Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

AUTOMOTIVE AIR CONDITIONING SYSTEM MAINTENANCE

AUTAM401

Competence: Maintain automotive air conditioning system

RQF Level: 4

Learning Hours: 50

Credits: 5

Sector: Transport and Logistics

Trade: Automobile Technology

Module Type: Specific

Curriculum: TLAUT4001- TVET Certificate IV in Automobile Technology

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Purpose statement	This module describes the knowledge, skills and attitude required to repair vehicle air conditioning system. It is intended to be pursued by learner at TVET certificate level IV in automobile technology. At the end of this module, the learner will be able to conduct preventive maintenance of air conditioning system, maintain air conditioning electrical system and perform piping works of air conditioning system.					
Leaning assumed to be in place	Implement SHE policies and procedures, Install and maintain automotive electrical system.					
Delivery modality	**Training delivery**		**100%**	**Assessment**		**Total 100%**
	Theoretical content		30%	Formative assessment	30%	50%
	Practical work:		70%		70%	
	• Group project and presentation	20%				
	• Individual project /Work	50%				
				Summative Assessment		50%

Elements of Competency and Performance Criteria	
Elements of competency	**Performance criteria**
1. **Conduct preventive maintenance of A/C system**	1.1. Workplace health and safety (WHS) requirements are appropriately applied throughout the work
	1.2. Tools, materials and equipment are properly selected for effective diagnosis and repair methods
	1.3. Air conditioning system is accurately inspected/diagnosed to isolate faults according to workplace procedures and without causing damage to components.
	1.4. A/C components replacements and adjustments are carried out without causing damage, according to workplace procedures and manufacturer instructions.
2. **Maintain A/C electrical system**	2.1. Tools, materials and equipment are properly selected for effective diagnosis and repair methods
	2.2. Faults are appropriately identified and isolated, using appropriate tools and diagnostic techniques

	2.3. Repair and replacement of the components are effectively carried out without causing damage, according to workplace procedures
	2.4. Performance test of electrical components are conveniently carried out according to initial state
3. **Perform piping works**	4.1 Tools, materials and equipment are properly selected according to the workplace procedures and manufacturer instructions.
	4.2 Refrigerant recovery is properly carried out with respect to ozone depleting substances and according to industry regulations/guidelines, legislation and enterprise procedures/policies.
	4.3 Air conditioning pipes and fitting are accurately joined accordance with joining techniques and procedures
	4.4 A/C system is properly evacuated in accordance with manufacturer/ component supplier specifications and industry codes of practice with reference to ozone depleting substances
	4.5 Refrigerant charging operations are conveniently carried out with respect to ozone depleting substances and according to industry regulations/guidelines, legislation and enterprise procedures/policies
	4.6 Performance test of air conditioning system repaired are properly checked according to manufacturer instructions

Intended Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
✓ Types of tools, materials, and equipment ✓ Basic mechanical principles ✓ Mechanical attitude ✓ Applied mathematics ✓ Applied physics ✓ Applied chemistry ✓ Safety rules, precautions and security ✓ Fluids principles	✓ Computer skills ✓ Communication skills ✓ Troubleshooting skills ✓ Report elaboration skills ✓ Good service delivering skills ✓ Interpersonal skills ✓ Analytical skills ✓ Problem-solving skills ✓ Task management skills	✓ Honest ✓ Accountability ✓ Self-motivated ✓ Gender sensitive ✓ Customer care oriented ✓ Decisive ✓ Time management ✓ Humble ✓ Creative ✓ Patient

✓ Use of Personal Protective equipment ✓ Technical drawing	✓ Parts replacement skills ✓ Diagnostic skills ✓ Proper use of measurement instruments. ✓ Use of tools, materials and equipment ✓ Pipe joining skills	✓ Responsible ✓ Innovative ✓ Flexible ✓ Integrity ✓ Goal oriented ✓ Self-confident

Course content

Learning outcomes	**At the end of this module the learner will be able to:** 1. Conduct preventive maintenance of A/C system. 2. Maintain A/C electrical system. **3.** Perform piping works
Learning outcome 1: Conduct preventive maintenance of A/C system	**Learning hours: 10**
Indicative content	

- **Application of workplace, health, and safety (WHS) requirements throughout the work**
  - ✓ Prepare workplace environment.
  - ✓ Use handling of materials,
  - ✓ Use of firefighting equipment,
  - ✓ Use first aid.
  - ✓ Control hazardous materials and substances
- **Selection of tools, materials and equipment**
  - ✓ Protective clothing and equipment,
  - ✓ Hand tools
  - ✓ Power tools
  - ✓ Measuring tool
  - ✓ Equipment
- **Inspection and diagnosis procedures for Air conditioning system**
  - ✓ Leakage testing
  - ✓ Condition of the compressor's drive belt
  - ✓ Condenser blockage

