Programme amendment cover sheet

Proposal name	Change ECEN major to EEEN		
Proposer	Gideon Gouws, Deputy Head of School.		
Faculty	Engineering		
Summary	To change the name of the Electronics and Computer Systems Engineering (ECEN) major to Electrical and Electronic Engineering (EEEN) in the BE(Hons)		
Year	2020		
Reference	BE(Hons)/2, BSc/5, BSc(Hons)/1, MSc/2		
CONSULTATION	**Person consulted**	**Summary and reference**	
Academic Office	Academic-office@vuw.ac.nz	Feedback received and incorporated.	
AD (Engineering)	Peter Andreae	Feedback received and incorporated.	
AD (Science)	Paul Teesdale-Spittle	No issues identified.	
AD (Architecture & Design)	Jan Smitheram	No issues identified	
CAD	Stephen Marshall	Feedback received and addressed.	
Course Admin.	Teresa Schischka	Feedback received and incorporated.	
Faculty Admin.	Johan Barnard	No issues identified	
Library	Nicola Atkinson	Feedback received and incorporated.	
Toihuarewa	Meegan Hall; ako@vuw.ac.nz	Feedback incorporated.	
School Admin.	Suzan Hall	No issues identified	
Students	src@vuwsa.org.nz	No issues identified	
APPROVAL	**Authority**	**Date**	**Recorded by**
Head of School	Stuart Marshall	04-03-20	Heather Day (APM)
Fac. Acad. Cttee.	Peter Andreae	19-02-2020	Peter Andreae
Engineering Faculty Board	Dale Carnegie	04-03-20	Heather Day (APM)
Science Faculty Board	Marc Wilson	27-02-20 presented and supported at meeting.	Heather Day (APM)
Acad. Committee	Academic Committee	08-04-2020	Pam Green
Academic Board	Academic Board	21-04-2020	Claire Williams
CUAP	CUAP Chair	19-06-2020	Pam Green

Programme amendment

Proposal name	Change ECEN major to EEEN
Faculty	Engineering

This proposal is being submitted to the Committee on University Academic Programmes under Section 6.1.8, a change in the name of a qualification or subject, of the *CUAP Handbook 2019*.

A1 Purpose

- To change the name of the Electronic and Computer Systems Engineering (ECEN) major in the Bachelor of Engineering with Honours (BE(Hons)) to Electrical and Electronic Engineering (EEEN) and change the Major Subject Requirements.
- To introduce four optional specialisations within this new major: Communication Engineering (CMNG), Machine Learning (MLEN), Renewable Energy Systems Engineering (RESE) and Robotics (ROBO).
- To relabel/rename and restructure the courses ECEN 202, 203, 204, 220, 301, 310, 315, 321, 403, 410, 415, 421, 422, 425, 426, 427, 430, 431 and RESE 313 into EEEN 202, 203, 204, 220, 301, 310, 313, 315, 320, ~~402,~~ 403, 410, 415, 421, 422, 425, 426, 427, 430, 431. Consequently, delete all these ECEN labelled courses and RESE 313.
- To add new courses EEEN 201, 325, 401, 402, 411, RESE 321, 322.
- To delete existing courses ECEN 302, 303, 404, 405, ELCO 580.
- To make consequential changes to the Electronic and Computer Systems (ELCO), Applied Physics (APHS), Physics (PHYS) and Renewable Energy Systems (RESY) majors in the BSc.
- To make consequential changes to the ELCO Subject in the BSc(Hons), PGDipSc, PGCertSc and the MSc.
- To make a consequential change to the prerequisites of one course (INDN 321) in the Bachelor of Design Innovation (BDI).

A2 Justification

The Bachelor of Engineering with Honours at Victoria University of Wellington currently consists of three majors: (1) Software Engineering (SWEN), (2) Cybersecurity Engineering (CYBR) and (3) Electronic and Computer Systems Engineering (ECEN). Over the past decade the ECEN major has been producing graduates skilled in the nexus between electronic engineering and computer systems, with additional skills in computer programming, computer networks and mechatronics. However, the offering of courses available to ECEN students has expanded during the last two years, with the appointment of several new staff in the areas of Renewable Energy due to the commitment from the university to invest in this area. In addition, students have also shown consistent interest in the mechatronics and robotics courses. These fields of renewable energy and robotics offer significant industry opportunities for graduating students and are key technology areas to ensure growth and success in the New Zealand economy. Both these subject areas build heavily on electrical and electronic engineering but are outside the scope of the existing ECEN major. It is therefore proposed to make several changes to the structure and requirements of the current major to ensure it conforms to the national and international expectation of an Electrical and Electronic Engineering major and to rename the major to reflect these changes.

Feedback was sought from Engineering New Zealand (ENZ) in the early stages of planning a new engineering major in Renewable Energy. In the feedback provided by the Engineering NZ's Standards Accreditation Board it was strongly recommended that stand-alone, specialised majors would not be desirable, but rather the incorporation of areas of specialisation within a well-defined, traditional engineering major. This feedback from ENZ then strongly guided the current proposal. The establishment of an Electrical and Electronic Engineering (EEEN) major will provide a broad academic foundation with enhanced international recognition, as the label of this major is recognised nationally and internationally. At the same time, it will also be possible to incorporate new areas of teaching and research into the degree, providing students with a clear path and opportunity for study in areas of modern technical specialisation. [ENZ has provided written support for this proposal.]

This proposal provides the details for the restructure and renaming of the current ECEN major to "Electrical and Electronic Engineering" (EEEN). A benchmarking exercise was carried out on the established Electrical and Electronic Engineering majors at both University of Auckland and Canterbury University. This benchmarking process informed both our proposed structure for the major as well as the course content. The proposed structure and the intended changes can be summarised as follows:

1. An unchanged first year compared to the current ECEN major; with courses including mathematics, general science and physics, programming, engineering modelling and an introduction to electronics. Most of these courses are shared with the other two BE(Hons) majors to provide a common first year where possible.

2. An unchanged sequence of general engineering courses (ENGR 201, 301, 302, 401) at 200-, 300- and 400-level that are common to all the engineering majors at Victoria University of Wellington. These courses include topics such as report writing and presentation, project management, group work and ethics. These courses are taken by all students from all three majors and will remain unchanged from the current offering.

3. A restructured core of required courses at 200-, 300- and 400-level to provide a broad coverage of essential electrical and electronic engineering topics as well as further programming, mathematics and suitable electrical and electronic design skills. It will provide students with the essential skills expected from a modern Electrical and Electronic Engineering major. Three specific courses are added to strengthen areas of deficiency recognised both during benchmarking and in feedback from ENZ. These new core courses are as follows:

- A second-year course (EEEN 201) to strengthen electrical and mechanical design, prototyping and testing skills. This is an area where we not only showed a deficiency during our benchmarking exercise, but in the previous ENZ accreditation visit a lack of foundation level mechatronics course material was also highlighted.
- A new third-year course on small scale power generation and electrical machines (EEEN 313), providing more explicit electrical content as required by the major. This is focussed at the

machine and nano/micro-grid level to provide a differentiation in our offering from the other ENZ providers.

- A new fourth year course on compliance and sustainability (EEEN 401) with a focus on applied electromagnetics. This is partly in response to feedback from the last ENZ accreditation visit that recommended a greater focus on sustainability issues in the final year programme of the BE(Hons).

4. The availability of elective courses at 300- and 400 level to allow students to satisfy the requirements of an optional Specialisation by completing specified selected courses in a defined area closely related to the major. This will enable students to complement their major with a recognised Specialisation in one of Renewable Energy Systems Engineering, Robotics, Machine Learning or Communications Engineering.

5. The final year programme will consist of the conventional full-year research and development project (ENGR489), the required general engineering course (ENGR 401), the new core course (EEEN 401) and a selection of courses from a suite of high-level courses in different areas of Electrical and Electronic Engineering.

The introduction of these changes to BE(Hons) will have consequential changes to the Electronic and Computer Systems (ELCO), Applied Physics (APHS), Physics (PHYS) and Renewable Energy Systems (RESY) majors in the BSc. The School has a joint teaching programme with Xiamen University of Technology (XMUT) in China and under this arrangement students from XMUT can transfer into the BSc (ELCO) at the start of their third year. The proposed relabeling/restructuring of the 200-level courses are sufficiently small that the programme will still be consistent with the Joint Programme agreement with XMUT.

In addition, consequential changes will be made to other relevant schedules and minor clean-up will be accomplished in the process.

A3 Proposed amendments

In the Major Requirements of the BE(Hons) (p. 313, 2020 Calendar) amend as follows:

Electrical and Electronic ~~and Computer Systems~~ Engineering (~~EC~~EEEN)

(a) (ENGR 121, 122) or (MATH 142, 151); (ENGR 141, 142) or (PHYS 114, 115)

(b) COMP 103, ~~EC~~EEEN 201, 202, 203, 204, 220, ENGR 222, NWEN 241

(c) EEEN 301, 313, 315, 320~~1, MATH 244 (c) At least one course form COMP 261, MATH 245, NWEN 241, 243, SWEN 221~~

~~(d) At least one course form (COMP 307, ECEN 302, 303, 310, NWEN 301, 302, 304, SWEN 303)~~

(d~~e~~) EEEN 401; ~~A~~at least three courses from ~~EC~~EEEN402~~1~~ – 439, ~~ENGR 440, one further course from COMP 421~~ AIML 425, 429, RESE 411, 412~~ ECEN 401 – 479, ENGR 440, 441, NWEN 402 403 404 or SWEN 422~~

Note: AIML 425 and 429 are being introduced in a concurrent CUAP proposal (MAI/1, MCompSc/2, MSc/5, BSc(Hons)/15, PGCertSc/4, PGDipSc/4); if that proposal is not approved, these courses will be replaced by existing courses COMP 421 and 471. ENGR 222 is being created in a concurrent proposal (BSc/14, BE(Hons)/14); if that proposal is not approved, ENGR 222 will be replaced by MATH 244.

