Engineering Technology
Senior Syllabus 2010
1. Rationale

Engineering Technology is a course of study that provides an opportunity for students to gain an understanding of the underlying principles of engineering in its broadest sense. It is concerned with the theoretical concepts and practical applications related to technology, industry and society, engineering materials, engineering mechanics, and control systems. Integrated throughout is the development of technical communication skills applicable to engineering. The course draws upon the fundamental principles of science, mathematics and technology, reinforcing conceptual ideas through practical workshop and laboratory activities.

Integral to the study of Engineering Technology is an understanding of the engineering design process — the creative, iterative process used by engineers to help develop products and to devise systems, components or processes that meet human needs. This is a decision-making process in which science, mathematics and engineering knowledge is applied to convert resources to meet a stated objective.

A course in Engineering Technology meets the needs of students in a modern society increasingly concerned with social, economic, humanitarian and environmental issues such as sustainability, renewable energies and Indigenous perspectives. Sustainability concepts will influence almost all engineering developments in the future. Awareness of Indigenous knowledges, especially as they relate to sustainability issues and care of the land, have developed over time. Local Indigenous communities are therefore integral to the consultation processes during the design, planning and construction of engineering projects.

Students will develop critical thinking skills through researching and analysing the concepts of sustainability using environmental, social and economic criteria, and by exploring the perspectives that Indigenous knowledges and practices bring to the field. Students will consider and apply sustainability concepts and Indigenous knowledges as they plan and design solutions to engineering problems.

In Engineering Technology students are required to undertake a variety of engineering design challenges which include activities such as testing of materials, formulation of problems, analysis of engineering solutions, modelling solutions and prototyping. These activities provide a framework by which theoretical principles can be investigated and tested. Through the engineering design process, students are encouraged to understand and appreciate the interaction and interdependence among engineering technologies, industry, society and the built and natural environments.

Engineering Technology is designed for students in the senior phase of learning who have an interest in the practical application of science, mathematics and technology. The course will provide them with the opportunity to pursue a wide variety of professional career pathways, especially those that involve scientific research and problem-solving skills. These include degree courses in all engineering streams\(^1\), the built environment, industrial design, and applied sciences and technology. A course of study in Engineering Technology will also be of benefit to students pursuing post school pathways in diploma and advanced diploma courses in the technical and paraprofessional areas of engineering, applied science, drafting, technology, aviation, electronics, mechanisms, and manufacturing and construction.

1.1 Indigenous perspectives

This syllabus recognises Aboriginal and Torres Strait Islander peoples, their traditions, histories and experiences prior to colonisation through to the present time. To strengthen

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\(^1\) Engineering streams include civil, mechanical, electrical, aerospace, mining, marine, informatechronics, medical, IT and software.
students’ appreciation and understanding of the first peoples of the land, relevant sections of
the syllabus identify content and skills that can be drawn upon to encourage engagement
with:

- Indigenous frameworks of knowledge and ways of learning
- Indigenous contexts in which Aboriginal and Torres Strait Islander peoples live
- Indigenous contributions to Australian society and cultures.

In Engineering Technology there is opportunity to explore Indigenous knowledges
concerning sustainable environmental practices, the use and management of natural
resources, and the conservation and protection of animal and plant life. Consideration should
also be given to spiritual connections to country, native title, access to specific places and
spaces, and the complex relationships with these places.
2. General objectives

Introduction

The general objectives for this subject are those that the school is required to teach and students have the opportunity to learn. The general objectives are grouped in four dimensions, i.e. the salient properties or characteristics of distinctive learning. The first three dimensions are the assessable general objectives. The fourth set of general objectives, *attitudes and values*, is not directly assessed as it is achieved through the teaching and learning approaches offered to students.

Progress in aspects of any dimension at times may be dependent on the characteristics and skills foregrounded and developed in another. The process of learning through each of the dimensions must be developed in increasing complexity and sophistication over a four-semester course.

Schools must assess how well students have achieved the general objectives. The standards are described in the same dimensions as the assessable general objectives.

The general objectives for a course in this subject are:

- *knowledge and application*
- *investigative and analytical processes*
- *evaluation and technical communication*
- *attitudes and values*.

These four dimensions reflect the engineering design process (see Section 4.1).

2.1 Knowledge and application

This dimension requires students to acquire knowledge and understanding of technology, industry and society, engineering materials, engineering mechanics and control systems. It also requires students to apply this knowledge in offering solutions to engineering problems, which may include unfamiliar and/or complex engineering situations.

By the conclusion of the course, students should:

- recall and explain engineering knowledge (facts, terms, principles and techniques), including mathematical concepts and techniques relevant to engineering situations
- identify the elements of engineering problems
- select and apply engineering knowledge, data, mathematical concepts and techniques to engineering problems.

2.2 Investigative and analytical processes

This dimension requires students to interpret and analyse engineering knowledge and data, and to propose engineering solutions to a range of problems within an engineering context, which may include unfamiliar and/or complex engineering situations.

By the conclusion of the course students should:

- interpret and analyse engineering data
• propose solutions based on engineering principles and techniques
• analyse solutions in relation to engineering principles
• develop prototypes and/or models that test solutions.

2.3 Evaluation and technical communication

This dimension requires students to evaluate solutions to engineering problems and to communicate conclusions and recommendations.

It also involves organising and presenting information, and selecting the most appropriate mode to communicate engineering information. The communication should conform to spatial and technical conventions.

By the conclusion of the course, students should:
• evaluate solutions in relation to the elements of the engineering problems
• draw conclusions and make recommendations based on investigations
• organise and present information in modes relevant to engineering situations, whether mathematical, written, graphical, oral, multimedia or by modelling
• demonstrate technical literacy through the selection and use of appropriate technical literacy forms such as technical vocabulary; symbolic, graphical, engineering and referencing conventions; and research and reporting techniques
• demonstrate spatial literacy through the selection and use of literacy forms such as communication principles, freehand sketching, conventions, and relevant standards.

2.4 Attitudes and values

This subject aims to develop ethical and responsible attitudes and values.

Attitudes and values are not assessed for the awarding of exit levels of achievement.

By the conclusion of the course, students should:
• critically appreciate the contribution made by engineering to the evolution of society
• develop an appreciation of the past and future social, economic, humanitarian and environmental impacts of engineering
• understand the impact of engineering on the built and natural environments, including local Indigenous countries
• value the importance of Indigenous perspectives, knowledges and practices to engineering technology, especially regarding the sustainable use of natural resources
• respect Indigenous peoples’ connections to country, traditional sites and lifestyles when engaging in engineering field work
• appreciate the need to adhere to safe working practices and to create safe working and living environments
• understand the value of cooperation, consultation, perseverance and responsibility appropriate for effective engineering problem solving.
3. Course organisation

3.1 Time allocation

The minimum number of hours of timetabled school time, including assessment, for a course of study developed from this syllabus, is 55 hours per semester. A course of study will usually be completed over four semesters (220 hours).

3.2 Physical resources

Schools will need to allocate resources related to equipment and space.

Suggested resources for this subject include access to:

- workshop/laboratory
- an automation system and appropriate software.

There are practical activities that require access to a variety of learning settings such as workshops, science/technology laboratories, computer rooms and resource centres.

Field trips are an important component of the course and provide contextual relevance for principles that would otherwise remain theoretical.

Teachers are encouraged to establish links with relevant industries and related tertiary institutions.

Teachers must also be aware of the implications of the relevant workplace health and safety legislation on the delivery of this course.

3.3 Structure of the course

The course of study is structured around an engineering design process that draws on scientific, mathematical and engineering knowledge covered in four interrelated areas of study. Technology contexts provide a real-world focus for coverage of the selected subject matter.

The course consists of:

- an engineering design process (see Section 4.1)
- technology contexts
- four areas of study
  - Technology, industry and society
  - Engineering materials
  - Engineering mechanics
  - Control systems.

3.4 Contexts

An integrative approach to the course emphasises the interrelationship that exists among theoretical concepts and engineering principles, materials and their properties, the
mechanics of machines, structures and components, automated technologies and mechanisms, and their associated practical applications in industry and society.

Contextualised units provide students with opportunity to learn in circumstances that are relevant and interesting to them and bring aspects of the areas of study together in real-world scenarios. Contextualised units provide meaningful frameworks for the development of learning experiences.

In the development of contextualised units, schools should consider student population, school resources, industry partnerships, local environments, and social and technological implications and issues.

The broad discipline of engineering encompasses a range of more specialised sub-disciplines, each with a specific emphasis on certain fields of application and particular areas of technology. These fields or contexts provide a real-world focus for coverage of the selected subject matter.

At least one technology context must be chosen and studied over the course.

The following contexts may be used as a guide.

