19.2.0 ENGINE TECHNOLOGY

19.2.01 INTRODUCTION

The course module is designed to equip the trainees with knowledge, skills and attitudes that will enable them carry out general maintenance and reconditioning vehicle engines.

The graduate of this module will be able to work in the formal and vehicle industry as a competent technician in vehicle service and maintenance.

19.2.02 GENERAL OBJECTIVES

By the end of this module the trainee will be able to:

a) understand the working principles of a petrol engine.
b) understand the working principles of fuel and engine cooling systems.
c) observe safety precautions while handling vehicle engines.
d) understand the working principles of a diesel engine.
e) perform the engine tune up and test for efficiency.

19.2.03 MODULE UNIT SUMMARY AND TIME ALLOCATION

ENGINE TECHNOLOGY

Module	Sub-Module Unit	Content	Time Hrs		
			T	P	Total
19.2.1	Engines	• Types of Engines • Construction • Combustion chamber designs • Engine balancing	6	18	24
19.2.2	Lubrication	• Terminologies • Lubricants • Methods of lubrication • Lubrication components	4	12	16
19.2.3	Cooling	• Types of cooling systems • Air cooled • Liquid cooled	4	10	14

		• Cooling system components			
19.2.4	S.I. fuel systems	• Layout • Simple carburettor • Methods of mixture correction • Constant choke carburettor • Variable choke carburettor • Manifold designs • Air cleaners • Silencers • Petrol injection systems • Fuel pumps • Liquefied petroleum gas • (2PG) • Cold starting devices • Emission control	12	20	32
19.2.5	C.I. fuel system	• Layout • Injector pump • Inline pump • DPA pump • Governors • Pressure time injection • system • Electronic diesel injection • system • Cold start devices • Supercharging	12	18	30
19.2.6	Special Engines	• Rotary engine • Striving engine • Gas turbine engine • Hybrid engine • Solar engine	10	16	26
Total Time			**48**	**94**	**142**

19.2.1 ENGINES

19.2.1T0 *Specific Objectives*
By the end of this sub module unit, the trainee should be able to:
a) explain the operating principles of various types of vehicle engines
b) describe the construction of engine components.
c) describe various engine valve arrangements and their limitations
d) describe the construction of types of combustion chambers
e) discuss engine balancing

19.2.1 Competence
The trainee should have the ability to*:*
i) overhaul a S.I and C.I. engines
ii) rebore engine cylinder block

Content
19.2.1T1 Operating principles of various vehicle engines
iii) Four stroke (S.I. & C.I.) engines
iv) Two stroke (S.I. & C.I.) engines
19.2.1T2 Engine construction and components layout
19.2.1T3 Engine Valve arrangements
- Limitations

19.2.1T4 Combustion chambers
i) Direct injection
ii) Indirect injection
19.2.1T5 Engine balancing
i) Need for engine balancing
ii) Methods of engine balancing

Practice

19.2.1P0 *Specific Objectives*
By the end of this sub module unit, the trainee should be able to:
a) overhaul a S.I. engine
b) overhaul a C.I. engine
c) rebore engine cylinder block

Content
19.2.1P1 S.I Engine overhaul
i) Cylinder head
ii) Removal
iii) Dismantling
iv) Inspection
v) Decarbonising
vi) Cutting and re facing valve seats
vii) Replacement of valve seats
19.2.1P2 C.I Engine Overhaul
19.2.1P3 Cylinder block
i) Pistons
ii) removal
iii) inspection
iv) measurements
v) replacement of rings

vi) Crankshaft and bearings
vii) removal
viii) inspection
ix) measurements
x) Cylinders
xi) inspection
xii) measurements
xiii) Seals and gaskets
xiv) Inspection
xv) Replacement

19.2.2 LUBRICATION

19.2.2T0 *Specific Objectives*

By the end of this sub module unit, the trainee should be able to:

a) define the various lubrication terminologies
b) explain the need for engine lubrication
c) sketch the basic engine lubrication layout
d) describe the methods of lubrication

Content

19.2.2T1 Lubrication terminologies
i) Flow
ii) Viscosity
iii) Multigrade oil
iv) SAE number
v) Oiliness

