DEPARTMENT OF EDUCATION
learners first

Professional studies

Technologies

Engineering Design 3

Course document

independent schools tasmania

Catholic Education Tasmania

Years 9-12 Learning

Tasmanian Government

Table of contents

Engineering Design Level 3, 150 hours

Focus area – Professional studies

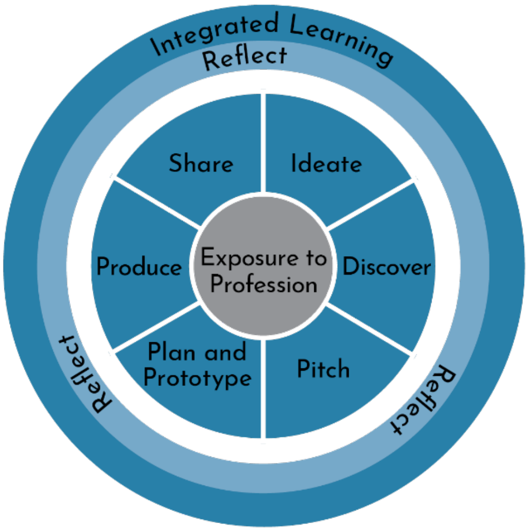
Courses aligned to the [Years 9 to 12 Curriculum Framework] belong to one of the five focus areas of Discipline-based study, Transdisciplinary projects, Professional studies, Work-based learning and Personal futures.

Engineering Design Level 3 is a Professional studies course.

Professional studies bridges academic courses and career-related study to provide learners with a combination of academic and practical knowledge, skills and understanding to pursue a particular pathway of interest. Courses integrate exposure to professional environments, processes and practice through inquiry-based learning. Professional studies reflects professional processes and standards and provides learners with an equivalent experience to that of someone working within that profession. Professional studies enhances learners' cognitive capacity, efficacy, creativity and craftsmanship in readiness for higher education, internships, apprenticeships, or work in a designated field of interest. Professional studies courses connect with recognised professional study pathways and contextually align with key Tasmanian industry sectors.

Professional studies courses have three key features that guide teaching and learning:

- exposure to professional practice
- ideation, research, discovery and integrated learning
- production and sharing replicating a professional paradigm.



In this course learners will do this by engaging in opportunities to research and appraise existing ideas, products, processes and solutions to problems. They will generate imaginative and creative solutions and communicate their ideas within the parameters and requirements of engineering-based tasks, while gaining and applying knowledge of professional standards of design, manufacture and safety. Learners will use technology to design, test and appraise products, systems and solutions and have the opportunity to identify and articulate further improvements and developments.

Rationale

The ability to design, make, acquire and apply skills and technologies is important to the lives of people and societies globally. The Technologies learning area engages learners practically in critical and creative thinking to solve complex problems using design thinking principles.

The *Engineering Design* provides a flexible framework for learners to engage with engineering principles and systems through integrated Science, Technology, Engineering and Mathematics (STEM) inquiry. Engineering is a broad term covering a wide range of skills and diverse disciplines but fundamentally, engineering is about improving people's lives through engineered solutions.

The *Engineering Design* encourages learners to become aware of factors that influence innovation and enterprise, and the subsequent success or failure of a product.

Learners will develop a specific skill set that will enable them to confidently explore a challenge or identify an existing problem and develop a solution in an engineering context. This will be achieved through an engineering design process and learners will gain valuable experience, not only in designing engineered components but also in project management.

Learners will learn to generate imaginative and creative solutions of their own. They will communicate their ideas within the parameters and requirements of engineering-based tasks whilst gaining and applying knowledge of industry standards of design, manufacture and safety. Through practical experiences, learners will learn to use technology to design, test and appraise products, systems and solutions and identify and articulate further improvements and developments.

The purpose of [Years 9 to 12 Education] is to enable all learners to achieve their potential through Years 9 to 12 and beyond in further study, training or employment.

Years 9 to 12 Education enables personal empowerment, cultural transmission, preparation for citizenship and preparation for work.

This course is built on the principles of access, agency, excellence, balance, support and achievement as part of a range of programs that enables learners to access a diverse and flexible range of learning opportunities suited to their level of readiness, interests and aspirations.

Learning outcomes

On successful completion of this course learners will be able to:

1. apply design and systems thinking to effectively generate creative ideas in response to an engineering design brief
2. select and apply appropriate engineering methodologies in the development of prototypes
3. initiate, implement and monitor project management strategies
4. apply a process to test, evaluate and refine engineered solutions against success criteria
5. communicate ideas, concepts and design solutions using a range of communication strategies and conventions
6. describe and analyse the role of creativity, innovation and enterprise in the professional practice of engineers
7. demonstrate knowledge and understanding of developments in technology and an appreciation of their influence on people and engineering practice
8. demonstrate knowledge and understanding of ethical, legal, economic and sustainability issues related to an engineered solution.

Integration of general capabilities and cross-curriculum priorities

The general capabilities addressed specifically in this course are:

- Critical and creative thinking
- Ethical understanding
- Information and communication technology capability
- Literacy
- Numeracy
- Personal and social capability

The cross-curriculum priorities enabled through this course are:

- Sustainability

Course description

Engineering Design Level 3 enables learners to actively engage in the process of engineering. Learners will investigate, research and present information through a design process, using project management skills to create engineered solutions in response to real-world problems.

Learners critically and creatively respond to needs, problems or challenges, exploring the interrelationships between engineering and society. They apply engineering, scientific and mathematical principles to turn ideas into reality and to develop solutions to problems.

Engineering Design Level 3 prepares learners with the skills and knowledge to make positive contributions to the future of societies and the environment and appreciate the engineering profession's role in improving the quality of people's lives.

Pathways

This course is designed for learners who are interested in studying an iterative design process to explore possible solutions to a problem or opportunity.

Engineering Design Level 2 provides a foundation for *Engineering Design* Level 3 but is not a prerequisite. *Engineering Design* Level 3 furthers learner understandings established through the engineering principles and systems context of the *Australian Curriculum: Technologies* (F–10).

This course complements senior secondary courses in mathematics, science, computing, electronics, automotive and mechanical technologies, and computer graphics.

Engineering Design Level 3 may lead to further studies at tertiary level, with courses such as Bachelor of Engineering, Bachelor of Science, or related technical trades.

Studying *Engineering Design* Level 3 provides learners with transferable skills useful in any occupation and for the future world of work, education and training.

Course requirements

Access

Learners enrolled in this course are required to be able to work responsibly and safely in practical situations.

This course requires learners to collaborate with others. This could include peers, teams, community members and industry professionals.

Previously submitted work cannot be used in meeting the requirements of *Engineering Design* Level 3. Therefore, a learner cannot use work including, but not limited to, an independent study, folio, project or assignment that has already been presented for assessment for a previously or concurrently studied TASC accredited or recognised senior secondary course.

Resource requirements

Providers offering this course will need equipment, materials and associated facilities for prototypes to be created and tested safely and effectively. Learners need to be able to access a wide range of reliable sources of information about the uses and applications of engineering within the wider community.

Consumable resources

Providers will make available a basic stock of consumable materials relevant to the engineering context. Additional consumable resources may be required for specific design briefs.