- ✓ wiring and connectors to all sensors and switches
- ✓ Diagnosis for noise, odors, and trouble code

- **Replacements of A/C components**
  - ✓ A/C Compressor
  - ✓ A/C Condenser
  - ✓ Evaporator
  - ✓ Receiver/Dryer or Accumulator
  - ✓ Thermal Expansion Valve or Orifice Tube
- **Adjustments of A/C components**
  - ✓ Driven belt
  - ✓ Compressor

Resources required for the learning outcome	
Equipment	PPEs, cleaning equipment, pressure testing equipment, sealing equipment, leak detection equipment, thermometer, evacuation equipment, heating/soldering equipment, refrigerant recovery and/or recycling equipment, and refrigerant regassing equipment
Materials	Soap solution, Solvent, Clothes rugs, spray bottle, soft brushes, scrubber sponge, Broom, Mops, Refrigeration oils, refrigerants, spare parts, and cleaning materials
Tools	Spanners, pliers, screwdrivers, Pipe Wrenches, Refrigerant Scale,
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming
Formative assessment methods	• Written assessment • Performance assessment • Product based assessment • Oral based assessment

Learning outcome 2: Maintain A/C electrical system	Learning hours: 20
Indicative content	

- **Selection of tools, materials and equipment**
  - ✓ Hand tools
  - ✓ Power tools

- ✓ Measuring tool
- ✓ Equipment

- **Testing procedures for electrical Air conditioning system**
  - ✓ Short circuit
  - ✓ Blown Relays and fuses.
  - ✓ Looseness of electrical connectors
  - ✓ Discontinuity wires
  - ✓ Malfunction indicator lamp
  - ✓ Malfunction Control unit
  - ✓ Malfunction switches and sensors
- **Repairing and Replacements of vehicle electrical A/C components**
  - ✓ Magnetic clutch
  - ✓ A/C Condenser fan
  - ✓ Blower fan
  - ✓ Sensors
  - ✓ Actuators
  - ✓ Control unit
  - ✓ Heater core
  - ✓ Relays and fuses
  - ✓ Wiring
- **Adjustments of A/C components**
  - ✓ Driven belt
  - ✓ Compressor
- **Testing the functionality of electrical circuit**
  - ✓ Performance test of electrical circuit

Resources required for the indicative content	
Equipment	PPEs, cleaning equipment, pressure testing equipment, sealing equipment, leak detection equipment, thermometer, evacuation equipment, heating/soldering equipment, refrigerant recovery and/or recycling equipment, and refrigerant regassing equipment

Materials	Refrigeration oils, refrigerants, spare parts and cleaning materials
Tools	Spanners, pliers, screwdrivers, Pipe Wrenches, Refrigerant Scale, Soldering irons, Circuit testers, Leads and probes , Fuses & fuse pullers
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming
Formative assessment methods	• Written assessment • Performance assessment • Product based assessment • Oral based assessment

Learning outcome 3: Perform piping works	**Learning hours: 20**
Indicative content	

- **Selection of tools, materials and equipment**
  - ✓ Hand tools
  - ✓ Power tools
  - ✓ Measuring tool
  - ✓ Equipment
- **Refrigerant recovery method**
  - ✓ Liquid Refrigerant Recovery
  - ✓ Vapour Refrigerant Recovery
  - ✓ Push-Pull Refrigerant Recovery
- **Pipes and fitting joining techniques of Air conditioning system**
  - ✓ Threading
  - ✓ Brazing
- **A/C system evacuation**
  - ✓ Application of setting out methods
  - ✓ Steps for A/C evacuation
- **Refrigerant charging operations**
  - ✓ Refrigerant safety and precaution
  - ✓ Emptying air conditioning system
  - ✓ Produces for recycling of refrigerant
  - ✓ Procedures for recharging refrigerant
- **Air conditioning system testing**
  - ✓ Air conditioning testing procedures
  - ✓ Detecting of Leakage
  - ✓ Testing of operating state for A/C system
    - Cool Mode

- Heat Mode
- Fan Mode
- Dry Mode
- Auto Mode

Resources required for the indicative content	
Equipment	Vehicle with A/C, PPEs, Diagnostic machine, brazing equipment, Refrigerant recovery, recycle and recharging machine ,leakage tester
Materials	Air conditioner copper pipe, Air conditioner blower, Flux powder ,Solvents chemicals, Lubricants ,Refrigerant , air filter, grease, dryer oil, seals, brushes, belt
Tools	Gauge manifold, digital multi meter , nozzle plier, screw driver, screw wrench, L key set, vacuum pump, swing tool, level, tubing cutter, tube bender, drill machine, measure tape, pipe cutter, wire cutter, core removal tool
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming
Formative assessment methods	• Written assessment • Performance assessment • Product based assessment • Oral based assessment