### 3.4.1 Agriculture

Agricultural technology involves the design of agricultural machinery, equipment, sensors, processes, and structures which assist the development and management of sustainable and marketable plant and animal enterprises. Consideration of the environmental, social and economic factors affecting agricultural industry is crucial. Some agricultural engineers specialise in areas such as power systems and machinery design; structures and environment engineering; and food and bioprocess engineering.

### 3.4.2 Appropriate technology

Appropriate technology (AT) or simple technologies is a genuine grassroots solution to economic needs — it is technology that “fits”. AT is often described as using the simplest level of technology that can effectively achieve the intended purpose in a particular location, usually in developing nations or less developed rural areas of industrialised nations which frequently have very small engineering capacities. It requires no complex machines and is easily explainable and usable by individuals or small communities for a sustainable and ecological future.

AT is technology that is designed in consideration of the environmental, ethical, cultural, social and economical aspects of the community it is intended for, and typically requires fewer resources, is easier to maintain, has a lower overall cost and less of an impact on the environment compared to industrialised practices.

### 3.4.3 Aerospace (aviation)

Aerospace (aviation) engineering is the application of resources to design, make and maintain systems and vehicles associated with aircraft and spacecraft. This technology takes the principles of mathematics, science and engineering and uses them to develop an understanding of modern-day flight. It involves a range of associated technologies including aerodynamics, avionics, materials science and propulsion. The result of aerospace engineering is unprecedented advances in aviation and aerospace and the opening of new opportunities using applied technology.
3.4.4 Biomedicine

Biomedical technology involves the application of engineering and technology principles to living or biological systems. It combines the design and problem-solving skills of engineering with medical and biological sciences to solve health-related problems through the design, development and manufacture of medical devices, procedures and components. Examples include dental materials, artificial skin, cardiovascular materials and devices, prosthetic devices, drug delivery, health and monitoring devices, diagnostic systems such as CT, MRI and ultrasounds, therapeutic systems such as surgical lasers and tissue engineering.

Biomedical engineers also play an important role in improving the lives of people with disabilities by designing technological solutions to meet their needs. This includes developing equipment to assist people to walk, communicate or complete essential daily tasks, as well as designing artificial joints and limbs for patients.

3.4.5 Communication

Communication technology is the application of resources that enable people to communicate with each other and covers all advanced technologies in manipulating and communicating information. The results have a significant impact on society and the environment and include print, film, video and facsimile machines, telephones, satellite communications and computers. Communication technology also covers technologies such as computer games, digital TV and recorders, iPods, mobile phones, smartphones, digital still and video cameras, IM, Skype and the social networks.

3.4.6 Construction

Construction technology is the way that humans build structures on sites — it is the application of resources to provide shelter and service, and to control the environment. The results, such as homes, buildings, power plants, roads, waterways and dams, have a great impact on the environment and society. It involves studying methods of construction to successfully achieve the structural design with recommended specifications. It also includes study of construction equipment, and temporary works required to facilitate the construction process.

3.4.7 Energy

Energy technology is the application of a range of energy sources and their conversion into power in a controlled manner. It is concerned with the efficient, safe, environmentally friendly and economical extraction, conversion, transportation, storage and use of energy. Meeting the range of demand for energy has significant implications for society and the environment, including local Indigenous communities.

3.4.8 Manufacturing

Manufacturing technology is the application of human and physical resources to make goods and products that are central to our daily lives. It provides the tools that enable production of all manufactured goods. The generation of these goods and products is in response to human needs and desires.

Production tools make possible modern communications, affordable agricultural products, efficient transportation, innovative medical procedures and space exploration, and include machine tools and other relevant equipment and their accessories and tooling. Machine tools are non-portable, power-driven manufacturing machinery and systems used to perform specific operations on man-made materials to produce durable goods or components.
3.4.9 Mining

Mining technology involves the extraction of valuable minerals or other geological materials from the earth. In a wider sense mining technology comprises the extraction of any non-renewable resource. The responsible application and development of this technology is of paramount importance in providing a viable and sustainable future for both society and the environment. Building relationships with local Indigenous communities will help in developing successful mining arrangements. Indigenous knowledges and practices, especially with respect to the sustainable use of natural resources and the conservation and preservation of animal and plant life, will lessen the impact that mining activity may have on their water supplies, wildlife and the productivity of their land.

3.4.10 Sustainability

Sustainability is the application of engineering principles in a manner which propagates, promotes and sustains a liveable planet for future generations. The development of renewable energy sources free of climate changing gases and by-products is the core concern for this area of engineering technology. Indigenous knowledges and practices demonstrate sustainable use of natural resources and assist in the management of resources and the conservation and protection of animal and plant life.

Sustainable technologies use less energy, fewer limited resources, do not deplete natural resources, do not directly or indirectly pollute the environment, and can be reused or recycled at the end of their useful life. There is a significant overlap with appropriate technology, which emphasises the suitability of technology to the context; in particular, considering the needs of people in developing countries. However, the most appropriate technology may not be the most sustainable one; and a sustainable technology may have high cost or maintenance requirements that make it unsuitable as an “appropriate technology” in the sense that the term is commonly used.

3.4.11 Transportation

Transportation technology is the application of resources to move materials, goods and people safely, more efficiently and more cost-effectively. It examines the impact of transportation on the environment and aims to reduce pollution with more fuel-efficient cars, computer monitoring of emissions, and public transportation systems.

Transportation technology is also at work in global positioning system (GPS) satellites and digital radio systems that enhance communication and navigation. Jobs in transportation technology range from the automobile industry to airlines, the environment and railways.

Transportation technicians plan, design, operate and maintain the equipment, vehicles and systems that make modern transportation possible. The capacity for transportation within a society has significant implications for its people, industries, economic base and environment.

3.4.12 School defined contexts

Schools selecting an alternative context must provide a brief description of it as a context of study, similar to those above. This gives a rationale for the teaching and learning strategies offered to students.

3.5 Areas of study

In selecting subject matter it should be noted that:
• all the associated study topics from the four areas of study should be covered in the four semester course
• not all suggested subject matter has to be covered in the course
• school resources, teacher expertise, student interest and community needs are important considerations.

3.5.1 Technology, industry and society

Introduction
Historically, developments in technology and industry have led to changes in lifestyle that continue to have an impact on worldwide societies, including Australia’s Indigenous communities. It is important, therefore, for students to appreciate the interdependence that occurs among technology, industry and society.

<table>
<thead>
<tr>
<th>Study topics</th>
<th>Suggested subject matter</th>
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</thead>
</table>
| 1. Engineering and related professions           | Engineering courses: course structures from bachelor, diploma and certificate qualifications; institutes that offer engineering courses such as university, TAFE and private providers  
Careers: the role of an engineer, various fields, career profiles, career outcomes, job activities  
Project management and current industry management practices: may include batch production, assembly line production, just in time (JIT), computer integrated manufacturing (CIM), total quality management (TQM)  
Workplace health and safety                                                                                           |
| 2. Evolution and influence of technology on society | History of technological change as applied to materials choice and design such as bridges, mobile phones or household appliances  
Influence of advances in engineering on technological change and the effect on society  
Social, economic, environmental and cultural implications, including Indigenous cultures  
Future perspectives                                                                                                                                                   |
| 3. Sustainable engineering                       | Social: sustainability principles, sustainable living, recycling  
Environmental: clean technology, nuclear energy, biofuel, geothermal power, hydropower, solar power, tidal power, wave power, wind power, carbon sinks  
Economic: ethical economics, peak oil, carbon tax, life cycle assessment, footprint analysis, green buildings, decarbonisation, car-free movement |
### 4. Indigenous perspectives

Indigenous peoples’ connections to country, lifestyles and access to specific places and spaces

- Traditional sites — middens and ceremonial places; protection of sacred sites; protection of significant and other sites (e.g. government settlements)
- Access to Indigenous land — permits; heritage listing; custodial rights to lands; native title (*Native Title Act 1993; National Native Title Tribunal*)
- Impact of mining, pastoral and other industries on land rights
- Negotiated agreements between Indigenous people, non-Indigenous people and governments on the sustainable use of natural resources

### 5. Engineering graphics

Australian Standards: layout, subtitles, dimensioning, printing

- Drawing methods: technical sketching, orthographic projection, pictorial drawing
- Computer-aided design

### 3.5.2 Engineering materials

**Introduction**

Study of engineering materials is intended to provide the student with an understanding of the nature of materials and their property–structure relationships. In addition, it provides an appreciation of the various mechanisms for modifying materials with respect to both properties and form, and an insight into the use of materials in the built environment and how this has changed.