In the Specialisation Requirements of the BE(Hons) (p. 314, 2020 Calendar) add:

A student completing an Electrical and Electronic Engineering major may obtain a specialisation by including courses as follows:

Communication Engineering (CMNG)
EEEN 220, NWEN 243, EEEN 310, 320, 411, one of (EEEN 410 or 421)

Machine Learning (MLEN)
EEEN 220, 320, COMP 307, 309, AIML 425, 429

Renewable Energy Systems Engineering (RESE)
EEEN 203, 313, RESE 321, 322, 411, 412

Robotics (ROBO)
EEEN 201, 315, 325, COMP 309, EEEN 425, one of (EEEN 415 or 430)

In the Combined Undergraduate Schedule (p. 150-223, 2020 Calendar) amend as follows:

EEEN 201	Mechatronic Design and Prototyping	15	P COMP 102 or 112; ENGR 101, 110; ENGR 121 or MATH 141 or equivalent; X ECEN 201	BE(Hons), BSc
ECEEEN 202	Digital Electronics and Microcontrollers	15	P one of (ENGR 101, 142, PHYS 115); 15 pts from (ENGR 121, 122, 123, MATH 141, 142, 151, 161); X PHYS 234 ECEN 202	BE(Hons), BSc
ECEEEN 203	Analogue Circuits and Systems Analysis	15	P (ENGR 122 or MATH 142); (ENGR 142 or PHYS 115); X PHYS 235 ECEN 203	BE(Hons), BSc
ECEEEN 204	Electronic Design Devices	15	P (ENGR 122 or MATH 142); (ENGR 142 or PHYS 115); X PHYS 235; ECEN 201 and 203 prior to 2016 ECEN 204	BE(Hons), BSc
ECEEEN 220	Signals, and Systems and Statistics I	15	P (ENGR 121, 122) or (MATH 142, 151); X ECEN 220	BE(Hons), BSc
ECEEEN 301	Computer Architecture and Embedded Systems	15	P EEEN 202 (or ECEN 202), NWEN 241 203; X ECEN 301, NWEN 342 PHYS 340	BE(Hons), BSc
ECEN 302	Integrated Digital Electronics	15	P ECEN 202 (or PHYS 234), ECEN 204	BE(Hons), BSc
ECEN 303	Analogue Electronics	15	P ECEN 203 (or PHYS 235), ECEN 204; X PHYS 341	BE(Hons), BSc
ECEEEN 310	Communication Engineering	15	P EEEN 220 (or ECEN 220); X ECEN 310 CSEN 303	BE(Hons), BSc
EEEN 313	Power Electronics and Electrical Machines	15	P EEEN 203 (or ECEN 203), EEEN 204 (or ECEN 204)	BE(Hons), BSc
ECEEEN 315	Control and Instrumentation Systems Engineering	15	P EEEN 203 (or ECEN 203) (or ECEN 220 prior to 2016); X ECEN 315 PHYS 422	BE(Hons), BSc
ECEEEN 3201	Engineering Signals, Systems and Statistics II	15	P (ENGR 121, 122) or (MATH 142, 151), 30 200-level ECEN pts EEEN 220 (or ECEN 220); X ECEN 321 220 prior to 2016	BE(Hons), BSc

EEEN 325	Robotic Engineering	15	P EEEN 201; X ECEN 301	BE(Hons), BSc
EEEN 401	Applied Electromagnetics and Compliance	15	P EEEN 313, one of (ENGR 222, MATH 243)	BE(Hons)
EEEN 402	Programmable Digital Logic	15	P EEEN 301 (or ECEN 301); X ECEN 302	BE(Hons)
~~EC~~EEEN 403	Advanced Electronic~~s~~ Instrumentation	15	P EEEN 315 (or ECEN 303);~~(or PHYS 340); ECEN 220 or MATH 243 or 244;~~ X ECEN 403 ~~PHYS 423~~	BE(Hons)
~~ECEN 404~~	~~Electronic Devices~~	~~15~~	~~P ECEN 303; X PHYS 309~~	~~BE(Hons)~~
~~ECEN 405~~	~~Power Electronics~~	~~15~~	~~P ECEN 303 (or PHYS 340)~~	~~BE(Hons)~~
~~EC~~EEEN 410	Advanced Communications Engineering	15	P EEEN 310 (or ECEN 310); X ECEN 410	BE(Hons)
EEEN 411	Coding and Cryptography for Communications	15	P EEEN 310 (or ECEN 310); X MATH 324	BE(Hons)
~~EC~~EEEN 415	Advanced Control Systems Engineering	15	P EEEN 315 (or ECEN 315) ~~(or PHYS 422)~~; X ECEN 415	BE(Hons)
~~EC~~EEEN 421	Advanced Signal Processing	15	P one of (EEEN 320 (or ECEN 321), MATH 318, MATH 377, STAT 332); X ECEN 421 ~~PHYS 421~~	BE(Hons)
~~EC~~EEEN 422	Convex Optimisation	15	P ~~ECEN 220~~ EEEN 320 (or ECEN 320 or 321); X ECEN 422, ECEN 426 in 2014–2016	BE(Hons)
~~EC~~EEEN 425	Advanced Robotic ~~Mechatronic~~ Engineering ~~1: Hardware and Control~~	15	P EEEN 325 (or ECEN 301) ~~(or PHYS 340);~~ X ECEN 425	BE(Hons)
~~EC~~EEEN 426–427	Special Topics	15		BE(Hons)
~~EC~~EEEN 430	Robotic Intelligence and Design ~~Advanced Mechatronic Engineering 2: Intelligence and Design~~	15	P one of (COMP 309, EEEN 325) (or ECEN 301)~~(or PHYS 340)~~ X ECEN 430	BE(Hons)
~~EC~~EEEN 431	Musical Robotics	15	P EEEN 325 (or ECEN 301); X ECEN 427 in 2017–2018, ECEN 431	BE(Hons)
INDN 321	Interactive Products / Ngā Hua Hei Pāhekohekotanga	15	P 60 200-level pts including either 30 pts from the BDI or BAS schedules or one of (MARK 203, COMP 313, EEEN 302 (or ECEN 302), PSYC 325)	BDI
RESE 311	Energy Economic Analysis	15	P (RESE 211, 212) or (RESE 321, 322); one of (EEEN 220 (or ECEN 321), QUAN 102, STAT 193)	BSc, BE(Hons)
RESE 312	Sustainability Modelling Techniques	15	P (RESE 211, 212) or (RESE 321, 322)	BSc, BE(Hons)
~~RESE 313~~	~~Power Electronics and Electrical Machines~~	~~15~~	~~P RESE 211, 212; or ECEN 203~~	~~BSc, BE(Hons)~~
RESE 321	Renewable Energy Generation Engineering	15	P EEEN 203, 204; X RESE 211	BE(Hons), BSc

RESE 322	Renewable Energy Storage Engineering	15	P EEEN 203, 204; X RESE 212	BE(Hons), BSc
RESE 323	Renewable Energy Policy	15	P (RESE 211, 212) or (RESE 321, 322)	BE(Hons), BSc
RESE 411	Power Systems Analysis	15	P ~~RESE~~EEEN 313~~; ECEN 202, 203~~	BE(Hons)
RESE 412	Advanced Development of Renewable Energy Systems	15	P ~~RESE~~EEEN 313	BE(Hons)

In the Major Subject Requirements of the BSc (p. 404, 2020 Calendar), amend as follows:

Applied Physics (APHS)

(a) MATH 142, 151, PHYS 114, 115

(b) 30 points from PHYS 201–299; 30 further points from (~~EC~~EEEN 201–204, MATH 243, 244, PHYS 201–299)

(c) PHYS 343; 30 further points from (~~ECEN 301 or 303~~EEEN 301–399, PHYS 301–399); 15 further approved 300-level points in Physics or a related subject

Electronic and Computer Systems (ELCO)

(a) (ENGR 121, 122) or (MATH142, 151); (ENGR141, 142) or (PHYS114, 115)

(b) COMP102 or 112; EEEN 202, 203, 204, ~~45 points from ECEN201–239;~~ 15 further points from (EEEN 201-299, ENGR 201, NWEN 241) ~~approved 200-level points from COMP, ECEN 201–239, MATH, NWEN or SWEN~~

(c) 60 points from (~~EC~~EEEN 301–399, COMP 309, RESE 321, 322)

Physics (PHYS)

(a) MATH 142, 151, PHYS 114, 115

(b) MATH 243; PHYS 221, 222, 223; 15 further points from (~~EC~~EEEN 201–204, PHYS 201 – 299)*

(c) PHYS 304, 305, 307, 309

Renewable Energy Systems (RESY)

(a) ENGR 141 or (CHEM 114 and PHYS 114); ENGR 111; one of (ENGR 121, MATH 141, 142, 151); STAT 193 or QUAN 102

(b) RESE 211, 212; 30 points from (~~EC~~EEEN 201-2042~~, 203~~, GEOG 214, 215, 217, 222)

(c) RESE 311, 312, 323; one of (GEOG 314, 315, ~~RESE~~EEEN 313)

In the Subject Requirements of the BSc(Hons) (p. 412, 2020 Calendar), amend as follows:

Electronic and Computer Systems (ELCO)

ELCO 489; 60 ~~further~~ approved 400-level points from (~~EC~~EEEN 401-479, RESE 401 - 479~~ENGR 440~~); 30 further approved 400-level points from (~~EC~~EEEN, RESE, ENGR 440, 441, COMP, NWEN, SWEN)

In the Schedule to the BSc(Hons) Regulations (p. 416, 2020 Calendar), amend as follows:

EEEN 401	Applied Electromagnetics and Compliance	15	P EEEN 313, one of (ENGR 222, MATH 244)
EEEN 402	Programmable Digital Logic	15	P EEEN 301 (or ECEN 301); X ECEN 302
~~EC~~EEEN 403	Advanced Electronics~~s~~ Instrumentation	15	P EEEN 315 (or ECEN 303);~~(or PHYS 340); ECEN 220 or MATH 243 or 244;~~ X ECEN 403 ~~PHYS 423~~
~~ECEN 404~~	~~Electronic Devices~~	~~15~~	~~P ECEN 303; X PHYS 309~~
~~ECEN 405~~	~~Power Electronics~~	~~15~~	~~P ECEN 303 (or PHYS 340)~~
~~EC~~EEEN 410	Advanced Communications Engineering	15	P EEEN 310 (or ECEN 310); X ECEN 410
EEEN 411	Coding and Cryptography for Communications	15	P EEEN 310 (or ECEN 310); X MATH 324
~~EC~~EEEN 415	Advanced Control Systems Engineering	15	P EEEN 315 (or ECEN 315) ~~(or PHYS 422)~~; X ECEN 415
~~EC~~EEEN 421	Advanced Signal Processing	15	P one of (EEEN 320 (or ECEN 321), MATH 318, MATH 377, STAT 332); X ECEN 421 ~~PHYS 421~~
~~EC~~EEEN 422	Convex Optimisation	15	P ~~ECEN 220~~ EEEN 320 (or ECEN 320 or 321); X ECEN 422, ECEN 426 in 2014–2016
~~EC~~EEEN 425	Advanced Robotic ~~Mechatronic~~ Engineering ~~1: Hardware and Control~~	15	P EEEN 325 (or ECEN 301) ~~(or PHYS 340);~~ X ECEN 425
~~EC~~EEEN 426–427	Special Topics	15	
~~EC~~EEEN 430	Robotic Intelligence and Design ~~Advanced Mechatronic Engineering 2: Intelligence and Design~~	15	P one of (COMP 309, EEEN 325) (or ECEN 301)~~(or PHYS 340)~~ X ECEN 430
~~EC~~EEEN 431	Musical Robotics	15	P EEEN 325 (or ECEN 301) ; X ECEN 427 in 2017–2018, ECEN 431
RESE 411	Power Systems Analysis	15	P ~~RESE~~EEEN 313~~; ECEN 202, 203~~
RESE 412	Advanced Development of Renewable Energy Systems	15	P ~~RESE~~EEEN 313

