DIGITAL TECHNOLOGIES: ASSEMBLE AND TEST ELECTRONIC AND EMBEDDED SYSTEMS

The assembly and testing of electronic and embedded system is focused on developing the skills needed to integrate technologies (hardware, software, mechanical) to produce a working prototype. These skills follow directly from those acquired during the development of an electronic environment as a functional model. It is also about the application of testing, debugging and modification skills to ensure the prototype is operational, fit for purpose and meets specifications.

Initially students learn basic assembly and testing skills and about working safely in the classroom and/or workshop environment. Students progress from here to levels that require more advanced and complex skills. This progression may require developing competency in calculating values and in the use and interpretation of data from devices such as multimeters (extended functions), oscilloscopes and other test instruments. At the highest level, students will be able to use complex techniques to construct and debug electronic and embedded systems to meet design specifications.

	LEVEL 6	LEVEL 7	LEVEL 8
LO	*Demonstrate basic assembly and testing techniques used in electronic and embedded systems*	*Demonstrate advanced assembly and testing techniques used in electronic and embedded systems*	*Demonstrate complex assembly and testing techniques used in complex electronic and embedded systems*
TEACHER GUIDANCE	To support students to demonstrate basic assembly and testing techniques used in electronic and embedded systems at level 6, teachers could: • Provide, or develop in negotiation with the student, specifications for an electronic environment that will require basic techniques. • Provide opportunity for students to select components that match a given schematic. • Provide instruction for students in the design and production of a simple PCB (printed circuit board) using 'pen and etch' technique. • Provide opportunity for students to develop correct soldering techniques. • Ensure students apply acceptable standards of cleanliness in their work area and care for their equipment. • Provide opportunity to discuss necessary safety procedures for soldering, drilling and PCB production. • Provide opportunity for students to develop skills in drilling, populating and soldering up of a circuit on a PCB. • Provide opportunity for students to work with other circuit platforms, such as a copper tape and veroboard. • Provide opportunity for students to develop the art of visual critical inspection of their handiwork, including all hardware (circuits and mechanicals) as well as software programs. • Ensure students test each soldered joint for continuity with a multimeter, as each joint is completed. • Guide students to use a multimeter to test components (eg, resistor values) and locate basic faults in a real circuit, such as a bad joint, by measuring voltage levels at different points. • Provide opportunity for students to develop, test and download programs into embedded software, given supplied programme structures as a starting point. • Provide opportunity for students to inspect and debug software programs. • Guide students to employ basic techniques to evaluate, test and debug the assembled electronic and embedded system so that the overall system is functional. • Provide students with opportunity to work and cooperate in groups. • Ensure students understand how an outcome is evaluated against specifications in a brief.	To support students to demonstrate advanced assembly and testing techniques used in electronic and embedded systems at level 7, teachers could: • Provide, or develop in negotiation with the student, specifications for an electronic environment that will require advanced techniques. The environment will include more than one subsystem and include at least one multi-pin device. • Provide opportunity for students to select an extended range of components to match a schematic. • Provide instruction for students in the design and production of a PCB using CAD techniques Provide opportunity for students to develop advanced soldering techniques (eg, temperature controlled, desoldering etc.) so that students can achieve consistently reliable results. • Provide opportunity for students to use advanced multimeter functions to test an extended range of components (eg, capacitor values) to locate faulty components and other problems in a circuit, visual inspection, using an extended range of techniques in a logical manner (eg, voltage levels at the system and progressive subsystem levels). • Provide opportunity for students to perform systematic and logical testing, evaluation of data and debugging in the electronic environment. • Provide instruction in and examples for students that show how calculation and measurement can assist in the testing and debugging of the hardware and software in the system. • Provide instruction in and examples of advanced techniques for the development, testing and debugging of clearly annotated embedded software that uses features such as variables and subroutines and simple data structures such as an array. • Guide students to employ advanced techniques to evaluate, test and debug the assembled electronic and embedded system so that the overall system is functional.	To support students to demonstrate complex assembly and testing techniques used in electronic and embedded systems at level 8, teachers could: • Provide, or develop in negotiation with the student, specifications for an electronic environment that will require complex techniques. The environment will include several subsystems and include at least three multi-pin devices. • Provide opportunity for students to select an extended range of components to match a schematic. • Guide students in the design and production of a quality, complex PCB to a high standard, using techniques that will achieve this result. • Provide opportunity for students to develop complex soldering techniques so that students can achieve consistently reliable results. • Provide opportunity for students to employ complex techniques to assemble a functional, reliable and well-laid out hardware platform on PCB(s) (organised layout, component size considerations, component and user safety, off-board connections, vias, logical routing, siting and protection of off-board components, with easy access to testing points. • Provide opportunity for students to acquire complex programming skills for the development, testing and debugging of clearly annotated embedded software that uses features such as communication protocols, macros, flags, interrupts and counters. • Provide opportunity for students to use complex diagnostic techniques (advanced multimeter, oscilloscope, signal generator, logic tester/analyser etc.) functions to test an extended range of component functions in situ, including integrated circuits. • Guide students to perform systematic and logical testing, evaluation of data and debugging in the electronic environment. • Guide students to employ calculation and measurement in the process of testing and debugging of the hardware and software in the system. • Support students to employ complex techniques to evaluate, test and debug the assembled electronic and embedded system so that the overall system is functional.
INDICATORS	Students can: • construct and test reliable functional systems with well-soldered joints; suitable track and component layout and secure, reliable, well-organised connections to any components that are mounted off the board • write and debug embedded software so that the program is logical, efficient and clearly annotated.	Students can: • develop and produce a printed circuit board (PCB) using PCB CAD software • construct and test reliable functional circuits on PCB, with improved track layout and soldering • write and debug well-structured, clearly annotated, and readily understandable embedded software which uses one extended feature or specialised command.	Students can: • use PCB (printed circuit board) CAD software to develop a PCB layout that will preserve signal integrity • construct, test, analyse and modify reliable functional circuits on PCB, with substantially improved track layout and soldering • write, debug and modify well-structured, clearly annotated, and readily understandable embedded software • analyse and effectively manage signal and data parameters.
AS	**AS91079 Digital Technologies 1.49** *Implement basic techniques in constructing a specified electronic and embedded system*	**AS91376 Digital Technologies 2.49** *Implement advanced techniques in constructing a specified electronic and embedded system*	**AS91640 Digital Technologies 3.49** *Implement complex techniques in constructing a specified complex electronic and embedded system*
	Level 1 Digital Technologies standards & assessment resources	Level 2 Digital Technologies standards & assessment resources	Level 3 Technology achievement standards & assessment resources DRAFT