



# TRINE CENTER FOR TECHNICAL TRAINING



## **C-210 Mechanical Power Systems Skill Standards**

### Abstract

Defines the knowledge, skills, and abilities required to succeed in positions (e.g. controls engineer or maintenance technician) that install, troubleshoot, program, and maintain factory automation in a modern environment that uses Industry 4.0 technologies.

Version 1.3

# Introduction to SACA

The Smart Automation Certification Alliance (SACA) is a non-profit foundation whose mission is to develop and deploy modular Industry 4.0 certifications for a wide range of industries. The vision is to provide highly affordable, accessible certifications that significantly increase the number of individuals who possess the skills represented by these credentials, thereby ensuring that companies have the highly skilled workers they need, and individuals are prepared to be successful in a “connected enterprise” world.

## Industry-Driven Quality

SACA certifications are industry-driven, developed by industry for industry. They use a rigorous process that starts with the development of truly international skill standards, developed and endorsed by leading experts in Industry 4.0 technology throughout the world. Certifications examinations are created based on these standards, pilot-tested and statistically analyzed to ensure quality. Each certification includes a proctored hands-on evaluation (Gold) and an online, multiple choice test (Silver) to confirm that candidates have a knowledgeable foundation for certification success. SACA uses an annual standards and examination review process for all certifications to ensure that the certifications continue to remain highly up-to-date.

## Certifying Individuals

Individuals can receive certifications through Trine University, an authorized SACA certification center. SACA ensures any certification center maintains high standards with proctored exams, certified evaluators, and approved equipment for consistent hands-on evaluation.

## Certification Structure

SACA certifications use a modular structure to enable them to fit into wide range of individual needs and industries and educational environments. The three SACA certification categories include:

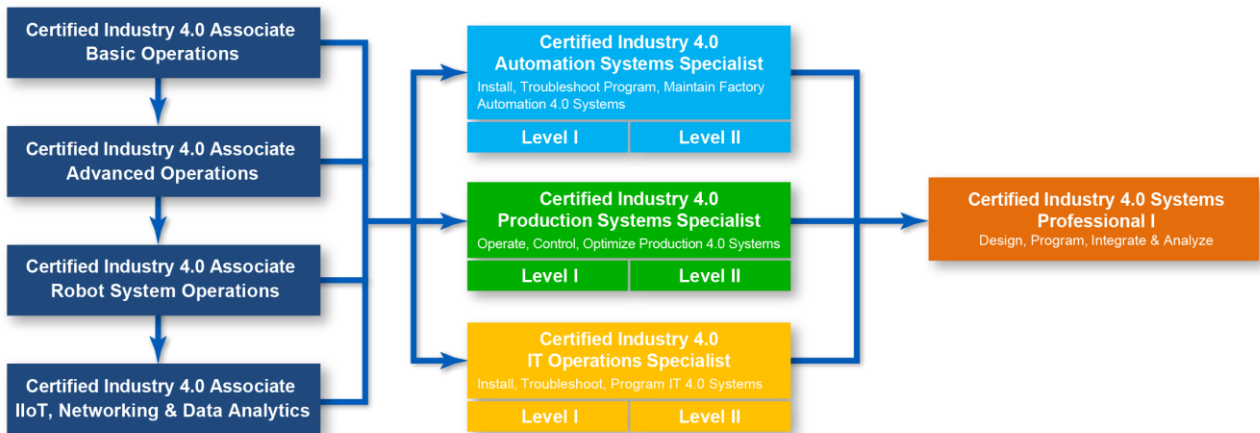
- Associate
- Specialist
- Professional



## SACA Certification Structure

Each certification is stackable. Individuals can start with one certification and add other certifications to customize their documented skills. Certifications are occupationally focused so they prepare individuals for specific occupations.

# Industry 4.0 Systems Occupational Certifications



## Associate Certifications

The Associate certifications include the following four (4) credentials:

- C-101 Certified Industry 4.0 Associate-Basic Operations
- C-102 Certified Industry 4.0 Associate-Advanced Operations
- C-103 Certified Industry 4.0 Associate-Robot System Operations
- C-104 Certified Industry 4.0 Associate-IIoT, Networking and Data Analytics

The Associate certifications are introductory certifications for those individuals working in an Industry 4.0 environment. These certifications are ideal for production technicians, IT professionals, and industrial maintenance technicians seeking to acquire Industry 4.0 skills.

