoid Operated Pneumatic Valves, 5/2
- (2) Pneumatic cylinders, double-acting
- (1) On/Off Safety Switch
- (1) Lead Set
- (1) Power Supply
- (1) Capacitive Proximity Sensor
- (1) Hall-Effect Sensor
- (1) Inductive Proximity Sensor
- (1) Magnetic Reed Sensor
- (1) Photoelectric Switch
- (1) Indicator Lamp (LED with Internal Resistor)
- (1) Target set: wood, steel, aluminum, glass, magnet, and wood

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Equipment Required
For
SACA C-206 Electrical Systems Installation 1 Credential

Note: This equipment is required to support the C-206 standards and the associated Gold certification assessment

Functional Capabilities

The electrical system installation workstation should consist of the following components with these three industrial enclosures: Operator Panel, Control Panel, and Junction Box. Candidates will wire components using direct terminal connection and run wire between enclosures to form AC electric motor control relay circuits for various applications. All components should be either NEMA or IEC rated industrial standard components.

Enclosure #1: Operator Panel Components

- (3) Indicator Lamps, push-to-test type
- (2) Pushbutton Switch, DPDT
- (2) Pushbutton Switch, NC, E-Stop with mushroom head
- (1) Selector Switch, DPDT
- (1) Terminal Strip

Enclosure #2: Control Panel Components

- (1) Lockout/Tagout set
- (2) Forward/Reverse Contactors, 3-phase
- (4) Auxiliary Relays, DPDT
- (1) Timer Relay, DPDT
- (1) Motor Overload Relay
- (1) Control Transformer
- (1) Circuit Breaker
- (1) 3-phase Safety Disconnect Switch
- (1) Lockout/Tagout set

Junction Box

- (1) Terminal Strip

Externally-Mounted Components

- (1) AC Motor, 3-phase Squirrel Cage Motor
- (1) Motor Safety Switch
- (1) 3-phase On/Off Motor Safety Switch
- (1) Limit Switch, DPDT
- (1) Electro-Pneumatic Solenoid Valve, 5/2
- (1) Pneumatic Cylinder, double-acting
- (1) Pressure Regulator with filter and gauge
- (1) Pressure Switch, DPDT

Instrumentation

- (1) Multimeter

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Equipment Required
For
SACA C-207 Programmable Controller Systems 1 Credential

Note: This equipment is required to support the C-207 standards and the associated Gold certification assessment

Functional Capabilities

The programmable controller system should consist of the following components to enable demonstration of PLC operation and programming skills. The programmable controller should be a major industrial PLC brand with PLC programming software and human machine interface of the same brand. The field components shall be pre-connected to the PLC or connected via plug-in or terminal-wired leads to enable candidates to demonstrate operation of logic program applications.

Components

  (1) Industrial PLC model: Rockwell Rockwell CompactLogix, ControlLogix, or equivalent with discrete inputs/ outputs (can be DC or AC) and Ethernet communications port
  (1) Human Machine Interface (HMI), Rockwell or Equivalent with Ethernet communication port
  (1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or equivalent
  (1) Master Control Relay Circuit for power distribution system
  (4) Output Indicator Lamps
  (2) Pushbutton Switches, Normally Open
  (1) Pushbutton Switches, Normally Closed
  (4) Selector Switches, 2-position
  (1) Electric Motor, AC or DC with contactor
  (2) Solenoid-Operated Pneumatic Valve/Cylinders or electric actuator
  (3) Limit Switches or Electronic Sensors, Normally Open (used for end of travel sensors for actuators)

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Equipment Required
For
SACA C-208 Programmable Controller Troubleshooting 1 Credential

Note: This equipment is required to support the C-208 standards and the associated Gold certification assessment

Functional Capabilities

This credential requires a programmable controller system with the same capabilities as the equipment specified in credential C-207. In addition, each system should have the capabilities to insert faults into the system to provide students with realistic troubleshooting.

The programmable controller system faults should include: field input devices, field output devices, PLC input module points, PLC output module points, PLC power supply, MCR relay coil and contacts, MCR start pushbutton, Stop pushbutton, power supply, and AC power in.

The PLC system shall provide accessible test points to enable candidates to take electrical measurements to troubleshoot PLC faults.

Components (same as those specified in C-207)

(1) Industrial PLC model: Rockwell Rockwell CompactLogix, ControlLogix, or equivalent with discrete inputs/ outputs (can be DC or AC) and Ethernet communications port
(1) Human Machine Interface (HMI), Rockwell or Equivalent with Ethernet communication port
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or equivalent
(1) Master Control Relay Circuit for power distribution system
(4) Output Indicator Lamps
(2) Pushbutton Switches, Normally Open
(1) Pushbutton Switches, Normally Closed
(4) Selector Switches, 2-position
(1) Electric Motor, AC or DC with contactor
(2) Solenoid-Operated Pneumatic Valve/Cylinders or electric actuator
(3) Limit Switches or Electronic Sensors, Normally Open (used for end of travel sensors for actuators)

Instrumentation

(1) Multimeter

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Equipment Required for SACA C-209 Pneumatics Credential

Note: This equipment is required to support the C-209 standards and the Gold certification assessment

Basic Pneumatic Components

- (3) – Pressure Gauges, 0-160 PSIG range, 2 ½-in.
- (1) – Pressure Regulator and Gauge, 0-160 PSIG range
- (1) – Air Filter
- (1) – Supply Manifold, 4-port with quick connects
- (1) – Rotameter, 20-200 SCFH range
- (1) – Manometer, inclined, 7-in. Hg
- (1) – Air Motor Assembly, vane-type
- (1) – Cylinder, double-acting, 1 1/8-in. bore, 6-in. stroke, with cam
- (1) – Cylinder, double-acting, 1 ½-in. bore, 4-in. stroke, with cam
- (2) – Flow Controls, with integral reverse free-flow check valve
- (1) – Cylinder, single-acting, 3/4" Bore, 1" Stroke, spring return, transparent
- (1) – Directional Control Valve, 3-position, 5-ported/4-way, spring centered, closed center, transparent
- (1) – Quick connect hoses, fitting tees, and fitting cross

Intermediate Pneumatic Components

- (1) – Pushbutton Valve Assembly
- (1) – Venturi Block Assembly
- (1) – DCV Air Pilot-Operated Assembly
- (1) – Check Valve Assembly
- (1) – Load Cylinder Assembly
- (1) – Cam Valve Assembly #1, 3-way
- (1) – Cam-Operated Valve #2, 2-way
- (1) – Filter Elements: 5 micron, 20 micron, and 70 micron
- (1) – Synthetic Filter Element
- (1) – Coalescing Element (2)
- (1) – Safety Relief Valve
- (1) – Air Bearing
- (1) – Lubricator Assembly

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Equipment Required
For
SACA C-210 Mechanical Power Systems 1 Credential

Note: This equipment is required to support the C-210 standards and the associated Gold certification assessment.