19.2.2T2 Need for engine lubrication
i) Friction
ii) Cooling
iii) Cleaning

19.2.2T3 Lubrication system layout
i) Sump pan
ii) Oil pressure relief valve
iii) Gallery
iv) Oil pump
v) Oil filter

19.2.2T4 Methods of lubrication
i) Pressure feed
ii) Splash
iii) Wet sump
iv) Dry sump

Practice

19.2. P0 *Specific Objectives*

By the end of this sub module unit, the trainee should be able to:

a) overhaul an oil pump
b) service the lubrication system

19.2.2C Competence

The trainee should have the ability to Service the engine lubrication system

Content

19.2. P1 Oil pumps
i) Gear pump
ii) Vane pump
iii) Rotor pump

19.2. P2 Servicing the lubrication system
i) Drain plug
ii) Oil filter
iii) Lubricating oil

Suggested Learning Resources

i) Charts
ii) Repair manuals
iii) Text books

iv) Vehicle engine

19.2. 3 COOLING SYSTEM

19.2. 3T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to:
a) describe the types of cooling systems
b) explain the operation of cooling systems
c) describe construction of cooling system components

19.2.3C Competence
The trainee should have the ability to
i) Locate cooling system components
ii) Identify faults
iii) Maintain cooling system
iv) Observe safety

Content

19.2.3T1 Types of cooling systems
i) Air cooled
ii) Liquid cooled
iii) Comparison of cooling systems

19.2.3T2 Operation of cooling systems
i) Air cooled
ii) Liquid cooled
iii) sealed system
iv) pressurized system

19.2.3T3 Cooling system Components
i) Pumps
ii) Thermostats
iii) Radiators
iv) Pressure caps
v) Cooling fans
vi) electric
vii) viscous
viii) Coolant
ix) Anti-freeze mixtures

Practice

19.2.3P0 *Specific Objectives*
By the end of the module unit, the trainee should be able to:
a) identify components of cooling systems
b) diagnose system faults
c) service the cooling systems
d) observe safety in cooling systems

Content

19.2.3P1 Components identification

19.2.3P2 System fault diagnosis
i) Pressure tests
ii) Thermost tests
iii) Leakages
iv) Pump faults

19.2.3P3 Service of cooling systems
i) Coolant level
ii) Antifreeze mixing
iii) Leakage repairs

19.2.3P4 Safety observation
i) Hot coolant
ii) Antifreeze

Suggested Learning Resources

i) Tools
ii) Equipment
iii) Cooling systems
iv) L.C.D.
v) Manuals

19.2.4 S.I. FUEL SYSTEMS

Theory

19.2.4T0 *Specific Objectives*
By the end of this sub module unit, the trainee should be able to:
a) sketch the layout of spark ignition fuel systems
b) describe the construction and operation of a simple carburettor
c) describe the different methods of mixture correction in a constant choke carburettor
d) explain the construction and operation of the constant choke carburettor
e) explain the construction and operation of the variable choke carburettor
f) explain the construction of inlet and exhaust manifolds in relation to performance of the engine
g) describe the construction and operation of various types of air cleaners
h) describe the construction and operation of exhaust silencers
i) describe the types and layout of petrol injection systems
j) describe the construction and operation of the fuel pumps
k) describe the construction and operation of the liquefied petroleum gas (LPG) systems
l) describe the construction and operation of various cold start devices
m) describe the various methods of emission control

19.2.4C Competence
The trainee should have the ability to:
i) Overhaul carburettors
ii) Service inlet and exhaust manifolds
iii) Service fuel injection
iv) Carryout engine testing

Content

19.2.4T1 Layout
i) Gravity feed

ii) Pressure feed

19.2.4T2 Construction and operation of a simple carburettor

19.2.4T3 Methods of mixture correction
- i) Air bleed compensation
- ii) Compensating set
- iii) Accelerator pump
- iv) Economy devices
- v) Idling system
- vi) Enrichment devices

19.2.4T4 Constant choke carburettor
- i) Single barrel
- ii) Twin choke carburettor

