Engineering Studies

Stage 6

Syllabus

Amended 2011

Original published version updated:

Nov/Dec 1999 – Board Bulletin/Official Notices Vol 8 No 9 (BOS 67/99)
September 1999 – Board Bulletin/Official Notices Vol 8 No 7 (BOS 54/99)
June 2009 – Assessment and Reporting information updated
September 2011 – Board Bulletin/Official Notice (BOS 31/11)

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Contents

1 The Higher School Certificate program of study

The purpose of the Higher School Certificate program of study is to:

- provide a curriculum structure which encourages students to complete secondary education
- foster the intellectual, social and moral development of students, in particular developing their:
  - knowledge, skills, understanding and attitudes in the fields of study they choose
  - capacity to manage their own learning
  - desire to continue learning in formal or informal settings after school
  - capacity to work together with others
  - respect for the cultural diversity of Australian society
- provide a flexible structure within which students can prepare for:
  - further education and training
  - employment
  - full and active participation as citizens
- provide formal assessment and certification of students' achievements
- provide a context within which schools also have the opportunity to foster students' physical and spiritual development.

2 Rationale for Engineering Studies in Stage 6 Curriculum

In the 21st century, engineering will continue to be directed towards developing insight and understanding to the provision of infrastructure, goods and services needed for industry and the community.

The role of engineers includes formulating problems, providing solutions and integrating technical understanding. The profession has a duty to take responsible approaches to wealth creation, to be ethical in their practices and to promote sustainability. With such key responsibilities, communication, synthesis and analysis of information, management skills and teamwork are becoming increasingly important.

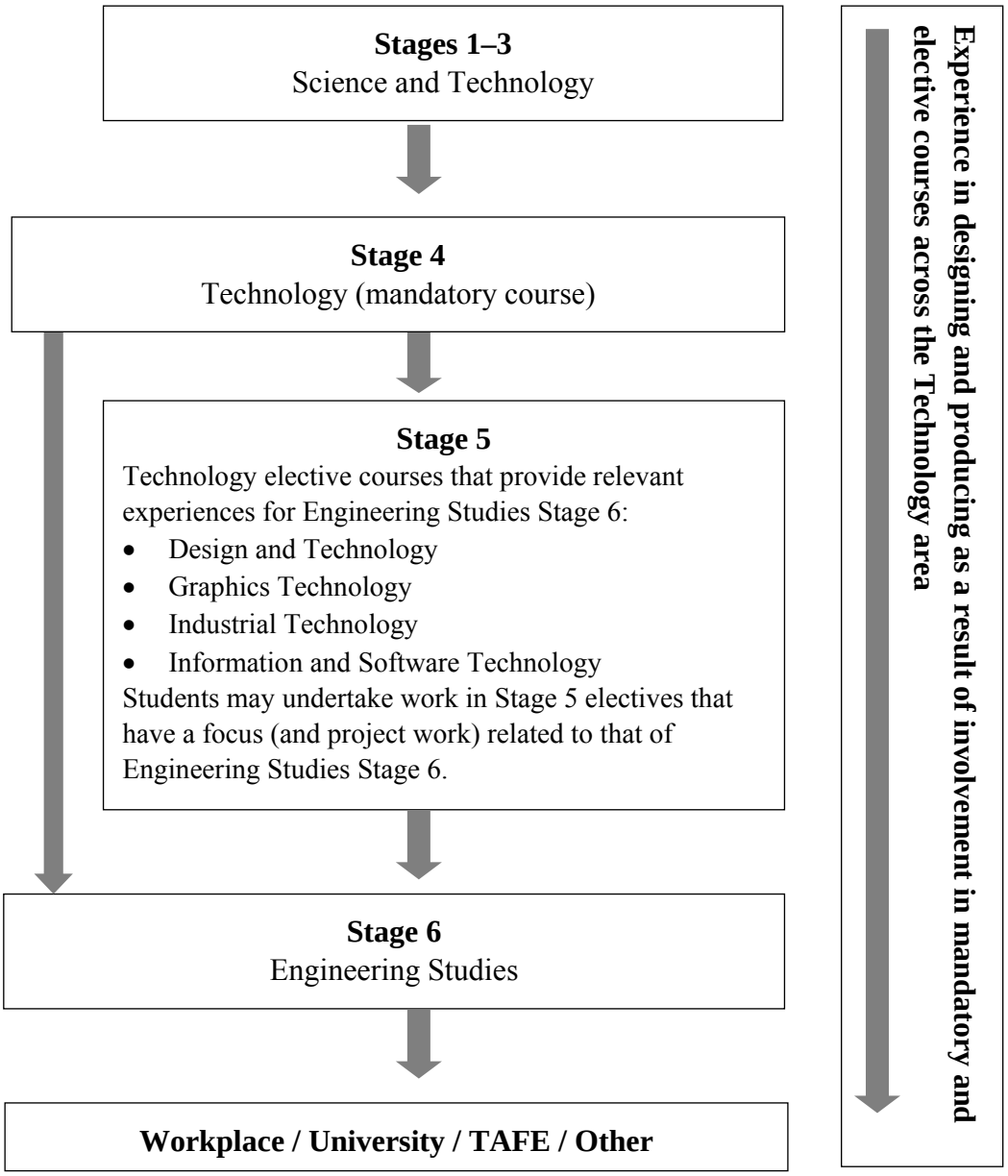
Professional engineering work is concerned with cost-effective, timely, reliable, safe, aesthetically pleasing and environmentally sustainable outcomes as well as maintaining a consciousness of ideals associated with social and ethical responsibilities and service.