<table>
<thead>
<tr>
<th>Study topics</th>
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<tbody>
<tr>
<td>1. Materials classification</td>
<td>Classification of engineering materials — metals, polymers, ceramics, composites and organics. Elements, compounds and mixtures. Ferrous and non ferrous alloys</td>
</tr>
<tr>
<td></td>
<td>Atomic and molecular bonding. Crystalline structures. Macro and micro structures. Primary and secondary bonds</td>
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<tr>
<td>2. Materials properties</td>
<td>Physical properties — conductivity, melting point, colour, lustre, density</td>
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<td></td>
<td>Mechanical properties — tensile and compressive strength, elasticity, hardness, ductility, malleability, toughness, creep and shear strength, fatigue, failure</td>
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<td></td>
<td>Deformation — elastic, plastic, slip, twinning and work hardening</td>
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<td></td>
<td>Properties testing — hardness, impact, fatigue, torsion and non-destructive testing</td>
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<tr>
<td></td>
<td>Properties analysis — plotting and calculations, Young’s modulus, stress/strain diagrams for steel, aluminium alloys, copper alloys, polymers, ceramics and composites</td>
</tr>
</tbody>
</table>
### 3. Metals
Production techniques — casting, welding, rolling, extrusion, forging, drawing, spinning, machining, powder metallurgy and welding. Heat treatments such as annealing, tempering and hardening. Recrystallisation. Cold working, hot working and work hardening
Introduction to corrosion. Nonferrous metals and alloys
Industrial and engineering applications of metals

### 4. Ceramics
Structure and properties — molecular structure and related physical and mechanical properties. Clay bodies, cements, glass-bonded ceramics, semiconductors, industrial ceramics and bioceramics
Production techniques — slip casting, shell casting, pressing and sintering
Degradation of ceramics — mechanical degradation due to low fracture toughness and wear abrasion
Industrial and engineering applications — insulators, semiconductors, abrasives, optics, refractories in electrical, biomedical and aerospace industries

### 5. Polymers
Structure and properties — linear and network structures of organic and inorganic polymers, related physical and mechanical properties. Bioplastics
Production techniques — injection, compression, transfer moulding, laminating and reinforcing, fabrication
Degradation of polymers — fatigue, ultraviolet radiation, thermal, mechanical and chemical degradation. Biodegradable plastics
Industrial and engineering applications — coatings (e.g. Teflon), films, packaging

### 6. Composites
Structure and properties — physical and mechanical properties
Cermets. Engineered woods. Fibre production, influence of length, orientation and concentration
Ceramic composites, concrete, glass fibre, carbon fibre and aramid fibre composites
Industrial and engineering applications — fibre reinforced plastics (e.g. Kevlar), dental, marine, aerospace and military
3.5.3 Engineering mechanics

Introduction

The study of mechanics and associated practical applications will permit students to investigate the effects of forces on the condition of machines, structures, and their components when at rest or in motion.

This area of study will concentrate on the mechanics of rigid structures, machines and components. The mechanics of machines, structures and components include two principal study topics: dynamics, which relates to objects in motion; and statics, which deals with forces on objects at rest.

<table>
<thead>
<tr>
<th>Study topics</th>
<th>Suggested subject matter</th>
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<tbody>
<tr>
<td>4. Machines</td>
<td>Load, effort, and mechanical advantage, velocity ratio and efficiency for simple mechanical systems. First, second and third-class levers Examples of simple machines: levers, wheel and axle, screw-jack, worm and wheel and pulley systems Gears, belts and pulleys. Velocity ratio for gear systems. Function of different types of gears in a range of objects. Types of belt or chain drive systems. Pulley systems. Mechanical advantage of pulley systems. Inclined planes and screw threads. Engineering applications of machines</td>
</tr>
</tbody>
</table>
3.5.4 Control systems

Introduction
The study of control systems, and the associated software, hardware and mechanisms, will enable students to appreciate the application of automated technologies in industry and society.

This area of study enables students to analyse the operation of basic automatically controlled industrial devices, define the operating sequences and develop the control logic necessary to achieve basic operational outcomes.

Safety: Where electrical systems are used, they should not exceed 24 volts.

<table>
<thead>
<tr>
<th>Study topics</th>
<th>Suggested subject matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overview of control systems</td>
<td>Domestic, commercial, industrial applications</td>
</tr>
<tr>
<td></td>
<td>Implications of control systems on society</td>
</tr>
<tr>
<td>2. Fundamentals of control systems</td>
<td>Control elements — input, process, output; control loop; feedback; sequential logic</td>
</tr>
<tr>
<td>3. Components</td>
<td>Some possible systems may include:</td>
</tr>
<tr>
<td>input</td>
<td>Pneumatic and electro-pneumatic — compressors, motors, cylinders, pressure regulators, valves (three- and five-port, solenoid-operated, flow-control)</td>
</tr>
<tr>
<td>processors</td>
<td>Hydraulic — pumps, motors, cylinders, valves (three- and four-port, solenoid-operated, pressure-relief)</td>
</tr>
<tr>
<td>output</td>
<td>Electrical and electronic — electric motors, starters, solenoid actuation of contactors, sensors (light, sound, heat, proximity), switches (momentary, push-button, toggle, limit), programmable logic controllers (PLCs)</td>
</tr>
<tr>
<td>4. Applying control systems</td>
<td>Simulation of integrated systems using modelling techniques</td>
</tr>
<tr>
<td></td>
<td>Flow charts, event-timing diagrams, functional block diagrams, industrial programming techniques, e.g. ladder logic, statement list, basic</td>
</tr>
<tr>
<td></td>
<td>Practical application of control systems using input/output devices connected to a control device, e.g. PLCs, CNC machines, robotics, household appliances, manufacturing plants, traffic-light systems, conveyor systems</td>
</tr>
</tbody>
</table>

3.6 Composite classes

This syllabus enables teachers to develop a course that caters for a variety of circumstances, such as combined Year 11 and 12 classes, combined campuses, or modes of delivery involving periods of student-managed study.

The flexibility of the syllabus can support teaching and learning for composite classes by enabling teachers to:

- structure learning experiences and assessment that allow students to access the key concepts and ideas suited to their needs in each year level
- provide opportunities for multilevel group work, peer teaching and independent work on appropriate occasions.
The following guidelines may prove helpful in designing a course of study for a composite class:

- The course of study could be written in a Year A / Year B format, if the school intends to teach the same topics to both cohorts.
- A topic that will allow Year 11 students ease of entry into the course should be placed at the beginning of each year.
- Learning experiences and assessment instruments need to cater for both year levels throughout the course. Even though tasks may be similar for both year levels, it is recommended that more extended and/or complex tasks be used with Year 12 students.

**Bridging study**

A bridging study could cater for students who enter the course later than the rest of the class. This may include students entering their first year of a composite class, or students entering significantly after the commencement of a course. Other contexts suited to a bridging study are when students have had little exposure to the subject or no experience of the necessary prerequisite learning in Year 10.

The bridging study

- might introduce key terms and concepts for independent study or supplement topics already covered in the course
- is not intended to be a substitute for teaching key terms and concepts or a topic; the intention is that the study will supplement any subsequent teaching
- is not expected to be included in a work program for approval.

Advice on designing a bridging study could be sought from the relevant QSA personnel.

### 3.7 Work program requirements

A work program is the school’s plan of how the course will be delivered and assessed, based on the school’s interpretation of the syllabus. It allows for the special characteristics of the individual school and its students.

The school’s work program must meet all syllabus requirements and must demonstrate that there will be sufficient scope and depth of student learning to meet the general objectives and the exit standards.

The requirements for on-line work program approval can be accessed on the Queensland Studies Authority’s website, <www.qsa.qld.edu.au> (select Years 10-12 > Years 11-12 subjects). This information should be consulted before writing a work program. The requirements for work program approval may be updated periodically.
4. Learning experiences

A variety of learning experiences in Engineering Technology should be devised to provide opportunities for students to achieve the general objectives of the syllabus and the specific objectives derived from these.

The course is designed to provide opportunities for students to experience the areas of study through a variety of practical and theoretical learning experiences relevant to the chosen contexts. A balance should be maintained in the teaching-learning process between normal classroom work and the workshop/laboratory so that adequate time is given to workshop/laboratory activities.

In this course, students undertake engineering design challenges/problems to investigate, experiment, make decisions, judgments and recommendations about engineering problems. In a developmental four-semester course, engineering design challenges provide students with the opportunity to demonstrate their capability when dealing with tasks that range from well-rehearsed (familiar) through to those that require the application of engineering principles in unrehearsed (unfamiliar) situations. Students should be provided with the opportunity to work on simple, single-step tasks through to complex tasks. Complexity may derive from either the nature of the principles involved or from the number of ideas or procedures that must be sequenced in order to produce an appropriate conclusion.

4.1 An engineering design process

An engineering design process is a creative, iterative decision-making process which involves a series of steps leading to the development of a product, system, component or process to meet a need. It is a non-linear process in which design challenges are identified, revisited, challenged, reconsidered, re-examined and solved at each and any stage of development.