## Specialist Certifications

Specialist certifications are modular certifications, consisting of a series of core and elective micro-credentials, each with its own hands-on practical assessment and a written (online) knowledge assessment. Core micro-credentials certify skills that are applicable to all companies, while elective micro-credentials can be added to match with regional or specific company needs.

- Automation Systems Specialist
- IT Systems Specialist
- Operations Specialist
- Electrical Systems Specialist
- Control Systems Specialist
- Robotics Specialist
- Network Systems Specialist
- Instrumentation Specialist
- Mechanical Systems Specialist
- Electro-Fluid Power Systems Specialist

## Certified Industry 4.0 Electrical Systems Specialist

SACA's Certified Industry 4.0 Electrical Systems Specialist certification prepares individuals to succeed as an industrial electrician in modern production environments that use Industry 4.0 technologies. In this role, individuals will install, troubleshoot, repair, and maintain industrial electrical circuits and electric motor systems.

### **Core Micro-Credentials:**

C-101 Associate-Basic Operations

C-201 Electrical Systems 1

C-202 Electric Motor Control Systems 1

C-204 Motor Control Troubleshooting 1

C-206 Electrical System Installation 1



## Certified Industry 4.0 Automation Systems Specialist

SACA's Certified Industry 4.0 Automation Systems Specialist certification prepares individuals to succeed in multi-skill maintenance technician positions in modern production environments that use Industry 4.0 technologies. This certification also features a variety of elective micro-credentials that are ideal for individuals seeking to become versed in Industry 4.0 automation or those pursuing SACA Professional Certification.

### Core Micro-Credentials:

C-101 Associate-Basic Operations  
C-201 Electrical Systems 1  
C-202 Electric Motor Control Systems 1  
C-203 Variable Frequency Drive Systems 1  
C-204 Motor Control Troubleshooting 1  
C-205 Sensor Logic Systems 1 (\*)  
C-206 Electrical System Installation 1  
C-207 Programmable Controller Systems 1 (\*\*)  
C-208 Programmable Controller Troubleshooting 1  
C-209 Pneumatic Systems 1  
C-210 Mechanical Power Systems I  
C-211 Industry 4.0 Total Productive Maintenance Management  
C-212 Ethernet Communications 1  
C-213 Smart Sensor and Identification Sys. 1  
C-214 Smart Factory Systems 1  
C-215 Robot System Operations 1 (\*\*\*)  
C-216 Robot Systems Integration 1

### Elective Micro-Credentials:

C-255 Hydraulic Systems 1  
C-256 Hydraulic Maintenance  
C-257 Process Control Systems 1  
C-258 Process Control Troubleshooting 1  
C-259 Rigging Systems 1  
C-260 Rigging Systems 2

(\*) - or SACA C101 Associate-Basic Operations and C-102 Associate-Advanced Operations Certifications

(\*\*) - or SACA C-102 Associate-Advanced Operations and C-104 Associate-IIoT and Data Analytics Certifications

(\*\*\*) - or SACA C-103 Associate-Robot Systems Certification

## Professional Certifications

SACA's Certified Industry 4.0 Professional certification is an engineering certification that focuses on analysis, design, and optimization of Industry 4.0 systems. It prepares engineers to succeed in positions in modern production environments that use Industry 4.0 technologies. The Certified Industry 4.0 Professional certification is designed in a modular format.

- Robot Systems Applications Design 1
- Smart Factory Systems Optimization 1
- Smart Factory Systems Optimization 2
- Smart Factory Systems Architecture Design 1
- Manufacturing Execution Systems 2
- Flexible Manufacturing Systems Optimization
- Process Simulation and Design 1





# SILVER & GOLD CERTIFICATIONS



**All SACA  
Certifications  
can be attained  
on two levels:  
Silver and Gold.**



SACA Silver Certifications are awarded to candidates who successfully pass the written knowledge exam delivered online through the SACA testing portal. Silver Certifications are ideal for individuals seeking to validate online core achievement or when hands-on testing is not available.