Course size and complexity

This course has a complexity level of 3.

For a full description of courses at a complexity level of 3, please refer to the Levels of complexity – Tasmanian senior secondary education: https://www.tasc.tas.gov.au/wp-content/uploads/2021/07/Levels-of-Complexity-Tasmanian-Senior-Secondary-Education.pdf

Level 3 course enable contextual opportunities for learners to:

- Apply required knowledge and skills to demonstrate judgement, taking personal responsibility and accountability for the quality of defined and emerging outcomes, as individuals and team members
- Demonstrate skills to access, analyse and evaluate knowledge and ideas and communicate expertise to others in the field; synthesise and act when solving problems; think creatively, flexibly and analytically to use judgement, vary procedures and work collaboratively.

This course has a size value of 15. Upon successful completion, this course may contribute 15 points towards the achievement of the Tasmanian Certificate of Education (TCE).

Course structure and delivery

Structure

This course consists of three 50-hour modules.

Module 1: Engineering systems

Module 2: Engineering practice

Module 3: Extended engineering design project

Delivery

Modules 1 and 2 should be delivered before module 3. There are two possible delivery methods for this course:

- Module 1, module 2 and module 3 in order.
- Module 1 and module 2 in combination. Module 3 following completion of the other two modules.

Providers are responsible for ensuring that the engineering context or contexts for course delivery can be supported by the discipline expertise, equipment and other resources available, and that it follows health and safety regulations. Providers will advise learners of the range of resources from which they can draw to carry out their projects.

Course content

Module 1: Engineering systems

This module develops the learner's understanding of the work of engineers. Learners learn how engineering design processes are applied to solve existing problems. They explore real world problems of increasing complexity requiring project-based solutions. Learners use guidelines and a context to apply knowledge of the engineering process and theory to develop and respond to design briefs.

Module 1 learning outcomes

The following learning outcomes are a focus of this module:

1. apply design and systems thinking to effectively generate creative ideas in response to an engineering design brief
2. select and apply appropriate engineering methodologies in the development of prototypes
3. initiate, implement and monitor project management strategies
4. apply a process to test, evaluate and refine engineered solutions against success criteria
5. communicate ideas, concepts and design solutions using a range of communication strategies and conventions
6. describe and analyse the role of creativity, innovation and enterprise in the professional practice of engineers.

Module 1 content

Exposure to professional practice

- authentic design briefs
- collaborative teams
- goal setting
- creativity, innovation and enterprise.

Ideation, research, discovery and integrated learning

- design and systems thinking methodologies
- engineering design processes.

Production and sharing replicating a professional paradigm

- rapid prototyping
- pitching design proposals
- design journaling.

Learners will work in teams to respond to authentic design briefs. They will apply design and systems thinking methodologies and engineering design processes, see Appendix 6, to propose and design a feasible solution. Learners will be challenged to use lean and agile design principles to problem solve and rapidly prototype as well as undertake sustained engineering design processes to optimise solutions for the client or end users. Learners will investigate the role of creativity, innovation and enterprise in engineering careers.

Key knowledge

- design and systems thinking
- engineering design process
- ideation strategies

- collaboration strategies
- personal management strategies
- project management strategies
- role of innovation and enterprise in engineering.

Key skills

- analyse real-world problems
- research and synthesise information
- generate ideas and concepts
- identify and apply design considerations
- apply innovative and original thinking
- prototype and test ideas and concepts
- use success criteria to review and evaluate designed solutions
- manage engineering design projects
- manage self
- collaborate
- communicate and justify ideas coherently using the language of engineering
- apply reflection and metacognition.

Module 1 work requirements summary

This module includes the following work requirements:

- one rapid prototype and design pitch
- one design journal and prototyping minor project.

See Appendix 3 for the full specifications of the work requirements of this course.

Module 1 assessment

This module has a focus on criteria 1, 2, 3, 4, 5 and 6.

Module 2: Engineering practice

This module asks the question: what skills and knowledge will today's engineers need to solve tomorrow's problems? Learners will apply industry practices and professional standards to respond to design briefs that addresses authentic, real-world problems related to emerging needs.

Module 2 learning outcomes

The following learning outcomes are a focus of this module:

1. apply design and systems thinking to effectively generate creative ideas in response to an engineering design brief
2. select and apply appropriate engineering methodologies in the development of prototypes
3. initiate, implement and monitor project management strategies
4. apply a process to test, evaluate and refine engineered solutions against success criteria
5. communicate ideas, concepts and design solutions using a range of communication strategies and conventions
7. demonstrate knowledge and understanding of developments in technology and an appreciation of their influence on people and engineering practice.

Module 2 content

Exposure to professional practice

- authentic design briefs

- intra and interpersonal skills
- goal setting and monitoring
- collaboration
- new and emerging technologies
- professional standards for engineers.

Ideation, research, discovery and integrated learning

- design and systems thinking methodologies
- engineering design processes.

Production and sharing replicating a professional paradigm

- case study analysis
- engineered solution
- production diary.

Learners will engage in solving real world problems relating to emerging needs such as smart cities, Industry 4.0, internet of things (IoT) and The Sustainable Development Goals (SDGs). Learners will apply relevant industry and professional standards for engineers when creating a product, communicating, designing and reporting and working in teams.

Key knowledge

- concepts of engineering communication for:
  - planning and production
  - recording and reporting
- properties of materials as they relate to their use, selection and application
- role of technology and its impact on society and the environment
- sustainability and sustainable development
  - Three pillars of sustainability: economic viability, environmental protection and social equity
- scientific concepts, mathematical tools and computer-based techniques
- roles and responsibilities within teams and collaborative partnerships
- strategies for metacognition
- relevant professional standards
- engineering design constraints.

Key skills

- think critically and creatively
- communicate
- solve problems
- use production techniques
- evaluate engineering design solutions against criteria
- collaborate
- manage self
- reflect on practice
- analyse the impact of emerging technologies on people and engineering practice.

Module 2 work requirements summary

This module includes the following work requirements:

- one case study analysis addressing the impact of emerging technologies on people and engineering practice: analyse the interrelationships between engineering projects and society
- one project and accompanying documentation in response to an engineering design brief.

See Appendix 3 for the full specifications of the work requirements of this course.

Module 2 assessment

This module has a focus on criteria 1, 2, 3, 4, 5 and 7.

Module 3: Extended engineering design project

In module 3 learners undertake a systems engineering project. Projects emphasise collaboration, communication skills and personal management, and a professional approach to engineering design, all of which are highly valuable traits for an engineer.

Module 3 learning outcomes

The following learning outcomes are a focus of this module:

1. apply design and systems thinking to effectively generate creative ideas in response to an engineering design brief
2. select and apply appropriate engineering methodologies in the development of prototypes
3. initiate, implement and monitor project management strategies
4. apply a process to test, evaluate and refine engineered solutions against success criteria
5. communicate ideas, concepts and design solutions using a range of communication strategies and conventions
8. demonstrate knowledge and understanding of ethical, legal, economic, and sustainability issues related to an engineered solution.

