Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

AUTOMOTIVE ELECTRICAL SYSTEMS INSTALLATION AND MAINTENANCE

AUTEM401

Install and maintain automotive electrical systems

Competence

RQF Level: 4

Learning Hours: 110

Credits: 11

Sector: Transport and Logistics

Trade: Automobile Technology

Module Type: Specific

Curriculum: TLAUT4001- TVET Certificate IV in Automobile Technology

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<table>
<tr><td>Purpose statement</td><td colspan="5">This module describes the knowledge, skills and attitude required to Install and maintain automotive electrical systems. It is intended to be pursued by learner at TVET level IV for TVET Certificate IV in Automotive technology. At the end of this module, the learner will be able to Service starter battery, maintain charging system, maintain starting system, perform ignition system service, Repair lighting and signaling system and troubleshoot electrical system accessories</td></tr>
<tr><td>Leaning assumed to be in place</td><td colspan="5">Safety, Health and environment at workplace, Apply basic electricity and electronics.</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="4">Formative assessment</td><td>30%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>• Group project and presentation</td><td>20%</td></tr>
<tr><td>• Individual project /Work</td><td>50%</td></tr>
<tr><td colspan="3"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1. **Service starter battery**	1.1. PPE are properly selected and worn as per safety measures
	1.2. Starter batteries are properly identified according to their types.
	1.3. Starter batteries are properly described according to the starter battery characteristics.
	1.4. Starter batteries components are correctly described according to their types
	1.5. Tests and checks starter battery efficiency are properly carried out on battery system based on manufacturer specifications and test procedures.
	1.6. Starter battery charging is correctly performed according to the charging mode
	1.7. Performance test of starter battery is properly checked according to manufacturer instructions
2. **Maintain**	2.1. Charging system components are properly described according to the charging

charging system	system designed
	2.2. Tools, materials and equipment are properly selected based on their function
	2.3. Charging system components are properly dismantled from the vehicle based on repair manual.
	2.4. Alternator is properly disassembled based on repair manual.
	2.5. Charging system components are appropriately replaced/ repaired according to the damaged parts without causing damage to other components or system
	2.6. Charging system components are properly re-mounted to the vehicle based on repair manual.
	2.7. Charging system is properly tested according to manufacturer instructions
3. **Maintain starting system**	3.1 Starting system components are properly described according to the system design.
	3.2 Tools, materials and equipment are properly selected based on the work.
	3.3 Starter motor is properly dismantled from the engine based on repair manual.
	3.4 Starting system components are properly disassembled based on repair manual.
	3.5 Starting system components are appropriately replaced/repaired according to the damaged parts without causing damage to other components or system.
	3.6 Starter motor is properly re-mounted to the engine based on repair manual.
	3.7 Starting system is properly tested according to manufacturer instructions
4. **Perform ignition system service**	4.1 Ignition system is properly identified according to the ignition system design/types.
	4.2 Ignition system components are properly described according to the ignition system design/types.
	4.3 Ignition system components are correctly checked according to the ignition system types.
	4.4 Ignition system parts are correctly dismounted according to the ignition system types.

	4.5 Ignition system parts are appropriately disassembled according to the ignition system types.
	4.6 Ignition system parts are correctly adjusted and replaced according to the ignition system types.
	4.7 Ignition system parts are appropriately re-assembled according to the ignition system types.
	4.8 Ignition system parts are correctly re-mounted according to the ignition system types.
	4.9 Performance test of ignition system is properly checked according to manufacturer instructions
5. **Repair lighting and signalling system**	5.1 Lighting and signalling system components are properly described according to the system design/types.
	5.2 Tools, materials and equipment are properly selected based on their function.
	5.3 Lighting and signalling system are correctly diagnosis according to the service manual
	5.4 Lighting and signalling system parts are correctly dismounted according to the ignition system types.
	5.5 Lighting and signalling system are correctly cleaned and replaced according to the service manual
	5.6 Headlights are accurately adjusted as per manufacturer service information
6. **Troubleshoot electrical system accessories**	6.1 Electrical system accessories are properly described according to the types of system.
	6.2 Electrical system accessories are correctly diagnosis according to the service manual.
	6.3 Electrical system accessories are correctly dismounted according to the system types.
	6.4 Electrical system accessories are appropriately disassembled according to the system types.

