Regional Development Australia HUNTER

me program
An initiative of RDA Hunter

iSTEM

NSW BOARD OF STUDIES TEACHING AND EDUCATIONAL STANDARDS (BOSTES) NSW ENDORSED COURSE STAGE 5

Version 3

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Australian Government
Department of Defence

LABOR OMNIA VINCIT


THE YEAR IS 2037
YOU ARE PART OF AN
INTELLIGENT ORGANISATION
YOU CREATED
OUR FUTURE
OUR ROBOTS
OUR TECHNOLOGY
OUR NEW WAY
OF LIFE
Science Technology EM
SHAPE OUR FUTURE
me
program

FOREWORD

The importance of Science, Technology, Engineering and Mathematics knowledge to Australia's future workforce is indisputable. In 2012, Ian Chubb, then Chief Scientist of Australia triggered a major focus on the decline in interest of studies in the STEM disciplines across the nation and its potential impact on our future. These sentiments were reinforced in a report by the Chief Executive of the Australian Industry Group in 2015 stating *"It is time for a major re-think of the Australian education system to address the failure to give young people the science, technology, engineering and mathematics (STEM) skills which business so desperately needs."*

Modelling by PwC in late 2015 found that shifting just 1 per cent of the workforce into STEM roles would add $57.4 billion to GDP (net present value over 20 years). To this end the Australian Government's Department of Defence Schools Pathways Programme, known as the 'ME Program' has achieved significant gains in the uptake of STEM subjects, including Physics, Mathematics, and Engineering in the Higher School Certificate.[i]

According to the report 'Australia's future workforce?' from the Committee for Economic Development of Australia (CEDA) *"A large part of the problem lies in showing students the need for, and applications of, STEM knowledge beyond the classroom."* They report on the need for hands-on, visible activities that place learning in real-world contexts to spark interest in STEM at secondary school level and in the retention of university students.[ii]

Information and Communication Technology challenges traditional methods of delivering education, meaning educational institutions and educators will have to adapt. Learners can also be expected to be much more self-directed and operate outside formal education institutions to gain and share their knowledge in a more connected world. Greater involvement of business working with education providers to invest to get the skills they want will assist this end. An example is the recent announcement by Cisco that it will invest up to $31 million in Australia in a bid to increase the pool of talent available with skills in STEM.[ii]

In the recent report prepared by Deloitte Access Economics 'Australia's Digital Pulse' it describes how digital disruption is dramatically changing industries and occupations across the economy. The report states that *"The number of Information and Communications Technology (ICT) workers increased to 600,000 in 2014, and now more than half (52%) are in industries outside ICT itself including professional services, public administration and financial services."* This has major implications for STEM education and training and highlights the growing need to integrate ICT's into curricula rather than just teach it as an explicit course.[iii]

"This syllabus appears to be ground-breaking through the integration of content areas that have historically been treated as stand alone"

Jeff Phillips
Managing Director
Varley Group

According to the Australian Industry Group, the importance of STEM disciplines for the future economic and social well-being of Australia cannot be underestimated. *International research indicates that 75 per cent of the fastest growing occupations require STEM skills and knowledge.*[iv] In the US, STEM employment grew three times more than non-STEM employment over the past twelve years and is expected to grow twice as fast by 2018.[v]

The National STEM School Education Strategy for 2016 – 2026 was published by the Education Council in December 2015. The strategy is focused on action that lifts foundational skills in STEM learning areas, develops mathematical, scientific and technological literacy, and promotes the development of the 21st century skills of problem solving, critical analysis and creative thinking.[vi]

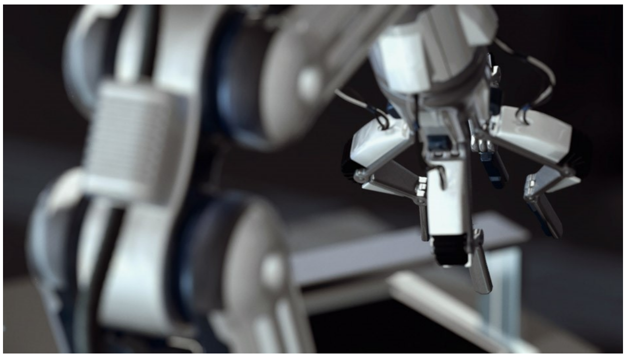
The Stage 5 iSTEM course captures the essential aspects of the ME Program, to create engaging and meaningful experiences for students and to reflect the skill requirements of the future Australian workforce. In July 2015 Professor Ian Chubb described the ME Program's iSTEM course as *"… one of the great examples of STEM education and exactly captures the practical nature of science and engineering"*. Australian Financial Review.

The collaborative development of the iSTEM course as a cross curriculum learning platform and through consultation with industry has led to an academically robust and unique course that will serve students and ultimately industry well. BAE Systems Australia has been a ME Program partner since 2010 and has assisted in the shaping and development of the iSTEM curriculum.

Steve Drury Director – Aerospace has commented *"BAE Systems Australia has benefitted greatly from RDA Hunter's ME Program in developing a workforce for the future. The Program is an important part of our workforce development strategy to recruit the skilled engineers and tradespeople we need."*

The iSTEM curriculum has been enthusiastically adopted by a large number of schools throughout NSW since its inception in 2012. It is recommended as a course which encapsulates the practical and inquiry based nature of true STEM education.

ME Program Director – Dr Scott Sleap



ACKNOWLEDGEMENTS

Maitland Grossmann High School - The iSTEM curriculum was written by the STEM teachers (Dr Scott Sleap, Mr Matt Davies, Mrs Jane Rose and Mr Roger Allon) of Maitland Grossmann High School. The school has been recognised as a leader in STEM education through its pioneering work with RDA Hunter's ME Program.

The iSTEM curriculum was developed in consultation with local Industry Leaders including; BAE Systems Australia, AMP Control, Varley Group and Thales.

A Special thank you to the Statistical Society of Australia and Dr Peter Howley for their work in developing the Statistics in Action Unit.