19.2.4T5 Variable choke carburettor

19.2.4T6 Manifold designs
- i) Inlet manifolds
- ii) Exhaust manifolds

19.2.4T7 Air cleaners
- i) Wet type
- ii) Dry type

19.2.4T8 Exhaust silencers

19.2.4T9 Fuel pumps
- i) Mechanical pumps
- ii) Electrical pump

19.2.4T10 Petrol injection systems
- i) Layout
- ii) Types
- iii) Petrol injection system components

19.2.4T11 Liquefied petroleum gas system
- i) Construction
- ii) Operation

19.2.4T12 Cold starting devices
- i) S.I. engine devices
- ii) C.I. engine devices

19.2.4T13 Emission control

Practice

19.2.4P0 *Specific Objectives*

By the end of this sub module unit, the trainee should be able to:
- a) replace and repair fuel system components
- b) overhaul carburettors
- c) tune up a twin carburettor engine
- d) service inlet manifolds
- e) service exhaust manifolds and mufflers
- f) service a fuel injections system
- g) identify liquefied petroleum gas system components
- h) carry out engine testing

Content

19.2.4P1 Fuel system components

19.2.4P2 Fuel lift pumps

19.2.4P3 Carburettor maintenance
- i) Overhaul
- ii) Tune-up

19.2.4P4 Servicing fuel injection system
- i) K-type injection system
- ii) D-type injection system
- iii) L-type injection system

19.2.4P5 Service inlet manifolds
- i) Air leaks
- ii) Leaks

19.2.4P6 Repair exhaust manifolds and mufflers
- i) Leaks

19.2.4P7 Identification of liquefied petroleum gas system

19.2.4P8 Engine testing
- i) Morse test
- ii) Dynamometer test
- iii) Engine emission test
- iv) Road test
- v) Tune-up

Suggested Learning Resources
- i) Textbook/workshop manuals
- ii) Models
- iii) Engines
- iv) Dynamometers

19.2.5T C.I. FUEL SYSTEM

Theory

19.2.5T0 *Specific Objectives*
By the end of the module unit, the trainee should be able to:
- a) describe the layout of diesel fuel system
- b) explain the operation of injectors
- c) describe the construction operation of inline pump
- d) describe the construction and operation of DPA pump
- e) explain types of governors
- f) describe the construction and operation of pressure time injection system
- g) describe the construction of electronic diesel injection system
- h) explain types of cold start devices
- i) describe the types of supercharging systems

19.2.5C Competence
The trainee should have the ability to:
- i) Trace faults in C.I fuel systems
- ii) Overhaul C.I fuel systems components
- iii) Carry out tests and adjustments in C.I fuel systems

Content

19.2.5T1 Layout of C.I. fuel system
- i) Lift pump
- ii) Fitters

19.2.5T2 Injectors
- i) Multi-hole
- ii) Single-hole
- iii) Pintaux
- iv) Pintle

19.2.5T3 Inline pump
- i) Construction
- ii) Operation

19.2.5T4 D.P.A pump

i) Construction
ii) Operation

19.2.5T5 Types of governors
i) Mechanical
ii) Pneumatic
iii) Hydraulic

19.2.5T6 Pressure time injection system
i) Layout
ii) Operation

19.2.5T7 Electronic diesel injection system
i) Layout
ii) Operation
iii) filling phase
iv) spill phase
v) injection phase
vi) pressure drop phase

19.2.5T8 Cold start devices
i) Glow plugs
ii) Manifold heat operated thermostat
iii) KI gas

19.2.5T9 Supercharging
i) Fundamentals of supercharging
ii) Boost pressure
iii) Superchargers
iv) screw
v) roots
vi) Turbochargers
vii) inter cooling
viii) waste gates

Practice

19.2.5P0 *Specific Objectives*
By the end of the module unit, the trainee should be able to:
a) identify components of diesel fuel system
b) diagnose faults in diesel fuel system
c) service injectors in C.I. fuel system
d) service fuel injection pumps
e) service superchargers

Content

19.2.5P1 Components of a diesel fuel system
i) Pump
ii) Filter
iii) Injectors
iv) Pressure lines
v) Governor

