NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

AUTOMOTIVE REPAIR AND MAINTENANCE

NQF LEVEL 4

IMPLEMENTATION: JANUARY 2015
INTRODUCTION

A. What is Automotive Repair and Maintenance?

This subject builds onto knowledge and skills obtained in Automotive Repair and Maintenance Level 2 and 3. The subject introduces students to specialised vehicle components and systems and their functioning in the vehicle technology, including air conditioning, automatic transmissions, reduction drives, electronic management systems, engine configuration and design as well as hybrid and electric drivelines.

The content of this subject was revised to address gaps and shortcomings in the first version of the curriculum. The Department of Higher Education and Training worked in close collaboration with stakeholders and role players from both industry and FET Colleges who all provided valuable input and participated in the revision process.

B. Why is Automotive Repair and Maintenance important in the Engineering and Related Design programme?

Automotive Repair and Maintenance transfers trade-specific skills, knowledge, values and attitudes so that students can explain how mechanics is applied in practice.

C. The link between the Automotive Repair and Maintenance Learning Outcomes and the Critical and Developmental Outcomes

In Automotive Repair and Maintenance, students will identify faults and solve problems relating to the automotive field. They will need to work effectively individually or in teams. Since they will need to record the requirements for fixing faults, they will also use communication and writing skills.

Automotive Repair and Maintenance covers two of the Development Outcomes:
- Explore strategies to learn more effectively
- Explore education and career opportunities.

D. Factors that contribute to achieving the Automotive Repair and Maintenance Learning Outcomes

An interest in the subject is necessary to reap the rewards of learning how to work on vehicles with the basic related knowledge, and to use the relevant terminology correctly.
AUTOMOTIVE REPAIR AND MAINTENANCE – LEVEL 4

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1 DURATION AND TUITION TIME

This is a one year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided all of the assessment requirements are adhered to.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL OUTCOMES AND FOCUS

SAQA Qualification ID: 50441

Exit level Outcome:

On completion of this subject the student should be able to:

Explain and perform specialised vehicle maintenance and repair tasks and activities

Range: Special vehicle maintenance services includes: automatic transmissions, conventional drives, reduction drives, electronic engine management systems, power assisted steering systems, specialised vehicle systems (ABS, TCS, ESC, SRS)

Associated Assessment Criteria:

- Specialised automotive systems in vehicles are identified and explained in terms of their properties and function.
- Common problems occurring with these systems are identified in terms of how they manifest.
- Solutions to the problems are identified and addressed where possible according to manufacturer’s specifications.
- Work is conducted in accordance with workplace safety requirements.

3 ASSESSMENT

Information provided in this document on internal and external assessment aims to inform, assist and guide lecturers to plan the effective teaching of the subject.

The Assessment Guidelines accompanying this document provides detailed information for planning and conducting internal and external assessments.

3.1 Internal assessment (50 percent)

Detailed information regarding internal assessment and moderation is outlined in the current Internal Continuous Assessment (ICASS) Guideline document provided by the Department of Higher Education and Training (DHET).

3.2 External assessment (50 percent)

A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. A practical component, the Integrated Summative Assessment Task (ISAT), will be included in the external assessment.

Detailed information regarding external assessment and moderation is outlined in the National Policy on the Conduct, Administration and Management of the Assessment of
4 WEIGHTED VALUES OF TOPICS (Topic weighting and time allocation)

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>WEIGHTED VALUE</th>
<th>*TEACHING HOURS</th>
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<tbody>
<tr>
<td>1. Engine configuration and design</td>
<td>10%</td>
<td>11</td>
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<td>2. Automatic transmission types and maintenance</td>
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<td>3. Conventional final drives</td>
<td>5%</td>
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<td>4. Single and Double reduction drives</td>
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<td>5. Electronic engine management systems (petrol)</td>
<td>10%</td>
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<td>6. Electronic engine management systems (diesel)</td>
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<td>7. Diagnosis and rectification of faults in power assisted steering systems</td>
<td>10%</td>
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<td>8. Diagnosis of electronic systems</td>
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<td>9. Air-conditioning in cars</td>
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<td>11. SRS systems in vehicles</td>
<td>5%</td>
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<tr>
<td>12. Hybrid and electric drivelines in vehicles</td>
<td>5%</td>
<td>5.5</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
<td><strong>110</strong></td>
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*Teaching Hours* refers to the minimum hours required for face to face instruction and teaching. This excludes time spent on revision, tests and internal and external examinations and assessment. The number of allocated teaching hours is influenced by the topic weighting, complexity of the subject content and the duration of the academic year.