	6.5 Electrical system accessories are correctly cleaned, adjusted, repaired and replaced according to the service manual.
	6.6 Electrical system accessories are appropriately re-assembled according to the system types.
	6.7 Electrical system accessories are correctly re-mounted according to the system types.
	6.8 Performance test of electrical system accessories are properly checked according to manufacturer instructions

Intended Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
✓ Types of tools, materials, and equipment ✓ Basic electrical principles ✓ Applied mathematics ✓ Applied physics ✓ Applied chemistry ✓ Safety rules, precautions and security ✓ Use of Personal Protective equipment ✓ Technical drawing	✓ Computer skills ✓ Communication skills ✓ Troubleshooting skills ✓ Report elaboration skills ✓ Good service delivering skills ✓ Interpersonal skills ✓ Analytical skills ✓ Problem-solving skills ✓ Task management skills ✓ Parts replacement skills ✓ Diagnostic skills ✓ Proper use of measurement instruments.	✓ Honest ✓ Accountability ✓ Self-motivated ✓ Gender sensitive ✓ Customer care oriented ✓ Decisive ✓ Time management ✓ Humble ✓ Creative ✓ Patient ✓ Responsible ✓ Innovative ✓ Flexible ✓ Integrity ✓ Goal oriented ✓ Self-confident

Course content	
Learning outcomes	**At the end of the module the learner will be able to:** 1. Service starter battery 2. Maintain charging system 3. Maintain starting system 4. Perform ignition system service 5. Repair lighting and signalling system 6. Troubleshoot electrical system accessories
Learning outcome 1: Service starter battery	**Learning hours: 10**
Indicative content	

- **Selection and wearing of PPE**
  - ✓ Head protection
  - ✓ Eyes protection
  - ✓ Skin protection
  - ✓ Foot protection
  - ✓ Noise protection
  - ✓ Clothing protection
- **Identification of starter batteries**
  - ✓ Dry charged
  - ✓ Wet charged
  - ✓ Free maintenance batteries
- **Description of Starter batteries components**
  - ✓ Plastic case
  - ✓ Negative plate
  - ✓ Positive plate
  - ✓ Separator
  - ✓ Cells
  - ✓ Positive terminal
  - ✓ Negative terminal
  - ✓ Grids
  - ✓ Electrolyte

- **The potential energy density of several battery types**
  - ✓ Lead-acid
  - ✓ Nickel-iron/cadmium
  - ✓ Nickel-metal-hydride
  - ✓ Sodium-sulphur
  - ✓ Sodium-nickel-chloride
  - ✓ Lithium
- **Charging techniques**
  - ✓ Boost charging
  - ✓ Constant Voltage
  - ✓ Constant Current
- **State of battery charge**
  - ✓ Discharged (20% or less)
  - ✓ Half charged (50%)
  - ✓ Charged (100%)
- **Performance test of starter battery**
  - ✓ Voltages
  - ✓ Starting capacity
  - ✓ Electrolyte density
  - ✓ Battery cell

Resources required for the learning outcome	
Equipment	Black board, Projector, Computer, PPEs, cleaning equipment, PPEs, cleaning equipment, battery, battery charger, battery tester, thermometer, multimeter and temperature gauge, hydrometer
Materials	Soap solution, Solvent, Clothes rags, white board, spray bottle, soft brushes, scrubber sponge, Broom, Mops, Marker pen, black board and Chalks, Electrolyte, Vaseline, sand paper, granite surface plate and cleaning materials
Tools	Spanners, pliers, screwdrivers, Wrenches, sockets spanner, scanner tool
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Simulation

Formative assessment methods	• Oral based assessment • Written assessment • Performance assessment • Product based assessment

Learning outcome 2: Maintain charging system	**Learning hours: 15**
Indicative content	

- **Identification and description of charging system components**
  - ✓ Alternator
  - ✓ Starter battery
  - ✓ Voltage regulator
  - ✓ Ignition switch
  - ✓ Wiring
  - ✓ Relays and fuses
  - ✓ Drive belt
- **Selection of tools, materials and equipment**
  - ✓ Hand tool
  - ✓ Power tool
  - ✓ Materials
  - ✓ Equipment
- **Dismantling of charging system components from the vehicle**
  - ✓ Dismantling procedures
- **Disassembling of alternator parts**
  - ✓ Alternator and their parts
  - ✓ Voltage regulator
- **Repairing or replacement of charging system components**
  - ✓ Worn or broken Drive belt
  - ✓ Voltage Regulator
  - ✓ Alternator
  - ✓ Starter battery

- ✓ Relays and fuses
- ✓ Warning lamp

- **Re-mounting of charging system components to the vehicle**
  - ✓ Re-mounting procedures
- **Testing the functionality of charging system**
  - ✓ Static
  - ✓ Dynamic