In the Subject Requirements of the MSc (p. 425, 2020 Calendar), amend as follows:

Electronic and Computer Systems (ELCO)

Part 1 ~~ELCO 580;~~ 60 ~~further~~ approved 400 level points from (~~EC~~EEEN or RESE 401-479, ENGR 440); 60~~30~~ further approved 400-level points from (COMP, ~~EC~~EEEN, ELCO, ENGR 440, 441, NWEN, RESE or SWEN) ~~points~~.

In the Schedule to the MSc Regulations (page 429, 2020 Calendar), amend as follows:

Schedule to the MSc Regulations

Part 1

Course	Title	Pts	Prerequisites (P), Corequisites (C), Restrictions (X)
~~ELCO 580~~	~~Research Preparation~~	~~30~~	

In the Subject Requirements of the PGCertSc (p. 431, 2020 Calendar), amend as follows:

Electronic and Computer Systems (ELCO)

45 points from an approved combination of ~~EC~~EEEN 401–440, RESE 401–439, ELCO 489~~, 580~~; 15 further approved 400-level points from the BE(Hons) schedule

In the Subject Requirements of the PGDipSc (p. 433, 2020 Calendar), amend as follows:

Electronic and Computer Systems (ELCO)

90 points from an approved combination of ~~EC~~EEEN 401–479, RESE 401-439, ENGR 440, ELCO 489~~, 580~~;
30 further approved 400-level points from the BE(Hons) schedule

A4 Implications and resources

The proposed changes will require some additional teaching load, and this has been considered in discussions with the relevant staff and detailed in the following section. However, in all cases, the School is confident that it has the resources to offer the programme, and that the changes will produce a more flexible engineering major with greater international recognition and enhanced enrolment, which will result in increased EFTS for the courses in the major.

The following are considered as the key areas with academic staff or resource implications:

Academic staff

There are currently twelve ECS staff members teaching in ECEN and RESE courses. Four of these academics are part of the Renewable Energy group, as the School hosts the Chair in Sustainable Energy Systems. This staffing level is sufficient to ensure teaching of all courses required for the major, with workload managed by rotation of 400-level courses (not all 400-level courses need to be offered every year for students to be able to complete the major and any of the specialisations). Academic staff are well supported by electronics technicians, computer and network support staff and student support staff. The group also has a large number of postgraduate students from whom tutoring support can be drawn.

Library

According to the Subject Librarian for the School of Engineering and Computer Science, the Library already has a lot of material in this area to support existing courses and research, and is already collecting material in appropriate subject areas, and at the correct academic level, to support this revised BE(Hons) major, including the proposed new courses EEEN 201, 313, 325, 401, 402, 411, and RESE 321 and 322. Any additional books, journal subscriptions and databases to support this revised major can be acquired through existing Library processes and within the existing budget. The Library already provides access to many relevant databases and online platforms, including Compendex and Inspec through Elsevier's Engineering Village platform, IEEE Xplore, O'Reilly Safari Online, IET Ebook collections pre-2019 titles, Elsevier's ScienceDirect and Scopus platforms, and ACM Digital Library journals.

The proposal indicates insignificant additional demand on other Library support services and existing Library resources are expected to be able to accommodate the anticipated increase in student numbers.

Teaching facilities and support

Feedback has been sought from the Manager of Course Administration & Timetabling, Student and Academic Services. Comments on potential timetabling difficulties resulting from the proposal will be addressed by the School during the 2020 timetabling process.

A refurbishment of laboratory undergraduate laboratory space in ECS is currently in progress and will be completed early in 2020. This will then provide the laboratory facilities for use in EEEN and RESE as detailed below. These facilities will be adequate to accommodate the courses planned in the new major.

Room	Number of Workstations	Description and purpose
LB217	18	Teaching laboratory, mainly used for 200 level courses
CO249	30	Teaching Laboratory, mainly used for 300 and 400 level courses
AM407	17	Teaching laboratory, intended for renewable energy laboratories
CO239	14 – 28 depending on configuration	Project laboratory intended for final year EEEN project students (ENGR 489)
AM219	12	Flexible laboratory space that can be configured as either teaching or project space.

Anticipated enrolments

Over the previous ten years the number of new students enrolling in an ECEN major in the BE(Hons) has averaged at approximately 40 students per year, with numbers relatively flat over this time. We expect that the proposed changes will increase these numbers, both by attracting students into a better defined, internationally recognised engineering major, but also by being able to effective marketing of this major through the clearly defined specialisation areas. We are hoping to see at least a 50% increase in EFTS over the next five years as a result of this rename and restructure.

Administrative implications

Transitional arrangements for the change from ECEN to EEEN, an expected increase in student numbers and the introduction of Specialisations will all lead to an increased administrative load for the faculty. In consultation with the Manager of Student and Academic Services in the Faculties of Science and Engineering strategies have been discussed to ensure a smooth transition for students and to minimise additional workload on the Faculty office.

The current OES, Banner system, and graduation application system do not support specialisations (or minors) well, because students do not realise that they need to specify that they wish to complete a specialisation in order for the Faculty Office to check that they have met the requirements and ensure that the specialisation is recorded on their transcript. All the systems need to prompt students explicitly to enter specialisations at appropriate times.

Programme or course limitations / selection criteria

The BE(Hons) has open enrolment at first year but requires completion of Part 1 at a satisfactory standard in order for students to progress with in BE(Hons). This proposal makes no change to Part 1 of the BE(Hons) and no change to the current criteria for progression in the degree.

Fee implications

Fee structure will be unchanged from the current BE(Hons). The EEEN courses are expected to have the same funding category as the current ECEN-labelled courses.

Website and publication amendments

Material on the website should change extensively to reflect the proposed changes, with focus on the Specialisations. Material will be provided to guide these changes.

Transitional arrangements and other consequential changes

It is intended that new courses will be rolled in from 2021, with the 200-level courses introduced in 2021, the 300-level courses introduced in 2022, and the 400-level courses introduced in 2023. All BE(Hons) (EEEN) students who start their programme in 2021 will need to complete under the new rules. Students who commenced a BE(Hons) (ECEN) in 2020 or earlier will be able to complete under the new rules for the Electrical and Electronic Engineering major, or under the existing rules for the Electronic and Computer Systems major with the substitutions the new rules for the Electrical and Electronic Engineering major described in the table below:

Current ECEN Regulations	**Substitute courses for students completing under the current ECEN regulations**
(b) COMP 103, ECEN 202, 203, 204, 220, 301, 315, 321, MATH 244	COMP 103, EEEN 202, 203, 204, 220, 301, 315, 320, ENGR 222 or MATH 244
(c) At least one course from COMP 261, MATH 245, NWEN 241, 243, SWEN 221	No change.
(d) At least one course from COMP 307, ECEN 302, 303, 310, NWEN 301, 302, 304, SWEN 303	At least one course from COMP 307, EEEN 310, 313, NWEN 301, 302, 304, SWEN 303, RESE 321, EEEN 325
(e) At least three courses from ECEN 401-439, ENGR 440; one further course from COMP 421, ECEN 401-479, ENGR 440, ENGR 441, NWEN 402, 403 or SWEN 422	At least three courses from EEEN 401-439, ENGR 440, one further course from COMP 421, 471 (in 2020), AIML 425, 429, ECEN 401-479, ENGR 440, ENGR441, NWEN 402, 403, RESE 411, 412 or SWEN 422

BSc (ELCO) students who started before 2021 will be permitted to complete under the existing regulations, substituting EEEN courses in place of the ECEN courses in the ELCO major requirements.

Internships, field trips and other external arrangements

The proposed new major makes no change to the work experience requirements currently required for all students in the BE(Hons).

A5 Treaty of Waitangi

Enrolments from Māori students into the first year of the ECEN major over 2009–2019 has been modest but steady, with an average of 8% Māori students in the first-year cohort over this time. However, the graduating records over this same period show less than 4% of Māori students in the graduating cohort. Addressing this loss in Māori students, particularly between first and second year to ensure a strong and viable stream of Māori graduates in this subject area will be the primary focus of the School in meeting its commitment to the Treaty of Waitangi in this new major. This will be achieved with coordinated and committed efforts including:

- In coordination with the Āwhina team, support Māori students particularly during their first year in the technical aspects of their studies, but additionally support potential social issues.
- Outreach into secondary school with high Māori rolls to not only inspire students to a potential career in engineering, but also give advice and selection of subjects essential for engineering and science studies.
- Commit to the appointment of an engineering student support coordinator.

The School has also identified a number of courses in the programme where examples and issues of particular relevance to Māori will be incorporated in the course, especially RESE 311 and 312, EEEN 401. ENGR 201 and 401. The School will encourage lecturers to find further courses where such material can be introduced.

A6 Consultation

Engineering New Zealand was consulted during the planning process. Their initial feedback strongly indicated a preference that topics such as Robotics or Renewable Energy should not be offered as specialist engineering majors but should rather be included in a broader engineering major. This was the driving force for the current name and structure. A letter of support for the current proposal is included as an Appendix.

The VUW Engineering Advisory Board was also consulted and provided positive feedback and input to the proposed changes. The Advisory board contains representatives from both the University of Auckland and Canterbury University.