19.2.5P2 Fault diagnoses in C.I. fuel systems
i) Fault tracing
ii) leakages
iii) loss of power
iv) clogged filters/injector

19.2.5P3 Servicing of fuel Injectors
i) Engine test
ii) Test rig
iii) Nozzle cleaning

19.2.5P4 Servicing of fuel injection Pumps
i) Inline pump
ii) Overhaul
iii) Calibration
iv) Phasing
v) Timing
vi) Bleeding
vii) DPA pump
viii) Overhaul
ix) Pressure tests
x) Timing
xi) Bleeding

19.2.5P5 Servicing of Superchargers
i) Overhaul
ii) Pressure test

iii) Fault diagnosis
iv) Service

Suggested Learning Resources
i) Workshop manuals
ii) Pumps
iii) Test rigs

23.3.6 SPECIAL ENGINES

23.3.6T0 *Specific Objectives*
By the end of this sub module unit, the trainee should be able to:
a) explain the construction and operation of the various rotary engine
b) describe the construction and operation of the sterling engine
c) explain the construction and operation of the gas turbine engine
d) describe the construction and operation of a hybrid engines
e) explain the construction and operation of a solar engine
f) explain the emerging trends in engine technology

19.3.6C Competence
The trainee should have the ability to:
i) Differentiate correctly between Wankel and Cottage loaf rotary engines
ii) Repair on service a rotary engine
iii) Diagnose faults in gas turbine engines

Content

19.3.6T1 Operation of Rotary engines
i) Cottage loaf
ii) Wankel
iii) construction
iv) operation

19.3.6.T2 Construction and operation of sterling engines

19.3.6T3 Gas turbine engines working principles
i) Construction
ii) Operation

19.3.6T4 Working principles of hybrid engines
i) Construction
ii) Operation

19.3.6T5 Solar powered engine

19.2.6T6 Emerging trends in engine technology

Practice

19.3.6P0 *Specific Objectives*
By the end of this sub module unit, the trainee should be able to:
a) identify the various rotary engines
b) service and replace worn out parts on a rotary engine
c) identify the various parts of a gas turbine engine

Content

19.3.6P1 Rotary engines
- i) Cottage loaf
- ii) Wankel

19.3.6P2 Servicing and repairing of a rotary engine

19.3.6P3 Gas turbine engine overhaul
- i) Simple shaft gas turbine
- ii) Two-shaft gas turbine

Suggested Learning Resources
- i) Models
- ii) Internet
- iii) Textbooks
- iv) Charts

20.2.0 VEHICLES BODYWORK

20.2.01 INTRODUCTION

This module unit is designed to give special attention to panel beating and body work to enable the trainee cover the complete collision or accident repair and new work body building procedures and processes.

20.2.02 G ENERAL OBJECTIVES

By the end of the module unit the trainee should be able to:
- a) understand the construction of vehicle body layouts
- b) assess and repair accident vehicles
- c) design and fabricate vehicle bodies
- d) observe safety while working in work place

20.2.03 MODULE UNIT SUMMARY AND TIME ALLOCATION

VEHICLES BODYWORK

Code	Sub Module unit	Content	Time Hrs		
			T	P	Total
20.2.1	Panel	• Tools, Equipment and	12	46	58

	Beating	materials • Body designs • Body structure • Chassis alignment • Panel beating procedures • Fillers • Hardeners • Body solder			
20.2.2	Spray Painting	• Automotive paints • Spot putty • Colour code • Colour mixing • Painting procedures • Polishing • Waxing • Valeting	10	34	44
20.2.3	Vehicle Upholstery	• Upholstery tools • Adhesives • Materials • Quality control	10	32	42
Total Time			**32**	**112**	**144**

20.2.1T PANEL BEATING

20.2.1T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to:
a) explain the tools and equipment used in panel beating
b) explain types of vehicle body designs
c) describe vehicle body parts
d) explain types vehicle body damage to be assessed
e) explain the methods used in chassis alignment
f) describe the materials used in panel beating
g) explain the panel beating procedures.

