Government of **Western Australia**
School Curriculum and Standards Authority

Engineering Studies

General course

Year 11 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2015.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority on a cyclical basis, typically every five years.

Content

Rationale

Engineers are involved in the design, manufacture and maintenance of a diverse range of products and infrastructure integral to the functioning of society, business and industry. They rely strongly on their creativity and problem solving to turn ideas into reality by applying lateral thinking and mathematical and scientific principles, to develop solutions to problems, needs and opportunities. An engineer also needs to be socially aware and involved in broader community issues; impacts on the environment, sustainable energy, health and safety, and consultation processes to understand social attitudes and opinion.

The Engineering Studies General course provides opportunities for students to investigate, research and present information, design and make products and undertake project development. These opportunities allow students to apply engineering processes, understand underpinning scientific and mathematical principles, develop engineering technology skills and explore the interrelationships between engineering and society.

The Engineering Studies General course is essentially a practical course focusing on real-life contexts. It aims to prepare students for a future in an increasingly technological world, by providing the foundation for life-long learning about engineering. It is particularly suited to those students who are interested in engineering and technical industries as future careers.

Course outcomes

The Engineering Studies General course is designed to facilitate achievement of the following outcomes.

Outcome 1 – Engineering process

Students apply and communicate a process to design, make, and evaluate engineered products.

In achieving this outcome, students:

- investigate needs and opportunities
- generate engineering production proposals to provide solutions
- manage engineering production processes to produce solutions
- evaluate intentions, plans and actions.

Outcome 2 – Engineering understandings

Students demonstrate understanding of materials, components, and scientific and mathematical concepts used in the engineering context.

In achieving this outcome, students:

- understand and explain properties and behaviours of materials and components
- understand and apply scientific and mathematical concepts used in the engineering context.

Outcome 3 – Engineering technology skills

Students use materials, skills and technologies when undertaking an engineering challenge.

In achieving this outcome, students:

- apply initiative and organisational skills
- apply materials, techniques and technologies to achieve solutions to engineering challenges
- operate equipment and resources safely
- apply skills of calculation and computation.

Outcome 4 – Engineering in society

Students investigate, analyse and understand the interrelationships between engineering projects and society.

In achieving this outcome, students:

- identify forms, sources and uses of energy
- describe advantages and disadvantages for society, business and the environment of automation and innovation.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 11 syllabus is divided into two units, each of one semester duration, which are typically delivered as a pair. The notional time for each unit is 55 class contact hours.

Unit 1

In this unit, students develop an understanding of the engineering design process. They study and interpret a given design brief, learn a range of research skills and devising methods to develop concepts, then plan and communicate proposed solutions to the given design brief. They study core engineering theory and relevant theory of their chosen specialist area, and learn to integrate and use this knowledge to develop and present proposals for practical solutions.

Students calculate requirements, prepare drawings and produce lists of materials and components and then follow a given timeline to produce, test and evaluate the finished product.

Unit 2

In this unit, students focus on the topics of automation and technical innovation. They investigate engineering examples within these themes and the impact these technologies have on society. Students study and interpret a given design brief. They develop responses to the brief through a process that requires them to engage in a range of activities including: researching similar existing engineered products; sketching, drawing and annotating concepts; and choosing the preferred concept for production as a prototype or working model. Students finalise their chosen design by documenting its specifications in the form of appropriate drawings and lists of materials and components. They follow a given timeline to undertake tasks required to produce, test, and evaluate the product. Core and specialist area theory continues to be studied to forge greater understanding of the scientific, mathematical and technical concepts that explain how engineered products function.

Each unit includes:

- a unit description – a short description of the purpose of the unit
- unit content – the content to be taught and learned.

Organisation of content

The course content is the focus of the learning program.

The course content is sequential and hierarchical in nature, and increases in complexity as further units are studied.

