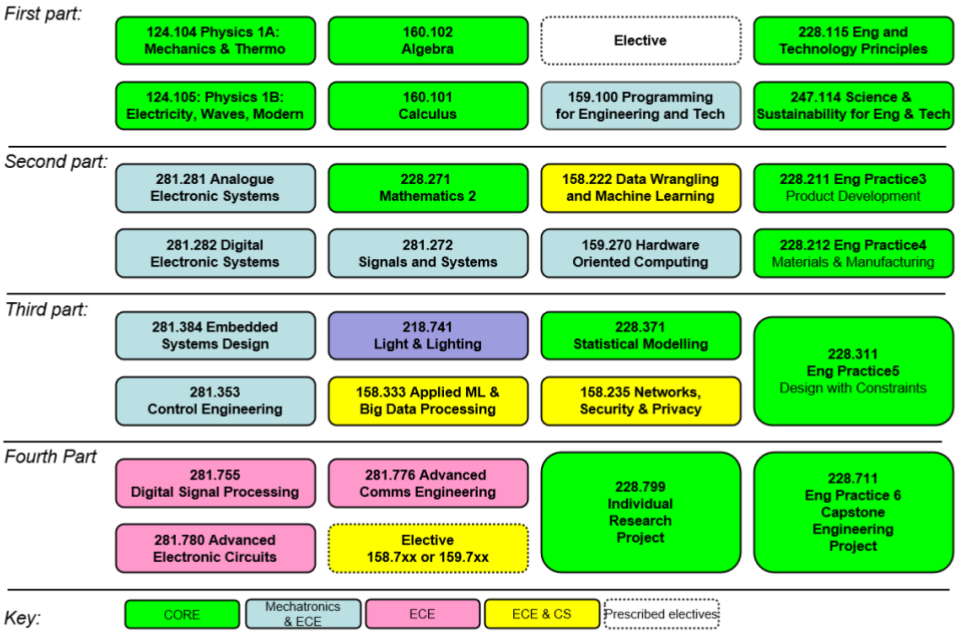
Electronics and Computer Engineering (ECE) course overview

Graduates of the ECE major are multi-disciplinary, have good practical skills, and possess a systems approach to the design, development and management of software and hardware projects. They are capable of working in a team environment to solve problems from the device level through to networks, communication systems and embedded systems. ECE graduates therefore should have the knowledge and potential to become successful project leaders, systems analysts and system designers who are equally at home in a small company or large multi-national.

A student graduating with the major of Electronics and Computer Engineering has the following body of knowledge that distinguishes them from other majors within the BE(Hons):

- A competency in the use of a multi-disciplinary systems approach to meet the management and technical challenges of computer software and hardware design, electronics, control and communication engineering projects.
- The capability to determine the required specifications for new systems and making technical recommendations for such developments.
- An ability to apply international standards and practices in electronic, telecommunication, computer and control engineering.
- The ability to apply their knowledge in physics, mathematics, electronic circuits, communication systems, signal processing, software design, and embedded systems to the electronics, telecommunication, computer and information related industries in designing, developing, operating and maintaining products, systems and networks.

The ECE major consists of 29 courses, worth a total of 480 credits. In full-time mode, students study four courses per semester, and the duration to complete the programme is eight semesters. Figure 1.9 illustrates how the courses are distributed over the semesters.



First part:	124.104 Physics 1A: Mechanics & Thermo	160.102 Algebra	Elective	228.115 Eng and Technology Principles
	124.105: Physics 1B: Electricity, Waves, Modern	160.101 Calculus	159.100 Programming for Engineering and Tech	247.114 Science & Sustainability for Eng & Tech
Second part:	281.281 Analogue Electronic Systems	228.271 Mathematics 2	158.222 Data Wrangling and Machine Learning	228.211 Eng Practice3 Product Development
	281.282 Digital Electronic Systems	281.272 Signals and Systems	159.270 Hardware Oriented Computing	228.212 Eng Practice4 Materials & Manufacturing
Third part:	281.384 Embedded Systems Design	218.741 Light & Lighting	228.371 Statistical Modelling	228.311 Eng Practice5 Design with Constraints
	281.353 Control Engineering	158.333 Applied ML & Big Data Processing	158.235 Networks, Security & Privacy	
Fourth Part	281.755 Digital Signal Processing	281.776 Advanced Comms Engineering	228.799 Individual Research Project	228.711 Eng Practice 6 Capstone Engineering Project
	281.780 Advanced Electronic Circuits	Elective 158.7xx or 159.7xx		