Integrated/Summative assessment (For specific module)

Integrated situation

A driver of a banana juice company Ltd located in Kayonza district, he was driving from Kayonza to Kigali with a TOYOTA RAV4 2018, Towards reaching kabuga town, the air conditioning system stopped working to supply the vehicle with flesh air yet it was too hot. The driver took the vehicle to **A&B garage** in Kabuga town for repair but after several test by the head of garage, he found that the vehicle air conditioning system does not operate at all. The head of the garage requested you as Vehicle A/C service and repair technician to repair A/C system within 4hours.

Resources

Tools	Gauge manifold, digital multi meter, nozzle plier, screwdriver, screw wrench, Allen key set, swing tool, spilt level, tubing cutter, tube bender, drill machine, measure tape, pipe cutter, wire cutter, core removal tool
Equipment	Vehicle with A/C, PPEs, Diagnostic machine, brazing equipment, Refrigerant recovery, recycle and recharging machine, leakage tester, vacuum pump, refrigerant scale
Materials/ Consumables	Air conditioner copper pipe, Air conditioner blower, Flux powder, Solvents chemicals, Lubricants, Refrigerant, air filter, grease, dryer oil, seals,

	brushes, belt

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Learning outcome 1: Conduct preventive maintenance of A/C system (10%)	1.1. Workplace health and safety (WHS) requirements are appropriately applied throughout the work	Workplace health and safety (WHS) requirements are appropriately applied			2
	1.2. Tools, materials, and equipment are properly selected for effective diagnosis and repair methods	Tools, materials, and equipment are properly selected			2
	1.3. Air conditioning system is accurately inspected/diagnosed to isolate faults according to workplace procedures and without causing damage to components.	Air conditioning system is accurately inspected/diagnosed			2
	1.4. A/C components replacements and adjustments are carried out without causing damage, according to workplace procedures and manufacturer instructions.	A/C components replacements and adjustments are carried out			4
2. Learning outcome 2: Maintain A/C electrical system (30%)	2.1. Tools, materials, and equipment are properly selected for effective diagnosis and repair methods	Tools, materials, and equipment are properly selected			7
	2.2. Faults are appropriately identified and isolated, using appropriate tools and diagnostic techniques	Faults are appropriately identified and isolated			8
	2.3. Repair and replacement of the components are effectively carried out without causing damage, according to workplace	Repair and replacement of the components are effectively carried out			8

	procedures				
	2.4. Performance test of electrical components are conveniently carried out according to initial state	Performance test of electrical components are conveniently carried out			7
3. Learning outcome 3: Perform piping works (60%)	3.1. Tools, materials, and equipment are properly selected according to the workplace procedures and manufacturer instructions.	Tools, materials, and equipment are properly selected			5
	3.2. Refrigerant recovery is properly carried out with respect to ozone depleting substances and according to industry regulations/guidelines , legislation, and enterprise procedures/policies.	Refrigerant recovery is properly carried out			10
	3.3. Air conditioning pipes and fitting are accurately joined accordance with joining techniques and procedures	Air conditioning pipes and fitting are accurately joined			13
	3.4. A/C system is properly evacuated in accordance with manufacturer/ component supplier specifications and industry codes of practice with reference to ozone depleting substances	A/C system is properly evacuated			10
	3.5. Refrigerant charging	Refrigerant charging			12

		operations are conveniently carried out with respect to ozone depleting substances and according to industry regulations/guidelines , legislation, and enterprise procedures/policies	operations are conveniently carried out			
	3.6.	Performance test of repaired air conditioning system are properly checked according to manufacturer instructions	Performance test of repaired air conditioning system are properly checked			10
Total marks						**100**
Percentage Weightage						**100%**
Minimum Passing line % (Aggregate): 70%						

References:

1. **Daly, S. (2011). *Automotive air conditioning and climate control systems*. Elsevier.**
2. **Denton, T. (2020). *Advanced automotive fault diagnosis: automotive technology: vehicle maintenance and repair*. Routledge.**
3. **Erjavec, J., & Thompson, R. (2014). *Automotive technology: a systems approach*. Cengage learning.**
4. **Schnubel, M. (2012). *Today's Technician: Automotive Heating & Air Conditioning Classroom Manual and Shop Manual*. Cengage Learning.**
5. **Gilles, T. (2019). *Automotive service: inspection, maintenance, repair*. Cengage Learning.**