ELECTROMECHANICAL I

COURSE DESCRIPTION

Electromechanical I is a course in which students will learn and practice introductory skills related to operation and maintenance of electrical, instrumentation, and mechanical (electromechanical) systems found in a typical manufacturing facility. Topics covered include shielded metal arc welding (SMAW), electrical safety and the National Electric Code, conduit, conductor splicing/terminating, protection devices, DC, AC, grinding, reading electrical sketches, Process Instrument Diagrams and elementary drawings, transformers, AC/DC motors, basic temperature/ pressure/ level instruments, basic troubleshooting, and a laboratory experience for students for all of topics. This course gives students the basic skills and foundational knowledge needed to enter a post-secondary Electromechanical Associates Degree program and prepares students for an electromechanical career within a manufacturing facility.

It is strongly recommended that administration and guidance follow the scope and sequence and course recommendations as listed.

Recommended Algebra I

Recommended Credits: 1

Recommended Grade Level(s): **10th,** 11th, 12th

Number of Competencies in Course: 65

ELECTROMECHANICAL I

STANDARDS

1.0 Students will demonstrate leadership, citizenship, and teamwork skills required for

success in the school, community, and workplace.

2.0 Students will demonstrate the principles of safety and health procedures in the electrical industry.

3.0 Students will evaluate career opportunities and career paths within the electromechanical industry.

4.0 Students will demonstrate interpersonal and employability skills required in the electromechanical industry.

5.0 Students will analyze and relate the risk when working with electrical systems and apply the National Electrical Code.

6.0 Students will set up a shield metal arc welder from a welding sketch or drawing, make single-pass fillet weld using a shielded metal arc welding (SMAW) process.

7.0 Students will safely store, operate, and maintain welding equipment and accessories.

8.0 Students will construct and explain the operation of direct current and alternating current circuits.

9.0 Students will demonstrate splicing, terminating, and insulating of conductors.

10.0 Students will analyze and install over-current protective devices, such as fuses and circuit breakers and demonstrate proper grounding according to NEC.

11.0 Students will demonstrate **basic troubleshooting techniques of a section of an electromechanical system**.

12.0 Students will analyze the theory of electric motors and install motors in accordance with industry requirements.

13.0 Students will interpret a basic Process Instrument Diagram (PID) and electrical elementary print.

14.0 Students will safely perform grinding operations.

15.0 Students will explain the operation of a basic single-phase transformer.

16.0 Students will check and calibrate basic instrumentation found on a typical industrial process.

17.0 Students will select and install common types of conduit and conductors in accordance with National Electrical Code (NEC) and local codes.

ELECTROMECHANICAL I

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

1.1 Demonstrate leadership skills.
1.2 Use problem-solving techniques to address and propose solutions to school, community, and workplace problems.
1.3 Demonstrate the ability to work professionally with others.
1.4 Participate in SkillsUSA as an integral part of instruction.
1.5 Exhibit integrity and pride in the practice and quality of work.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

1.1A Uses critical-thinking and consensus building skills in-group deliberations.
1.1B Keeps group work focused on task.
1.2A Determines the root causes of observed conflicts or problems.
1.2B Mediates disputes between parties.
1.3A Participates in a job shadowing experience.
1.3B Assembles a student team to solve an assigned problem.
1.4 Attends and participates in periodic meetings of SkillsUSA or similar organization.
1.5 Exhibits integrity and pride in practice and quality of work.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Participate in various SkillsUSA or similar programs and/or competitive events.
- Attend a professional organization meeting such as, local Chamber of Commerce meeting.
- Participate in the American Spirit Award competition with SkillsUSA.
- Participate in job shadowing or internship program with local business or industry.
- Take an active role in a group project assigned by the instructor.
- Identify and detail a problem area in the school, community, or workplace, and propose solutions. If possible, and with appropriate approvals, implement or facilitate the solution.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP),* SkillsUSA, Communications and

Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 2.0

Students will demonstrate the principles of safety and health procedures in the electrical industry.