Programme amendment

Proposal name	Change ECEN major to EEEN
Faculty	Engineering

Appendix

Proposal name	Change ECEN major to EEEN

Consultation	**Response to feedback**
Prof Peter Chong, Head of Department, Electrical and Electronic Engineering, Auckland University of Technology	Thanked us for informing them; they have no issues with the proposal.
Prof Gourab Sen Gupta, Academic Dean, Food and Engineering, Massey University	In general, supportive; but one reservation about the mechatronics course in an EEE programme.
[redacted] School of Engineering, University of Waikato	Supported the proposal
[redacted] Electrical and Computer Engineering, University of Canterbury	Identified no problems with the proposal
[redacted] University of Auckland	
Brett Williams, General Manager, Engineering New Zealand	Supported the proposal. Indicated that they would consider it to be a change to an accredited programme, rather than a new programme requiring accreditation.

Course Description: EEEN 201 (2021,T2)

Course title	Mechatronic Design and Prototyping		
Short title	Mechatronic Design	**Point value**	15
Course coordinator	TBC	**NZQF level**	6
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P COMP 102 or 112; ENGR 101, 110; ENGR 121 or MATH 141 or equivalent; X ECEN 201		
Prescription	This course will equip students with basic understanding of mechanical theory and the skills of electronic and mechanical design and construction so that they can successfully design and complete a moderately complex project. A presentation of this project work forms an integral part of the course.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	18
The course will be taught through a combination of lectures and laboratory		**Tutorials**	
		Seminars	
		Labs/Studios	36
		TOTAL	54

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Configure a microcontroller to interface with a variety of sensors and actuators to implement data acquisition and control (BE Graduate Attribute 3(a), 3(b).
2	**Demonstrate the understanding of a range of mechanical principles in relation to engineering design (BE Graduate Attribute 3(a), 3(c).**
3	Use a variety of rapid prototyping techniques and tools to produce an electromechanical prototype (BE Graduate Attribute 3(c), 3(f).
4	Apply an engineering design process to achieve a project outcome (BE Graduate Attribute 3(d), 3(f).

	Assessment items and workload per item	**%**	**CLO(s)**
1	Two in-term tests (1 hour each)	40%	1,2,4
2	Laboratory exercises and reports (3 hours per week)	20%	1,2,3
3	Design project (60 hours)	40%	1,2,3,4

Mandatory course requirements	None

The course contributes to the graduate attributes of the BE(Hons) and the BSc(ELCO)

Course Description: EEEN 202 (2021,T1)

Course title	Digital Electronics and Microprocessors		
Short title	Digital Electronics	**Point value**	15
Course coordinator	TBC	**NZQF level**	6
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P one of (ENGR 101, 142, PHYS 115); 15 pts from (ENGR 121, 122, 123, MATH 141, 142, 151, 161); X ECEN 202		
Prescription	An introduction to the design and construction of digital electronic instruments. Following a review of binary arithmetic and Boolean algebra, the course will focus on the design of digital circuits using both combinatorial and sequential logic. Further work will study microprocessor architectures, programming and interfacing and the conversions of digital and analogue signals.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The course will be taught through lectures and tutorials and with a strong focus on laboratory design and construction skills.		**Tutorials**	12
		Seminars	
		Labs/Studios	30
		TOTAL	66

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Describe the properties, construction and operating characteristics of digital integrated circuits from the most important CMOS Logic families. (BE graduate attribute 3(a))
2	Use the understanding of the basic logic operations and logic circuit elements to create digital circuits. (BE graduate attribute 3(a,b))
3	Design synchronous sequential circuits. (BE graduate attribute 3(b,c))
4	Explain the basic architecture of a microcontroller (BE graduate attribute 3(a))
5	Program a microprocessor in assembly language to implement an embedded system. ((BE graduate attribute 3(a, b))

	Assessment items and workload per item	**%**	**CLO(s)**
1	Two design projects	30%	1,2,3
2	Laboratory work (3 hrs per week)	20%	2,3,5
3	Two Tests (90 min each)	50%	1, 2, 3, 4, 5
Mandatory course requirements	None		

This course contributes to the graduate attributes of the BE(Hons) and the BSc(ELCO)

Course Description: EEEN 203 (2021,T2)

Course title	Circuit Analysis		
Short title	Circuit Analysis	**Point value**	15
Course coordinator	TBC	**NZQF level**	6
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P (ENGR 122 or MATH 142); (ENGR 142 or PHYS 115); X ECEN 203		
Prescription	This course covers the analysis of analogue electrical and electronic circuits. Topics covered include basic circuit theorems, operational amplifier circuits, the use of phasors for AC circuit analysis and the Laplace transform for switched systems. The use of computational and measurement tools for circuit characterisation is also covered.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The theory component of the course will be taught in two face to face weekly lectures and a weekly tutorial. The course requires mastery of the mathematical processes for circuit analysis, so students are expected to spend significant non-contact hours working on practice problems. The tutorial sessions will be used to support this work on practice problems, and the tests will assess the development of this skill. A series of six three-hour laboratory sessions will enable students to develop fundamental skills in the use of: 1. Basic electronic test equipment, 2. Software for circuit analysis and data analysis,		**Tutorials**	12
		Labs/Studios	18
		TOTAL	54

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Formulate differential equation-based models of analogue circuits containing passive components and operational amplifiers. (BE graduate attribute 3(a,c))
2	Use a range of circuit analysis techniques to find unknown voltages, currents and power. (BE graduate attribute 3(a))
3	Apply phasor and Laplace transform based circuit analysis techniques. (BE graduate attribute 3(b))
4	Describe, measure and characterise first and second order systems in the frequency domain. (BE graduate attribute 3(b))
5	Competently use electronic test equipment to measure analogue circuit performance. (BE graduate attribute 3(d,e,f))
6	Use industry standard software tools for the analysis of measured circuit data and simulate analogue circuit performance. (BE graduate attribute 3(f))

	Assessment items and workload per item	**%**	**CLO(s)**
1	Laboratory sessions (5 of 3-4 hours each, including write-up)	20	5, 6
2	2 Tests (1 hour each)	20	1 – 4
3	2 Assignments (approx. 5 hours each)	10	1 - 4
3	Final Examination (2 hours)	50	1 – 4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must
Achieve at least a D grade in the final examination. *Justification: to give confidence that the circuit analysis techniques have been learned long term, not just briefly in preparation for the tests.*	

This course contributes to the graduate attributes of the BE(Hons) and the BSc(ELCO)

Course Description: EEEN 204 (2021,T1)

Course title	Electronic Devices		
Short title	Electronic Devices	**Point value**	15
Course coordinator	tbc	**NZQF level**	6
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P (ENGR 122 or MATH 142); (ENGR 142 or PHYS 115); X ECEN 204		
Prescription	This course introduces fundamental electronic devices and their circuit applications. Topics include semiconductor fundamentals, diodes, transistors and operational amplifiers and the operation and application of special function diodes such as light emitting diodes and solar cells. Prototyping and testing of practical circuits using these electronic devices will be addressed in the laboratory sessions.		
Student workload hours	150 hrs	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The theoretical aspects of the course will be taught through a combination of lectures and tutorials. At the same time a strong emphasis is placed on practical skills and the use of measurement instrumentation, design construction and testing skills are covered in laboratory work.		**Tutorials**	12
		Seminars	
		Labs/Studios	30
		TOTAL	66

Course learning objectives (CLOs)	Students who pass this course will be able to:		
1	Use a range of electronic measuring instruments (BE Graduate Attribute 3(a)).		
2	Use their understanding of the basic characteristics of semiconductor materials to explain the design of diodes, transistors and other related devices (BE Graduate Attributes 3(a) & 3(b)).		
3	Describe the functions and current-voltage characteristics of diodes and transistors and calculate circuit characteristics and behaviour employing these devices (BE Graduate Attribute 3(a) & 3(b)).		
4	Design, prototype and test basic circuits that contain active devices (BE Graduate Attribute 3(c) & 3(f)).		
Assessment items and workload per item		**%**	**CLO(s)**
1	10 Labs: work logs, demonstrations, and brief reports (scheduled lab sessions plus 1 additional hour per lab)	25%	1, 2, 3 4
2	Two design exercises with design reports (20 hrs each)	25%	1,3,4
3	Test (1 hour)	10%	2,3,4
4	Exam (2 hours)	40 %	2,3,4
Mandatory course requirements	None		

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 220 (2021,T2)

Course title	Signals, Systems and Statistics I		
Short title	Signals, Systems and Statistics I	**Point value**	15
Course coordinator	TBC	**NZQF level**	6
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P (ENGR 121, 122) or (MATH 142, 151); X ECEN 220		

Prescription	The course introduces analysis techniques for signals and linear time-invariant systems as well as fundamentals of engineering statistics. The first part of the course focuses on continuous time signals and systems and Fourier transform techniques, with applications to circuit analysis and communication systems. The second part of the course introduces probability mass and density functions, random variables and functions of random variables.

Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	36 hrs
Taught during face-to-face lectures and tutorials. The latter will be primarily used to work through example problems. Labs will feature programming exercises using Matlab, Python or similar.		**Tutorials**	12 hrs
		Seminars	
		Labs/Studios	20 hrs
		TOTAL	68 hrs

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Analyse continuous-time signals and linear time-invariant systems. (BE graduate attribute 3(a)).
2	Derive continuous-time Fourier transforms and use them in the characterisation of systems and signals (BE graduate attribute 3(a), 3(c)).
3	Use random variables to model observations in engineering applications. (BE graduate attribute 3(a), 3(c)).
4	Select an appropriate standard family of probability mass or density functions for a task, and estimate its parameters (BE graduate attribute 3(a), 3(c)).
5	Use an appropriate programming language to solve problems in statistics, linear systems and signals encountered by engineers (BE graduate attributes 3(f)).

	Assessment items and workload per item	**%**	**CLO(s)**
1	10 weekly assignments (2 hrs each)	15%	1,2,3,4
2	5 lab exercises done in the lab sessions (total 20 hours)	10%	1,2,3,4,5
3	2 tests (1 hour each)	30%	1,2,3,4
4	Final examination (2 hours)	45%	1,2,3,4

Mandatory course requirements — In addition to achieving an overall pass mark of 50%, students must:

- Achieve at least 40% in the final examination.
- Submit reports demonstrating completion of all labs.

