**Course Description:**

Students will inspect, adjust and repair internal combustion engines and drivetrain. Topics include physical and mechanical principles of engines, transmissions and transaxles, differentials and cooling systems. Students will learn precision measurement, inspection, and reconditioning techniques. Students will also identify customer’s needs, determine labor rates, and create estimates.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome 1.1. Employability Skills**

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

**Competencies**

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

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

certification, licensure and experience.

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

postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and

organized labor and use networking techniques to develop and maintain professional

relationships.

1.1.5. Develop strategies for self‐promotion in the hiring process (e.g., filling out job applications,

résumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate

associated behaviors in fulfilling personal, community and workplace roles.

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

and formulating solutions.

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

establish and maintain professionalism.

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

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

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

for them.

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

behavior.

**Outcome 1.2. Leadership and Communications**

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

**Competencies**

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

1.2.2. Deliver formal and informal presentations.

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

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

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

intended audience and purpose.

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

1.2.7. Use problem‐solving and consensus‐building techniques to draw conclusions and determine

next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence

internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications

(e.g., common content for large audience, control of tone, speed, cost, lack of non‐verbal

cues, potential for forwarding information, longevity).

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

team.

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

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

1.2.13. Identify stakeholders and solicit their opinions.

1.2.14. Use motivational strategies to accomplish goals.

**Outcome 1.3. Business Ethics and Law**

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

**Competencies**

1.3.1. Analyze how regulatory compliance affects business operations and organizational

performance.

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

environment.

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

integrity, compassion, justice).

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

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety

data sheets [SDSs], product safety data sheets [PSDSs], 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 [ADA], Fair Labor Standards Acts [FLSA], Equal Employment Opportunity Commission [EEOC]).

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal,

organizational and professional ethical standards.

**Outcome 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

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

public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g.,

word processing, 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 1.5. Global Environment**

Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.

**Competencies**

1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.

1.5.4. Recognize barriers in cross‐cultural relationships and implement behavioral adjustments.

1.5.5. Recognize the ways in which bias and discrimination may influence productivity and

profitability.

1.5.7. Use intercultural communication skills to exchange ideas and create meaning.

**Outcome 1.6. Business Literacy**

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

**Competencies**

1.6.1. Identify business opportunities.

1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure).

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

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

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

1.6.12. Describe classifications of employee benefits, rights, deductions and compensations.

**Outcome 1.7. Entrepreneurship/Entrepreneurs**

Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.

**Competencies**

1.7.10. Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co-op] education, work placement, internship, job shadowing) related to an entrepreneurial objective.

**Outcome 1.8. Operations Management**

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

**Competencies**

1.8.4. Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies).

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] productions 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.

1.8.10. Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability.

**Outcome 1.10. Sales and Marketing**

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

**Competencies**

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/services satisfaction by using measurement tools.

1.10.10. Demonstrate sales techniques.

**Strand 2. Safety, Tools and Maintenance**

Learners apply principles of safety and use of tools to maintain equipment and the environment to prevent accidents and mitigate hazards.

**Outcome 2.1. Facility Safety**

Handle materials, prevent accidents and mitigate hazards.

**Competencies**

2.1.1. Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, situations that require working in confined spaces and safety labeling.

2.1.2. Identify and communicate hazards associated with slippery surfaces and lighting.

2.1.6. Identify and eliminate workplace clutter and maintain clearance and boundaries.

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

2.1.9. Identify locations and describe use of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

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

2.1.12. Conduct safety inspection of a workspace.

2.1.13. Identify the types of ergonomic workflow and the need for them.

2.1.14. Inspect air and exhaust systems, intake filters, fans and other mechanical components.

**Outcome 2.2. Personal Safety**

Practice personal safety.

**Competencies**

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

2.2.2. Describe the risk factors associated with working under the influence of drugs, alcohol and stimulants and how it increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

2.2.3. Select, use, maintain and dispose of Personal Protective Equipment (PPE) appropriate to job tasks, conditions and materials.

2.2.4. Identify workplace risk factors associated with repetitive motion and lifting, operating and moving heavy objects.