LEARNING EXPECTATIONS:

The student will:

2.1 Implement safety procedures established by the Environmental Protection Agency (EPA) and Occupational Safety & Health Administration (OSHA).
2.2 Analyze and categorize safety and health hazards and their prevention and treatment in the electrical industry.
2.3 Determine safe and correct procedures for working with electricity.
2.4 Exhibit acceptable dress and personal grooming identified by the electrical industry.
2.5 Use protective clothing, eye protection, and safety equipment.
2.6 Demonstrate first aid practices.
2.7 Use fire protection equipment.
2.8 Comprehend the importance of a safe work environment.
2.9 Pass with 100% accuracy a written examination relating to safety issues.
2.10 Pass with 100% accuracy a performance examination relating to tools and equipment.
2.11 Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

2.1A Establishes and maintains a safe and healthy working environment.
2.1B Distinguishes and employs preventive measures of ecological, chemical, and physical contaminants.
2.1C Interprets information from a Material Safety Data Sheet (MSDS).
2.1D Comprehends their responsibilities, regulations, and Occupational Safety and Health Administration (OSHA) policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
2.1E Comprehends their responsibilities, regulations, and Occupational Health and Safety Administration (OSHA) policies to protect coworkers and bystanders from hazards.
2.2A Differentiates between hazardous materials, substances, and waste.
2.2B Retrieves MSDSs and identifies the health hazards associated with new materials.
2.2C Reports hazards found on the job site to their supervisor.
2.2D Maintains electrical equipment and laboratory in a safe and clean condition.
2.2E Identify and explain Confined Spaces as per the Occupational Safety & Health Administration (OSHA) guidelines.
2.2F Comprehends their responsibilities under HazCom regulations.

2.3A Selects, inspects, and uses the correct instruments for working with electrical equipment and systems.
2.3B Selects, inspects, and uses the correct personal protective equipment for working with electrical equipment and systems.
2.3C Understand and explain the effects of voltage on the human body.
2.3D Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous electrical tasks.

2.4A Compares and contrasts acceptable dress and personal grooming for specific jobs in the electrical industry.
2.4B Understand the importance of personal hygiene and cleanliness in work and social environments.
2.5A Selects, inspects, and uses the correct personal protective equipment for the assigned task.
2.5B Inspects, maintains, and employs safe operating procedures with tools and equipment, such as hand and power tools, ladders, and lifting equipment.
2.6 Administers simulated basic first aid procedures including treating burns and cuts and electrical shock.
2.7A Identify the components of fire.
2.7B Identify the four types of fire extinguishers.
2.7C Explain the proper use of each class of fire extinguisher.
2.7D Explain the PASS method (**P**ull, **A**im, **S**queeze, and **S**weep)
2.8A Continuously is aware of potential hazards to themselves and others.
2.8B Provides and activates adequate ventilation equipment as required by the task.
2.8C Researches the effects of substance abuse on performance.
2.8D Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or Occupational Safety and Health Administration (OSHA) policy.
2.9 Passes with 100% accuracy a written examination relating specifically to electrical safety issues.
2.10 Passes with 100% accuracy a performance examination relating specifically to electrical tools and equipment.
2.11 Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Conduct a safety and health inspection and identify any potential hazards.
- List causes of most common accidents and outlines a safety prevention program.
- Participate in the Occupational Health and Safety competitions with SkillsUSA.
- Outline a safety management program.
- Develop emergency policies for the electrical laboratory or classroom.
- Role-play proper procedure for treating burns, cuts, electrical shock treatments according to standards set forth by the American Red Cross.
- Obtain an American Red Cross First Aid Certification and/or CPR Certification.
- Select fire extinguishers for the proper application.
- Demonstrate the ***PASS*** method of fire extinguisher use.
- Select, inspect, and use the correct personal protective equipment for the assigned task.
- Inspect power tools for intact guards, shields, insulation, and other protective devices.
- Inspect extension cords for the presence of a functional ground connection, prior to use.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International

Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

STANDARD 3.0

Students will evaluate career opportunities and career paths within the electromechanical industry.

LEARNING EXPECTATIONS

The student will:

3.1 Explain titles, roles, and functions of individuals in the electrical industry.
3.2 Investigate employment and entrepreneurial opportunities in the electrical industry.
3.3 Evaluate personal characteristics required for working in the electrical industry.