5 CALCULATION OF FINAL MARK

Internal assessment mark: \(\text{Student's mark}/100 \times 50/1 = \text{a mark out of 50 (a)}\)

Examination mark: \(\text{Student's mark}/100 \times 50/1 = \text{a mark out of 50 (b)}\)

Final mark: \((a) + (b) = \text{a mark out of 100}\)

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, among others, purposes of moderation and verification, and reporting.

6 PASS REQUIREMENT

The student must obtain at least fifty (50) percent in ICASS and fifty (50) percent in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

Topic 1: Engine configuration and design
Topic 2: Automatic transmission types and maintenance
Topic 3: Conventional final drives
Topic 4: Single and Double reduction drives
Topic 5: Electronic engine management systems (petrol)
Topic 6: Electronic engine management systems (diesel)
Topic 7: Diagnosis and rectification of faults in power assisted steering systems
Topic 8: Diagnosis on electronic systems
Topic 9: Air-conditioning in cars
Topic 10: ABS/TCS/ESC systems in vehicles
Topic 11: SRS systems in vehicles
Topic 12: Hybrid and electric drivelines in vehicles

**Topic 1: Engine configuration and design**

**Subject Outcome 1.1: Explain the compression ratio**

**Learning Outcomes:**
The student should be able to:
- Describe the advantages and disadvantages of increasing the compression ratio of an engine
- Describe different methods of increasing the compression ratio.
- Explain the importance of compression pressure
- Name different factors that influence the final compression pressure.
- Explain the importance of volumetric efficiency
- List different reasons for low volumetric efficiency.
- Describe different methods of increasing the volumetric efficiency
- Explain the compensation for altitude by a turbo charger

**Subject Outcome 1.2: Explain thermal efficiency in an engine**

**Learning Outcomes**
The student should be able to:
- Explain the concept ‘thermal efficiency’.
- Describe the effect of altitude on engine power
- Compare petrol engines with diesel engines.
- Calculate the compression ratio of an engine
- Explain the concept ‘Air Standard Efficiency’ (ASE)
- Calculate the Air Standard Efficiency (ASE) of an engine.

**Subject Outcome 1.3: Explain different types of crankshaft design**

**Learning Outcomes**
The student should be able to:
- Explain static and dynamic crankshaft balancing.
- Name different types of crankshafts
- Explain power and mechanical balances.
- Describe the function of vibration dampers
- Explain different crankshaft layouts and firing orders.
- Explain different methods to increase the compression ratio.
Topic 2: Automatic transmission types and maintenance

Subject Outcome 2.1: List and describe different types of automatic transmissions

Learning Outcomes:
The student should be able to:
- List and describe various types of automatic transmissions
  Range: conventional hydraulic, hydraulic/electronic, CVT, Multitronic, Tiptronic and Steptronic
- Explain the advantages of automatic transmissions
- Explain the working principles of different types of planetary gear sets and torque converters

Subject Outcome 2.2: Describe the construction of an automatic transmission

Learning Outcomes:
The student is able to:
- Identify automatic transmission components and describe their operation
  Range: gears, clutches, brake belts, governors, pump, hydraulic unit, dampers, and cooler
- Trace on a given diagram automatic transmission power flow in different situations
  Range: drive, reverse, 2, 1, park
- Trace on a given diagram hydraulic pressure flow in different situations
- Explain torque converter lock-up constructions.
- Explain overdrive/hold switches in relation to the shifting pattern.

Subject Outcome 2.3: Perform basic maintenance and repairs on an automatic transmission

Learning Outcomes:
The student should be able to:
- Perform a regular service on an automatic transmission
  Range: oil level check, oil and filter change
- Describe how to perform a stall test to identify possible mechanical or hydraulic faults
- Describe the appropriate equipment used to read out fault codes from the transmission control unit and draw conclusions according to factory specifications
- Explain the checking of the different electrical circuits that affect the performance of the automatic transmission
  Range: selector switch, temperature sensor, turbine speed sensor, vehicle speed sensor, solenoid valves

Topic 3: Conventional final drives

Subject Outcome 3.1: Understand conventional final drive differentials

- Describe the operation of a conventional final drive differential.
- Identify conventional final drive differential parts and explain their functions.
- Explain the reconditioning of conventional final drive differentials.
- Explain procedures to test and check differentials prior to dismantling and after reconditioning.
- Explain the methods of assessing serviceability of differential parts.
• Explain the procedure for ordering replacement parts.