Course content contains core content material and two specialist fields offered in all four units. The core content utilises an engineering design process to enable students to learn about engineering in a practical project focussed approach. The study of core content develops student knowledge, understandings and skills of general engineering concepts and processes. The content of the two specialist fields allow for students to develop a more specific, practical understanding of major engineering and industrial technologies.

Core content

- Engineering design process
- Materials
- Fundamental engineering calculations
- Engineering in society

Specialist engineering fields

- Mechanical

  OR

- Mechatronics

Core content

Engineering design process

Investigating

Creating, interpreting, and responding to a design brief is the starting point for the engineering design process. Existing engineered products, materials, components and sources of energy are researched to develop a greater understanding of what a solution might include.

Devising

Annotated sketches and drawings of design ideas are used to generate concepts that are analysed and compared to the requirements of the design brief. The preferred concept is identified and used for the production phase.

Producing

The production phase commences with the specifications of the chosen design being confirmed and documented. Pictorial and orthographic drawings are produced that contain sufficient information for manufacture of the product to be undertaken. Depending on the specialist area being studied, there may also be other forms of drawing or graphics necessary to explain the final solution. Materials and parts lists are derived from the drawings and production techniques identified. The construction and testing of the product – a prototype or working model – is undertaken by following safe and appropriate work practices.

Evaluating

Evaluation occurs throughout the engineering design process to assess the viability, appropriateness and performance of existing solutions, materials, components, energy systems, design ideas, construction methods and the prototype or working model.

Materials

Identifying and understanding the characteristics of common materials used in engineering is a necessary requirement for the selection and use of materials in making functional models and prototypes.

Fundamental engineering calculations

Applying mathematical concepts is a fundamental requirement for the Engineering Studies General course. This entails extracting data from drawings, charts, diagrams and tables; determining perimeters, surface area, volume, density and mass of engineered products; simple energy and efficiency calculations; and using unfamiliar formulae to solve problems.

Engineering in society

The impact of engineering on society is a vital consideration. Forms, source and uses of energy are studied. At particular stages, automation and technical innovation, obsolescence, and product life cycle analysis are studied.

Specialist engineering fields

Mechanical

The content in this section is specialised knowledge that applies to mechanical engineering. It is divided into four content organisers:

- materials
- statics
- dynamics
- mechanisms

An understanding of the scientific and mathematical nature and properties of materials underpins fundamental decisions concerning their selection and use in the design of engineering projects.

Materials used in engineering and solid state structures are classified on the basis of their structure and properties. Plastics, wood, and most importantly, metals (ferrous, non-ferrous, pure and alloy), are materials commonly used in engineering because of their structure and properties; both static and dynamic.

Young’s modulus and stress-strain graphs are fundamental to all materials, structures and mechanical principles used throughout engineering.

There are testing regimes for stress, strain, tension, compression and torsion. The analysis of results from such regimes, together with information on existing data and specifications tables, forms the basis for selecting materials for engineering technologies.

Structures are defined as a body of materials selected and used because they can resist applied forces. Equilibrium, forces, structures, bending moments, shear force, torsion and Newton's Three Laws of Motion are important when analysing static loads and the application of forces to structures.

Newton's Three Laws of Motion, in conjunction with equilibrium principles, are the basis for analysing engineering mechanisms and motion conversion systems.

Mechatronics

The content in this section is specialised knowledge that applies to candidates who are undertaking the study of mechatronics. It is divided into three content organisers:

- electrical/electronics
    - components
    - laws and principles
    - production
    - quantities and unit prefixes
- systems and control
    - nature of control systems
    - interfacing with a microcontroller
- mechanics (Unit 2 only)
    - types of motion
    - mechanical drive systems
    - calculations

An understanding of scientific, mathematical and technical concepts contained in the three strands, coupled with the engineering design process, provides students with the opportunity to design, make, analyse, test and evaluate mechatronics devices.

These devices are an integration of electrical/electronic circuits, process control delivered using microcontrollers and mechanical actuators. Moreover, some form of structure or chassis is often required to complete the design.