Module 3 content

Exposure to professional practice

- identification of a problem, need, opportunity or situation and the creation of a design brief
- intra and interpersonal skills
- goal setting and reflective practice
- ethical, legal, economic and sustainability issues.

Ideation, research, discovery and integrated learning

- design and systems thinking methodologies
- engineering design processes.

Production and sharing replicating a professional paradigm

- concept pitch
- engineering project report detailing problem solving, project planning, implementation, testing, refining and management.

Learners will replicate a professional paradigm by establishing a team or collaborative partnership with clearly defined roles. The team will ideate and identify a problem, need, opportunity or situation that has an achievable engineering design solution and create a design brief. Learners will pitch their concept to an audience before reviewing feedback and undertaking a systems design process to plan, create and evaluate an optimised engineering design solution.

Key knowledge

- factors that influence the creation and use of an engineered solution
- systems design processes

- critical and creative design thinking techniques
- production techniques for the use of materials, tools, equipment and machines, including risk management, to make a product safely
- the role of scheduled production plans for collaborative work
- methods of testing and checking the finished product against evaluation criteria
- methods used to record and report progress, including decisions and modifications made during the production process.

Key skills

- analyse the interrelationships between engineering projects and society
- develop a design brief and identify aspects that require research
- develop and use evaluation criteria
- generate and select ideas using creative and critical design thinking techniques
- identify and allocate responsibilities within the team to conduct and share research
- research and synthesis
- create innovative and high-quality design solutions and products using engineering techniques and approaches
- use risk management strategies
- use tools, equipment, machines and materials competently and safely
- justify selection of materials
- determine and recommend improvements to the product
- communicate complex ideas and insights in a range of mediums to a variety of audiences using appropriate evidence, technical terminology and accurate referencing
- use digital technologies appropriately to support collaboration in the product design process
- work individually and collaboratively to make a product or components safely
- individually record progress, decisions made and modifications to the preferred design option and production plans
- evaluate the finished product or components to determine how they satisfy the design brief.

Module 3 work requirements summary

This module includes the following work requirement:

- one extended engineering design project.

Learners should be advised to rein in the scope of the extended design project rather than choosing expansive and overly ambitious topics. It is vital that learners are advised to produce a fully resolved engineering design project, such that each stage of the engineering design process is fully addressed for the context of the project.

See Appendix 3 for the full specifications of the work requirements of this course.

Module 3 assessment

This module has a focus on criteria 1, 2, 3, 4, 5 and 8.

Assessment

Criterion-based assessment is a form of outcomes assessment that identifies the extent of learner achievement at an appropriate endpoint of study. Although assessment as part of the learning program is continuous, much of it is formative and is done to help learners identify what they need to do to attain the maximum benefit from their study of the course. Therefore, assessment for summative reporting to TASC will focus on what both teacher and learner understand to reflect endpoint achievement.

The standard of achievement each learner attains on each criterion is recorded as a rating 'A', 'B', or 'C', according to the outcomes specified in the standards section of the course.

A 't' notation must be used where a learner demonstrates any achievement against a criterion less than the standard specified for the 'C' rating.

A 'z' notation is to be used where a learner provides no evidence of achievement at all.

Internal assessment of all criteria will be made by the provider. Providers will report the learner's rating for each criterion to TASC.

TASC will supervise the external assessment of designated criteria which will be indicated by an asterisk (*). The ratings obtained from the external assessments will be used in addition to internal ratings from the provider to determine the final award.

Criteria

The assessment for *Engineering Design* Level 3 will be based on the degree to which the learner can:

1. apply critical and creative thinking to the design of a solution*
2. apply an iterative design cycle to develop engineering design solutions*
3. apply and monitor personal and project management skills
4. use success criteria to review, reflect on and refine the design process*
5. communicate for technical and non-technical audiences*
6. analyse the role of creativity, innovation and enterprise in the professional practice of engineers
7. analyse the impact of emerging technologies on people and engineering practice
8. analyse the interrelationships between engineering projects and society*.

*denotes criteria that are both internally and externally assessed.

	Module 1	Module 2	Module 3
Criteria focus	1,2,3,4,5,6	1,2,3,4,5,7	1,2,3,4,5,8

Standards

Criterion 1: apply critical and creative thinking to the design of a solution*

This criterion is both internally and externally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Problem analysis	analyses problems, challenges and user briefs to identify ways to meet a wide range of needs and requirements	analyses problems, challenges and user briefs to identify ways to meet a range of needs and requirements	analyses problems, challenges and user briefs to identify ways to meet a limited range of needs and requirements
E2 - Problem solving	sequences and presents graphics and annotations to clearly show the problem-solving process and all pivotal points† in design decisions	sequences and presents graphics and annotations to clearly show the problem-solving process and some pivotal points† in design decisions	sequences and presents graphics and annotations to clearly show the problem-solving process used
E3 - Design considerations	creates a comprehensive design brief‡ including targeted success criteria and specified constraints	creates a detailed design brief‡ including targeted success criteria and identified constraints	creates a basic design brief‡ and develops success criteria
E4 - Engineering design specifications§ and production proposal	generates and uses comprehensive design specifications and production proposals to provide optimised solutions.	generates and uses detailed design specifications and production proposals to provide optimised solutions.	generates and uses design specifications and production proposals to provide optimised solutions.

† Demonstrating the evolution of the design concept.

‡ design brief:

- determine the function and user requirements
- establish the limits or constraints on design.

§ design specification:

- to specify size, shape, function, limiting features and functional requirements.

Criterion 2: apply an iterative design cycle to develop engineering design solutions*

This criterion is both internally and externally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Knowledge and application of STEM concepts	analyses and accurately applies technological, scientific and mathematical concepts to interpret problems, and to inform and support decisions	explains and accurately applies technological, scientific and mathematical concepts to interpret problems, and to inform and support decisions	describes and applies technological, scientific and mathematical concepts to interpret simple problems, and to inform and support decisions
E2 - Safety protocols	details comprehensively and implements risk assessment and mitigation strategies across all stages of a project	details and implements risk assessment and mitigation strategies across all stages of a project	identifies and implements risk assessment and mitigation strategies with limited detail
E3 - Use of specialist tools and equipment	uses and develops a wide range of technology skills, and fabrication processes to enable the detailed production of quality engineering solutions and ensures appropriate WHS procedures	uses and develops a range of technology skills and fabrication processes to enable the detailed production of quality engineering solutions and ensures appropriate WHS procedures	uses technology skills and fabrication processes to enable the production of engineering solutions and ensures appropriate WHS procedures
E4 - Prototype production	implements engineering methodologies to design and create prototypes that effectively address all aspects of the brief with a high degree of resolution.	implements engineering methodologies to design and create prototypes that effectively address all aspects of the brief.	implements engineering methodologies to design and create prototypes that address key aspects of the brief.