**Subject Outcome 3.2: Identify and select correct tools and equipment**

**Learning Outcomes:**
The student should be able to:
• Read and interpret job instructions and determine a sequence of operations according to worksite procedures.
• Identify and select appropriate personal protective equipment (PPE) according to statutory requirements.
• Identify and select appropriate tools and equipment according to job requirements and worksite procedures.
• Identify and select appropriate measuring instruments and care for the instruments related to differential reconditioning.
• Use, and give reasons for using, manufacturer’s manuals and/or specifications according to job requirements.
• Prepare work area and differential according to safety, worksite and manufacturer’s procedures, and give reasons for doing so.

**Subject Outcome 3.3: Assess a conventional final drive differential**

**Learning Outcomes:**
The student should be able to:
• Clean the differential before assessment, according to manufacturer’s, worksite and safety procedures.
• Disassemble differential as per manufacturer’s specifications and procedures.
• Lay out the parts neatly on a clean work surface, giving reasons for doing so.
• Inspect parts visually for defects, according to manufacturer’s guidelines.
• Use appropriate measuring instruments to measure parts according to manufacturer’s procedures and record the actual measurements.
• Compare measurements to manufacturer’s specifications for serviceability.
• Separate and mark unserviceable parts according to worksite and quality procedures.
• Compile a condition report that identifies unserviceable parts, giving reasons for their not being serviceable.
• Order replacement parts according to worksite procedures.

**Subject Outcome 3.4: Assemble a conventional final drive differential**

**Learning Outcomes:**
The student should be able to:
• Describe the principles of using lubricants related to differentials.
• Explain safety procedures related to reconditioning differentials.
• Clean parts before assembly according to safety and worksite procedures.
• Assemble the differential according to manufacturer’s specifications, worksite procedures and timetables.
• Apply attachment agents according to manufacturer’s procedures and job requirements.
• Provide reasons for using specified lubricants during assembly.
• Perform measurements and/or adjustments during assembly according to manufacturer’s specifications and procedures.
• Perform post checks, where necessary, according to manufacturer’s and worksite procedures.
Subject Outcome 3.5: Complete documentation and report on conditions

Learning Outcomes:
The student should be able to:
• Explain the purpose of documentation.
• Complete documentation according to worksite procedures.
• Give reasons for preparing vehicle differential sub-assembly for storage.
• Prepare differential for storage according to manufacturer’s and worksite procedures.
• Restore work area to serviceable condition according to worksite procedures.

Topic 4: Single and Double reduction drives

Subject Outcome 4.1: Understand single and double reduction drive differentials
• Explain the operation of a single reduction drive
• Explain the operation of a single speed double reduction differential.
• Explain the operation of a two speed double reduction differential.
• Identify reduction type differential parts and explain their functions.
• Explain the reconditioning of reduction type differentials.
• Explain the testing and checking of reduction type differentials after reconditioning and prior to dismantling.
• Explain the methods of assessing differential parts for serviceability.
• Explain the procedure for ordering replacement parts.

Subject Outcome 4.2: Identify and select correct tools and equipment

Learning Outcomes:
The student should be able to:
• Read and interpret job instructions and determine a sequence of operations according to worksite procedures.
• Identify and select appropriate personal protective equipment (PPE) according to statutory requirements.
• Identify and select appropriate tools and equipment according to job requirements and worksite procedures.
• Identify and select appropriate measuring instruments and care for the instruments related to differential reconditioning.
• Use, and give reasons for using, manufacturer’s manuals and/or specifications according to job requirements.
• Prepare work area and differential according to safety, worksite and manufacture’s procedures, and give reasons for doing so.

Subject Outcome 4.3: Assess double reduction drive differentials

Learning Outcome:
The student is able to:
• Clean parts before assessment according to manufacturer’s worksite and safety procedures.
• Disassemble a reduction type differential as per manufacturer’s specifications and procedures.
• Neatly lay out the parts on a clean work surface, giving reasons for doing so.
• Inspect parts visually for defects according to manufacturer’s guidelines.
• Use appropriate measuring instruments and measure parts according to manufacturer’s procedures.
• Record and compare measurements to manufacturer’s specifications for serviceability.
• Separate and mark unserviceable parts according to worksite and quality procedures.
• Compile a condition report that identifies unserviceable parts, giving reasons for their not being serviceable.
• Order replacement parts according to worksite procedures.