Representation of the general capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for the Engineering Studies General course. The general capabilities are not assessed unless they are identified within the specified unit content.

Literacy

Literacy is of fundamental importance in the study of the Engineering Studies General course. Students access engineering and technological content through a variety of print, oral, visual, spatial and electronic forms, including data books, texts, computer software, images, and written technical materials. They learn to investigate, interpret and apply engineering principles from a variety of sources to design solutions for engineering tasks. They analyse and evaluate information for authority, reliability, relevance and accuracy. They learn to monitor their own language use for accuracy in the use of design principles and technological terms for clarity of ideas, processes and explanations of engineering activities and development and evaluation of functioning prototypes.

Numeracy

Numeracy is fundamental in calculating and evaluating engineering processes. Students develop their understanding and skills of numeracy while undertaking tasks to produce, test and evaluate engineered products. Core and specialist area theory continues to be studied to forge greater understanding of the scientific, mathematical and technical concepts that explain how engineered products function.

Information and communication technology capability

Information and communication technology (ICT) capability is important in all stages of the design process. Students use digital tools and strategies to locate, access, process and analyse information. They use ICT skills and understandings to investigate and devise design ideas. Students access information from websites and software programs to develop design solutions. Students use computer-aided drawing software and computer control software to produce engineered products.

Critical and creative thinking

Critical and creative thinking is integral to the design process. Design thinking methodologies are fundamental to the Engineering Studies General course. Students develop understandings and skills in critical and creative thinking during periods of evaluation at various stages of the design process. They devise plausible solutions to problems and then, through interrogation, critically assess the performance of the most efficient solution. Students identify possible weaknesses in their design solutions and then analyse, evaluate, and modify the developing solution to construct a functioning prototype.

Personal and social capability

Personal and social capability skills are developed and practiced in the Engineering Studies General course by students enhancing their communication skills and participating in teamwork. Students have opportunities to work collaboratively during stages of investigation and when producing engineering products. Students develop increasing social awareness through the study of the impact of engineering in society and on the environment.

Ethical understanding

Students have opportunities to explore and understand the diverse perspectives and circumstances that shaped engineering technology and the actions and possible motivations of people in the past compared with those of today. Students have opportunities, both independently and collaboratively, to explore the values, beliefs and principles that have influenced past engineering achievements and global engineering activities of today.

Intercultural understanding

Students have opportunities to explore the different beliefs and values of a range of cultural groups and develop an appreciation of cultural diversity. Students have opportunities to develop an understanding of different contemporary perspectives with regard to building materials, styles of structures, energy supply and use, and engineering and technological influences on different groups within society, and how they contribute to individual and group actions in the contemporary world.

Representation of the cross-curriculum priorities

The cross-curriculum priorities address contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for the Engineering Studies General course. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.

Aboriginal and Torres Strait Islander histories and cultures

Students have opportunities to explore Aboriginal and Torres Strait Islander development and use of engineering and technology, and the interconnectedness between technologies and identity, People, Culture and Country/Place. Students understand that many engineering activities occur on land that is part of traditional Country.

Asia and Australia's engagement with Asia

Students have opportunities to explore traditional, contemporary, and emerging technological achievements in the countries of the Asian region. Students explore Australia’s rich and ongoing engagement with the peoples and countries of Asia, to create appropriate products and services to meet personal, community, national, regional and global needs.

Sustainability

Students take action to create more sustainable patterns of living. Students can develop knowledge, understanding and skills necessary to design for effective sustainability.

Students focus on the knowledge, understanding and skills necessary to choose technologies and systems with regard to costs and benefits. They evaluate the extent to which the process and designed solutions embrace sustainability. Students reflect on past and current practices, and assess new and emerging technologies from a sustainability perspective.