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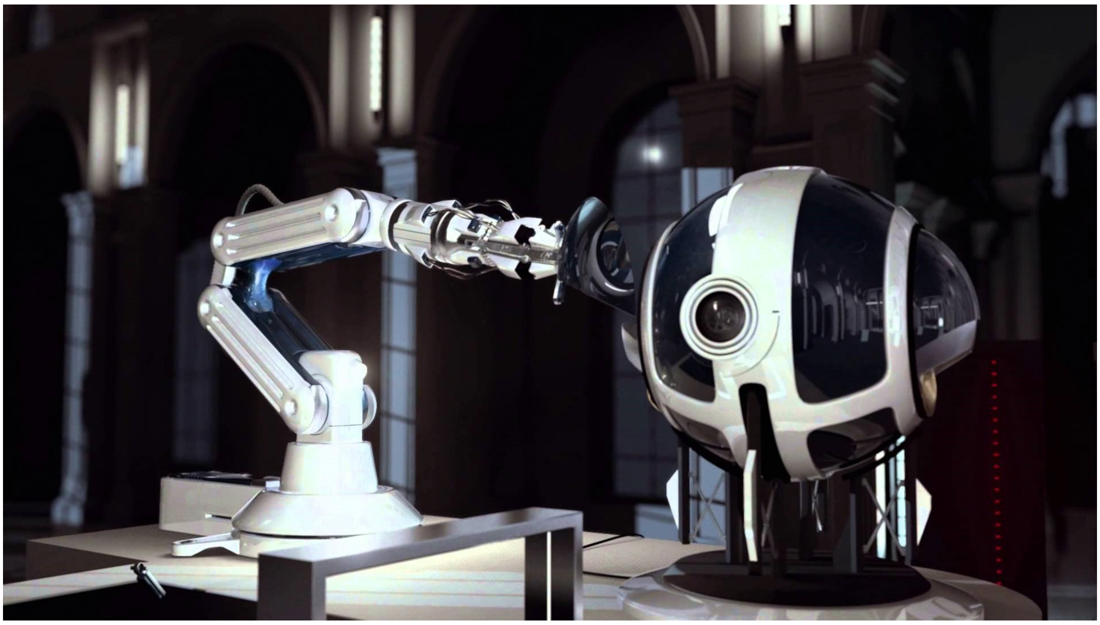


RATIONALE

Science, technology, engineering and mathematics are fundamental to shaping the future of Australia. They provide enabling skills and knowledge that increasingly underpin many professions and trades, and the skills of a technologically based workforce. The iSTEM course utilises these knowledge pillars in their application to Skills, Technology Engineering and Mechanics.

After a sustained period of economic prosperity, Australia is facing some tough challenges. Slowing growth, declining real wages, falling productivity, and the end of the mining boom, to name but a few. At the same time, businesses are coming to terms with the massive disruptive impact that digital technologies are having on business models, supply chains and customer behaviour in a more connected world.

These changes are putting major pressure on the Australian workforce, and the companies that rely on it. Building on cutting edge work undertaken at Oxford University, new analysis by PwC shows that 44 per cent (5.1 million) of current Australian jobs are at high risk of being affected by computerisation and information and communication technologies over the next 20 years.

Businesses competing in a global economy driven by data, digital technologies and innovation will need more employees trained in science, technology, engineering and mathematics (STEM). Research indicates that 75 per cent of the fastest growing occupations now require these skills.

Modelling by PwC finds that shifting just 1 per cent of the workforce into STEM roles would add $57.4 billion to GDP (net present value over 20 years).[ii]

Australia's graduation rates in science, technology, engineering and mathematics are low by international standards. Yet a high output in these disciplines is seen to be a critical underpinning for the future of innovative economies. Policies are emerging around the world that focus on these fields and seek to grow the supply of graduates with the skills and knowledge developed through a quality education in STEM subjects. The reason is straightforward, the world's dependence on knowledge and innovation will grow and not diminish and to be ahead in the race, a community needs the skills to anticipate rather than follow. [ii] Consider the US, in which, one survey suggests, already spends $1.1 trillion every year on training, recruiting and developing STEM workers.[vii] In order for Australia to remain competitive in the future it must make significant investment in STEM education and training.

The Australian pipeline of STEM skills to the workforce remains perilous. In the national school system participation in science and advanced mathematics is in decline and our students underperform in all the major international measures. In the tertiary education sector, participation in STEM-related disciplines is also in decline in absolute terms and in comparison with other comparable nations. Participation is also low in the Vocational Education and Training sector in all STEM areas except engineering.[viii]

"iSTEM is one of the great examples of STEM (science, technology, engineering and maths) education and exactly captures the practical nature of science and engineering"

Ian Chubb
Australian Financial Review
July 2015

The recommendations from the report, *Mathematics, Engineering & Science, in the National Interest*, from the Chief Scientist, states that "*teachers, have the greatest influence on the choices students make and we need to ensure that the school sector maximises interest and provides opportunities for all students to study high quality mathematics and science courses leading to careers in those disciplines and in engineering*". The Smarter Schools National Partnerships, in particular, the National Partnership Agreement on Improving Teacher Quality, both concur with many of the objectives discussed above.[ix]

There are a number of highly successful STEM based intervention programs in operation across Australia, some international and national programs include; F1inSchools, the ME program, Science and Engineering Challenge, RoboCUP, Electric Vehicle Festival, Solar Car Challenge, Pedal Prix, P-TECH, Science and Technology Education Leveraging Relevance (STELR) program, and many others. The challenge for schools has been integrating these programs into their existing curriculum.

Schools across NSW are involved in the above mentioned STEM intervention programs. Many of these programs are run partially within, but mainly outside the current school curriculum. The development of the iSTEM course is in part as a result of the need for the school to provide a more structured approach to gaining the most out of these intervention programs. Although components of the Board of Studies Teaching and Educational Standards (BOSTES), Design & Technology, Graphics Technology and Industrial Technology – Engineering, syllabuses can be adapted to accommodate some parts of these STEM programs, none are suitable to implement the full integrated program of study.

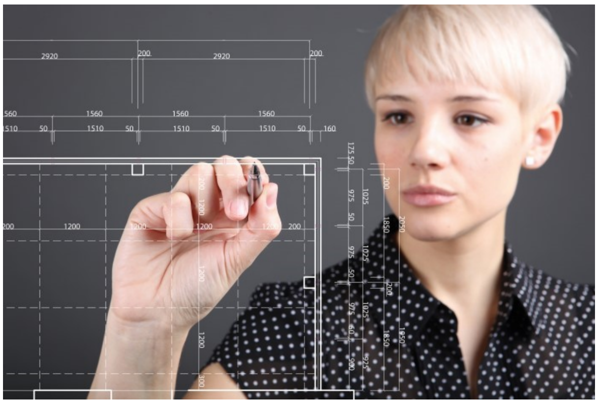
The iSTEM course utilises a practical integrated approach with engineering and technology being used to drive engagement in science and mathematics, through the development of technical skills and mechanical engineering knowledge. Its purpose is to increase the numbers of students studying STEM based subjects in the senior years and ultimately the number of student matriculating to tertiary study at both university and trade levels in STEM or STEM based employment.