3.4 Investigate post-secondary education, professional organizations, and trade publications appropriate for continuing education.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

3.1A Researches occupations within the electrical industry.
3.1B Categorizes major responsibilities for each occupation in the electrical industry.
3.2 Researches and develops a projection of industry trends related to career opportunities in the electrical industry.
3.3 Profiles personal characteristics that are beneficial to the success of a professional in the electrical industry.
3.4A Investigates career options and charts the characteristics of various careers in the electrical industry.
3.4B Researches, sets up, and maintains a file outlining professional organizations, current issues, future trends, and emerging technologies in the electrical industry.
3.4C Researches and locates information on post secondary schools that offer electrical training.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Categorize employment and entrepreneurial opportunities (listing salary).
- Develop a profile of career opportunities, education requirements, and projected future employment.
- Develop a personal career plan.
- Appraise professional heating, ventilation, air conditioning, and refrigeration industry organizations and explain their purposes.
- Incorporate professional terminology into conversation.
- Attend meetings of a related professional trade organization.

INTEGRATION LINKAGES

Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Science, Math, Computer Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, SkillsUSA *Professional Development Program* (PDP), Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

STANDARD 4.0

Students will demonstrate interpersonal and employability skills required in the electromechanical industry.

LEARNING EXPECTATIONS

The student will:

4.1 Infer relationships between work ethics and organizational and personal job success.
4.2 Demonstrate attitudes conducive to workplace success.
4.3 Maintain a neat and orderly work area.
4.4 Assess implications of diversity for communities and workplaces.
4.5 Exhibit positive employability behaviors.
4.6 Develop individual time management and work sequencing skills.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

4.1A Illustrates the concept of a ‘‘work ethic.’’

4.1B Assesses the potential impact of an individual's work ethic on an organizational system.
4.1C Infers the relationship between work ethics and personal job success.
4.2A Judges which attitudes are conducive to success.
4.2B Modifies behavior to reflect attitudes for success.
4.3A Keeps work area organized and free from clutter.
4.3B Cleans work area according to shop standard.
4.3C Deduces the correlation between a clean orderly work environment and successful and efficient job performance.
4.4A Points out benefits and problems that may arise from diversity in the transportation service workplace.
4.4B Devises solutions to problems arising from diversity.
4.5A Demonstrates proper dress for work in electrical industry.
4.5B Demonstrates appropriate grooming for work in electrical industry.
4.6A Assesses the benefits of incorporating time management principles into work in the electrical industry.
4.6B Displays time management and work sequencing skills in class assignments.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Explain hazards associated with improper dress.
- Explain the importance of arriving at work at the assigned time.
- Explain the importance of honesty and integrity in the workplace.
- Explain multi cultural environments and there importance in the workplace.

- Research cultural diversity and equity issues impacting the electrical industry.
- Students are divided into groups of four to six. Each group is given a different scenario of an electrical industry service workplace situation in which an employee demonstrates a poor work ethic. The group identifies the problem and all the possible ramifications of the individual's behavior for the organization, other employees, and the employee him/herself. Each group then presents its scenario and analysis to the class.
- Explain the importance of community involvement by companies and employees.
- Maintain a clean and safe working environment in all shop and class activities.
- Demonstrate proper time management in assigned activities.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

STANDARD 5.0

Students will analyze and relate the risk when working with electrical systems and apply the National Electrical Code.

LEARNING EXPECTATIONS

The student will:

5.1 Evaluate the potential risk of injury from electrical shock, burns, and arc blasts.
5.2 Research various types, applications, and care of protective equipment for electrical workers.
5.3 Practice industry and company safety policies and standards.
5.4 Evaluate the potential risk of injury from non-electrical risks.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

5.1A Demonstrates methods to prevent injury from electrical shock.
5.1B Demonstrates methods to prevent injury from electrical burns.
5.1C Demonstrates methods to prevent injury from arc blasts.
5.2A Selects, inspects, and uses personal protective equipment, such as rubber gloves, and head, eye, and face protection.
5.2B Selects and uses special tools, such as hot sticks and shorting probes.
5.3A Identifies possible risks and completes reports of safety violations.
5.3B Complies with applicable safety policies and standards.
5.3C Demonstrates de-energizing the circuit.
5.3D Completes lockout/tagout procedures.
5.3E Reports safety hazards to supervisors and safety personnel.
5.4A Explains the potential risk of injury from falls and falling objects, and the recommended risk mitigation procedures.
5.4B Explains the potential risk of injury from confined space entry, and the recommended risk mitigation procedures.
5.4C Explains the potential risk of injury from respiratory hazards, and the recommended risk mitigation procedures.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Students will assess risk factors, address safety policies and standards (using National Electric Code) to the instructor's satisfaction, for tasks such as those described below, and then execute the task (real or simulated).
- Replace a 20A circuit breaker in a 277V lighting sub panel, where activity in the building precludes de-energizing the entire sub panel.
- Tighten a loose through-bolt on a one-barrel fixed-tongue compression connector used to connect a 500-KCMIL wire to a 12V, 2000A electroplating power supply.