**Subject Outcome 4.4: Assemble single and double reduction drive differentials**

**Learning Outcomes:**
The student is able to:
• Explain the principles of lubrication related to differentials.
• Describe safety procedures related to reconditioning reduction type differentials.
• Clean parts before assembly according to safety and worksite procedures.
• Assemble a reduction type differential according to manufacturer’s specifications, worksite procedures and time tables.
• Apply attachment agents according to manufacturer’s procedures and job requirements.
• Provide reasons for using specified lubricants during assembly.
• Perform measurements and/or adjustments during assembly according to manufacturer’s procedures and specifications.
• Perform post checks, where necessary or possible, on completion of the reconditioning procedures according to manufacturer’s and worksite procedures.

**Subject Outcome 4.5: Complete documentation and a report on condition of components**

**Learning Outcomes:**
The student should be able to:
• Explain the purpose of documentation.
• Complete documentation according to worksite procedures.
• Provide reasons for preparing vehicle differential sub-assembly for storage.
• Prepare differential for storage according to manufacturer’s and worksite procedures.
• Restore work area to serviceable condition according to worksite procedures.

**Topic 5: Electronic engine management systems (petrol)**

**Subject Outcome 5.1: Test and diagnose faults in the EFI system of an engine**

**Learning Outcomes:**
The student should be able to:
• Describe various types of electronic fuel injection systems
• Investigate and apply safe working practices throughout the task.
• Check the fuel system and the engine compartment visually to ensure no obvious faults exist.
• Select and use suitable test instruments and equipment to enable a system test to be conducted without damaging electronic and circuit components
• Activate, read and interpret the self-test codes and identify faulty circuits.
• Test the faulty circuit indicated by the self-test codes to locate and identify the fault.
• Test the EFI circuits not monitored by the self-test system, to identify and locate faults.
• Record and compare the results of the tests performed to the vehicle specification.
• Analyse the results to locate and identify the cause of any fault.

**Subject Outcome 5.2: Replace EFI system components of an engine**

**Learning Outcomes:**
The student should be able to:
- Investigate and apply safe working practices throughout the task.
- Replace any faulty EFI system components with parts that meet manufacturer’s specifications in a manner prescribed by the manufacturer.
- Test the system to ensure that the integrity of the wiring is in a serviceable condition.
- Test the system to ensure there are no air or fuel leaks.
- Check all adjustments and, where necessary, correct to comply with manufacturer’s specifications.
- Confirm if the EFI system is performing according to manufacturer’s specifications.

**Subject Outcome 5.3: Test and diagnose faults in an electronic ignition computer system of an engine. NOTE: Tasks to be performed only on a practical simulator**

**Learning Outcomes:**
The student should be able to:
- Investigate and apply safe working practices throughout the task.
- Check the electronic ignition system and the engine compartment visually to ensure that no obvious faults exist.
- Select and use suitable test instruments and equipment to enable the completion of a system test without damaging electronic and circuit components.
- Activate, read and interpret the self-test codes and identify any faulty circuit.
- Test the faulty circuit indicated by the self-test codes to locate and identify the fault.
- Test the electronic ignition circuits not monitored by the self-test system, to locate and identify any faults.
- Record and compare the results of the performed tests with the vehicle specification.
- Analyse the results to locate and identify the cause of any fault.

**Subject Outcome 5.4: Replace electronic ignition system components of an engine**

**Learning Outcomes:**
The student should be able to:
- Investigate and apply safe working practices throughout the task.
- Remove and replace faulty electronic ignition system components with parts that meet manufacturer’s specifications.
- Test the system to ensure that the integrity of the wiring is in a serviceable condition.
- Check all adjustments and, where necessary, correct to comply with manufacturer’s specifications.
- Confirm if the electronic ignition system operates according to manufacturer’s specifications.