Functional Capabilities

The mechanical power system should consist of the following components and a workstation to permit installation, setup, adjustment and operation of basic mechanical power drive systems, including: motor drivers and keyways, couplings, v-belt drives, chain drives, spur gear drives, and multiple shaft drives.

Each component should be standard industrial grade, US Customary or SI standards. Dimensions below are given in US Customary. Equivalent SI dimensions are acceptable.

Mechanical Workstation

(1)-Worksurface to be heavy duty solid steel or tooling aluminum to ensure stable surface for alignment tasks, at least .5-in thickness, pattern of holes for mounting of components using thru-hole fasteners
(1)-Safety Guard, removable, transparent
(1)-Drive Train Load Device, manually adjustable, can be connected directly to motor or to any drive train to demonstrate load on system
(1) Variable Speed Drive to drive electric motor, manually adjustable
(1) Electric Motor, 3-phase AC, totally enclosed
(1) Load Readout, for monitoring/measuring load on drive system
(1)-Lockout / Tagout kit
(1)-On/Off E-Stop Switch
(1)-Adjustable base for tensioning parallel shaft drive systems

Basic Mechanical Components

(2)-Pillow block bearing, 1-in. bore, set screw
(6)-Pillow block bearing, 5/8-in. bore, set screw
(1)-Shaft, 5/8-in. dia., 12-in. L
(1)-Shaft, 5/8-in. dia., 8-in. L
(1)-Shaft, 5/8-in. dia., 12-in. L (3 keyways)
(1)-Shaft, 1-in. dia., 12-in. L
(1)-Set of Pillow block bearing standoffs, for shaft alignment with motor
(1)-Flexible Jaw coupling, 5/8-in. bore
(1)-Sleeve coupling, 5/8-in. bore
(1)-Sheave, FHP, 5/8-in. bore, 2-in. PD
(1)- Sheave, FHP, 5/8-in. bore, 3-in. PD
(1)- Sheave, FHP, 5/8-in. bore, 4-in. PD
(1)-Sprocket, 5/8-in. bore, 12 teeth
(1)-Sprocket, 5/8-in. bore, 16 teeth
(1)-Sprocket, 5/8-in. bore, 24 teeth
(1)-Spur gear, 5/8-in. bore, 24 teeth
(2)-Spur gear, 5/8-in. bore, 36 teeth
(1)-Spur gear, 5/8-in. bore, 48 teeth
(1)-Spur gear, 5/8-in. bore, 24 teeth

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(1)-Spur gear, 5/8-in. bore, 60 teeth
(1)-Set of Stainless steel shims, 2-in. X 2-in. X 0.003-in.
(1)-Set of Stainless steel shims, 2-in. X 2-in. X 0.005-in.
(1)-Set of Stainless steel shims, 2-in. X 2-in. X 0.010-in.
(1)-Set of Stainless steel shims, 2-in. X 2-in. X 0.020-in.
(1)-Set of Stainless steel shims, 2-in. X 2-in. X 0.050-in.
(1)-V-belt, SPA section
(1)-Roller chain, 0.5-in. pitch
(1)-Master link
(1)-Set of Keystock, 3/16-in.
(1)-Fastener Set, with grade 5 or above bolts, plain washers, lock washers, and nuts of various sizes

Supporting Devices and Supplies

(1)-Chain puller
(1)-Thickness Gauge
(1)-3 3/8-in. Level
(1)-36-in. Straight Edge
(1)-9-in. Magnetic Torpedo Level
(1)-Combination Square, 4-in.
(1)-Dial indicator
(1)-Magnetic base with clamps and attachment rods for the dial indicator
(1)-Magnetic base mounting with fastening knobs and hardware
(1)-Needle indicator contact point
(1)-Belt tension checker
(1)-Sheave gauge set
(1)-Involute gear tooth gauge
(1)-Industrial grade digital tachometer, handheld
(1)-Reflective tape, 23-in. L x 0.6-in. W
(1)-Teflon lubricant, aerosol can for easy application
(1)-Tool Set, wrenches, screwdrivers, etc.

Equipment Required
For
SACA C-211 Industry 4.0 Total Productive Maintenance Management Credential

Note: This equipment is required to support the C-211 standards and the associated Gold certification assessment

Functional Capabilities

A cloud-based maintenance management software should be provided to candidates, which enables demonstration of skills in setting up and using software to manage maintenance information flow and notification in an Industry 4.0 plant environment.

The software should have the following features:
- Ability to send manual or automatic push notifications to between individuals with a phone app
- Ability to configure the system to notify groups of individuals
- Ability to review the history of maintenance notifications from a PC with a web browser by displaying a list of notifications sent and explaining the structure of the data
- Ability to escalate messages to supervisor if not claimed by intended individual

Components

(1) Cloud-Based Maintenance Management Software
(1) Downloadable Smart Phone App for interaction with maintenance management software
(1) PC with access to Internet

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Equipment Required
For
SACA C-212 Ethernet Communications 1 Credential

Note: This equipment is required to support the C-212 standards and the associated Gold certification assessment

Functional Capabilities

The Ethernet network system should consist of the following components to enable demonstration of the ability to set up and use industrial managed Ethernet networks. The managed switch should be a major industrial brand (e.g. Rockwell Stratix or equivalent). The network shall integrate communications between industrial automation devices such as PLCs and robots.

Candidates must be able to demonstrate the ability to configure the switch, set IP addresses, test communications over the network, configure system for static and DHCP addressing, configure port security, configure a VLAN, monitor network traffic, perform basic troubleshooting using indicators and software, set up a PC for use in an Ethernet network, and transfer programs between devices on network.