2.2.5. Demonstrate appropriate body mechanics in lifting and moving heavy objects.

**Outcome 2.3. Tool and Equipment Preventative Maintenance**

Identify, use, clean, maintain and perform planned preventative maintenance on tools and equipment.

**Competencies**

2.3.1. Identify the types of hand tools, power tools and stationary equipment and describe their function.

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

2.3.3. Operate power tools and stationary equipment in accordance with established procedures and safety standards.

2.3.5. Clean, lubricate and adjust power tools and stationary equipment.

**Outcome 2.4. General Maintenance**

Provide general maintenance to mechanical systems.

**Competencies**

2.4.22. Inspect, repair or replace fasteners.

**Strand 3. Engine Adjustments and Repair**

Learners apply principles of computerized engine controls, two- and four-stroke cycle combustion, emission controls, cooling systems, cylinder head and block assemblies and lubrication systems to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment.

**Outcome 3.1. Engine Cylinder Head and Block Assemblies**

Remove, disassemble and repair components in engine cylinder head and block assemblies.

**Competencies**

3.1.1. Describe the physical and mechanical principles of engine operation (i.e., motion, friction, thermodynamics).

3.1.2. Calculate displacement and compare and contrast displacement, horsepower and torque.

3.1.3. Describe two-cycle and four-cycle engines and their operating principles.

3.1.4. Describe the features, benefits and applications of engine types.

3.1.5. Inspect an engine assembly for fuel, oil, coolant and other leaks and determine potential causes.

3.1.6. Identify engine noises and vibrations and potential causes.

3.1.7. Verify the engine operating temperature.

3.1.8. Describe potential causes of excessive oil consumption and unusual exhaust color and sound.

3.1.9. Perform engine tests for vacuum, power balance, compression and leakage.

3.1.10. Inspect, adjust and replace drive belts and chains.

**Outcome 3.5. Lubrication and Cooling Systems**

Inspect lubrication and cooling systems operation.

**Competencies**

3.5.1. Explain principles of engine lubrication and cooling

3.5.2. Perform lubrication, cooling system and pressure and sensor tests.

3.5.3. Perform oil sampling and consumption tests.

3.5.4. Inspect the oil pump gears or rotors, housing, pressure relief devices and pump drive.

3.5.5. Inspect and test the radiator, pressure cap, coolant recovery tank and hose, cooling and heater system hoses and water pump.

3.5.6. Remove and replace radiator, pressure cap, coolant recovery tank and hose, cooling and heater system hoses.

3.5.7. Inspect, test and replace the thermostat and gasket.

3.5.8. Measure coolant concentration using a refractometer.

3.5.9. Identify types of coolants and their applications.

3.5.10. Test, drain, flush and refill coolant and bleed the cooling system.

3.5.11. Remove and replace the water pump.

3.5.12. Inspect mechanical and electrical fans, fan clutches, fan shrouds and air dams.

**Strand 5. Drivetrain**

Learners apply principles of transmissions and transaxles, manual drivetrains and axles, steering and suspension, drive shafts and wheels to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment to manufacturer’s specifications.

**Outcome 5.1. Automatic Transmission and Transaxle Performance**

Identify, inspect, adjust and replace automatic transmissions and transaxles.

**Competencies**

5.1.1. Research applicable vehicle and service information (e.g., transmission and transaxle system operation, fluid type, vehicle service history, service precautions, technical service bulletins).

5.1.2. Locate and interpret vehicle and major component identification numbers (i.e., vehicle identification number [VIN], vehicle certification labels, calibration decals).

5.1.3. Investigate fluid loss and condition concerns.

5.1.4. Inspect powertrain mounts.

5.1.5. Inspect and service the transmission, transaxle and torque converter.

5.1.6. Inspect for leaks on cooler lines and fittings.

**Outcome 5.2. Manual Transmission and Transaxle**

Identify, inspect and replace manual transmissions and transaxles.

**Competencies**

5.2.1. Identify the major components of manual transmissions, their function and the overall operation of manual transmissions.

5.2.2. Inspect, test and replace transmission and transaxle sensors and switches.

**Outcome 5.3. Clutches**

Identify and inspect clutches.

