Maintenance & Repair - Heavy Vehicle
(Syllabus content)

Assessment Requirements

Unit G01/02K – Knowledge of Health, Safety and Good Housekeeping in the Automotive Environment

Content:

Economic use of Resources
a. consumable materials e.g. grease, oils, split pins, locking and fastening devices etc.

Requirement to maintain work area effectively
a. cleaning tools and equipment to maximise workplace efficiency.
b. requirement to carry out the housekeeping activities safely and in a way that minimises inconvenience to customers and staff.
c. risks involved when using solvents and detergents.
d. advantages of good housekeeping.

Spillages, leaks and waste materials
a. relevance of safe systems of work to the storage and disposal of waste materials.
b. requirement to store and dispose of waste, used materials and debris correctly.
c. safe disposal of special / hazardous waste materials.
d. advantages of recycling waste materials.
e. dealing with spillages and leaks

Basic legislative requirements
a. Provision and Use of Work Equipment Regulations 1992.
b. Power Presses Regulations 1992.
c. Pressure Systems and Transportable Gas Containers Regulations 1989.
d. Electricity at Work Regulations 1989.
e. Noise at Work Regulations 1989.
f. Manual Handling Operations Regulations 1992.
g. Health and Safety (Display Screen Equipment) Regulations 1992.
h. Abrasive Wheel Regulations.
i. Safe Working Loads.
j. Working at Height Regulations (date)

Routine maintenance of the workplace
a. Trainees' personal responsibilities and limits of their authority with regard to work equipment.
b. Risk assessment of the workplace activities and work equipment.
c. Workplace person responsible for training and maintenance of workplace equipment.
d. When and why safety equipment must be used.
e. Location of safety equipment.
f. Particular hazards associated with their work area and equipment.
g. Prohibited areas.
h. Plant and machinery that trainees must **not** use or operate.
i. Why and how faults on unsafe equipment should be reported.
j. Storing tools, equipment and products safely and appropriately.
k. Using the correct PPE.
l. Following manufacturers' recommendations.

m. Location of routine maintenance information e.g. electrical safety check log.

Legislation relevant to Health and Safety

i. HASAWA
ii. COSHH
iii. EPA
iv. Manual Handling Operations Regulations 1992
v. PPE Regulations 1992

General regulations to include an awareness of:

i. Health and Safety (Display Screen Equipment) Regulations 1992
ii. Health and Safety (First Aid) Regulations 1981
iii. Health and Safety (Safety Signs and Signals) Regulations 1996
iv. Health and Safety (Consultation with Employees) Regulations 1996
v. Employers Liability (Compulsory Insurance) Act 1969 and Regulations 1998
vi. Confined Spaces Regulations 1997
vii. Noise at Work Regulations 1989
viii. Electricity at Work Regulations 1989
ix. Electricity (Safety) Regulations 1994
x. Fire Precautions Act 1971
xi. Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1985
xii. Pressure Systems Safety Regulations 2000
xiii. Waste Management 1991
xiv. Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002
xv. Control of Asbestos at Work Regulations 2002

Legislative duties

a. The purpose of a Health and Safety Policy.
b. The relevance of the Health and Safety Executive.
c. The relevance of an initial induction to Health and Safety requirements at your workplace.
d. General employee responsibilities under the HASAWA and the consequences of non-compliance.
e. General employer responsibilities under the HASAWA and the consequences of non-compliance.
f. The limits of authority with regard to Health and Safety within a personal job role.
g. Workplace procedure to be followed to report Health and Safety matters.

Precautions to be taken when working with vehicles, workshop materials, tools and equipment including electrical safety, pneumatics and hydraulics

a. Accessing and interpreting safety information
b. Seeking advice when needed
c. Seeking assistance when required
d. Reporting of unsafe equipment
e. Storing tools, equipment and products safely and appropriately
f. Using the correct PPE
g. Following manufacturers recommendations
h. Following application procedures e.g. hazardous substances
i. The correct selection and use of extraction equipment

PPE to include:

a. Typical maintenance procedures for PPE equipment to include:

i. typical maintenance log
ii. cleaning procedures
iii. filter maintenance
iv. variation in glove types

v. air quality checks

b Choice and fitting procedures for masks and air breathing equipment.

c. Typical workplace processes which would require the use of PPE to include:

i. welding
ii. sanding and grinding
iii. filling
iv. panel removal and replacement
v. drilling
vi. cutting
vii. chiselling
viii. removal of broken glass
ix. removal of rubber seals from fire damaged vehicles
x. removal of hypodermic needles
xi. servicing activities
xii. roadside recovery

d. Unserviceable PPE.

e. PPE required for a range automotive repair activities. To include appropriate protection of:

i. eyes
ii. ears
iii. head
iv. skin
v. feet
vi. hands
vii. lungs

Fire and extinguishers

a. Classification of fire types
b. Using a fire extinguisher effectively.

Types of Extinguishers

a. foam
b. dry powder
c. CO2
d. water
e. fire blanket

Action to be taken in the event of a fire to include:

a. The procedure as:

i. raise the alarm
ii. fight fire only if appropriate
iii. evacuate building
iv. call for assistance

Product warning labels to include:

a. Reasons for placing warning labels on containers.
b. Warning labels in common use, to include:

i. toxic
ii. corrosive
iii. poisonous
iv. harmful
v. irritant
vi. flammable
vii. explosive

Warning signs and notices

a. Colours used for warning signs:

i. red
ii. blue
iii. green

b Shapes and meaning of warning signs:
i. round
ii. triangular
iii. square

c. The meaning of prohibitive warning signs in common use.
d. The meaning of mandatory warning signs in common use.
e. The meaning of warning notices in common use.
f. General design of safe place warning signs.

Hazards and risks to include:

a. The difference between a risk and a hazard.
b. Potential risks resulting from:
i. the use and maintenance of machinery or equipment
ii. the use of materials or substances
iii. accidental breakages and spillages
iv. unsafe behaviour
v. working practices that do not conform to laid down policies
vi. environmental factors
vii. personal presentation
viii. unauthorised personal, customers, contractors etc entering your work premises
ix. working by the roadside
x. vehicle recovery
c. The employee's responsibilities in identifying and reporting risks within their working environment.
d. The method of reporting risks that are outside your limits of authority.
e. Potential causes of:

i. fire
ii. explosion
iii. noise
iv. harmful fumes
v. slips
vi. trips
vii falling objects
viii accidents whilst dealing with broken down vehicles

Personal responsibilities

a. The purpose of workplace policies and procedures on:
i. the use of safe working methods and equipment
ii. the safe use of hazardous substances
iii. smoking, eating , drinking and drugs
iv. emergency procedures
v. personal appearance
b. The importance of personal appearance in the control of health and safety.

Action to be taken in the event of colleagues suffering accidents

a. The typical sequence of events following the discovery of an accident such as:
i. make the area safe
ii. remove hazards if appropriate i.e. switch off power
iii. administer minor first aid
iv. take appropriate action to re-assure the injured party
v. raise the alarm

vi. get help
vii. report on the accident

b Typical examples of first aid which can be administered by persons at the scene of an accident:

i. check for consciousness
ii. stem bleeding
iii. keep the injured person's airways free
iv. place in the recovery position if injured person is unconscious
v. issue plasters for minor cuts
vi. action to prevent shock i.e. keep the injured party warm
vii. administer water for minor burns or chemical injuries
viii. wash eyes with water to remove dust or ingress of chemicals (battery acid)
ix. need to seek professional help for serious injuries

c Examples of bad practice which may result in further injury such as:

i. moving the injured party
ii. removing foreign objects from wounds or eyes
iii. inducing vomiting
iv straightening deformed limbs

Assessment Requirements

Unit G3K – Knowledge of Support for Job Roles in the Automotive Environment

Content:

The structure of a typical vehicle repair business

a. How these areas relate to each other within the business

i. body shop
ii. vehicle repair workshop
iii. paint shop
iv. valeting
v. vehicle parts store
vi. main office
vii. vehicle sales
viii reception

b. Sources of information

a. other staff
b. manuals
c. parts lists
d. computer software and the internet
d. manufacturer
e. diagnostic equipment

Communication requirements when carrying out vehicle repairs

a. Locating and using correct documentation and information for:

i. recording vehicle maintenance and repairs
ii. vehicle specifications
iii. component specifications
iv. oil and fluid specifications
v. equipment and tools
vi. identification codes

b. Procedures for:

i. referral of problems
ii. reporting delays
iii. additional work identified during repair or maintenance
iv. keeping others informed of progress

Methods of Communication

a. verbal
b. signs and notices

c. memos
d. telephone
e. electronic mail
f. vehicle job card
g. notice boards
h. SMS text messaging
i. Letters

a. Organisational & Customer requirements:

i. importance of time scales to customer and organization
ii. relationship between time and costs
iii. meaning of profit

b. Choice of Communication

a. distance
b. location
c. job responsibility

b. Importance of maintaining positive working relationships:
a. morale
b. productivity
c. company image
d. customer relationships
e. colleagues

Assessment Requirements

Unit G4K – Knowledge of Materials, Fabrication, Tools and Measuring Devices used in the Automotive Environment

Content:

Common types of hand tools used for fabricating and fitting in the automotive workplace. To include:

a. files
b. hacksaws and snips
c. hammers
d. screwdrivers
e. pliers
f. spanners
g. sockets
h. punches
i. types of drill and drill bits
j. taps and dies
k. stud removers
l. marking out tools

Common measuring devices used for fabrication and fitting in the automotive workplace. To include:

a. rule/tape
b. callipers
c. feeler gauge
d. volume measures
e. micrometer
f. dial gauges
g. torque wrenches
h. depth gauges

Common electrical measuring tools used in the repair of vehicles and components. To include:

a. ammeter
b. voltmeter
c. ohmmeter
d. multi-meter

Common electrical terms when measuring:

a. voltage
b. current
c. resistance

Workshop equipment (including appropriate PPE). To include:

a. hydraulic jacks
b. axle stands
c. pillar drills
d. air tools
e. vehicle lifts
f. cranes

g. hoists
h. electrical power tools

Properties, application and limitations (to include safe use) of ferrous and non-ferrous metals used when constructing, modifying and repairing vehicles and components. Materials to include:

a. carbon steels
b. alloy steels
c. cast iron
d. aluminium alloys
e. brass
f. copper
g. lead

Properties, application and limitations (to include safe use) of non-metallic materials used when constructing, modifying and repairing vehicles and components. Materials to include:

a. glass
b. plastics (inc. GRP)
c. Kevlar
d. rubber

Terms relating to the properties of materials. To include:

a. hardness
b. toughness
c. ductility
d. elasticity
e. tenacity
f. malleability
g. plasticity

Assessment Requirements

Unit G6K – Knowledge of how to Make Learning Possible through Demonstrations and Instruction

Content:

Separate areas of demonstration which encourage learning. To include:

a. demonstration is particularly applicable to learning manual skills.
b. learning to do something usually involves:
    i. purpose – the aim or objective
    ii. procedure - the most effective way of completing the task
    iii. practice – all skills require practice to improve
c. practical tasks are more quickly learnt through demonstration.
d. emphasis is required to body movements when demonstrating.
e. the demonstrator should encourage learners to ask questions.
f. emphasis should be placed upon key points whilst demonstrating.
g. any demonstration should ensure that all safety aspects are covered.