Components

- (1) Managed Ethernet Switch, Layer 2 type or higher, multi-port
- (1) Managed Switch Power Supply
- (1) Managed Ethernet Switch Configuration Software
- (1) Set of Ethernet Cables
- (1) PC with Ethernet port
- (2) Industrial Programmable Controllers with Ethernet port
- (1) Robot with Ethernet port or Human Machine Interface or 3rd Programmable Controller

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Equipment Required
For
SACA C-213 Smart Sensor and Identification Systems 1 Credential

Note: This equipment is required to support the C-213 standards and the associated Gold certification assessment

Functional Capabilities

The credential requires candidates to set up, adjust, configure, program, and operate smart sensors, barcode reader, and RFID systems that integrate with industrial programmable controllers via Ethernet and IO-Link communications. These devices can be demonstrated individually or as part of a smart factory system. If demonstrated individually, a means must be provided of operating the physical element of each sensor.

Components

(1) Industrial PLC model: Rockwell CompactLogix, ControlLogix, or equivalent with discrete inputs/ outputs, IO link communications capability, and two Ethernet communications ports
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or equivalent
(1) IO-Link Master Module
(1) Smart Analog Pressure Sensor, vacuum or pressure, IO-Link communications
(1) Smart Photoelectric Sensor, IO-Link communications
(1) Smart Stacklight, IO-Link communications (Optional)
(1) Smart Ultrasonic Sensor, IO-Link communications (Optional)
(1) Barcode Reader with Serial output
(1) Set of Barcode Labels
(1) Ethernet Server Module-Converts serial to Ethernet communications
(1) Ethernet Server Configuration software, PC-based
(1) RFID Read/Write Head, IO-Link communications
(1) Set of RFID Tags
(1) RFID configuration software, PC-based
(1) PC with access to Internet
(1) Means of testing the physical element of each sensor.
　　-Vacuum-means of changing vacuum at sensor port
　　-Pressure-means of changing pressure at sensor port
　　-Ultrasonic-means of exposing sensor head to objects of different heights or distances
　　-Photoelectric-requires a target to trigger sensor

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Equipment Required
For
SACA C-214 Smart Factory Systems 1 Credential

Note: This equipment is required to support the C-214 standards and the associated Gold certification assessment

Functional Capabilities

The smart factory system should consist of the following automation stations to enable demonstration of skills in programming, setup, integration and operation of multi-station factory automation systems using industrial programmable controllers and robot systems

Each programmable controller should be a major industrial PLC brand with PLC programming software. The robot shall be a major industrial brand.

The system shall consist of at least 3 of the following stations plus an industrial robot. The stations shall be able to operate independently and integrate with each other to form a multi-step manufacturing process. Each station shall perform a different task and include material handling to transfer product to the next station in the sequence. Each station shall be controlled by a separate controller, which has the ability to communicate to other controllers via Ethernet and discrete I/O handshaking.

The Ethernet communications can be performed using an Ethernet switch or using PLCs equipped with two Ethernet ports each.

Pick and Place Feeding Station

Function: Pick and place manipulator retrieves parts from a powered parts feeder and transfer them to next station.

(1) Industrial PLC model: Rockwell or equivalent with discrete inputs and outputs (can be DC or AC) and Ethernet communications port(s)
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or or equivalent
(1) 2-Axis Electro-Pneumatic Pick and Place Device with variety of sensors to detect each axis and adjustable stroke
(1) Vacuum Pickup System
(1) Electro-Pneumatic Parts Feeder Device
(1) Set of Parts

Automated Gauging Station

Function: Parts (dimension or feature) is inspected with electronic sensors. Actuator system transports parts through the station and ejects to a reject bin or transfers to next station in process based on results of inspection.
(1) Industrial PLC model: Rockwell or equivalent with discrete inputs and outputs (can be DC or AC) and Ethernet communications port(s)
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or or equivalent
(1) Parts Dimension Measurement Sensor, e.g. ultrasonic, fiber optic, or analog position, with discrete output
(1) Single axis electrical actuator system with ball screw, adjustable coupling, and sensor
(1) Electro-pneumatic eject station

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Indexing Station

Function: This station rotates parts through an inspection to ensure orientation or part type is correct. Parts can be rejected or transferred to next station in process.
(1) Industrial PLC model: Rockwell or equivalent with discrete inputs and outputs (can be DC or AC) and Ethernet communications port(s)
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or equivalent
(1) Stepper motor drive index table with controller to rotate parts to multiple positions
(1) Parts Orientation/Inspection and position sensors
(1) Parts electro-pneumatic manipulator

Automated Sorting and Queuing Station

Function: This station allows parts to accumulate (buffering) and can sort them based on part type. Feeds parts to next station in process based on demand.
(1) Industrial PLC model: Rockwell or equivalent with discrete inputs and outputs (can be DC or AC) and Ethernet communications port(s)
(1) PC-Based PLC programming Software, Rockwell Studio 5000 with RSLinx or equivalent
(1) Belt conveyor with adjustable tracking/tension control, electric-motor powered, PLC controlled
(1) Part type sensors
(1) Part position sensors
(1) Parts sorting PLC-controlled actuators

Assembly Station with Industrial Robot

Function: This station performs a combination of material handling and assembly of parts. The robot performs the assembly process and material handling, aided by electro-pneumatic fixture actuators. The assembly process should involve a close tolerance parts fit with fasteners.
(1) Industrial PLC model: Rockwell or equivalent with discrete inputs and outputs (can be DC or AC) and Ethernet communications port(s)
(1) PC-Based PLC programming Software, Rockwell Studio 5000 or equivalent
(1) Part feeder Set
(1) Part position sensor Set
(1) Industrial Robot, 6-axis, pneumatic gripper, Ethernet port, digital I/O (FANUC LRMate or equivalent)

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Equipment Required
For
SACA C-215 Robot Systems Operations 1Credential

Note: This equipment is required to support the C-215 standards and the associated Gold certification assessment

Functional Capabilities

The Robot System should include an industrial robot and workstation to enable demonstration of skills in setup and operation of industrial robots. The robot shall be a major industrial brand, FANUC or equivalent. The robot and workstation shall include the following components:

Industrial Robot

-6-Axis Servo Manipulator
-Teach Pendant
-Digital Inputs and Outputs
-Controller with On/Off Power Switch, and circuit protection
-Emergency Stop Pushbutton
-Electro-pneumatic 2-point gripper
-Ethernet Communications Port
-Ethernet I/P Communications

Workstation

-Robot mounting pad or plate
-Worksurface, steel or aluminum tooling plate
-Physical Guards around robot work envelope or laser scanner
-Connection Panel, for Ethernet and Digital I/O for connection to external devices
-DC Power Supply for I/O Devices
-Pneumatic filter/regulator with gauge

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Equipment Required
For
SACA C-216 Robot Systems Integration 1 Credential

Note: This equipment is required to support the C-216 standards and the associated Gold certification assessment