- Change ballast on a 277V, four-tube, ceiling-mounted, fluorescent lighting fixture mounted 18 feet above the floor.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANCIAL I

STANDARD 6.0

Students will set up a shield metal arc welder from a welding sketch or drawing, make single-pass fillet weld using a shielded metal arc welding (SMAW) process.

LEARNING EXPECTATIONS

The student will:

6.1 Make single-pass fillet and groove welds in the flat position.
6.2 Make single-pass fillet and groove welds in the horizontal position.
6.3 Make single-pass fillet and groove in the vertical position.
6.4 Make single-pass fillet and groove welds in the overhead position.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

6.1A Makes a single-pass fillet weld and a groove weld on plain carbon steel in the flat position.
6.2A Makes a single-pass fillet weld and a groove weld on plain carbon steel in the horizontal position.
6.3A Makes a single-pass fillet weld and a groove weld on plain carbon steel in a vertical position.
6.4A Makes a single-pass fillet weld and a groove weld on plain carbon steel in an overhead

SAMPLE PERFORMANCE TASKS

- Complete projects to enhance the learning activity. Integrate related academic skills and knowledge to design, layout, and fabricate a welding project.
- Practice for the Entry-Level Welder Certification.

INTEGRATION LINKAGES

Language Arts, Mathematics, Technical Algebra, Technical Geometry, Algebra, Geometry English IV: Communication for Life, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), Professional Development Program, SkillsUSA

ELECTROMECHANCIAL I

STANDARD 7.0

Students will safely store, operate, and maintain welding equipment and accessories.

LEARNING EXPECTATIONS

The student will:

7.1 Implement and comply with ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes* and Occupational Safety and Health Administration (OSHA*)* requirements for operating each piece of equipment.
7.2 Demonstrate required safety practices while operating all equipment and tools.
7.3 Exhibit acceptable dress and personal grooming as identified by the welding industry.
7.4 Demonstrate the use of basic metal working and welding equipment.
7.5 Evaluate the importance and use of ventilation.
7.6 Properly handle welding gas cylinders.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

7.1A Passes with 100% accuracy a written safety examination relating to the applicable sections of ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes* and Occupational Safety and Health Administration (OSHA) requirements.
7.1B Demonstrates compliance with ANSIZ49.1 as it relates to protection of personnel in the general area, ventilation, fire prevention and protection, precautionary information, and general aspects.
7.1C Establishes and maintains a working environment incorporating the principles of ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes.*
7.1D Analyzes fire prevention, electrical and safety methods to be incorporated with the use of welding equipment.
7.1E Completes a safety inspection introducing HazCom confined space and lockout/tagout implications.
7.2A Maintain a portfolio record of equipment for which the student has passed an examination covering the operation of welding equipment and tools.
7.2B Maintain a portfolio record of equipment for which the student has passed an operational checkout by the instructor.
7.3A Compares and contrasts appropriate and inappropriate dress and personal grooming characteristics for specific jobs in the welding industry.
7.3B Uses appropriate dress, eye/face protection, gloves, and other protective devices as required by ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes*.
7.4 Demonstrates grinding, sawing, and drilling operations within the tolerance specified on a drawing or blueprint.
7.5A Uses ventilating equipment, safety shields, and curtains as required by ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes*.
7.5B Develops and administers formative or diagnostic tests for proper ventilation.

7.6A Stores welding gas cylinders in an upright and secure position.
7.6B Operates with welding gas cylinders in an upright and secured position.
7.6C Installs cylinder caps immediately upon removal of gauges from welding gas cylinders.

SAMPLE PERFORMANCE TASKS

- Write a report on potential skin and eye damage caused by ultraviolet radiation produced by arc welding processes.
- Participate in a job interview where a portfolio is used to show welding equipment and tools that the student has received an operational checkout by the instructor and grades on written examinations of the operation of welding equipment and tools
- Look up MSDS for welding fluxes, shielding compounds, and filler materials to assess the risks of toxic gas release and acidity in the school welding shop.
- Demonstrate the proper handling and transportation of compressed gas cylinders.
- Simulate use of fire extinguisher.
- Appraise the work area for safety hazards and list common causes of typical accidents and injuries in the welding industry. Based on the findings of the appraisal, outline a safety corrections program and present the program to the school and professional organizations.
- Cut, saw, and drill holes in metal.