Justification: ensures the students demonstrate the understanding of key ideas independent of any external assistance and that students have learned the practical skills assessed only in the labs

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 301 (2021,T1)

Course title	Computer Architecture and Embedded Systems		
Short title	Embedded Systems	**Point value**	15
Course coordinator	Robin Dykstra	**NZQF level**	7
Qualification schedule:	BSc, BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 202 (or ECEN 202), NWEN 241; X ECEN 301, NWEN 342		
Prescription	The course develops an understanding of the structure of computers, how they execute programs and how they interface to the real world. The course first covers ARM assembly language programming, data representation, computer arithmetic, microprocessor architecture at the hardware level and a comparison with GPU, DSP and FPGA architectures. The course then explores the design flow and application of embedded computers in real-world engineering problems. Practical experience is gained through the use of microprocessors, techniques to interface them with the physical world, development tool chains, debugging and embedded Linux operating systems.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
During the trimester there will be two lectures per week plus one hour for tutorials. The lab component will consist of ten lab sessions of three hours each.		**Tutorials**	12
		Seminars	
		Labs/Studios	30
		TOTAL	66

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Explain the main components of a typical computer and their interconnections, standard ways of representing data in hardware, the arithmetic and logic unit (ALU), data paths, pipelining, caches, and I/O. (BE graduate attribute 3(a))
2	Analyse the effects of the hardware logic designs in a computer on the basic operations in programming languages and the performance of computer programs. (BE graduate attribute 3(a))
3	Use an embedded computer to solve a variety of real-world problems, with and without the linux embedded operating system. (BE graduate attribute 3(b) 3(f))
4	Identify and explain the advantages and disadvantages of low-level programming versus using an embedded operating system. (BE graduate attribute 3(b) 3(f))
5	Effectively communicate in a written manner the methodology, design compromises, results and evaluation of embedded computer-based solutions to real-world problems. (BE graduate attribute 2(b) 3(f))

	Assessment items and workload per item	**%**	**CLO(s)**
1	2 Tests (1 hour each)	40%	1, 2, 4, 5
2	2 Assignments (5 hours each)	10%	1, 2, 5
3	10 Laboratory exercises / report (3 hour lab session plus 2 hours for analysis and write-up)	30%	2, 3, 4, 5
4	1 Project report (20 hours)	20%	3, 5

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
achieve at least a D grade for 80% of the labs. *Justification: The practical work in the labs is critical to CLO 3, and is not assessed in the tests/assignments.*	

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 310 (2021,T1)

Course title	Communication Engineering		
Short title	Communication Engineering	**Point value**	15
Course coordinator	TBC	**NZQF level**	7
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P EEEN 220 (or ECEN 220); X ECEN 310		
Prescription	The course provides students with an introduction to the physical layer of communication systems. It begins with basics of analog communications (AM, FM). Digital communications topics include intersymbol interference and Nyquist pulse shaping for bandlimited channels, matched filter receivers for additive noise channels and their error rate performance. Also covered are fundamentals of wireless fading channels and diversity receivers, followed by a brief overview of equalisation and OFDM.		
Student workload hours	150	**Contact Hours**	

Teaching/learning summary	**Lectures**	24
Taught during face-to-face lectures and tutorials. The latter will be primarily used to work through example problems. The labs/projects will feature programming exercises using Matlab.	**Tutorials**	10
	Seminars	
	Labs/Studios	12
	TOTAL	46

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	describe various analogue and digital modulation techniques, including their relative merits (BE graduate attribute 3(a))
2	design receivers to mitigate the effects of noise and interference of bandlimited channels (BE graduate attributes 3(a),3(c))
3	describe wireless propagation channel models in different operating environments (BE graduate attributes 3(a),3(c))
4	design Monte Carlo simulations to evaluate the performance of wireless systems (BE graduate attributes 3(d),3(f))

	Assessment items and workload per item	**%**	**CLO(s)**
1	4 Assignments (approx. 6 hours each)	16%	1, 2, 3, 4
2	1 Lab (approx. 10 hours)	9%	2, 4
3	1 Project (approx. 20 hours)	15%	3, 4
4	Test (1 hr)	20%	1, 2
5	Exam (2 hrs)	40%	1, 2, 3, 4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve an average mark of at least 40% in the exam *Justification: ensures the students demonstrate the understanding of key ideas and achieved CLOs independent of any external assistance.*	

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 313 (2021,T2)

Course title	Power Electronics and Electrical Machines		
Short title	Power Electronics	**Point value**	15
Course coordinator	Prof Ramesh Rayudu	**NZQF level**	7
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 203 (or ECEN 203), EEEN 204 (or ECEN 204)		
Prescription	This course covers the theory, design and application of electrical machines, power electronic circuits, electric drives, and the transformation and control of electrical energy. The course introduces the fundamentals of electromagnetics and electrical machines, as well as power electronics, and discusses the design issues related to electrical drives and small-scale power generation. Practical work will involve the design, development, and implementation of solutions to drive motors, convert renewable power, and switch mode power amplifiers.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
Weekly lectures, tutorials, laboratory sessions, and individual assignments during whole course.		**Tutorials**	12
		Labs/Studios	24
		TOTAL	60

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Explain the advantages/disadvantages of different converter topologies (WA2)
2	Evaluate the key features and operational aspects of power electronic systems (WA2)
3	Evaluate the key features and operational aspects of electric machines and their converter systems (WA2)
4	Design electric power conversion systems using common components and configurations (WA3)

	Assessment items and workload per item	**%**	**CLO(s)**
1	Power Electronics assignment (14 hours)	15%	1, 2
2	Electrical Machines assignment (14 hours)	15%	1, 3
3	4 Laboratory exercises with a report on their learning (completed in the scheduled lab time)	10%	2, 3, 4
4	Two Tests (45 mins each)	20%	1, 2, 3, 4
5	Design project with a 2000-word report (36 hours)	40%	4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:

- Achieve an average of at least 40% on the two tests, and
- Achieve at least 40% on the final design report.

Justification: the tests and the design project address important aspects of the CLOs that are not assessed elsewhere.

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 315 (2021,T1)

Course title	Control and Instrumentation		
Short title	Control and Instrumentation	**Point value**	15
Course coordinator	TBC	**NZQF level**	7
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P: EEEN 203 (or ECEN 203); X ECEN 315		
Prescription	The course shows how models can be used to analyse, describe and predict the behaviour of mechanical and electrical systems. The use of feedback to alter the properties of these systems to meet desired specifications is presented. A variety of methods are developed for designing control systems, including the use of a PID controller.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The course contact hours consist of two weekly face to face lectures and a weekly tutorial. The lectures cover control theory, while the tutorials cover problem solving, discuss applications of the material and allow preparation for the practical work. Tutorials also allow for discussion of the broader impact of control engineering, in areas such as system safety, energy efficiency and sustainability. The course includes a single trimester long project, done partly in the labs, where students apply the material to the identification and control of a real world system. Students produce two reports of approximately 20 pages outlining their work on the project. Outside of contact hours, students are expected to work on problems taken from the text or elsewhere. These contribute to the assignments, and/or are discussed in tutorial sessions.		**Tutorials**	12
		Labs/Studios	30
		TOTAL	66

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Produce mathematical models of mechanical, electrical and electromechanical systems using differential equations. (Graduate Attributes 3a,c.)
2	Predict the behaviour of a system given a differential equation or transfer function model for the system. (Graduate Attribute 3c.)
3	Understand the concept of feedback and how it influences the response of a system. (Graduate Attribute 3c.)
4	Understand the operation and implementation of lead, lag and PID compensation and be able to design such compensators in continuous time using Root Locus and frequency response techniques. (Graduate Attribute 3b.)
5	Predict and design operational amplifier circuit performance using the principles of negative feedback. (Graduate Attribute 3b.)
6	Analyse a real world system and then design, test and evaluate an appropriate control system to achieve specified objectives. (Graduate Attributes 3b, d, e, f)
7	Produce concise, correctly structured engineering reports, including statistical analysis, graphical presentation of results and discussion of methodological limitations. (Graduate Attribute 2b)

Assessment items and workload per item	**%**	**CLO(s)**

1	Assignments (4) (approx 6 hours each)	30	1 – 5
2	Project Reports (2) (approx 10 hours each)	20	1 – 7
3	Test (1 hour)	10	1 – 5
4	Examination (2 hours)	40	1 – 5

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve a grade of at least 40% for each of the project reports. *Justification: The projects are the only assessment items addressing CLO's 6 and 7*	

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Major/Programme attribute		**CLO(s)**
1	2b (Communication)	7
2	3a (Application of fundamental engineering sciences)	1
3	3b (Synthesise and demonstrate solutions)	4 – 6
4	3c (Formulate and solve models for prediction)	1 – 3
5	3d (Seek required information)	6
6	3e (Deal with uncertainty and risks)	6
7	3f (Practical competence)	6

Course Description: EEEN 320 (2022,T1)

Course title	Signals, Systems and Statistics II		
Short title	Signals, Systems and Statistics II	**Point value**	15
Course coordinator	TBC	**NZQF level**	7
Qualification schedule:	BE(Hons), BScs)		
Prerequisites, corequisites, restrictions	P EEEN 220 (or ECEN 220); X ECEN 321		
Prescription	The course introduces analysis techniques for discrete-time signals and linear time-invariant systems as well as topics in engineering statistics. The first part of the course focuses on discrete-time signals and systems and discrete Fourier transform techniques, with applications to circuit analysis and communication systems. The second part of the course covers topics in engineering statistics, including confidence intervals, statistical tests, and regression, as applied to engineering problems.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	36
Taught during face-to-face lectures and tutorials. The latter will be primarily used to work through example problems. Students will need to spend considerable time studying the material introduced in lectures. Labs will feature programming exercises using Matlab, Python or similar.		**Tutorials**	12
		Seminars	
		Labs/Studios	20
		TOTAL	68

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Apply sampling theory as applied to continuous-to-discrete-time signal conversion. (BE graduate attribute 3(a)).
2	Analyse discrete-time signals and linear time-invariant systems. (BE graduate attribute 3(a)).
3	Derive discrete-time Fourier transforms and use them in the characterisation of systems and signals (BE graduate attribute 3(a), 3(c).
4	Apply statistical tests to and compute confidence intervals for observed data. (BE graduate attribute 3(a), 3(c).
5	Identify relationships between sets of data using linear regression. (BE graduate attribute 3(a), 3(c).
6	Use an appropriate programming language to solve problems in statistics, linear systems and signals encountered by engineers. (BE graduate attributes 3(f)).

