DRAFT- STEM Stage 5 - Science, Graphics Technology, Industrial Technology Engineering, Mathematics – Architectural Drawing Option Module – *Tiny House*

Summary	Duration
This project requires students to research and develop a design for a *Tiny House* and produce a range of presentation drawings with the option to also construct a 3D model of their design. There is scope for innovative and flexible design solutions using a range of alternative materials and sustainable technologies. This project allows for creative design solutions as well as developing skills in Architectural presentation drawing, scientific enquiry and mathematical application.	25 hours (7-8 weeks)

Teacher background information

This unit is an example of the integration of **Science, Graphics Technology, Industrial Technology Engineering, and Mathematics**. The unit of work has a theme and focus which draws syllabus content, thinking and skills from all four KLA areas. The relevant key syllabus outcomes and content from each area are provided so that explicit teaching can be applied throughout the unit. Students should be able to use mathematical calculations to assist with their design development, scientific concepts to address the environmental requirements and apply AS1100* drawing standards to realise the final design and presentation of their *Tiny House*. An option would be to also construct a scale model of the design to assist with communicating their *Tiny House* concept. Students will follow a process of research, investigation, design development, calculations, drawing production, documentation and evaluation.

Tiny Houses provide small-footprint, low-cost, accessible housing for a variety of purposes both permanent and temporary. For more *Tiny House* ideas and information, go to episodes of *Tiny House Nation* at: http://www.imdb.com/title/tt3869500/

AS1100 standards:

http://web.aeromech.usyd.edu.au/ENGG1960/Documents/Week11/Engineering%20Drawings%20Lecture%20Detail%20Drawings%202014.pdf

Key inquiry questions	Vocabulary
• How do people use interior spaces? • Can spaces be multifunctional? • What are the basic functions that interior spaces need to provide? • What mathematical and scientific knowledge will be needed to assist with developing an informed design solution?	activity, architect, architectural, area, AS1100, biological, composite, conservation, construction, cylinders, data, displacement, drafting, drawings, dwelling, earning, elevation, energy, engineering, environmental, events, figures, formulas, foundation, geological, global, impact, investing, money, natural, pictorial, presentation, prisms, render, right, scale, shapes, similar, solids, spending, standards, surface, sustainable, systems, template, visualise, volume

Outcomes

Science:
Research how engineers and architects employ scientific concepts and principles in designing energy-efficient devices and buildings.
SC5-11PW explains how scientific understanding about energy conservation, transfers and transformations is applied in systems.
SC5-13ES explains how scientific knowledge about global patterns of geological activity and interactions involving global systems can be used to inform decisions related to contemporary issues.
SC5-14LW analyses interactions between components and processes within biological systems.

Graphics Technology: Option Module, Architectural Drawing
5.1.1 communicates ideas graphically using freehand sketching and accurate drafting techniques.
5.2.1 designs and produces a range of graphical presentations.
5.3.1 identifies, interprets, selects and applies graphics conventions, standards and procedures in graphical communications.
5.3.2 manages the development of graphical presentations to meet project briefs and specifications.

5.4.1 manipulates and produces images using computer-based drafting and presentation technologies.
5.6.1 demonstrates the application of graphics to a range of industrial, commercial and personal settings.
5.6.2 evaluates the impact of graphics on society, industry and the environment.

Industrial Technology Engineering
5.5.1 applies and transfers acquired knowledge and skills to subsequent learning experiences in a variety of contexts and projects.
5.7.1 describes, analyses and uses a range of current, new and emerging technologies and their various applications.
5.7.2 describes, analyses and evaluates the impact of technology on society, the environment and cultural issues locally and globally.

Mathematics:
MA5.1-8MG calculates the areas of composite shapes, and the surface areas of rectangular and triangular prisms.
MA5.1-11MG describes and applies the properties of similar figures and scale drawings.
MA5.2-12MG applies formulas to calculate the volumes of composite solids composed of right prisms and cylinders.