INTEGRATION LINKAGES

Language Arts, Mathematics, Technical Algebra, Technical Geometry, English IV: Communication for Life, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), *Professional Development Program*, SkillsUSA

ELECTROMECHANICAL I

STANDARD 8.0

Students will construct and explain the operation of direct current and alternating current circuits.

LEARNING EXPECTATIONS

The student will:

8.1 Analyze the basic characteristics of direct current and alternating electricity.
8.2 Apply Ohm's law to electrical and systems.
8.3 Examine electrical circuits and components.
8.4 Apply basic control wiring and wiring processes used in the electrical industry.
8.5 Determine the role of electron flow as it related to electricity.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

8.1A Correlates basic electrical concepts with electrical function.
8.1B Illustrates the concepts of valence, voltage, current, resistance, and voltage drop.
8.1C Compares the two theories of current flow and indicates which theory(s) are used in electrical systems.
8.1D Distinguishes between conductor, insulator, and semi-conductor
8.1E Distinguishes between DC (direct current) and AC (alternating current).
8.2A Deduces the cause and effect relationship in Ohm's law between voltages, current, resistance, and voltage drop.
8.2B Uses Ohm's law to determine values mathematically.
8.3A Analyzes series circuit structure both in application and mathematically.
8.3B Analyzes parallel circuit structure both in application and mathematically.
8.3C Analyzes series-parallel circuit structure both in application and mathematically.
8.3D Differentiates between a short and a ground.
8.3E Compares magnetism and electromagnetism.
8.4A **Wire and test different devices used in the electrical industry.**
8.4B Wire and test different control circuits and systems used in the electrical industry.
8.5A Illustrates electron induction and flow.
8.5B Compares concepts of magnetism to their electrical counterparts: reluctance to resistance, field distance to voltage, and magnetic force to current.
8.5C Analyzes the role of magnetism and electromagnetic induction in electrical systems.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Use appropriate instruments and meters to measure watts, volts, Ohms, and amps.
- Select appropriate meter to check amps, voltage, watts, and ohms.
- Demonstrate the proper use of an ammeter, ohmmeter, voltmeter, and wattmeter
- Construct series and parallel circuits.
- Select proper fuse or breaker for a given size wire.
- Determine the capacities of a given run capacitor.
- Wire and test electrical switches and devices used in a typical system or job.
- Identify the different types of electrical switches and components by rating and appearance.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication **Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development**

ELECTROMECHANICAL I

STANDARD 9.0

Students will demonstrate splicing, terminating, and insulating of conductors.

LEARNING EXPECTATIONS

The student will:

9.1 Research National Electrical Code (NEC) and local code requirements for splicing, terminating, and insulating of conductors.

9.2 Demonstrate splicing, terminating, and insulating of conductors.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

9.1A Evaluates common wire nuts for making connections and explains when and how to use.

9.1B Explains which crimp-on wire lugs or mechanical compression connectors are acceptable in various situations.

9.1C Analyzes special considerations for making splices and connections to aluminum conductors.

9.1D Evaluates insulation systems applicable to common splices and terminations.

9.2A Completes multiple wire connections using proper size wire nuts.

9.2B Demonstrates wire terminations and splices using proper crimp-on wire lugs and mechanical compression connectors.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Complete wiring for residential service or mockup.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

STANDARD 10.0

Students will analyze and install over-current protective devices, such as fuses and circuit Breakers and demonstrate proper grounding according to NEC.

LEARNING EXPECTATIONS

The student will:

10.1 Compare the characteristics and uses of fuses and circuit breakers.
10.2 Identify physical examples of fuses and circuit breakers.
10.3 Demonstrate the installation, wiring, testing, and operation of fuses and breakers in both single and three-phase circuits.
10.4 Utilize effective grounding practices, as prescribed by the National Electrical Code (NEC) and local code

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

10.1 Justifies a specific choice of fuse or circuit breaker for over-current protection.
10.2A Determines characteristics of a fuse needing replacement based on markings printed on the fuse.
10.2B Classifies a circuit breaker by its voltage, current, and interrupting-capacity ratings by physical observation or reference to technical manuals.
10.3A Installs, connects, and tests fuses.
10.3B Installs, connects, and tests circuit breakers.
10.4A Demonstrates connection of ground wires and installation of bonding straps

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Install and test breakers for residential service or mockup.
- Remove, tests for continuity, and reinstall fuses in three-phase disconnect switches.
- Determine required ground wire for industrial service or mockup.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communication, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER, International Brotherhood of Electrical Workers

ELECTROMECHANICAL I

STANDARD 11.0

Students will demonstrate **basic troubleshooting techniques of a section of an electromechanical system**.