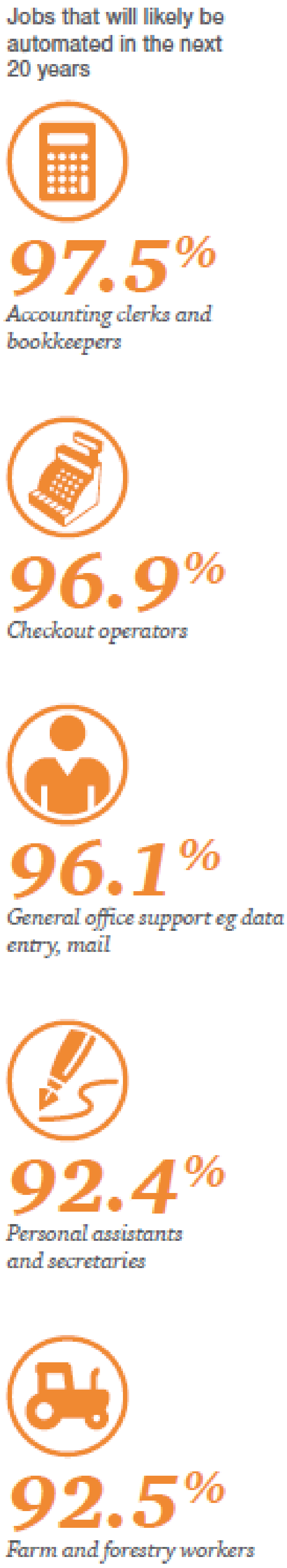
Pure mathematics and science topics are not included in this course, it is not intended as being a vehicle to increase the number of hours in which students study pure science or mathematics in Stage 5. Instead students learn about technological and engineering concepts which by their very nature are scientific and mathematical. Great effort has been taken to ensure that no specific content that appears in the upcoming Science or Mathematics NSW syllabuses incorporating the Australian Curriculum have been repeated in this course.

In the review of Science, Mathematics and Engineering (2012) by the Office of the Chief Scientist of Australia, it was commented that teaching needs to be high quality and inspirational while science and mathematics based content was generally seen as … "*irrelevant to life after school*." and "*Content based teaching is seen as boring because so much is seen as knowledge transmission of correct answers with neither time nor room for creativity, reflection or offering opinions*".[ii]

The development of effective and attractive STEM curricula and teaching methods are at the heart of the drive to make STEM studies and careers a more popular option for young learners. Inspiring students to engage with mathematics and science can be best achieved by teachers who are passionate about the subject and have the knowledge and confidence to present the curriculum imaginatively. The iSTEM course has been developed to be a vehicle for the effective delivery of inquiry and project based learning activities.

According to Sanders,[x] the integrative STEM education pedagogical model is best practice. In addition over the past two decades, the technology education literature has been heavily populated with articles describing instructional materials designed to integrate technology, science, and mathematics and articles addressing issues associated with the integration of STEM concepts and practices. There is strong evidence to suggest that the approach taken in this course is "best practice" and will lead to advantageous outcomes for students.[xi]
This stage 5 iSTEM School Developed Board Endorsed Course is an attempt to provide an innovative and imaginative curriculum which will inspire students to take up the challenge of a career in science, technology, engineering or mathematics. This will go some way to improving the current mismatch between the skills required by employers and those of job applicants.[xii]





Source: PwC *A Smart Move*

COURSE STRUCTURE

The iSTEM School Developed Board Endorsed Course covers a number of STEM based fields, including; Fundamentals, Aerodynamics, Motion, Mechatronics, Surveying, Aerospace, Statistics, CAD/CAM and Biotechnology. These specific modules are not reflected together in any existing BOSTES Syllabus document.

There are four core modules (STEM Fundamentals 1, STEM Fundamentals 2, Mechatronics 1 and Mechatronics 2) and ten elective modules (Aerodynamics, Motion, CAD/CAM1, CAD/CAM2, STEM PBL Minor, STEM PBL Major, Surveying, Design for Space, Statistics in Action and Biotechnology). Each elective module is 25 hours (indicative) in duration. Schools must design their curriculum around 100 hours in each school year i.e. 100 hours in Year 9 and 100 hours in Year 10.

If you are offering a 100 hour course, schools need to include the four core modules and three elective modules.

The order of completion of the modules is up to the school, based on teacher knowledge, timetabling and school preference, however, the four core modules must be completed within the 100 or 200 hour course. Elective modules have been developed as alternatives for schools in order for the course to better cater for the individualised needs of the students in the local area.

Schools may take a unit of work approach to programming and may wish to combine modules across a unit, taking advantage of a Project Based Approach to learning.

Year 9		Year 10	
100 Hours		100 Hours	
Core Module 1 STEM Fundamentals 1 10 hours Core Module 2 STEM Fundamentals 2 15 Hours	Core Module 3 Mechatronics 1 10 Hours Core Module 4 Mechatronics 2 15 Hours	Elective Module 5 Aerodynamics 25 Hours	Elective Module 8 3D CAD/CAM 2 25 Hours
Elective Module 8 3D CAD/CAM 1 25 Hours	Elective Module 6 Motion 25 Hours	Elective Module 7 STEM Project Based Learning Minor 25 Hours	Elective Module 8 STEM Project Based Learning Major 25 Hours

Year 9		Year 10	
100 Hours		100 Hours	
Core Module 1 STEM Fundamentals 1 10 hours Core Module 2 STEM Fundamentals 2 15 Hours	Core Module 3 Mechatronics 1 10 Hours Core Module 4 Mechatronics 2 15 Hours	Elective Module 14 Biomedical Innovation 25 Hours	Elective Module 11 Surveying 25 Hours
Elective Module 12 Design For Space 25 Hours	Elective Module 9 STEM Project Based Learning Minor 25 Hours	Elective Module 13 Statistics in Action 25 Hours	Elective Module 10 STEM Project Based Learning Major 25 Hours

INQUIRY AND PROJECT-BASED LEARNING

To satisfy the requirements of the course students must undertake a range of inquiry-based (IBL) and project based (PBL) learning activities which occupy the majority of course time. Inquiry-based and project based learning assists students to actively pursue and use STEM based knowledge beyond the simple transmission of content. Thus in the course structure there are many points at which students raise questions and explore ideas.

In module 1 'guided inquiry' strategies are used, but students are later encouraged to shape their own inquiry around questions that interest them, such as the Project-Based Learning Module. This involves students being able to design investigative approaches. These include experimental as well as other primary and secondary research approaches.

