ADVICE TO TEACHERS

This document helps to describe the nature and sequence of teaching and learning necessary for students to demonstrate achievement of course outcomes.

It suggests appropriate learning activities to enable students to develop the knowledge and skills identified in the course outcome statements.

Tasks should provide a variety and the mix of tasks should reflect the fact that different types of tasks suit different knowledge and skills, and different learning styles. Tasks do not have to be lengthy to make a decision about student demonstration of achievement of an outcome.

COURSE SPECIFIC ADVICE

This Teaching and Learning Supplement for Automotive and Mechanical Technology level 2 must be read in conjunction with the Introduction to Automotive and Mechanical Technology level 2 course document.

It contains advice to assist teachers delivering the course and can be modified as required. This Teaching and Learning Supplement is designed to support teachers new to or returning to teaching this course.

In Automotive and Mechanical Technology 2 learners will study the internal combustion engine, associated systems and subsequent application to transport, recreation, agriculture and other powered equipment. Automotive technology in its broadest definition has had a significant impact on our transportation systems, leisure activities, labour saving devices in domestic and industrial settings, built environment and employment opportunities. While a significant proportion of the course is centred on automotive maintenance and development, learners will also learn about the impact this technology has had on our lives and society. The course should not be limited to motor vehicles and may include small engines, bicycles, other forms of transport and the application of an internal combustion engine to a piece of equipment.

Through practical exercises learners will study automotive systems and components by dismantling and re-assembling them in a controlled manner. Course delivery should allow learners a number of opportunities to work with systems and wherever possible, variations and development of the system should also be studied. By developing an awareness of the variations and developments, learners gain an understanding of general automotive systems and the engineering behind the changes. Automotive technology is a dynamic area undergoing continuous change and improvement as manufacturers seek to improve fuel economy, use of materials and the impact on the environment. All of these areas listed may be used as a starting points in the discussion around the social, environmental and economic impacts in Unit 5.

Project based learning is part of this course with learners having the opportunity to undertake a project of their own guided choice. Using the Engineering Design Process learners identify the problem to be addressed in completing their project, propose a solution and research the processes required. During completion of the project, learners use the iterative Engineering Design Process to refine the product, hone the functions and analyse the results.
COURSE CONTENT

<table>
<thead>
<tr>
<th>Core Knowledge and Skills</th>
<th>A Safety</th>
<th>40% of delivery time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Knowledge and Skills</td>
<td>B Tools and Equipment</td>
<td></td>
</tr>
<tr>
<td>Area 1</td>
<td>Mechanical and automotive components and systems</td>
<td>40% of delivery time</td>
</tr>
<tr>
<td>Area 2</td>
<td>Principles of operation</td>
<td></td>
</tr>
<tr>
<td>Area 3</td>
<td>Servicing and repairs</td>
<td></td>
</tr>
<tr>
<td>Area 4</td>
<td>Fault finding, problem solving and analysis</td>
<td></td>
</tr>
<tr>
<td>Area 5</td>
<td>Social, economic and environmental impacts</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Project</td>
<td>20% of delivery time</td>
</tr>
</tbody>
</table>

The core develops an understanding of essential mechanical and automotive principles to provide skills in checking and maintaining the safe operation of automotive vehicles or mechanical devices. Learners are initially inducted in safe workshop practices prior to learning about the selection and use of appropriate tools and equipment as well as an overview of systems in automotive and mechanical equipment.

Key Concepts

**Hazards and risks:**
Hazards and risks are not the same.
- a hazard is something with the potential to cause harm.
- risk is the likelihood that death, injury or illness might result because of the hazard.

**Hierarchy of control:**
The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of risk control and is a requirement when in working in workshop settings.

It involves a step-by-step process to:
- identify hazards – find out what could cause harm
- assess risks if necessary – understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening
- control risks – implement the most effective control measure that is reasonably practicable in the circumstances
- review control measures to ensure they are working as planned.

Administrative controls (as defined in the course glossary) are often implemented as part of a risk-management process.