LEARNING EXPECTATIONS

The student will:
11.1 Troubleshoot a small section of an electromechanical system.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
11.1 Given blueprints of a typical electromechanical system and after confirming the correct operation of an operational section of an electromechanical system, will systematically and logically troubleshoot, within a given amount of time, the system after the instructor has put in a problem.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion

- Instructor sets up an operational electromechanical system (motor driving a pump with a coupling, an instrumentation loop, etc.) and ensures the students understand the sectioni of the system. The instructor then puts a problem in the system and takes the role of an operator and tells the student of the symptoms of the problem in the section. The student then begins to diagnose/troubleshoot the system. The student is given a definite amount of time to systematically and logically troubleshoot the problem.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, English IV Communications for Life, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

STANDARD 12.0

Students will analyze the theory of electric motors and install motors in accordance with industry requirements.

LEARNING EXPECTATIONS

The student will:

12.1 Select and identify a motor based on its intended use.

12.2 Determine the installation requirements to satisfy National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations given a motor and specified application.

12.3 Select, install, and wire DC, single-phase, and three phase-electric motors.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

12.1A Given an application, determines the size, speed, operating voltage, and National Electrical Manufacturing Association (NEMA) type for the required motor.

12.1B Identifies and properly selects a motor based upon the intended use and National Electrical Manufacturing Association (NEMA) enclosure classification.

12.2 Determines the required over-current protection, motor control circuits, conductor types and sizes, and conduit types and sizes, as required by National Electric Code (NEC), Occupational Safety and Health Administration (OSHA) regulations and described by installation drawings for a given motor and application.

12.3A Comprehends basic operation of DC motors and common, single phase AC motors, and three-phase induction motors.

12.3B Distinguishes between and contrasts the operating characteristics of series and shunt DC motors.

12.3C Contrasts and compares starting procedures and circuits for split-phase induction motors and capacitor-type induction motors.

12.3D Selects, installs, and properly wires three-phase induction motors with the necessary motor contactors, overload protection, and control switches.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given an application requiring a DC motor (other than a permanent magnet motor), select, install, and wire the motor in accordance with installation needs and NEC and OSHA requirements.
- Given an application requiring a single-phase capacitor motor, select, install, and wire the motor in accordance with installation needs and NEC and OSHA requirements.
- Given an application requiring a reversing three-phase motor, select, install, and wire the motor in accordance with installation needs and NEC and OSHA requirements.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP),* SkillsUSA, Communications and

Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 13.0

Students will interpret a basic Process Instrument Diagram (PID) and electrical elementary print.

LEARNING EXPECTATIONS

The student will:

13.1 Interpret the field devices shown on a basic Process Instrument Diagram (PID).
13.2 Interpret the field devices shown on a basic electrical elementary print.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student will:

13.1A Correctly associate/identify all field device symbols and equipment symbols shown on a PID to the actual field devices of a process loop and explain the basic process operation of the devices and equipment shown in the process loop.
13.1B Correctly associate/identify all electrical symbols shown on an electrical elementary print to the actual field devices of a control loop and explain the basic electrical operation.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given an a PID and a basic instrumentation control loop, the student will associate the parts of the loop in the field to the instruments and field devices shown on the PID.
- Given an electrical elementary print and a basic electrical control system/circuit, the student explains the flow of electrical current through the system and explains the basic operation the system/circuit performs.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP)*, SkillsUSA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 14.0

Students will safely perform grinding operations.

LEARNING EXPECTATIONS

The student will:
14.1 Safely and correctly grind a piece of metal using various types of grinders.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
14.1A Safety and correctly perform a grinding operation (cutting, smoothing, and deburring) on metal using a hand-held grinder.
14.1B Safety and correctly perform a grinding operation (cutting, smoothing, and deburring) on metal using a pedestal bench grinder.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given a piece of metal, students will perform a smoothing and deburring operation using a pedestal bench grinder.
- Given a piece of metal, students will perform a smoothing and deburring operation using a hand-held grinder.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP),* SkillsUSA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 15.0

Students will explain the operation of a basic single-phase transformer.