The *Engineering Studies Stage 6 Syllabus* is directed towards the development and application of mathematical, scientific and technological skills and their integration with business and management. It provides students with skills, knowledge and understanding associated with a study of engineering, its practices and associated methodologies. The subject promotes environmental, economic and global awareness, problem-solving ability, engagement with information technology, self-directed learning, communication, management and skills in working as a team.

The *Engineering Studies Stage 6 Syllabus* is unique in that it develops knowledge and understanding of the profession of engineering. It also provides an opportunity to integrate the science and mathematics disciplines with societal development and change. The syllabus is inclusive of the needs, interests and aspirations of all students and provides opportunities and challenges to deal with engineering concepts.

Students undertaking Engineering Studies Stage 6 will have the opportunity to follow a number of pathways. These include tertiary study, vocational education and training, and the world of work. For those following a pathway of further study, the insight and experience associated with a study of engineering will be beneficial in their presumed knowledge of the area of study. Students entering into the world of work will benefit from understanding what engineers do, as the work of engineers affects us all.

3 Continuum of learning for Engineering Studies Stage 6 students



4 Aim

The aim of the *Engineering Studies Stage 6 Syllabus* is to develop students' understanding and appreciation of the nature, significance and methodology of engineering and its impact on society.

5 Objectives

Students will develop:

1 understanding of the scope of engineering and the role of the engineer

2 knowledge and understanding of engineering principles and an appreciation of the responsibilities of engineers in society

3 communication skills appropriate to engineering practices

4 knowledge and understanding of developments in technology and an appreciation of their influence on people and engineering practice

5 management and problem-solving skills in engineering contexts

6 skills in the application of engineering methodology.

6 Course structure

The *Engineering Studies Stage 6 Syllabus* comprises a Preliminary course made up of four compulsory modules (three application modules and one focus module), and an HSC course made up of four compulsory modules (two application modules and two focus modules).

Engineering Studies syllabus structure

Preliminary modules	**HSC modules**
*120 hours indicative time	*120 hours indicative time
Engineering application module 1 Engineering fundamentals	**Engineering application module** Civil structures
Engineering application module 2 Engineered products	**Engineering application module** Personal and public transport
Engineering application module 3 Braking systems	**Engineering focus module** Aeronautical engineering
Engineering focus module 4 Biomedical engineering	**Engineering focus module** Telecommunications engineering

Note: The modules in the Preliminary course have been designed to progressively develop knowledge, understandings and skills, commencing with Engineering fundamentals module 1 and concluding with Biomedical engineering module 4.

* Each module is 30 hours indicative time

6.1 Modules

A module is a discrete unit of study that integrates knowledge and understanding of various elements of engineering.

Types of modules

Two types of modules are used to facilitate learning in the course. These are **engineering application modules** and **engineering focus modules.**

Engineering application modules develops knowledge and understanding of engineering concepts and impacts through the study of engineered products.

Engineering focus modules develops knowledge and appreciation of the role of engineers by studying the nature of the engineering profession and emphasising the scope of engineering activities in a given field.

6.2 The Engineering Report

In the engineering profession, an Engineering Report contributes to effective management, communication, decision-making and teamwork by providing a synthesis of the various elements that are relevant to a given project. The report can be developed by individuals or collaboratively as a team.

An Engineering Report can be developed for a new project that involves the synthesis of a new design, or it can be prepared as a result of the analysis of an existing engineering application. Engineering Reports may be related to individual components, complex engineered products or engineered systems.

The process of reporting on investigation and practical activities in this course will be through the preparation of Engineering Reports.

In the Preliminary course students will learn to understand the significance of an Engineering Report and then develop an Engineering Report. Students are first required to produce a component of an Engineering Report in Engineering application module 3, Braking systems, before producing a complete Engineering Report in Engineering focus module 4, Biomedical engineering.

In the HSC course students must produce **one** Engineering Report from either of the two Engineering application modules of Civil structures or Personal and public transport, and **one** from either of the two engineering focus modules of Aeronautical engineering or Telecommunications engineering.

Reports will be less detailed in the Preliminary course than those required for the HSC course. Engineering Reports may include:

- introduction to the purpose of the report
- appropriate research
- analysis/synthesis of related issues
- conclusions and/or recommendations
- references.

Reports developed in the HSC course should encompass a degree of both analysis and synthesis of relevant content, and reflect actual engineering practice.

One Engineering Report from the Preliminary course and **one** Engineering Report from the HSC course must be the result of collaborative work, reflecting the importance of teamwork to successful engineering projects.

7 Objectives and outcomes

7.1 Table of objectives and outcomes

Objectives	Preliminary course outcomes	HSC course outcomes
Students will develop:	**A student:**	**A student:**
1. understanding of the scope of engineering and the role of the engineer	P1.1 identifies the scope of engineering and recognises current innovations	H1.1 describes the scope of engineering and critically analyses current innovations
	P1.2 explains the relationship between properties, structure, uses and applications of materials in engineering	H1.2 differentiates between the properties and structure of materials and justifies the selection of materials in engineering applications
2. knowledge and understanding of engineering principles and an appreciation of the responsibilities of engineers in society	P2.1 describes the types of materials, components and processes and explains their implications for engineering development	H2.1 determines suitable properties, uses and applications of materials, components and processes in engineering
	P2.2 describes the nature of engineering in specific fields and its importance to society	H2.2 analyses and synthesises engineering applications in specific fields and reports on the importance of these to society
3. communication skills appropriate to engineering practices	P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice	H3.1 demonstrates proficiency in the use of mathematical, scientific and graphical methods to analyse and solve problems of engineering practice
	P3.2 develops written, oral and presentation skills and applies these to engineering reports	H3.2 uses appropriate written, oral and presentation skills in the preparation of detailed engineering reports
	P3.3 applies graphics as a communication tool	H3.3 develops and uses specialised techniques in the application of graphics as a communication tool