**Topic 6: Electronic engine management systems (diesel)**

**Subject Outcome 6.1: Test and diagnose faults in a diesel engine management system of an engine**

**Learning Outcomes:**
The student should be able to:

- Describe various types of diesel engine management systems

  **Range: conventional type, common rail and electronic injection**

- Investigate and apply safe working practices throughout the task.
- Check the air intake system for blockages and leaks and determine if it is operating correctly.
- Check the fuel system and the engine compartment visually to ensure no obvious faults exist.
- Select and use suitable equipment to enable system test to be conducted.
- Use test instruments without causing damage to circuit components and electronic devices.
- Activate, read and interpret the self-test codes to identify any faulty circuit.
- Use a simulator/running engine to test the faulty circuit indicated by the self-test codes to locate and identify the fault.
- Test the electronic diesel circuits not monitored by the self-test system, to identify and locate any faults.
- Test the fuel supply system for operating pressure, pressure retention, and fuel flow rate, and record the results.
- Record and compare the results of the above tests with the vehicle specification.
- Analyse results to locate and identify the cause of any fault.

**Subject Outcome 6.2: Rectify electronic diesel injection system faults on an engine**

**Learning Outcomes:**
The student should be able to:

- Investigate and apply safe working practices throughout the task.
- Replace any faulty electronic diesel injection system components with parts that meet manufacturer’s specifications, as prescribed by the manufacturer.
- Use a simulator/running engine and test the system to ensure that the integrity of the wiring is in a serviceable condition.
- Use a simulator/running engine and test the system to ensure that there are no fuel blockages.
- Use a simulator/running engine and test the system to ensure that there are no air or fuel leaks.
- Check all adjustments and where necessary, correct to comply with manufacturer’s specifications.
- Confirm if the electronic diesel injection system operates and performs according to manufacturer’s specifications.

**Topic 7: Diagnosis and rectification of faults in power assisted steering systems**

**Subject Outcome 7.1: Explain the functioning of power assisted steering systems**

**Learning Outcomes:**
The student should be able to:

- Explain the operation of hydraulic assisted power steering
- Identify and explain the purpose of individual parts of hydraulic assisted power steering.
- Explain the operation of electronically controlled hydraulic assisted power steering.
- Identify and explain the purpose of individual parts of electronically controlled hydraulic assisted power steering.
• Explain the operation of electronically controlled electric assisted power steering.
• Identify and explain the purpose of individual parts of electronically controlled electric assisted power steering.

Subject Outcome 7.2: Test and service power assisted steering

Learning Outcomes:
The student should be able to:
• Investigate and apply safe working practices throughout the task.
• Select and use suitable tools and equipment to enable tests and service work to be carried out.
• Acquire all necessary factory data in relation to servicing the steering.
• Check, and if necessary replace the hydraulic fluid in the steering system.
• Check, and if necessary adjust the tension of the drive belt driving the hydraulic pump.
• Check, and if necessary adjust the free-play between the rack and pinion of the steering housing.
• Check the steering system to determine possible faults and provide repair advice

Subject Outcome 7.3: Diagnose faults in an electronic power assisted steering system

Learning Outcomes:
The student should be able to:
• Investigate and apply safe working practices throughout the task.
• Describe how to test the system and read out trouble codes using a diagnostic tool/ scanner (in case of an electronic power assisted steering)
• Replace any faulty components with parts that meet the manufacturer’s specifications, as prescribed by the manufacturer.
• Test the system to ensure the integrity of the wiring is in a serviceable condition.
• Test the system to ensure there are no electrical or hydraulic problems.
• Test the system to ensure that there are no leaks.
• Check all adjustments and where necessary, correct to comply with manufacturer’s specifications.
• Confirm the system performs according to manufacturer’s specifications.

Topic 8: Diagnosis of electronic systems

Subject Outcome 8.1: Inspect and replace an electronic system

Learning Outcomes:
The student is able to:
• Locate and use relevant service information
  Range: Includes diagnostic procedures, flow charts, and wiring diagrams.
• Inspect and replace electrical connector terminals, seals, and locks.
• Inspect and test sensors, controls, actuator components, and circuits; adjust or replace as needed.
• Access and change customer parameters, using recommended electronic diagnostic tools.
  Range: Includes PC based software and/or data scan tools
• Perform a cylinder contribution test using the recommended electronic diagnostic tool.

Subject Outcome 8.2: Use advanced electronic diagnostic tools to trace faults
Learning Outcomes:
The student is able to:
• Use a digital multi-meter to measure frequency, duty-cycle/pulse of electronic signals.
• Use a lab-scope to measure different wave forms.
• Use a scanning tool to retrieve fault codes from various control units in the car.
• Use a scanning tool to capture live data from different sensors/actuators of electronic circuits.