Types of learning which are best achieved and supported through demonstrations. **To include:**

a. types of learning:
    i. psychomotor – measurement of manual skill performance
    ii. cognitive – learning involving thought processes
    iii. affective – demonstration of feelings, emotions or attitudes
b. demonstration - involves learning to do something (Psychomotor Domain).
c. combination of instruction and practical demonstrations are very effective means of learning practical skills.

How to structure demonstration and instruction sessions. To include:

a. Before the demonstration and/or instruction ensure that the following good practice is recognised:
    i. identify key points
    ii. relate theoretical underpinning knowledge to key points
    iii. rehearse to ensure that all equipment is working
    iv. ensure all students can see even small equipment and processes
    v. time the demonstration
    vi. consider how to make students participate
    vii. consider how to emphasise safe working practices
b. During the demonstration and/or instruction good practice is to:
    i. give a clear introduction
    ii. identify any tools/equipment
    iii. determine the current audience level of knowledge
    iv. complete the demonstration correctly (do not show how not to do it)
    v. stress key points and show links between them
    vi. monitor safety aspects
    vii. check learner understanding
c. After the demonstration(if possible)
    i. enable the audience to practice the techniques
    ii. provide feedback on their performance

How to identify individual learning needs

a. Diagnose the learning needs of your audience to include:

i. what competencies they already have
ii. what experience they have of the subject area
iii. what competencies they need to achieve
iv. what demonstration techniques are best suited to their needs
v. how you will assess their needs have been met

What factors are likely to prevent learning. To include:

i. language barriers
ii. physical barriers
iii. specialist knowledge
iv. pace of learning
v. method of delivery
vi. environmental factors
vii. teaching styles
viii. dyslexia

How to check learners understanding and progress

a. Questionnaires.
b. Verbal questioning.
c. Observation.
d. Assessment.
e. Role play.
f. Projects/assignments.
g. Multi-choice questions.
h. Simulation.
i. Tests.

How to organise information and prepare materials

a. Identify the course aim.
b. Identify the subject aim.
c. Identify the lesson aim.
d. Complete a lesson plan - plan the teaching.
e. Identify a series of 'cues' to be used during the lesson.
f. Logically organise the information.
g. Use suitable resources and equipment to maximise learning opportunities.
h. Assess the learners progress and understanding.

Instructional techniques

a. types of instructional techniques to include:
   i. lectures
   ii. handouts
   iii. team teaching
   iv. peer teaching
   v. discussion – individual, group and peer
   vi. question and answer
   vii. multimedia
   viii. seminars
   ix. case studies
   x. project/assignments

Environmental factors that effect learning

a. environmental factors that should be considered before demonstration/instruction to include:
   i. loud noises
   ii. bright colours
   iii. bright lights

iv. strong smells
v. atmosphere
vi. temperature
vii. classroom seating
viii. classroom layout
ix. bright lights

Health and safety factors that affect learning

a. health and safety factors that should be considered before demonstration/instruction to include:
   i. assessment of risk and hazards
   ii. condition of electrical/electronic equipment
   iii. position of cables and wires
   iv. safety of equipment used in demonstration/instruction
   v. condition of classroom equipment/furniture/structure
   vi. suitable protective clothing/equipment

Analysis of demonstration/instruction

a. Analysis of demonstration/instruction to include:
   i. feedback from students
   ii. feedback from colleagues
   iii. organisational quality assessment
   iv. feedback from external organisations
   v. awarding body requirements

Developments in learning. To include:

i. multimedia based materials
ii. web based materials
iii interactive materials

How to choose and prepare appropriate materials. To include:

a. putting information in order
b. deciding whether the language used is appropriate
c. type of material i.e. paper and technology based etc.

Assessment Requirements

Unit G8K – Knowledge of how to Identify and Agree Customer Service Needs

Content:

Organisational Requirements

a. Explain the organisation's terms and conditions applicable to the acceptance of customer vehicles.
b. Explain the content and limitations of vehicle and component warranties for the vehicles dealt with by your organisation.
c. Detail what, if any, limits there are to the authority for accepting vehicles.
d. Detail why it is important to keep customers advised of progress and how this is achieved within the organisation.
e. Detail the organisation's procedures for the completion and processing of documentation and records, including payment methods and obtaining customer signatures as applicable.

Principles of Customer Communication and Care.

a. First Impressions.
b. Listening skills – 80:20 ratio.
c. Eye contact and smiling.
d. Showing interest and concern.
e. Questioning techniques and customer qualification.
f. Giving clear non-technical explanations.
g. Confirming understanding (statement/question technique, reflective summary).
h. Written communication – purpose, content, presentation and style.
i. Providing a high quality service – fulfilling (ideally exceeding) customer expectations within agreed time frames.
j. Obtaining customer feedback and corrective actions when dissatisfaction expressed.
k. Dealing with complaints.

Company Products and Services

a. Service standards
    i. national
    ii. manufacturer
    iii. organisational
b. The range and type of services offered by the organisation.
    i. diagnostic.
    ii. servicing.
    iii. repair.
    iv. warranty.
    v. MOT testing.
    vi. fitment of accessories/enhancements.
    vii. internal.
c. The courses of action available to resolve customer problems.
    i. the extent and nature of the work to be undertaken.
    ii. the terms and conditions of acceptance.
    iii. the cost.
    iv. the timescale.
    v. required payment methods.

d. The effect of resource availability upon the receipt of customer vehicles and the completion of work.
    i. levels and availability of equipment.
    ii. levels and availability of technicians.
    iii. workshop loading systems.
e. How to access costing and work completion time information.
    i. manuals.
    ii. computer based.

Vehicle Information Systems, Servicing and Repair Requirements

a. Accessing technical data including diagnostics.
b. Servicing to manufacturer requirements/standards.
c. Repair/operating procedures.
d. MOT standards/requirements.
e. Quality controls – interim and final.
f. Requirements for cleanliness of vehicle on return to customer.
g. Handover procedures.

Consumer Legislation To include:

a. consumer protection
b. sale of goods
c. data protection
d. product liability
e. health and safety
f. discrimination

Assessment Requirements

Unit HV01K – Knowledge of Conducting Routine Heavy Vehicle Maintenance

Content:

Vehicle maintenance, adjustment and record findings

a. Vehicle inspection techniques used in routine maintenance including:
    1. aural
    2. visual and functional assessments on:
        i. engine systems
        ii. chassis systems
        iii. wheels and tyres
        iv. transmission system
        v. electrical and electronic systems
        vi. exterior vehicle body
        vii. vehicle interior

b. The procedures used for inspecting the condition and serviceability of the following:
    i. filters
    ii. drive belts
    iii. wiper blades
    iv. brake linings
    v. pads
    vi. lights

c. Preparation and appropriate use of equipment to include:
    i. test instruments
    ii. emission equipment
    iii. wheel alignment
    iv. beam setting equipment
    v. tyre tread depth gauges

d. Procedures for checking and replenishing where applicable:
    i. oil (engine, gearbox, final drive, hub reduction)
    ii. water (coolant and screenwash)
    iii. hydraulic fluids (brake and clutch)
    iv. engine emission additives (Urea)
    v. pneumatic systems

e. Procedures for replacement of lubricants and filters (to include chassis systems):
    i. replace oil filters
    ii. types of oil
    iii. cleanliness
    iv. disposal of old oil and filters

f. Procedures for carrying out adjustments on vehicle systems or components:
    i. clearances
    ii. settings
    iii. alignment
    v. operational performance (engine idle, exhaust gas)

g. Procedures for checking electrical systems:
    i. operation
    ii. security
    iii. performance

h. Importance and process of detailed inspection procedures:
    i. following inspection checklists
    ii. checking conformity to manufacturer's specifications
    iii. legal requirements as applicable
i. Importance and process of completing all relevant documentation relating to routine maintenance:
    i. inspection records
    ii. job cards
    iii. vehicle repair records
    iv. in-vehicle service history

The need to use vehicle protection prior to repair

a. Requirements and methods used for protecting:
    i. vehicle body panels
    ii. paint surfaces
    iii. seats
    iv. interior floor protection

The need to check the vehicle following routine maintenance

a. The need to inspect the vehicle following routine maintenance:
    i. professional presentation of vehicle
    ii. customer perceptions
b. The basic checks of vehicle following routine maintenance:
    i. removal of oil and grease marks
    ii. body panels
    iii. paint surfaces
    iv. seats
    v. interior floor protection
    vi. re-instatement of components

Assessment Requirements

Unit HV02.1K – Knowledge of Heavy Vehicle Engine Mechanical, Lubrication, and Cooling System Units and Components

Content:

Engines

a. Engine types and configurations:
    i. inline
    ii. flat
    iii. vee
    iv. four-stroke cycle for compression ignition engines
    v. naturally aspirated, turbo-charged and turbo-charged aftercooled engines
    vi. alternative fuel engines
    vii. hybrid arrangements where applicable
b. Key engineering principles related to engine mechanical systems
    i. compression ratios
    ii. volumetric efficiency
    iii. cylinder capacity
    iv. power
    v. torque
c. Terms used in engine mechanical systems
    i. tdc
    ii. bdc
    iii. stroke
    iv. bore

i. Relative advantages and disadvantages of different engine types and configurations.
ii. Engine components and layouts:
    i. side camshaft and overhead camshaft
    ii. single and multi cylinder
    iii. wet and dry liners
    iv. crankshaft dampers
d. Cylinder head layout and design, combustion chamber and piston design.
e. Calculate compression ratios from given data.
f. The procedures used when inspecting engines
g. The procedures to assess:
    i. serviceability
    ii. wear
    iii. condition
    iv. clearances
    v. settings
    vi. linkages
    vii. joints
    viii. fluid systems
    ix. adjustments
    x. operation and functionality
    xi. security
h. Symptoms and faults associated with mechanical engine operation:
    i. poor performance
    ii. abnormal or excessive mechanical noise
    iii. erratic running

iv. low power
v. exhaust emissions
vi. abnormal exhaust smoke
vii. unable to start
viii. exhaust gas leaks to cooling system
ix. exhaust gas leaks

Lubrication

a. Key engineering principles relating to lubrication systems
   x. classification of lubricants
   xi. properties of lubricants
   xii. methods of reducing friction
b. The advantages and disadvantages of wet and dry systems.
c. Engine lubrication system:
   i. splash and pressurised systems
   ii. pumps
   iii. pressure relief valve
   iv. filters
   v. oil ways
   vi. oil coolers
d. Terms associated with lubrication and engine oil:
   i. full-flow
   ii. hydrodynamic
   iii. boundary
   iv. viscosity
   v. multi-grade
   vi. natural and synthetic oil
   vii. viscosity index
   viii. multi-grade
e. The requirements and features of engine oil:
   i. operating temperatures
   ii. pressures
   iii. lubricant grades
   iv. viscosity
   v. multi-grade oil
   vi. additives (detergents, dispersants, anti-oxidants inhibitors, anti-foaming agents, anti-wear)
   vii. synthetic oils
   viii. organic oils
   ix. mineral oils
f. Symptoms and faults associated with lubrication system
   i. excessive oil consumption
   ii. oil leaks
   iii. oil in water
   iv. low or excessive pressure
   v. oil contamination
g. The procedures used when inspecting lubrication system
h. The construction and operation of heavy vehicle engine lubrication systems and components, to include:
   i. full flow
   ii. by pass
   iii. wet sump
   iv. dry sump