Objectives	**Preliminary course outcomes**	**HSC course outcomes**
Students will develop:	**A student:**	**A student:**
4. knowledge and understanding of developments in technology and an appreciation of their influence on people and engineering practice	P4.1 describes developments in technology and their impact on engineering products P4.2 describes the influence of technological change on engineering and its effect on people P4.3 identifies the social, environmental and cultural implications of technological change in engineering	H4.1 investigates the extent of technological change in engineering H4.2 applies knowledge of history and technological change to engineering-based problems H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems
5. management and problem-solving in engineering contexts	P5.1 demonstrates the ability to work both individually and in teams P5.2 applies management and planning skills related to engineering	H5.1 works individually and in teams to solve specific engineering problems and prepare engineering reports H5.2 selects and uses appropriate management and planning skills related to engineering
6. skills in the application of engineering methodology	P6.1 applies knowledge and skills in research and problem-solving related to engineering P6.2 applies skills in analysis, synthesis and experimentation related to engineering	H6.1 demonstrates skills in research and problem-solving related to engineering H6.2 demonstrates skills in analysis, synthesis and experimentation related to engineering

7.2 Key competencies

The *Engineering Studies Stage 6 Syllabus* provides a context within which to develop general competencies considered essential for the acquisition of effective, higher-order thinking skills necessary for further education, work and everyday life.

Key competencies are embedded in the *Engineering Studies Stage 6 Syllabus* to enhance student learning. The key competencies of **collecting, analysing and organising information** and **communicating ideas and information** reflect core processes of inquiry and reporting which are explicit in the objectives and outcomes of Engineering Studies. The other key competencies are developed through the methodologies of the syllabus and through classroom pedagogy. Students work as individuals and as members of groups to conduct investigations into engineered products and systems and through this, the key competencies **planning and organising activities** and **working with others and in teams** are developed. When students solve problems related to engineering and analyse data they become competent in **using mathematical ideas and techniques.** When students analyse, synthesise and report on engineered products and systems they will be involved in a specific study and application of a range of technologies and they will develop competency in **using technology.** Finally, the exploration of issues and investigation of the nature of engineered products and systems contributes towards the students' development of the key competency **solving problems.**

8 Content: Engineering Studies Preliminary course

Engineering application module 1: Engineering fundamentals

30 hours indicative time

This module develops an understanding of the basic principles associated with engineering. Examples can be used to explain these principles without this knowledge being applied to a specific component, product or system.

A student:

P1.2 explains the relationship between properties, structure, uses and applications of materials in engineering

P2.1 describes the types of materials, components and processes and explains their implications for engineering development

P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice

P3.3 applies graphics as a communication tool

P4.1 describes developments in technology and their impact on engineering products

P4.2 describes the influence of technological change on engineering and its effect on people

P4.3 identifies the social, environmental and cultural implications of technological change in engineering.

Students learn about:	**Students learn to:**
Areas of engineering practice	
• nature and range of the work of engineers	• identify areas of engineering
Historical and societal influences	
• historical developments of engineering • effect of engineering innovation on people's lives	• outline historical uses and appropriateness of materials in the design and production of engineering projects • demonstrate an understanding of the historical developments of engineering
Engineering mechanics	
• mass and force • scalar and vector quantities • simple machines – levers, inclined plane, screws, wheel and axle, pulley systems and gears	• use mathematical and graphical methods to solve problems in engineering • examine the function of simple machines
Engineering materials	
• classification of materials • properties of materials – physical and mechanical properties	• classify a variety of materials • identify the properties of materials and explain the reason for their selection

Students learn about:	**Students learn to:**
• structure of materials – atomic structure – bonding – crystalline and non-crystalline structure	• describe the structure and bonding of materials
• metals – ferrous metals including mild steels – non-ferrous metals including copper, brass, bronze and aluminium	• distinguish between and explain reasons for the use of ferrous and non-ferrous metals as components in engineering
• basic forming processes suitable for materials – casting – rolling – extruding – cutting – joining – fabricating	• describe the suitability of basic forming processes used on materials
• polymers – thermo softening – thermosetting	• distinguish between thermo softening polymers and thermosetting polymers
• ceramics – common types used – forming and shaping	• identify the types of engineering ceramics • identify forming and shaping methods
• composites – timber – concrete	• outline the properties and uses of composites in engineering
Communication	
• freehand sketching in three-dimensional and third angle orthogonal projection	• identify third angle orthogonal projection • draw freehand, orthogonal and three dimensional pictorial drawings of objects
• research methods	• conduct research using computer technologies and other resources
• collaborative work practices	• appreciate the value of team work
• Engineering Reports and their significance in engineering practice	• outline the use and basic structure of an Engineering Report

Engineering application module 2: Engineered products

30 hours indicative time

Select one or more products as an introduction to engineering applications. Some products include: kettles, washing machines, toasters, portable power tools, irons, vacuum cleaners, wheelbarrows, sprinklers, garden implements, garden mulchers, lawnmowers and motor vehicles.