Criterion 3: apply and monitor personal and project management skills

This criterion is internally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Project management†	selects and uses appropriate project management approaches† to monitor progress towards goals and makes adjustments when and where necessary	uses appropriate project management approaches to monitor progress towards goals and makes adjustments when necessary	uses project management approaches to monitor progress towards goals
E2 - Individual goals	uses appropriate resources to effectively address barriers to achieving personal goals	identifies realistic, attainable personal goals and uses appropriate resources to address barriers to achieving them	identifies personal goals and uses appropriate resources to address key barriers to achieving them
E3 - Collaborative professional relationships	establishes, manages and negotiates professional relationships with others‡ to solve problems, propose solutions and justify ideas	establishes and maintains professional relationships with a range of appropriate people with whom to collaborate to explore ideas‡	identifies and establishes professional relationships with appropriate people with whom to collaborate‡
E4 - Reflection on performance	evaluates own performance in realising engineered solutions, demonstrating a clear understanding of their own strengths and weaknesses.	analyses own performance in realising engineered solutions, demonstrating some understanding of their own strengths and weaknesses.	explains own performance in realising engineered solutions, demonstrating a limited understanding of strengths and weaknesses.

† Project management approaches may include time scheduling, resource scheduling and tracking documents.

‡ Appropriate people to collaborate with may include engineers or associated industry professionals, mentors, subject experts, end-users, peers and targeted community groups.

Criterion 4: use success criteria to review, reflect on and refine the design process*

This criterion is both internally and externally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Plan and test	designs and conducts testing to collect and record valid and reliable data in response to design specifications	plans and conducts testing to collect and record valid data in response to design specifications	conducts testing, using given methodologies, to collect and record data in response to design specifications
E2 - Data analysis	analyses data correctly† to inform and support the development of comprehensive and realistic solutions to identified problems	interprets data, including stakeholder feedback, correctly to inform the development of realistic solutions to identified problems	uses data, including stakeholder feedback, to develop and refine partial or simple solutions to identified problems
E3 - Evaluating process and production techniques	critically evaluates process and production techniques using success criteria to make considered recommendations for optimising a solution	evaluates process and production techniques using success criteria to make a range of recommendations for improving a solution	accurately explains process and production techniques using success criteria to identify the features that make the engineered solution effective
E4 - Refining the engineered solution	creates an optimised final solution addressing all aspects of the design brief, and documents how successfully the solution is performed in relation to its problem, need, opportunity or situation.	creates a final solution addressing all aspects of the design brief, and documents how successfully the solution is performed in relation to its problem, need, opportunity or situation.	creates a final solution that addresses key aspects of the design brief, and documents how successfully the solution is performed in relation to its problem, need, opportunity or situation.

† Including stakeholder feedback.

Criterion 5: communicates for technical and non-technical audiences*

This criterion is both internally and externally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Conceptual communication	comprehensively communicates design concepts, using engineering drawings, specialised terminology and technical information to meet the needs and context of the audience	clearly communicates design concepts, using engineering drawings, specialised terminology and technical information to meet the needs and context of the audience	communicates design concepts, using engineering drawings, specialised terminology and technical information to meet the needs and context of the audience
E2 - Communicating as an engineer	critically analyses the design process and evaluates opportunities, constraint and implications for proposing solutions	analyses the design process and explains opportunities, constraints and implications for proposing solutions	explains the design process and describes opportunities, constraints and implications for proposing solutions
E3 - Engineering documentation	produces coherent and well-structured project documentation across a wide range of appropriate mediums† for the identified purpose and audience	produces logical and structured project documentation using a range of appropriate mediums† for the identified purpose and audience	produces project documentation appropriate for purpose and audience
E4 - Academic Integrity	clearly and accurately differentiates the information, images, ideas and words of others from the learner's own	clearly differentiates the information, images, ideas and words of others from the learner's own	differentiates the information, images, ideas and words of others from the learner's own
E5 - Referencing	creates appropriate, well-structured reference lists, and follows referencing conventions and methodologies with a high degree of accuracy.	creates appropriate, structured reference lists, and follows referencing conventions and methodologies correctly.	creates appropriate, structured reference lists and generally follows referencing conventions and methodologies correctly.

† Mediums may include project reports, production journals, proposals, project management plans, reflective journals, folio.

Criterion 6: analyse the role of creativity, innovation and enterprise in the professional practice of engineers

This criterion is only internally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Creativity in the professional practice of engineers	critically analyses the role engineers play in creatively solving societal problems including the role of failure in successful design	analyses the role engineers play in creatively solving societal problems including the role of failure in successful design	describes the role engineers play in creatively solving societal problems including the role of failure in successful design
E2 - Innovation in the professional practice of engineers	critically analyses and evaluates the influence of new and emerging technologies on engineering practice resulting in the evolution and innovation of products and systems	analyses and evaluates the influence of new and emerging technologies on engineering practice, resulting in the evolution and innovation of engineered products and systems	evaluates the influence of new and emerging technologies on engineering practice, resulting in the evolution and innovation of engineered products and systems
E3 - Enterprise	analyses how enterprise can help engineers drive the development of new product ideas.	explains how enterprise can help engineers drive the development of new product ideas.	describes how enterprise can help engineers drive the development of new product ideas.

Criterion 7: analyse the impact of emerging technologies on people and engineering practice

This criterion is only internally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 - Emerging technologies† in future focused sectors	evaluates the impact of emerging technologies on current and future focused engineering sectors‡, their planning and services	analyses the impact of emerging technologies on current and future focused engineering sectors‡, their planning and services	assesses the impact of emerging technologies on current and future focused engineering sectors‡, their planning and services
E2 - Impacts of technology choices	critically analyses impacts, including unintended negative consequences, of choices made about technology use in an engineering context	analyses impacts, including unintended negative consequences, of choices made about technology use in an engineering context	evaluates impacts, including unintended negative consequences, of choices made about technology use in an engineering context

Criterion elements	Rating A	Rating B	Rating C
E3 - Circular economy	critically analyses the role of the circular economy in sustainable engineering design.	analyses the role of the circular economy in sustainable engineering design.	explains the role of the circular economy in sustainable engineering design.

† Emerging technologies may include but are not limited to artificial intelligence (AI), robotics, the internet of things (IoT), automation, materials science, digital fabrication.
‡ Future focused engineering sectors; for example, space colonisation, nanotechnology, robotics and biomimicry, biomedical advances.

Criterion 8: analyse the interrelationships between engineering projects and society*

This criterion is both internally and externally assessed.

Criterion elements	Rating A	Rating B	Rating C
E1 – Factors influencing product development	evaluates the factors that influence and inform the evolution and innovation of engineered products and systems	analyses engineered products to describe factors that influence product evolution over time	assesses engineered products to identify factors that influence their evolution over time
E2 – Learning from existing products and practices	analyses how learning from existing products and practices informs innovation in own projects	describes how existing products and practices inform design decisions to enable innovation	identifies how existing products and practices influence design decisions to offer continuous product enhancement
E3 - Social, ethical, economic and environmental Issues	critically analyses social, ethical, economic and environmental issues related to technology, materials selected, processes used and solution design	analyses social, ethical, economic and environmental issues related to technology, materials selected, processes used and solution design	explains social, ethical, economic and environmental issues related to technology, materials selected, processes used and solution design
E4 - Professional standards†	analyses the impact of professional standards on ethics in engineering design practice and consumer rights.	describes the impact of professional standards on ethics in engineering design practice and consumer rights.	identifies the impact of professional standards on ethics in engineering design practice and consumer rights.