Functional Capabilities

This credential requires an industrial robot and workcell with the same features specified in credential C-215. In addition, this credential also requires workcell components to enable demonstration of skills in industrial robot programming, integration, I/O interfacing, and applications. The robot shall be a major industrial brand, FANUC or equivalent. The robot, workstation, and workcell components shall include the following:

Industrial Robot (same equipment as C-215)

-6-Axis Servo Manipulator
-Teach Pendant
-Digital Inputs and Outputs
-Controller with On/Off Power Switch, and circuit protection
-Emergency Stop Pushbutton
-Electro-pneumatic 2-point gripper
-Ethernet Communications Port
-Ethernet I/P Communications

Workstation (same equipment as C-215)

-Robot mounting pad or plate
-Worksurface, steel or aluminum tooling plate
-Physical Guards around robot work envelope or laser scanner
-Connection Panel, for Ethernet and Digital I/O for connection to external devices
-DC Power Supply for I/O Devices
-Pneumatic filter/regulator with gauge

Workcell Components

(3) Parts Bins, for placement of cylindrical and rectangular parts
(1) Set of Cylindrical Parts, for pickup by the robot. Parts should be capable of being fed by one of the two gravity feeders.

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(1) Set of rectangular parts, for pickup by the robot. Parts should all be same size with several parts having a hole drilled halfway through and several having a hole drilled completely through. These parts should be able be fed to robot by one of the two gravity feeders.

(2) Gravity Feeders with limit switches, to feed rectangular and cylindrical parts to robot with limit switch to sense when feeder is empty.

(1) Push button and indicator light, to enable an input and an output to be wired to robot's digital inputs.

(1) Pallet Fixture, at least a 4x4 matrix that have recessed locations to locate rectangular parts

(1) Inspection Station with Limit Switch, a fixture with a recessed location for holding rectangular parts placed by the robot. The station should have a limit switch to sense presence and fixtures to hold an inductive sensor.

(1) Assembly Fixture, must have a Powered Pneumatic Clamp that can hold a cylindrical or rectangular part placed in fixture by robot. The fixture must have a 24 VDC solenoid valve that can be connected to be wired to a robot digital output to operate the clamp.

(1) Inductive Sensor, with mounting for inspection station, 24 VDC signal output compatible with digital inputs of robot.

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Equipment Required for SACA C-256 Hydraulic Maintenance Credential

Note: This equipment is required to support the C-256 standards and the Gold certification assessment

Hydraulic Maintenance Test Platform with these features:
- Panel with pre-mounted hydraulic components for demonstrating ability to connect fittings to components and connect flexible hose or steel tubing to fittings
- Filter cart for servicing hydraulic fluid.
- Two types of filters for demonstrating filter maintenance
- Cylinder with ability to demonstrate alignment with a load

Component Installation
- Should include components for installation demonstrating skills:
  - Directional Control Valve with subplate mounting
  - Fittings with straight thread o-ring and tapered thread
  - Obstacles that require candidate route conductors around
  - Spin on filter for demonstrating element change
  - Cartridge Filter for demonstrating element change

Filter Cart System
- Hydraulic pump and electric motor with valves and dual filter that can be used to demonstrate these applications
  - Reservoir filling
  - Oil filter/cleaning
  - Reservoir replenishment
  - multi-stage, single stage filtering by changing valves
  - Wands for attachment to hydraulic reservoir

Hydraulic Power Supply
- Hydraulic pump, electric motor, relief valve, filler/breather, reservoir, filter, pressure gauge.

Hydraulic Components
- (1)- JIC Tie Rod Cylinder
- (1)- Flow Control Valve
- (1) –Multi-Port Manifold with a variety of with threaded ports which can be connected via steel tubing and flexible hose.
- (1) -Gauge 0-1000 PSI, Liquid-Filled
- (1) – Directional Control Valve

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Equipment Required for SACA C-303 Electric Motor Troubleshooting Credential

Note: This equipment is required to support the C-303 standards and the Gold certification assessment

Motor Test Platform with these features:
- Test platform to setup and test motor operation.
- Integral power supply, mounting base, and safety protection.
- The power supply shall provide a minimum of:
    - Single phase variable AC:0-140 VAC @ 8 AMPS
    - Variable DC: 0-120 VDC @ 8 AMPS
    - 3-Phase Fixed 208 VAC: L_1, L_2, L_3, N, Earth connections
    - DC field supply adjustable: 0-0.5 AMPS

Fault Insertion System
- Must include the ability to fault windings with short and open faults of each type of motor, either with manual fault insertion or electronic fault insertion

Electrical Components

- (1)- Phototachometer
- (1)- Motor Load device such as a Prony Brake
- (1) -Hand Held Multimeter
- (1) - Megohmmeter
- (1) - AC Multipurpose Single Phase Motor or the following individual motors
    - Capacitor start single phase AC motor
    - Capacitor start-Capacitor Run single phase AC motor
    - Permanent Capacitor motor
- (1) - AC split phase AC motor
- (1) – 3-Phase Induction motor
- (1) – DC motor/ generator

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Date 1-19-2022

November 2023

Labor Market Analysis

Industrial Electronics

Prepared by Central Valley/Mother Lode Center of Excellence

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Summary

The Central Valley/Mother Lode Center of Excellence developed this report for Modesto Junior College to determine whether there is demand in the local labor market that is not being met by the supply from postsecondary programs. This report summarizes labor market demand, wages, skills, and postsecondary supply for *Industrial Electronics*, which includes:

- Helpers—Electricians (SOC 47-3013)
- First-Line Supervisors of Mechanics, Installers, and Repairers (SOC 49-1011)
- Electrical and Electronics Repairers, Commercial and Industrial Equipment (SOC 49-2094)
- Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers (SOC 51-1011)

Key Findings

- **Occupational Demand —** Occupations related to *Industrial Electronics* have a labor market demand of 373 annual job openings in the North Central Valley/Northern Mother Lode (NCV/NML) subregion. Between 2022 and 2027, first-line supervisors of mechanics, installers, and repairers are projected to have the most demand with 258 annual job openings and jobs with a growth projection of 9%.

- **Wages —** Average entry-level earnings of $22.58/hour for *Industrial Electronics occupations* are higher than the living wage in the NCV/NML subregion, which is $12.65/hour for a single adult.[1] First-line supervisors of mechanics, installers, and repairers earn the highest entry-level wage, $29.94/hour.

- **Employers and Occupational Titles —** Employers in the NCV/NML subregion include Penske Automotive Group, SunOpta, and Foster Farms. The most common job title is maintenance supervisors.