Outcomes

A student:

P1.1 identifies the scope of engineering and recognises current innovations

P2.1 describes the types of materials, components and processes and explains their implications for engineering development

P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice

P3.2 develops written, oral and presentation skills and applies these to engineering reports

P3.3 applies graphics as a communication tool

P4.1 describes developments in technology and their impact on engineering products

P4.2 describes the influence of technological change on engineering and its effect on people

P4.3 identifies the social, environmental and cultural implications of technological change in engineering

P5.1 demonstrates the ability to work both individually and in teams.

Students learn about:	**Students learn to:**
Skills of the professional engineer	
• engineers as: – problem-solvers – designers – communicators – project managers	• identify the skills required for a professional engineer
Historical and societal influences	
• historical development of various engineered products	• recount the historical development of the engineered products
• the effects of engineered products on peoples' lives and living standards	• describe the effects of various engineered products on people's lives
• the environmental implications of the engineered product	• identify the social and environmental implications of engineered products

Students learn about:	**Students learn to:**
Engineering mechanics	
• forces – nature and types of forces – addition of vectors – space and free body diagrams – resultants and equilibrants – principle of transmissibility of forces – three force rule for equilibrium – moments of a force – force/couple systems	• apply mathematical and/or graphical methods to solve problems related to forces in engineered products
– equilibrium of concurrent coplanar forces	• investigate and interpret the concept of equilibrium in the mechanics of engineered products
Engineering materials	
• modification of materials – work hardening – heat treatment – alloying materials	• conduct simple tests aimed at improving materials' properties through work hardening and heat treatment • identify common alloy materials
• engineering applications of materials	• analyse the properties, uses and appropriateness of materials for engineered products
• recyclability of materials – implications for recycling – costs and benefits of recycling materials	• explain the benefits of recycling materials
Engineering electricity/electronics	
• basic principles – potential difference – current – simple circuits and components	• explain the basic electrical principles occurring in the operation of electrical components and circuits • appreciate the importance of safety when using electricity
• magnetic induction	• explain the working of an induction motor
• electrical safety – related Australian electrical safety standards	• outline field force in currents • distinguish between AC and DC current transmission
• fundamentals of AC and DC currents	
• electric motors and generators	• explain the workings of electric motors and/or generators
Communication	
• orthogonal and pictorial drawings • Australian Standard (AS 1100) • dimensioning • materials lists	• produce dimensioned orthogonal assembly drawings applying appropriate Australian Standard (AS 1100)

Students learn about:	**Students learn to:**
• computer graphics such as computer aided drawing (CAD) • collaborative work practices • developing an Engineering Report	• use appropriate application software to produce a range of pictorial drawings • work with others and identify the benefits of working as a team • complete an analysis of materials used in a selected engineering product • incorporate the use of computer software in developing the Engineering Report

Engineering application module 3: Braking systems

30 hours indicative time

Select one or more products related to braking systems as an introduction to engineering applications. Some examples include: the band brake, drum brake, disc brake, anti-lock braking systems (ABS) and regenerative braking systems, as well as the automotive handbrake.

Outcomes

A student:

P1.1 identifies the scope of engineering and recognises current innovations
P2.1 describes the types of materials, components and processes and explains their implications for engineering development
P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice
P3.2 develops written, oral and presentation skills and applies these to engineering reports
P3.3 applies graphics as a communication tool
P4.1 describes developments in technology and their impact on engineering products
P4.2 describes the influence of technological change on engineering and its effect on people
P4.3 identifies the social, environmental and cultural implications of technological change in engineering
P5.1 demonstrates the ability to work both individually and in teams
P6.2 applies skills in analysis, synthesis and experimentation related to engineering.

Students learn about:	**Students learn to:**
Historical and societal influences • historical developments of braking systems including band, drum, disc, ABS, regenerative brake systems and the automotive hand brake • engineering innovations in braking systems and their effect on people's lives • environmental implications from the use of materials in braking systems	• identify historical developments in braking systems • explain the principles of braking systems • examine the changing applications of materials used in components of braking systems • discuss the social implications of technological change in braking systems
Engineering mechanics and hydraulics • static friction (with simple calculations) • loads and extension – load/extension diagram – tension and compression • stress and strain	• use mathematical methods to solve simple static friction problems • distinguish between extension, stress and strain

Students learn about:	**Students learn to:**
– stress/strain diagram – tension and compression	
• work, power, energy (without calculations), principle of the conservation of energy	
• fluid mechanics – Pascal's principle – hydrostatic pressure – applications to braking systems	• investigate and apply the basic principles of fluid mechanics to simple braking systems
Engineering materials	
• materials for braking systems – steels – cast irons – composites – manufacturing/forming processes of composites	• investigate the macrostructure and microstructure as well as the properties of appropriate materials used in braking systems • describe the manufacturing processes and application of composites to friction materials
• testing of materials – tensile and compression test – hardness test	• describe and/or conduct relevant mechanical tests on materials
Communication	
• graphical mechanics; graphical solutions to simple mechanical problems	• use of graphics to solve engineering problems
• pictorial, orthogonal and exploded drawings • Australian Standard (AS 1100), including dimensioning	• produce pictorial and assembled orthogonal drawings using exploded views of braking systems and their components, applying appropriate Australian Standard (AS 1100)
• computer graphics, computer aided drawing (CAD)	• use appropriate application software to produce dimensioned orthogonal drawings
• collaborative work practices	• work with others and identify the benefits of working as a team
• Engineering Report writing	• complete an Engineering Report based on the analysis of one type of brake or a component of a braking system

Engineering focus module 4: Biomedical engineering

30 hours indicative time

This module will provide an introduction to the study of engineering focus modules.

One or more examples of biomedical engineering must be used to develop an understanding of the scope and nature of this profession. Some examples include: artificial joints, surgical equipment, artificial limbs, the bionic ear and artificial hearts.