**Competencies**

5.3.1. Identify clutch noise, binding, slippage, pulsation and chatter.

5.3.2. Inspect the clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots and springs.

5.3.3. Inspect the hydraulic clutch slave and master cylinders, lines and hoses.

5.3.4. Inspect the clutch pressure plate assembly and clutch disc.

5.3.5. Bleed the clutch hydraulic system.

5.3.6. Inspect and measure the flywheel runout, crankshaft endplay and ring gear for wear and cracks.

5.3.7. Inspect and adjust the clutch master cylinder levels and check for leaks.

**Outcome 5.4. Drive Axle Universal and Differentials**

Identify, inspect and replace drive axle and differential components.

**Competencies**

5.4.1. Identify and inspect drive axle and differential assemblies for noise, vibration and fluid leakage.

5.4.2. Service and replace the shaft, yokes, boots and joints.

5.4.3. Replace drive axle seals, bearings and retainers.

5.4.4. Inspect and replace drive axle housing cover plates, gaskets, sealants, vents, plugs and seals.

**Strand 12. Vehicle Diagnosis and Estimating**

**Outcome 12.1. Vehicle Analysis**

**Competencies**

12.1.1 Identify differences between computer generated and manually written estimates.

12.1.2. Identify and record vehicle identification number (VIN) information, including nation of origin, make, model, restraint system, body type, production date, engine type, build data, and assembly plant.

12.1.3. Identify and document illuminated dash malfunction indicator lamp(s) (MIL).

12.1.5. Verify customer complaint, perform visual inspection, and/or road test vehicle.

12.1.6. Research applicable vehicle and service information, such as engine management system operation, vehicle service history, warranties, service contracts, service precautions, recalls and technical service bulletins.

**Outcome 12.2. Vehicle Inspection and Diagnosis**

**Competencies**

12.2.3. Identify components to be removed to access repair areas.

12.2.4. Perform visual inspection of components.

12.2.5. Diagnose noises and/or vibration problems related to engine performance; determine needed action.

12.2.6. Diagnose the cause of unusual exhaust color, odor, and sound; determine needed action.

12.2.7. Perform engine manifold vacuum or pressure tests; determine needed action.

12.2.8. Perform cylinder power balance test; determine needed action.

12.2.9. Perform cylinder cranking, relative, and running compression tests; interpret test results; determine needed action.

12.2.10. Perform cylinder leakage/leak-down test; determine needed action

12.2.11. Diagnose engine mechanical, electrical, electronic, fuel, and ignition problems with oscilloscope, engine analyzer, and/or scan tool; determine needed action.

**Outcome 12.3. Estimating**

**Competencies**

12.3.1. Determine parts, components, material type(s) and procedures necessary for a proper repair.

12.3.2. Determine appropriate methods for overall repairs.

12.3.4. Identify safety systems and advanced driver assistance systems; determine precautions, inspections and replacement items.

12.3.5. Determine and apply appropriate estimating sequence.

12.3.6. Use estimating procedure pages.

12.3.7. Apply estimating footnotes, headnotes, and line notes.

12.3.8. Identify operations requiring labor value judgement.

12.3.9. Select appropriate labor code for each operation.

12.3.10. Select and price OEM parts, optional OEM parts, aftermarket parts, recyclable/used parts, remanufactured, rebuilt, and reconditioned parts; verify availability, compatibility, and condition.

12.3.11. Determine necessary sublet operations.

12.3.12. Determine included and non-included operations and miscellaneous items.

12.3.13. Recognize and apply overlap deductions.

12.3.14. Determine additional material and charges.

12.3.15. Apply appropriate estimating and parts nomenclature (terminology).

12.3.16. Apply math skills to establish charges and totals.

12.3.17. Recognize the cost effectiveness of the repair and determine the approximate vehicle retail, and repair value.

12.3.18. Recognize the differences in estimating platforms when using different information provider systems.

12.3.19. Review estimate to determine appropriate methods for overall repair; communicate with team members to verify accuracy and resolve discrepancies.

12.3.20. Verify accuracy of estimate compared to the actual repair and replacement operations.