Engineering Studies
Preliminary Course

Engineering Fundamentals

Engineering Application Module 1
(30 Hours Indicative Time)
(8 weeks)

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

Outcomes:

A student:

P 1.2	explains the relationship between properties, structure, uses and applications of materials in engineering
P 2.1	describes the types of materials, components and processes and explains their implications for engineering development
P 3.1	uses mathematical, scientific and graphical methods to solve problems of engineering practice
P 3.3	applies graphics as a communication tool
P 4.1	describes developments in technology and their impact on engineering products
P 4.2	describes the influence of technological change on engineering and its effect on people
P 4.3	identifies the social, environmental and cultural implications of technological change in engineering

programmed by
Mr. Ian Preston

MURRUMBIDGEE
Regional High School

ENGINEERING FUNDAMENTALS

Stage 6: Preliminary Engineering Studies

Engineering Application Module 1

Unit 1: ENGINEERING FUNDAMENTALS | **Unit Length: 8 weeks**

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

The unit is divided into five distinct areas of study. They are;

1) ***Areas of engineering practice:*** students learn about the nature and range of work of engineers and identify areas of engineering.
2) ***Historical and societal influences:*** students learn about the historical developments of engineering and the effect of engineering innovation on people's lives.
3) ***Engineering mechanics:*** students are introduced to mass and force as well as scalar and vector quantities. Simple machines including levers, inclined planes, screws, wheel and axle, pulley systems and gears are also introduced.
4) ***Engineering materials:*** students learn how to classify materials. They also learn about the properties of materials, the structure of materials, ferrous and non-ferrous metals, basic forming processes suitable for materials, polymers, ceramics and composites.
5) ***Communication:*** this section is based around freehand sketching in three-dimensional and third angle orthogonal projection. Students also learn about research methods and collaborative work practices. Students are introduced to Engineering Reports and their significance in engineering practice.

Assessment: students will need to complete a task that addresses Graphical Communication concepts covered in the areas of engineering mechanics, engineering materials and communication.

Outcomes:

A student:

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

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

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

P3.3 applies graphics as a communication tool

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

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

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

Resources:

Text: Excel - Year 11 Engineering Studies: Peter & Roger Metcalfe
Text: Engineering Studies – The Definitive Guide: Paul L. Copeland
Text: Introduction to Engineering Mechanics Schlenker / McKern
Text: Introduction to Materials Science Schlenker
Software: Focus on Design Technology: Mechanisms Focus Educational Software
Videos: Ferrous Metals, Non Ferrous Metals
Multimedia: Engineering Fundamentals - Metcalfe Resources
Text: Engineering Your Future - An Australasian Guide, Dowling, Carew, Hadgraft
Text: Rochford: Engineering Studies, A Students Workbook
Text: Engineering Studies, Engineering Mechanics, Aouni El-Hajje
Household Appliances, OTEN - DET
Text: Rochford: Engineering Studies Communication, A Students Workbook
A Design and Technology Site, **http://www.technologystudent.com/**
MathsOnline computer program, **mathsonline.com.au**

Assessment: students complete a graphic communication based task to demonstrate their skills in using graphics as a tool to solve or communicate engineering problems/principles in relation to engineering mechanics, engineering materials and communication.

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PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	*Engineering Fundamentals*	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.
Terminology: • Amorphous • Austenite • Atomic bonding • Bonds • Brass • Bronze • Cementite • Ceramic • Concrete • Composites • Crystal • Density • Ductility • Ferrous • Fulcrum • Hardness • Lever • Mass • Metal • Non-ferrous • Pearlite • Polymer • Pulley • Scalar • Screw • Steel • Stiffness • Timber • Thermoplastic • Thermoset • Toughness • Vector	○ Define terms used in engineering fundamentals. ○ Correctly use terms relevant to engineering fundamentals. **Resources** Excel Preliminary Engineering Studies Peter & Roger Metcalfe	• Students are exposed to a wide range of new terms in this introductory topic. The students are to define each of the terms over the course of the topic (approx. 8 weeks) • Students should have a glossary section at the beginning of the topic in their notes. *programmed by* *Mr. Ian Preston* MURRUMBIDGEE Regional High School	

PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	*Engineering Fundamentals*	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.
Areas of engineering practice: • Nature and range of work of engineers	• identify areas of engineering	**Course Introduction:** • this is the starting point of the Preliminary course. Welcome and introduce students to the course. Use the interactive whiteboard or similar to access the NESA site and demonstrate to students how to locate the Preliminary Engineering Studies section. Download the Preliminary syllabus and explicitly go through with students. After this hand out and discuss the scope and sequence for the course and the assessment schedule. Ensure students sign off on these documents for the Preliminary monitoring folder. • Introduce students to the MRHS LMS and demonstrate how they will access the Preliminary Engineering Studies course. **Engineering Fundamentals:** • read and discuss 'Areas of Engineering Practice' from Metcalfe resource P1. Students copy notes. • Question students and lead discussion on their understanding of the types of engineering and engineering occupations (civil, mechanical, aeronautical etcetera.) • View teacher created (Preston) PowerPoint presentation on the nature and range of work of engineers based on the text Engineering Your Future. (students take notes as appropriate) • using YouTube watch small clips of different mining disciplines eg: Mining Engineering Australia, Civil Engineering Australia. • create the WOW factor by starting the course with the Space Station episode of Big, Bigger, Biggest or a suitable title from MegaFactories or MegaStructures or Engineering Connections or Seven Wonders of the Engineering World. Ensure to create discussion with students concerning the role or the engineer in the chosen DVD. **Extension Activity:** • Students complete activity based on Metcalfe resources P2	
	Resources Excel Year 11 Engineering Studies Peter & Roger Metcalfe Pages: 17 – 31 Engineering Your Future - An Australasian Guide Dowling, Carew, Hadgraft John Wiley & Sons Engineering Fundamentals - Metcalfe Resources MRHS LMS, NESA website, engineering DVD's as selected.		

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PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	*Engineering Fundamentals*	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.
Historical and societal influences: • Historical developments of engineering • Effect of engineering innovation on people's lives *programmed by* *Mr. Ian Preston* MURRUMBIDGEE Regional High School	• Outline historical uses and appropriateness of materials in the design and production of engineering projects. • Demonstrate an understanding of the historical developments of engineering **Resources** Excel Year 11 Engineering Studies Peter & Roger Metcalfe Pages: 17 – 31 Household Appliances Part 1 – Development pages 1 - 30 OTEN - DET	**Historical Developments:** • break students into groups of two for a think/pair/share activity where they discuss what they consider to be the most important engineering achievements of the 20th century. Then combine 2 x groups and discuss further. Students should have a list of at least 10-15 achievements. Brainstorm with class the main achievements and record. Generate class discussion by placing the list in priority order. • direct students to www.greatachievements.org which lists the 'experts' opinion of the 20 greatest engineering achievements of the 20th century. Generate discussion to compare this list with what class came up with. Students to copy list into their notes. • Examine no. 15 – Household Appliances and discuss why this is on the list. Brainstorm a list of household appliances found in the home with students. Discuss the **Domestic Clothes Iron** in relation to the appropriateness of materials in the design and production over time. Teacher to have examples to show class from Sad Iron through to a modern iron. Emphasis on developments in manufacturing and materials. **Effects on People's Lives:** • General teacher led discussion on the effects of engineering innovation on peoples lives. (Excel p. 10) • Students select five of the most important engineering achievements of the 20th century and for each list positive and negative effects on people's lives. Class discussion on responses. Extension: • Students complete Exercise 1.1 – 1.6 (OTEN notes Household Appliances p. 27-30)	

PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	Engineering Fundamentals	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.

Engineering Mechanics:
 	
• **mass and force**
• **scalar and vector quantities**
• simple machines
  ○ levers
  ○ inclined planes
  ○ screws
  ○ wheel and axle
  ○ pulley systems
  ○ gears
	• use mathematical and graphical methods to solve problems in engineering
	• examine the function of simple machines
	
	Resources
	
	Excel Year Preliminary Engineering Studies
	Peter & Roger Metcalfe
	Pages: 3-4, and 11-23
	
	Rochford: Engineering Studies, A Students Workbook Unit 1: Introductory Engineering Materials and Mechanics
	