**Identification, use and safety in use of tools and equipment:**
Tools and equipment are required to assemble, maintain and dis-assemble mechanical components. Measurement tools assist in the diagnosis of mechanical problems. The use of tools is linked to developing an understanding of mechanical principles and process.
**Mechanical systems:**
Mechanical systems contain elements that interact using mechanical principles to create movement. The mechanised movement assists a range of functions in everyday contexts such as transport, recreation, agriculture, industrial, landscaping, personal mobility or mining. Automotive systems contain a number of sub-systems which interact.

**Technical terminology:**
Using the correct technical terminology related to mechanical and automotive technology allows information to be sourced and is used to solve problems. The literacy skills to access relevant information requires explicit teaching and opportunities for learners to learn, practice and refine their vocabulary and comprehension of technical terms.

**A. Safety**
A safety induction involving the explicit teaching of safety principles should be addressed prior to any practical work in the course.

**Examples of learning activities**
Learners:
- complete a safety induction using explicit teaching techniques which is undertaken in the practical workspace including identification of all environmental, chemical, equipment, energy and work practice hazards.

- complete safety activities and online tests.

- complete a Job Safety Analysis (JSA) prior to using any high risk equipment or activity (e.g. use of hoist, safe disposal of waste, compressor and air tool management).

- work in small groups to identify risks and hazards in the automotive workshop (or practical workspace) and justify their classification. These are then collated and discussed with the rest of the class to reach consensus e.g. spot the hazard.

- set up a vehicle for lifting ensuring it is in a safe condition to commence and complete work.

- select a hazard in automotive workshop settings and estimate the likelihood of an incident occurring, bearing in mind existing control measures and predict a range of consequences (i.e. any potential injuries) if an incident occurred and develop a list of priority actions to minimise or eliminate identified risks.

While specific activities, assignments and tasks are a requirement it is also necessary to develop an ongoing awareness and safe working culture within the workshop.
B. Tools and Equipment

Learners learn to identify and safely use and store the tools and equipment and undertake workshop housekeeping.

Examples of learning activities

Learners:

- complete online simulations or learning activities and tests on safety.
- work in small groups to undertake a tool labelling exercise matching flash cards to the tools and equipment to develop knowledge and technical literacy:
  - identify tools and equipment
  - tabulate the uses, operating procedures and safety considerations for each
- This step could be scaffolded by providing prepared options for the columns relating to operational procedures and safety considerations from which learners may select the correct option from a list of tools.
- construct a digital, illustrated glossary of technical terminology to build vocabulary throughout the course.
- create a multimedia presentation of three tools used in a mechanical workshop that are not in the workshop.
- compile a digital display using information from manufacturers web sites of specific mechanical tools and equipment detailing information on their development and use.
- compile a list at the end of each week/month of the tools they have identified, used and recorded in their diaries.
- identify and classify relevant tools and equipment for particular workshop activities, including vehicle/mechanism lifting, movement and stabilization; engine and driveline assembly; measurement and diagnosis tools and engines and automotive systems.
- compile a comprehensive list of the key tasks for workshop housekeeping to be completed at the end of practical sessions, for example:
  - devise 'job lists' for tool check, waste manager, materials storage and safety.
  - develop accountability measures (e.g. sign off sheets, safety signage protocols) and rotate through roles in teams to take responsibility for end of session housekeeping tasks.
  - support each other to achieve strong team result.
C. Mechanical and Engine Operations

Learners develop an understanding of mechanical principles and components involved in the transfer of motion, petrol engine types and configurations and operations and an overview of automotive and mechanical systems.