Design challenges are open ended in nature, which means they may have more than one solution. Solving design challenges through an engineering design process is iterative, i.e. the desired result is reached by means of a repeated cycle of operations.
In this course students are required to:

- identify the elements of the problem — students should state the problem in their own words, describing the aspects that are known and what is unknown
- recall, select and apply relevant engineering knowledge — students should research and investigate current best practice in the field, noting relevant information and the design implications
- interpret and analyse engineering data — students should investigate the design specifications, identify constraints and information gathered. Students should also identify relevant mathematical concepts and engineering principles
- propose possible solutions — students should propose possible solutions based on research. Annotated sketches should identify the key features and explain the preliminary concepts
- analyse solutions — students should analyse proposed solutions and identify the critical elements relevant to the engineering problem
- select and evaluate a solution — students should identify the design that appears to solve the problem most effectively. They describe and justify why they chose the solution. This should include some reference to the specifications and constraints identified above as well as relevant mathematical concepts and engineering principles
- prototype and test the solution — students should produce a full-size or scale model based on their drawings. They should identify appropriate modelling environments, materials and tools. They should test their model and gather relevant mathematical and scientific data to determine its effectiveness
- draw conclusions and make recommendations — students should interpret and analyse test data and analyse and evaluate their prototype in relation to the identified elements of the initial engineering problem. Students should apply relevant engineering knowledge to identify any problems and suggest proposed modifications.

Communication of engineering knowledge is integral to the entire engineering design process. Throughout the course of study, emphasis must be given to the development of appropriate communication skills within engineering (see Section 6.1).

### 4.2 Suggested learning experiences

Learning experiences should be planned to help students acquire a knowledge and understanding of engineering principles and their application to engineering problems; apply the engineering design process; and develop an appreciation of the impact of engineering technology on industry, society and the environment.

Students may:

- undertake and solve engineering design challenges
- clarify, formulate and analyse the nature of engineering technology problems and their impact on society, the environment and local Indigenous communities
- make use of testing techniques
- undertake laboratory testing and modelling exercises
- create prototypes
- observe expert demonstration
- research using a variety of sources, including multimedia
- communicate solutions to others using a variety of techniques, including modelling, simulation and extended writing
• apply basic scientific skills
• undertake field trips
• apply Australian Standards
• interpret tables and graphs related to mechanical testing and engineering mechanics
• sketch graphical solutions
• use computer technology and automation
• undertake real-life case studies
• investigate current issues in engineering
• solve problems by applying suitable processes and skills
• work individually and collaboratively to analyse and draw conclusions relevant to engineering problems
• use information communication technologies to develop links and working partnerships with industry and educational institutions, locally, nationally and internationally
• examine the historical development of industrial enterprises and postulate future scenarios
• critically examine the role of technology and its impact on society, the environment and local Indigenous communities.
5. Assessment

Assessment is an integral part of the teaching and learning process. For Years 11 and 12 it is the purposeful, systematic and ongoing collection of information about student learning outlined in the senior syllabuses.

In Queensland, assessment is standards-based. The standards for each subject are described in dimensions, which identify the valued features of the subject about which evidence of student learning is collected and assessed. The standards describe the characteristics of student work.

The major purposes of assessment in senior Authority subjects are to:

- promote, assist and improve learning
- inform programs of teaching and learning
  - advise students about their own progress to help them achieve as well as they are able
  - give information to parents and teachers about the progress and achievements of individual students to help them achieve as well as they are able
- provide comparable levels of achievement in each Authority subject to be recorded in students' learning accounts. The comparable levels of achievement may contribute to the award of a Queensland Certificate of Education
- serve as the base data for tertiary entrance purposes
- provide information about how well groups of students are achieving for school authorities and the State Education and Training Minister.

5.1 Principles of exit assessment

All the principles of exit assessment must be used when planning an assessment program and must be applied when making decisions about exit levels of achievement.

A standards-based assessment program for the four-semester course of study requires application of the following interdependent principles.

- Information is gathered through a process of continuous assessment.
- Balance of assessment is a balance over the course of study and not necessarily a balance over a semester or between semesters.
- Exit achievement levels are devised from student achievement in all areas identified in the syllabus as being mandatory.
- Assessment of a student’s achievement is in the significant aspects of the course of study identified in the syllabus and the school’s work program.
- Selective updating of a student’s profile of achievement is undertaken over the course of study.
- Exit assessment is devised to provide the fullest and latest information on a student’s achievement in the course of study.

While most students will exit a course of study after four semesters, some will exit after one, two or three semesters.
Continuous assessment

Judgments about student achievement made at exit from a course of study must be based on an assessment program of continuous assessment.

Continuous assessment involves gathering information on student achievement using assessment instruments administered at suitable intervals over the developmental four-semester course of study.

In continuous assessment, all assessment instruments have a formative purpose. The major purpose of formative assessment is to improve teaching and student learning and achievement.

When students exit the course of study, teachers make a summative judgment about their levels of achievement in accordance with the standards matrix.

The process of continuous assessment provides the framework in which the other five principles of exit assessment operate: balance, mandatory aspects of the syllabus, significant aspects of the course, selective updating, and fullest and latest information.

Balance

Judgments about student achievement made at exit from a course of study must be based on a balance of assessments over the course of study.

Balance of assessments is a balance over the course of study and not a balance within a semester or between semesters.

Balance of assessment means judgments about students' achievements of all the assessable general objectives are made a number of times using a variety of assessment techniques and a range of assessment conditions over the developmental four-semester course.

See also Section 5.6 Requirements for verification folio.

Mandatory aspects of the syllabus

Judgments about student achievement made at exit from a course of study must be based on mandatory aspects of the syllabus.

The mandatory aspects are:

• the general objectives of knowledge and application, investigative and analytical processes, evaluation and technical communication
• the four areas of study: Technology, industry and society, Engineering materials, Engineering mechanics, Control systems.

To ensure that the judgment of student achievement at exit from a four-semester course of study is based on the mandatory aspects, the exit standards for the dimensions stated in the standards matrix (refer to Section 5.8.1) must be used.

Significant aspects of the course of study

Judgments about student achievement made at exit from a course of study must be based on significant aspects of the course of study.

Significant aspects are those areas described in the school's work program that have been selected from the choices permitted by the syllabus to meet local needs.

The significant aspects must be consistent with the general objectives of the syllabus and complement the developmental nature of learning in the course over four semesters.
Selective updating

Judgments about student achievement made at exit from a course of study must be selectively updated throughout the course.

Selective updating is related to the developmental nature of the course of study and works in conjunction with the principle of fullest and latest information.

As subject matter is treated at increasing levels of complexity, assessment information gathered at earlier stages of the course may no longer be representative of student achievement. Therefore, the information should be selectively and continually updated (not averaged) to accurately represent student achievement.

Schools may apply the principle of selective updating to the whole subject group or to individual students.

Whole subject group

A school develops an assessment program so that, in accordance with the developmental nature of the course, later assessment information based on the same groups of objectives replaces earlier assessment information.

Individual students

A school determines the assessment folio for verification or exit (post-verification). The student’s assessment folio must be representative of the student’s achievements over the course of study. The assessment folio does not have to be the same for all students; however, the folio must conform to the syllabus requirements and the school’s approved work program.

Selective updating must not involve students reworking and resubmitting previously graded responses to assessment instruments.

Fullest and latest information

Judgments about student achievement made at exit from a course of study must be based on the fullest and latest information available.

- "Fullest" refers to information about student achievement gathered across the range of general objectives.
- “Latest” refers to information about student achievement gathered from the most recent period in which achievement of the general objectives is assessed.

As the assessment program is developmental, fullest and latest information will most likely come from Year 12 for those students who complete four semesters of the course.

The fullest and latest assessment data on mandatory and significant aspects of the course of study is recorded on a student profile.

5.2 Planning an assessment program

To achieve the purposes of assessment listed at the beginning of this section, schools must consider the following when planning a standards-based assessment program:

- general objectives (see Section 2)
- learning experiences (see Section 4)
- principles of exit assessment (see Section 5.1)
• variety in assessment techniques over the four-semester course (see Section 5.5)
• conditions in which assessment instruments are undertaken (see Section 5.5)
• verification folio requirements, that is, the range and mix of assessment instruments necessary to reach valid judgments of students' standards of achievement (see Section 5.6)
• post-verification assessment (see Section 5.6)
• exit standards (see Section 5.7).

In keeping with the principle of continuous assessment, students should have opportunities to become familiar with the assessment techniques that will be used to make summative judgments.

Further information can be found at: <www.qsa.qld.edu.au> (select Years 10-12 > Years 11-12 subjects).