- **Skills and Certifications —** The top baseline skill is management, the top specialized skill is preventive maintence, and the top software skill is Microsoft software. The most in-demand certification is a commercial driver's license.

- **Education —** A high school diploma or equivalent is typically required for three occupations. A postsecondary nondegree award is typically required for electrical and electronics repairers, commercial and industrial equipment.

- **Supply and Demand Analysis —** An analysis of supply and demand reveals that there are 373 annual openings (i.e., demand) and 20 average annual postsecondary degrees awarded (i.e., supply) in the NCV/NML subregion. This suggests an undersupply of 353 workers. In the CVML region, there are 938 annual openings and 133 awards were conferred suggesting an undersupply of 805 workers.

Recommendation

Based on a comparison of demand and supply, there is an undersupply of trained workers in the NCV/NML subregion and the CVML region. The Center of Excellence recommends that Modesto Junior

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[1] The term "living wage" in Center of Excellence reports is calculated by averaging the self-sufficiency wages from the Insight Center's California Family Needs Calculator for each county in the subregion: https://insightcced.org/tools-metrics/self-sufficiency-standard-tool-for-california/.

College work with the regional directors, the college's advisory board, and local industry in the development of programs to address the shortage of Industrial Electronics workers.

Introduction

The Central Valley/Mother Lode Center of Excellence developed this report to provide Modesto Junior College with labor market information for *Industrial Electronics*. The geographical focus for this report is the North Central Valley/Northern Mother Lode (NCV/NML) subregion, but regional demand and supply data has been included for broader applicability and use. Analysis of the program and occupational data related to *Industrial Electronics* is included in the report. The Standard Occupational Classification (SOC) System codes and occupational titles used in this report from the Bureau of Labor Statistics and O*NET OnLine are shown below. There is no O*Net Online data available for Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers (SOC 51-2028).

Helpers--Electricians (SOC 47-3013)

- **Job Description:** Help electricians by performing duties requiring less skill. Duties include using, supplying, or holding materials or tools, and cleaning work area and equipment.
- **Knowledge:** Building and Construction, Mechanical, Public Safety and Security, Customer and Personal Service, Design
- **Skills:** Active Listening, Critical Thinking, Speaking, Coordination, Judgement and Decision Making

First-Line Supervisors of Mechanics, Installers, and Repairers (SOC 49-1011)

- **Job Description:** Directly supervise and coordinate the activities of mechanics, installers, and repairers. May also advise customers on recommended services. Excludes team or work leaders.
- **Knowledge:** Administration and Management, Mechanical, Customer and Personal Service, Administrative, English Language
- **Skills:** Monitoring, Management of Personnel Resources, Coordination, Critical Thinking, Judgment and Decision Making

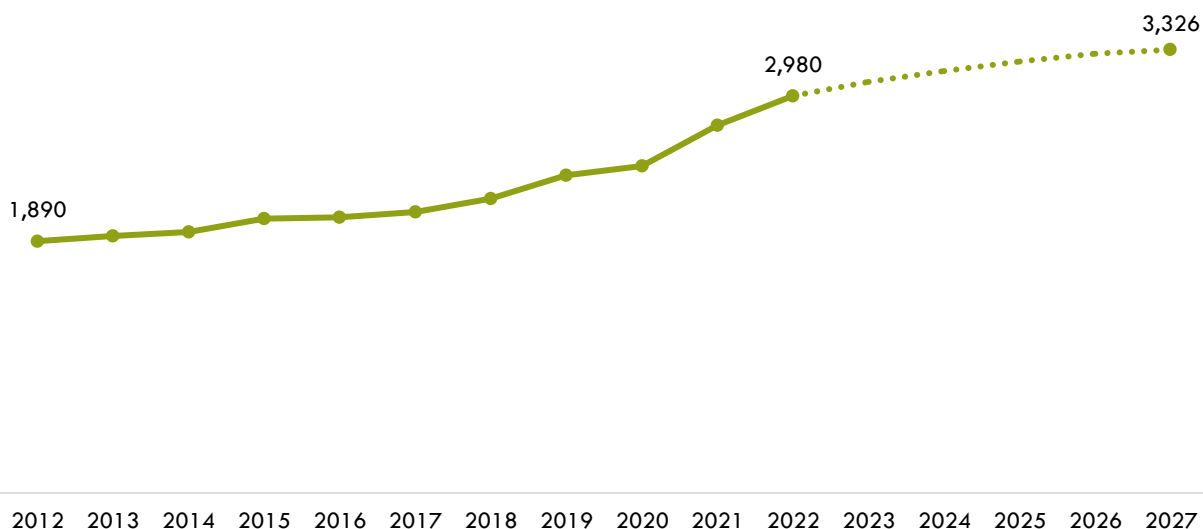**Electrical and Electronics Repairers, Commercial and Industrial Equipment (SOC 49-2094)**

- **Job Description:** Repair, test, adjust, or install electronic equipment, such as industrial controls, transmitters, and antennas.
- **Knowledge:** Computers and Electronics, Mechanical, Production and Processing, Customer and Personal Service, Mathematics
- **Skills:** Operations Monitoring, Repairing, Critical Thinking, Equipment Maintenance, Quality Control Analysis

Employment

Exhibit 1a shows trends for *Industrial Electronics* in the NCV/NML subregion. Between 2022 to 2027, the number of jobs for occupations related to *Industrial Electronics* is projected to increase by 346, growing by 12%.

Exhibit 1a. Historical employment and projected occupational demand for occupations related to *Industrial Electronics* in the NCV/NML subregion, 2012-2027

Occupations related to *Industrial Electronics* in the NCV/NML subregion employed 2,980 workers in 2022 (Exhibit 1b). First-line supervisors of mechanics, installers, and repairers are projected to have 258 annual openings.