Examples of learning activities

Learners:
- dismantle and rebuild mechanical systems and identify major components.
- remove, replace and adjust ancillary components on single cylinder engines.
- service and adjust outdoor power equipment.
- refurbish, service bicycles or other personal transport.
- complete an oil service on a multicylinder engine.
- create a short presentation about the key features and applications of a mechanical component.
- construct a basic model to explain a mechanical principle to peers using readily available objects and materials.
- complete an illustrated assignment on engine configurations and components.
- prepare a graphic organiser (e.g. matrix) to compare the similarities and differences between petrol engine types and configurations.
- annotate virtual 3D models of automotive and mechanical systems to outline main functions within the larger system.
- source and interpret exploded views of systems (e.g. engine mechanics, ignition, braking, cooling) to use in a group jig-saw activity in which 'system experts' teach their home group about specific systems using visual aids.
- build an electrical circuit using manufactured 12volt automotive electrical components.
- complete an electrical repair on a vehicle or component.
- pressure test a cooling system and check coolant condition.
- complete a detailed job sheet for each workshop activity to identify skills and knowledge.
explain the need for cooling and lubrication in mechanical and automotive systems and locate examples of the consequences of failed systems on online automotive forums.

identify examples of each mechanical principle in numerous real world situations by collating and annotating images from transport, recreation, agriculture, industrial, landscaping, personal mobility, mining or other settings.

collaborate with others to develop a mind map which explains the relationship between the ignition, fuel, cooling, brake and transmission systems.

**Content Areas**

In the first four content areas, learners develop an understanding of how mechanical systems and subsystems in an engine work independently and how they interact to perform their specific purpose. This area is designed to be undertaken using small motors, engines on stands or vehicles in a practical workshop environment with tools, equipment and associated resources. Each of these areas should be delivered through an integrated approach through activities relating to maintenance and repair to enable learners to explore how automotive and mechanical components, parts, equipment, and systems function, operate and interact.

Work Requirements in the course state that practical work must include:

- dismantling and re-assembling mechanical components to service and repair mechanical systems
- undertaking basic fault finding processes.

In Content Area 5 learners develop an understanding of the social, economic and environmental impact of mechanical and automotive technologies.

**Key Concepts:**

**ICT as a tool:**

ICT capability is developed to access information and as a learning tool. Learners use the internet to research information, locate forums and technical information to assist with problem solving and repair, keep learning records such as a digital diary or log of their projects and other work and use engine analysis equipment.

**Area 1**

**Mechanical and Automotive Components and Systems**

Each of the essential mechanical systems must be covered and learners should work on three (3) different types of engines including 2 and 4 stroke and multi-cylinder engines.

Demonstrations and activities to identify components, types and related components or systems in the essential mechanical systems should be primarily workshop based.

Learners need to dismantle and reassemble components, use basic fault-finding techniques and perform routine maintenance to support their development of understanding.
Key Concepts

**Essential mechanical systems:**
Essential mechanical systems include engine types, ignition systems, fuel systems, cooling systems, transmission systems and electrical systems and engine management.

**Component assembly and routine maintenance:**
The dismantling and re-assembly of components, use of basic fault-finding techniques and completion of perform routine maintenance tasks.

**Examples of learning activities**
Learners:
- observe the sequencing of diagnosing and maintenance in a demonstration and summarise the sequence using fault finding techniques such as flow charts.
- dismantle a system according to recommended steps, recording the sequence either in writing and/or through photos and using masking tape labels and notations on components to support re-assembly.
- create a digital logbook with tabs for each of the essential mechanical systems which identifies components, sequence of dis-assembly, routine maintenance needs and testing.
- access a variety of online resources and tests related to component assembly and routine maintenance.
- test maintenance work using measurement tools, visual and auditory checks to determine effectiveness.
- draw or create a 3D model which demonstrates the flow of mechanical energy through a two or four stroke engine.
- read and interpret an electrical circuit diagram and identify the possible points where a connection may be broken or a fault may occur.
- identify sensors and actuators in engine management systems explain the purpose of the fuel, air and ignition management systems in vehicles.

Area 2

**Principles of Operation**
Underpinning scientific, mathematical and mechanical principles in the operation of vehicles, plant and equipment. This knowledge is developed through explicit learning activities linked to practical workshop tasks.

Key Concepts

**Mathematical information:**
Use of units of measurement, measuring tools and equipment as well as diagnostic and pressure measurement tools to make mechanical judgements regarding performance and wear.

