**Electronic & Electrical Systems**

Subject Code: 010215

Course & Unit Descriptions

**Course Description:**

Students will diagnose, test and repair the electronic and electrical components found in industrial power equipment. Students will learn the physical principles of electricity and apply this knowledge in the maintenance, diagnostics and repair of electrical and electronic systems. Students will learn the physical and mathematical principles of electronics, controllers and sensors and will learn the operation of onboard computers and programmable controllers. Site and personal safety along with business and employability skills are emphasized throughout the course.

**Unit: Safety**

Students will demonstrate their knowledge of safety rules and regulations along with identifying safety signs and signals. Students will describe health and safety practices, demonstrate appropriate responses for major types of hazardous materials disasters and how identify potential hazards and their prevention.

Outcome 1.12

Site and Personal Safety Procedures: Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

Competency:

1.12.1. Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.

1.12.2. Interpret safety signs and symbols.

1.12.3. Interpret personal safety rights according to the employee Right to Know plan.

1.12.4. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

1.12.5. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

1.12.6. Identify procedures for the handling, storage and disposal of hazardous materials.

1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.

1.12.8. Identify safety hazards and take corrective measures.

1.12.9. Identify, inspect and use safety equipment appropriate for the task.

1.12.10.Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

1.12.11. Set up for ergonomic workflow.

1.12.12. Apply inspection, rejection criteria, hitch configurations and load handling practices to slings and rigging hardware.

1.12.15. Select and operate fire extinguishers based on the class of fire.

**Unit: Basic Electrical Theory**

Students learn the nature of electricity and how to wire the three types of electrical circuits; series, parallel, and series parallel. Students will demonstrate the role of magnetism, electromagnetism, and induction in electrical circuits along with the functions of electrical components.

Outcome 5.1

Electrical Theory: Interpret and apply electrical and electronic principles and theories.

Competency:

5.1.1. Interpret symbols and wiring diagrams.

5.1.2. Describe the features, benefits and applications of electrical and electronic systems.

5.1.3. Explain atomic structure and its relationship to electricity.

5.1.4. Describe the relationship between electrical effect and electromagnetic effect.

5.1.5. Explain methods of producing electrical current.

5.1.6. Describe the differences between alternating current (AC) and direct current (DC).

5.1.7. Compare and contrast conductors and insulators.

5.1.8. Differentiate the relationships among voltage, current, resistance and power in circuits.

5.1.9. Measure the amperage of AC and DC electrical systems and system components.

5.1.10. Calculate voltage, current, resistance, impedance and power in circuits using Ohm’s Law,

Kirchhoff’s Law and Watt’s Law.

5.1.11. Describe the purpose of grounding and common methods used for grounding.

5.1.12. Describe the uses of series, parallel and series-parallel circuits.

5.1.13. Use a digital multimeter to determine voltage, current, frequency and phase.

**Unit: Tools**

Students learn to identify the tools and instruments (e.g. hydrometers, digital multi-meters, ignition analyzers, generator-alternator-regulator tester) needed for electrical systems.

Outcome 4.1

Tool, Stationary and Mobile Equipment Maintenance: Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

Competency:

4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.

4.1.2. Ensure the presence and functionality of safety systems and hardware.

4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.

4.1.5. Inspect and service the electrical connections and lamps.

4.1.11. Calibrate metering, monitoring and sensing equipment.

**Unit: Diagnose and Repair Electrical Systems Components**

Students test and diagnose electrical systems by using tools and instruments (e.g. hydrometers, digital multi-meters, ignition analyzers, generator-alternator-regulator tester).

Outcome 4.3

Engines: Apply concepts to service components of both small and large internal combustion engines.

Competency:

4.3.2. Retrieve and record stored on-board diagnostics (OBD) trouble codes and clear codes where applicable.

4.3.3. Locate the name plate and determine engine specifications.

4.3.4. Analyze, evaluate and troubleshoot an engine.

Outcome 4.6

Ignition System: Perform ignition system diagnosis and repair.

Competency:

4.6.1. Explain basic ignition system theory.

4.6.2. Use wiring diagrams and schematics to troubleshoot and repair ignition system components

4.6.3. Diagnose and repair ignition system problems, including poor drivability, spark knock, excessive fuel consumption, power loss and emissions concerns, on vehicles with electronic and distributor ignition systems.

4.6.4. Identify and repair causes of start failures.

4.6.5. Identify and repair the causes of surging, rough operation, misfiring, low power, slow deceleration, slow acceleration and shutdown problems.

4.6.6. Inspect and test ignition primary and secondary circuit wiring and solid state components.

4.6.8. Inspect and test ignition system pickup sensor or triggering devices.

Outcome 4.8

Starting and Charging Systems: Identify, inspect and repair starting and charging system components.

Competency:

4.8.1. Differentiate between electrical and engine mechanical problems that cause a slow crank or no crank condition.

4.8.2. Use wiring diagrams and schematics to troubleshoot and repair starting and charging system components.

4.8.3. Inspect, test and replace relays and solenoids.

4.8.4. Perform charging system output tests to identify causes of undercharge, no charge and overcharge conditions.

4.8.6. Remove, inspect and install an alternator and starter.

**Unit: Schematics and Diagrams**

Students will read schematics to understand a machine’s electrical system, learn the differences between schematics and diagrams and how to use schematics and diagrams to troubleshoot equipment problems.