Exhibit 1b. Current employment and projected occupational demand for occupations related to *Industrial Electronics* in the NCV/NML subregion, 2022-2027

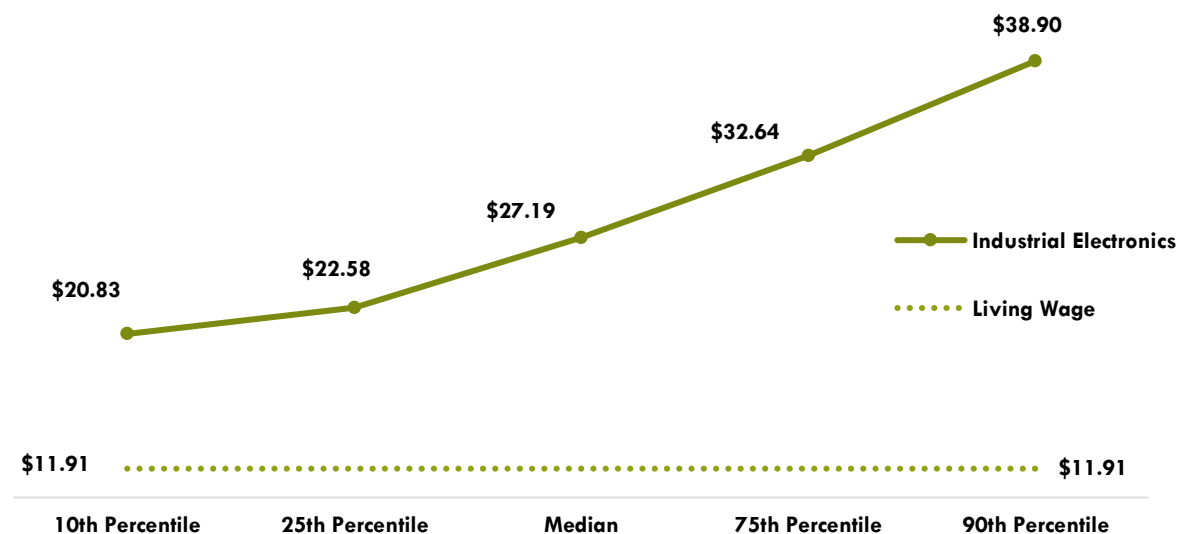| Occupation	2022 Jobs	2027 Jobs	5-Year Change	5-Year % Change	Annual Openings
First-Line Supervisors of Mechanics, Installers, and Repairers	2,219	2,428	209	9%	258
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	265	348	83	31%	52
Electrical and Electronics Repairers, Commercial and Industrial Equipment	388	414	26	7%	43
Helpers--Electricians	107	136	28	27%	20
TOTAL	**2,980**	**3,326**	**346**	**12%**	**373**

Wages

The average living wage for a single adult in the NCV/NML subregion is $12.65/hour.[2] Exhibit 2a shows the highest entry-level hourly wages for first-line supervisors of mechanics, installers, and repairers, an *Industrial Electronics Occupation*, which has an entry-level wage of $29.94/hour.[3]

Exhibit 2a. Hourly wages for occupations related to *Industrial Electronics* in the NCV/NML subregion

Occupation	25th Percentile Hourly Earnings	Median Hourly Earnings	75th Percentile Hourly Earnings
First-Line Supervisors of Mechanics, Installers, and Repairers	$29.94	$38.49	$48.13
Electrical and Electronics Repairers, Commercial and Industrial Equipment	$28.51	$33.04	$38.29
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	$16.37	$18.81	$22.74
Helpers--Electricians	$15.51	$18.43	$21.39

Exhibit 2b shows the average hourly wages for *Industrial Electronics* occupations; the average entry-level wage is more than the living wage for the NCV/NML subregion.

Exhibit 2b. Average hourly wages for occupations related to *Industrial Electronics* in the NCV/NML subregion

Job Postings

There were 335 unique job postings for occupations related to *Industrial Electronics* in the NCV/NML subregion from April 2023 to September 2023.[4]

Top Employers

The top employers with the most job postings are listed in Exhibit 3. The top employers in online job postings were Penske Automotive Group, SunOpta, and Foster Farms.

Exhibit 3. Top employers of *Industrial Electronics* in job postings

Employer
Penske Automotive Group
SunOpta
Foster Farms
Texas Roadhouse
The Michaels Organization
Constellation Brands
Randstad
Leprino Foods Company
E&J Gallo Winery
Clean Harbors

Top Job Titles

Exhibit 4 shows the most common job titles for *Industrial Electronics* in the NCV/NML subregion.

Exhibit 4. Top job titles in job postings for *Industrial Electronics*

Job Title
Maintenance Supervisors
Maintenance Managers
Bottling Supervisors

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[4] Other than occupational titles and job titles, the categories below can be counted one or multiple times per job posting, and across several areas in a single posting. For example, a skill can be counted in two different skill types, and an employer can indicate more than one education level.

Salaries

Exhibit 5 shows the "Market Salaries" for *Industrial Electronics*. These are calculated by Lightcast using a machine learning model built from millions of job postings every year. This accounts for adjustments based on location, industry, skills, experience, education, among other variables.

Exhibit 5. Market salaries for *Industrial Electronics*

Market Salary	Job Postings
$72,000-$79,999	40
$40,000-$47,999	39
$80,000-$87,999	38
$88,000-$95,999	38
$120,000-$193,000	35

Education

Of the 335 unique job postings, 285 listed a preferred or minimum educational requirement for the position being filled. Among those, 45% requested high school diploma or GED, 39% requested a bachelor's degree, and 12% requested an associate degree (Exhibit 6).

Exhibit 6. Education levels requested in job postings for *Industrial Electronics*

Education Level	Job Postings	% of Job Postings
High school diploma or GED	129	45%
Bachelor's degree	110	39%
Associate degree	34	12%
Master's degree	11	4%
Ph.D. or professional degree	1	0%

Baseline, Specialized, and Software Skills

Exhibit 7 depicts the top baseline, specialized, and software skills in job postings. The most commonly requested baseline skill is management. The most commonly requested specialized skill is preventive maintenance. The most commonly requested software skill is Microsoft Software.

Exhibit 7. In-demand baseline, specialized, and software skills for *Industrial Electronics* in job postings

Baseline Skills	Specialized Skills	Software Skills
Management	Preventive Maintenance	Microsoft Software
Operations	Plumbing	SAP Applications
Communication	HVAC	Inventory Control Systems
Leadership	Housekeeping	Spreadsheets
Customer Service	Equipment Repair	IBM Maximo

Certifications

Of the 335 job postings, there were six certifications listed. Among those, 4% indicated a need for a commercial driver's license (CDL). The next top certification is a forklift certification (Exhibit 8).

Exhibit 8. Top *Industrial Electronics* certifications requested in job postings

Certifications	% of Job Postings
Commercial Driver's License (CDL)	4%
Forklift Certification	3%
Automotive Service Excellence (ASE) Certification	2%
Certified Apartment Service Technician	2%

Education, Work Experience, & Training

A high school diploma or equivalent is typically required for three occupations. A postsecondary nondegree award is typically required for electrical and electronics repairers, commercial and industrial equipment (Exhibit 9).