The core principle that has been used to describe inquiry based learning is 'explore before explain', meaning that students are introduced to STEM concepts after they have explored phenomena rather than simply being told the answer.

Inquiry-Based Learning;

- Involve students in initial exploration before ideas are introduced and explanations developed,
- Incorporate and value students' own questions,
- Involve open ended investigation as part of the teaching sequence,
- Use activities to explore and develop ideas rather than simply demonstrate previously presented ideas.[xiii]

Project-Based Learning;

- Organised around an open-ended question or challenge,
- Creates a need to know essential content and skills,
- Requires inquiry to learn and/or create something new,
- Requires critical thinking, problem solving, collaboration and various forms of communication,
- Allows some degree of student voice and choice,
- Incorporates feedback and revision,
- Usually results in a publicly presented product or performance.

*"**BAE Systems Australia** has benefitted greatly from RDA Hunter's ME Program in developing a workforce for the future.*

*The **Program** is an important part of our workforce development strategy, to recruit the **skilled** engineers and tradespeople we need."*

Steve Drury
Director—Aerospace
BAE Systems Australia

AIM

The aim of the iSTEM course is to promote the areas of science, technology, engineering and mathematics through the study of technology, engineering, skills and mechanics.

Students will learn to use a range of tools, techniques and processes, including relevant technologies in order to develop solutions to a wide variety of problems and challenges relating to their present and future needs and aspirations.

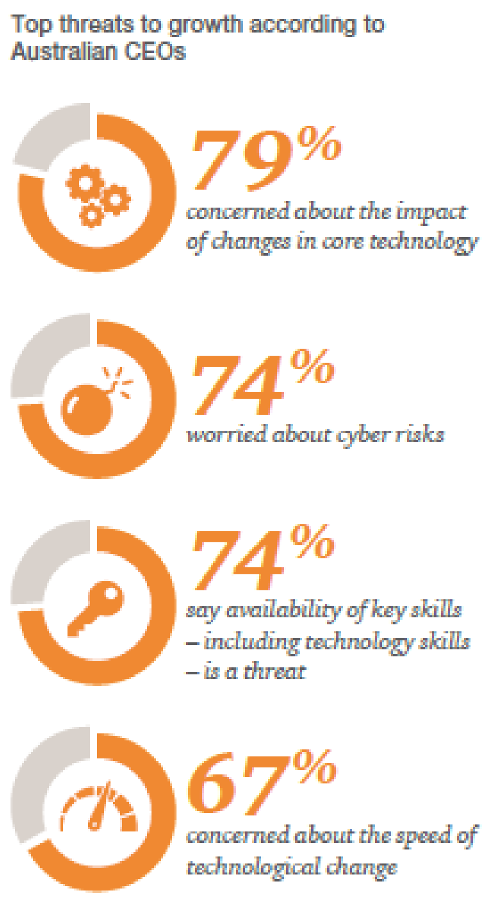
The iSTEM course aims to reverse these lowered participation rates by inspiring and enabling secondary school students to appreciate the role and potential of science, technology, engineering and mathematics in the world in which they live, and to learn from their journey of technological inquiry, the essence of evidence-based critical thinking.

One of the main aims of the iSTEM course is to increase the number of students studying physics, chemistry, engineering, design and technology, computing and the higher levels of mathematics at the upper secondary school level. This is to be achieved through an integrative technology and engineering course structure, which gives practical relevance to scientific and mathematical concepts.

The course also aims to increase the participation rate of female students in science, technology, engineering and mathematics via the use of engaging learning and teaching customised to meet the individualised learning needs of students. Research by Dr Michael Myers suggests that girls respond to a different set of motivators to boys. Through the overt engagement of industry and providing curricula which promotes an understanding of processes involved in the STEM professions, particularly in a way that a female student can relate to, are critical in making career decisions. The iSTEM course attempts to capture this interest.

Secondary aims of the iSTEM course include;

1. improve the level of STEM literacy and understanding in the community
2. prepare students to engage with STEM ideas and be knowledgeable about the way scientists, mathematicians, engineers and technologists work
3. increase the number of students choosing STEM careers to address the shortage of graduates in these areas
4. increase students' awareness of careers in STEM areas including trades
5. improve the quality of classroom teaching practices and enable teachers to develop confidence and skills in inquiry and project based learning
6. improve teaching quality through a cross-curriculum approach to programming and lesson delivery.



Source: PwC *A Smart Move*

OBJECTIVES

KNOWLEDGE, UNDERSTANDING AND SKILLS

Students will develop:

1. inquiry and project based learning skills appropriate to STEM practice
2. knowledge and understanding of scientific and mechanical concepts through Investigations of technology and engineering
3. knowledge and understanding of STEM principles and processes
4. skills in solving STEM based problems and meeting STEM challenges using mechanical, graphical and scientific methods
5. skills in communicating and critically evaluating
6. problem solving skills in a range of STEM contexts.

VALUES AND ATTITUDES

Students will develop:

7. an appreciation of the role and potential of STEM in the world in which they live
8. an understanding of the contribution of STEM disciplines to the economic well-being of nations

OBJECTIVES & OUTCOMES

Objectives Students will develop:	Stage 5: Outcomes A student:
1. initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities	5.1.1 develops ideas and explores solutions to STEM based problems 5.1.2 demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities
2. knowledge, understanding and application of cognitive processes to address real world STEM based problems	5.2.1 describe how scientific and mechanical concepts relate to technological and engineering practice 5.2.2 applies cognitive processes to address real world STEM based problems in a variety of contexts
3. knowledge and understanding of STEM principles and processes	5.3.1 applies a knowledge and understanding of STEM principles and processes 5.3.2 identifies and uses a range of technologies in the development of solutions to STEM based problems
4. skills in planning and managing projects using an iterative and collaborative design process	5.4.1 plans and manages projects using an iterative and collaborative design process 5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team
5. skills in communicating and critically evaluating	5.5.1 applies a range of communication techniques in the presentation of research and design solutions 5.5.2 critically evaluates innovative, enterprising and creative solutions
6. problem solving and decision making skills in a range of STEM contexts	5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts 5.6.2 will work individually or in teams to solve problems in STEM contexts
7. an appreciation of the value of STEM in the world in which they live	5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
8. an appreciation of the importance of working collaboratively, cooperatively and respectfully	5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

CONTENT: STAGE 5 iSTEM

CORE: MODULE ONE: STEM FUNDAMENTALS 1
INDICATIVE TIME: 10 HOURS

This module develops an understanding of the basic principles associated with iSTEM. To satisfy the requirements of this module, students must undertake a range of experimental, group work and inquiry based learning activities that occupy the majority of the time. These activities should be used to develop a deep knowledge and understanding of the integration of STEM subjects.