Content	Teaching, learning and assessment	Student diversity
Science **SC5-11PW explains how scientific understanding about energy conservation, transfers and transformations is applied in systems.** • compare the characteristics and applications of series and parallel circuits • outline recent examples where scientific or technological developments have involved specialist teams from different branches of science, engineering and technology, for example, low-emission electricity generation and reduction in atmospheric pollution • describe how, in energy transfers and transformations, a variety of processes can occur so that usable energy is reduced and the system is not 100% efficient • discuss, using examples, how the values and needs of contemporary society can influence the focus of scientific research in the area of increasing efficiency of the use of electricity by individuals and society • discuss viewpoints and choices that need to be considered in making decisions about the use of non-renewable energy resources **SC5-13ES explains how scientific knowledge about global patterns of geological activity and interactions involving global systems can be used to inform decisions related to contemporary issues.** • describe some impacts of natural events, including cyclones, volcanic eruptions or earthquakes, on the Earth's spheres (biosphere, lithosphere, hydrosphere, atmosphere) • evaluate scientific evidence of some current issues affecting society that are the result of human activity on global systems, for example, the greenhouse effect, ozone layer depletion, effect of climate change on sea levels, long-term effects of waste management and loss of biodiversity **SC5-14LW analyses interactions between components and processes within biological systems**	**Week 1 – Design Brief** **Design Situation: Architects design both permanent and temporary dwellings and structures** **Design Brief:** Disasters can cause displacement of the local population and the provision of permanent or temporary housing can be difficult. Students are to research and design their own low-cost, resource-efficient temporary dwelling, **a *tiny house*** to be used in situations of population displacement. Students are to research the most efficient use of local materials and environmental conditions to create low-cost, energy-efficient sustainable housing, using the ***tiny house*** model. Students will submit a range of presentation drawings using both traditional and CAD methods, a documentation folio and, optionally, a 3D model of their design. **A Study of the Local Environment:** • Students research and present their findings. – What was the local disaster that led to this displacement? – geological, environmental, socio-political? – this needs to be reflected in the design/choice of materials for the tiny house. – What were the geological or environmental forces which caused the disaster? – Is this type of disaster likely to recur? How can the design take this into account e.g. earthquake/flood protection. – What materials are available in the local ecosystem? – What are the environmental characteristics that may affect the efficiency of the house design e.g. path of the sun to align solar panels; prevailing rain and winds for stability or the need for wind breaks? **Design Limitations of the *Tiny House*:** – A tiny house is a home of 40 square metres or less, either on wheels or a foundation. – The layout of the tiny house must include a bathroom, kitchen, sleeping area and living space. – The design should be environmentally sustainable, taking into account the use of recycled or claimed materials. – The tiny house may be mobile or in a fixed location, and the design should reflect this. – The tiny house must utilise solar energy as well as the use of tank or recycled water. • Teacher introduces the *Tiny House* movement to students. Class research and presentation about the	*New Inventors* episode: Disaster relief shelter http://www.abc.net.au/tv/newinventors/txt/s1919836.htm Basic housing-related mathematics (mortgage/rent payments, rates, upkeep, etc.) Cost/benefit analysis (in comparison to the 'standard' housing styles) Students set their own criteria for their house design, using knowledge learned through the introduction to unit phase.