SACA Gold Certifications are awarded to candidates that successfully pass the written knowledge exam and successfully complete a hands-on performance assessment on SACA-approved equipment. Gold Certifications are ideal for individuals seeking to show they possess job-ready, hands-on Industry 4.0 skills.



## C-210 Mechanical Power Systems

### E-Learning Content

1. Introduction to Mechanical Drive Systems
2. Motor Mounting
3. Key Fasteners
4. Torque, Power, and Efficiency
5. Power Transmission Systems
6. Introduction to V-Belt Drives
7. V-Belt Operation
8. Introduction to Chain Drives

9. Chain Drive Operation
10. Chain Tensioning and Installation
11. Introduction to Spur Gear Drives
12. Spur Gear Drive Operation
13. Spur Gear Drive Installation
14. Multiple Shaft Drives
15. SACA Test / Study Guide

Prepares individuals to install, adjust, align, tension, operate and analyze basic mechanical power transmission drive systems using these components: motors, shafts, flexible jaw couplings, fractional horsepower (FHP) chain drives, FHP v-belt drives, spur gear drives, pillow block bearings, and flange bearings. Other key skills include: adhering to mechanical drive safety rules, mounting and leveling motors, testing and correcting for soft foot, installing components and shafts with keyways, sizing keys, aligning shafts using feeler gage and straight edge method, calculating speed and torque from component size ratios, interpreting rotary power specifications, determining mechanical efficiency, greasing bearings using a grease gun, refilling oil lubrication reservoirs, interpreting lubrication specifications, and identifying component given a model number.

### 970-ME1 Technical Trainer for Gold Certification



Amatrol's Mechanical Drives 1 Learning System (970-ME1) covers mechanical drive installation, mechanical drive operation, motor drive alignment, and applications of various motor drive systems. Learners will use the mechanical drives training system and the interactive online mechanical drives curriculum to gain theoretical knowledge and hands-on skills for shaft, belt, gear, and chain drives using real-world motor drive components. This hands-on mechanical drive skill-building system covers topic areas like mechanical drive systems, key fasteners, power transmission systems, v-belt drives, chain drives, spur gear drives, and multiple shaft drives. This combination of basic pneumatic knowledge and practice with hands-on equipment helps learners build the pneumatic skills they will need to succeed in the workplace.

## SACA FAQ's

### ***Who and What is SACA?***

[Smart Automation and Certification Alliance](#) is a third-party certification body whose purpose is to validate technical knowledge and ability and prepare the next generation of skilled workers.

Each SACA certification is stackable, allowing individuals to start with one certification and add other certifications to customize their documented skills. Certifications are occupationally focused so they prepare individuals for specific occupations in the world of Industry 4.0.

### ***How will SACA contribute to Student Success in the Workforce?***

SACA credentials provide students industry driven competencies in an applied learning (hands on lab) format. These skills translate directly to jobs that are in high demand, great paying, and leading to exciting lifelong career paths.

### ***What's the difference between Silver and Gold SACA certifications?***

Silver is a theory only, multiple choice, proctored exam. Exams are 1 - 2 hour in length and varies from 40 to 100 questions depending on the subject.

Gold is a combination of theory in addition to hands on skills. This is the lab portion of the certification and vastly ranges from 15 minutes to 4 hours till completion depending on the subject.

### ***Are Instructors required to be SACA certified?***

Yes! Instructors must earn the SACA certification for the courses they teach to be credentialed.

### ***How do Instructors earn SACA Silver certifications?***

Instructors can take the theory exam before or at the same time as the exam is being taken with the students. Trine University will help you with this process.

### ***How do Instructors earn SACA Gold certifications?***

Instructors will work with Trine University to complete and validate the hands-on skills required.

### ***What resources are students allowed to use while taking the certification exams?***

Formulas are available within the testing environment as well as a calculator, and blank piece of paper. Note: All resources are pending SACA approval and may be modified.