20.2.1C Competence
The trainee should have the ability to carry out valuation weld panels and produce quality profiles

Content
20.2.1T1 Tools and equipment used in panel beating
i) Bumping hammers
ii) Dolly blocks
iii) Bumping spoons
iv) Body spoons
v) Pry/pick tools
vi) Caulking tools
vii) Screw equipped slide hammers
viii) Cutting tools
ix) Body file
x) Hydraulic body tools
xi) car lifts
xii) portable crane
xiii) hydraulic press
xiv) power jack
xv) body frame strengtheners
xvi) Portable tools and equipment
xvii) floor anchor/pot type
xviii) stationery /floor rack
xix) bench/universal

20.2.1T2 Vehicle body designs
i) Small cars
ii) saloon
iii) hatchback
iv) estates
v) coupe
vi) limousine
vii) Light trucks and vans
viii) box vans
ix) pantenichons
x) Luton’s
xi) open vans Trucks
xii) types o f trucks
xiii) normal control
xiv) forward control
xv) sleeper cabs
xvi) half cabins
xvii) articulated vehicles
xviii) tankers
xix) Coaches & buses
xx) town buses
xxi) coaches
xxii) double Decker
xxiii) intercity

buses

20.2.1T3 Vehicle body parts
- i) Bonnet
- ii) Boot
- iii) Firewall/bulkhead
- iv) Sill
- v) Pillars
- vi) Cant rails
- vii) Panels
- viii) Door skins
- ix) Scuttle
- x) Drip moulding
- xi) Valance

20.2.1T4 Vehicle damages assessed
- i) Types of damage
- ii) minor damage
- iii) major damage
- iv) Technical report

20.2.1T5 Chassis alignment methods & checks
- i) Wheel base check
- ii) Chord alignment check
- iii) Plumb line check/pendant and vertical rod
- iv) Laser beam
- v) Centre gauge

20.2.1T16 Materials used on panel beating
- i) Sheet metal
- ii) plain
- iii) ribbed
- iv) Cloth
- v) Abrasives
- vi) Water
- vii) Soaps
- viii) Fillers and hardeners

20.2.1T7 Panel beating process
- i) Window and trim stripping
- ii) Paint removal
- iii) chemical means
- iv) mechanical means
- v) Metal straightening
- vi) stretching
- vii) shrinking
- viii) Welding & cutting
- ix) Sanding
- x) machine
- xi) hand
- xii) Dent filling
- xiii) hardeners & fillers
- xiv) Filing
- xv) Washing
- xvi) Panel adjustments methods
- xvii) Shims
- xviii) Slotted holes
- xix) Floating anchor plates
- xx) Adjustable stops
- xxi) Stickers
- xxii) Suggested Learning Resources
- xxiii) reference material
- xxiv) manuals
- xxv) LCD

Practice

20.2.1P0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:
- a) select tools for appropriate tasks
- b) carry out chassis checks and alignments
- c) repair a damaged panel

d) observe safety in the panel shop.

Content

20.2.1P1 Selection of tools and equipment for
- i) pulling/stretching panels
- ii) absorbing blows
- iii) cutting

20.2.1P2 Chassis alignment checks and alignments
- i) Alignment checks
- ii) Type of damage
- iii) Use of alignment jigs
- iv) Report writing

20.2.1P3 Repair of a damaged panel
- i) assessment of damages
- ii) stripping of trim, panels and windows
- iii) Paint removal
- iv) Panel stretching, shrinking, crowning and joining/cutting
- v) Dent filling
- vi) Filing
- vii) Washing
- viii) Panel adjustments
- ix) Fitting of windows & weather-strips

20.2.1P4 Safety observation
- i) Tool and equipment safety
- ii) Personal care

Suggested learning/teaching Resources
- i) panel beating tools and equipment
- ii) vehicle body
- iii) alignment manuals

20.2.2 SPRAY PAINTING

20.2.2T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to:
- a) describe tools, equipment used in spray painting
- b) explain the materials used in spray painting
- c) explain the spray painting process.