5.3 Special provisions

Guidance about the nature and appropriateness of special provisions for particular students may be found in the Authority's Policy on Special Provisions for School-based Assessments in Authority and Authority-registered subjects (2009), available from <www.qsa.qld.edu.au> (select Years 10-12 > Moderation and quality assurance).

This statement provides guidance on responsibilities, principles and strategies that schools may need to consider in their school settings.

To enable special provisions to be effective for students, it is important that schools plan and implement strategies in the early stages of an assessment program and not at the point of deciding levels of achievement. The special provisions might involve alternative teaching approaches, assessment plans and learning experiences.

5.4 Authentication of student work

It is essential that judgments of student achievement are made on accurate and genuine student assessment responses. Teachers should ensure that students' work is their own, particularly where students have access to electronic resources or when they are preparing collaborative tasks.

The QSA information statement Strategies for authenticating student work for learning and assessment is available from <www.qsa.qld.edu.au> (search on "authenticating"). This statement provides information about various methods teachers can use to monitor that students' work is their own. Particular methods outlined include:

• students' planning production of drafts and final responses
• teachers seeing plans and drafts of student work
• maintaining documentation of the development of responses
• students acknowledging resources used.

Teachers must ensure students use consistent accepted conventions of in-text citation and referencing, where appropriate.
5.5 Assessment techniques

The techniques and associated conditions of assessment most suited to the judgment of student achievement in this subject are described below. The general objectives and dimensions to which each technique is best suited are also indicated.

For each dimension, standards are described. These standards descriptors are used to determine the properties or characteristics to be assessed by individual assessment instruments. The properties or characteristics for each instrument determined by a school are termed criteria. Therefore, the criteria for an assessment instrument are drawn from the syllabus standards descriptors for relevant dimensions (see Section 5.8.1 Standards matrix).

Schools decide the instruments to be used for assessment. For each assessment instrument, schools develop a criteria sheet: a tool for making judgments about the quality of students’ responses to an assessment instrument. It lists the properties or characteristics used to assess students’ achievements. Students must be given a criteria sheet for each assessment instrument.

Where students undertake assessment in a group or team, instruments must be designed so that teachers can validly assess the work of individual students and not apply a judgment of the group product and processes to all individuals.

5.5.1 Supervised written

### Supervised written assessment

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>This technique is used to assess student responses that are produced independently, under supervision and in a set timeframe. This ensures the originality and authenticity of student work.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>This technique is written (by hand or on a computer) and conducted under supervised conditions. It may include single or multiple items.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What dimensions will be assessed through this instrument?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This technique could be used to determine student achievement in the three dimensions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific guidance to the assessment technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supervised examination may consist of a number of response types and could be constructed using one or more items. The items may be in response to stimulus materials or questions which may be seen or unseen. When using seen questions, schools must ensure the purpose of this technique is maintained. These conditions must be explained on the assessment instrument. Unseen means that the students have not previously seen the material or question. Unseen materials or questions should not be copied from information or texts that students have previously been exposed to or have directly used in class. When stimulus materials are used they should be succinct enough to allow students sufficient time to engage with them. If the stimulus materials are lengthy, complex or large in number they may need to be shared with students prior to the administration of the assessment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Types of items that could be included in a supervised written assessment</th>
</tr>
</thead>
</table>
| • Closed questions (require a limited response), definitions of terms  
  - useful for diagnostic and formative purposes  
  - mainly used as a quick, effective method of assessing students’ ability  
  - often used for testing content knowledge  
  - usually require single word or sentence answers  

• Short responses — calculations  
Students are required to demonstrate problem solving through interpreting and analysing a situation in order to calculate a solution. |
Such responses involve:
- graphical representations
- interpretations of engineering data
- practical exercises involving graphs, diagrams and statistics
- selection and application of mathematical concepts
- mathematical calculations

- Short responses — prose
  Written responses in the form of:
  - annotations, notes or sentences, e.g. explanation of a concept
  - paragraphs, explanations and evaluations
  - report style.

- Short responses — response to stimulus materials
  - stimulus materials may include engineering case studies, engineering reports, testing
data, graphs, charts, video/audio recordings, webcasts, podcasts and DVDs
  - questions may be designed to illustrate understanding of issues that are referred to
directly or alluded to in the stimulus material
  - questions may require analysis, synthesis and evaluation of the stimulus materials to
develop and justify decisions or develop courses of action.

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recommended time: 1–1½ hours</td>
<td>• Recommended time: 1½ –2 hours</td>
</tr>
<tr>
<td>• Perusal times may be required</td>
<td>• Perusal times may be required</td>
</tr>
<tr>
<td>• Schools must ensure that where computers / word processing are used the purpose of this instrument is maintained. Teachers should consider which general objectives are most appropriate</td>
<td>• Schools must ensure that where computers / word processing are used the purpose of this instrument is maintained. Teachers should consider which general objectives are most appropriate</td>
</tr>
<tr>
<td>• May be open book or notes allowed; these conditions must be clearly outlined on the assessment</td>
<td>• May be open book or notes allowed; these conditions must be clearly outlined on the assessment</td>
</tr>
<tr>
<td>• 50–250 words (applies to the prose; graphs, mathematical calculations, workings, diagrams and/or models are not included in the word count)</td>
<td>• 50–250 words (applies to the prose; graphs, mathematical calculations, workings, diagrams and/or models are not included in the word count)</td>
</tr>
</tbody>
</table>

**What must teachers do when planning for a supervised written assessment? What information must be provided to students about this technique?**

Teachers should:
- construct questions that are unambiguous
- format the assessment to allow for ease of reading and responding
- consider the language needs of the students
- ensure the questions allow the full range of standards to be demonstrated
- consider the instrument conditions in relation to the requirements of the question/stimulus
- determine appropriate use of stimulus materials and students notes
- provide students with learning experiences that support the types of items included in the assessment and demonstrate the syllabus emphasis on an issue or design challenge related to the wellbeing of individuals, families and communities
- teach the appropriate language and communication skills and strategies
- inform the students and indicate on the assessment what dimensions will be assessed.
5.5.2 Technical engineering report

Technical engineering report

Purpose
A technical engineering report is a response to an engineering design challenge that requires the application of the engineering design process. Appropriate tasks would encourage modelling and simulation of engineering principles and applications.

Brief description
A typical design challenge would require student to:
- identify the elements of the problem
- recall, select and apply relevant engineering knowledge
- interpret and analyse engineering data
- propose possible solutions
- analyse solutions
- select and evaluate a solution
- prototype and test the solution
- draw conclusions and make recommendations.

Integral to this process is the communication of engineering knowledge.

What dimensions will be assessed through this instrument?
This technique is used to determine student achievement in all three dimensions.

Specific guidance
While reports vary in the type of information they present, (e.g. original research, the results of an investigative study, or the solution to a design problem), they are based on a similar structure. Reports are designed for quick and easy communication of information and for selective reading. They use sections with numbered headings and subheadings, and figures and diagrams to convey data.

Typically the report would contain:
- title page
- table of contents
- introduction
- investigation
- design ideas
- final solution
- test results
- conclusions and recommendations
- references
- appendices.

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed over an extended period of time (approximately 4–10 weeks)</td>
<td>Completed over an extended period of time (approximately 4–10 weeks)</td>
</tr>
<tr>
<td>under unsupervised conditions</td>
<td>under unsupervised conditions</td>
</tr>
<tr>
<td>The report consists of a compilation of materials which may include</td>
<td>The report consists of a compilation of materials which may include</td>
</tr>
<tr>
<td>mathematical calculations, annotated graphical and diagrammatic</td>
<td>mathematical calculations, annotated graphical and diagrammatic</td>
</tr>
<tr>
<td>responses, models, and supported by 800–1000 words</td>
<td>responses, models, and supported by 1000–1500 words</td>
</tr>
</tbody>
</table>
What must teachers do when planning for a technical engineering report? What information must be provided to students about this technique?

- The teacher provides a focus for the technical report or works in conjunction with the student to develop one.
- Teachers must allow class time for students to be able to effectively undertake each component of the report. However, independent student time will be required to complete the task.
- Teachers must implement strategies to ensure authentication of student work.
- Teachers must consult, negotiate and provide feedback before and during the time the students are working on the assessment to provide ethical guidance (refer to drafting guidelines) and to monitor student work. Feedback and assistance should be provided judiciously, gradually being reduced with the development of student experience and confidence.
- Scaffolding must be provided. When a technical report is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the process and skills required. However, the scaffolding provided should not specify or lead the student through a series of steps dictating a solution. Scaffolding should be reduced from Year 11 to Year 12 to allow the student to better demonstrate independence in the process. When an assessment technique is revisited (most likely in Year 12), the scaffolding should be reduced and could be a series of generic questions.
- The teacher should provide students with learning experiences in the use of appropriate communication strategies, including the generic requirements for presenting a technical engineering report (e.g. technical report structures, referencing conventions).
- The teacher should inform the students and indicate on the assessment what dimensions will be assessed and debrief the instrument specific standards.