Cooling, Heating and Ventilation

a. Key engineering principles relating to engine cooling, heating and ventilation systems
   i. heat transfer
   ii. linear and cubical expansion
   iii. specific heat capacity
   iv. boiling point of liquids

b. Procedures used to remove, replace and adjust cooling system components
   i. cooling fans and control devices
   ii. header tanks, radiators and pressure caps
   iii. coolant filters
   iv. heater matrix's and temperature control systems
   v. expansion tanks hoses, clips and pipes
   vi. thermostats impellers and coolant
   vii. ventilation systems

c. The preparation and method of use of appropriate specialist equipment used to evaluate system performance following component replacement
   i. system pressure testers
   ii. pressure cap testers
   iii. anti-freeze testing equipment
   iv. chemical tests for the detection of combustion gas
   v. supplementary coolant additive

d. The layout and construction of internal heater systems.

e. The controls and connections within internal heater system.

f. Symptoms and faults associated with cooling systems:
   i. water leaks
   ii. water in oil
   iii. internal heating system: efficiency, operation, leaks, controls, air filtration, air leaks and contamination
   iv. excessively low or high coolant temperature

g. The procedures used when inspecting
   i. internal heating system
   ii. cooling system

General

a. The preparation, testing and use of tools and equipment used for:
   i. dismantling
   ii. removal and replacement of engine units and components

b. Appropriate safety precautions:
   i. PPE
   ii. vehicle protection when dismantling
   iii. removal and replacing engine units and components

c. The important of logical and systematic processes.

d. The inspection and testing of engine units and components.

e. The preparation of replacement units for re-fitting or replacement.

f. The reasons why replacement components and units must meet the original specifications (OES) – warranty requirements, to maintain performance and safety requirements.

g. Refitting procedures.

h. The inspection and testing of units and system to ensure compliance with manufacturer's, legal and performance requirements.

i. The inspection and re-instatement of the vehicle following repair to ensure customer satisfaction;
   i. cleanliness of vehicle interior and exterior
   ii. security of components and fittings
   iii. re-instatement of components and fittings

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Assessment Requirements

Unit HV02.2K – Knowledge of Heavy Vehicle Fuel, Air Supply and Exhaust System Units and Components

Content:

Mechanical Injection Systems

a. The layout and construction of inline and rotary diesel systems. To include governor control.

b. The principles and requirements of compression ignition engines
   i. combustion chambers (direct and indirect injection)
c. The function and operation of diesel fuel injection components:
   i. fuel filters
   ii. sedimenters
   iii. injector types (direct and indirect injection)
   iv. fuel pipes
   v. cold start systems
   vi. manifold heaters
   vii. fuel cut-off systems

Electronic Diesel Control

a. **The function and operation of common Electronic Diesel Control components:**
   i. air mass sensor
   ii. throttle potentiometer
   iii. idle speed control
   iv. coolant sensor
   v. fuel pressure sensor
   vi. flywheel and camshaft sensors
   vii. electronic control units

Electronic Common Rail Systems

a. The layout and construction of Common Rail diesel systems
b. The function and operation of Common Rail diesel fuel injection components:
   i. low and high pressure pumps
   ii. rail pressure regulator
   iii. rail pressure sensor
   iv. electronic injector

Electronic Unit Injector Systems

a. The layout and construction of Electronic Unit Injector diesel systems
b. The function and operation of Electronic Unit Injector diesel fuel injection components:
   i. low pressure pump
   ii. electronic unit injector

Forced Induction

c. The purpose, construction and operation of:
   i. superchargers
   ii. turbochargers
      1) waste-gate controlled

2) variable geometry
iii. after-coolers

d. Explain the procedures for injection pump timing and bleeding the system
e. The procedures used when inspecting the diesel system

Fuel

a. Key engineering principles related to engine fuel systems:
   i. properties of fuels
   ii. combustion processes
   iii. exhaust gas constituents
b. The meaning of terms related to:
   i. hydro-carbon fuels
   ii. volatility
   iii. calorific value
   iv. flash point
   v. cetane value
c. The composition of hydro-carbon fuels:
   i. % hydrogen and carbon in compression ignition fuels
d. The composition of air
e. Symptoms and faults associated with diesel fuel systems
   i. air in fuel system, water in fuel, filter blockage leaks, difficult starting, erratic running, excessive smoke(black, blue, white), engine knock, turbocharger, faults

Air supply and exhaust systems

a. The construction and purpose of air filtration systems.
b. The operating principles of air filtration systems.
c. The construction and operation of air supply and exhaust systems to include:
   i. supercharging
   ii. turbo charging
d. The construction and purpose of the exhaust emission control systems including:
   iii. exhaust gas recirculation (EGR)
   iv. selective catalytic reduction (SCR)
   v. particulate trap (filter)
e. The operating principles of the systems.
f. Exhaust system design to include silencers and vertical stacks
g. The procedures used when inspecting induction, air filtration and exhaust systems
h. Symptoms and faults associated with air and exhaust systems
   i. exhaust gas leaks
   ii. air leaks
i. Regulated pollutants to include**:**
   i. Hydrocarbons (HC)
   ii. Particulate matter (PM)
   iii. Oxides of Nitrogen (NOx)
   iv. Carbon Monoxide (CO)
i. Key principles in exhaust emission control systems to include:
   i. flame travel
   ii. injection timing
   iii. fuel pressure
   iv. combustion chamber design

General

j. The preparation, testing and use of tools and equipment used for:
   iii. dismantling
   iv. removal and replacement of engine units and components
k. Appropriate safety precautions:
   iv. PPE
   v. vehicle protection when dismantling
   vi. removal and replacing engine units and components
l. The important of logical and systematic processes.
m. The inspection and testing of engine units and components.
n. The preparation of replacement units for re-fitting or replacement.
o. The reasons why replacement components and units must meet the original specifications (OES) – warranty requirements, to maintain performance and safety requirements.
p. Refitting procedures.
q. The inspection and testing of units and system to ensure compliance with manufacturer's, legal and performance requirements.
r. The inspection and re-instatement of the vehicle following repair to ensure customer satisfaction;
   iv. cleanliness of vehicle interior and exterior
   v. security of components and fittings
   vi. re-instatement of components and fittings

Assessment Requirements

Unit HV03K – Knowledge of Heavy Vehicle Electrical Units and Components

Content:

Electrical and Electronic Principles

a. Electrical units:
    i. volt (electrical pressure)
    ii. ampere (electrical current)
    iii. ohm (electrical resistance)
    iv. watt (power)
b. The requirements for an electrical circuit:
    i. battery
    ii. cables
    iii. switch
    iv. current consuming device
    v. continuity
c. The direction of current flow and electron flow.
d. Series and parallel circuits to include:
    i. current flow
    ii. voltage
    iii. volt drop
    iv. resistance
    v. the effect on circuit operation of open circuit component(s)
e. Earth and insulated return systems.
f. Cable sizes and colour codes.
g. Different types of connectors, terminals and circuit protection devices.
h. Common electrical and electronic symbols.

i. The meaning of:
    i. short circuit
    ii. open circuit
    iii. bad earth
    iv. high resistance
    v. electrical capacity

j. The principles of vehicle electronic systems and component.

k. Interpret vehicle wiring diagrams to include:
    i. vehicle lighting
    ii. auxiliary circuits
    iii. indicators
    iv. starting and charging systems

l. Function and construction of electrical components including:
    i. circuit relays
    ii. bulb types including LED's and alternative lighting systems
    iii. fan and heater
    iv. circuit protection

m. The safety precautions when working on electrical and electronic systems to include:
    i. disconnection and connection of battery
    ii. avoidance of short circuits
    iii. power surges
    iv. prevention of electric shock
    v. protection of electrical and electronic components
    vi. protection of circuits from overload or damage

n. The set-up and use of:
    i. digital and analogue multi-meters
    ii. voltmeter
    iii. ammeter
    iv. ohmmeter
    v. oscilloscope
    vi. manufacturer's dedicated test equipment

o. Electrical and electronic checks for electrical and electronic systems to include:
    i. connections
    ii. security
    iii. functionality
    iv. performance to specifications
    v. continuity, open circuit
    vi. short circuit
    vii. high resistance
    viii. volt drop
    ix. current consumption
    x. output patterns (oscilloscope)

p. Symptoms and faults associated with electrical and electronic systems to include:
    i. high resistance
    ii. loose and corroded connections
    iii. short circuit
    iv. excessive current consumption
    v. open circuit
    vi. malfunction
    vii. poor performance
    viii. battery faults to include flat battery
    ix. failure to hold charge
    x. low state of charge

xi. overheating
xii. poor starting

Battery and Charging

a. The construction and operation of vehicle batteries including:
   i. low maintenance and maintenance free
   ii. battery cell construction
b. The operation of the vehicle charging system:
   i. alternator
   ii. rotor
   iii. stator
   iv. slip ring
   v. brush assembly
   vi. three phase output
   vii. diode rectification pack
   viii. voltage regulation
   ix. phased winding connections
   x. cooling fan
   xi. alternator drive system

Starting

a. The layout, construction and operation of engine starting systems: inertia and pre-engaged principles.
b. The function and operation of the following components:
   i. axial and pre-engaged starter motor
   ii. starter ring gear
   iii. starter solenoid
   iv. ignition/starter switch
   v. starter relay
   vi. one-way clutch (pre-engaged starter motor)

Lighting

a. Function and construction of electrical components including:
   i. front, tail and number plate lamps
   ii. main and dip beam headlamps
   iii. fog and spot lamps
   iv. lighting switches including main/dip switch
   v. directional indicators
   vi. hazard warning
b. The circuit diagram and operation of components for:
   i. side tail and marker lamps
   ii. headlamps
   iii. interior lamps
   iv. fog, high-intensity rear and spot lamps
   v. direction indicators
c. The statutory requirements for vehicle lighting when using a vehicle on the road.
d. Headlamp adjustment and beam setting.