**Scientific principles:**
The scientific principles related to motion, forces, electrical and mechanical energy, energy conversion, friction and pressure which builds on the concepts covered in the Core Part C relating to mechanical and engine operations.

**Examples of learning activities**
Learners:

- use a multi-meter to check voltage, resistance and amps on a circuit and explain the meaning of the measurements.
- dismantle and reassemble vehicle 12V electrical devices.
- install aftermarket products such as cameras, GPS units and radios.
- in small groups compile a multimedia resource detailing the operation and integration of engine/vehicle management components.
- complete assignments on electrical fundamentals.
- operate an oscilloscope and scan tool to diagnose components and interpret the results.
- identify risks when taking pressure measurements and undertake supervised radiator, compression and fuel pressure tests.
- calculate volume of the cylinder in an engine.
- use measurement tools such as callipers and verniers to determine the level of wear on a component (e.g. brakes or bearings) and suggest future actions based on measurement.
- interpret data from technical manuals to determine correct size for a replacement component when undertaking maintenance.
- use the digital logbook (see Content Area 1 example) to record relevant mechanical principles for each of the essential mechanical systems of practical work using terminology such as transfer of motion, cranks and cams, levers (first, second and third), linkages (bell cranks), pulley systems, sprockets and chains).
- explain the safety risks in working with systems which convert energy, e.g. chemical to mechanical, mechanical to heat, heat into mechanical energy and how these risks are managed within the plant and for the mechanical operator.
identify examples of reciprocating and rotary motion, forces (torque, tensile, compression) and atmospheric, hydraulic and pneumatic pressure in mechanical systems.

ascertain areas in mechanical systems where friction occurs and prescribe appropriate lubrication and additives.

Area 3
Servicing and Repairs

Learners develop mechanical and automotive servicing, repair and testing skills and processes by using tools and computer-assisted technology to diagnose faults, repair equipment and source databases.

This area has strong links with all other areas including applying safe work practices and workshop management as introduced in the core.

Key Concepts

Observation and diagnosis:
Learners use observation and diagnostic equipment to analyse mechanical condition, components serviceability, measure system performance, complete maintenance schedules and determine repair procedures.

Examples of learning activities
Learners:

- compare multimeter readings with required measurements and identify circuit faults.

- use a vehicle maintenance schedule to check and maintain vehicle components.

- fit and adjust wheel bearings.

- remove and replace underbody components.

- complete a fuel, ignition and air management service.

- suggest subsequent maintenance of components based on oscilloscope and code reader measurements.

- undertake mechanical compression tests to identify faults.

- operate a scan tool and code reader and interpret the results to undertake maintenance and repairs.

- make observations, assess repair options, undertake repairs and service procedures following recommended procedure and record in digital log.

Area 3
Fault finding, problem solving and analysis

Learners develop skills in identifying faults, problem solving and mechanical analysis using an engineering design process. Integration of knowledge and skills from the core and content areas is required to address mechanical problems when applying the Engineering Design Process (see Course document).
Key Concepts

**Iteration:**
The Engineering Design Process is iterative as learners re-visit previous steps in the problem solving cycle or progress through the problem solving cycle numerous times in order to solve the problem.

**Reflection:**
The Engineering Design Process requires that learners reflect on their actions and inferences, to re-evaluate their progress, make necessary modifications and eliminate and isolate the cause of the mechanical fault or problem.

**Examples of learning activities**
Learners:
- identify the stages of the Engineering Design Process which are used during a real world repair when viewing case studies of mechanical problem solving.
- working in small groups record vehicle identification features including Vehicle Identification Number (VIN), model details and describe Australian Design Rules (ADR).
- predict the nature of a mechanical problem using visual, auditory and mechanical evidence to provide formative assessment of a topic in the content area. The data from the assessment can be used to inform subsequent teaching of concepts.
- use flow charts for fault finding and problem solving.
- complete a repair to a component or system and evaluate the outcome.
- record likely solutions for a range of commonly occurring problems relating to mechanical systems.
- modify the Engineering Design Process graphic to represent the steps taken in their own problem solving when addressing a slightly more complex mechanical problem. Annotate the steps, providing brief reasons for decisions. The graphic is likely to include examples of recycling through the process or 'sub-inquiries' if the problem was more complex.