Exhibit 9. Education, work experience, training, and Current Population Survey results for occupations related to *Industrial Electronics*[5]

Occupation	Typical Entry-level Education	Work Experience Required	Typical On-The-Job Training	CPS
First-Line Supervisors of Mechanics, Installers, and Repairers	High school diploma or equivalent	Less than 5 years	None	41.7%
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	High school diploma or equivalent	None	Moderate-term	29.5%
Helpers--Electricians	High school diploma or equivalent	None	Short-term	17.6%
Electrical and Electronics Repairers, Commercial and Industrial Equipment	Postsecondary nondegree award	None	Long-term	44.4%

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[5] "Labor Force Statistics from the Current Population Survey," Bureau of Labor Statistics, https://www.bls.gov/cps/.

Supply

An analysis of program data from the Integrated Postsecondary Education Data System (IPEDS) for the last three program years shows that, on average, 20 awards were conferred in the NCV/NML subregion (Exhibits 10 and 11).

Exhibit 10. TOP and CIP codes for *Industrial Electronics*

| TOP Titles	CIP Titles
0934.00 - Electronics and Electric Technology	15.0303 - Electrical, Electronic and Communications Engineering Technology/Technician
	15.0399 - Electrical and Electronic Engineering Technologies/Technicians, Other
	47.0101 - Electrical/Electronics Equipment Installation and Repair, General
	15.0612 - Industrial Technology/Technician
093420 - Industrial Electronics	47.0105 - Industrial Electronics Technology/Technician
093440 - Electrical Systems and Power Transmission	46.0301 - Electrical and Power Transmission Installation/Installer, General

Exhibit 11. Postsecondary supply for *Industrial Electronics* for Program Years 2019-20 through 2021-22

TOP/CIP Code- Title	College	Associate Degree	Certificate 30 < 60 Semester Units	Certificate 16 < 30 Semester Units	Certificate 6 < 18 Semester Units	Total
0934.00 - Electronics and Electric Technology	Bakersfield	21	4		9	**34**
	Fresno City	18	10	43		**71**
	Merced	1				**1***
	San Joaquin Delta		1			**1***
0934.20 - Industrial Electronics	Fresno City			8		**8**
	Modesto Junior	7	6		5	**18***
NCV/NML TOTAL		**8**	**7**	**0**	**5**	**20**
CVML TOTAL		**47**	**21**	**51**	**14**	**133**

*NCV/NML awards

There is an undersupply of 353 *Industrial Electronics* workers in the NCV/NML subregion and an undersupply of 805 workers in the region (Exhibit 12).
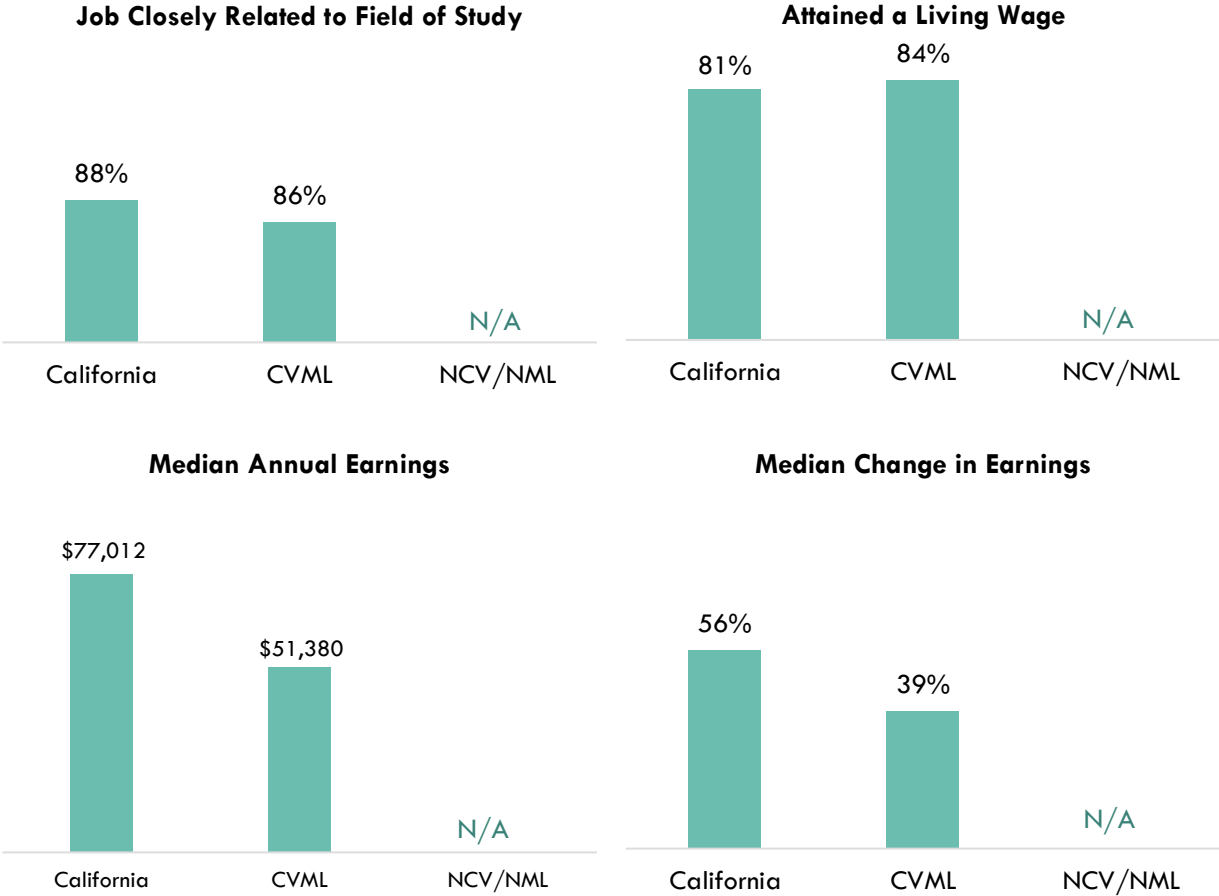
Exhibit 12. *Industrial Electronics* **workforce demand (annual job openings), postsecondary awards (supply), and additional students needed to fill gap in the NCV/NML subregion and region**
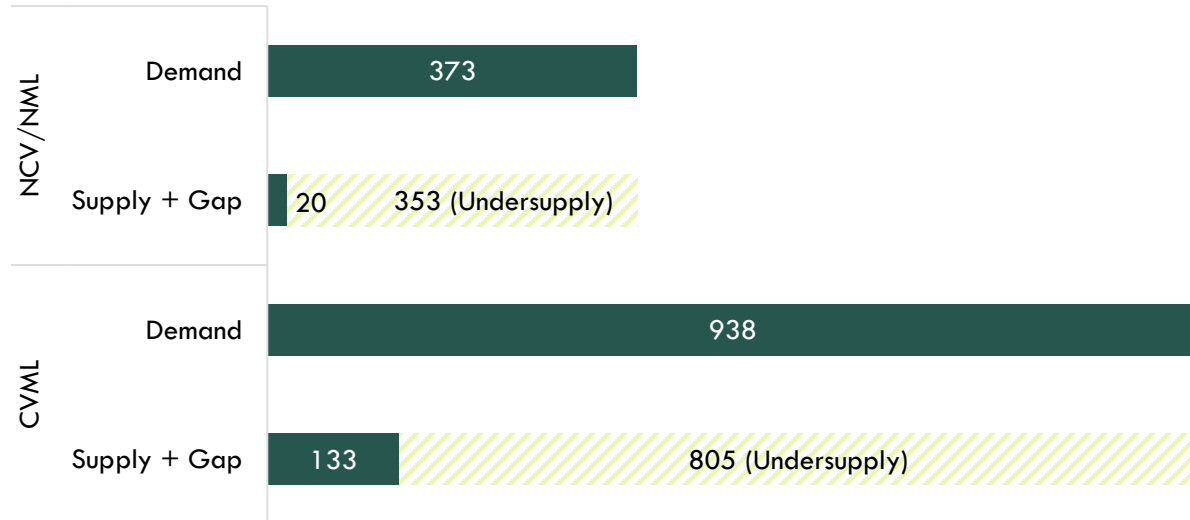
Student Outcomes