Content	Teaching, learning and assessment	Student diversity
• recall that ecosystems consist of communities of interdependent organisms and abiotic components of the environment • outline using examples how matter is cycled through ecosystems • evaluate some examples in ecosystems, of strategies used to balance conserving, protecting and maintaining the quality and sustainability of the environment with human activities and needs **Graphics Technology** **5.1.1 communicates ideas graphically using freehand sketching and accurate drafting techniques.** **5.2.1 designs and produces a range of graphical presentations.** **Design in Graphics** • freehand architectural design drawings • related government authorities and statutory requirements • environmental issues relating to architectural design • current building practice **5.3.1 identifies, interprets, selects and applies graphics conventions, standards and procedures in graphical communications.** **5.3.2 manages the development of graphical presentations to meet project briefs and specifications** **Planning and Construction** • architectural working drawings including – site/block plans – floor plans – sub-floor plans – standard elevations – sections • applications of CAD software in the development of architectural drawings **5.4.1 manipulates and produces images using computer-based drafting and presentation technologies.** **5.6.1 demonstrates the application of graphics to a range of industrial, commercial and personal settings**. **Presentation** • use sheet and detail numbering to link several architectural drawings as part of a complete set of working drawings • model and render architectural designs in 3D using graphics software • create and render pictorial drawings for presentation • access and utilise architectural symbol libraries • set CAD software preferences **Additional Content** • use specialised architectural CAD features such as 2D/3D wall	reason(s) for this housing trend: – environmental awareness – cost of housing – carbon footprints – sustainability • Definition of population displacement http://www.unesco.org/new/en/social-and-human-sciences/themes/international-migration/glossary/displaced-person-displacement/ • Discuss reasons for displacement and how architects/designers can provide solutions. http://www.australiandesignreview.com/architecture/55745-architecture-and-disaster-emergency-shelter-in-nepal • Students brainstorm what is in a family home. • In the brainstorm colour-code the basic requirements of a home. • How is a *tiny house* different to a conventional Australian home? **Students write the design brief, create a set of constraints – refer to and integrate design limitations and a list of criteria to evaluate success.** **Take Home Task:** • Read the following article to better understand the *Tiny House* movement. http://www.heraldsun.com.au/news/special-features/in-depth/living-small-the-tiny-house-movement-grows-in-australia/news-story/435d87004a787c5c60be8471b6f2b3f3?= **Weeks 2 & 3 – Application of Scale and Measurement** Students are given a sample floor plan for a tiny house, and a sample floor plan for an average home • Students are asked to compare the two plans, with focus on: – size of living areas – use of innovative/creative storage ideas – materials used (if applicable) • Students will learn how to correctly measure objects in terms of overall dimensions and surface area. http://www.fredstinyhouses.com.au/tiny-house-construction.html • Students learn to read a 'blueprint'-style floor plan (which they will be recreating as part of their practical submission). • Students learn how to interpret the plans and understand the measurements and scale required. Khan Academy: https://www.khanacademy.org/math/basic-geo/basic-geo-area-perimeter/basic-geo-scale-drawings/v/constructing-scale-drawings • Students learn about types of materials used in standard construction versus the tiny house movement trend of reclaimed and recycled materials, often with multiple functions. • Students relate the materials used to those available and renewable within the local ecosystem. • Students investigate which construction materials are most suitable for use in the chosen environment. • Students look at examples of tiny houses, use these to work out: floor area, material use, estimation of quantities and cost. • Students determine the most efficient way to provide electricity to the house/area. • Students determine the electrical needs of the house e.g. lighting, appliances and determine how to efficiently wire the house to provide these needs. • Teacher leads student discussion about recyclability in construction materials:	Students research standard sizes of household furniture and appliances such as ovens, fridges, etc. Students will learn about alternative energies and their conversion, transfers and transformations. **Additional Content** **Industrial Technology Engineering** use formulas to solve problems relating to simple engineered structures.