Outcome 4.3

Engines: Apply concepts to service components of both small and large internal combustion engines.

Competency:

4.3.2. Retrieve and record stored on-board diagnostics (OBD) trouble codes and clear codes where applicable.

4.3.3. Locate the name plate and determine engine specifications.

Outcome 4.6

Ignition System: Perform ignition system diagnosis and repair.

Competency:

4.6.2. Use wiring diagrams and schematics to troubleshoot and repair ignition system components

Outcome 4.8

Starting and Charging Systems: Identify, inspect and repair starting and charging system components.

Competency:

4.8.2. Use wiring diagrams and schematics to troubleshoot and repair starting and charging system components.

Outcome 5.1

Electrical Theory: Interpret and apply electrical and electronic principles and theories.

Competency:

5.1.1. Interpret symbols and wiring diagrams.

**Unit: Diagnose and Repair Electrical Systems Troubleshooting**

Students learn how to follow and when to use a systematic troubleshooting procedure.

Outcome 4.1

Tool, Stationary and Mobile Equipment Maintenance: Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

Competency:

4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.

4.1.2. Ensure the presence and functionality of safety systems and hardware.

4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.

4.1.5. Inspect and service the electrical connections and lamps.

4.1.11. Calibrate metering, monitoring and sensing equipment.

Outcome 4.3

Engines: Apply concepts to service components of both small and large internal combustion engines.

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Competency:

4.6.1. Explain basic ignition system theory.

4.6.2. Use wiring diagrams and schematics to troubleshoot and repair ignition system components

4.6.3. Diagnose and repair ignition system problems, including poor drivability, spark knock, excessive fuel consumption, power loss and emissions concerns, on vehicles with electronic and distributor ignition systems.

4.6.4. Identify and repair causes of start failures.

4.6.5. Identify and repair the causes of surging, rough operation, misfiring, low power, slow deceleration, slow acceleration and shutdown problems.

4.6.6. Inspect and test ignition primary and secondary circuit wiring and solid state components.

4.6.8. Inspect and test ignition system pickup sensor or triggering devices.

Outcome 4.8

Starting and Charging Systems: Identify, inspect and repair starting and charging system components.

Competency:

4.8.1. Differentiate between electrical and engine mechanical problems that cause a slow crank or no crank condition.

4.8.2. Use wiring diagrams and schematics to troubleshoot and repair starting and charging system components.

4.8.3. Inspect, test and replace relays and solenoids.

4.8.4. Perform charging system output tests to identify causes of undercharge, no charge and overcharge conditions.

4.8.6. Remove, inspect and install an alternator and starter.

**Unit: Business Operations**

Students will develop business goals and objectives using real-world examples of various organizational and business structures. Students will budget resources, evaluate outcomes, and forecast future budgetary needs according to standard business principles.

Outcome 1.10

Sales and Marketing: Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service.

Competency:

1.10.1. Identify how the roles of sales, advertising and public relations contribute to a company’s brand.

1.10.2. Determine the customer's needs and identify solutions.

1.10.3. Communicate features, benefits and warranties of a product or service to the customer.

1.10.4. Identify the company policies and procedures for initiating product and service improvements.

1.10.5. Monitor customer expectations and determine product/service satisfaction by using measurement tools.

1.10.6. Discuss the importance of correct pricing to support a product’s or service’s positioning in the marketing mix.

Outcome 1.6

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

Competency:

1.6.1. Identify business opportunities.

1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments and interdepartmental interactions.

1.6.6. Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry.

1.6.7. Identify the effect of supply and demand on products and services.

1.6.8. Identify the features and benefits that make an organization’s product or service competitive.

1.6.9. Explain how the performance of an employee, a department and an organization is assessed.

Outcome 1.8

Operations Management: Plan, organize and monitor an organization or department to maximize contribution to organizational goals and objectives.

Competency:

1.8.5. Use inventory and control systems to purchase materials, supplies and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN).

1.8.6. Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability.

1.8.8. Identify routine activities for maintaining business facilities and equipment.

**Unit: Communication & Information Management**

Students will research and conduct presentations using a variety of computer applications including Internet. Students will utilize personal information management to develop recordkeeping and communication skills. Students will organize information accurately and practice workplace communication techniques.

Outcome 1.4

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

Competency:

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.

1.4.4. Use system hardware to support software applications.

1.4.5. Use information technology tools to maintain, secure and monitor business records.

1.4.6. Use an electronic database to access and create business and technical information.

1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books).

1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.2

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

Competency:

1.2.1. Extract relevant, valid information from materials and cite sources of information.

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity)

**Unit: Business Leadership, Employability & Interpersonal Skills**

Students will develop critical thinking and problem solving skills through the use of a variety of practical scenarios. Students will demonstrate leadership skills through participation with peer groups, support services, and professional organizations.

Outcome 1.1

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

Competency:

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

Outcome 1.2

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

Competency:

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict-resolution skills to reach solutions.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g.,

common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.10. Use interpersonal skills to provide group leadership, promote collaboration and work in a team.

1.2.11. Write professional correspondence, documents, job applications and resumés.

1.2.12. Use technical writing skills to complete forms and create reports.

1.2.14. Use motivational strategies to accomplish goals.

Outcome 1.3

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

Competency:

1.3.1. Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).

1.3.8. Verify compliance with computer and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational and professional ethical standards.