Unit 1

Unit description

In this unit, students develop an understanding of the engineering design process. They study and interpret a given design brief, learn a range of research skills and devising methods to develop concepts, then plan and communicate proposed solutions to the given design brief. They study core engineering theory and relevant theory of their chosen specialist area, and learn to integrate and use this knowledge to develop and present proposals for practical solutions.

Students calculate requirements, prepare drawings and produce lists of materials and components and then follow a given timeline to produce, test and evaluate the finished product.

Unit content

This unit includes the knowledge, understandings and skills described below.

It is divided into core content and specialist engineering fields. Students must study all of the core content material and at least one of the specialist engineering fields.

Core content

Engineering design process

Investigating

- interpret a design brief
- use research skills to identify and describe existing solutions or similar products
- describe materials and components relevant to the design brief
- describe suitable forms of energy

Devising

- annotated pictorial drawings of design ideas
- annotated orthographic drawings of design ideas
- identify and describe the chosen option

Producing

- present specifications for the selected solution
  - dimensioned pictorial and orthographic drawings
  - orthographic drawings and sketches are 3rd angle projections and include:
    - lines – outlines, hidden detail and centrelines
    - dimensioning – linear, radii, circles, holes through or partial depth with flat base
  - materials selected
  - parts lists
  - costing of prototype or working model
- timelines to construct and test the solution
- solution construction by selecting and using appropriate tools and machines, and following safe work practices
- solution testing for correct function

Evaluating

- final solution in terms of:
  - meeting the requirements of the design brief
  - function and finish of the product

Materials

Classify types of materials

- metals (pure)
  - aluminium
  - copper
  - zinc
  - iron
- alloys (ferrous)
  - steel (mild and structural)
  - stainless steel
- alloys (non-ferrous)
  - brass
  - solder
- polymers
  - polypropylene
  - polycarbonate
  - acrylic
  - abs
  - nylon
- composites
  - concrete
  - reinforced concrete

Fundamental engineering calculations

Dimensional

- examine dimensioned drawings to calculate:
  - overall length, height and width
  - direct and indirect dimensions
    - linear measurements
    - radii and diameters

Perimeter

- square and rectangular plane figures
- circle $p = \pi d$

Surface area

- square and rectangular plane figures
- cubes and rectangular right prisms
- circle $a = \pi r^2$
- open ended cylinder $a = \pi dh$

Quantity estimates

- estimation of lengths and surface area for:
  - geometric shapes and forms
  - individual shapes
  - simple combinations of shapes and forms

Engineering in society

Energy

- definition of:
  - energy
  - power
  - work
- forms of energy
  - kinetic
  - potential
  - thermal
  - chemical
  - electrical
  - electro-chemical
  - electromagnetic
  - nuclear

Specialist engineering fields

Mechanical

Materials

- engineering material properties of hardness, strength and tendency to corrode for the following materials:
  - mild steel/structural steel
  - aluminium
  - brass
  - nylon
  - copper
  - stainless steel

Statics

- state that force is measured in newtons [N]
- identify how lever length relates to mechanical advantage in crowbars, can crushers, trebuchets
- rigidity, strength and resilience in simple static structures
  - angular ties in square and rectangular frames
  - use of angle iron or hollow section instead of flat
  - addition of a web, gusset or fillet to a corner

Dynamics

- simple single stage, single variable problems of speed, distance and time using the equation $v_{av} = \frac{s}{t}$

Mechanisms

- operating principles of the following motion conversion systems
  - cranks and slider
  - linkages
  - rack and pinion
  - bevel gears
  - bearings and bushes