Skills	
Students Learn About:	Students learn to:
1.1 STEM investigations - systematic observation - measurement - experiment - formulation, testing and modification of hypotheses	- design investigations which produce valid and reliable data - investigate STEM based problems using primary and secondary sources - use identified investigative strategies to develop a range of solutions to STEM based problems
Technologies	
1.2 the use of STEM in developing solutions to problems - hardware - software	- describe a range of technologies used to collect, organise and analyse data - use a variety of technologies which assist in investigations into engineered solutions - utilise various hardware and software technologies to solve a broad range of STEM based problems

CONTENT: STAGE 5 iSTEM

CORE: MODULE TWO: STEM FUNDAMENTALS 2 INDICATIVE TIME: 15 HOURS

This module develops an understanding of the basic principles associated with iSTEM. To satisfy the requirements of this module, students must undertake a range of experimental, group work and inquiry based learning activities that occupy the majority of the time. These activities should be used to develop a deep knowledge and understanding of integrated STEM. The completion of core module 1 is a pre-requisite for this module.

STEM Principles & Processes	
2.1 **STEM principles** - strength of materials - material properties - fluid mechanics - electricity & magnetism - thermodynamics	- carry out experiments to demonstrate basic STEM principles - determine the properties of materials - use models to demonstrate describe Pascal's Principle - complete basic experiments involving electricity and magnetism - explain basic thermodynamic processes
Mechanics	
2.2 **fundamental mechanics** - basic units - prefixes - statics - dynamics - modelling	- apply units to concepts of mechanics - utilise metric prefixes related to every day technologies - complete basic calculations related to statics - describe the difference between a static and a dynamic - simulate mathematical problems using appropriate modelling techniques
Problem Solving & Design	
2.3 **problem solving** - nature of - strategies to solve - evaluation - collaboration	- identify the nature of problems - use identified strategies to develop a range of possible solutions to every day STEM based problems - evaluate the appropriateness of different problem solving strategies - work collaboratively to solve problems - draw information from a range of sources to aid in the solution of practical everyday problems - uses appropriate design processes and techniques in the context of developing STEM based solutions

CORE: MODULE THREE: MECHATRONICS 1
INDICATIVE TIME: 10 HOURS

Select one or more related areas as a theme for an introduction to STEM concepts related to Mechatronics. Possible examples include: Mars Rover Challenge, Robotics, Lego Mindstorms, PLC's, Pneumatic & Hydraulic systems, etc. In this module students will utilise inquiry and /or problem based learning strategies to design & develop solutions to problems associated with combined mechanical and electrical systems. Core module 3 must be completed prior to core module 4.

Skills	
Students learn about:	**Students learn to:**
3.1 **mechatronics** - building mechatronic components - programming logic - writing macros - fault finding	- build mechatronic components using a variety of electrical and mechanical componentry - use a range of equipment to carry out experiments and construct projects in relation to mechatronic systems - use a programming language to control mechatronic devices - write macros to complete a variety of operations involving mechatronics
Technologies	
3.2 **technologies related to robotics** - sensors and transducers - manipulators - PLC's - actuators (pneumatic & hydraulic)	- apply and understand the uses of a range of sensor and transducer technologies - incorporate mechatronic hardware to complete a variety of problem solving tasks - use a programmable logic controller to actuate a pneumatic or hydraulic device - utilise and program devices to perform a variety of control or monitoring tasks

CORE: MODULE FOUR: MECHATRONICS 2
INDICATIVE TIME: 15 HOURS

Select one or more related areas as a theme for an introduction to STEM concepts related to Mechatronics. Possible examples include: Mars Rover Challenge, Robotics, Lego Mindstorms, PLC's, Pneumatic & Hydraulic systems, etc. In this module students will utilise inquiry and /or problem based learning strategies to design & develop solutions to problems associated with combined mechanical and electrical systems. Core module 3 is a pre-requisite for core module 4.

STEM Principles and Processes	
4.1 **mechatronics and control technology** - logic gates - mechanical and electrical actuation systems - motors	- plan solutions to problems using logic gates - design, construct and evaluate motorised mechatronic systems which solve identified problems - use a variety of mechanical and electrical actuation systems to solve every day problems - develop programming skills to manipulate sensors, motors and actuators
Mechanics	
4.2 **programming & computations** - algorithms - calculating distance - trigonometry - circle geometry - input/output systems	- solve practical logic problems with applications to mechatronics using algorithmic functions - make predictions involving, time, distance, speed, velocity - use trigonometry to determine efficient pathways - use circle geometry to understand movement in order to solve problems
Problem Solving & Design	
4.3 **design mechatronic solutions for a range of applications**	- design solutions to various mechatronic applications to meet set criteria(s) - produce peripheral enhancements to mechatronic devices to provide additional functions - use innovative processes to create mechatronic devices which meet societal needs in the near future

ELECTIVE: MODULE FIVE: AERODYNAMICS
INDICATIVE TIME: 25 HOURS

Select one or more related areas as a theme for an introduction to the engineering concepts related to aerodynamics. Possible examples include: Aeronautics, Aeronautical Velocity Challenge, F1inSchools program, CO_2 dragsters, Scalectrix cars, Bottle Rockets, kites, motor racing, or sports science. In this module students will utilise inquiry and/or project based learning strategies to develop solutions to aerodynamic problems.

Skills	
Students learn about:	Students learn to:
5.1 **research and exploration** - interpreting and analysing data - quantitative and qualitative research - surveys - interviews - observation - testing and experimenting	- analyse, interpret and apply research data in the development of aerodynamic projects - complete quantitative and qualitative research - use research techniques to develop design ideas by testing and experimenting - select and use a variety of research methods to inform the generation, modification, and development of aerodynamic projects - experiment to optimise solutions for aerodynamics related projects
Technologies	
5.2 **technologies related to aerodynamics** - wind tunnels - smoke tunnels - computational fluid dynamics (CFD)	- describe a range of technologies used in aerodynamics - perform experiments using a range of aerodynamic technologies to solve STEM based problems - utilise modelling software to determine optimum aerodynamic conditions using CFD techniques
STEM Principles and Processes	
5.3 **aerodynamics principles** - dynamic, static friction - lift/drag ratios - lift, drag, weight, thrust - Finite Element Analysis (FEA) - flight	- explain aerodynamic principles - describe the effects of lift, drag, weight and thrust - design, construct or simulate solutions to problems related to friction - construct models for the purpose of solving aerodynamic problems - describe how Finite Element Analysis is applied aerodynamic systems
Mechanics	
5.4 **aerodynamics forces** - lift, drag, weight, thrust - simple vectors - efficiency	- apply mathematical and graphical methods to solve aerodynamic related problems - determine solutions using vector notation - solve aerodynamic problems related to lift, drag, weight and thrust - perform simple calculations related to efficiency
Problem Solving & Design	
5.5 **aerodynamic design solutions**	- develop engineered solutions to meet detailed specifications - evaluate results from testing to improve aerodynamic performance of engineered solutions

ELECTIVE: MODULE SIX: MOTION
INDICATIVE TIME: 25 HOURS

Select one or more related areas as a theme for an introduction to STEM concepts related to motion. Possible examples include: solar & electric powered vehicles, alternative energy devices, UAV's, subs, rockets, etc. In this module students will utilise inquiry and/or project based learning strategies to develop solutions to problems associated with motion.