5.5.3 Extended responses

Extended responses

Purpose
These techniques are used to assess students’ application of higher order cognition to known and provided materials, stimuli and concepts.

A brief description
Students are required to analyse, synthesise and evaluate data and information in the development of a response. It may involve expressing and justifying a point of view, explaining and evaluating an issue, or the application of concepts or theories to a circumstance. The response may be the result of research work or student investigations of an engineering problem.

Extended responses occur over a period of time using class and students’ own time and may be presented in a variety of modes.

What dimensions will be assessed through this technique?
This technique could be used to determine student achievement in the three dimensions.

Specific guidance
Extended responses may be written, spoken or multimodal presentations.

Written techniques may include:
- essays
- journal articles
- reports
- critiques
- reviews.

Spoken and multimodal techniques may include:
• interviews
• speeches
• debates
• datashow presentations
• seminar presentations
• video recordings and podcasts
• computer software programs
• webpages.

This technique may be used in association with the technical engineering report or research assignments. The techniques used will require students to present to a real audience (e.g. speech), or a virtual audience through the use of technology.

The student spoken or multimodal response is the focus for assessment decisions; however, supporting documentation will be required to substantiate decisions and for monitoring, verification and exit purposes.

<table>
<thead>
<tr>
<th>Year 11</th>
<th>Year 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written instruments: 600–1000 words</td>
<td>Written instruments: 800–1200 words</td>
</tr>
<tr>
<td>Spoken 3–4 minutes</td>
<td>Spoken 4–5 minutes</td>
</tr>
<tr>
<td>Multimodal instruments 3–5 minutes</td>
<td>Multimodal instruments 5–7 minutes</td>
</tr>
</tbody>
</table>

5.6 Requirements for verification folio

A verification folio is a collection of a student’s responses to assessment instruments on which the level of achievement is based. For students who are to exit with four semesters of credit, each folio must contain the range and mix of assessment techniques for making summative judgments stated below.

Students’ verification folios for Engineering Technology must contain:

• a minimum of **four** and a maximum of **six** assessment instruments
• a technical engineering report that demonstrates the application of the engineering design process (up to 1500 words, with supporting material, both graphical and experimental); this report must assess all three dimensions
• two supervised written examinations (at least one examination must include assessment of the dimension investigative and analytical processes)
• evidence that each dimension has been assessed summatively at least twice in Year 12 before verification
• the individual student profile detailing achievement in all dimensions, and including the on-balance judgment for each of the three dimensions
• a proposed exit level of achievement.

The assessment instruments and the associated student responses must demonstrate an appropriate depth of study in each of the areas of study, as dealt with in at least one of the specified technology contexts. The technology context(s) studied must be readily identifiable.

In addition, each verification submission must contain:

• a copy of the school’s approved work program
• clean copies of all summative assessment instruments, with conditions
• instrument specific criteria and standards sheets for each assessment instrument.
For information about preparing monitoring and verification submissions schools should refer to <www.qsa.qld.edu.au> (select Years 10-12 > Moderation and quality assurance > Forms and procedures).

5.6.1 Post-verification assessment

Schools must use assessment information gathered after verification in making judgments about exit levels of achievement for those students who are completing the fourth semester of the course of study. For this syllabus students are to complete additional assessment which must show evidence of all three dimensions.

5.6.2 Student profile

The purpose of the student profile is to record student achievement over the four-semester course of study. Key elements on the profile include:

- semester units/themes/topics
- assessment instruments in each semester
- standard achieved in each dimension for each instrument
- instruments used for summative judgments
- interim level of achievement at monitoring and verification.

5.7 Exit standards

The purpose of standards is to make judgments about students’ levels of achievement at exit from a course of study. The standards are described in the same dimensions as the assessable general objectives of the syllabus. The standards describe how well students have achieved the general objectives and are stated in the standards matrix.

The following dimensions must be used:

- Dimension 1: Knowledge and application
- Dimension 2: Investigative and analytical processes
- Dimension 3: Evaluation and technical communication.

Each dimension must be assessed in each semester, and each dimension is to make an equal contribution to the determination of exit levels of achievement.
5.8 Determining exit levels of achievement

When students exit the course of study, the school is required to award each student an exit level of achievement from one of the five levels:

- Very High Achievement (VHA)
- High Achievement (HA)
- Sound Achievement (SA)
- Limited Achievement (LA)
- Very Limited Achievement (VLA).

Exit levels of achievement are summative judgments made when students exit the course of study. For most students this will be after four semesters. For these students, judgments are based on exit folios providing evidence of achievement in relation to all general objectives of the syllabus and the standards.

All the principles of exit assessment must be applied when making decisions about exit levels of achievement.

5.8.1 Determining a standard

The standard awarded is an on-balance judgment about how the qualities of the student’s work match the standards descriptors overall in each dimension. This means that it is not necessary for the student to have met every descriptor for a particular standard in each dimension.

When standards have been determined in each of the dimensions for this subject, the following table is used to award exit levels of achievement, where A represents the highest standard and E the lowest. The table indicates the minimum combination of standards across the dimensions for each level.

<table>
<thead>
<tr>
<th>VHA</th>
<th>Standard A in any two dimensions and no less than a B in the remaining dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA</td>
<td>Standard B in any two dimensions and no less than a C in the remaining dimension</td>
</tr>
<tr>
<td>SA</td>
<td>Standard C in any two dimensions and no less than a D in the remaining dimension</td>
</tr>
<tr>
<td>LA</td>
<td>At least Standard D in any two dimensions</td>
</tr>
<tr>
<td>VLA</td>
<td>Standard E in the three dimensions</td>
</tr>
</tbody>
</table>

Some students will exit after one, two or three semesters. For these students, judgments are based on folios providing evidence of achievement in relation to the general objectives of the syllabus covered to that point in time. The particular standards descriptors related to those objectives are used to make the judgment.

Further information can be found at: <www.qsa.qld.edu.au> (select Years 10-12 > Moderation and quality assurance > Forms and procedures > scroll to Additional guidelines and procedures).
### Standards matrix

<table>
<thead>
<tr>
<th>Dimension</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and application</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>• accurate and consistent recall and explanation of engineering knowledge, mathematical concepts and techniques relevant to complex engineering situations, across the areas of study</td>
<td>• accurate recall and explanation of engineering knowledge, mathematical concepts and techniques relevant to engineering situations, across the areas of study</td>
<td>• obvious elements of engineering problems are identified</td>
<td>• recall of engineering knowledge related to engineering situations</td>
<td>• recall of basic engineering facts</td>
</tr>
<tr>
<td></td>
<td>• critical elements of engineering problems are clearly identified and prioritised</td>
<td>• significant elements of engineering problems are identified</td>
<td>• basic aspects of engineering problems are recognised</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• discerning selection and correct and efficient application of engineering knowledge, mathematical concepts and techniques to complex familiar and unfamiliar engineering problems.</td>
<td>• appropriate selection and correct application of engineering knowledge, mathematical concepts and techniques to complex familiar or simple unfamiliar engineering problems.</td>
<td>• selection and application of engineering knowledge, mathematical concepts and techniques to simple familiar engineering problems.</td>
<td></td>
<td>• use of basic engineering knowledge.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Dimension</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigative and analytical processes</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>• effective interpretation and thorough analysis of relevant engineering data</td>
<td>• correct interpretation and detailed analysis of obvious relevant engineering data</td>
<td>• interpretation and analysis of engineering data</td>
<td>• explanation of basic engineering data</td>
<td>• factual statements are made about data</td>
</tr>
<tr>
<td></td>
<td>• efficient and mathematically validated engineering solutions based on engineering principles and techniques are proposed</td>
<td>• effective solutions based on engineering principles and techniques, and including mathematical calculations, are proposed</td>
<td>• solutions based on engineering principles and techniques are proposed</td>
<td>• solutions related to engineering principles or techniques are proposed</td>
<td>• ideas related to aspects of the problems are suggested</td>
</tr>
<tr>
<td></td>
<td>• solutions are analysed in depth and detail from multiple perspectives to identify relevant engineering principles</td>
<td>• solutions are analysed in detail to identify relevant engineering principles</td>
<td>• solutions are analysed in relation to engineering principles</td>
<td>• prototypes or models that test aspects of solutions are developed.</td>
<td>• incomplete models are produced.</td>
</tr>
<tr>
<td></td>
<td>• optimal prototypes and/or models that validate solutions are developed and refined.</td>
<td>• effective prototypes and/or models that test solutions are developed and modified.</td>
<td>• workable prototypes and/or models that test solutions are developed.</td>
<td>• prototypes or models that test aspects of solutions are developed.</td>
<td></td>
</tr>
</tbody>
</table>

Investigative and analytical processes: The student work has the following characteristics:
- Effective interpretation and thorough analysis of relevant engineering data
- Efficient and mathematically validated engineering solutions based on engineering principles and techniques are proposed
- Solutions are analysed in depth and detail from multiple perspectives to identify relevant engineering principles
- Optimal prototypes and/or models that validate solutions are developed and refined.