Resources required for the indicative content	
Equipment	Personal protective equipment (PPE), personal computer, projector, cleaning equipment, Diagnostic equipment, lamp tester , PPEs, cleaning equipment, multi-meter, Oscilloscope, Battery charger, Battery load tester, Computer with software (Auto data),measuring equipment,
Materials	Complete Alternator, Grease , Paper sand, Mark pen, Lubricants, Brushes , Lamps, Insulator taps, wires, distilled water, electrolyte, tin wire
Tools	Spanners, pliers, screwdrivers, Pipe Wrenches, Soldering irons, Circuit testers, Fuses & fuse pullers, plastic hummer
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Trainer guided • Simulation
Formative assessment methods	• Written assessment • Performance assessment • Product based assessment • Oral based assessment

Learning outcome 3: Maintain starting system	Learning hours: 20
Indicative content	

- **Identification and description of starting system components**
  - ✓ Starter motor
  - ✓ Starter battery
  - ✓ Ignition switch

- ✓ Ground wire
- ✓ Relays and fuses
- ✓ Flywheel

- **Selection of tools, materials and equipment**
  - ✓ Complete toolbox
  - ✓ Power tool
- **Inspecting/testing of the starter control circuit**
  - ✓ Battery
  - ✓ Fusible link
  - ✓ Ignition switch
  - ✓ Neutral safety switch
  - ✓ Clutch switch starter relay
  - ✓ Solenoid
- **Dismounting of Starter motor from engine**
  - ✓ Dismantling procedures
- **Disassembling of Starter motor components**
  - ✓ Disassembling procedures
- **Repairing/replacement of starting system components**
  - ✓ Control circuit
  - ✓ Solenoid contacts
  - ✓ Meshing drive
  - ✓ Rotor and starter
  - ✓ Housing
  - ✓ Brushes holder and carbon brushes
  - ✓ Heavy ground cables
  - ✓ Bearing
- **Testing functionality of starter motor**
  - ✓ Bench testing of starter motor
- **Re-mounting of the Starter motor on the engine**
  - ✓ Re-mounting procedures of starter motor
- **Testing functionality of the starting system**
  - ✓ Static
  - ✓ Dynamic

Resources required for the indicative content	
Equipment	Projector, computer, Personal protective equipment (PPE), Multi-meter, Oscilloscope, Battery charger, Battery load tester, Computer with software (Auto

	data), PPE, starter motor
Materials	Lamp tester, Grease, Paper sand, Mark pen, Lubricants, Brushes, Lamps, Insulator taps
Tools	Screw driver, screw wrench, Spanners, Terminal cleaner, Screw driver, Hummer, Pliers, Scanner tool, Bench vise, Pulley remover, Jump start cable, Wire brush
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Trainer guided • Simulation
Formative assessment methods	• Oral based assessment • Written assessment • Performance assessment • Product based assessment

Learning outcome 4: Perform ignition system service	**Learning hours: 20**
Indicative content	

- **Identification of Ignition system types**
  - ✓ Battery coil ignition system (Conventional coil ignition system)
  - ✓ Transistorized ignition system
  - ✓ Electronic Ignition System
  - ✓ Full electronic ignition system

- **Description of Ignition system components**
  - ✓ Battery
  - ✓ Ignition coil
  - ✓ Ignition distributor
  - ✓ Ignition control module
  - ✓ Low and high voltage cables
  - ✓ Sensor
  - ✓ Spark plugs
  - ✓ Capacitor
  - ✓ Contact breaker
- **Checking of ignition system components**
  - ✓ Visual inspection
  - ✓ Test sparks strength
  - ✓ Test ignition coil

- ✓ Measure the air gap
- ✓ Cleaning and inspection of spark plug
- ✓ Ignition timing

- **Dismounting of ignition system parts**
  - ✓ Dismantling procedures
- **Disassembling of ignition system parts**
  - ✓ Disassembling procedures
- **Replacement of ignition system parts**
  - ✓ Ignition distributor
  - ✓ Battery
  - ✓ Ignition coil
  - ✓ Ignition control module
  - ✓ Control module
  - ✓ Spark plugs
  - ✓ High tension cables
  - ✓ Sensors
- **Adjustment of ignition system parts**
  - ✓ Ignition distributor
- **Re-assembling of the ignition system parts**
  - ✓ Re-assembling procedures
- **Re-mounting of the ignition system parts**
  - ✓ Re-mounting procedures of ignition system parts
- **Checking of performance test of ignition system**
  - ✓ Misfire
  - ✓ Rough idling or hesitation under load
  - ✓ No- starter situation