Mechatronics

Electrical/electronic

Components

- recognise and describe general characteristics of components and the circuit symbols for
  - cells and batteries
  - power supply (DC)
  - fuse
  - voltage regulator – 3 pin fixed voltage positive
  - switches
    - SPST, SPDT and DPDT
    - push to make and push to break
  - fixed value resistors
  - potentiometer, including its use as a variable resistor
  - light dependent resistor (LDR)
  - thermistor (NTC)
  - capacitor – polarised and non-polarised
  - diodes – rectifier and LED
  - bulbs/lamps
  - DC motor
  - SPDT and DPDT relays
  - transistor (NPN)
  - integrated circuit (generic)
  - measuring instruments – voltmeter, ohmmeter and ammeter
- read and sketch simple circuit diagrams that contain the components listed above
- recognise markings
  - fixed value resistors – 4 band E12 series
  - capacitors: pF, nF and µF
  - serial numbers – refer to data sheets
    - pin outs: voltage regulator, transistor and integrated circuits

Laws and principles

- application of:
  - Ohm's Law
    - $V = IR$
  - Kirchhoff's Laws
    - $\sum I = 0$ Kirchhoff's Current Law
    - $\sum \Delta V = 0$ Kirchhoff's Voltage Law
  - power
    - $P = V I = I^2R$
- cells and batteries
  - series
    - $V_T = V_{B1} + V_{B2} + \ldots\ldots.$
    - $I_T = I_{B1} = I_{B2} = \ldots\ldots.$
  - parallel
    - $V_T = V_{B1} = V_{B2} = \ldots\ldots.$
    - $I_T = I_{B1} + I_{B2} + \ldots\ldots$
- resistor networks
  - series
    - $R_T = R_1 + R_2 + R_3 + \ldots\ldots.$
  - parallel (maximum of 2 resistors)
    - $R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ for a pair
    - $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$
- capacitor
  - series (maximum of 2)
    - $C_T = \dfrac{C_1 C_2}{C_1 + C_2}$ for a pair
    - $\dfrac{1}{C_T} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$
  - parallel
    - $C_T = C_1 + C_2 + C_3 + \ldots\ldots$
- transformers
  - $V_P / V_S = I_S / I_P = N_P / N_S$
  - $V_P I_P = V_S I_S$

Production

- safety
  - electrical
  - drilling
  - soldering
- population of a through hole printed circuit board

- soldering technique using correct equipment
  - identify and correct soldering faults
- measure resistance, voltage and current using a digital multimeter

Quantities

Quantity	Unit name	Symbol
electric potential difference/e.m.f.	volt	V
current (I)	ampere	A
resistance	ohm	Ω
power	watt	W
capacitance (C)	farad	F

Unit prefixes

Prefix	Symbol	Factor
pico	p	10^{-12}
nano	n	10^{-9}
micro	µ	10^{-6}
milli	m	10^{-3}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
tera	T	10^{12}

Systems and control

Nature of control systems

- systems/control diagrams
  - simple open loop (universal block diagram)
    - input
    - process
    - output
  - simple closed loop
    - input
    - process
    - control
  - feedback loop
    - output

- flowcharts
  - standard symbols
    - start/end
    - input/output
    - decision
    - process
    - subroutine/procedure
    - flow of computation

Interfacing with microcontroller

- nature of microcontroller
  - internal subsystems
    - ALU, ROM, RAM, ADC, I/O and bus Memory, I/O
- power supply
  - batteries
    - voltage to be specified
  - voltage regulator
    - fixed positive voltage to be specified
- digital input
  - 'high' and 'low' signals (also 0 and 1, 'on' and 'off')
  - sensors
    - switch with resistor (pull up and tie down)
- analogue input
  - signal values that can vary on a defined scale
  - sensors
    - voltage dividers

Unit 2

Unit description

In this unit, students focus on the topics of automation and technical innovation. They investigate engineering examples within these themes and the impact these technologies have on society. Students study and interpret a given design brief. They develop responses to the brief through a process that requires students to engage in a range of activities including: researching similar existing engineered products; sketching, drawing and annotating concepts; and choosing the preferred concept for production as a prototype or working model. Students finalise their chosen design by documenting its specifications in the form of appropriate drawings and lists of materials and components. They follow a given timeline to undertake tasks required to produce, test and evaluate the product. Core and specialist area theory continues to be studied to develop greater understanding of the scientific, mathematical and technical concepts that explain how engineered products function.