Skills	
Students learn about:	**Students learn to:**
6.1 **electronics** - circuitry - motors & generators - fault detection - prototypes - making models - practical applications	- design and construct basic electronic circuitry - develop basic motors and generators - use fault diagnosis techniques to isolate problems - use multimeters to test circuits and components - use continuity testers/multimeters in the production and testing of practical projects - develop prototypes using a variety of materials to simulate motion - produce models in order to solve problems related to motion
Technologies	
6.2 **technologies related to motion** - gyroscopes - accelerometers - sensors	- describe how various technologies related to motion function - apply various motion technologies to the design of student projects
STEM Principles and Processes	
6.3 **energy** - energy sources - motors - electric vehicles - motion	- identify and describe a range of energy sources including renewables and non-renewables - utilise electric motors to develop a project related to motion - select and use a range of components and hardware in the development and production of a practical project related to motion
Mechanics	
6.4 **motion calculations** - velocity - acceleration - inertia - circular motion - momentum	- apply mathematical and graphical methods to solve motion related problems involving velocity, acceleration, inertia, circular motion and momentum - determine solutions to simple problems related to motion - perform simple calculations related to momentum
Problem Solving & Design	
6.5 **developing projects related to motion**	- apply problem solving techniques to identified problems related to motion - plan, implement and evaluate a sequence of operations for the completion of a design project related to motion

ELECTIVE: MODULE SEVEN: 3D CAD/CAM 1
INDICATIVE TIME: 25 HOURS

Students develop skills in Computer Aided Design (CAD) and Computer Aided Manufacture (CAM). Possible examples of CAD Software include: AutoDesk 123, CREO, CATIA, Google Sketchup, Solid Works, etc. Possible examples of CAM hardware include: 3D printers, CNC Mills, CNC Routers, CNC Lathes, Laser cutters etc. In this module students will learn about manufacturing three dimensional objects for which they have designed.

SKILLS	
Students learn about:	**Students learn to:**
7.1 **CAD/CAM** - 3D drawing on an x, y & z axes in planes. - basic commands in a 3D CAD package - CAM processes - engineering drawing	- use common features in a 3D CAD package to produce parts, products and assemblies in order to design 3D objects - use rendering techniques to represent 3D designs - use AS1100 standards to interpret engineering drawings
TECHNOLOGIES	
7.2 **technologies related to CAM** - Additive and Subtractive manufacturing - Computer Numerical Controls - CNC, mills, routers & lathes - LEAN Manufacturing processes	- describe a range of technologies used in CAD and CAM processes - perform experiments using a range of CAM technologies to solve engineering problems - develop an awareness of LEAN manufacturing processes
STEM PRINCIPLES AND PROCESSES	
7.3 **CAD/CAM operations** - Reading and interpreting engineering drawings - rapid prototyping - 3D CAD operations - Computer Aided Manufacturing (CAM) - 3D modelling	- read and interpret basic drawing conventions - explain the operation of CAD/CAM software and hardware - describe how rapid prototyping works
MECHANICS	
7.4 **3D environments** - vectors - 3D Shapes - Computer Numerical Control - spatial comprehension - 3D Surface Modelling	- apply mathematical and graphical methods to solve questions related to 3D vectors - determine solutions to simple problems using vector notation - manipulate 3D shapes and objects

ELECTIVE: MODULE EIGHT 3D CAD/CAM 2
INDICATIVE TIME: 25 HOURS

Students develop skills in Computer Aided Design (CAD) and Computer Aided Manufacture (CAM). Possible examples of CAD Software include: AutoDesk 123, CREO, CATIA, Google Sketchup, Solid Works, etc. Possible examples of CAM hardware include: 3D printers, CNC Mills, CNC Routers, CNC Lathes, Laser cutters etc. In this module students will manufacture three dimensional objects for which they have designed. ***Note:*** Students must complete elective module seven prior to completing elective module eight. However, schools can choose to only complete elective module seven in their scope and sequence.

SKILLS	
Students learn about:	Students learn to:
8.1 CAD/CAM - 3D drawing on an x, y & z axes in planes. - CAM processes	- modify 3D CAD drawings so they can be manufactured using 3D technologies - manipulate Computer Aided Manufacturing processes to produce parts for an assembly
8.2 technologies related to CAM - Additive and Subtractive manufacturing - Computer Numerical Controls - CNC, mills, routers & lathes	- use a variety of technologies which assist in the rapid prototyping process - utilise 3D drawing and manufacturing software to produce new products
8.3 CAD/CAM operations - rapid prototyping - 3D CAD operations - Computer Aided Manufacturing (CAM) - 3D modelling	- design, construct parts, products or assemblies using CAD software and producing them using appropriate CAM software - produce solutions to set problems by constructing 3D models
8.4 3D environments - Computer Numerical Control	- construct source code for 3D CAM operations.
8.5 CAD/CAM	- design parts, products or assemblies to meet specific criteria - solve problems related to typical Computer Aided Manufacturing issues

ELECTIVE: MODULE NINE:
STEM PROJECT BASED LEARNING TASK MINOR
INDICATIVE TIME: 25 HOURS

In this module students are to develop and realise a ***minor*** STEM related Project Based Learning Task. The project involves students utilising a project-based learning strategies to apply appropriate design, production and evaluation skills to a contemporary STEM based problem. The students relate the techniques and technologies used in previous modules to those used in the development of the STEM project.

