ELECTRICAL ENGINEERING/ RED RIVER COLLEGE POLYTECHNIC ARTICULATION AGREEMENT

Electrical Engineering/Red River College Polytechnic Articulation Agreement

Electrical Engineering Technology Diploma Program

Course	Title	Hours
Preliminary Engineering Program		
CHEM 1100	Introductory Chemistry 1: Atomic and Molecular Structure and Energetics	3
CHEM 1122	Introduction to Chemistry Techniques for Engineering 1	1.5
COMP 1012	Computer Programming for Scientists and Engineers	3
ENG 1430	Design in Engineering	3
ENG 1440	Introduction to Statics	3
ENG 1450	Introduction to Electrical and Computer Engineering [RRC1]	3
ENG 1460	Introduction to Thermal Sciences	3
MATH 1210	Techniques of Classical and Linear Algebra	3
MATH 1510	Applied Calculus 1 [RRC2]	3
MATH 1710	Applied Calculus 2 [RRC3]	3
PHYS 1050	Physics 1: Mechanics [RRC4]	3
"W" Elective - One course that satisfies the university "writing" requirement		3
CS Elective 1 - One complementary studies elective [1]		3
Program courses and electives taught by the department		
ECE 2160	Electronics 2E [RRC5]	5
ECE 2220	Digital Logic Systems [RRC6]	5
ECE 2240	Numerical Methods for Electrical Engineers	4
ECE 2262	Electric Circuits [RRC7]	4
ECE 3540	Advanced Circuit Analysis and Design	4
ECE 3580	Foundations of Electromagnetics	4
ECE 3590	Electromagnetic Theory	4
ECE 3600	Physical Electronics	4
ECE 3610	Microprocessing Systems	4
ECE 3670	Electronics 3E	4
ECE 3720	Electric Power and Machines [RRC8]	4
ECE 3730	Principles of Embedded System Design	4
ECE 3780	Signal Processing 1	4
ECE 4150	Control Systems	4
ECE 4260	Communications Systems	4
ECE 4600	Group Design Project [2]	6
"A" Elective 1 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 2 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 3 - Technical elective from the "Group A" list of qualified electives		4
ECE 4850	Topics in Electrical and Computer Engineering 1 (Tech Elective 1) [RRC9]	4
ECE 4860	Topics in Electrical and Computer Engineering 2 (Tech Elective 2) [RRC10]	4
Tech Elective 3 - Technical Elective from either "Group A" list or "Group B" list		3-5
Tech Elective 4 - Technical Elective from either "Group A" list or "Group B" list		3-4
Program courses taught by other academic departments		
ANTH 2430	Ecology, Technology and Society [3]	3
ENG 2040	Engineering Communication: Strategies, Practice and Design [RRC11]	3
ENG 3000	Engineering Economics	3
MATH 2130	Engineering Mathematical Analysis 1	3
MATH 2132	Engineering Mathematical Analysis 2	3
MATH 3132	Engineering Mathematical Analysis 3	3
PHYS 2152	Modern Physics for Engineers	3
STAT 2220	Contemporary Statistics for Engineers [4]	3
Electives taught by other departments		
CS Elective 2 - Complementary studies elective [1]		3
NS Elective - Natural science elective course from the approved list		3
Total Hours		**161.5-164.5**

1 The complementary studies electives can be any course at the 1000 level or above from either the faculties of Arts or Management. However, ARTS 1110 may not be used from credit in the Price Faculty of Engineering.

2 Course continues through both terms with credit given upon completion.

3 ANTH 2430 is an Indigenous Knowledge course.

4 STAT 2220 is the recommended statistics course within this program, however STAT 1000 and STAT 2000 together are considered equivalent to STAT 2220.

RRC1 RRC Polytech Equivalent Course: CIRC-1005 DC Circuits AND DIGI-1003 Digital Logic

RRC2 RRC Polytech Equivalent Course: MATH-2013 Calculus

RRC3 RRC Polytech Equivalent Course: MATH-2013 Calculus AND CTRL-1001 Linear Controls

RRC4 RRC Polytech Equivalent Course: PHYS-1001 Physics 1 AND PHYS-2001 Physics 2

RRC5 RRC Polytech Equivalent Course: DEVC-2003 Power Electronics 1 AND DEVC-2004 Semiconductor Devices AND DEVC-3001 Power Electronics 2

RRC6 RRC Polytech Equivalent Course: DIGI-1003 Digital Logic

RRC7 RRC Polytech Equivalent Course: CIRC-1005 DC Circuits AND CIRC-2002 AC Circuits AND PROJ-3002 Final Project

RRC8 RRC Polytech Equivalent Course: MACH-1092 Electrical Machines 1 AND MACH-2000 Electrical Machines 2 AND TRAN-1000 Transformers