Outcomes

A student:

P1.1 identifies the scope of engineering and recognises current innovations

P1.2 explains the relationship between properties, structure, uses and applications of materials in engineering

P2.2 describes the nature of engineering in specific fields and its importance to society

P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice

P3.2 develops written, oral and presentation skills and applies these to engineering reports

P3.3 applies graphics as a communication tool

P4.1 describes developments in technology and their impact on engineering products

P4.3 identifies the social, environmental and cultural implications of technological change in engineering

P5.1 demonstrates the ability to work both individually and in teams

P5.2 applies management and planning skills related to engineering

P6.1 applies knowledge and skills in research and problem-solving related to engineering.

Students learn about:	**Students learn to:**
Scope of the profession • nature and range of the work of biomedical engineers • current projects and innovations • health and safety matters • training for the profession • career prospects • relations with the community • technologies unique to the profession • ethics and engineering • engineers as managers	• conduct research on the nature and range of the work of biomedical engineers • identify the health and safety issues relevant to biomedical engineering • appraise the training requirements and career prospects of biomedical engineers • debate social and ethical issues relating to biomedical engineering

Students learn about:	**Students learn to:**
Historical and societal influences	
• historical background to biomedical engineering • historical developments of products • the effect of biomedical engineering on people's lives	• discuss and relate the historic development of materials as used in biomedical engineered products • discuss the impact of biomedical engineering on people's lives
Engineering mechanics and hydraulics	
• orders of levers • mechanical advantage, velocity ratio and efficiency	• apply mathematical and/or graphical methods to solve problems of biomedical engineering practice
Engineering materials	
• forming methods – forging – casting – cutting – joining • structure and properties of appropriate materials – alloy steels such as stainless steel, titanium – polymers – ceramics	• describe forming processes for materials used in biomedical engineering • discuss emerging technologies used in biomedical engineering materials • compare the macrostructure and properties of materials used in biomedical engineering • explain the properties and uses of appropriate biomedical engineering materials
Electricity/electronics	
• Ohm's Law • series and parallel circuits • power source • microcircuits/integrated circuits • digital technology	• apply Ohm's Law and explain the basic operation of electronic circuits • discuss the development of electronic components • explain the advantages of microcircuits/integrated circuits and their application • explain elementary digital logic
Communication	
• sectioning of orthogonal drawings • Australian Standard (AS 1100) • dimensioning • computer graphics, CAD	• produce dimensioned, sectioned orthogonal drawings applying appropriate Australian Standard (AS 1100) • justify the use of graphics as a communication tool
• graphical design	• use appropriate application software to produce graphical designs. • construct quality graphical solutions
• collaborative work practices	• work with others and identify the benefits of working as a team

Students learn about:	**Students learn to:**
• Engineering Report writing	• complete an Engineering Report on the biomedical engineering profession with reference to the following aspects: – nature and range of work done – engineers as managers – technologies unique to the profession – current projects and innovations – health and safety issues – ethics related to the profession and – community – career prospects – training for the profession – use of appropriate computer – software and presentation – technique

9 Content: Engineering Studies HSC course

Engineering application module: Civil structures

30 hours indicative time

Select one or more civil structures in this module. Some examples of civil structures include: bridges, roads, dams, buildings, cranes and lifting devices, parklands and children's playgrounds and equipment.

Outcomes

A student:

H1.2 differentiates between the properties and structure of materials and justifies the selection of materials in engineering applications

H2.1 determines suitable properties, uses and applications of materials, components and processes in engineering

H3.1 demonstrates proficiency in the use of mathematical, scientific and graphical methods to analyse and solve problems of engineering practice

H3.2 uses appropriate written, oral and presentation skills in the preparation of detailed engineering reports

H3.3 develops and uses specialised techniques in the application of graphics as a communication too

H4.1 investigates the extent of technological change in engineering

H4.2 applies knowledge of history and technological change to engineering-based problems

H5.1 works individually and in teams to solve specific engineering problems and prepare engineering reports

H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems

H6.1 demonstrates skills in research and problem-solving related to engineering

H6.2 demonstrates skills in analysis, synthesis and experimentation related to engineering.

Students learn about:	**Students learn to:**
Historical and societal influences • historical developments of civil structures • engineering innovation in civil structures and their effect on people's lives • construction and processing materials used in civil structures over time • environmental implications from the use of materials in civil structures	• outline the history of technological change as applied to civil structures • investigate the construction processes and materials used in civil structures from a historical point of view • critically examine the impact of civil structures upon society and the environment

Students learn about:	**Students learn to:**
Engineering mechanics	
• truss analysis – actions (loads) – reactions – pin jointed trusses only – method of joints – method of sections	• apply mathematical and/or graphical methods to solve problems related to the design of pin jointed trusses
• bending stress induced by point loads only – concept of shear force and bending moment – shear force and bending moment diagrams – concept of neutral axis and outer fibre stress – bending stress calculation (second moment of area given)	• evaluate the importance of the stress/strain diagram in understanding the properties of materials • calculate and graph the bending stress and shear force of simply supported beams involving vertical point loads only
• uniformly distributed loads	• describe the effect of uniformly distributed loads on a simple beam, without calculations
• stress and strain – shear, compressive and tensile stress – engineering and true stress – yield stress, proof stress, toughness, Young's modulus, Hooke's law, engineering applications – factor of safety – stress/strain diagram	• apply mathematical and/or graphical methods to solve problems related to stress and strain • apply mathematical methods to solve problems related to materials used in civil structures
Engineering materials	
• testing of materials – specialised testing of engineering materials and systems – X-ray • testing of concrete	• describe basic and specialised testing conducted on materials used in civil structures • examine the properties, uses and appropriateness of materials used in civil structures
• crack theory – crack formation and growth – failure due to cracking – repair and/or elimination of failure due to cracking	• examine how failure due to cracking can be repaired or eliminated
• ceramics – structure/property relationships and their application to civil structures – glass – cement – bricks	• make appropriate choices of materials and processes for use in civil structures • investigate the relationship of structure to properties of materials and their use in civil structures