Key: 🟩 CORE · Mechatronics & ECE · ECE · ECE & CS · Prescribed electives

Figure 1.9 Programme Map for the Electronics and Computer Engineering Major

Core programme courses develop:

1. **D**esign & **P**rofessional Practice attributes – referred to as the 'Project Based Spine'. Students must complete a project (per semester or double semester) that involves utilising the common practice of the engineering method to solve a variety of problems. The problems increase in difficulty, and the

students’ solutions increase in sophistication as the students advance through the four-year programme. The results of this project-based spine approach are that students gain experience at developing technically detailed problem-solutions, and develop other attributes, such as communication, teamwork, financial and sustainable design skills. For the ECE major the following are examples of projects that the students undertake:

First Part	The first project has well-defined system boundaries, stakeholders and deliverables, where significant support is provided with information and decision-making. Students start developing their practical skills needed to design and solve engineering problems. Electronics and Computer Engineering students are combined with Mechatronics students in teams to develop cars with conflicting objectives of speed and load carrying capacity. Designs are optimised by identifying factors which affect performance before competing in a competition to determine which vehicle performs best in the speed and weight categories. The second project requires the definition of system boundaries and deliverables, where available information is both ambiguous and incomplete. Teams are made up of students from across the different engineering and food technology majors. An existing NZ industry is selected by each team and students examine the life cycle of the product. Ideas are generated for how the industry can become more sustainable in the future. Feasibility of the ideas are examined taking into account social, cultural, environmental, and financial considerations. Industries selected include avocados, salmon, timber, mushrooms, wine and hemp.
Second Part	The third project is based on the context of a specific company or industry where requiring the definition of system boundaries, the identification of constraints and decision making based on uncertainty (mainly related to market information) and trade-offs (mainly related to prioritization of product features). The types of companies the students study are Spidertracks, Tait Communications, Fisher & Paykel Healthcare, Levno, etc. The fourth project involves planning the launch (i.e. designing and testing the machine and meeting the initial marketing plan) of a new coil winding machine, which is complementary to a Company's existing range. The Company is of medium size and is well established as a supplier of a range of coil winders, mainly to Europe. It has Marketing, Sales, Design and Production departments and the typical infrastructure departments (Finance HR etc).
Third Part	The fifth project is based on the design of an autonomous vacuum cleaner. The context for the project is well defined, centred on a hypothetical NZ based company that has experience in the design, manufacturing and marketing of robotic systems. Although there is significant freedom in the development of the design concept, significant constraints are imposed in terms of system functionality, and development budget. Sustainability is imposed as an essential requirement for the final product concept, particularly emphasising legislative constraints and Life Cycle Analysis. Although a clear design brief is provided, the level of direction and supervision is significantly reduced, relative to previous projects. Definition of team goals and milestones, allocation of individual responsibilities (based on disciplines) with the team, and overall project management are central to successful project outcomes and assessment. A strong emphasis is also placed on

	(a) technical problem solving, using knowledge from within the programme including mechanical design, electronic circuit design, embedded system design, computer programming, mathematics, communication and control systems; (b) acquiring knowledge required to resolve specific project issues.
Fourth Part	A sixth, capstone project is regarded as the culmination of the degree – the bringing together of all learning from throughout the programme and a demonstration of the students' ability to clearly define the scope, outcomes, and deliverables from a complex engineering problem, and to enable successful resolution of this problem through appropriate project planning and implementation. As such, the project places significant demands on the student to solve a problem of significant complexity, which is largely defined by the breadth of scope and the need to seek and resolve inputs from a broad range of stakeholders and disciplines. A particular feature of the Capstone project is the requirement for the students to take full responsibility for the project definition, planning and completion with limited supervision and guidance. The problems are ones encountered by the industry or research organizations.