Unit content

This unit builds on the content covered in Unit 1.

This unit includes the knowledge, understandings and skills described below.

It is divided into core content and specialist engineering fields. Students must study all of the core content material and at least one of the specialist engineering fields.

Core content

Engineering design process

Investigating

- interpret a design brief
- use research skills to identify and describe existing solutions or similar products
- describe materials and components relevant to the design brief
- describe suitable forms of energy

Devising

- annotated pictorial drawings of design ideas
- annotated orthographic drawings of design ideas
- features of the chosen option

Producing

- specifications for the selected solution
  - dimensioned pictorial and orthographic drawings
  - orthographic drawings and sketches are 3rd angle projections and include:
    - lines – outlines, hidden detail and centrelines
    - dimensioning – linear, radii, circles, holes through or partial depth with flat base
  - materials selected
  - parts lists
  - costing of prototype or working model

- a timeline to construct and test the solution
- solution construction through selection and use of appropriate tools and machines and following safe work practices
- solution testing for correct function

Evaluating

- final solution evaluation in terms of:
  - meeting the requirements of the design brief
  - function and finish of the product

Materials

Physical properties of materials

- definition of:
  - density
  - elasticity
  - strength – tensile and compressive
  - malleability
  - conductivity – electrical and thermal

Fundamental engineering calculations

Volume

- cubes and rectangular right prisms
- cylinder $v = \pi r^2 h$

Density

- density = mass/volume kg m^{-3}

Quantity estimates

- estimate volume, mass and density of geometric forms
  - individual or simple combinations
  - hollow or solid

Engineering in society

Automation and technical innovation

- define the terms automation and innovation and give examples of each in the engineering context
- describe advantages and disadvantages for society, business and the environment of automation and innovation in the engineering context

Specialist engineering fields

Mechanical

Materials

- define and describe engineering properties of ferrous and non-ferrous metals and their tendency to corrode for:
  - mild steel
  - structural steel
  - aluminium
  - brass
  - copper
  - stainless steel

Statics

- equilibrium and basic structural integrity in simple structures using Newton's Third Law statement
  - for every force acting on an object, the object will exert an equal, yet opposite, force on its cause
- calculate loads or distances on 2D balanced beams/seesaws, with two loads, using
  - $M = rF$
  - $\Sigma M = 0$
  - $\Sigma CWM = \Sigma ACWM$
- application of webs, bosses, supports, fillets and folds for strength and rigidity

Dynamics

- operating principles in the following four motions
  - linear
  - reciprocating
  - oscillating
  - rotary
- work and power using the expressions
  - $W = Fs$
  - $\text{Power} = \frac{Fs}{t}$
  - single stage, single variable calculations

Mechanisms

- identify and explain the operating principles of the following motion conversion systems and the change in the direction of force and velocity
  - levers and linked levers
  - gears, pulley and chain drives, and idler gears
  - worm and wheel
  - pulleys
  - belt including tensioner, twist to change angle/direction
  - cam and lifters including dimensions of lift, radius and lobe
  - ratchet and pawl

Mechatronics

Electrical/electronic

Laws and principles

- analogue inputs
  - voltage dividers
    - LDR with resistor or variable resistor
    - thermistor with resistor or variable resistor
    - potentiometer
  - $V_1 = V_{cc}\dfrac{R_1}{(R_1 + R_2)}$
  - $V_2 = V_{cc}\dfrac{R_2}{(R_1 + R_2)}$
  - $V_{CC} = V_1 + V_2$
- NPN transistor
  - buffer/driver for a microcontroller
    - driving relays, DC motor (unidirectional), bulb/lamp, high current LED
- diodes
  - power/rectifier diode (silicon)
    - forward bias voltage 0.6 V
    - back e.m.f. protection
  - light emitting diode (LED)
    - $R = \dfrac{(V_{CC} - V_{LED})}{I_{LED}}$
- voltage regulator
  - positive voltage 3 pin fixed value in 78XX series
  - smoothing capacitors