Students learn about:	**Students learn to:**
• composites – timber – concrete (reinforced, pre- and post-tensioned) – asphalt paved surface – laminates – geotextiles	• explain the special properties produced by composite materials • compare simple reinforced, pre-tensioned and post-tensioned structures
• corrosion – corrosive environments – dry corrosion, wet corrosion, stress corrosion, galvanic corrosion	• evaluate the significance of corrosion problems in civil structures • describe methods used to protect civil structures against corrosion
• recyclability of materials	• describe methods used for recycling materials when civil structures are replaced
Communication	
• Australian Standard (AS 1100) • orthogonal assembly dimensioned drawings	• produce orthogonal assembly dimensioned drawings applying appropriate Australian Standard (AS 1100)
• freehand pictorial drawings	• produce freehand pictorial drawings
• graphical mechanics – graphical solutions to engineering problems	• apply graphical methods to the solutions of relevant problems
• computer graphics – Computer Aided Drawing (CAD) – applications for solving problems	• describe and/or use software to solve problems
• collaborative work practices	• work with others and identify the benefits of working as a team
• Engineering Report writing	• complete an Engineering Report based on the analysis and synthesis of an aspect of civil structures using appropriate computer software

Note: An Engineering Report **must** be completed in **either** the Civil structures **or** the Personal and public transport module.

Engineering application module: Personal and public transport

30 hours indicative time

Select one or more forms of transport in this module. Some examples include: bicycles, motor cars, boats, motor cycles, buses, trucks, trains and trams.

Outcomes

A student:

H1.2 differentiates between the properties and structure of materials and justifies the selection of materials in engineering applications

H2.1 determines suitable properties, uses and applications of materials, components and processes in engineering

H3.1 demonstrates proficiency in the use of mathematical, scientific and graphical methods to analyse and solve problems of engineering practice

H3.2 uses appropriate written, oral and presentation skills in the preparation of detailed engineering reports

H3.3 develops and uses specialised techniques in the application of graphics as a communication tool

H4.1 investigates the extent of technological change in engineering

H4.2 applies knowledge of history and technological change to engineering-based problems

H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems

H5.1 works individually and in teams to solve specific engineering problems and prepare engineering reports

H6.1 demonstrates skills in research and problem-solving related to engineering

H6.2 demonstrates skills in analysis, synthesis and experimentation related to engineering.

Students learn about:	**Students learn to:**
Historical and societal influence • historical developments in transport systems • effects of engineering innovation in transport on society • construction and processing materials used over time • environmental effects of transport systems • environmental implications from the use of materials in transport	• investigate the history of technological change related to transport and its impact on society • identify design features in the engineering of transport systems • describe the environmental impact of energy requirements for transport systems • analyse the impact of developments in transport systems on the environment

Students learn about:	**Students learn to:**
Engineering mechanics	
• simple machines	• apply mathematical and/or graphical methods to solve engineering problems related to transport including mechanical advantage, velocity ratio and efficiency
• static friction – concept of friction and its application in engineering	• analyse problems involving static friction
• coefficient of friction – normal force – friction force – angle of static friction – angle of repose	
• basic calculations for work, energy and power – potential energy – kinetic energy	• differentiate between the concepts of energy and power and apply appropriate basic calculations
Engineering materials	
• testing of materials – hardness – impact	• investigate the application of testing of materials
• heat treatment of ferrous metals – annealing – normalising – hardening and tempering – changes in macrostructure and microstructure – changes in properties	• outline how changes in properties occur as a result of heat treatment processes • identify appropriate heat treatment processes • justify appropriate choices for ferrous materials and processes used in transportation parts and systems • experiment with metals to reinforce the concepts of heat treatment
• manufacturing processes for ferrous metals – forging – rolling – casting – extrusion – powder forming – welding	• explain the method and applications of various ferrous metal forming processes
• changes in macrostructure and microstructure of ferrous metals	
• changes in properties of ferrous metals	

Students learn about:	**Students learn to:**
• manufacturing processes for non-ferrous metals – alloying – annealing – solid solution hardening	• justify the use of non-ferrous metals in transportation parts and systems based on relevant structure/property relationships
• changes in macrostructure and microstructure of non-ferrous metals	
• changes in properties of non-ferrous metals	
• ceramics and glasses – as an insulation material – laminating and heat treatment of glass – structure/property relationship and their application	• justify appropriate choices of ceramics and glasses used in transportation parts and systems
• thermo softening polymers – engineering textiles – manufacturing processes – extrusion – injection moulding – blow moulding – structure/property relationships and application	• justify appropriate choices of polymers used in transportation parts and systems • explain the properties, uses, testing and appropriateness of materials used in transportation
Engineering electricity/electronics	
• power generation/distribution – electrical energy and power – simple circuits	• identify the electrical systems used in the transport industry • describe current transmission and simple circuit diagrams
• electric motors used in transport systems – principles – applications	• investigate the principles and application of electric motors used in the transport industry, including motor speed control
• control technology	• analyse the basic principles of control technology as applied to the transport industry
• electrical safety	• appreciate the safe use of electricity and electrical equipment
Communication	
• freehand sketching, design and orthogonal drawings • sectional views • Australian Standard (AS 1100)	• produce dimensioned, sectioned orthogonal drawings applying appropriate Australian Standard (AS 1100)
• computer graphics, computer aided drawing for orthographic projection	• use appropriate software to produce orthogonal drawings

Students learn about:	**Students learn to:**
• collaborative work practices	• work with others and identify the benefits of working as a team
• Engineering Report writing	• complete an Engineering Report based on the analysis and synthesis of an aspect of personal and public transport using appropriate computer software

Note: An Engineering Report **must** be completed in **either** the Civil structures **or** the Personal and public transport module.