Skills	
Students learn about:	**Students learn to:**
9.1 **processes of design** - identifying problems - project management - developing solutions to problems - generating ideas	- develop a project proposal, a design specification or design brief. - respond to the findings of experimentation and research - follow a process to identify and solve contemporary needs of society - formulate management plans including; i) action ii) time iii) finance - manage a minor project based learning task that successfully solves an identified problem - select and apply appropriate research methods to solve a minor STEM based problem - justify decisions made based on the analysis of data - identification and exploration of the research problem - areas of investigation - criteria to evaluate success
Technologies	
9.2 **presentation and communication technologies**	- select and use appropriate digital communication techniques for the development of a minor project based learning task - use appropriate technological processes in the completion of a minor project based learning task
STEM Principles and Processes	
9.3 **realisation, evaluation, research methods and experimentation**	- test possible solutions to problems - use tools, materials and processes to produce a solution to an identified problem - develop methods to communicate solutions to problems through a visual display - conduct continual evaluations throughout the design and production of the minor project - evaluate the project in terms of the identified criteria for success.
Mechanics	
9.4 **mechanical knowledge**	- demonstrate mechanical aptitude in the development of solutions to a minor project
Problem Solving & Design	
9.5 **creative and innovative approaches to solve problems**	- demonstrate creativity and problem solving skills in the development of the STEM related Minor Project Based Learning Task

ELECTIVE: MODULE TEN:
STEM PROJECT BASED LEARNING TASK MAJOR
INDICATIVE TIME: 25 HOURS

In this module students are encouraged to extend their minor STEM related Project Based Learning Task into a more substantial ***major project.*** The project involves students utilising a project-based learning strategies to apply appropriate design, production and evaluation skills to a contemporary STEM based problem. The students relate the techniques and technologies used in previous modules to those used in the development of the STEM project. ***Note:*** Students must complete elective module nine prior to the completion of elective module eight. However, schools can choose to only complete elective module nine in their scope and sequence.

Skills	
Students learn about:	Students learn to:
10.1 processes of design - identifying problems - project management - developing solutions to problems - generating ideas	- manage a major project based learning task that successfully solves an identified problem - select and apply appropriate research methods to solve a major STEM based problem - manage a major design based project through to completion
Technologies	
10.2 presentation and communication technologies	- select and use appropriate digital communication techniques for the development of a major project based learning task - use appropriate technological processes in the completion of a major project based learning task
STEM Principles and Processes	
10.3 realisation, evaluation, research methods and experimentation	- test possible solutions to problems - use tools, materials and processes to produce a solution to an identified problem - develop methods to communicate solutions to problems through a visual display - conduct continual evaluations throughout the design and production of the major project - evaluate the major project in terms of the identified criteria for success.
Mechanics	
10.4 mechanical knowledge	- demonstrate mechanical aptitude in the development of solutions to a major project
Problem Solving & Design	
10.5 creative and innovative approaches to solve problems	- demonstrate creativity and problem solving skills in the development of the STEM related Major Project Based Learning Task

ELECTIVE: MODULE ELEVEN: SURVEYING
INDICATIVE TIME: 25 HOURS

In this module students develop skills and understanding associated with a surveying by completing an inquiry-based and/or problem based learning task. Possible examples include: civil structures, architectural design, industrial design, etc. Students develop skills in fundamental surveying concepts, then apply this to both simulated and real world applications.

Skills	
Students learn about:	**Students learn to:**
11.1 **site risk management and WHS in surveying** - common surveying workplace hazards and associated risk control - site safety plan - PPE equipment - surveying software	- identify hazards - outline appropriate skills to work safely - use tools and equipment to control risks - communicate and report relevant WHS information (potential and existing risks and hazards) - use software related to surveying - produce surveying related drawings
Technologies	
11.2 **technologies related to surveying** - Total Station Theodolite (TST) - GPS - digital terrain models - laser scanning	- describe how surveying principles are utilised by contemporary technologies - perform relevant tasks using surveying technologies - simulate
STEM Principles and Processes	
11.3 **fundamental surveying principles** - cadastral surveyors - engineering surveyors - mining engineers - hydrographic engineers - geodetic surveyors - GIS - photogrammetry	- carry out basic surveying activities in the field to determine spatial elements - communicate findings using surveying terminology - outline the working environment and conditions for a range of surveying occupations - recognise the mathematical and physical science knowledge that underpins surveying
Mechanics	
11.4 **spatial data** - appreciation of spatial skills - calculating distance - trigonometry - geometry - mapping	- solve practical surveying based problems - make predictions involving, height, depth, breadth, dimension, position - use trigonometry to determine efficient pathways - use geometry and spatial data to produce maps
Problem Solving & Design	
11.5 **problem solving** - design surveying solutions to a range of applications	- design, construct or simulate solutions to surveying problems - work individually or in teams to solve surveying problems using appropriate technologies

ELECTIVE MODULE TWELEVE: DESIGN FOR SPACE INDICATIVE TIME: 25 HOURS

Select one or more related areas as a theme for an introduction to STEM concepts related to Space. Possible examples include: Create for Space, Deep Space Program, Mars Rover, Lego, PLC's, Arduino, etc. Students will develop skills and understanding of space, technology, electronics and coding. In this module students will utilise inquiry and /or problem based learning strategies to design & develop solutions to problems associated with space.

Skills	
Students learn about:	Students learn to:
12.1 **Coding for Space** - basic coding to manipulate wireless devices - manipulate sensors, actuators, remote sensing **space** - history and future - impact on daily life - space applications	- use common features within a programming environment to run and control sensors - utilise wireless communications devices to control sensors and actuators - evaluate the historical and current significance of space and its importance in various fields - develop solutions to problems related to space applications
Technologies	
12.2 **technologies related to coding and space** - microcontrollers - electronics - computer software - satellites and rockets - radio communication	- design and use electronic circuits and systems including microcontrollers - perform experiments using a range of electronic devices to solve real STEM based problems - describe a range of technologies used in satellites, rockets and space communication
STEM Principles and Processes	
12.3 **space vehicles and experiments** -STEM design methodologies - engineering requirements - circuit diagrams - electricity, radio and other waves, thermal conductivity, spectra, motion in 3D	- read and interpret basic drawing conventions - explain the operation of circuits and various electronic components - describe design processes related to space - create design plans and requirements - produce practical solutions to space related problems - produce circuit diagrams
Mechanics	
12.4 **data analysis and modelling** - modelling data using software - analysing and drawing useful conclusions from data - efficiency	- apply mathematical and graphical methods to represent data sets - determine statistical properties and draw useful conclusions from visual representations of data - use formulas and theories to explain and describe phenomena - perform simple calculations
Problem Solving & Design	
12.5 **experimental design** - design solutions to space related applications	- design, construct or simulate solutions to problems - work individually or in teams to solve space related problems using appropriate technologies - evaluate experiments and solutions in order to identify possible improvements

ELECTIVE: MODULE THIRTEEN: STATISTICS IN ACTION
INDICATIVE TIME: 25 HOURS

In this module students develop skills and understanding associated with statistical literacy and decision making. This unit supports the International Statistical Literacy Project promoting statistical literacy around the world. Students will utilise project based learning activities to collect and interpret data that addresses practical research questions in areas such as business, industry, healthcare and medicine. Students develop fundamental skills in data collection, analysis and reporting methods and apply this to both simulated and real world applications.