**Area 5**
Social, economic and environmental impacts
Learners describe the social, economic and environmental impacts of automotive and mechanical equipment, making link with contexts such as agriculture, maritime, motorsports, four wheel drive vehicles, personal mobility vehicles, cycling, motorcycles or heavy transport systems.

**Key Concepts:**

**Social impacts:**
The impact of mechanical and automotive systems on the well-being of individuals and communities. For example, the social connectedness and interactions derived by:
• the aged through access to personal mobility vehicles
• pre-licence adolescents through the use of cycles
• bike and vehicle owners in sporting events and clubs.

Economic impacts:
The impact of mechanical and automotive systems on the resources available for individuals and communities. For example, the economic impacts of:
• industry sectors including transport and logistics, automotive and agricultural
• cost of repairs, accidents and compliance with safety requirements
• road and rural safety campaigns.

Environmental impacts:
The impact of mechanical and automotive systems on the natural or constructed environment and the health of the ecosystem in allowing for renewal of natural systems and valuing of environmental qualities that support life.

Sustainability:
Sustainability factors include economic, environmental and social sustainability issues that impact on design decisions. Sustainable design supports the needs of the present without compromising the ability of future generations to support their needs. Sustainable practices are those which do not reduce the economic opportunities of future economies while recognising the finite nature of resources and use resources optimally over the longer term without resulting in economic loss.

Note: many mechanical and automotive systems have a mixture of social, economic and environmental impacts.

Examples of learning activities:
Learners:
• identify the social and economic impacts of minimum safety standards for design of motor vehicles.
• dispose of waste from an automotive service in an appropriate manner.
• predict consequences of poor sustainability practices in automotive workshops in a visual organiser which summarises cause and effect.
• create and present a multimodal presentation to demonstrate the positive and negative impacts of mechanical and automotive systems for a chosen context, e.g. motorsports, downhill mountain biking racing, trail bikes, personal mobility transportation, agricultural pumps or hybrid vehicles.
• analyse the costs and benefits of undertaking a repair on an older vehicle to determine course of action using a mind map to capture the factors influencing an individual's decision.
• tabulate and compare the emissions from a range of fuels and lubricants to make recommendations about the most sustainable.
calculate the estimated running costs of operating automotive alternatives, e.g. an older model car in comparison to a newer model, a motor bike in comparison to a car, four-wheel drive in comparison to a two-wheel drive.

**Project**

The *Automotive and Mechanical Technologies* Project provides the opportunity to apply the skills and knowledge covered in the core and content areas of the course which is based on learners' interests and potential pathways.

Projects should either repair, develop or enhance a mechanical or automotive system and are required to be approved by the teacher prior to commencement to ensure the project meets the course requirements, the scope of the project is achievable in the available time and there are no safety or legal issues.

**Key Concepts:**

**Problem identification:**
Problem identification requires appropriate fault finding and diagnostic testing to ensure that the work to be completed is addressing the correct problem.

**Problem solving:**
Problem solving is the iterative inquiry process that is undertaken during the completion of the project in an ongoing basis using the Engineering Design Process.

**Project planning and implementation:**
The project proposal scaffolds the planning phase of the project and may require refinement based on teacher feedback. Time management strategies during implementation of the project support the completion of the project.

**Examples of learning activities:**
Learners:

- propose possible projects during the core to consider potential topics for their individual or team project based on class discussions, websites, forums and individual needs.

- research possible ideas to devise a proposal which provides a time-line, parts required, processes and an estimated costing.

- take photos of the assembly of components prior to dismantling as a support for re-assembling and a record to include in the Project Journal.

- maintain a daily log of activities undertaken during completion of the project to record fault finding processes and problem solving processes.