2. **K**nowledge attributes – these courses are focused on embedding the underlying sciences (such as mathematics and physical principles). Along with the project spine, a final year individual 30 credit research project ensures that students apply their technical knowledge and have an opportunity explore the forefront of the major's discipline. The topic of research could be in any area of electronics and computer engineering. Examples of possible topics include image denoising, memristor circuits, accelerating computing, localization and mapping algorithms for mobile robots, waveform design of ultra-wideband signals, nonlinear control of an inverted pendulum and models of hearing impairment.

Major specific courses develop the knowledge attributes. These courses provide a systematic coverage of the coherent body of knowledge related to electronics and computer engineering. They are focused on the technical knowledge in electronic circuits, computer hardware and software design, machine learning, communication networks, and signal processing. Many of the courses, particularly within the first two years, are shared with the Mechatronics major. Other courses are drawn from Computer Science and Information Technology. In their final year, the major specific courses focus on applying these underlying fundamentals within communications, data acquisition, and signal processing domains. Table 1.11 shows how courses contribute to building the specific body of knowledge for the Electronics and Computer Engineering major.

The prescribed elective in the final year allows students to focus on an area of information technology and computing that is of interest to them.

Table 1.11 Electronics and Computer Engineering Major Body of Knowledge

Knowledge Profile	**Courses that Contribute to Building the Body of Knowledge for the Major**
WK1: A systematic, theory-based understanding of the **natural sciences** applicable to the discipline	124.104 Physics 1A: Mechanics and Thermodynamics 124.105 Physics 1B: Electricity, Waves and Modern Physics
WK2: Conceptually-based **mathematics**, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline	159.100 Programming for Engineering and Technology 160.101 Calculus 160.102 Algebra 159.270 Hardware-Oriented Computing 228.271 Engineering Mathematics 2 281.272 Signals and Systems 158.222 Data Wrangling and Machine Learning 158.333 Applied Machine Learning and Big Data 228.371 Statistical Modelling for Engineers & Technologists 281.755 Digital Signal Processing
WK3: A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline	124.104 Physics 1A: Mechanics and Thermodynamics 124.105 Physics 1B: Electricity, Waves and Modern Physics 281.281 Analogue Electronic Systems 281.282 Digital Electronic Systems 281.272 Signals and Systems 158.222 Data Wrangling and Machine Learning 158.333 Applied Machine Learning and Big Data 281.353 Control Engineering 281.384 Embedded Systems Design
WK4: Engineering **specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.	228.311 Eng Practice 5: Design with Constraints 228.371 Stats Modelling for Engineers & Technologists 281.353 Control Engineering 158.333 Applied Machine Learning and Big Data 218.741 Light and Lighting 228.798 Individual Research Project 281.755 Digital Signal Processing 281.776 Advanced Communication Engineering 281.780 Advanced Electronic Circuits
WK5: Knowledge that supports **engineering design** in a practice area	247.114 Science and Sustainability for Eng. and Tech. 228.115 Engineering and Technology Principles 159.270 Hardware-Oriented Computing 228.211 Eng Practice 3: Product Development 228.212 Eng Practice 4: Materials & Manufacturing 281.281 Analogue Electronic Systems 281.282 Digital Electronic Systems 228.311 Eng Practice 5: Design with Constraints 281.384 Embedded Systems Design 218.741 Light and Lighting 281.755 Digital Signal Processing 281.776 Advanced Communication Engineering 281.780 Advanced Electronic Circuits 228.711 Eng Practice 6: Design Capstone Project 228.798 Individual Research Project
WK6: Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline	228.212 Eng Practice 4: Materials & Manufacturing 281.384 Embedded Systems Design