Auxiliary Systems

a. Auxillary systems to include:
   i. lighting
   ii. wiper
   iii. security and alarm
   iv. comfort and convenience
   v. information and entertainment

vi. telephone and two way communication
vii. electric window

b. Function and construction of electrical components including:
i. central door locking
ii. anti theft devices
iii. manual locking and dead lock systems
iv. window winding
v. demisting systems
vi. door mirror operation mechanisms
vii. interior lights and switching

c. The circuit diagram and operation of components for:
i. central door locking
ii. anti theft devices
iii. manual locking and dead lock systems
iv. window winding
v. demisting systems
vi. door mirror operation mechanisms

d. Comfort and convenience systems to include:
i. heated seats
ii. electrically adjusted seats
iii. heated screens
iv. electric mirrors
v. heating
vi. climate control
vii. air conditioning
viii. monitoring and instrumentation

General

a. The preparation, testing and use of:
i. tools and equipment
ii. electrical meters and equipment used for dismantling
iii. removal and replacement of electrical and electronic systems and components

b. Appropriate safety precautions:
i. PPE
ii. vehicle protection when dismantling
iii. removal and replacing electrical and electronic components and systems

c. The importance of logical and systematic processes.

d. Preparation of replacement units for re-fitting or replacement electrical and electronic components and systems.

e. The reasons why replacement components and units must meet the original specifications (OES) – warranty requirements, to maintain performance, safety requirements.

f. Refitting procedures.

g. The inspection and testing of units and systems to ensure compliance with manufacturer's, legal and performance requirements.

h. Inspection and re-instatement of the vehicle following repair to ensure:
i. customer satisfaction
ii. cleanliness of vehicle interior and exterior
iii. security of components and fittings
iv. re-instatement of components

Assessment Requirements

Unit HV04K – Knowledge of Heavy Vehicle Chassis Units and Components

Content:

Chassis layouts

i. types of chassis
ii. axle configurations
iii. rear steered axles
iv. self-steered axles

1.3 describe how to remove and replace

Steering

a. Key engineering principles related to steering:
   i. geometry
   ii. angles
   iii. damping
   iv. stress and strain
b. The construction and operation of steering systems
   i. power and non-assisted steering
   ii. multi axle steering arrangements
   iii. heavy vehicle steering units and components
c. The action and purpose of steering geometry:
   v. castor angle
   vi. camber angle
   vii. kingpin or swivel pin inclination
   viii. negative offset
   ix. wheel alignment (tracking) (toe in and toe out)
   x. toe out on turns
   xi. steered wheel geometry
   xii. multi axle steered wheel geometry
d. The following terms associated with steering:
   i. Ackerman principle
   ii. slip angles
   iii. self-aligning torque oversteer and understeer
   iv. neutral steer
   v. rear steer
   vi. self-steer
e. The components and layout of hydraulic power assisted steering systems:
   i. piston and power cylinders
   ii. drive belts and pumps
   iii. control valve (rotary, spool and flapper type)
   iv. hydraulic fluid
f. The advantages of power assisted steering.
g. The operation of hydraulic power assisted steering.
h. The principles of electronic power steering systems.
i. The procedures used for inspecting the serviceability and condition of:
   i. manual steering
   ii. power assisted steering

h. Steering system defects to include:
   i. uneven tyre wear
   ii. wear on outer edge of tyre
   iii. wear on inner edge of tyre
   iv. uneven wear
   v. flats on tread
   vi. steering vibrations
   vii. wear in linkage
   viii. damaged linkage
   ix. incorrect wheel alignment
   x. incorrect steering geometry

Suspension

a. Types of suspension
   i. non independent suspension
   ii. independent suspension
   iii. air suspension
   iv. electronically controlled air suspension (ECAS)
   v. steel suspension
   vi. lifting axles

b. The layout and components of suspension systems:
   i. non-independent suspensions
   ii. independent front suspension (IFS)
   iii. air suspension
   iv. electronically controlled air suspension (ECAS)
   v. rubber suspension
   vi. tandem axle suspension
   vii. lifting axles

b. The operation of suspension systems and components:
   i. leaf and coil springs
   ii. torsion bar
   iii. air springs
   iv. air suspension levelling mechanism (mechanical and electronic)
   v. dampers
   vi. trailing arms
   vii. ball joints
   viii. bump stops
   ix. anti-roll bars
   x. stabiliser bars
   xi. swinging arms
   xii. parallel link
   xiii. transverse link
   xiv. "A" frame axle location
   xv. suspension damping
   xvi. stress and strain

c. The advantages of different systems including:
   i. non-independent
   ii. independent suspension (IFS)
   iii. air suspension (mechanical)
   iv. air suspension (electronically controlled)
   v. lifting axles

d. The principles of electronically controlled air suspensions systems.
e. The forces acting on suspension systems during braking, driving and cornering.
f. The methods of locating the road wheels against braking, driving and cornering forces.

g. The methods of controlling cornering forces by fitting anti-roll torsion members
h. Suspension terms:
    i. rebound
    ii. bump
    iii. yaw
    iv. dive
    v. pitch
    vi. roll
    vii. compliance
i. The procedures used for inspecting the serviceability and condition of the suspension system
j. Suspension system defects:
    i. wheel hop
    ii. ride height (unequal and low)
    iii. wear
    iv. noises under operation
    v. fluid leakage
    vi. excessive travel
    vii. excessive tyre wear
    viii. bounce
    ix. poor vehicle handling
    x. worn dampers
    xi. worn joints/damaged linkages
    xii. vehicle “crabbing”

Brakes

a. Key principles relating to braking systems:
    i. laws of friction
    ii. hydraulics
    iii. pneumatics
    iv. properties of fluids
    v. properties of air
    vi. braking efficiency
b. The construction and operation of braking systems:
    i. air brakes
    ii. air-over-hydraulic brakes
    iii. electronic brakes including Anti-lock Braking Systems and Anti-Slip Regulation
    iv. endurance (retarding) systems
c. The construction and operation of drum brakes:
    i. leading and trailing shoe construction
    ii. self-servo action
    iii. slack adjusters
    iv. cam expanders
    v. wedge expanders
    vi. automatic adjusters
    vii. backing plates
    viii. parking brake system
    ix. wear indicators and warning lamps
d. The construction and operation of disc brakes:
    i. disc pads
    ii. caliper
    iii. brake disc
    iv. ventilated disc
    v. disc pad retraction
    vi. parking brake system
    vii. wear indicators and warning lamps

e. The construction and operation of the hydraulic braking system:
   i. line layout
   ii. master cylinders
   iii. wheel cylinders
   iv. disc brake callipers & pistons
   v. brake pipe
   vi. brake servo
   vii. warning lights
   viii. parking brakes
   ix. equalising valves
f. The construction and operation of the air braking system
   i. air compressors
   ii. air dryers
   iii. air processing units
   iv. pressure regulating valves
   v. circuit protection valves
   vi. air reservoirs
   vii. control valves (foot, park and hand)
   viii. relay valves
   ix. load sensing valves (mechanical and automatic)
   x. brake actuators
   xi. parking brake mechanisms
   xii. trailer control valves
   xiii. two-line trailer brake system
   xiv. warning light/buzzer systems
   xv. air pipes
   xvi. valve port numbering
g. The construction and operation of the air-over-hydraulic braking system
   i. air supply and storage
   ii. air control valves
   iii. conversion from pneumatic pressure to hydraulic pressure
   iv. hydraulic control valves
h. The requirements and hazards of brake fluid:
   i. boiling point
   ii. hygroscopic action
   iii. manufacturer's change periods
   iv. fluid classification and rating
   v. potential to damage paint surfaces
i. Terms associated with braking systems:
   i. braking efficiency
   ii. brake fade
   iii. brake balance
j. The procedures used for inspecting the serviceability and condition of the braking system
h. Braking system defects:
   i. worn shoes or pads
   ii. worn or scored brake surfaces
   iii. abnormal brake noises
   iv. brake judder
   v. fluid contamination of brake surfaces
   vi. fluid/air leaks
   vii. pulling to one side
   viii. poor braking efficiency
   ix. lack of assistance
   x. loss of air pressure
   xi. brake drag

xii. brake grab
xii brake fade

Endurance Brakes

a. The construction and operation of heavy vehicle endurance (retarder) brakes:
- i. exhaust brake
- ii. compression (engine) brake
- iii. hydraulic retarder
- iv. electro-magnetic retarder

ABS and ASR

a. The construction and operation of heavy vehicle ABS systems
- i. category one (2S/2M)
- ii. category two (2S/1M)
- iii. category three (1S/1M)
- iv. wheel speed sensors
- v. modulators
- vi. electronic control unit

Terms associated with ABS systems
- i. individual control
- ii. modified individual control
- iii. select low

The construction and operation of heavy vehicle ASR systems
The procedures used for inspecting the serviceability and condition of the ABS/ASR system

Wheel and Tyres

a. The engineering principles for wheels and tyres
- i. Friction
- ii. un-sprung weight
- iii. dynamic and static balance

b. The construction of different types of tyre:
- iii. radial
- iv. cross ply
- v. bias belted
- vi. tread patterns
- vii. tyre mixing regulations
- viii. tyre applications
- ix. tyre markings
- x. wheel construction
- xi.

c. Tyre markings:
- i. tyre and wheel size markings
- ii. speed rating
- iii. direction of rotation
- iv. profile
- v. load rating
- vi. ply rating
- vii. tread-wear indicators

d. Wheel construction:
- i. alloy
- ii. pressed steel
- iii. one-piece rims

iv. two-piece rims
v. three-piece rims

e. Wheel retention
   i. conical seating
   ii. spherical seating
   iii. spigot mounted
f. Types of wheel bearing arrangements:
   i. non-driving and driven wheels
   ii. fully floating
   iii. three quarter floating
g. Types of bearing used for wheel bearing arrangements and their adjustment:
   i. taper roller
   ii. angular contact ball
   iii. integrated
h. The procedures used for inspecting the serviceability and condition of:
   iii. tyres & wheels
   iv. bearings
i. The defects associated with tyres and wheels:

   i. abnormal tyre wear
   ii. cuts
   iii. side wall damage
   iv. wheel vibrations
   v. loose wheel retainers
   vi. tyre over heating
   vii. tread separation

j. Hazards when loading heavy vehicles

   i. flammable liquids
   ii. Gases that are lighter than air and heavier than air
   iii. increased vehicle mass
   iv. raised tipper bodies
   v. raised centre of gravity
   vi. working at heights

General

The procedures for dismantling, removal and replacement of chassis system components

a. The preparation:
   i. testing and use of tools and equipment
   ii. electrical meters and equipment used for dismantling
   iii. removing and replacing chassis systems and components
b. Appropriate safety precautions:
   i. PPE
   ii. vehicle protection when dismantling
   iii. removing and replacing chassis systems and components
c. The importance of logical and systematic processes.
d. The inspection and testing of chassis systems and components.
e. The preparation of replacement units for re-fitting or replacement of chassis systems or components.
f. Identify the reasons why replacement components and units must meet the original specifications (OES):
   i. warranty requirements

   ii. to maintain performance
   iii. safety requirements

g. Refitting procedures.
h. The inspection and testing of units and systems to ensure compliance with manufacturer's, legal and performance requirements.
i. The inspection and re-instatement of the vehicle following repair to ensure customer satisfaction:
   i. cleanliness of vehicle interior and exterior
   ii. security of components and fittings
   iii. re-instatement of components and fittings

Assessment Requirements

Unit HV0506K – Knowledge of Inspecting Heavy Vehicles

Content:

Different types of heavy vehicle inspection

a. Types of inspection:
   i. pre-purchase / pre-delivery
   ii. pre-MOT inspection
   iii. scheduled safety inspections
   iv. daily vehicle checks
   v. pre-rental / post rental inspections