Subject Outcome 8.3: Construct and test advanced electronic circuits
Learning Outcomes:
The student is able to:
• Describe the fundamentals of advanced electronics.
• Explain the operation of advanced electronic circuits.
• Read and interpret advanced electronic circuit diagrams.
• Identify and select advanced electronic and related components for circuit construction.
• Complete a requisition form.
• Select and use appropriate tools, personal and automobile protective equipment correctly.
• Identify and use appropriate hand tools and test equipment correctly.
• Construct advanced electronic circuits.
• Test advanced electronic circuits for static and dynamic voltages.
• Operate circuit according to manufacturers’ specifications.
• Apply the relevant safety procedures when working with electronic equipment.
• Describe incidents and problems related to advanced electronic work.
• Compile a fault finding report.

Topic 9: Air-conditioning in cars

Subject Outcome 9.1: Explain basic operation of air-conditioning systems
Learning Outcomes:
The student is able to:
• Investigate and describe relevant safety practices and procedures when working with air conditioning systems
• Explain the basic operating principles of the refrigeration cycle
• Name the components of an automobile air-conditioning system and explain their functions
• Name different types of air-conditioning systems used in cars and explain the differences between them
• Explain the functions of different refrigerant gases
• Explain the advantages and disadvantages of different refrigerant gases
• List and describe international laws on the use of different gases in automobile refrigerant systems

Subject Outcome 9.2: Perform basic checks and maintenance on air-conditioning systems in cars
Learning Outcomes:
• Identify and select appropriate tools, test equipment and components
• Read and interpret air-conditioning electrical circuit diagrams and component symbols
- Test and diagnose air-conditioning problems without connecting pressure gauges or gas bottles
- Compile a requisition form
- Service and maintain automobile air-conditioning systems according to manufacturer’s specifications
- Check that the air-conditioning system is operating according to manufacturer’s specifications
- Compile fault finding reports on automobile air-conditioning systems.

**Subject Outcome 9.3: Repair and rebuild air-conditioning systems in cars**

**Learning Outcomes:**
The student is able to:
- Identify and select appropriate tools for emptying, disassembling, assembling and refilling air-conditioning systems
- Use appropriate filling station to recover the refrigerant gas from the air-conditioning system
- Renew different parts in the system
  - Range: condenser, evaporator, filter/dryer, pipes, expansion valve
- Test the system for leakage (vacuum) and refill it with the right amount of refrigerant using the appropriate filling station
- Read out fault codes from electronic climate control systems and determine the repair procedure according to factory specifications
- Test the performance of the system according to factory specifications and write a report on the repair.

**Topic 10: ABS/TCS/ESC systems in vehicles**

**Subject Outcome 10.1: Explain vehicle dynamics during braking, accelerating and cornering**

**Learning Outcomes:**
The student should be able to:
- Explain the braking, acceleration and cornering forces between tyre and road surface.
- Explain the coefficient of friction and slip.
- Explain the Anti-lock Brake System (ABS) control
- Explain the difference between ‘select high’ and ‘select low’ control
- Explain the Traction Control System (TCS)
- Explain the Electronic Stability Control (ESC)
- Describe braking and acceleration control on low and high traction surfaces
- Describe braking and acceleration control in cornering

**Subject Outcome 10.2: Explain the operation of the ABS/ TCS/ ESC system**

**Learning Outcomes:**
The student should be able to:
- Identify and explain the functions of differential parts of an ABS system.
- Explain the functions of different wheel sensors used in modern ABS systems.
- Explain the working of the Hydraulic Electronic Control Unit (HECU)
- Explain the electric circuit diagram of a basic ABS system
- Identify additional circuits in the wiring diagram for the ABS system to work as a TCS
and/or ESC system as well
• Explain the working of Electronic Brake Distribution (EBD) as part of the ABS control system
• Explain the working of Hydraulic Brake Assist (HBA) as part of the ABS system.
• List the important safety issues when working on the ABS/TCS/ESC system.

Topic 11: SRS systems in vehicles

Subject Outcome 11.1: Understand dynamic safety issues in a car

Learning Outcomes:
The student should be able to:
• Explain the impact forces on a car in the event of a collision.
• Explain the importance of ‘crumple zones’ in a car.
• Explain internationally recognised crash tests and ‘star’ ratings for cars
• Explain the importance of active headrests and ISO fix systems for child seats
• Explain the term ‘Supplementary Restraint System’ in relation to the use of seat belts
• Explain the importance of the seat/ driver/ passenger position in case of a collision.