	Household Appliances
	Part 3 – Mechanics
	pages 1 - 38
	OTEN – DET
	
	Introduction to Engineering Mechanics
	Schlenker / McKern
	
	www.MathsOnline.com.au
		• introduce mathematical concepts that will be used in engineering mechanics including trigonometry, Pythagoras theorem, sine rule and cosine rule. Use worked examples if required by students. Source from MathsOnline and watch video snippets if necessary for student understanding.
		• Copy or distribute and discuss tables of engineering units SI Units, Prefixes and SI derived units from Excel p.4.
		• discuss ***mass*** with students (amount of matter contained in an object). Discuss the basic unit (kg). Question students on does a mass of 100 kg remain the same on earth as it does on the moon.
		• discuss *force* with students (push or a pull). Discuss the basic unit (Newton = N). Discuss Newton's laws and demonstrate the basic formula F = ma.
		• discuss with students the 4 basic forces of weight force, action force, reaction force and friction force.
		• discuss *scalar* and *vector* quantities giving examples of each. (Schlenker p. 9-10) Demonstrate how *vectors* are represented graphically to scale. Include in discussion the principle of transmissibility, centre of gravity and the adding and subtracting of vectors. Introduce the terms *resultant* and *equilibrant* and discuss its meaning. Also introduce space diagrams and free body diagrams.
		• teacher to go through each of the 5 worked examples in the OTEN notes with class on the board. These examples show graphical and mathematical examples.
		
		Activities:
		1. students to complete exercises 3.1 – 3.10 (OTEN).
		
		Extension:
		• Schlenker review problems 1/5, 1/6, 1/7, 1/8 and 1/9 on pages 14 and 15.	

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PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	Engineering Fundamentals	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.

Engineering Mechanics:
• mass and force
• scalar and vector quantities
• **simple machines**
  ○ **levers**
  ○ **inclined planes**
  ○ **screws**
  ○ **wheel and axle**
  ○ **pulley systems**
  ○ **gears**
	• use mathematical and graphical methods to solve problems in engineering
	• examine the function of simple machines
	
	Resources
	
	Excel Year Preliminary Engineering Studies Peter & Roger Metcalfe , Pages: 14-23
	
	Focus on Design Technology: Mechanisms Focus Educational Software
	
	Introduction to Engineering Mechanics Schlenker / McKern , pages 1 - 40
	
	Rochford: Engineering Studies A Students Workbook, Unit 4: Machines
	
	Engineering Studies, Engineering Mechanics Aouni El-Hajje, Chapter 3, Simple Machines, pages 56 - 81
	
	ClickView titles
	Simple Machines Junior and Senior
		Simple Machines:
		• brainstorm "what is the function of a simple machine"?
		• brainstorm various types of simple machines and compare students list with that in the syllabus.
		• introduce concept that all complicated machinery is based on six simple machines (Excel p. 14)
		• note taking on Mechanical Advantage, Velocity Ratio and Efficiency (see Aouni El-Hajje) with emphasis on mathematical formulae for each.
		• watch ClickView titles "Simple Machines Junior" and "Senior" to introduce the simple machines.
		• **extension:** introduce simple machines using Focus on Design Technology Mechanisms. Note: ensure the program is loaded onto PC prior to lesson.
		• teacher to distribute to students handouts on simple machines levers, wheel & axle, pulleys, inclined plane, gears and screws. Discuss each with students and have student's complete activities on each sheet.
		Activities:
		1. students do activities from simple mechanisms handouts.
		2. Teacher to select appropriate activities from Aouni El-Hajje to complete
		
		Extension:
		• Schlenker review problems on Moments 4/12, 4/13, 4/14, 4/15, 4/16, 4/19, 4/20, 4/21, 4/28 on pages 79 to 83.
		• Watch video Simple Machines & answer review questions
		• View Rochford presentation, Unit 4, Machines
		• Use LEGO Simple machines to demonstrate each concept	

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PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3
Topic: ***Engineering Fundamentals***		Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About

Engineering materials:

- Classification of materials
- Properties of materials
  - physical and mechanical properties
- Structure of materials
  - atomic structure
  - bonding
  - crystalline and non-crystalline structure
- Metals
  - ferrous metals including mild steels
  - non-ferrous metals including copper, brass, bronze and aluminium
- Basic forming processes suitable for materials
  - casting, rolling, extruding, cutting, joining, fabricating
- Polymers
  - thermo softening
  - thermosetting
- Ceramics
  - common types used
  - forming and shaping
- Composites
  - Timber
  - concrete

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Students Learn To

- Classify a variety of materials.
- Identify the properties of materials and identify the reason for their selection.
- Describe the structure and bonding of materials.
- Distinguish between and explain reasons for the use of ferrous and non-ferrous metals as components in engineering.
- Describe the suitability of basic forming processes used on materials.
- Distinguish between thermo softening polymers and thermosetting polymers
- Identify the types of engineering ceramics.
- Identify forming and shaping methods.
- Outline the properties and uses of composites in engineering.