Vehicle inspections and maintenance records

b. The purpose and scope of the different types of vehicle inspection.

c. Vehicle inspection techniques for different types of inspection including:
   i. systematic inspections
   ii. aural
   iii. visual and functional assessments on engine
   iv. engine systems
   v. chassis systems
   vi. wheels and tyres
   vii. transmission and driveline system
   viii. electrical and electronic systems
   ix. exterior vehicle body
   x. vehicle interior

d. The procedure for inspection of the vehicle for damage, corrosion, fluid leaks, wear, security, mounting. Security and condition to include;
   i. engines and engine systems
   ii. chassis systems
   iii. brakes
   iv. transmission and driveline
   v. steering
   vi. suspension
   vii. wheels
   viii. tyres
   ix. body panels (structural and non-structural)
   x. electrical and electronic systems and components
   xi. vehicle seating and vehicle interior
   xii. instruments

e. Preparation and use of appropriate inspection equipment and tools including:
   i. emission testing
   ii. brake testing
   iii. headlamp alignment
   iv. wheel alignment
   v. torque setting
   vi. specialist diagnostic equipment
   vii. tyre tread depth gauges

f. Inspection procedures following inspection checklists.

g. Checking conformity to manufacturer's specifications and legal requirements.
   i. workshop manuals

ii. heavy goods vehicle inspection manual

h. Testing and operation of vehicle systems and vehicle condition including workshop based tests and road tests.

i. The completion and maintenance of:
   i. documentation
   ii. defect reports
   iii. inspection records
   iv. job cards
   v. vehicle records

j. Make recommendations based on results of vehicle inspections.

k. The implications of not carrying out vehicle inspections correctly including:
   i. legal aspects (impact on Operator Licence)
   ii. safety aspects
   iii. financial aspects
   iv. customer retention
   v. customer relationships

The need for vehicle protection prior to carrying out vehicle inspection

l. Protection relating to:
   i. vehicle body panels
   ii. paint surfaces
   iii. seats
   iv. carpets and floor mats

m. Checks to be made following maintenance and repair:
   i. vehicle body panels
   ii. paint surfaces
   iii. seats
   iv. carpets and floor mats

Assessment Requirements

Unit HV07K – Knowledge of Diagnosis and Rectification of Heavy Vehicle Engine Faults

Content:

a. The construction and operation of engine systems
   i. electronic diesel control systems (EDC)
   ii. common rail fuel systems
   iii. unit injection fuel systems
   iv. engine management
   v. pressure charged induction systems
   vi. exhaust emission reduction systems
   vii. mechanical fuel injection systems
   viii. valve mechanisms
   ix. heating, ventilation and cooling

Common Rail and Unit Injection Systems

a. The operation and construction of common rail and unit injection systems including:
   i. types of air flow sensor
   ii. fuel supply system
   iii. fuel pump
   iv. filter
   v. fuel regulator
   vi. injectors
   vii. main injection
   viii. pre injection
   ix. post injection
   x. electronic control unit (ECU)
   xi. injector pulse width
   xii. sensors

b. The operation of each system under various operating conditions including:
   i. cold starting
   ii. warm up
   iii. hot starting
   iv. acceleration
   v. deceleration
   vi. cruising
   vii. full load

Engine Management

a. The function and purpose of engine management systems.
b. The difference between analogue, digital, programmable and non-programmable systems.
c. Open loop and closed loop control, types of input and output devices.
d. The function and operation of digital components and systems.
e. The operation of engine management systems under various conditions.

Pressure Charged Induction Systems

a. The meaning of volumetric efficiency; explain the effect of volumetric efficiency on engine performance, torque and power.
b. The methods used to improve volumetric efficiency:
   i. variable geometry turbo-charging
   ii. turbo-charging

iii. supercharging
iv. aftercoolers (intercooler)

c. The operation of turbo-chargers and the purpose of:
i. turbo-charging
ii. supercharging
iii. aftercoolers (intercooler)
iv. waste gates
v. exhaust gas recirculation

d. Advantages and disadvantages of pressure charging induction systems.

Terms Associated with Combustion

a. Phases of combustion, flame travel, pre-injection and diesel knock.
b. Fuel properties:
i. cetane rating
ii. flash point
iii. fire point
iv. volatility
v. composition of compression ignition fuels
vi. hydro-carbon content
c. Composition of carbon fuels:
i. % hydrogen and carbon
ii. composition of air

The by-products of combustion for compression ignition engines:
i. Carbon Monoxide
ii. Carbon dioxide
iii. Oxides of Nitrogen
iv. Particulates

Diesel Exhaust Emission Control

a. Describe the legal requirements for exhaust emissions;
i. MOT requirements
ii. EU regulations
b. The operation and construction of Selective Catalytic Reduction systems
c. The operation and construction of Exhaust Gas Recirculation systems

Assessment, Repair and Restoration of Mechanical Engine Components

a. How engine mechanical components are assessed and measured for wear and serviceability:
i. cylinder bores and liners
ii. pistons
iii. cylinder heads
iv. crankshaft journals
v. valve faces
vi. valve guides
vii. valve seats
viii. camshafts
b. The methods used for the repair and restoration of engine components.

Symptoms and Faults in Engine Mechanical Systems and Components

a. Symptoms and faults related to:
i. engine mechanical components
ii. injection systems
iii. fuel supply systems
iv. engine management system
v. pressure charged induction systems

vi. exhaust emission reduction systems
vii. valve mechanisms
viii. heating and ventilation
ix. cooling
x. worn cylinders
xi. cylinder liners
xii. pistons
xiii. piston rings
xiv. crankshaft
xv. camshaft
xvi. bearings
xvii. cylinder head and gasket
xviii. valves
xix. valve seats and valve guides
xx. camshaft drives
xxi. lubrication system and components
xxii. oil pump
xxiii. relief valve
xxiv. filter
xxv. turbo-charger
xvii supercharger

Diagnosis of Faults in Engine Mechanical Systems and Components

a. Interpret information for:
   i. diagnostic tests
   ii. manufacturer's vehicle and equipment specifications
   iii. use of equipment
   iv. testing procedures
   v. test plans
   vi. legal requirements
b. The preparation of tools and equipment for use in diagnostic testing and assessment.
c. Systematic assessment, testing and inspection of engine components and systems including:
   i. mechanical system & component condition
   ii. engine balance
   iii. power balance
   iv. performance and operation
   v. wear
   vi. run out
   vii. alignment
d. Use of appropriate tools and equipment including:
   i. compression gauges
   ii. leakage testers
   iii. cylinder balance tester
   iv. pressure gauges
   v. micrometers
   vi. vernier gauges
e. Evaluate and interpret test results from diagnostic testing.
f. Compare test result and values with vehicle manufacturer's specifications and settings.
g. The procedures for dismantling, components and systems and the use of appropriate equipment and procedures.
h. Assess, examine and measure components including:
   i. settings
   ii. values
   iii. condition

iv. wear and performance of components and systems

i. Make suitable adjustments to components including:
- i. settings
- ii. input and output values
- iii. voltages
- iv. current consumption
- v. resistance
- vi. output patterns with oscilloscope
- vii. pressures
- viii. condition
- ix. wear and performance

j. Probable faults
- i. malfunctions
- ii. incorrect settings
- iii. wear

k Rectification or replacement procedures.

l. Evaluate operation of components and systems following diagnosis and repair to confirm system performance.

Faults and Symptoms in Electronic Diesel Injection Systems

a. Diesel injection system failures or malfunctions including:
- i. cold or hot starting problems
- ii. poor performance
- iii. exhaust emissions
- iv. high fuel consumption
- v. erratic running power
- vi. unstable idle speed

Faults and Symptoms in Engine Management Systems

a. Engine management system failure or malfunctions including:
- vii. misfiring
- viii. cold or hot starting problems
- ix. poor performance
- x. diesel knock
- xi. exhaust emission levels
- xii. fuel consumption
- xiii. low power
- x. unstable idle speed

Diagnosis of Faults in Electronic Diesel Injection and Engine Management Systems

a. Locate and interpret information for:
- i. diagnostic tests
- ii. manufacturer's vehicle and equipment specifications
- iii. use of equipment
- iv. testing procedures
- v. test plans
- vi. fault codes
- vii. legal requirements

b. The preparation of tools and equipment for use in diagnostic testing and assessment.

c. Conduct systematic assessment, testing of engine systems including:
- i. component condition and performance
- ii. component settings
- iii. component values
- iii. electrical and electronic values

   iv. system performance and operation
   v. use of appropriate tools and equipment including gauges
   vi. multi-meter
   vii. breakout box
   viii. oscilloscope
   ix. diagnostic tester
   x. manufacturer's dedicated equipment
   xi. exhaust gas analyser
   xii. pressure gauges

d. Evaluate and interpret test results from diagnostic testing.
e. Compare test result, values and fault codes with vehicle manufacturer's specifications and settings.
f. The procedures for dismantling, components and systems using appropriate equipment.
g. Assess, examine and measure components including:
   i. settings
   ii. input and output values
   iii. voltages
   iv. current consumption
   v. resistance
   vi. output patterns with oscilloscope
   vii. condition
   viii. wear and performance of components and systems
h. Identify probable faults and indications of:
   i. faults
   ii. malfunctions
   iii. incorrect settings
   iv. wear
   v. values
   vi. inputs and outputs
   vii. fault codes
i. Rectification or replacement procedures.
j. Evaluation and the operation of components and systems following diagnosis and repair to confirm system performance.