Skills	
Students learn about:	**Students learn to:**
13.1 **research methods** - 3Rs (randomisation, replication and ARRR), blocking - understanding variation - survey design - bias and precision - visualisation	- complete research using a variety of methods (including both summarising data and testing hypotheses based on that data) - describe aspects of well-designed data collection methods - identify problems using survey and comparison methods - implement data collection methods - work collaboratively to succinctly communicate and report relevant recommendations to real-world applications (citing limitations)
Technologies	
13.2 **technologies related to statistical analysis** - computer software for simulations - computer software for design and analysis	- use software and computing technologies to simulate and/or analyse data in contemporary business, medicine, healthcare and industry contexts for the purposes of making data-informed recommendations - describe how analytical principles are utilised within contemporary technologies - perform relevant simulations, create visual displays and perform analyses using computing technologies
STEM Principles and Processes	
13.3 **fundamental statistical analysis** - basic statistical key figures **concepts describing society** - product comparisons, consumer behaviour, inflation, gross domestic product **Data** - data sources - evaluation of data sources	- engage in study design and apply data collection principles to field activities/ projects - communicate project's purpose, design, analysis and recommendations succinctly in an A1-sized poster - recognise the statistical thinking that underpins data-based investigations and decision-making - participate in a national competition
Mechanics	
13.4 **analyse, interpret and evaluate statistical information** - communicate statistical findings	- identify the issues or questions, specify objectives and formulate hypotheses - determine appropriate analytical techniques and undertake data analysis - assess the results of analysis against the objectives and expectations - review the objectives, iterate data analysis cycle as appropriate to refine the analysis - using tables, graphs and maps to communicate statistical findings
Problem Solving & Design	
13.5 **creative and innovative approaches to solve practical research problems**	- work in teams to design, implement & creatively report upon an investigation on a topic of interest, based on the collection and interpretation of data

ELECTIVE: MODULE FOURTEEN: BIOMEDICAL INNOVATION

In this module students develop skills and understanding associated with Biomedical Innovation. Select one or more related areas as a theme for an introduction to STEM concepts related to Biomedical Innovation. Possible examples include: design of a medical innovation, biomedical engineering, forensics, biotechnology, national secondary poster competition, etc. Students will develop skills and understanding related to biomedicine. In this module students will utilise inquiry and /or problem based learning strategies to design & develop solutions to problems associated with biotechnology.

Skills	
Students learn about:	**Students learn to:**
14.1 **Biomedical Innovation** - applying processes - designing - researching - investigating - communicating - managing projects - evaluating	- use a process to develop solutions to biomedical related problems - design investigations that allow valid and reliable data and information to be collected - use appropriate technologies and strategies for data collection or gathering information - collect, analyse and apply the results of research and investigation - produce solutions to problems related to biomedical - manage the development of a biomedical project - effectively communicate solutions to problems - evaluate processes and solutions to biomedical problems
Technologies	
14.2 **Biotechnologies** - range of technologies used in biotechnology	- describe a range of technologies used in developing biomedical solutions - perform experiments using a range of technologies to solve biomedical related problems - use appropriate technologies for collecting data including data loggers and sensors - use technologies typically used in the biosciences - assesses the impact of new technologies on biomedical engineering
STEM Principles and Processes	
14.3 **Biomedical Innovation concepts** - biomedical innovations - design and engineering processes - environmental health - molecular biology - forensics - bioengineering - scope and nature of biomedicine	- use biomedical processes to develop solutions to problems - utilise biomedical principles to evaluate current and emerging bioengineering solutions harness cellular and biomolecular processes - describe solutions to biomedical and/or bioengineering problems - solve problems using forensic science methods - explain how biomedical innovation has been able to solve environmental issues that have impacted human health - use techniques related to genetic engineering and molecular biology - develop an understanding of the scope and nature of the biomedical professions
Mechanics	
14.4 **Analysis** - statistics - using data to develop evidence based arguments and conclusions	- use mathematical, scientific and/or graphical methods to solve biomedical related problems - analyse data using statistical methods to develop evidence-based arguments and conclusions for biomedical based problems - undertakes investigations to collect valid and reliable data and information, individually and collaboratively
Problem Solving & Design	
14.5 **Designing solutions to biomedical problems**	- apply an appropriate design process to design solutions to identified problems related to biomedicine

SAMPLE ASSESSMENT SCHEDULE

Year 9

Outcomes	Modules	Weighting	Components	Task 1 Inquiry Based Learning Task	Task 2 Aerodynamic Design	Task 3 CAD/CAM Project	Task 4 Examination	Total
5.1.2, 5.2.2	STEM Fundamentals, Aerodynamics, 3D CAD/CAM	10	Research	5	5			10
5.1.1, 5.4.1, 5.4.2, 5.5.1	STEM Fundamentals, Aerodynamics, 3D CAD/CAM	40	Skills	5	15	20		40
5.6.1, 5.6.2, 5.3.2, 5.5.2	STEM Fundamentals, Aerodynamics, 3D CAD/CAM	30	Problem Solving	5	10	15		30
5.2.1, 5.3.1	STEM Fundamentals, Aerodynamics, 3D CAD/CAM	20	Knowledge & Understanding				20	20
TOTAL		100		15	30	35	20	100

Year 10

Outcomes	Modules	Weighting	Components	Task 1 Motion Project	Task 2 Mechatronics Design Task	Task 3 STEM Project Based Learning Task	Task 4 Examination	Total
5.1.2, 5.2.2	Motion, Mechatronics, STEM Project Based Learning Task	10	Research			10		10
5.1.1, 5.4.1, 5.4.2, 5.5.1	Motion, Mechatronics, STEM Project Based Learning Task	40	Skills	10	10	20		40
5.6.1, 5.6.2, 5.3.2, 5.5.2	Motion, Mechatronics, STEM Project Based Learning Task	30	Problem Solving	10	10	10		30
5.2.1, 5.3.1	Motion, Mechatronics, STEM Project Based Learning Task	20	Knowledge & Understanding				20	20
TOTAL		100		20	20	40	20	100

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