LEARNING EXPECTATIONS

The student will:

15.1 Demonstrate their understanding of the operation of a single-phase step-up, step-down, isolating, and current transformer.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

15.1A Will confirm the correct operation of a single-phase step-up transformer.
15.1B Will confirm the correct operation of a single-phase step-down transformer.
15.2A Will confirm the correct operation of a single-phase isolation transformer.
15.2B Will confirm the correct operation of a single-phase current transformer.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given an operating transformer, the student will be directed by the instructor to connect a single-phase transformer for specific primary and secondary parameters.

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP)*, SkillsUSA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 16.0

Students will check and calibrate basic instrumentation found on a typical industrial process.

LEARNING EXPECTATIONS

The student will:
16.1 Check and calibrate basic pressure, temperature, flow, and level instrumentation.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
16.1A Will check and calibrate (+/- 1% tolerance) a basic pressure transmitter.
16.1B Will check and calibrate (+/- 1% tolerance) a basic temperature transmitter.
16.2A Will check and calibrate (+/- 1% tolerance) a basic flow transmitter.
16.2B Will check and calibrate (+/- 1% tolerance) a basic level transmitter.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given an operational instrument (pressure, temperature, flow, or level) and a calibration range, the student confirm the instrument is operational, confirm what the instrument's current calibration range is, and calibrate the instrument to a new specific range calibration (within +/- 1%).

INTEGRATION LINKAGES

SkillsUSA *Professional Development Program (PDP)*, SkillsUSA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, English IV Communications for Life, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, Multistate Academic and Vocational Curriculum Consortium (MAVCC), SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTROMECHANICAL I

STANDARD 17.0

Students will select and install common types of conduit and conductors in accordance with National Electrical Code (NEC) and local codes.

LEARNING EXPECTATIONS

The student will:

17.1 Select type and size of conduit for given electrical installations in accordance with National Electrical Code (NEC) and local codes.
17.2 Select type and size of conductors for a given electrical installation in accordance with the National Electrical Code (NEC) and local codes.
17.3 Physically identify conductors and cables by accepted industry designation and suitability under National Electrical Code (NEC).
17.4 Connect conductors according to National Electrical Code (NEC) and local codes.
17.5 Demonstrate electrical installations with electrical metal tubing (EMT) and polyvinyl chloride (PVC) conduit.
17.6 Demonstrate electrical installations with intermediate metal conduit (IMC) and rigid conduit.
17.7 Plan and set up a cable pull through assorted conduit and cable trays configurations.
17.8 Pull conductors into conduits and raceways.
17.9 Compare manual and power fish-tape or cable-puller systems.
17.10 Demonstrate cable pull through assorted conduit configurations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

17.1A Explains choices for type and size of conduit to comply with National Electrical Code (NEC) and local codes.
17.1B Selects fittings and boxes which meet installation and code requirements.
17.1C Determines the spacing of clamps and supporting devices for conduit and cables.
17.2A Determines allowable current in a specified conductor.
17.2B Determines the maximum number and sizes of conductors in a conduit of given dimensions.
17.3A Categorizes conductors and cables based upon wire size and gauge, insulation and jacket types, and voltage ratings.
17.3B Reads and identifies markings on conductors and cables.
17.3C Uses tables in National Electrical Code (NEC) to determine current capacity of a conductor.
17.4 Adheres to National Electrical Code (NEC) requirements for color codes for grounded conductors and ‘‘high-leg’’ conductors.
17.5A Demonstrates stub, offset, saddle, and parallel bends with electrical metal tubing (EMT) conduit.
17.5B Demonstrates stub, offset, saddle, and parallel bends with polyvinyl chloride (PVC) conduit.
17.5C Cuts and reams electrical metal tubing (EMT) and polyvinyl chloride (PVC) conduit.
17.5D Installs and secures electrical metal tubing (EMT) and plastic conduit with clamps and fittings conforming to National Electrical Code (NEC) and local code.
17.6A Demonstrates stub, offset, saddle, and parallel bends with intermediate metal conduit (IMC) and rigid conduit.
17.6B Cuts, reams, and threads intermediate metal conduit (IMC) and rigid conduit.