Faults and Symptoms in Vehicle Comfort Systems

a. System failure, malfunction or ineffectiveness of internal heating system, air conditioning system or climatic control system including:
   i. leaks
   ii. abnormal noise
   iii. ineffective operation
   iv. failure to operate
   v. control faults
   vi. inadequate operation

Diagnosis of Faults in Vehicle Comfort Systems

a. Locate and interpret information for:
   i. diagnostic tests
   ii. manufacturer's vehicle and equipment specifications
   iii. use of equipment
   iv. testing procedures
   v. test plans
   vi. fault codes
   vii. legal requirements
b. The preparation of tools and equipment for use in diagnostic testing and assessment.
c. Conduct systematic assessment and testing of comfort systems including:

   i. component condition and performance
   ii. component settings
   iii. component values
   iv. electrical and electronic values
   v. system performance and operation
   vi. drive belts
   vii. controls
   viii. compressors
   ix. condensers
   x. receivers
   xi. dryers
   xii. connections
   xiii. valve
   xiv. hoses
   xv. thermostats and refrigerants
   xvi. sensors
   xvii. speed controls
   xviii. control systems
   xix. servomotors

d. Use of appropriate tools and equipment including:
   i. pressure gauges
   ii. multi-meter
   iii. breakout box
   iv. oscilloscope
   v. diagnostic tester
   vi. manufacturer's dedicated equipment
   vii. flow meter

e. Evaluate and interpret test results from diagnostic testing.
f. Compare test result, values and fault codes with vehicle manufacturer's specifications and settings
g. How to dismantle, components and systems using appropriate equipment and procedures
h. How to assess, examine and measure components including: settings, input and output values, voltages, current consumption, resistance, output patterns with oscilloscope, pressures, condition, wear and performance of components and systems
i. Identification of probable faults and indications of faults, malfunctions, incorrect settings, wear, values, inputs and outputs, fault codes, pressures and leaks
j. Rectification or replacement procedures
k. Evaluation and operation of components and systems following diagnosis and repair to confirm system performance

Assessment Requirements

Unit HV08K – Knowledge of Diagnosis and Rectification of Heavy Vehicle Chassis Faults

Content:

Chassis system operation:

a. Construction and operation of heavy vehicle chassis systems to include:
   i. Anti-lock Braking Systems (ABS)
   ii. Electronic Braking Systems (EBS)
   iii. Electronic Brake-force Distribution (EBD)
   iv. Anti-Slip Regulation / Traction Control (ASR)
   v. Electronic Stability Programme (ESP)
   vi. Rear wheel steer
   vii. power assisted steering
   viii. Electronically Controlled Air Suspension (ECAS)

b. The Engineering principle relating to heavy vehicle chassis systems:
   i. inertia force, mass and acceleration
   ii. laws of friction
   iii. statics (springs and torsion bars)
   iv. hydraulic and pneumatic principles

c. Make suitable adjustments to components including:
   x. settings
   xi. input and output values
   xii. voltages
   xiii. current consumption
   xiv. resistance
   xv. output patterns with oscilloscope
   xvi. pressures
   xvii. condition
   xviii. wear and performance

Electrical and electronic principles of heavy vehicle chassis systems

a. The operation of electrical and electronic systems and components related to heavy vehicle chassis systems including:
   v. ECU
   vi. sensors and actuators
   vii. electrical inputs
   viii. voltages
   ix. oscilloscope patterns
   x. digital and fibre optic principles

b. The interaction between the electrical/electronic system and mechanical components of chassis systems.

c. Electronic and electrical safety procedures.

Operation of electronic ABS, EBS, ASR and EBD braking systems

a. Layout of:
   i. ABS, EBS, ASR and EBD braking systems
   ii. anti-lock braking

iii. anti-spin regulation systems
iv. warning systems

b. Operation of:
i. pneumatic, hydraulic and electronic control units
ii. wheel speed sensors
iii. load sensors
iv. hoses
v. cables and connectors

c. Advantage of ABS and EBS braking systems over conventional braking systems.
d. The relationship and interaction of electronic braking control with other vehicle systems

Steering geometry for heavy vehicle applications

a. Non-steered wheel geometry settings.
b. Front/rear wheel geometry:
i. castor
ii. camber
iii. kingpin or swivel pin inclination
iv. negative offset
v. wheel alignment (tracking)
vi. toe out on turns and steered wheel geometry
vii. Ackerman principle
viii. slip angles
ix. self-aligning torque
x. oversteer and understeer
xi. neutral steer

c. The operation and layout of rear wheel steering and self-steered axles.
d. The construction and operation of power assisted steering systems:
i. hydraulic system
ii. power cylinders
iii. drive belts and pumps
iv. hydraulic valve (rotary, spool and flapper type)

Components and operation of electronically controlled air suspension

a. The components, construction and operation of an electronically controlled air suspension system.
b. The operation of electronically controlled air suspension systems under various conditions:
i. laden
ii. unladen
iii. cornering

c. The relationship and interaction of electronically controlled air suspension with other vehicle systems

Symptoms and faults in braking systems

a. Symptoms and faults associated with conventional braking systems, ABS, EBS and EBD systems:
i. mechanical
ii. hydraulic
iii. electrical and electronic systems
iv. fluid and air leaks
v. poor brake efficiency
vi. wheel locking under braking

Diagnosis and faults in braking systems

a. Locate and interpret information for:
i. diagnostic tests

   ii. vehicle and equipment specifications
   iii. use of equipment
   iv. testing procedures
   v. test plans
   vi. fault codes
   vii. legal requirements
b. Prepare equipment for use in diagnostic testing.
c. Conduct systematic testing and inspection of:
   i. braking system
   ii. ABS
   iii. pneumatic
   iv. mechanical
   v. hydraulic
   vi. electrical and electronic systems
d. Using appropriate tools and equipment including:
   i. multi-meters
   ii. oscilloscope
   iii. pressure gauges
e. Evaluate and interpret test results from diagnostic testing.
f. Compare test result and values with vehicle manufacturer's specifications and settings.
g. How to dismantle components and systems using appropriate equipment and procedures.
h. Assess, examine and evaluate the operation, settings, values, condition and performance of components and systems.
i. Probable faults, malfunctions, incorrect settings.
j. Rectification or replacement procedures.
k. Operation of systems following diagnosis and repair to confirm operation and performance.

Symptoms and faults associated with steering systems

a. Symptoms and faults associated with steering systems:
   i. mechanical
   ii. hydraulic
   iii. electrical and electronic
   iv. steering boxes
   v. steering arms and linkages
   vi. steering joints and bushes
   vii. idler gears
   viii. bearings
   ix. steering columns (collapsible and absorbing)
   x. power assisted steering system

Diagnosis and faults in steering systems

a. Locate and interpret information for:
   i. diagnostic tests
   ii. vehicle and equipment specifications
   iii. use of equipment
   iv. testing procedures
   v. test plans
   vi. fault codes
   vii. legal requirements
b. How to prepare equipment for use in diagnostic testing.
c. Conduct systematic testing and inspection of:
   i. steering systems
   ii. mechanical
   iii. hydraulic
   iv. electrical and electronic systems

   v. power assisted steering system
d. Using appropriate tools and equipment including:
   i. multi-meters
   ii. oscilloscope
   iii. pressure gauges
   iv. wheel alignment equipment
   v. steering geometry equipment
e. Evaluate and interpret test results from diagnostic testing.
f. Compare test result and values with vehicle manufacturer's specifications and settings.
g. How to dismantle, components and systems using appropriate equipment and procedures.
h. Assess, examine and evaluate the:
   i. operation
   ii. settings
   iii. values
   iv. condition and performance of components and systems
i. Probable faults, malfunctions, and incorrect settings.
j. Rectification or replacement procedures.
k. Operation of systems following diagnosis and repair to confirm operation and performance.

Symptoms and faults associated with suspension systems

a. Symptoms and faults associated with suspension systems:
   i. mechanical
   ii. pneumatic
   iii. electrical and electronic
   iv. self-levelling and ride controlled suspension systems
   v. ride height (unequal and low)
   vi. wear
   vii. noises under operation
   viii. fluid or air leakage
   ix. excessive travel
   x. excessive tyre wear

Diagnosis and faults in suspension systems

a. Locate and interpret information for:
   i. diagnostic tests
   ii. vehicle and equipment specifications
   iii. use of equipment
   iv. testing procedures
   v. test plans
   vi. fault codes
   vii. legal requirements
b. How to prepare equipment for use in diagnostic testing.
c. How to conduct systematic testing and inspection of:
   i. suspension systems
   ii. mechanical
   iii. hydraulic
   iv. electrical and electronic systems
   v. self-levelling and ride controlled suspension systems
d. Using appropriate tools and equipment including:
   i. multi-meters
   ii. oscilloscope
   iii. pressure gauges
   iv. alignment equipment
   v. geometry equipment
e. Evaluate and interpret test results from diagnostic testing.

f. Compare test result and values with vehicle manufacturer's specifications and settings.
g. How to dismantle, components and systems using appropriate equipment and procedures.
h. Assess, examine and evaluate the operation, settings, values, condition and performance of components and systems.
i. Probable faults, malfunctions and incorrect settings.
j. Rectification or replacement procedures.
k. Operation of systems following diagnosis and repair to confirm operation and performance.

Assessment Requirements

Unit HV11.1K – Knowledge of Overhauling Heavy Vehicle Engine Units

Content:

How the units and assemblies being overhauled operate

a. Identify unit components
b. Understand unit construction
c. Describe unit operation

How units are dismantled and reassembled

a. The dismantling procedure.
b. Tools and equipment used for stripping and rebuilding units and assemblies.
c. Methods of safe storage for removed components during overhaul activities.
d. The process for assessing the condition of sub-assemblies including:
    i. fit
    ii. tolerances
    iii. permitted limits
e. The rebuild procedure for units and assemblies.
f. Adjustment procedures during re-assembly.

Unit and assembly testing and evaluation procedures

a. Appropriate testing and evaluation procedures prior to dismantling units.
b. Appropriate testing and evaluation procedures of components after dismantling units.
c. How to use overhauling and test equipment for the task.
d. The cost-benefit relationship between reconditioning, repair and replacement of components within units.
e. How to test and evaluate the performance of the overhauled units against the operating specification.
f. How to interpret test results.
g. Adjustment procedures during final evaluation.

Faults associated with units and assemblies being overhauled

a. Causes of faults and failures within units and assemblies.
b. The faults associated with units and assemblies.
c. How to make adjustments to meet final specification after testing and evaluation of assembled units and assemblies.

Assessment Requirements

Unit HV11.2K – Knowledge of Overhauling Heavy Vehicle Transmission Units

Content:

How the units and assemblies being overhauled operate

a. Identify unit components
b. Understand unit construction
c. Describe unit operation

How units are dismantled and reassembled

a. The dismantling procedure.
b. Tools and equipment used for stripping and rebuilding units and assemblies.
c. Methods of safe storage for removed components during overhaul activities.
d. The process for assessing the condition of sub-assemblies including:
    iv. fit
    v. tolerances
    vi. permitted limits
g. The rebuild procedure for units and assemblies.
h. Adjustment procedures during re-assembly.

Unit and assembly testing and evaluation procedures

a. Appropriate testing and evaluation procedures prior to dismantling units.
b. Appropriate testing and evaluation procedures of components after dismantling units.
c. How to use overhauling and test equipment for the task.
d. The cost-benefit relationship between reconditioning, repair and replacement of components within units.
e. How to test and evaluate the performance of the overhauled units against the operating specification.
f. How to interpret test results.
g. Adjustment procedures during final evaluation.

Faults associated with units and assemblies being overhauled

a. Causes of faults and failures within units and assemblies.
b. The faults associated with units and assemblies.
d. How to make adjustments to meet final specification after testing and evaluation of assembled units and assemblies.