Resources

Excel Year 11 Engineering Studies Peter & Roger Metcalfe , Pages: 17 – 31

Household Appliances , Part 2 – Materials pages 36 - 47 , OTEN – DET

Introduction to Materials Science Schlenker Chapters 2 and 3

Engineering Studies – Definitive Guide Paul Copeland

Rochford: Engineering Studies A Students Workbook Unit 1: Introductory Engineering Materials and Mechanics

Teaching & Learning Activities

- Copy Fig 2.1 p. 3 OTEN and discuss
- Give examples of some classifications for engineering purposes eg1: elements, solutions, compounds and mixtures (Copeland p. 8), eg2: metals, non metals (see Excel p. 36 and draw table in notes) eg3: natural and artificial, eg4: organic and inorganic, eg5: solid, liquid, gas.
- Properties of materials (OTEN p. 7-9), discuss mechanical, physical & chemical properties. Students copy table p.7
- Structure of Materials: use Schlenker p. 22-26 to explain *atomic structure*. Students copy fig 3.1, define protons, neutrons and electrons. Discuss the Bohr atom p.24 and handout table 3.2 page 25 to students and discuss. Watch ClickView titled 'Arrangement of Electrons in an Atom' and discuss. Handout to students a Periodic Table of Elements and discuss (from inside cover of Schlenker). Identify the 4 zones present in table and define each.
- Bonding: introduce Primary and Secondary bonds. Examples of Primary bonds, ionic, covalent, metallic. Use OTEN, Copeland notes to explain and Excel notes for properties. Discuss briefly *secondary bonds* eg: Van der Waals.
- Discuss particle theory p. 16 OTEN with reference to HCP, FCC, BCC, crystalline and amorphous.
- List the basic forming processes and have students compile brief revision notes on each with diagrams where possible. Teacher to source appropriate video or YouTube clips to demonstrate each process.
- Distinguish between *ferrous* and *non ferrous* metals using OTEN p. 16-19 and video's "Ferrous Metals" and "Non Ferrous Metals".
- Discuss polymers (thermoplastics and thermosets) and ceramics (clay based, glass etc..) with students.
- Define composites with relation to properties of a composite material. Use timber and concrete as examples.

Activities:

1. students complete OTEN exercises 2.1 – 2.8. Use www.webelements.com to answer ex 2.4

Extension:

1. Watch video "Joining Metals"
2. View and discuss Rochford presentation of Unit 1.

Reg.

PRELIMINARY: ENGINEERING STUDIES	Weighting: 25%	Outcomes: P1.2, P2.1, P3.1, P3.3, P4.1, P4.2, P4.3

Topic	*Engineering Fundamentals*	Programmed by: Ian Preston Murrumbidgee Regional High School

Students Learn About	Students Learn To	Teaching & Learning Activities	Reg.
Communication: • freehand sketching in three-dimensional and third angle projection • research methods • collaborative work practices • engineering reports and their significance in engineering practice *programmed by* *Mr. Ian Preston* MURRUMBIDGEE Regional High School	• Identify third angle projection • Draw freehand, orthogonal and three dimensional pictorial drawings of objects • Conduct research using computer technologies and other resources • Appreciate the value of teamwork • Outline the use and basic structure of an Engineering report **Resources** Excel Preliminary Engineering Studies Peter & Roger Metcalfe Pages: 41 – 43 Rochford: Engineering Studies Communication, A Students Workbook A Design and Technology Site http://www.technologystudent.com/	**Freehand Sketching in 3D and 3rd Angle Projection:** • Introduce students to graphical communication using 'A Design and Technology Site' at the URL shown in the resources section. Start inside Graphics and go through Basic Drawing Equipment. Ensure teacher has examples of all equipment to show students. • Using a CUBE as an example, and various sections of the website (Isometric, Oblique, Perspective) introduce pictorial drawing. Students to draw each pictorial drawing freehand. • Using the Orthographic Projection section of the website, introduce Third Angle Projection. Teacher to use other teaching aides where possible. Ensure the distinction between 1st and 3rd Angle Projection is covered. Ensure students know the symbol that represents 3rd angle projection. Students draw a 3rd angle orthogonal projection of the cube ensuring views are in correct positions and aligned. **Activities:** • Students complete graphical exercises as selected by teacher to cement understanding of pictorial and orthogonal projection. See Rochford resource for suitable activities. **Research Methods:** • Covered in historical and societal influences section. **Collaborative Work Practices:** • Discuss how engineers work in teams. Define the term collaborative. Teacher led discussion on importance of communication for engineers. Brainstorm types of communication (verbal, graphical, signals etc). **Engineering Reports:** • Discuss features of engineering reports and provide an example.	