	Assessment items and workload per item	**%**	**CLO(s)**
1	10 Assignments (3 hours each)	15%	1,2,3,4,5
2	5 Lab reports (5 hours each including 4 hours in the scheduled lab session)	10%	1,2,3,4,5,6
3	Tests (2 of 1 hours each)	30%	1,2,3,4,5
4	Exam (2 hours)	45%	1,2,3,4,5

Mandatory course requirements — In addition to achieving an overall pass mark of 50%, students must:

- Achieve a grade of at least 40% for the final exam.
- Submit reports demonstrating completion of all labs.

Justification: ensures the students demonstrate the understanding of key ideas independent of any external assistance and that students have learned the practical skills assessed only in the lab.

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: RESE 321 (2021,T1)

Course title	Renewable Energy Generation Engineering		
Short title	Renewable Energy Generation	**Point value**	15
Course coordinator	Dr Jim Hinkley	**NZQF level**	7
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 203, 204; X RESE 211		
Prescription	This course introduces a range of different energy generation systems, and especially those that utilise renewable resources: wind energy (pumping and power), geothermal, hydro (at different scales), solar photovoltaic, solar thermal, and bioenergy. For each technology, the theoretical underpinning is examined – for example, optical physics to harness solar radiation in concentrating solar systems – and the engineering approaches to identify and design efficiency improvements for such systems are established.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
Weekly lectures, tutorials, laboratory sessions, and individual assignments. Practical work will involve the analysis of different generation systems. Project work will entail the technical design and demonstration of efficiency improvements.		**Tutorials**	12
		Labs/Studios	24
		TOTAL	60

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Design advanced, integrated renewable energy generation solutions for given problems.
2	Analyse the sustainability and efficiencies of the generation technology systems.
3	Critically review energy generation technologies to identify efficiency gains that can be achieved.
4	Design and demonstrate an efficiency improvement to energy generation.

	Assessment items and workload per item	**%**	**CLO(s)**
1	Sustainability and efficiency assignment with a 1000-word essay (20 hours total)	20%	1, 2
2	Six laboratory exercises with one-page reports (12 hours)	10%	3
3	Design and demonstration project, with a 1000-word report (20 hours)	25%	3, 4
4	Final exam (2hrs)	45%	1, 2, 3

Mandatory course requirements In addition to achieving an overall pass mark of 50%, students must:

- Achieve 40% on the final exam.

Justification: the exam assesses the overall understanding of concepts, techniques and skills independent of external assistance.

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: RESE 322 (2021,T2)

Course title	Renewable Energy Storage Engineering		
Short title	Renewable Energy Storage	**Point value**	15
Course coordinator	Dr Jim Hinkley	**NZQF level**	7
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 203, 204		
Prescription	This course provides insights into technologies that convert renewable energy generation into useful fuels or power in the economy and society. It will include bioenergy conversion processes, such as gasification, pyrolysis and torrefaction; chemical storage (solid-state and liquid batteries); thermal storage; and pumped and mechanical storage. It examines the underlying physics and chemistry for each technology platform, with related practical experiments in the laboratory. The engineering approaches to identify and design efficiency improvements for such systems are established.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
Weekly lectures, tutorials, laboratory sessions, and individual assignments. Practical work will involve the analysis of different storage systems. Project work will entail the technical design and demonstration of efficiency improvements, with the aim of having a competition between the students in a cohort.		**Tutorials**	12
		Labs/Studios	24
		TOTAL	60

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Design advanced, integrated renewable energy storage solutions for given problems.
2	Analyse the sustainability and efficiencies of the storage technology systems.
3	Critically review energy storage technologies to identify efficiency gains that can be achieved.
4	Design and demonstrate an efficiency improvement to energy storage.

	Assessment items and workload per item	**%**	**CLO(s)**
1	Sustainability and efficiency assignment with a 1000-word essay (20 hours total)	20%	1, 2
2	Six laboratory exercises with one-page reports (12 hours)	10%	3
3	Design and demonstration project, with a 1000-word report (20 hours)	25%	3, 4
4	Final exam (2 hours)	45%	1, 2, 3

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve 40% on the final exam. *Justification: the exam assesses the overall understanding of concepts, techniques and skills independent of external assistance.*	

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 325 (2021,T2)

Course title	Robotic Engineering		
Short title	Robotic Engineering	**Point value**	15
Course coordinator	Dale Carnegie	**NZQF level**	7
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P EEEN 201; X ECEN 301		
Prescription	This course presents the principles of robotic and mechatronic design, construction and control. It covers both the theoretical and practical aspects of integrating mechanical, electronic and software components.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
This course is a combination of theoretical material and the practical applications of that material. As such, there is a combination of lectures (two per week), tutorials (approximately one per week) and three-hour laboratory sessions (one per week). These will be delivered over the duration of a normal semester.		**Tutorials**	10
		Seminars	0
		Labs/Studios	33
		TOTAL	67

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Interface a variety of sensors and actuators to an embedded processor (BE Graduate Attribute 3(b), 3(f))
2	Understand and be able to apply mechanical theory and practice in a mechatronic/robotic setting (BE Graduate Attribute 3(a), 3(b), 3(c), 3(f))
3	Design and implement an integrated robotic system (BE Graduate Attribute 3(a), 3(b), 3(c), 3(d), 3(e), 3(f))
4	Use a variety of rapid prototyping techniques to develop a proof-of-concept robotic system (BE Graduate Attribute 3(f))
5	Implement a robotic control system using appropriate machine learning techniques (BE Graduate Attribute 3(a), 3(c), 3(e))

	Assessment items and workload per item	**%**	**CLO(s)**
1	Two x one-hour tests @15% each	30%	2, 4
2	Five formative 10-minute quizzes @ 1% each	5%	2, 4
3	Two written assignments @ 15% each. They should each take 5-6 hours to complete.	30%	2, 4, 5
4	Seven laboratory quizzes/exercises (done in the lab sessions).	15%	1, 3
5	Practical Robotic/Mechatronic design and implementation project. This should take students 6-9 hours in the laboratory and 3 hours to write up.	20%	1, 3, 5

Mandatory course requirements — In addition to achieving an overall pass mark of 50%, students must:

- Achieve an average grade of at least 40% over the two tests
- Achieve at least a D for the project.

Justification: ensures the students demonstrate the understanding of key ideas independent of any external assistance and that students have learned the practical skills assessed only in the project.

This course contributes to the Graduate attributes of the BE(Hons) and the BSc (ELCO)

Course Description: EEEN 401 (2021,T1)

Course title	Applied Electromagnetics and Compliance		
Short title	Electromagnetics & Compliance	**Point value**	15
Course coordinator	TBC		
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 313, one of (ENGR 222, MATH 244)		
Prescription	This course will address the engineering applications of electromagnetism, including propagation of signals, low EM emissions circuit board design, radio waves and antennas, grounding, high voltage insulators, and electrical safety design and testing. An important focus of the course is to become familiar with the international framework of product compliance and sustainability.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24hrs
During the trimester there will be two lectures plus 1 tutorial per week. The lab component will consist of four laboratory sessions of three hours each.		**Tutorials**	12hrs
		Seminars	
		Labs/Studios	12hrs
		TOTAL	48hrs

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Be able to describe the propagation of electromagnetic waves in free space and transmission lines (BE graduate attribute 1(a))
2	Demonstrate the understanding of the key international product compliance and sustainability requirements. (BE graduate attribute 1(a))
3	Demonstrate the understanding of the principles of electrical safety and electromagnetic compliance (EMC) and be able to apply them to designs. (BE graduate attribute 3(a) 3(b) 3(f))
4	Design a suitable antenna and test set to perform EMC tests. (BE graduate attribute 3(f)
5	Choose materials for product designs and packaging that are safe and sustainable. (BE graduate attribute 1(a) 3(f))

	Assessment items and workload per item	**%**	**CLO(s)**
1	2 Tests (1 hour each)	50%	1, 2, 3, 5
2	4 assignments (10 hours each)	30%	1,2,3,4,5
3	4 Laboratory exercises (done in lab sessions, with additional 2 hours each for write-up)	20%	2, 3, 4

Mandatory course requirements	none

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 402 (2021,T1)

Course title	Programmable digital logic and high-level design methods.		
Short title	Programmable digital logic	**Point value**	15
Course coordinator	Robin Dykstra	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 301 (or ECEN 301); X ECEN 302		
Prescription	The course develops an understanding of the structure of Field Programmable Gate Arrays, how to program them and how to interface them to the real world. The topics covered are VHDL programming, logic design, state machine design, I/O, design tools, simulation, timing analysis, debugging, IP block design methodology, softcore microprocessors and system on a chip implementation. Practical experience is gained through the use of professional design tools and hardware to interface FPGAs with the physical world.		
Student workload hours	150hrs	**Contact Hours**	
Teaching/learning summary		**Lectures**	24hrs
During the trimester there will be two lectures per week plus some further hours will be used for tutorials. The lab component will consist of eleven lab session of three hours each.		**Tutorials**	12hrs
		Seminars	
		Labs/Studios	34hrs
		TOTAL	70hrs

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Demonstrate the understanding of Field Programmable Gate Array technology, it's internal architecture and interfaces. (BE graduate attribute 3(a)).
2	Implement a complex digital circuit in an FPGA using VHDL and higher-level design entry approaches (BE graduate attribute 3(f)).
3	Demonstrate the understanding of Field Programmable Gate Array technology design, implementation and debugging flow. (BE graduate attribute 3(a)).
4	Implement a design in an FPGA that includes an embedded softcore microprocessor and a custom hardware block. (BE graduate attribute 3(f)).

	Assessment items and workload per item	**%**	**CLO(s)**
1	2 Tests (1 hour each)	40%	1, 2, 4
2	2 Assignments (10 hours each)	20%	1,2,3,4
3	Laboratory work (done in lab sessions, with additional 1 hours each for write-up)	40%	2,4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Satisfactorily complete at least 80% of the assigned labs. *This ensures the students demonstrate the understanding of all CLOs.*	

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 403 (2021,T1)

Course title	Advanced Electronic Instrumentation		
Short title	Advanced Electronics	**Point value**	15
Course coordinator	Robin Dykstra	**NZQF level**	8
Qualification schedule:	BSc(Hons), BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 315 (or ECEN 303); X ECEN 403		
Prescription	This course develops a deeper understanding of electronic instrumentation and the underlying models and methodologies used in electronic design. Topics covered are: derivation of discrete device models (including noise behaviour) for simulation, radio frequency design and simulation, two port networks, power transfer and impedance matching, transmission lines, high speed PCB design, noise, discrete device and Op Amp low noise amplifier design and Phase Locked Loop modelling and implementation. Practical skills are developed through laboratory simulation and design exercises.		
Student workload hours	150hrs	**Contact Hours**	
Teaching/learning summary		**Lectures**	24hrs
During the trimester there will be two lectures per week plus some further hours will be used for tutorials. The lab component will consist of 4 laboratory-based exercises.		**Tutorials**	12hrs
		Seminars	
		Labs/Studios	12hrs
		TOTAL	48hrs

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Demonstrate the understanding of the basis of the parameters that specify the behaviour of various semiconductor devices and how to use them to design and simulate electronic circuits.
2	Demonstrate the understanding of key Radio Frequency circuit design principles and how to apply them.
3	Design and model Phase Locked Loop circuits.
4	Design circuit boards that contain high speed interconnects.