† Professional standards may include but are not limited to intellectual property (IP), registered designs, registered trademarks, copyright, design rights and patents, codes of conduct.

Quality assurance

The following processes will be facilitated by TASC to ensure there is:

- a match between the standards of achievement specified in the course and the skills and knowledge demonstrated by learners
- community confidence in the integrity and meaning of the qualification.

Process – TASC gives course providers feedback about any systematic differences in the relationship of their internal and external assessments and, where appropriate, seeks further evidence through audit and requires corrective action in the future.

This process will be scheduled by TASC using a risk-based approach.

To ensure academic integrity, schools must demonstrate that consideration has been given to the contribution of others to an individual's work. This includes referencing the work of others and identifying members of peer teams.

Qualifications and award requirements

The final award will be determined by the Office of Tasmanian Assessment, Standards and Certification from 13 ratings (8 from the internal assessment, 5 from external assessment).

The minimum requirements for an award in this course are as follows:

EXCEPTIONAL ACHIEVEMENT (EA)
10 'A' ratings, 3 'B' ratings (3 'A' ratings, 2 'B' ratings from external assessment)

HIGH ACHIEVEMENT (HA)
5 'A' ratings, 5 'B' ratings, 3 'C' ratings (1 'A' ratings, 3 'B' ratings, 1 'C' rating from external assessment)

COMMENDABLE ACHIEVEMENT (CA)
6 'B' ratings, 6 'C' ratings (2 'B' ratings, 3 'C' ratings from external assessment)

SATISFACTORY ACHIEVEMENT (SA)
11 'C' ratings (3 'C' ratings from external assessment)

PRELIMINARY ACHIEVEMENT (PA)
6 'C' ratings

A learner who otherwise achieves the ratings for a CA (Commendable Achievement) or SA (Satisfactory Achievement) award but who fails to show any evidence of achievement in one or more criteria ('z' notation) will be issued with a PA (Preliminary Achievement) award.

Course evaluation

Years 9-12 Learning will develop and regularly review and revise the curriculum. Course evaluation is informed by the experience of the course's implementation, delivery and assessment. More information about course evaluation can be found on the Years 11 and 12 website.

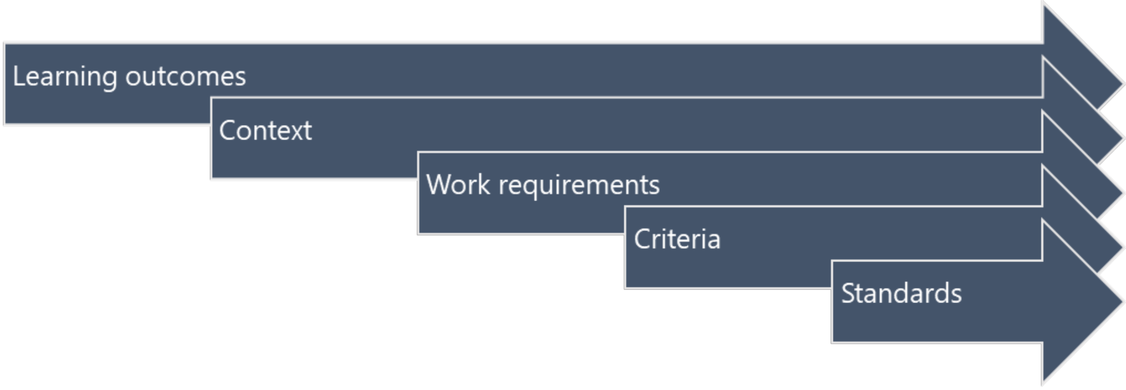
Course developer

This course has been developed by the Department of Education's Years 9-12 Learning Unit in collaboration with Catholic Education Tasmania and Independent Schools Tasmania.

Accreditation and version history

Version 1. Accredited on 21 March 2022 for use from 1 January 2023 to 31 December 2027.

Appendix 1 - Line of sight



Learning outcomes	Course content: module	Work requirements: module	Criteria	Criterion elements	General capabilities
1. apply design and systems thinking to effectively generate creative ideas in response to an engineering design brief*	1, 2, 3	1, 2, 3	1*	1, 2, 3, 4	
2. select and apply appropriate engineering methodologies in the development of prototypes	1, 2, 3	1, 2, 3	2*	1, 2, 3, 4	
3. initiate, implement and monitor project management strategies	1, 2, 3	1, 2, 3	3	1, 2, 3, 4	
4. apply a process to test, evaluate and refine engineered solutions against success criteria	1, 2, 3	1, 2, 3	4*	1, 2, 3, 4	
5. communicate ideas, concepts and design solutions using a range of communication strategies and conventions	1, 2, 3	1, 2, 3	5*	1, 2, 3, 4, 5	
6. describe and analyse the role of creativity, innovation and enterprise in the professional practice of engineers	1	1	6	1, 2, 3	
7. demonstrate knowledge and understanding of developments in technology and an appreciation of their influence on people and engineering practice	2	2	7	1, 2, 3	

Learning outcomes	Course content: module	Work requirements: module	Criteria	Criterion elements	General capabilities
8. demonstrate knowledge and understanding of ethical, legal, economic, and sustainability issues related to an engineered solution.	3	3	8*	1, 2, 3, 4	

Appendix 2 - Alignment to curriculum frameworks

Progression from the F-10 Australian Curriculum: Science

As a STEM discipline, this course component provides a progression to develop student understanding and skills from both subjects within the F-10 Australian Curriculum: Technologies curriculum:

- Design and Technologies
- Digital Technologies

alongside further developing student understanding and skills from F-10 Australian Curriculum: Science and Mathematics Curricula.

Appendix 3 - Work requirements

The work requirements of a course are processes, products or performances that provide a significant demonstration of achievement that is measurable against the course's standards. Work requirements need not be the sole form of assessment for a module.

Module 1 work requirements specifications

Work requirement 1 of 2

Title of work requirement: Rapid prototype and design pitch
Mode or format: project and performance
Description: Plan, build, user-test and share an innovative prototype in response to a design brief.
Size: a recommended maximum of 9 minutes multimodal
Timing: complete prior to commencing module 3
External agencies: audience
Relevant criteria:

- Criterion 1: E1, 2, 4
- Criterion 2: E1, 2, 3, 4
- Criterion 3: E1
- Criterion 4: E1
- Criterion 5: E1, 2, 3, 4, 5
- Criterion 6: E1, 2, 3

Relationship to external assessment: internal assessment

Work requirement 2 of 2

Title of work requirement: Design journal and prototyping
Mode or format: minor project
Description: Design and production of an engineered solution to a specified real-world project brief as provided by the course provider.
There is flexibility in this work requirement for learners to complete a single assessment task or a series of three smaller, discrete sections to form the task.

Throughout this area of study, learners apply skills in documentation and communication. They will record the creation of an engineering solution through a production diary or equivalent; for example, a blog that includes:

- the original brief
- evidence of project management strategies
- the initial research
- initial designs and thoughts on a solution
- prototyping and appropriate testing
- final analysis of prototype for effectiveness.
- brief reflection on goals and learning.