The type and range of project needs to be considered in relation to available workshop facilities, costs involved and access to any specialist equipment. Throughout the project learners are expected to maintain a diary and to submit a proposal before the project is started.
As automotive technology is broad based and encompassing of powered equipment and alternate forms of personal transport, projects need not be limited to motor vehicle systems components or maintenance. Processes may include fabrication and machining both with the immediate workshop facilities or outsourced to specialist suppliers.

SUPPORTING STUDENT RESPONSES AND ELABORATIONS

The work requirements outlined in the course document should form the minimum assessment tasks for each of the units. Teachers will need to acknowledge these requirements when designing their scope and sequence and additional assessment (particularly of a formative nature) may be included to support and enhance the learning program. The learning activities, described in the preceding section, may support, facilitate and enrich learners’ understandings in preparation for completion of the following work requirement.

Project:
As outlined in the Content section above, the Project is a learner driven activity which can be undertaken either individually or as a group. The Project should integrate the learning from the core and content areas within the course.

Initially learners devise a Project Proposal which scopes the project and this is submitted to the teacher for approval prior to commencement of the work. In completing the Project Proposal learners will be required to research the nature and scope of the work to be undertaken, potential costs for materials and parts, management of safety, risks and hazards, testing and/or monitoring of work. A list of areas for coverage in the Project Proposal is provided in the course document and could be the basis of headings within a template for submission. In addition to analysing the relevant skills and knowledge required to complete the project, teachers need to evaluate the feasibility and appropriateness of the proposal within the context of their workshop facilities and access to resources.

After teacher approval or adjustment of the Project Proposal, all learners must complete a project. Time management is a vital aspect of the project with learners using the timeline devised in their Project Proposal as a tool for monitoring their progress. This can also be linked with the completion of a Daily Journal to document the procedures, processes and problem solving undertaken.

If learners work as part of a group, each student must document their own work within the project including details of their specific role and actions. Due to the nature and scale of most project topics, small group sizes are recommended; projects undertaken in pairs or groups of three enable learners to be actively engaged in the practical aspects.

The Project Journal is written by the learner whilst undertaking the practical project work. The course document provides a list of areas for coverage.

It is expected that learners include graphical content such as photos or drawings in their Project Journal during completion of the practical project. For example, photos taken of components or systems before and during dis-assembly not only record their practical work but also are a prompt to support correct re-assembly.
The project should strongly reflect the Engineering Design Process as a basis for problem solving and fault finding. This may be represented in graphical format with annotations to provide detail about the nature of the testing and outcomes. Flow charts, mind maps or other graphic organisers may also support the documentation of the Engineering Design Process.

**Practical work**

Opportunities for developing an understanding of the core areas and the essential mechanical systems are best provided through practical work which should account for 75% of course time.

Digital logs or work journals/diaries are recommended to 'log' the practical activities and to monitor the breadth of coverage. Required knowledge and skills relating to practical activities includes dismantling and re-assembling mechanical components to service and repair mechanical systems, undertaking basic fault finding processes and undertaking the practical aspects of the project.

**RESOURCES**

**Safety**


Safework Australia, 2015,

Victorian Department of Education and Training
- safe@work program
  Online OHS program for learners is designed to improve their knowledge and understanding of OHS before entering a workplace. In addition, a series of industry-specific hazards fact sheets have been developed and can be used in conjunction with this resource.

- General safety and differentiated resources

*Components, systems, maintenance and scientific principles*


**Online Simulations**

- Four-Stroke Engine Simulation
  Interactive 3D Four-Stroke Engine Learning Simulator Software

- Engine simulations
  [http://auto.howstuffworks.com/engine.htm](http://auto.howstuffworks.com/engine.htm)

- Glossaries, vehicle and component manufacturers websites, e.g.

Workshop manuals for range of engines

YouTube presentations

---

Copyright: Creative Commons Attribution 4.0 International unless otherwise indicated.
State of Tasmania (Department of Education) 2016