	Assessment items and workload per item	**%**	**CLO(s)**
1	2 Tests (1 hour each)	50%	1, 2, 3
2	4 Assignments (10 hours each)	30%	1, 2, 3, 4
3	Laboratory exercises (done in lab sessions, with additional 1 hour each for write-up)	20%	3, 4

Mandatory course requirements	None

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 410 (2021,T1)

Course title	Advanced Communications Engineering		
Short title	Advanced Communications Engineering	**Point value**	15
Course coordinator	Pawel Dmochowski	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 310 (or ECEN 310); X ECEN410		

Prescription	The course covers advanced topics in physical layer wireless communications. It begins with a brief introduction to Information Theory, leading to the concept of channel capacity. Multiple antenna techniques for both single and multiple user communications are discussed, including diversity, space time coding and digital beamforming. Large scale systems and advanced channel models are discussed. Matlab system simulations are used throughout the course for evaluating the communication system performance.

Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
Taught during face-to-face lectures and tutorials. The assignments and projects will feature programming exercises using Matlab.		**Tutorials**	8
		Seminars	
		Labs/Studios	
		TOTAL	32

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Demonstrate the understanding of the basic concepts of information theory as applied to wireless communication systems (BE graduate attributes 3(a), 3(b) and 3(c)).
2	Characterise the capacity of additive white Gaussian noise and fading wireless channels (BE graduate attributes 3(a), 3(b) and 3(c)).
3	Demonstrate the understanding of the signal processing techniques used in multi-antenna communications for single and multiple users. (BE graduate attributes 3(a), 3(b) and 3(c)).
4	Evaluate the performance of wireless communication systems by means of computer simulations (BE graduate attributes (3(b) and 3(d) and 3(f)).

	Assessment items and workload per item	**%**	**CLO(s)**
1	Assignments (2, approx. 6 hours each)	10%	1, 2, 3, 4
2	Test (2 hours)	40%	1, 2, 3
3	Projects (2, approx. 15 hours each)	50%	3, 4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve a mark of at least 40% on the test. *Justification: This ensures the students demonstrate the understanding of key ideas and achieved CLOs independent of any external assistance.*	

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 411 (2021,T2)

Course title	Coding and Cryptography for Communications		
Short title	Coding & Cryptography for Comms	**Point value**	15
Course coordinator		**NZQF level**	8
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	P EEEN 310 (or ECEN 310); X MATH 324		
Prescription	The course covers key topics in modern coding theory (finite vector spaces, linear codes, coding bounds, perfect codes, cyclic codes) as applied to wireless communication systems. Further topics include cryptography (classical ciphers, the one-time pad, Shannon's Theorem, linear shift registers, public key cryptography, one-way functions, the RSA cryptosystem, key distribution and digital signatures).		
Student workload hours		**Contact Hours**	
Teaching/learning summary		**Lectures**	36
Taught during face-to-face lectures and tutorials as well as a project. The former are done in conjunction with MATH324, while the project, focusing on applications to wireless communication systems, will be done independently.		**Tutorials**	12
		Seminars	
		Labs/Studios	
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course should be able to:		
1	Demonstrate an understanding of the mathematical foundations that underlay modern codes and cryptosystems.		
2	Solve mathematical problems in the area of codes and cryptosystems, including understanding and developing proofs.		
3	Design and implement a wireless communication system simulation which evaluates the performance of modern error control codes		
Assessment items and workload per item		**%**	**CLO(s)**
1	9 Assignments (3 hrs each)	15%	1, 2
2	2 Tests (1 hr each)	15%	1, 2
3	Exam (3 hours)	50%	1, 2
4	Project (30 hours)	20%	3
Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:		
Obtain at least a D on the Project *Justification: to demonstrate achievement of CLO 3.*			

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 415 (2021,T1)

Course title	Advanced Control Systems Engineering		
Short title	Advanced Control Systems Engineering	**Point value**	15
Course coordinator	TBC	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	EEEN 315 (or ECEN315); X ECEN 415		
Prescription	This course extends previous control studies to cover the use of modern control techniques in shaping the behaviour of complex systems having multiple inputs and outputs, in both discrete and continuous time. Optimal control (LQR) and estimation (the Kalman filter) are introduced. The course concentrates on linear and linearised systems, but some introductory nonlinear material is presented, including applications to robot control.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The course contact hours consist of two weekly face to face lectures and a weekly tutorial. These lectures cover control theory, while the tutorials cover problem solving, including use of the Matlab control toolbox. Tutorials also allow for discussion of the broader impact of control engineering, in areas such as system safety, energy efficiency and sustainability. Outside of contact hours, students are expected to work on substantial control problems using Matlab simulations. Some of these problems are drawn from the areas of robotic or mechatronic system control, and from engineering systems encountered in energy production systems.		**Tutorials**	12
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Produce state space models of both linear and non-linear mechanical, electrical and other real-world systems. (Graduate Attributes 3a,c.)
2	Predict the behaviour of a system and analyse fundamental properties such as stability, controllability and observability. (Graduate Attribute 3c.)
3	Design continuous and discrete time controllers using state-space techniques, including optimal control methods such as LQR (BE graduate attributes 3(a),3(b)),
4	Design Luenberger state observers and Kalman filters, (BE graduate attributes 3(a),3(b),3(e))
5	Use the Matlab software package to solve practical problems in control engineering (BE graduate attributes 3(d),3(f)).

	Assessment items and workload per item	**%**	**CLO(s)**
1	Assignments (4) (approx 12 hours each)	40	1 – 5
2	Practical Tests (2) (2 hours each)	20	1 – 5
3	Examination (2 hours)	40	1 – 4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve a mark of at least 40% across the two practical tests. Achieve a mark of at least 40% in the final examination.	

Justification: The mandatory minimum requirement on the tests is to ensure that the students have at least a basic ability in using Matlab to solve control problems (CLO 5). The minimum requirement on the exam is to provide some assurance that the students have independent ability in CLOs 1 to 4.

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Major/Programme attribute		**CLO(s)**
1	3a (Application of fundamental engineering sciences)	1, 3
2	3b (Synthesise and demonstrate solutions)	3
3	3c (Formulate and solve models for prediction)	2
4	3e (Deal with uncertainty and risks)	4, 5
5	3f (Practical competence)	5

Course Description: EEEN 421 (2021,T2)

Course title	Advanced Signal Processing		
Short title	Advanced Signal Processing	**Point value**	15
Course coordinator	TBC	**NZQF level**	8
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	P one of (ECEN 321, EEEN 320, MATH 318, MATH 377, STAT 332); X ECEN 421		
Prescription	This course provides a geometric intuition to signal processing. This geometric point of view is a powerful tool for the understanding of signal processing techniques including transforms, sampling, time-frequency analysis and wavelets. The course provides the mathematical depth and rigor that is necessary for the study of more advanced topics in signal processing, including stochastic processes and estimation.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	26
Taught using lectures, and tutorials that cover the material of each of the 10 assignments, some of which have a programming content.		**Tutorials**	10
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Apply geometrical intuition to select the right tools to tackle advanced signal and data processing problems.
2	Demonstrate the understanding of and apply the theory of stochastic processes to signal processing problems.
3	Demonstrate the understanding of and apply estimation theory to signal processing problems.
4	Demonstrate the understanding of understand new and emerging techniques at the forefront of signal processing research.

	Assessment items and workload per item	**%**	**CLO(s)**
1	10 written assignments (4 hours each),	30%	1, 2, 3, 4
2	Test (1 hour)	10%	1, 2, 3, 4
3	Final examination (3 hours)	60%	1, 2, 3, 4

Mandatory course requirements	None

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO) and the MSc(ELCO).

Course Description: EEEN 422 (2021,T2)

Course title	Convex Optimisation		
Short title	Convex Optimisation	**Point value**	15
Course coordinator	[Course Coordinator]	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc		
Prerequisites, corequisites, restrictions	P EEEN 320 (or ECEN 320 or 321); X ECEN 422, ECEN 426 in 2014–2016		
Prescription	Convex optimisation problems are common in science, engineering and economics. The course teaches identifying and solving convex optimisation problems. It discusses convex sets and functions, linear and quadratic programs, semi-definite programming, and duality theory. It uses these concepts to solve practical optimisation problems.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
The course has 24 hours of standard lectures and 12 hours of tutorials (1 hour per week), where the assignments are discussed.		**Tutorials**	12
		Seminars	0
		Labs/Studios	0
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Demonstrate an understanding of the fundamental concepts of convex optimization such as convexity, linear, quadratic and semi-definite programs, and duality theory.
2	Recognize and formulate convex optimization problems.
3	Solve convex optimization problems by selecting and implementing suitable algorithms.
4	Use standard software package(s) for solving convex optimization problems.