This is to be presented in an appropriate format including evidence of design development through sketching and annotated photos of the production process and documentation of testing processes.

Size: Recommendation of 800-1000 words or multimodal equivalent. Includes sketches, drawings and annotated diagrams and images.

Work requirements do not exclude other assessment opportunities and learners may undertake multiple minor systems design challenges within this module.

Timing: complete prior to commencing module 3

External agencies: none specified

Relevant criteria:

- Criterion 1: E1, 2, 3, 4
- Criterion 2: E1, 2, 3, 4
- Criterion 3: E1, 2, 3, 4
- Criterion 4: E1, 2, 3
- Criterion 5: E1, 2, 3, 4, 5
- Criterion 6: E1

Relationship to external assessment: internal assessment

Module 2 work requirements specifications

Work requirement 1 of 2

Title of work requirement: Case study

Mode or format: extended response

Description: Learners respond to real world or hypothetical case study or studies relating to the impact of emerging technologies on people and engineering practice. Learners analyse the interrelationships between engineering projects and society.

Size: a written response such as a report or essay will be between 1000–1500 words in total or a multimodal presentation of 6–9 minutes

Timing: complete prior to commencing module 3

External agencies: none specified

Relevant criteria:

- Criterion 3: E1
- Criterion 5: E3, 4, 5
- Criterion 7: E1, 2, 3

Relationship to external assessment: internal assessment

Work requirement 2 of 2

Title of work requirement: Design and solution

Mode or format: project

Description: Design and production of an engineered solution to a brief addressing an emerging need, as provided by the course provider.

There is flexibility in this work requirement for learners to complete a single assessment task or a series of three smaller, discrete sections to form the task.

Throughout this area of study, learners apply skills in documentation and communication. They will record the creation of an engineering solution through a production diary or equivalent such as a folio or blog, that includes:

- the original brief
- evidence of project management strategies
- the initial research
- initial designs and thoughts on a solution
- prototyping and appropriate testing
- final analysis of product for effectiveness.

This is to be presented in an appropriate format including evidence of design development though sketching and annotated photos of production process and documentation of testing processes.

Size: the size, complexity and scale of the engineering solution will be appropriate to a guided range of 15–25 hours for this module.

Timing: complete prior to commencing module 3

External agencies: access to focus groups, community stakeholders or experts

Relevant criteria:

- Criterion 1: E1, 2, 3, 4
- Criterion 2: E1, 2, 3, 4
- Criterion 3: E1, 2, 3, 4
- Criterion 4: E1, 2, 3, 4
- Criterion 5: E1, 2, 3, 4, 5

Relationship to external assessment: internal assessment

Module 3 work requirements specifications

Work requirement 1 of 1

Title of work requirement: Learner project folio

Mode or format: extended engineering design project

Description: Learners should be encouraged to select an extended design project topic that links with an area of genuine interest to them. This project may be undertaken as a team utilising individual expertise and drawing upon collaborative partnerships including input from peers, community members and industry professionals. All assessment products are to be submitted individually and the journal is a formal record enabling authentication of the learner's work. The journal documents the result of collaborative work, reflecting the importance of collaboration to successful engineering projects.

Learners will replicate a professional paradigm by:

- following an engineering design process to produce an engineered solution and engineering report: external assessment
- demonstrating reflective practice – design journal: internal assessment.

Initial proposal of 300–400 words: internal assessment

- identified engineering design problem

- background research to inform design brief
- work plan including timeline, risk mitigation and role allocation
- pitch or presentation.

External component 1: Engineering report: external assessment

- Title page
  The title page must include:
  - the project title and candidate's TASC ID number
  - project team details, if relevant, to assist providers with monitoring but must be removed before final submission to TASC.
- Design brief
  The design brief includes analysis of an engineering design problem and background information connected to the identified need of the project's design intention:
  - statement of problem(s)
  - description of main aim(s) and objective(s)
  - the potential user, target audience or intended client
  - constraints, and limitations
  - identification of success criteria.
- Production proposal
  The production proposal includes:
  - design specifications
  - resource requirements including materials, components, tools, equipment, etc
  - risk assessment
  - budget or costing
  - identification of potential collaborations.
- Research analysis
  This is an integral part of the engineering design process. Research provides a window to essential information about important aspects of the brief, the investigation of materials and components and existing solutions that guide the functional intentions, understanding of professional standards and identify the STEM concepts and processes to inform the design development of the project.

  This includes:
  - review of previous work, research and relationship to current project
  - evidence of stakeholder engagement
  - technological, scientific and mathematical concepts to interpret problems and to inform and support decisions
  - identification of professional standards in relation to ethics in engineering design practice and consumer rights
  - social, ethical, economic and environmental issues related to technology, materials selected, processes used and solution design.
- Design development:
  The design development must include articulation of the engineering design process including diagrams, sketches, photographs, annotations:
  - ideation
  - consideration of alternative solutions and reasons for selection
  - production drawings and plans.

- Design production
  The design production must include:
  - Photographs or screen grabs and supportive annotations that explain the project production process used to generate the design context. This will help to prove the project is the student's original work
  - prototype development and selection
  - testing methods and methods for obtaining stakeholder feedback:
    - testing methodology, experimental design
    - evidence of data collection and data analysis.
  - description of how prototyping and testing are to be used to articulate the positive and negative aspects of each method when assessed against the design brief and needs.
    - refinement of solution.
- Final engineered design: resolved engineered solution - product, service, environment
  The final design should be a suitably resolved engineering design solution that addresses the project's success criteria. The final design should include:
  - annotated photos
  - video file containing voice over or annotation of key features.
- Evaluation and recommendations
  This section should include:
  - evaluation against project's stated purpose and needs
  - reflection on what has been achieved and also what may not have been achieved
  - recommendations for further research, testing, improvements or redesign.
- References
  This section should include:
  - all in-text referencing
  - a reference list.

Reflective journal including communications log: internal assessment – demonstrating how the learner:

- monitored the effectiveness of the plans for their inquiry using appropriate strategies; for example developing criteria to measure effective implementation, checking progress according to a timeline, providing progress reports on action taken and decisions made during the process
- collaborated with others: communications log
- addressed problems encountered
- analysed how perspectives were shaped by the sources of information used
- reflected on the effectiveness of the collaborative strategies used in planning and implementing the inquiry
- evaluated the effectiveness of the inquiry including research sources, methods, findings and plans and revised plans as problems arose.

The reflective journal serves an important function. The journal assists with ongoing support and supervision and is a formal record enabling authentication of the learner's work. The journal documents the result of collaborative work, reflecting the importance of collaboration to successful engineering projects. It may be maintained in print or electronic form. All items in the journal must be dated and legible.

Size:

Internal:

- proposal 750–1000 words or multimodal equivalent of 4-6 minute
- reflective journal 1000–1500 words or multimodal equivalent of 6-9 minutes.

External:

- folio maximum of 40 A4 equivalent pages this includes research, evidence of planning, concept sketches with annotations, photographs, charts, diagrams, etc. It will be no larger than 100 megabytes in total size, including a research essay 1500–2000 words in length.