Systems and control

Interfacing with microcontroller

- outputs
  - LED (low power)
  - piezo sounder
  - NPN transistor driver/buffer
    - relays, DC motor (unidirectional), bulb/lamp, high current LED
  - DC motor (bi-directional)
    - H-bridge integrated circuit – motor controlled by two (2) outputs from microcontroller
      - includes L293D motor controller

Mechanics

Types of motion

- linear, rotary, oscillating and reciprocating
- transformation
  - identify examples and applications of:
    - rotary to linear
    - rotary to reciprocating
    - rotary to oscillating

Mechanical drive systems

- general characteristics and applications for:
  - pulley belt
  - chain and sprocket
  - spur gear drive
  - compound gear drive
  - rack and pinion

Calculations

- pulley belt ratio = $\dfrac{\text{Ø follower pulley}}{\text{Ø driver pulley}}$ = input revolutions:1 output revolution

- chain and sprocket ratio = $\dfrac{\text{n}^{\text{o}}\text{ teeth follower gear}}{\text{n}^{\text{o}}\text{ teeth driver gear}}$ = input revolutions:1 output revolution

- gear ratio = $\dfrac{\text{n}^{\text{o}}\text{ teeth follower gear}}{\text{n}^{\text{o}}\text{ teeth driver gear}}$ = input revolutions:1 output revolution
  - pinion gear
  - idler gear
- rack and pinion
  - distance moved = $\dfrac{\text{n}^{\text{o}}\text{ teeth pinion} \times \text{n}^{\text{o}}\text{ revolutions}}{\text{n}^{\text{o}}\text{ teeth per metre of rack}}$

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Engineering Studies General Year 11 syllabus and the weighting for each assessment type.

Assessment table – Year 11

Type of assessment	Weighting
Design Students investigate needs, opportunities and problems defined in a design brief. They devise a solution that considers factors such as function, environment, materials, components and parts. Teachers assess how well students conduct the investigation and the devising of a solution in response to the design brief, by referring to the student's documentation of the process. Types of evidence must include, a project folio (hard copy or electronic or combination) and may also include a research assignment.	20%
Production Students finalise and document the specifications for their solution. They plan the making process by identifying and using appropriate tools and techniques, and then manufacture and/or assemble their engineered product which they test for safe and correct function. Planning also includes working to deadlines. The product and process are also evaluated by the student. Teachers assess the students' understanding, confidence and competence when undertaking the making and evaluation of their engineered product. Types of evidence must include the engineered product and project folio (hard copy or electronic or combination). Other evidence may include a journal and observation checklists.	70%
Response Students apply their knowledge and skills in responding to a series of stimuli or prompts. Types of evidence can include tests, worksheets and research assignments. Other evidence may include a journal and observation checklists.	10%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units (or for a single unit where only one is being studied).

The assessment outline must:

- include a set of assessment tasks
- include a general description of each task
- indicate the unit content to be assessed
- indicate a weighting for each task and each assessment type
- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

In the assessment outline for the pair of units, each assessment type must be included at least twice. In the assessment outline where a single unit is being studied, each assessment type must be included at least once.

The set of assessment tasks must provide a representative sampling of the content for Unit 1 and Unit 2.

Assessment tasks not administered under test/controlled conditions require appropriate validation/authentication processes.