The procedures for dismantling, removal and replacement of units and components

a. The preparation, testing and use of:
    i. tools and equipment
    ii. removal and replacement of electrical and electronic systems and components
b. Appropriate safety precautions:
    i. PPE
    ii. vehicle protection when dismantling
    iii. removal and replacing electrical and electronic components and systems
c. The importance of logical and systematic processes.
d. Preparation of replacement units for re-fitting or replacement electrical and electronic components and systems.
e. The reasons why replacement components and units must meet the original specifications (OES) – warranty requirements, to maintain performance, safety requirements.

f. Refitting procedures.
g. The inspection and testing of units and systems to ensure compliance with manufacturer's, legal and performance requirements.
h. Inspection and re-instatement of the vehicle following repair to ensure:
    i. customer satisfaction
    ii. cleanliness of vehicle interior and exterior
    iii. security of components and fittings
    iv. re-instatement of components and fittings
    i. cancelling of any fault codes and warning lights

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Assessment Requirements

Unit HV11.3K – Knowledge of Overhauling Heavy Vehicle Steering and Suspension Units

Content:

How the units and assemblies being overhauled operate

a. Identify unit components
b. Understand unit construction
c. Describe unit operation

How units are dismantled and reassembled

a. The dismantling procedure.
b. Tools and equipment used for stripping and rebuilding units and assemblies.
c. Methods of safe storage for removed components during overhaul activities.
d. The process for assessing the condition of sub-assemblies including:
    vii. fit
    viii. tolerances
    ix. permitted limits
e. The rebuild procedure for units and assemblies.
f. Adjustment procedures during re-assembly.

Unit and assembly testing and evaluation procedures

a. Appropriate testing and evaluation procedures prior to dismantling units.
b. Appropriate testing and evaluation procedures of components after dismantling units.
c. How to use overhauling and test equipment for the task.
d. The cost-benefit relationship between reconditioning, repair and replacement of components within units.
e. How to test and evaluate the performance of the overhauled units against the operating specification.
f. How to interpret test results.
g. Adjustment procedures during final evaluation.

Faults associated with units and assemblies being overhauled

a. Causes of faults and failures within units and assemblies.
b. The faults associated with units and assemblies.
c. How to make adjustments to meet final specification after testing and evaluation of assembled units and assemblies.

The procedures for dismantling, removal and replacement of electrical and electronic units and components

a. The preparation, testing and use of:
    iii. tools and equipment
    iv. removal and replacement of electrical and electronic systems and components
b. Appropriate safety precautions:
    iv. PPE
    v. vehicle protection when dismantling
    vi. removal and replacing electrical and electronic components and systems
c. The importance of logical and systematic processes.
d. Preparation of replacement units for re-fitting or replacement electrical and electronic components and systems.

e. The reasons why replacement components and units must meet the original specifications (OES) – warranty requirements, to maintain performance, safety requirements.
f. Refitting procedures.
g. The inspection and testing of units and systems to ensure compliance with manufacturer's, legal and performance requirements.
h. Inspection and re-instatement of the vehicle following repair to ensure:
    ii. customer satisfaction
    iii. cleanliness of vehicle interior and exterior
    iv. security of components and fittings
    v. re-instatement of components and fittings
    vi. cancelling of any fault codes and warning lights

Assessment Requirements

Unit HV12K – Knowledge of Heavy Vehicle Transmission and Driveline Units

Content:

Key principles related to clutch systems

a. Clutch systems to include:

i. principles of friction
ii. principle of levers
iii. torque transmission

The operation of clutch operating systems

Clutch operating mechanisms

iv. pedal and lever
v. hydraulic operated
vi. air assisted
vii. hydraulic components
viii. master cylinder
ix. slave cylinder
x. hydraulic pipes
xi. electrical and electronic components (fluid level indicators)

The operation of friction clutches

a. The reasons for fitting a clutch.

The construction and operation of:

i. coil spring clutches
ii. diaphragm spring clutches
iii. single plate clutches
iv. multi plate clutches
v. clutch/upshift brakes

Types of friction materials used in clutch construction:

i. organic
ii. ceramic

Clutch mechanisms

i. diaphragm spring clutches
ii. single plate clutches
iii. multi plate clutches
iv. air assistance
v. hydraulic operation

Gearbox systems

a. Construction and operation of gearbox systems including**:**

i. gearshift control systems
ii. manual gearbox
iii. automatic gearbox

Key principles relating to gearbox systems

i. gear ratios
ii. input and output ratios

iii. torque multiplication

The operation of manual gearboxes

a. The reasons for fitting gearboxes, to provide neutral, reverse, torque multiplication.
b. Different gearbox types:
    i. single layshaft
    ii. twin layshaft
    iii. range change
    iv. splitter
    v. twin splitter
c. The layout and construction of gears and shafts for 5, 6, 8, 12 and 16 speed gearbox designs, constant mesh and synchromesh gearboxes, reverse gear.
d. The construction and operation of:
    i. gear selection linkages
    ii. selector forks and rods
    iii. detents and interlock mechanisms
e. The construction and operation of synchromesh devices.
f. The arrangements for gearbox bearings:
    i. bushes
    ii. oil seals
    iii. gaskets
    iv. gearbox lubrication
    v. tachograph drive
g. The electrical and electronic components including reverse lamp switch.
h. Calculate gear ratios and driving torque for typical gearbox specifications.
i. The need to remove the propshaft before towing a casualty vehicle

The operation of automatic gearboxes

a. The reasons for using automatic gearboxes over manual (urban use, stop/start applications)
b. The construction and operation automatic gearboxes to include:
    i. epicyclic geartrain
    ii. brake bands
    iii. fluid couplings and torque converters
c. Properties of automatic transmission fluid

The construction and operation of driveline systems and components

a. including:
    i. universal couplings
    ii. sliding couplings
    iii. constant velocity joints
    iv. final drive units
    v. propshafts
    vi. split-propshafts
    vii. driveshafts
    viii. hub reduction
    ix. tandem drive axles
b. Key principles relating to driveline systems including:
    i. gear ratios
    ii. simple stresses

a. The layout and construction of propshafts and drive shafts used in multi-axle drive systems.
c. The reasons for using flexible couplings and sliding joints in transmissions systems.
d. The reason for using constant velocity joints in drive shafts incorporating steering mechanisms.
e. The construction and operation of:
    i. universal joints

ii. sliding couplings
iii. constant velocity joints
iv. centre bearings

f. The simple stresses applied to shafts: torsional, bending and shear.
g. The construction and operation of:
i. final drive units
ii. multi-drive axle arrangements
iii. crown wheel & pinion
iv. bevel, hypoid and helical gears
v. differential gears
vi. lubricants
vii. lubrication bearings and seals
viii. differential locks
ix. epicyclic hub reduction
h. The reasons for fitting differential/s
i. Calculate final drive gear ratios.
j. Calculate the overall gear ratio from given data (gearbox ratio x final drive ratio).

The construction and operation of gear selector systems

a. including:
i. remote linkages
ii. servo-assistance
iii. range change selection
iv. splitter selection
v. electronic gear selection
b. The layout and operation of gear selector mechanisms used on heavy vehicles:
i. manual shift using rods and levers
ii. manual shift using cables
iii. manual shift using servo assistance
iv. range change selection
1) manual switch (gearstick mounted)
2) automatic (gearbox mounted)
v. splitter selection
c. The layout and operation of electronically controlled gear selector systems:
i. clutch system
ii. gear selection
iii. gear speed synchronisation

The testing and inspection techniques used for heavy vehicle transmission systems

a. The techniques and procedures used for inspecting and testing clutches and clutch mechanisms including:
i. clearances
ii. pedal and lever settings
iii. cables & linkages
iv. hydraulic system
v. leaks (fluid and air)
vi. adjustments
vii. travel
b. The techniques and procedures used for inspecting and testing gearboxes including:
i. leaks
ii. gear selection
iii. synchromesh operation
iv. abnormal noise
c. The techniques and procedures used for inspecting and testing drive line systems (prop & drive shafts, couplings and centre bearings) including:

i. security
ii. serviceability
iii. leaks
iv. alignment
v. balance weights (where applicable)

d. The techniques used when inspecting and testing final drive systems including:
i. fluid levels
ii. leaks
iii. noise

The faults and symptoms associated with vehicle transmissions systems

a. The faults and symptoms associated with transmission systems:
i. clutch faults
ii. gearbox faults
iii. drive line faults (propshaft, drive shaft, universal and constant velocity joints)
iv. universal joint alignment
v. final drive faults
vi. gear selection faults

b. Faults and symptoms to include mechanical, electrical and hydraulic systems.

The procedures for dismantling, removal and replacement of transmission units and components

a. The preparation, testing and use of tools and equipment, electrical meters and equipment used for
dismantling removing and replacing transmission systems and components.

b. Appropriate safety precautions:
i. PPE
ii. vehicle protection when dismantling
iii. removing and replacing transmission systems and components

c. The importance of logical and systematic processes.

d. The inspection and testing of transmission systems and components

e. The preparation of replacement units for re-fitting or replacement of transmission systems or components.

f. The reasons why replacement components and units must meet the original specifications (OES):
i. warranty requirements
ii. to maintain performance
iii. safety requirements

g. Refitting procedures.

j. The inspection and testing of units and system to ensure compliance with manufacturer's, legal and performance requirements.

k. The inspection and re-instatement of the vehicle following repair to ensure customer satisfaction:
i. cleanliness of vehicle interior and exterior
ii. security of components and fittings
iii. re-instatement of components and fittings

Assessment Requirements

Unit HV13K – Knowledge of Diagnosis and Rectification of Heavy Transmission and Driveline Faults

Content:

The construction and operation of transmission and driveline systems

a. Including::

i. friction clutches
ii. fluid couplings
iii. multi-speed gearboxes
iv. fully automatic - including electronic control
v. electronically controlled gearshift systems
vi. hub reduction
vii. final drive units
viii. hubs & shafts

a. Key principles relating to heavy vehicle transmission and driveline systems

ix. friction
x. torque transmission
xi. materials
xii. fluids & energy
xiii. potential & kinetic energy

Electrical and electronic principles related to heavy vehicle transmission systems

a. The operation of electrical and electronic systems and components related to heavy vehicle transmission systems including:
   i. ECU
   ii. sensors and actuators
   iii. electrical inputs & outputs
   iv. voltages
   v. oscilloscope patterns
   vi. digital and fibre optic principles
b. The interaction between the electrical/electronic system, hydraulic system and mechanical components of the transmission systems.
c. Electronic and electrical safety procedures.