Content	Teaching, learning and assessment	Student diversity
and roof tools/wizards in the creation of drawings • produce additional detail drawings such as sub-floor plan, footing detail, shadow, plumbing and electrical plans • create physical models of architectural designs • use CAD animation techniques to create architectural walkthroughs and flyovers • combine rendered drawings and photographs to create montages to help realistically visualise an architectural design **Industrial Technology Engineering** **5.5.1 applies and transfers acquired knowledge and skills to subsequent learning experiences in a variety of contexts and projects.** **Materials** • the basic structure and advantages of composite materials used in engineered structures • the corrosion and/or degradation of materials used in structures **5.7.1 describes, analyses and uses a range of current, new and emerging technologies and their various applications.** **Engineering Principles and Processes** • the nature and purpose of structures • elements that make up structures • fundamental quantities, derived quantities and their units. • forces that act on structures • the effects of forces on structures **Links to Industry** • a range of engineering fields and traditional, current and emerging technologies that relate to engineering **Design** • alternative design solutions appropriate to engineered structures **5.7.2 describes, analyses and evaluates the impact of technology on society, the environment and cultural issues locally and globally.** **Societal and Environmental Impact** • the impact of engineering on society and the physical environment **Mathematics** **Measurement and Geometry** **MA5.1-8MG calculates the areas of composite shapes, and the surface areas of rectangular and triangular prisms** • solve a variety of practical problems involving the areas of quadrilaterals and composite shapes **MA5.1-11MG describes and applies the properties of similar figures and scale drawings** • construct scale drawings • interpret and use scales in photographs, plans and drawings	– Australian building standards – financial benefits and constraints to sustainability and environmental consciousness in construction. – existing products and companies • Students conduct group or independent research on materials used in Australian housing projects, and reasons for their selection. • Teacher discusses the pros and cons of using standard sizes in construction, for materials as well as appliances and furniture. – ease of manufacturing – waste reduction **Week 4 – Drawing Skills** • Students are guided through drawing basic floor plans using Australian drawing standards (AS1100). • Scale drawing exercise: https://www.mathsisfun.com/definitions/scale-drawing.html • Students practise drawing items to scale. • Students should be able to identify the difference between, draw and name features of the following architectural working drawings: – site/block plans – floor plans – sub-floor plans – standard elevations – sectional views **Week 5 – Digital Skills** Students are to create a presentation of their designs, research and ideas – this could be done digitally. Students may: • learn the use and function of an appropriate CAD software • use specialised architectural CAD features such as 2D/3D wall and roof tools/wizards in the creation of drawings • produce additional detail drawings such as sub-floor plans, footing details, shadow, plumbing and electrical plans • create physical models of architectural designs • use CAD animation techniques to create architectural walkthroughs and flyovers • combine rendered drawings and photographs to create montages to help realistically visualise an architectural design. **Weeks 6–8** Students are to design their own tiny house to suit their needs. They can use range of hand-drawing and CAD techniques to create floor plans and a 3D rendering of their design. Students are to calculate the cost to create their design, factoring in: – material costs – labour – furnishing & appliances – environmental sustainability and alternative energies Students will create a client presentation of their final design. As part of the presentation, students will need	Use of templates http://goo.gl/UmWQOx Home Styler: http://www.homestyler.com/designer Use Google Drive to create collaborative documents. **Option:** Produce a scale model using foamcore board and surface rendering.

Content	Teaching, learning and assessment	Student diversity
found in the media and in other key learning areas **MA5.2-12MG applies formulas to calculate the volumes of composite solids composed of right prisms and cylinders** • solve a variety of problems related to the volumes and capacities of prisms, cylinders and related composite solids **Statistics and Probability** **MA5.1-12SP uses statistical displays to compare sets of data and evaluates statistical claims made in the media** • interpret media reports and advertising that quote various statistics, for example, media ratings, house prices, sports results, environmental data • critically review claims linked to data displays in the media and elsewhere • consider informally, the reliability of conclusions from statistical investigations, taking into account issues such as factors that may have masked the results, the accuracy of measurements taken, and whether the results can be generalised to other situations	to fully explain the alternative energies used, and justify their use.	

Assessment overview

Assessment should follow the school's policies in terms of task weightings and this unit should assess:

Documentation of project:

- Analysis
- Research
- Planning
- Design
- Evaluation

Finished presentation drawings (for example):

- Dimensioned orthogonal drawings (to AS1100 standards)
- A range of rendered pictorials
- CAD drawings and walkthroughs (depending on software used)

Architectural model (optional)

Evaluation