***How long do students or instructors wait before re-attempting a failed attempt?***

Re-attempts can be proctored again after 24 hours.

***Is Trine University an Authorized Certification Assessment Center for SACA?***

Yes! Trine University partnered with SACA in 2021 and Trine University has several Amatrol Industrial trainers that are SACA Gold certification approved.

***What do Employers have to say about SACA?***

*“Technology disruption is widening the gap between student learning and industry relevance of learning. At the same time, it is also shortening the shelf life of degrees and opening up variable pathways of learning. To narrow this gap, we are actively participating with the Smart Automation Certification Alliance and other industry stakeholders working alongside education to create relevant standards around Industry 4.0 and more importantly access to relevant stackable learning.”*

**- Michael Cook, Director Global Academic Partnerships, Rockwell Automation**

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## C-210 Mechanical Power Systems Skill Standards

- **Introduction to Mechanical Drive Systems**

- Can you describe five methods of rotary mechanical power transmission and give an example?
- Can you explain eight mechanical transmission safety rules?
- Can you explain the operation of a spirit level?
- Do you know how greases and oils are specified?

- **Motor Mounting**

- Can you describe three types of motor mounts and give an application of each?
- Do you know how fasteners are used to attach a motor mount to a bedplate?
- Can you mount and level an electric motor?

- **Key Fasteners**

- Do you know the function and operation of a key fastener?
- Can you explain how keys and keyseats are specified?
- Can you describe six types of set screws?

- **Torque, Power, and Efficiency**

- Can you describe two methods of loading a mechanical drive system?
- Can you calculate rotary mechanical power?
- Do you know how to calculate mechanical efficiency and explain its importance?
- Can you explain three methods of measuring electric motor current?

- **Power Transmission Systems**

- Can you describe the function of a bearing and give an application?
- Can you define three types of bearing loads and give an example of each?
- Do you know how bearings are positioned to support a load?
- Can you explain the operation of two categories of bearings and give an application of each?
- Can you describe two methods of mounting a shaft bearing and give an application of each?
- Do you know the function and application of four categories of mechanical couplings?
- Can you describe the operation of a flexible jaw coupling?
- Do you know the purpose of shaft alignment and two types of misalignment?
- Can you describe a general procedure for shaft alignment and four measurement methods?
- Can you explain the operation of the straight edge and feeler gauge alignment method?



- **Introduction to V-Belt Drives**
  - Can you calculate pulley ratio?
  - Do you know how to calculate the shaft speed and torque of a belt drive system?
- **V-Belt Operation**
  - Can you list five types of belt drives and give an application of each?
  - Can you explain how to install and align a V-Belt drive?
  - Do you know three methods of adjusting belt tension?
  - Can you describe three methods of measuring belt tension and give an application of each?
- **Introduction to Chain Drives**
  - Can you calculate sprocket ratio?
  - Do you know how to calculate shaft speed and torque of a chain drive system?
- **Chain Drive Operation**
  - Can you list four types of chains and give an application of each?
  - Do you know how to install, align, and remove a roller chain drive system with adjustable centers?
- **Chain Tensioning and Installation**
  - Can you determine allowable chain sag for a given application?
  - Can you describe two methods used to adjust chain sag?
  - Do you know how to measure chain sag?
  - Can you explain the operation of a chain puller?
- **Introduction to Spur Gear Drives**
  - Can you describe the function of the three components of a gear drive system?
  - Can you calculate gear ratio?
  - Do you know how to calculate the shaft speed and torque of a gear drive system?
- **Spur Gear Drive Operation**
  - Can you describe eleven features of a gear?
  - Can you explain the operation of a spur gear drive?
- **Spur Gear Drive Operation**
  - Can you describe the function of backlash?
  - Can you explain how to determine the allowable backlash in a gear drive?
  - Do you know two methods of measuring spur gear backlash?



- **Multiple Shaft Drives**

- Can you calculate the shaft speed and torque of a multiple shaft gear drive system?
- Can you calculate the torque and speed output of a compound gear drive system?
- Do you know how to determine the direction of rotation of a gear drive?