20.2.2C Competence
The trainee should have the ability to:
- i) Select tools, equipment and materials for a given task
- ii) Carryout a spray painting task on a damaged panel
- iii) Observe safety

Content

20.2.2T1 Tools & equipment
- i) Spray guns
- ii) Gravity feed
- iii) Pressure feed
- iv) Suction
- v) Compressors
- vi) Strainers
- vii) Computerized paint mixer
- viii) Spectrophotometer
- ix) Spreaders

20.2.2T2 Materials
- i) Cloth/paper towels
- ii) Tack rags

iii) Paint paddle
iv) Spot and glaze putty
v) Sanding blocks, paper and tapes
vi) Rubbing compounds
vii) Polishes and wax
viii) Paints
ix) Undercoats
x) Thinners
xi) Guide coat

20.2.2T3 Spray painting process
i) Surface preparation
ii) Colour coding
iii) Colour mixing
iv) Painting sequence
v) Safety in handling paints and lacquer

Practice

20.2.2P0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to:
a) select tools, equipment and materials used in spray painting
b) spray paint a vehicle
c) observe safety in the spray painting shop.

Content

20.2.2P1 Selection of tools, equipment and materials for spray painting tasks
i) Cleaning
ii) Rubbing
iii) Painting
iv) Polishing

20.2.2P2 Spray painting process
i) Selection of colours from colour charts
ii) Mixing of colours to a standard
iii) Adjustments of spray guns, paint mixers
iv) Surface preparation
v) Painting sequence
vi) Polishing
vii) Tinting of windows

20.2.2P3 Safety in the paint shop
i) Personal safety
ii) Equipment
iii) Paints & lacquers

Suggested learning resources
i) Industrial visits
ii) Manuals
iii) Colour code charts
iv) Vehicle bodies

20.2.3 VEHICLES UPHOLSTERY

20.2.3T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to;
a) describe tools and equipment used in upholstery
b) explain types of vehicle seats and seat belts
c) describe types of joining agents

used in car upholstery
d) describe materials suitable for use in car upholstery
e) explain quality control measures in fitting car upholstery

20.2.2C Competence

The trainee should have the ability to:
i) select tool and materials
ii) fit finished upholstery onto vehicle panel
iii) assess quality of finished product
iv) use materials economically

Content

20.2.3T1 Tools and equipment for upholstery work
i) Sewing machines
ii) Web stretchers
iii) Ripping chassis
iv) Cutting tools
v) Joining tools

20.2.3T2 Types of Seats
i) Bench
ii) Bucket
iii) Seat belts
iv) Continuous lap
v) Lap
vi) Shoulders

20.2.3T3 Joining agents in car upholstery work
i) Epoxy resin
ii) Polyvinyl chloride (PVC) adhesives
iii) Adhesive caulking materials (urethane/polysulfide tapes)
iv) Screws & rivets
v) Pins
vi) Threads

20.2.3T4 Materials suitable for use in car upholstery
i) Poly Vinyl Chloride (PVCS)
ii) Leather
iii) Fabric
iv) Wood
v) Foam
vi) Wool
vii) Meta

20.2.3T5 Quality control
i) Types of quality control
ii) Need for quality control

Suggested learning resources
i) Text books & bulletins
ii) Various material (leather, PVCs, pins)

Practice

20.2.3P0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:
a) select appropriate tools, equipments and materials to suit given task.
b) fit upholstery a vehicles
c) observe safety in upholstery shop
d) maintain quality in fitting car upholstery

Content

20.2.3P1 Selection of tools, equipment and materials for selected task
- i) vehicle roofs
- ii) seats
- iii) floors
- iv) door trim
- v) dashboard
- vi) application of adhesives, staples, hems

20.2.3P2 Fitting of upholstery in a vehicle

20.2.3P3 Safety
- i) Personal
- ii) Material storage

20.2.3P4 Quality control
- i) Check, finished product
- ii) raw materials
- iii) workmanship
- iv) Rectification of faults

Suggested learning resources
- i) Manuals
- ii) Selection charts
- iii) Upholstery materials tools & equipment

DIPLOMA IN AUTOMOTIVE ENGINEERING

MODULE III