Timing: maximum 50 hours of dedicated class time including internal and external components. Learners should be advised to rein in the scope of the extended design project rather than choosing expansive and overly ambitious topics. It is vital that learners are advised to produce a fully resolved engineering design project such that each stage of the engineering design process is fully addressed for the context of the project.

External agencies: access to peers, focus groups, community stakeholders or experts

Relevant criteria:

- Criterion 1: E1, 2, 3, 4
- Criterion 2: E1, 2, 4
- Criterion 3: E1, 2, 3, 4 (internal only)
- Criterion 4: E1, 2, 3, 4
- Criterion 5: E1, 2, 3, 4, 5
- Criterion 8: E1, 2, 3, 4

Appendix 4 – General capabilities and cross-curriculum priorities

Learning across the curriculum content, including the cross-curriculum priorities and general capabilities, assists students to achieve the broad learning outcomes defined in the *Alice Springs (Mparntwe) Education Declaration* (December 2019).

General capabilities:

The general capabilities play a significant role in the Australian curriculum in equipping young Australians to live and work successfully in the twenty-first century.

In the Australian curriculum, capability encompasses knowledge, skills, behaviours and dispositions. Students develop capability when they apply knowledge and skills confidently, effectively and appropriately in complex and changing circumstances, in their learning at school and in their lives outside school.

The general capabilities include:

- Critical and creative thinking
- Ethical understanding
- Information and communication technology capability
- Intercultural understanding
- Literacy
- Numeracy
- Personal and social capability.

Cross-curriculum priorities:

Cross-curriculum priorities enable students to develop understanding about and address the contemporary issues they face, for their own benefit and for the benefit of Australia as a whole. The priorities provide national, regional and global dimensions which will enrich the curriculum through development of considered and focused content that fits naturally within learning areas. Incorporation of the priorities will encourage conversations between students, teachers and the wider community.

The cross-curriculum priorities include:

- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability.

Appendix 5 – Glossary

Term	Definition
analyse	Identify components and the relationship between them: draw out and relate implications.
artificial intelligence (AI)	The ability of machines to mimic human capabilities in a way that we would consider 'smart. In conventional computing, a programmer writes a computer program that precisely instructs a computer what to do to solve a particular problem. With AI, however, the programmer instead writes a program that allows the computer to learn to solve a problem by itself.
automation	The creation and application of technologies to produce and deliver goods and services with minimal human intervention. The implementation of automation technologies, techniques and processes improve the efficiency, reliability, and speed of many tasks that were previously performed by humans. Automation is being used in a number of areas such as manufacturing, transport, utilities, defence, facilities, operations and information technology.

Term	Definition
biomedical engineering	The application of engineering principles, practices, and technologies to the fields of medicine and biology especially in solving problems and improving care, as in the design of medical devices and diagnostic equipment or the creation of biomaterials and pharmaceuticals.
biomimicry	Inspiration of functions found in nature for use and adaptation in the design of a product, service, environment, or to solve human problems. For example, Velcro fastening was inspired by small hooks on the end of burr needles. Termite mounds that maintain a constant temperature through air vents inspired architects when designing cooling for buildings.
case study	A descriptive analysis of a person, group, product or event which can be used to identify whether something is possible.
circular economy	A circular economy is based on the principles of designing out waste and pollution: keeping products and materials in use and regenerating natural systems.
code of conduct	The code of conduct for a group or organisation is an agreement on rules of behaviour for the members of that group or organisation.
collaboration	Working with others towards a shared goal.

Term	Definition
copyright	The exclusive legal right to reproduce, publish, sell or distribute the matter and form of something; such as a literary, musical, or artistic work.
critically analyse	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to analyse.
define - as a component of design thinking	Mode of the design process about bringing clarity and focus to the design space. In a word, the define mode is sensemaking.
design brief	A concise statement clarifying a project task and defining a need or opportunity to be resolved after some analysis, investigation and research. It usually identifies users, criteria for success, constraints, available resources and the timeframe for a project and may include possible consequences and impacts.
design challenge	An integral part of educational content where students have the opportunity to work on real-world challenges in a collaborative, team-based environment, applying the lessons learned to the technical problems of the workplace.

Term	Definition
design right	A design right protects the overall visual appearance of new and distinctive products. The overall visual appearance can be a combination of visual features including: • shape • colour • configuration • pattern • ornamentation. A design right aims to protect the visual appearance of a whole product that: • has physical and tangible form • is manufactured or handmade • is produced on a commercial scale.
design thinking	Use of strategies for understanding design problems and opportunities, visualising and generating creative and innovative ideas, and analysing and evaluating those ideas that best meet the criteria for success and planning.
designed solution	A product, service or environment that has been created for a specific purpose or intention as a result of design thinking, design processes and production processes. See also engineered solution, product, service, environment.

Term	Definition
design specifications	A list of criteria a product needs to address. Using the brief as a starting point for research, a specification can be written when more facts are known. Information needs to be found through research. The statements need to be technical, measurable and justified as this then allows them to be used to evaluate the success of the prototype as it is being designed, developed and manufactured through the iterative design process.
designing	A process that typically involves investigating and defining; generating; producing and implementing; evaluating; and collaborating and managing to create a designed solution.
digital fabrication	Digital fabrication is a type of manufacturing process where the machine used is controlled by a computer. The most common forms of digital fabrication are: • CNC machining: where, typically, shapes are cut out of wooden sheets • 3D printing: where objects are built up out of layers of metal or plastic • laser cutting: where materials like metal are burnt or melted by a laser beam.

Term	Definition
Empathy or empathise - as a component of design thinking	The centrepiece of a human-centered design process. The empathise mode is the work done to understand people, within the context of a design challenge. It is the designer's effort to understand the way people do things and why, their physical and emotional needs, how they think about world and what is meaningful to them.
Engineering	A practical application of scientific and mathematical understanding and principles as a part of the process of developing and maintaining solutions for an identified need or opportunity.
engineering design process	A series of steps used by engineering teams to guide them as they develop new solutions, products or systems. The process is cyclical and iterative. It is also called the engineering design cycle.
engineering drawing	Technical drawings used to fully and clearly define requirements for engineered items. Their purpose is to capture all the geometric features of a product or a component and required for a manufacturer to produce that component.
engineered solution	A product, service or environment that has been created for a specific purpose or intention as a result of design thinking, design processes and production processes. See also designed solution.

Term	Definition
enterprise	A project or activity that may be challenging, requires effort and initiative and may have risks.
environment	One of the outputs of technologies processes such as a place or space in which technologies processes operate. An environment may be natural, managed, constructed or digital.
environmental sustainability	Practices that have minimal impact on an ecosystem's health, allow renewal of natural systems and value environmental qualities that support life.
evaluating	Measuring performance against established criteria. Estimating nature, quality, ability, extent or significance to make a judgement determining a value.
fabrication	Fabrication is the process of constructing products by combining typically standardised parts using one or more individual processes.
ideate	To form an idea of a particular thing.
ideate - as a component of design thinking	The mode of the design process in which a person concentrates on idea generation.