Engineering focus module: Aeronautical engineering

30 hours indicative time

One or more examples of aeronautical engineering must be used to develop an understanding of the scope and nature of this profession.

Some examples include: design and construction of recreational aircraft, general aviation aircraft, military aircraft, space craft, agricultural aircraft, helicopters and home-built aircraft.

Outcomes

A student:

H1.1 describes the scope of engineering and critically analyses current innovations

H1.2 differentiates between the properties and structure of materials and justifies the selection of materials in engineering applications

H2.2 analyses and synthesises engineering applications in specific fields and reports on the importance of these to society

H3.1 demonstrates proficiency in the use of mathematical, scientific and graphical methods to analyse and solve problems of engineering practice

H3.2 uses appropriate written, oral and presentation skills in the preparation of detailed engineering reports

H3.3 develops and uses specialised techniques in the application of graphics as a communication tool

H4.1 investigates the extent of technological change in engineering

H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems

H5.2 selects and uses appropriate management and planning skills related to engineering

H6.1 demonstrates skills in research, and problem-solving related to engineering

Students learn about:	**Students learn to:**
Scope of the profession • nature and scope of the aeronautical engineering profession • current projects and innovations • health and safety issues • training for the profession • career prospects • unique technologies in the profession • legal and ethical implications • engineers as managers • relations with the community	• define the responsibilities of the aeronautical engineer • describe the nature and range of the work of aeronautical engineers • examine projects and innovations from within the aeronautical profession • analyse the training and career prospects within aeronautical engineering

Students learn about:	**Students learn to:**
Historical and societal influences	
• historical developments in aeronautical engineering • the effects of aeronautical innovation on people's lives and living standards • environmental implications of flight	• research the history of flight in Australia and understand the way it has impacted on people's lives • examine safety issues related to flight and flying
Engineering mechanics and hydraulics	
• fundamental flight mechanics – relationship between lift, thrust, – weight and drag – lift to drag ratio – effect of angle of attack	• apply mathematical and graphical methods to solve flight-related problems
• Bernoulli's principle and its application to – venturi effect – lift	• outline Bernoulli's principle as applied to instrumentation and lift
• bending stress – airframes	• investigate the nature and effect of bending stresses, applying appropriate mathematical methods
• propulsion systems including – internal combustion engines – jet including turbofan, ram and scram – turboprop – rockets	• describe the operational principles and use of the stated propulsion systems used in the aircraft industry
• fluid mechanics – Pascal's principle – hydrostatic and dynamic pressure – applications to aircraft components and instruments	• apply mathematical methods to solve hydraulics-related problems • describe the basic operation of an altimeter and pitot tube
Engineering materials	
• specialised testing of aircraft materials – dye penetrant – X-ray, gamma ray – magnetic particle – ultrasonic	• describe non-destructive tests used on aircraft materials and components
• aluminium and aluminium alloys used in aircraft including aluminium silicon, aluminium silicon magnesium, aluminium copper	

Students learn about:	**Students learn to:**
• structure/property relationship and alloy applications – changes in macrostructure and microstructure – changes in properties	• analyse structure, property relationship, uses and appropriateness of materials and processes used in aeronautical engineering applications
• heat treatment of applicable alloys	• investigate the effects of heat treatment on the structure and properties of aluminium alloys
• thermosetting polymers – structure/property relationships and their application – manufacturing processes – compression moulding – hand lay-up – vacuum lay-up – modifying materials for aircraft applications	• justify appropriate choices of polymers for their application and use in aircraft
• composites – types including reinforced glass fibre, Kevlar, carbon fibre and Fibre Metal Laminate (FML) as used in aircraft construction – structure/property relationships and their application in aircraft	• describe the uses and application of composites used in aircraft construction
• corrosion – common corrosion mechanisms in aircraft structures – pit and crevice corrosion – stress corrosion/cracking – corrosion prevention in aircraft	• understand the mechanism of corrosion common to aircraft components and identify corrosion prevention techniques
Communication	
• freehand and technical drawing – pictorial and scaled orthogonal drawings • Australian Standard (AS 1100)	• produce dimensioned orthogonal component and scaled drawings applying appropriate Australian Standard (AS 1100)
• developments – transition pieces	• construct the development of non-circular transition pieces
• graphical mechanics – graphical solution to basic aerodynamic problems	• construct quality graphical solutions

Students learn about:	**Students learn to:**
• computer graphics, computer aided drawing (CAD) – 3D applications	• use appropriate software to produce pictorial drawings
• collaborative work practices	• work with others and identify the benefits of working as a team
• Engineering Report writing	• complete an Engineering Report on the aeronautical engineering profession with reference to the following aspects: – nature and range of the work of aeronautical engineers – engineers as managers – technologies unique to the profession – current projects and innovations – health and safety issues – ethics related to the profession and community career prospects – training for the professions – use of appropriate computer software and presentation technique

Note: An Engineering Report **must** be completed in **either** the Aeronautical engineering focus module **or** the Telecommunications engineering focus module **.**

Engineering focus module: Telecommunications engineering

30 hours indicative time

One or more examples of telecommunications engineering must be used to develop an understanding of the scope and nature of this profession.