Resources required for the indicative content	
Equipment	Projector, computer, Personal protective equipment (PPE), multi-meter, Oscilloscope, Battery charger, Battery load tester, Computer with software (Auto data), PPE, ignition tester
Materials	Water, Lamp tester, Grease, Paper sand, Mark pen, Lubricants, Brushes, Lamps, Insulator taps, spark plugs
Tools	Screw driver, screw wrench, Spanners, Terminal cleaner, Screw driver, Hummer, Pliers, Scanner tool, Bench vise, Pulley remover, Jump start cable
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Trainer guided • Simulation

Formative assessment methods	• Oral based assessment • Written assessment • Performance assessment • Product based assessment

Learning outcome 5: Repair lighting and signalling system	Learning hours: 25
Indicative content	

- **Description of lighting and signalling system components**
  - ✓ Bulbs
  - ✓ Socket
  - ✓ Relays and fuses
  - ✓ Rear lights
  - ✓ Headlights
  - ✓ Alarm
  - ✓ Starter battery
  - ✓ Control module
  - ✓ Commutators
  - ✓ Switches
  - ✓ Indicator
  - ✓ Front/rear position lamp
  - ✓ Ignition switch
- **Selection of tools, materials and equipment**
  - ✓ Complete toolbox
  - ✓ Diagnostic machine
  - ✓ Battery capacity load tester
  - ✓ Bulbs
- **Diagnosis of lighting and signalling system components**
  - ✓ Bulbs
  - ✓ Socket
  - ✓ Relays
  - ✓ Fuses
  - ✓ Rear lights
  - ✓ Headlights
  - ✓ Alarm
  - ✓ Starter battery
  - ✓ Control module
  - ✓ Commutators
  - ✓ Switches
  - ✓ Indicator
  - ✓ Front/rear position lamp
  - ✓ Ignition switch

- **Replacement and cleaning of lighting and signalling system parts**
    - ✓ Bulbs
    - ✓ Socket
    - ✓ Relays and fuses
    - ✓ Rear lights
    - ✓ Headlights
    - ✓ Alarm
    - ✓ Starter battery
    - ✓ Control module
    - ✓ Commutators
    - ✓ Switches
    - ✓ Indicator
    - ✓ Front position lamp
    - ✓ Ignition switch
- **Adjustment of headlights**

Resources required for the indicative content	
Equipment	Projector, computer, Personal protective equipment (PPE), multi-meter, Oscilloscope, Battery charger, Battery load tester, Computer with software (Auto data)
Materials	Water, Lamp tester, Grease, Paper sand, Mark pen, Lubricants, Brushes, Lamps, Insulator taps
Tools	Screw driver, screw wrench, Spanners, Terminal cleaner, Screw driver, pate measure, Pliers, Scanner tool, Bench vise, Pulley remover, Jump start cable, Wire brush.
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Simulation
Formative assessment methods	• Oral based assessment • Written assessment • Performance assessment • Product based assessment

Learning outcome 6: Troubleshoot electrical system accessories	Learning hours: 20

Indicative content

- **Description of electrical system accessories**
  - ✓ Wiper and washer circuit
  - ✓ Power window
  - ✓ Flasher circuit
- **Diagnosis of electrical system accessories**
  - ✓ Voltage
  - ✓ Fuse continuity
  - ✓ Check battery
- **Dismounting of electrical system accessories**
  - ✓ Wiper and washer circuit
  - ✓ Power window
  - ✓ Flasher circuit
- **Disassembling of electrical system accessories**
  - ✓ Disassembling procedures
- **Adjustment /cleaning of electrical system accessories**
  - ✓ Wiper and washer circuit
  - ✓ Power window
  - ✓ Flasher circuit
- **Re-assembling of the electrical system accessories**
  - ✓ Re-assemble procedure
- **Re-mounting of the electrical system accessories**
  - ✓ Re-mounting procedures
- **Testing of electrical system accessories functionality**

Resources required for the indicative content	
Equipment	Projector, computer, Personal protective equipment (PPE), multi-meter, Oscilloscope, Battery charger, Battery load tester, Computer with software (Auto data)
Materials	Lamp tester, Paper sand, Mark pen, Brushes, Insulator taps, electrical system accessories

Tools	Screw driver, screw wrench, Spanners, Terminal cleaner, Screw driver, Hummer, Pliers, Scanner tool
Facilitation techniques	• Group discussion, • Demonstration • Brainstorming • Simulation • Demonstration
Formative assessment methods	• Oral based assessment • Written assessment • Performance assessment • Product based assessment

Integrated/Summative assessment

Integrated situation

Mr. KANOGO a driver of MERCEDESS BENZ Motor Company in KAMONYI District was heading to wheat miller Plant located at Nyanza District to collect wheat floor for Mr. Otto food store at KAMONYI. As he was approaching RUHANGO center while it was raining, the vehicle made an accident which damaged engine compartment of the vehicle, which causes the following faults: Hard engine starting, Engine misfiring, Alternator is not charging the battery, right head lamps breaks and wiper and washer systems is not working at all.