17.6C Installs and secures intermediate metal conduit (IMC) and rigid conduit with clamps and fittings conforming to National Electrical Code (NEC) and local code.
17.7A Selects proper locations to start and end a conductor pull.
17.7B Uses mandrel, swabs, and brushes to prepare conduit for conductors.
17.7C Sets up conductor reels to assure proper feed during the pull.
17.8 Demonstrates the ability to pull conductors into conduits and raceways.
17.9A Installs manual and power fish-tape or cable-puller systems.
17.9B Attaches conductors to manual and power fish-tape or cable-puller systems.
17.10A Completes a cable pull through assorted conduit and pull-box configurations.
17.10B Calculates allowable pulling tension for a specified group of conductors.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Given a proposed addition to a commercial electrical system, determine the type and size of conduit required to conform to National Electrical Code (NEC) and local code.
- Make stub bends to a specified height, offset bends to a specified depth and angle, and saddle bends to clear a specified obstacle. Repeats performance until industry standards are met.
- Given a starting and termination point, determine an optimum route to minimize the bends required for a conduit run.
- Given termination points and obstacles, determine an optimum route, make bends and cuts, install, and secure the conduit with proper clamps.
- Select and use proper switches in lighting and motor control circuits in residential and commercial mockups.
- Install permanent labels as required on disconnect devices in residential and commercial mockups.
- Given a floor plan for a single-family residence, determine type and location of switches and receptacles, as reasonable for use and required by NEC.
- For the residential project above, create a switch and receptacle bill of materials
- Produce a 32 ft^2 or larger mockup of a three-phase commercial electrical installation,
- including a service and three subsystems. Project steps (also relevant to other standards) should include blueprint of the mockup, bill of materials, simulated electrical inspections, completion of wiring, and functional testing.
- Participate in a class field trip to local commercial or industrial operating facility to view examples of large scale conduit, raceways, cable trays, and so forth.
- Repeat all performance tasks until industry standards are met including time standard.
- For commercial and residential mockups, select and install proper conductors and cables in conduit. Repeat performance task until industry standards and time factor is achieved.
- Pull multiple conductors through conduit runs in residential and commercial mockups.
- Repeat performance until industry standard is met including time factor.
- For a given group of conductors, calculate the allowable pulling tension.
- Given the size and number of conductors required in an underground conduit to a separate paint-shop building, determine the minimum conduit diameter.
- Install a specified run of electrical metal tubing (EMT) conduit on a masonry wall using the proper spacing of clamps and supports.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary

Skills (SCANS), SkillsUSA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), Multistate Academic and Vocational Curriculum Consortium (MAVCC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTROMECHANICAL I

SAMPLING OF AVAILABLE RESOURCES

- *Core Curriculum*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Welding Level One*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Electrical Level One*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Electrical Level Two*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Electrical Level Three*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Electrical Level Four*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Residential Electrical I*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- *Residential Electrical II*, National Center for Construction Education and Research (NCCER), Prentice Hall, Upper Saddle River, NJ. Also known as the Contren Learning Series materials.
- Multistate Academic and Vocational Curriculum Consortium (MAVCC), Oklahoma Department of Vocational and Technical Education
- *Total Quality Curriculum*, National SkillsUSA
- Professional Development Program, National SkillsUSA—www.skillsusa.org
- Power Tool Institute, www.powertoolinstitute.com
- Fluke Educators Portal, http://support.fluke.com/educators
- National Association of Home Builders, www.nahb.org

- International Brotherhood of Electrical Workers, www.ibew.org
- National Association of Women in Construction, www.nawiceducation.org
- Homebuilders Institute, www.hbi.org
- United States Department of Labor, www.dol.gov
- United States Department of Labor, Occupational Outlook Handbook, www.dol.gov (link)
- Secretary's Commission on Achieving Necessary Skills, www.dol.gov (link)
- Occupational Safety and Health Administration (OSHA), www.osha.gov
- Environmental Protection Agency (EPA), www.epa.gov
- National Safety Council, www.nsc.org
- National Skills Standards Board Institute, www.nssb.org
- Vocational Information Center, www.khake.com
- Power Tool Institute (PTI), www.powertoolinstitute.com
- Associated Builders and Contractors, www.abc.org
- Associated General Contractors of America, www.agcofamerica.org
- Building Officials and Code Administration International, www.bocai.org