	Assessment items and workload per item	%	CLO(s)
1	Final examination (2 hours)	45%	1,2,3
2	Two midterm tests (1 hour each)	35%	1,2,3
3	10 weekly assignments (approx 3 hours each)	20%	1,2,3,4

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
Achieve a grade of 40% on the final examination, *Justification: to demonstrate a minimal comprehensive understanding of the material independent of any external assistance.*	

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 425 (2023,T2)

Course title	Advanced Robotic Engineering		
Short title	Advanced Robotic Engineering	**Point value**	15
Course coordinator	Dale Carnegie	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	EEEN 325 (or ECEN 301); X ECEN 425		
Prescription	This course presents advanced principles of robotic and mechatronic design, prototyping, construction and control. It covers both the theoretical and practical aspects of integrating the mechanical, electronic and software components and applies relevant machine learning concepts.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	24
This course is a combination of theoretical material and the practical applications of that material. The main mode of delivery will be 24 face-to-face lectures. The material will be reinforced by practical assignments where groups and individuals will be expected to consult with the lecturer on an appointment basis (expect approximately 12 hours of such individualised tutorial engagement during the course). These will be delivered over the duration of a normal semester.		**Tutorials**	12
		Seminars	
		Labs/Studios	
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Demonstrate an understanding of the integration of the inter-dependent electronic, mechanical and software components of a mechatronic design. (BE Graduate Attribute 3(a), 3(b), 3(c), 3(d), 3(e), 3(f))
2	Interact with a client to fully specify a complex robotic engineering design. (BE Graduate Attribute 2(a), 2(b))
3	Design functional bespoke components using 3D design software. (BE Graduate Attribute 3(f))
4	Use a variety of embedded tools, including relevant machine learning techniques, to control a complex robotic device. (BE Graduate Attribute 3(b), 3(c), 3(d), e(e))
5	Apply an understanding of the issues involved in high power switching to design power switching solutions for battery-powered mechatronic devices. (BE Graduate Attribute 3(a), 3(c))

	Assessment items and workload per item	**%**	**CLO(s)**
1	Formative client focussed robotic design assignment (10 hours)	10%	1, 2, 4
2	Summative complex robotic design assignment (25 hours)	25%	1, 2, 4
3	Robotic design and implementation exercise (20 hours)	20%	1, 4
4	Solidworks practical assignment (15 hours)	15%	1, 3
5	Mechanical engineering assignment (10 hours)	10%	1
6	Test (1 hour)	20%	1, 5

Mandatory course requirements	None

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 430 (2023,T1)

Course title	Robotic Intelligence and Design		
Short title	Robotic Intelligence & Design	**Point value**	15
Course coordinator	Will Browne	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	P one of (COMP 309, EEEN 325 (or ECEN 301), X ECEN 430		
Prescription	The course addresses the applications of artificially intelligent systems in embodied scenarios. It will teach the skills to assess tasks, evaluate appropriate techniques, and will provide experience in designing and implementing solutions and communicating the benefits of AI in physically based tasks.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	20
This course is based around project-based assessments, done in the scheduled lab sessions and outside contact time. The lectures and tutorials will provide background, theory, and support for the projects.		**Tutorials**	4
		Seminars	
		Labs/Studios	30
		TOTAL	54

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Describe real-world tasks in a manner suited to be addressed by embodied AI techniques.
2	Formulate appropriate task-solving strategies based on advanced AI techniques.
3	Specify appropriate solutions to real-world tasks that address functionality and wider concerns such as role of customers, sustainability and ethics.
4	Synthesise, specify, select and utilise a wide range of artificial intelligence techniques in order to solve complex tasks that would be impractical using conventional approaches.
5	Evaluate and communicate the effectiveness, practicality and wider concerns of embodied AI solutions to real-world problems.

	Assessment items and workload per item	**%**	**CLO(s)**
1	Evaluate an intelligent robotic design (approx. 10 hr)	10%	1, 5
2	Cognitive Robotics (practical test of theory) (approx. 8 hr)	20%	3, 4
3	Cognitive Robotics design and implementation exercise (approx. 16 hr)	25%	2, 3, 4
4	Test of Theory (1 hr)	15%	2, 5
5	AI learning for Robotic task solving assignment (approx. 24 hr)	30%	1 - 5

Mandatory course requirements	None

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: EEEN 431 (2023,T1)

Course title	Musical Robotics		
Short title	Musical Robotics	**Point value**	15
Course coordinator	TBC	**NZQF level**	8
Qualification schedule:	BE(Hons), BSc(Hons)		
Prerequisites, corequisites, restrictions	ECEN 325 or equivalent; X ECEN 427 in 2017-2018		
Prescription	This project-based course incorporates a music theme in the design and construction of a novel mechatronic instrument. The necessary fundamentals of the appropriate music theory are introduced, and then students are guided in a project-based learning style to develop an actuator and sensor rich robotic device that can play a suitable music score. Students are evaluated on their design, construction and testing of this robotic device.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	12
The course will use a Problem Based Learning pedagogy where students will work on a series of problems and projects which will be supplemented by weekly lectures and labs		**Tutorials**	
		Seminars	
		Labs/Studios	24
		TOTAL	36

Course learning objectives (CLOs)	Students who pass this course should be able to:
1	Critically analyse an engineering problem and develop a plan to address it using mechatronics. (BE Graduate Attribute 3(b), 3(c), 3(d), 3(e), 3(f))
2	Identify and develop suitable evaluation techniques for analysing and enhancing a music-themed robotic system. (BE Graduate Attribute 3(b), 3(c), 3(d), 3(e), 3(f))
3	Work collaboratively and efficiently in a group environment. (BE Graduate Attribute 2(a))
4	Write a succinct and coherent professional report. (BE Graduate Attribute 2(b))
5	Give a clear and engaging oral presentation of an engineering project. (BE Graduate Attribute 2(b))

	Assessment items and workload per item	**%**	**CLO(s)**
1	Project I: Literature Review (750-word report, 5-minute presentation)	5%	1, 4
2	Project I: Demonstration and individual report (2000-word report, 10-minute presentation)	20%	1, 2, 3, 5
3	Project II: Literature Review (750-word report, 5-minute presentation)	10%	1, 4
4	Project II: work in progress group report (500-word report, 10-minute group presentation)	5%	1, 2, 3
5	Project II: Demonstration and individual report (2000-word report, 10-minute presentation)	50%	1, 2, 3, 5
6	Final group paper (2000-word group report; group mark)	10%	3, 4

Mandatory course requirements	None

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.

Course Description: RESE 411 (2021,T1)

Course title	Power Systems Analysis		
Short title	Power Systems Analysis	**Point value**	15
Course coordinator	Dr Daniel Burmester	**NZQF level**	8
Qualification schedule:	BE(Hons)		
Prerequisites, corequisites, restrictions	(P) EEEN 313		
Prescription	This course provides an overview of the electricity industry and its constituent parts, with a particular focus on renewable generation. Students will explore modern electric power system modelling, analysis, and computation techniques used in industry. Topics include transmission line models, transformers and per unit systems, generator models, network matrices, power flow analysis and computation, real and reactive power control, voltage control, and protection systems. The interplay of different kinds of electricity markets and the operation of the technical power system is also examined.		
Student workload hours	150	**Contact Hours**	
Teaching/learning summary		**Lectures**	12
Weekly lectures, tutorials, laboratory sessions, and individual assignments during the whole course.		**Tutorials**	18
		Labs/Studios	30
		TOTAL	60

Course learning objectives (CLOs)	Students who pass this course will be able to:
1	Describe how the working of the electricity market affects the operation of the power system.
2	Describe the working and interaction of the various power system components
3	Develop network models and analyse power flows.
4	Analyse power system static behaviours and contingencies, with an industry standard software package.
5	Make grid design decisions, based on stability and cost, with respect to new renewable energy integration.

	Assessment items and workload per item	**%**	**CLO(s)**
1	Tests of spreadsheet analytical skills in the first three weeks (12 hours total)	15%	1
2	Three lab exercises with one-page reports in the second three weeks (12 hours total)	15%	2, 3, 4
3	Essay (1000 words) with spreadsheet analysis of economics/market (20 hours)	25%	1
4	Simulation modelling assignment and report (36 hours)	45%	2, 3, 4, 5

Mandatory course requirements	In addition to achieving an overall pass mark of 50%, students must:
• Achieve 40% on the simulation modelling assignment. *Justification: the assignment assesses the overall understanding of critical concepts, techniques and skills as required by the industry.*	

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO) and the MSc(ELCO).

Course Description: RESE 412 (2021,T2)

<table>
<tr><td>Course title</td><td colspan="3">Advanced Development of Renewable Energy Systems</td></tr>
<tr><td>Short title</td><td>Adv Development of RE Systems</td><td>Point value</td><td>15</td></tr>
<tr><td>Course coordinator</td><td>Dr Daniel Burmester</td><td>NZQF level</td><td>8</td></tr>
<tr><td>Qualification schedule:</td><td colspan="3">BE(Hons)</td></tr>
<tr><td>Prerequisites, corequisites, restrictions</td><td colspan="3">P EEEN 313</td></tr>
<tr><td>Prescription</td><td colspan="3">This course presents techniques used to design advanced, integrated renewable energy solutions for given situations. The designs of nano- and micro-grids are analysed, with students applying this knowledge to design, construct and test a fit-for-purpose renewable energy system. This course also presents the concepts of systems engineering, which introduces systems thinking principles.</td></tr>
<tr><td>Student workload hours</td><td>150</td><td colspan="2">Contact Hours</td></tr>
<tr><td colspan="2">Teaching/learning summary</td><td>Lectures</td><td>12</td></tr>
<tr><td colspan="2" rowspan="3">Weekly lectures, tutorials, laboratory sessions, and individual assignments during the whole course.</td><td>Tutorials</td><td>18</td></tr>
<tr><td>Labs/Studios</td><td>30</td></tr>
<tr><td>TOTAL</td><td>60</td></tr>
</table>

<table>
<tr><td colspan="2">Course learning objectives (CLOs)</td><td>Students who pass this course will be able to:</td></tr>
<tr><td>1</td><td colspan="2">Design advanced, integrated renewable energy solutions for given problems.</td></tr>
<tr><td>2</td><td colspan="2">Critically analyse renewable energy solutions and specific improvement opportunities.</td></tr>
<tr><td>3</td><td colspan="2">Build renewable energy systems.</td></tr>
<tr><td>4</td><td colspan="2">Justify solutions to different stakeholders through effective written and oral communication.</td></tr>
</table>

Assessment items and workload per item		%	CLO(s)
1	Nanogrid/Microgrid case study analysis with 1000-word report (32 hours total)	35%	1, 2
2	RE system design with 1000-word report (32 hours)	35%	1, 2
3	Group presentation and demonstration, with group assessment (14 hours)	15%	4
4	Individual assignment with 1000-word report (14 hours)	15%	2, 3, 4

Mandatory course requirements In addition to achieving an overall pass mark of 50%, students must:

- Achieve at least 40% on the individual assignment report.

Justification: the assignment assesses the overall understanding of concepts, techniques and skills outside of a group context.

This course contributes to the graduate attributes of the BE(Hons), the BSc(Hons)(ELCO), the MSc(ELCO), and the MEP.