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units (or for a unit where only one unit is being studied). The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Engineering Studies General Year 11 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

Appendix 1 – Grade descriptions Year 11

A	**Design** Independently interprets a given design brief. Develops engineering solutions that use all of the elements of the engineering design process, to investigate individual design needs, existing products, systems, components and parts as well as the student's ideas. Generates design proposals supported by a variety of drawings, diagrams, tables, charts and text included in the design folio, as required, and these are complete, accurate and clearly communicate information that is central to understanding the development, testing and evaluation of the design. Thoroughly evaluates the final design against all criteria that are defined in the design brief.
	Production Communicates accurate, complete and neatly presented final specifications. Independently implements planned production processes organised in a timeline for producing and testing the resulting model or prototype. Works independently and collaboratively using available tools and techniques in a safe and appropriate manner to manufacture and/or assemble the engineered product, which is crafted to a very high standard with care and attention to detail. Recognises hazards and works with regard for the safety of self and others. Presents a product that functions correctly, reliably and safely.
	Response Independently uses technical language and data that includes the application and manipulation of different formulae and calculations to compute correct answers. Presents well-structured information with detailed supporting evidence. Explores alternatives and makes comparisons and conclusions which are briefly explained and interpreted.

B	**Design** Interprets and documents, with minimal assistance, a given design brief. Investigates, evaluates and documents several alternative solutions covering all significant and obvious criteria identified in the design brief. Presents accurate and clear information that is central to understanding the development, testing and evaluation of the design. Includes relevant drawings, diagrams, tables, charts and text in the design folio, as required. Presents a final design that links back to the design brief.
	Production Communicates clearly the final specifications for the solution, with some minor omissions and/or errors but most of the specifications are accurate, complete and neatly presented. Uses safe production processes, including a planned timeline for producing and testing the resulting model or prototype, resulting in deadlines being met on time. With incidental guidance, uses available materials, techniques and equipment, and works with regard for the safety of self and others. Presents a product that functions correctly, reliably and safely.
	Response Uses technical language and data that includes the application of given formulae and simple arithmetic skills, to compute a correct answer. Presents information with supporting evidence. Requires guidance in exploring alternatives and making comparisons and conclusions.

C	**Design** Interprets and documents, with direction and prompting, a given design brief. Investigates and documents several alternative solutions, while attempting to cover all significant criteria identified in the design brief. Presents relevant information that is central to understanding the development, testing and evaluation of the design. Includes appropriate drawings, diagrams, tables, charts and text in the design folio, as required. Presents a final design that relates back to the design brief.
	Production Provides reasonable representations of the final solution, but with some noticeable omissions and/or errors in completed specifications. Amends the final specifications to make them an appropriate response to the design brief. Uses tools and techniques, with a planned timeline in a safe and appropriate manner to manufacture and/or assemble the solution which is crafted to a satisfactory standard with care and attention to most details. Presents a resulting product that functions safely, correctly and reliably most of the time.
	Response With some guidance and direction, uses technical language and data, including the use of given formulae and simple arithmetic skills, to compute an answer. Presents information with some supporting evidence. Requires direction in exploring alternatives and in making comparisons and conclusions.

D	**Design** Develops an *ad hoc* design process, and with some considerable direction and prompting interprets a teacher-directed design brief that results in a simplistic understanding of the need, opportunity or problem. Investigates and documents one or two alternative solutions, these may be referenced to some of the criteria identified in the design brief. Presents few detailed drawings, diagrams, tables, charts and text in a design folio. These are mostly incomplete, and only provide limited explanation of the development, testing and evaluation of the design. Presents the final design in a superficial manner with little relation to some of the criteria that are defined in the design brief.
	Production Attempts production with limited planning using *ad hoc* design processes, and communicates with minimal use of engineering terminology and techniques. Requires guidance in adhering to a timeline for producing and testing the resulting model or prototype, and most deadlines are not met on time. With regular guidance and direct instruction uses tools and techniques in a safe and appropriate manner to manufacture and/or assemble the engineered product with some obvious inaccuracies and/or incomplete sections. Presents a resulting product that occasionally functions reasonably well but is prone to being unreliable.
	Response With regular guidance and direction, uses basic technical language and data, including the use of given formulae, and demonstrates simple arithmetic skills to compute an answer. Presents incomplete, disorganised information that lacks supporting evidence and provides inadequate conclusions.

E	Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.