B: The student work has the following characteristics:
- Correct interpretation and detailed analysis of obvious relevant engineering data
- Effective solutions based on engineering principles and techniques, and including mathematical calculations, are proposed
- Solutions are analysed in detail to identify relevant engineering principles
- Effective prototypes and/or models that test solutions are developed and modified.

C: The student work has the following characteristics:
- Interpretation and analysis of engineering data
- Solutions based on engineering principles and techniques are proposed
- Solutions are analysed in relation to engineering principles
- Workable prototypes and/or models that test solutions are developed.

D: The student work has the following characteristics:
- Explanation of basic engineering data
- Solutions related to engineering principles or techniques are proposed
- Prototypes or models that test aspects of solutions are developed.

E: The student work has the following characteristics:
- Factual statements are made about data
- Ideas related to aspects of the problems are suggested
- Incomplete models are produced.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation and technical communication</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
<td>The student work has the following characteristics:</td>
</tr>
<tr>
<td></td>
<td>• comprehensive evaluation of solutions in relation to the critical elements of engineering problems</td>
<td>• considered evaluation of solutions in relation to the significant elements of engineering problems</td>
<td>• evaluation of solutions in relation to obvious elements of engineering problems</td>
<td>• comparison of solutions in relation to engineering problems</td>
<td>• comparison of ideas</td>
</tr>
<tr>
<td></td>
<td>• valid, well-reasoned conclusions and recommendations based on investigations and justified by relevant engineering knowledge and data</td>
<td>• valid conclusions and recommendations based on investigations and supported by engineering knowledge or data</td>
<td>• conclusions and recommendations are based on investigations</td>
<td>• conclusions are stated and recommendations made</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• effective organisation and succinct presentation of information in the most appropriate modes relevant to engineering situations</td>
<td>• logical organisation and clear presentation of information in appropriate modes relevant to engineering situations</td>
<td>• organisation and presentation of information in modes relevant to engineering situations</td>
<td>• presentation of engineering information</td>
<td>• presentation of some information related to engineering.</td>
</tr>
<tr>
<td></td>
<td>• consistent and proficient demonstration of technical and spatial literacy through the discerning selection and appropriate use of a wide range of literacy forms.</td>
<td>• demonstration of technical and spatial literacy through the selection and use of a range of literacy forms.</td>
<td>• demonstration of technical and spatial literacy.</td>
<td>• demonstration of technical or spatial literacy.</td>
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6. Language education

Teachers of Senior English have a special responsibility for language education. However, it is the responsibility of all teachers to develop and monitor students’ abilities to use the forms of language appropriate to their own subject areas. Their responsibility entails developing the following skills:

- ability in the selection and sequencing of information required in the various forms (such as reports, essays, interviews and seminar presentations)
- the use of technical terms and their definitions
- the use of correct grammar, spelling, punctuation and layout.

Assessment in all subjects needs to take into consideration appropriate use of language.

6.1 Communication in an engineering context

Communication within engineering includes technical reporting, graphical communication and modelling. Often two or all three methods may be used simultaneously to best convey information, concepts, principles and ideas.

To communicate effectively, students should acquire knowledge and understanding of:

- technical vocabulary
- research and reporting techniques
- the relevant Australian Standards and engineering conventions
- the principles of graphical communication
- freehand sketching
- multimedia presentation techniques
- modelling techniques.

A course in Engineering Technology should provide opportunities for students to develop competency, not only in communication skills, but also the ability to use the forms of language suitable for this course, and to further extend their skills in technical and spatial literacy.

Language learning is a developmental process and teachers of Engineering Technology should take this into account when planning for the development of skills necessary for students to successfully participate in the subject. This includes developing students’ abilities to:

- use suitable and effective language when speaking and writing
- use technical terms accurately
- select and use appropriate forms of communication such as technical reports, procedures, descriptions, arguments, explanations, research assignments, multimedia presentations, journals, data recording etc.
- develop and communicate ideas logically and succinctly
- interpret engineering drawings, reports, data and models
- generate and model solutions
- use symbolic, graphical, engineering and referencing principles and conventions.
Technical reporting, both oral and written, should be succinct, logically developed and the conclusions drawn should be supported by the evidence presented. Technical vocabulary should be used consistently and correctly.

Students should be provided with a background in graphical communication. The focus should be on freehand sketching and/or engineering drawing.

Graphical communication should adhere to the relevant Australian Standards and engineering conventions, and enable students to communicate their ideas and designs effectively.
7. Quantitative concepts and skills

Success in dealing with issues and situations in life and work depends on developing and integrating a range of abilities, such as being able to:

- comprehend basic concepts and terms underpinning the areas of number, space, probability and statistics, measurement and algebra, e.g. in analysing material properties
- extract, convert or translate information given in numerical or algebraic forms, or as diagrams, maps, graphs or tables, e.g. interpreting tables and graphs in materials properties testing and in engineering mechanics contexts; sketching graphical solutions
- calculate and apply algebraic procedures, e.g. resolving forces in structures
- manage and manipulate electronic sources of data, databases, software applications, e.g. in the study of control systems and materials testing devices
- use calculators and computers
- transfer skills or concepts from one problem to another.

Some subjects focus on the development and application of numerical and other mathematical concepts and skills. These subjects may provide a basis for the general development of such quantitative skills or have a distinct aim, such as to prepare students to cope with the quantitative demands of their personal lives or to participate in a specific workplace environment.

In Engineering Technology, students are encouraged to develop their understanding and to learn through the incorporation — to varying degrees — of mathematical strategies and approaches to tasks. They should be presented with experiences that stimulate their mathematical interest and hone those quantitative skills that contribute to operating effectively within Engineering Technology and participating successfully in society.

Mathematical concepts and skills should focus on preparing students to cope with the quantitative demands in their personal lives and to participate in a specific community or workplace environment. Within suitable learning contexts and experiences, opportunities must be provided for revising, maintaining and extending quantitative skills and understandings.

The distinctive nature of Engineering Technology may require that new mathematical concepts be introduced and new skills be developed for some students. All students need opportunities to practise the quantitative skills and understandings that they have developed previously. Within appropriate learning contexts and experiences in Engineering Technology, opportunities are to be provided for the revision, maintenance, and extension of such skills and understandings.

Engineers make use of a variety of numerical and other mathematical concepts and skills, especially those relating to graphs and tables, diagrams, statistics and maps. They also make extensive use of computer software packages to manipulate and represent engineering and technological data and concepts.
8. Educational equity

Equity means fair treatment of all. In developing work programs from this syllabus, schools should incorporate the following concepts of equity.

All young people in Queensland have a right to gain an education that meets their needs and prepares them for active participation in creating a socially just, equitable and democratic global society. Schools need to provide opportunities for all students to demonstrate what they know and can do. All students, therefore, should have equitable access to educational programs and human and physical resources. Teachers should ensure that particular needs of the following groups of students are met: female students; male students; Aboriginal students; Torres Strait Islander students; students from non–English-speaking backgrounds; students with disabilities; students with gifts and talents; geographically isolated students; and students from low socioeconomic backgrounds.

Subject matter chosen should include, whenever possible, the contributions and experiences of all groups of people. Learning contexts and community needs and aspirations should also be considered. In choosing appropriate learning experiences teachers can introduce and reinforce non-racist, non-sexist, culturally sensitive and unprejudiced attitudes and behaviour. Learning experiences should encourage the participation of students with disabilities and accommodate different learning styles.

Resource materials used should recognise and value the contributions of both females and males to society and include social experiences of both genders. Resource materials should also reflect cultural diversity within the community and draw from the experiences of the range of cultural groups in the community.

To allow students to demonstrate achievement, barriers to equal opportunity need to be identified, investigated and removed. This may involve being proactive in finding the best ways to meet the diverse range of learning and assessment needs of students. The variety of assessment techniques in the work program should allow students of all backgrounds to demonstrate their knowledge and skills related to the dimensions and standards stated in this syllabus. Syllabus dimensions and standards should be applied in the same way to all students.

Teachers should consider equity policies of individual schools and schooling authorities, and may find the following resources useful for devising an inclusive work program:


9. Resources

**Text and reference books**

A wide variety of textbooks and resource materials that could be used as sources of information about Engineering Technology are available. Book suppliers provide information regarding current publications.