Some examples include: telephone systems (fixed and mobile), radio systems, television systems and satellite communication systems.

Outcomes

A student:

H1.1 describes the scope of engineering and critically analyses current innovations

H1.2 differentiates between the properties and structure of materials and justifies the selection of materials in engineering applications

H2.2 analyses and synthesises engineering applications in specific fields and reports on the importance of these to society

H3.1 demonstrates proficiency in the use of mathematical, scientific and graphical methods to analyse and solve problems of engineering practice

H3.2 uses appropriate written, oral and presentation skills in the preparation of detailed engineering reports

H3.3 develops and uses specialised techniques in the application of graphics as a communication tool

H4.1 investigates the extent of technological change in engineering

H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems

H5.2 selects and uses appropriate management and planning skills related to engineering

H6.1 demonstrates skills in research and problem-solving related to engineering

Students learn about:	**Students learn to:**
Scope of the profession • nature and scope of telecommunications engineering • health and safety issues • training for the profession • career prospects • relations with the community • technologies unique to the profession • legal and ethical implications • engineers as managers • current applications and innovations	• define the responsibilities of the telecommunications engineer • describe the nature and range of the work of telecommunications engineers • examine projects and innovations in the telecommunications profession • analyse the training and career prospects within telecommunications engineering
Historical and societal influences • historical development within the telecommunications industry • the effect of telecommunications engineering innovation on people's lives • materials and techniques used over time and development of cathode ray television including B/W and colour	• research the history of technological change in the field of telecommunications • describe the nature of engineering systems in the telecommunications field and the importance of this to society
Engineering materials • specialised testing – voltage, current, insulation – signal strength and testing	• analyse structure, properties, uses and appropriateness of materials in telecommunications engineering applications
• copper and its alloys used in telecommunications including copper beryllium, copper zinc, electrolytic tough pitched copper – structure/property relationships and their application	• select and justify materials and processes used in telecommunications engineering
• semiconductors such as transistors, zener diodes, light emitting diodes and laser diodes – uses in telecommunications	• identify the types and functions of common semiconductors used in the telecommunications industry

Students learn about:	**Students learn to:**
• polymers – insulation materials • fibre optics – types and applications – materials	• describe the uses and applications of polymers and fibre optics in telecommunications
Engineering electricity/electronics	
• telecommunications including: – analogue and digital systems – modulation, demodulation – radio transmission (AM, FM, digital) – digital television transmission and display media such as plasma, LED, LCD, 3D – telephony: fixed and mobile – transmission media – cable – wireless – infrared – microwave – fibre-optic	• describe the basic concepts and application of modulation/ demodulation in telecommunications • describe the types and methods of radio and digital television transmission and reception systems in telecommunications • contrast the differences in fixed and mobile telephony systems in telecommunications • distinguish the communication bands in the electromagnetic spectrum • contrast the differences in transmission media
• satellite communication systems, geostationary, low orbit satellite and GPS	• describe the basic principles of satellite communication systems
• digital technology (AND, NAND, NOR, OR GATES)	• explain elementary digital logic
Communication	
• freehand and technical pictorial drawing, graphical design drawings	• produce pictorial drawings
• computer graphics; computer aided drawing (CAD) – graphical design – in the solution of problems	• justify computer graphics as a communication tool and problem solving device for telecommunications engineering
• collaborative work practices	• work with others and identify the benefits of working as a team

Students learn about:	**Students learn to:**
• Engineering Report writing	• complete an Engineering Report on the telecommunications engineering profession with reference to the following aspects: – nature and range of the work of telecommunications engineers – engineers as managers – technologies unique to the profession – current projects and innovations – health and safety issues – ethics related to the profession and community career prospects – training for the professions – use of appropriate computer software and presentation technique

Note: An Engineering Report **must** be completed in **either** the Aeronautical engineering focus module **or** the Telecommunications engineering focus module**.**

10 Course requirements

The *Engineering Studies Stage 6 Syllabus* includes a Preliminary course of 120 hours (indicative time) and a HSC course of 120 hours (indicative time).

There is no prerequisite study for the Preliminary course. Completion of the Preliminary course is a prerequisite for study of the HSC course.

The Preliminary course consists of four modules. Each module is compulsory. These four modules comprise three engineering application modules and one engineering focus module. During the Preliminary course, students are required to produce a component of an Engineering Report from the Engineering application module: Braking systems and an Engineering Report from the Engineering focus module: Biomedical engineering.

The HSC course consists of four modules comprising two engineering application modules and two engineering focus modules. Each module is compulsory. During the HSC course students are required to produce two Engineering Reports with one report from either of the engineering application modules and one from either of the engineering focus modules.

11 Assessment and reporting

Advice on appropriate assessment practice in relation to Engineering Studies Stage 6 is contained in *Assessment and Reporting in Engineering Studies Stage 6*. That document provides general advice on assessment in Stage 6 as well as the specific requirements for the Preliminary and HSC courses. The document contains:

- suggested components and weightings for the internal assessment of the Preliminary course
- mandatory components and weightings for the internal assessment of the HSC course
- the HSC examination specifications, which describe the format of the external HSC examination.

The document and other resources and advice related to assessment in Stage 6 Engineering Studies are available on the Board's website at www.boardofstudies.nsw.edu.au/syllabus_hsc.