Subject Outcome 11.2: Explain the operation of the SRS system

Learning Outcomes:
The student should be able to:
• Identify different parts of a SRS system and explain their functions.
• Identify additional parts when the SRS system is equipped with Passenger Airbag Deactivating device (PAD).
• Identify additional parts when the SRS system is equipped with Passenger Presence Detecting device (PPD).
• Explain the deployment conditions of the different SRS devices.
• Explain airbag classification standards
• Explain the electric circuit diagram of an SRS system
• Identify additional circuits in the wiring diagram if the SRS is equipped with PAD and/or as PPD
• Explain the firing sequence of the different SRS devices
• Explain the interpretation of the warning light for the driver.
• List the safety issues that are important for working on the SRS system.

Topic 12: Hybrid and electric drivelines in vehicles

Subject Outcome 12.1: Explain the operation of the hybrid/electrical driveline in a vehicle

Learning Outcomes:
The student should be able to:
• Identify different parts of a hybrid/electrical driveline and explain their functions. 
  Range: Combustion engine, electro motor/generator unit, DC-DC converter, inverter, converter, batteries (both high voltage and low voltage), ECU and safety switch.
• Explain the climate control system of the hybrid/electrical driveline
• Explain the brake system of the hybrid/electrical driveline.
• Explain the cooling system of the hybrid/electrical driveline.
• Draw the electric circuit diagram of a hybrid/electrical driveline system

**Subject Outcome 12.2: Explain the advantages and safety risks of hybrid and electrical cars**

**Learning Outcomes:**
The student should be able to:
• Describe the advantages of using hybrid or electrical drivelines in cars
• Distinguish between the hybrid and conventional drivelines in terms of safety
• List the important safety issues when working on the hybrid/electrical driveline system
• Explain the consequences for starting a hybrid vehicle with a low 12V battery
• Explain the internationally recognised safety regulations for working on hybrid and electrical vehicles.
• Explain different ways of charging the battery in a hybrid/electrical driveline
• Explain the appropriate tools and protection when working on hybrid and electrical vehicles

**RESOURCE NEEDS FOR THE TEACHING OF AUTOMOTIVE REPAIR AND MAINTENANCE - LEVEL 4**

**8.1 Physical resources**
• A fully equipped workshop with all the necessary tools and equipment required to achieve the outcomes expected in this subject
  • Practical simulators to use for practical diagnosis
• Availability of computers and printers for students to complete assignments or case studies and to conduct research
• Research software, for example Encarta
• Subject related magazines (Motor Vehicle Technology; Auto Data Book & Technique, etc.), newspapers related to subject and subject-related reference books
• Subject-related DVDs and videos
• List of stakeholders prepared to be involved in the learning process through making presentations or providing the opportunity for students to gain practical experience
• Applicable legislation or Acts for use by lecturers during lessons and students for research purposes
• Stock room to store video or DVD machines, televisions, etc.
• Security for stockroom, media centre and practicum room.
• Computer and data projector or latest technology to electronically project data for students
• Flash disk for lecturer to store information
• Presentation programme on computer to be used by lecturer to provide students with visual information on Learning Outcomes

• White board, black board and pull-down screen

• Desks big enough for students to work on

8.2 Human resources

• Lecturing staff must be appropriately qualified and must possess the necessary knowledge, skills and reflexive approach to ensure that students’ learning is kept up to date with the latest technologies and changing trends in their specialist field.

• Lecturers should be a qualified (red seal) in the following trades:
  o Motor mechanic
  o Diesel fitter
  o Diesel mechanic

• Lecturers must have a minimum qualification of N3 Motor Trade Theory, must have passed the official trade test and have a minimum of five years practical experience in a trade after completing the trade test.

• It would be an advantage to have available a full time technology and research centre manager, with knowledge of computers, website browsing, research and reference books.

• Continuous staff development with exposure to an industrial environment is necessary for lecturers to acquire new skills and to update their existing skills where new technologies have been introduced. Lecturers are required to spend a structured and routine period annually in an industrial environment for these purposes.

• Staff development in terms of updating teaching, learning and assessment skills is required on an ongoing basis, particularly for staff that move from industry into the educational environment of an FET College.

8.3 Other Resources

The institution should have funding available to provide the following:

• consumables necessary to perform practical assignments and examinations

• maintenance of physical recourses

• purchasing of new equipment.