Exhibits 13 summarize outcomes from California Community College Chancellor's LaunchBoard for TOP codes related to *Industrial Electronics*. Notably, 86% of students obtained a job closely related to their field of study in the region and 84% of students attained a living wage in the region.

Exhibit 13. LaunchBoard Metrics for TOP 0934.40 - Electrical Systems and Power Transmission in California, CVML region, and NCV/NML subregion

Job Closely Related to Field of Study

California	CVML	NCV/NML
88%	86%	N/A

Attained a Living Wage

California	CVML	NCV/NML
81%	84%	N/A

Median Annual Earnings

California	CVML	NCV/NML
$77,012	$51,380	N/A

Median Change in Earnings

California	CVML	NCV/NML
56%	39%	N/A

Recommendation

This report suggests there is a shortage of 353 workers in the NCV/NML subregion and a shortage of 805 workers in the CVML region for *Industrial Electronics*. Based on these findings, it is recommended that Modesto Junior College work with the regional directors, the college's advisory board, and local industry in the development of programs to address the shortage of *Industrial Electronics* workers in the region.

Appendix: Methodology & Data Sources

Data Sources

Labor market and educational supply data compiled in this report derive from a variety of sources. Data were drawn from external sources, including the Economic Modeling Specialists, Inc., the California Community Colleges Chancellor's Office Management Information Systems Data Mart and the National Center for Educational Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS). Below is the summary of the data sources found in this study.

Data Type	Source
Labor Market Information/Population Estimates and Projections/Educational Attainment	Economic Modeling Specialists, Intl. (Lightcast). Lightcast occupational employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates also affected by county-level Lightcast earnings by industry: economicmodeling.com.
Typical Education Level and On-the-job Training	Bureau of Labor Statistics (BLS) uses a system to assign categories for entry-level education and typical on-the-job training to each occupation for which BLS publishes projections data: https://www.bls.gov/emp/tables/educational-attainment.htm.
LaunchBoard	Chancellor's LaunchBoard. https://www.calpassplus.org/LaunchBoard/SWP.aspx
Labor Force, Employment and Unemployment Estimates	California Employment Development Department, Labor Market Information Division: labormarketinfo.edd.ca.gov.
Job Posting and Skills Data	Lightcast: https://lightcast.io/.
Additional Education Requirements/ Employer Preferences	The O*NET Job Zone database includes over 900 as well as information on skills, abilities, knowledge, work activities and interests associated with specific occupations: onetonline.org.

Key Terms and Concepts

Annual Job Openings: Annual openings are calculated by dividing the number of years in the projection period by total job openings.

Education Attainment Level: The highest education attainment level of workers age 25 years or older.

Employment Estimate: The total number of workers currently employed.

Employment Projections: Projections of employment are calculated by a proprietary Economic Modeling Specialists, Intl. (LIGHTCAST) formula that includes historical employment and economic indicators along with national, state and local trends.

LaunchBoard (Attained the Living Wage): Among SWP students who exited college and did not transfer to any postsecondary institution, the proportion who attained the district county living wage for a single adult measured immediately following academic year of exit

LaunchBoard (Median Annual Earnings): Among SWP students who exited the community college system and who did not transfer to any postsecondary institution, median earnings following the academic year of exit.

LaunchBoard (Median Change in Earnings): Among SWP students who exited and who did not transfer to any postsecondary institution, median change in earnings between the second quarter prior to the beginning of the academic year of entry and the second quarter after the end of the academic year of exit from the last college attended.

LaunchBoard (Job Closely Related to Field of Study): Among SWP students who responded to the CTE Outcomes Survey and did not transfer to any postsecondary institution, the proportion who reported that they are working in a job very closely or closely related to their field of study.

Living Wage: The cost of living in a specific community or region for one adult and no children. The cost increases with the addition of children.

Occupation: An occupation is a grouping of job titles that have a similar set of activities or tasks that employees perform.

Percent Change: Rate of growth or decline in the occupation for the projected period; this does not factor in replacement openings.

Replacements: Estimate of job openings resulting from workers retiring or otherwise permanently leaving an occupation. Workers entering an occupation often need training. These replacement needs, added to job openings due to growth, may be used to assess the minimum number of workers who will need to be trained for an occupation.

Total Job Openings (New + Replacements): Sum of projected growth (new jobs) and replacement needs. When an occupation is expected to lose jobs, or retain the current employment level, number of openings will equal replacements.

Typical Education Requirement: represents the typical education level most workers need to enter an occupation.

Typical On-The-Job Training: indicates the typical on-the-job training needed to attain competency in the skills needed in the occupation.