The operation heavy vehicle clutches and fluid couplings

a. The construction and operation of friction clutches (coil spring, diaphragm) including single and twin clutch designs.
b. The construction and operation of fluid couplings including:
   i. fluid flywheel
   ii. torque converter (torque multiplication, efficiency)
   iii. benefits of fluid couplings
   iv. benefits of toque converter over fluid flywheel

The operation of heavy vehicle transmissions and driveline systems

a. The construction and operation of manual gearboxes:
   i. multi-speed gearboxes
   ii. gear arrangements
   iii. shaft and bearing arrangements
   iv. synchromesh devices

   v. interlock mechanisms
   vi. linkages
   vii. overdrive
   viii. lubrication
b. The construction and operation of automatic gearboxes including hydraulic and electronic control systems: operations of epicyclic gears (sun, planet, annulus and carrier), method for achieving different gear ratios using epicyclic gearing; hydraulic control systems, components and operation; electronic control system, components and operation.
c. The construction and operation of the electronically controlled gearshift systems
d. The construction and operation of final drive systems including:
   i. crown wheel and pinion
   ii. differential gears
   iii. differential lock
e. The construction and operation of heavy vehicle tandem drive systems including third differential and differential locks.
f. The operation of heavy vehicle traction control systems and launch control.
g. The construction and operation of heavy vehicle hub arrangements.
h. The construction and operation of:
   i. drive shafts
   ii. prop shafts including flexible joints and couplings
   iii. universal joints
   iv. constant velocity joints
   v. sliding joints

Symptoms and faults in heavy vehicle transmissions and drive-line systems

a. Clutch and coupling faults:
   i. abnormal noises
   ii. vibrations
   iii. fluid leaks
   iv. slip
   v. judder
   vi. grab
   vii. failure to release
b. Gearbox faults:
   i. abnormal noises
   ii. vibrations
   iii. loss of drive
   iv. difficulty engaging or disengaging gears
   v. abnormal noises
   vi. vibrations
   vii. loss of drive
   viii. failure to engage gear
   ix. failure to disengage gear
   x. leaks
   xi. failure to operate
   xii. incorrect shift patterns
   xiii. electrical and electronic faults
c. Final drive faults:
   i. abnormal noises
   ii. vibrations
   iii. loss of drive
   iv. oil leaks
   v. failure to operate
   vi. electrical and electronic faults
d. Drive-lines and couplings:

i. abnormal noises
ii. vibrations
iii. loss of drive

Faults in heavy vehicle transmission systems

a. Interpret information for diagnostic tests, vehicle and equipment specifications, use of equipment, testing procedures, test plans, fault codes and legal requirements.
b. How to prepare equipment for use in diagnostic testing.
c. How to conduct systematic testing and inspection of transmission system, mechanical, hydraulic, electrical and electronic systems using appropriate tools and equipment including, mullet-meters, oscilloscope and pressure gauges.
d. How to carry out workshop based and road testing of vehicle and transmission system.
e. Evaluate and interpret test results from diagnostic and/or road testing.
f. Compare test result and values with vehicle manufacturer's specifications and settings.
g. How to dismantle, components and systems using appropriate equipment and procedures.
h. Assess, examine and evaluate the operation, settings, values, condition and performance of components and systems.
i. Probable faults, malfunctions and incorrect settings.
j. Rectification or replacement procedures.
k. Operation of systems following diagnosis and repair to confirm operation and performance.

Transmission units and components

a. Friction clutches
b. Fluid couplings
c. Multi speed gearboxes
d. Fully automatic - including electronic control
e. Electronically controlled gearshift systems
f. Hub reduction
g. Final drive units
h. Hubs & shafts

Measurements and settings

a. Settings
b. Input and output values
c. Voltages
d. Current consumption
e. Resistance
f. Output patterns with oscilloscope
g. Pressures
h. Condition
i. Wear and performance

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Assessment Requirements

Unit AE06K – Knowledge of Diagnosis and Rectification of Automotive Auxiliary Electrical Faults

Content:

The electrical principles that are related to light vehicle electrical circuits:

a. Ohms law
b. Voltage
c. Power
d. Current (AC and DC)
e. Resistance
f. Magnetism
g. Electromagnetism and electromagnetic induction
h. Digital and fibre optic principles
i. Electrical units and symbols
j. Electrical and electronic terminology
k. Relevant electrical safety

Battery and Charging

a. The construction and operation of vehicle batteries including:
   iii. low maintenance and maintenance free
   iv. lead acid and nickel cadmium types
   v. cells
   vi. separators
   vii. plates
   viii. electrolyte
b. The operation of the vehicle charging system:
   xii. alternator
   xiii. rotor
   xiv. stator
   xv. slip ring
   xvi. brush assembly
   xvii. three phase output
   xviii. diode rectification pack
   xix. voltage regulation
   xx. phased winding connections
   xxi. cooling fan
   xxii. alternator drive system

Starting

a. The layout, construction and operation of engine starting systems: inertia and pre-engaged principles.
b. The function and operation of the following components:
   vii. inertia and pre-engaged starter motor
   viii. starter ring gear
   ix. pinion
   x. starter solenoid
   xi. ignition/starter switch
   xii. starter relay (if appropriate)
   xiii. one-way clutch (pre-engaged starter motor)

Lighting systems and technology

a. Lighting systems should include:
    i. Xenon lighting
    ii. gas discharge lighting
    iii. ballast system
    iv. LED
    v. intelligent front lighting
    vi. blue lights
    vii. complex reflectors
    viii. fibre optic
    ix. optical patterning

Lighting circuits and the relationship between each circuit

a. Circuits must include:
    i. Sidelights including number plate lights and marker lights
    ii. dipped beam
    iii. main beam
    iv. dim/dip
    v. indicators and hazard lights
    vi. high intensity and fog light

Common faults and testing methods associated with external lighting system

a. Fault diagnosis for:
    i. lighting systems failing to operate correctly
    ii. switches
    iii. relays
    iv. bulbs failing to operate

The operating principles of external lighting systems and multiplexing systems

a. To include all external lighting systems and a good knowledge of multiplexing systems.

The different types of electric windows, and mirror systems and components

a. Components should include:
    i. window
    ii. mirror motors
    iii. multi-functional switches
    iv. relays
    v. total closure modules

The function of component parts in the electric window and mirror systems

a. Components must include:
    i. motors
    ii. relays
    iii. interfaces
    iv. modules
    v. switches

The operating principles of electric windows and mirror systems

a. Operating principles of the following:
    i. motors
    ii. interfaces
    iii. switches
    iv. modules

Common faults and testing methods associated with electric windows mirror systems

a. Fault diagnosis for:
   i. electric windows failing to open or close
   ii. electric mirrors fail to adjust
   iii. slow operation on both systems

The different types of screen heating systems and components

a. Systems must include:
   i. heated front screens
   ii. heated rear screens
   iii. heated mirrors

The function and operating principles of components for heated screen and mirror systems

a. Components must include:
   i. front screen elements
   ii. mirror elements
   iii. time control relays
   iv. multifunction relays and switches

Common faults and testing methods associated with heated screen and mirror systems

a. Faults must include:
   i. screen elements not operating
   ii. timer relays not operating and staying on permanently

The different types of In Car Entertainment (ICE) systems and components

a. Systems and components must include:
   i. radio CD and multi play units
   ii. DVD players
   iii. MP3 players
   iv. speakers
   v. aerial systems
   vi. amplifiers
   vii. V.D.U. screens
   viii. Satellite Navigation
   ix. communication units

The function of components in ICE systems

a. Systems include:
   i. radios
   ii. CD players
   iii. video players
   iv. DVD players
   v. aerial systems
   vi. speakers
   vii. amplifiers
   viii. VDU screens
   ix. mobile communication units

The operating principles of ICE systems

a. Operation of entertainment systems speaker and aerial systems

Common faults and testing methods associated with ICE systems

a. Faults to include:
   i. entertainment and navigation units not operating

ii. speaker, aerial and amplifier systems not functioning correctly
iii. excessive radio interference (suppression)
iv. use of diagnostic computers and systems

The different types of integrated security/warning systems and components

a. Components to include:
   i. control units
   ii. alarm modules
   iii. audible warning units
   iv. immobiliser units
   v. sensing units
   vi. horn
   vii. audible warning speakers

The function of component parts in integrated security and warning systems

a. Components to include
   i. control units
   ii. alarm modules
   iii. audible warning units
   iv. interior sensing systems
   v. immobiliser units
   vi. relays
   vii. LED's
   viii. horns

The operating principles of integrated security and warning systems

a. Operation of alarm systems and audible warning units.

The relevant legislation relevant to security and warning systems

a. Find and apply all relevant legislation for the fitment and use of security and warning systems.

Common faults and testing methods associated with security and warning systems

a. Components to include:
   i. control units
   ii. audible warning units
   iii. immobiliser units
   iv. horns
   v. relays
   vi. LED's
   vii. wiring
   viii. connections and protection devices
   ix. removal and refitting procedures
   x. using computer diagnostics to identify faults
   xi. use of manufacturers diagnostic equipment

The different wiper system components

a. Components must include:
   i. wiper motors
   ii. washer motors
   iii. wiper linkage
   iv. multifunction relays
   v. headlamp wash/wipe
   vi.

The function of component wiper and washer components

a. Components and systems must include:

i. wiper motors
ii. intermittent wash wipe relays
iii. parking systems

The operating principles, faults and testing methods of wiper and washer systems

a. Principles, fault diagnosis and testing for:

i. wiper motors failing
ii. damaged linkages
iii. incorrect operation of intermittent and parking systems
iv. earth faults
v. control unit failure

The different heater, cooling system components and air con.

a. Components include:

i. heater motors
ii. speed rheostats,
iii. switches
iv. valves
v. radiator cooling fan motors
vi. relays
vii. air conditioning units

The function of component heater, cooling parts and air conditioning

a. Components include:

i. heater motors
ii. rheostats
iii. valves
iv. switches
v. relays
vi. cooling fan motors
vii. air conditioning units
viii. thermostatic switches

The operating principles of heater, cooling systems and air conditioning

a. Principles to include:

i. conduction
ii. convection
iii. radiation
iv. circulation
v. boiling points
vi. states of matter (Gas, liquid, solid)
vii. temperature control
viii. antifreeze mixtures
ix. heat transfer

Common faults and testing methods associated with heater, cooling systems and air conditioning

a. Fault diagnosis for:

i. heater motor failing to operate on all/one speed
ii. radiator cooling fan not operating
iii. valves
iv. relays

v. switches not operating
vi. electrical related faults on the air conditioning system

The different types of locking system components
a. Door locking actuators, solenoids, deadlocking actuators, anti-theft modules.

The function of component parts in the locking system
a. Solenoids, actuators (electrical and pneumatic), multifunctional relays, anti-theft modules and release systems.

The operating principles of locking systems
a. Doors and cabs

Common faults and testing methods associated with locking systems
a. Door locking actuators, solenoids, connections, wiring, relays, and protection devices/fuses

The different types of Supplementary Restraint and Airbag systems
a. Components include:
   i. control units
   ii. sensors
   iii. seat belt pretensioners
   iv. airbag assemblies
   v. wiring systems
   vi. warning systems

The function of component parts in the Supplementary Restraint and Airbag systems
a. Components include:
   i. control units
   ii. interfaces
   iii. sensors
   iv. airbag units
   v. pretensioners

The operating principles of Supplementary Restraint and Airbag systems
a. Operation of the sensors.
b. Operation of the airbag unit.
c. Operation of the various types of pretension.
d. Safe handling procedures and regulations.

Common faults and testing methods associated Supplementary Restraint and Airbag systems
a. Fault diagnosis for Airbag and SRS faults:
   i. fault code identification
   ii. wiring faults
   iii. component failure
   iv. earth problems
   v. sensor faults.

How to examine, measure and make suitable adjustments to components are:
a. Settings
b. Input and output values
c. Voltages
d. Current consumption
e. Resistance

f. Input and output patterns with oscilloscope (including frequency and duty cycle measurements)
g. Condition
h. Wear and performance

How to select, prepare and use diagnostic and rectification equipment for automotive auxiliary electrical systems:

a. Voltmeters
b. Ammeters
c. Ohmmeters
d. Multi-meters
e. Battery testing equipment
f. Dedicated and computer based diagnostic equipment
g. Oscilloscopes