**World Wide Web**

Many interactive and static websites can be used to enhance a course in Engineering Technology and often include useful resources. Some particularly useful sites include:

- The Bridge Site. Fun and Learning about Bridges <www.bridgesite.com/funand.htm>
- Engineers Australia <www.ieaust.org.au>
- The Junior Engineering Technical Society <www.jets.org>
- Super Bridge. Nova Online <www.pbs.org/wgbh/nova/bridge>
- A digital library for engineering education <www.needs.org/needs>
- Material information and property data <www.matweb.com>
- Technologystudent <www.technologystudent.com>
- West Point Bridge Designer software <http://bridgecontest.usma.edu>

**Newspaper reports**

Many newspapers carry regular pages, columns and features about Engineering Technology. Local newspapers can also be a source of useful data. The compilation of news files on particular topics can broaden the knowledge base of students and provide a valuable source of material for developing assessment instruments.

**Periodicals**

Journals and periodicals provide current, relevant information. Journals and periodicals relevant to Engineering Technology may include:

INTAD Journal <www.intad.asn.au>

School librarians should be able to provide assistance with identifying and locating other useful periodicals.

**Electronic media and learning technology**

A wide range of videos, DVDs and television recordings are available on a variety of topics related to Engineering Technology. Computer software programs and CD-ROMs may be useful for a course in Engineering Technology, both as learning tools, to gain access to information presented in a variety of forms and to assist students in gaining ICT skills. Educational program distributors are able to supply updated resource lists.
Organisations and community resources

Many government and community organisations provide personnel, advice, resources and information to assist in constructing and implementing a course in Engineering Technology. Some of these include:

- Australian Aerospace <www.ausaero.com.au>
- Engineering departments and libraries of tertiary institutions
- Engineers Australia, Engineering House, 11 National Circuit, Barton ACT 2600 <www.ieaust.org.au>
- GE Aviation <www.geae.com>
- Industrial Technology Design Teachers' Association of Queensland (INTAD) <www.intad.asn.au>
- Intellecta Technologies Pty Ltd <www.intellecta.net/index.html>
- Manufacturing Skills Queensland <www.msq.org.au>
- Queensland Resources Council <www.qrc.org.au>
10. Glossary

**Analytical processes**: Procedures and techniques employed to perform an analysis of a situation or event.

**Appropriate technology (AT)**: Technology that is designed in consideration of the environmental, ethical, cultural, social and economical aspects of the community it is intended for. It typically requires fewer resources, is easier to maintain, has a lower overall cost and less of an impact on the environment compared to industrialised practices. The term is usually used to describe simple technologies suitable for use in developing nations or less developed rural areas of industrialised nations.

**Achievement**: The extent to which a student has demonstrated knowledge, skills, values and attitudes as the result of the teaching and learning process.

**Assessment**: The purposeful and systematic collection of information about students’ achievements.

**Assessment instrument**: The tool or device used to gather information about student achievement.

**Assessment item**: An individual question on an assessment instrument; a subset or part of an assessment instrument.

**Assessment task**: A particular type of assessment instrument involving students applying and using relevant knowledge and theoretical and practical skills to create a product or a response to a meaningful problem or issue.

**Assessment technique**: The method used to gather evidence about student achievement.

**Continuous assessment**: Gathering evidence about students’ achievements throughout a course of study.

**Control system**: A device or set of devices to manage, command, direct or regulate the behaviour of other devices or systems; a mechanical, optical or electronic system that is used to maintain a desired output.

**Criteria sheet**: A tool for making judgments about the quality of students’ responses to an assessment instrument. It lists the properties or characteristics used to assess students’ achievements.

**Dimension**: A salient characteristic or property of a subject.

**Engineering**: The application of scientific, physical, mechanical and mathematical principles to design processes, products and structures that improve the quality of life.

**Engineering design challenge**: An open-ended activity in which design problems are solved through an engineering design process.

**Engineering design process**: The creative, iterative decision-making process which involves a series of steps leading to the development of a product, system, component or process to meet a need. It is a non-linear process in which design challenges are identified, revisited, challenged, reconsidered, re-examined and solved at each and any stage of development.

**Engineering graphics**: Technical drawings used to fully and clearly define requirements for engineered items. The purpose of these graphics is to capture all the geometric features of a product or a component and to convey all the required information that will allow a manufacturer to produce that component. The study covers various drawing methods, computer-aided design (CAD), and Australian Standards.
**Engineering materials:** A study of the nature, properties and classification of materials, their use in the built environment, and of the various mechanisms used for modifying materials.

**Engineering mechanics:** A study of the application of mechanics to solve problems involving common engineering elements. It covers the effects of forces on the condition of machines, structures, and their components when at rest or in motion and concentrates on the mechanics of rigid structures, machines and components.

**Engineering technology:** A field of study which focuses on the applications of engineering and modern technology, rather than the theoretical. It focuses primarily on the applied aspects of science, mathematics and engineering related to product improvement, industrial processes, and operational functions.

**Exit level of achievement:** The overall standard reached by students by the time they complete a course of study in an Authority subject or Authority-registered subject. An exit level of achievement is usually issued at the end of four semesters of study, but may be issued at the end of one, two or three semesters of study if the student is exiting the course.

**Formative assessment:** Assessment whose major purpose is to improve teaching and student achievement.

**General objectives:** Objectives specified in the syllabus that the school is intended to pursue directly and for which student achievement is assessed by the school.

**Indigenous:** In the Australian context, Indigenous refers to Aboriginal people and Torres Strait Islander people.

**Indigenous perspectives:** Refers to Aboriginal and Torres Strait Islander ways of knowing, viewing and relating to the world. These perspectives acknowledge the viewpoints of Indigenous people on time, country, place and people within local, regional, national and global contexts. Individual and community experiences, learning, cultural beliefs and values inform these viewpoints.

**Infomechatronics:** A hybrid discipline involving mechanical engineering, electrical and electronic engineering, and computing. It is the design and maintenance of machinery with electronic and computer control systems, such as aircraft and power generators, to work in the high-tech fields of automated systems and robotics. Infomechatronics engineering is concerned with the design, implementation and maintenance of intelligent engineered systems such as automated production systems and products, and processes enabled by the integration of mechanical, electrical, computer and information technologies.

**Literacy:** The ability to communicate by listening, reading, speaking, writing and viewing. In a technological society, the concept of literacy includes the media and electronic text. Literacy also includes all the symbol systems relevant to a particular discipline or learning community, and the associated abilities to understand and use these symbol systems.

**Mechanics:** The branch of physics concerned with the behaviour of physical bodies when subjected to forces or displacements, and the subsequent effect of the bodies on their environment.

**Monitoring:** The process by which review panels provide advice to schools on the quality of their assessment instruments and the standards reached by students up to that point in time. Monitoring occurs at the end of Year 11.

**On-balance judgment:** A teacher’s decision as to the standard that best matches the quality of a student’s work overall, either for a single assessment instrument or across the dimensions or entire course of study.
**Practical task:** An assessment instrument that is used to assess accounting procedures either manually or electronically.

**Prototype:** An original type, form, or instance of something serving as a typical example, basis, or standard for other things of the same category. A prototype is often used as part of the product design process to allow engineers and designers the ability to explore design alternatives, test theories and confirm performance prior to starting production of a new product.

**Seen task:** A task which involves the teacher providing only the stimulus material, not the question or statement relating to the material before the task is administered under supervised conditions.

**Solution:** An idea, concept, product, system, component or process that has been developed through an engineering design process to meet human needs.

**Spatial literacy:** The ability to think spatially and adopt an explicitly spatial metaphor for problems and relationships. Virtually every knowledge domain contains spatial metaphor. It includes issues to do with distance, orientation, navigation, spatial networks, understanding spatial interrelationships, changes in dimension (2D–3D), frames of reference, map-reading and landmark recognition.

**Summative assessment:** Assessment whose major purpose is to indicate the achievement status or standards achieved at particular points of schooling. It is geared toward reporting or certification.

**Sustainability:** In a broad sense, sustainability is the capacity to endure. It is the potential for long-term maintenance of wellbeing, which in turn depends on the wellbeing of the natural world and the responsible use of natural resources.

**Technical engineering report:** A report based on an extended engineering design project.

**Technical literacy:** The specialised vocabulary of the discipline; the list of words, terms, abbreviations, symbols, phrases etc.

**Verification:** A process occurring towards the end of Year 12 as part of the moderation procedures, through which review panels reach consensus on the standards exhibited in verification folios.

**Unseen task:** A task when neither the stimulus material nor the question or statement relating to the material is provided before the task is administered under supervised conditions.

**Work program:** A document approved by the QSA that provides the detail of how a school intends to implement a syllabus for an Authority subject.