He decided to look for intervention in AMAN Garage nearby. Garage electrical supervisor, requested you as an automotive electrician to solve those problems within 8hours.

Tools	Screw driver, screw wrench, Spanners, Terminal cleaner, Screw driver, Hummer, Pliers, Scanner tool, Wire brush, starter Battery, lamp tester
Equipment	Multi-meter, Oscilloscope, Personal protective equipment(PPE) Battery charger, Head light tester
Materials/ Consumables	Water ,Paper sand, Mark pen, Brushes, Insulator taps, electrical wires, Fuses ,Relays, Dc motors, shop rags, Solvents, Multifunction switches, Resistors, Bulbs, spark plugs, high and low voltage cables,

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
Learning outcome 1: Select tools,	1.1. Tools are appropriately selected according to the	Tools are properly selected			5

materials and equipment (15%)	work to be performed				
	1.2. Equipment is accurately selected according to the work to be performed	Equipment are properly selected			5
	1.3. Materials are adequately selected according to the standard	Materials are properly selected			5
Learning outcome 2: Repair electrical system (70%)	2.1. Electrical systems are properly diagnosis according to the types of system	Ignition system is properly diagnosed			3
		Starter is properly diagnosed			1
		Wiper and washer systems are properly diagnosed			2
		Alternator is properly diagnosed			2
		Right head lamps are diagnosed			2
	2.2. Electrical systems are properly dismantled from the engine based on repair manual.	Ignition system is properly dismantled			2
		Starter is properly dismantled			3
		Wiper and washer systems are properly dismantled			3
		Alternator is properly dismantled			3
		Right head lamps are dismantled			3
	2.3. Electrical system components are properly disassembled based on repair manual.	Ignition system components are properly disassembled			3
		Starter parts are properly disassembled			2
		Wiper and washer are properly disassembled			3
		Alternator parts are properly disassembled			3
		Right head lamps are correctly disassembled			2
	2.4. Electrical systems are properly replaced/repaired	Ignition system is properly repaired			3
		Starting system is properly			3

	according to the system	repaired			
		Wiper and washer systems are properly replaced /repaired			2
		Alternator is properly repaired			3
		Right head lamps are correctly replaced			2
	2.5. Electrical systems are properly re-assembled in the circuit according to system.	Ignition system is properly re-assembled			3
		Starter motor is properly re-assembled			2
		Wiper and washer systems are properly re-assembled			3
		Alternator is correctly re-mounted			2
		Right head lamps are correctly re-assembled			2
	2.6. Electrical systems are properly re-mounted in the circuit according to system.	Ignition system is properly re-mounted			3
		Starter motor is properly re-mounted			2
		Wiper and washer systems are properly re-mounted			3
		Alternator is correctly re-mounted			2
		Right head lamps are correctly re-mounted			2
Learning outcome 3: Test electrical system performance (15%)	3.1. Ignition system is correctly tested according to the performance of the system	Engine misfiring is correctly fixed			3
	3.2. Starting system is correctly tested according to the performance of the system	Poor cranking is correctly fixed			2
	3.3. Wiper and washer are correctly tested according to the performance of the system	Wiper and washer systems are correctly fixed			2
	3.4. Charging system is correctly tested according to the performance of the system	Alternator is correctly charging the battery			2
	3.5. Headlights are accurately adjusted as per manufacturer service information	Right head lamps are correctly Adjusted			2
Total marks					**100**

Percentage Weightage	100%
Minimum Passing line % (Aggregate): 70%	

References:

1. Denton, T. (2017). *Automobile electrical and electronic systems*. Routledge.
2. Asef, P., Padmanaban, S., & Lapthorn, A. (Eds.). (2022). *Modern Automotive Electrical Systems*. John Wiley & Sons.
3. Denton, T. (2011). *Automobile mechanical and electrical systems*. Routledge.
4. Candela, T. (2009). *Automotive wiring and electrical systems* (Vol. 160). CarTech Inc.