Term	Definition
Industry 4.0 or Industrie 4.0	The digital transformation of manufacturing and production and related industries and value creation processes. Industrie 4.0 refers to the intelligent networking of machines and processes for industry with the help of information and communication technology. Industry 4.0 is used interchangeably with the fourth industrial revolution and represents a new stage in the organisation and control of the industrial value chain.
innovation	The use of a new idea or method.
Intellectual property (IP)	The property of a person's mind or proprietary knowledge. The productive new ideas a person creates. It can be an invention, trademark, design, brand or the application of an idea.
internet of things (IoT)	Describes the network of physical objects or 'things' that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools.
iterative	The process of design development involving cyclical inquiry, enabling multiple opportunities to revisit ideas and reflect on their possibilities.

Term	Definition
nanotechnology	Also sometimes called molecular manufacturing, it is the design, production and application of structures, devices and systems at the nanoscale.
optimised	Best, most favourable, under a particular set of circumstances.
patents	A right that is granted for any device, substance, method or process that is new, inventive and useful. A patent is a legally enforceable right to commercially exploit the invention for the life of the patent.
preferred futures	A selected future identified by a student, used to inform the creation and evaluation of solutions.
product	One of the outputs of design and production processes. Products are the tangible end results of natural, human, mechanical, manufacturing, electronic or digital processes to meet a need or want.
production process	A context-specific process used to transform technologies into a product, service or environment; for example the steps used for producing a product.

Term	Definition
production proposal or production planning	The determination, acquisition and arrangement of all facilities and materials necessary for the production of the products.
professional standards	A set of practices, ethics, and behaviours that members of a particular professional group must adhere to. These sets of standards are frequently agreed to by a governing body that represents the interests of the group. Examples of professional standards include accountability, confidentiality, honesty, integrity, transparency and objectivity.
project	An individual or collaborative problem-solving activity undertaken by students that is planned to achieve an articulated aim.
project management	A responsibility for planning, organising, controlling resources, monitoring timelines and activities and completing a project to achieve a goal that meets identified criteria for judging success.

Term	Definition
prototype	A trial product or model built to test an idea or process to inform further design development. A prototype can be developed in the fields of service, design, electronics or software programming. Its purpose is to see if and how well the design works and is tested by users and systems analysts. It can be used to provide specifications for a real, working product or system rather than a virtual or theoretical one. Prototype is derived from Greek terms that, when translated, mean 'primitive form', 'first' and 'impression'.
rapid prototype or rapid prototyping	The process of creating prototypes quickly to visually and functionally evaluate an engineering product design.
registered design	A process to protect the shape, configuration, pattern or ornamentation of a product – that is, what gives a product a unique appearance.
robotics	A branch of engineering that involves the conception, design, manufacture and operation of robots. This field overlaps with electronics, computer science, artificial intelligence, mechatronics, nanotechnology and bioengineering.

Term	Definition
service	One of the outputs of technologies processes: the end result of processes and production. Services are a less tangible outcome, compared to products, of technologies processes to meet a need or want. They may involve development or maintenance of a system and include; for example, catering, cloud computing, communication, transportation and water management. Services can be communicated by charts, diagrams, models, posters and procedures.
smart cities	An urban area that has become more efficient, more environmentally friendly or more socially inclusive through the use of digital technologies. The goal of a smart city is to improve its attractiveness to citizens and businesses by enhancing or adding city services.
STEM: science, technology, engineering and mathematics	A teaching philosophy that integrates all four disciplines into a single, cross-disciplinary program which offers instruction in real-world, as opposed to purely academic, applications and teaching methods.
success criteria	A descriptive list of essential features against which success can be measured. The compilation of criteria involves literacy skills to select and use appropriate terminology.

Term	Definition
sustainable	Supporting the needs of the present without compromising the ability of future generations to support their needs.
Sustainability goals (SDGs)	Also known as the Global Goals, they were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. There are 17 integrated SDGs. For details, refer to: https://www.undp.org/sustainable-development-goals
systems thinking	A holistic approach to the identification and solving of problems, where parts and components of a system, their interactions and interrelationships are analysed individually to see how they influence the functioning of the whole system. This approach enables students to understand systems and work with complexity, uncertainty and risk.
technologies	Materials, data, systems, components, tools and equipment used to create solutions for identified needs and opportunities, and the knowledge, understanding and skills used by people involved in the selection and use of these.

Term	Definition
trademarks	A way of distinguishing goods and services from those of another business.

Appendix 6 – Engineering design process

Engineering design is a process. It is a way of thinking that is usually represented as a series of steps that guides the problem-solving process from problem identification to the development and improvement of solutions. Design and systems thinking are complementary methodologies.

Engineering design is iterative. The steps of the engineering process are not always followed in sequence, and will vary depending on the project itself, allowing for steps to be repeated enabling lessons to be learnt from failures and improvements to be made to develop the best possible solution.

Engineers use a design process to define the problem and brainstorm ideas before creating a prototype to test. That is then modified and improved until the solution meets the needs of the project.

The process allows for the application of science, mathematics and engineering concepts to be used to achieve a high level of optimisation to meet the requirements of an objective. There are numerous versions of an engineering design process. Typical steps include problem solving processes such as those identified below.

Identify and document problem, need, opportunity or situation: creating, interpreting, and responding to a design brief.

- Identify, empathise and explore a problem, need, opportunity or situation requiring an engineering solution. Requirements for solving the problem are identified and investigated. This may include researching existing engineered products, materials, components and engaging with possible users or clients to develop a greater understanding of what the solution might include.
- A design brief is developed that defines the problem and provides context. The design brief may identify the target audience, scope of the project, objectives and goals, along with design specifications, constraints and considerations such as aesthetics, costs and environmental issues. Success criteria are developed to evaluate how well the solution addresses the design brief.

Ideating and developing Ideas – generating ideas using brainstorming strategies. Specifications of the chosen design are confirmed and documented.

- Ideating and developing design ideas includes brainstorming possible solutions and considering alternative solutions. At this stage, collaborating, experimenting and engaging with user groups can support the generation of ideas. Creating sketches and drawings of design ideas may be used to generate concepts to assess and compare to the requirements of the design brief.
- Once options have been assessed, a preferred concept that best meets the design requirements may be identified and used for the production phase.
- A design proposal may be developed to document the specifications of the chosen design. This may include pictorial and orthographic drawings that contain information for the manufacture of the product. Depending on the engineering context being studied, there may also be other forms of drawing or graphics necessary to explain the final solution. Resources such as materials and parts and production techniques can be identified, and production timelines established.

Experimenting and making: construction of a prototype or working model

Creation of a prototype or prototypes that will enable testing of how the final product will perform. This may include:

- experimenting with materials and components to produce low-fidelity solutions

- using computer aided design (CAD) to produce non-physical models
- using computer aided manufacturing (CAM) to produce full-size or scale 3D models.

Testing, evaluating and refining: conducted throughout design process to assess viability, appropriateness and performance of existing solutions, materials, components, energy systems, design ideas, construction methods and the final prototype or working model.

- Each prototype will need testing, re-evaluation and improvement. Testing, including user testing, generates data to analyse and enable the evaluation of the strengths and weaknesses of the design.
- Once testing has been completed, the design can be revised and improved. This step can be repeated several times as more prototypes are created and evaluated.
- Recommendations for further improvements are documented.