	158.333 Applied Machine Learning and Big Data 228.311 Eng Practice 5: Design with Constraints 218.741 Light and Lighting 281.776 Advanced Communication Engineering 281.780 Advanced Electronic Circuits 228.711 Eng Practice 6: Design Capstone Project
WK7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability	247.114 Science and Sustainability for Eng. and Tech. 228.115 Engineering and Technology Principles 228.211 Eng Practice 3: Product Development 228.212 Eng Practice 4: Materials & Manufacturing 228.311 Eng Practice 5: Design with Constraints 228.711 Eng Practice 6: Design Capstone Project
WK8: Engagement with selected knowledge in the **research literature** of the discipline	247.114 Science and Sustainability for Eng. and Tech. 228.211 Eng Practice 3: Product Development 228.212 Eng Practice 4: Materials & Manufacturing 228.311 Eng Practice 5: Design with Constraints 228.711 Eng Practice 6: Design Capstone Project 228.798 Individual Research Project 281.776 Advanced Communication Engineering

The Engineering Body of Knowledge (WA1 Learning Outcome Summary) table and the Accord Attribute tables (WA2 to WA12) for the ECE Major are provided in Appendix 1.2. A concise overview of the alignment of the compulsory courses to the Washington Accord attributes is shown in Table 1.12.

Table 1.12 Washington Accord Attributes alignment map for BE(Hons) – ECE courses

				WA Attributes											
			🟦 Common courses 🟩 ECE specific courses 🟨 Project-spine courses	Engineering Knowledge	Problem Analysis	Design/Development of Solution	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Project Management	Lifelong Learning
		Course Number	**Course Title**	1	2	3	4	5	6	7	8	9	10	11	12
Year 1	**S1**	124.104	Physics 1A: Mechanics and Thermodynamics	☒	☒		☒	☒							☒
		160.102	Algebra	☒	☒			☒							
		228.115	Engineering and Technology Principles	☒	☒	☒	☒	☒	☒	☒	☒		☒	☒	
		Elective													
	S2	159.100	Programming for Engineering and Technology	☒				☒					☒		
		124.105	Physics 1B: Electricity, Waves and Modern Physics	☒	☒		☒	☒							☒
		160.101	Calculus	☒	☒			☒							
		247.114	Science and Sustainability for Engineering and Technology	☒		☒	☒		☒	☒	☒	☒	☒	☒	☒
Year 2	**S1**	281.281	Analogue Electronic Systems	☒	☒			☒							
		228.271	Engineering Mathematics 2	☒	☒			☒							
		158.222	Data Wrangling and Machine Learning	☒	☒		☒	☒							
		228.211	Engineering Practice 3: Product Development	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
	S2	281.282	Digital Electronic Systems	☒	☒			☒					☒		
		281.272	Signals & Systems	☒	☒			☒							
		159.270	Hardware-Oriented Computing	☒	☒			☒					☒		
		228.212	Engineering Practice 4: Materials & Manufacturing	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Year 3	**S1**	281.384	Embedded Systems Design	☒	☒			☒					☒		
		218.741	Light and Lighting	☒	☒	☒									
		228.371	Statistical Modelling for Engineers & Technologists	☒	☒		☒	☒							
		228.311	Engineering Practice 5: Engineering Design with Constraints	☒	☒	☒	☒	☒	☒	☒	☒		☒	☒	☒
	S2	281.353	Control Engineering	☒	☒		☒	☒							
		158.333	Applied Machine Learning and Big Data Processing	☒	☒		☒	☒							
		158.235	Networks, Security and Privacy	☒	☒			☒					☒		
		228.311	Engineering Practice 5: Engineering Design with Constraints	☒	☒	☒	☒	☒	☒	☒	☒		☒	☒	☒
Year 4	**S1**	281.755	Digital Signal Processing	☒	☒		☒	☒							
		281.776	Advanced Communications Engineering	☒	☒	☒	☒	☒	☒	☒			☒		☒
		228.798	Individual Research Project	☒	☒		☒	☒			☒		☒	☒	☒
		228.711	Engineering Practice 6: Design Capstone Project	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
	S2	281.780	Advanced Electronic Circuits	☒	☒			☒							
		228.798	Individual Research Project	☒	☒		☒	☒			☒		☒	☒	☒
		228.711	Engineering Practice 6: Design Capstone Project	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
		Elective													