RRC9 RRC Polytech Equivalent Course: CODE-2001 Electrical Practices and Design AND PRJ-2000 Project Management AND WRKS-1037 Introduction to Quality

RRC10 RRC Polytech Equivalent Course: DCOM-1001 Digital Communications AND PLCS-1110 PLCs 1 AND PLCS-2111 PLCs 2

RRC10 Polytech Equivalent Course: COMM-1152 Technical Communications AND COMM-3005 Technical Thesis AND PROJ-3002 Final Project

Electronic Engineering Technology Diploma Program

Course	Title	Hours
Preliminary Engineering Program		
CHEM 1100	Introductory Chemistry 1: Atomic and Molecular Structure and Energetics	3
CHEM 1122	Introduction to Chemistry Techniques for Engineering 1	1.5
COMP 1012	Computer Programming for Scientists and Engineers	3
ENG 1430	Design in Engineering	3
ENG 1440	Introduction to Statics	3
ENG 1450	Introduction to Electrical and Computer Engineering RRC1	3
ENG 1460	Introduction to Thermal Sciences	3
MATH 1210	Techniques of Classical and Linear Algebra	3
MATH 1510	Applied Calculus 1 RRC2	3
MATH 1710	Applied Calculus 2 RRC3	3
PHYS 1050	Physics 1: Mechanics RRC4	3
"W" Elective - One course that satisfies the university " writing" requirement		3
CS Elective 1 - One complementary studies elective [1]		3
Program courses and electives taught by the department		
ECE 2160	Electronics 2E RRC5	5
ECE 2220	Digital Logic Systems RRC6	5
ECE 2240	Numerical Methods for Electrical Engineers	4
ECE 2262	Electric Circuits RRC7	4
ECE 3540	Advanced Circuit Analysis and Design	4
ECE 3580	Foundations of Electromagnetics	4
ECE 3590	Electromagnetic Theory	4
ECE 3600	Physical Electronics	4
ECE 3610	Microprocessing Systems	4
ECE 3670	Electronics 3E	4
ECE 3720	Electric Power and Machines	4
ECE 3730	Principles of Embedded System Design	4
ECE 3780	Signal Processing 1	4
ECE 4150	Control Systems	4
ECE 4260	Communications Systems	4
ECE 4600	Group Design Project [2]	6
"A" Elective 1 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 2 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 3 - Technical elective from the "Group A" list of qualified electives		4
ECE 4850	Topics in Electrical and Computer Engineering 1 (Tech Elective 1) RRC8	4
ECE 4860	Topics in Electrical and Computer Engineering 2 (Tech Elective 2) RRC9	4
Tech Elective 3 - One technical elective from either "Group A" list or "Group B" list		3-5
Tech Elective 4 - One technical elective from either "Group A" list or "Group B" list		3-4
Program courses taught by other academic departments		
ANTH 2430	Ecology, Technology and Society [3]	3
ENG 2040	Engineering Communication: Strategies, Practice and Design RRC10	3
ENG 3000	Engineering Economics	3
MATH 2130	Engineering Mathematical Analysis 1	3
MATH 2132	Engineering Mathematical Analysis 2	3
MATH 3132	Engineering Mathematical Analysis 3	3
PHYS 2152	Modern Physics for Engineers	3
STAT 2220	Contemporary Statistics for Engineers [4],RRC11	3
Electives taught by other departments		
CS Elective 2 - Complementary studies elective [1]		3
NS Elective - Natural science elective course from the approved list		3
Total Hours		**161.5-164.5**

1 The complementary studies electives can be any course at the 1000 level or above from either the faculties of Arts or Management. However, ARTS 1110 may not be used from credit in the Price Faculty of Engineering.

2 Course continues through both terms with credit given upon completion.

3 ANTH 2430 is an Indigenous Knowledge course.

4 STAT 2220 is the recommended statistics course within this program, however STAT 1000 and STAT 2000 together are considered equivalent to STAT 2220.

RRC1 Polytech Equivalent Course: CIRC-1005 DC Circuits AND DIGI-1003 Digital Logic

RRC2 Polytech Equivalent Course: MATH-2013 Calculus

RRC3 Polytech Equivalent Course: MATH-2013 Calculus AND MATH-3007 Advanced Calculus

RRC4 Polytech Equivalent Course: PHYS-1001 Physics 1 AND PHYS-2001 Physics 2

RRC5 Polytech Equivalent Course: DEVC-2004 Semiconductor Devices AND DEVC-2005 Analog Devices and Applications

RRC6 Polytech Equivalent Course: DIGI-1003 Digital Logic AND DIGI-2224 Digital Systems

RRC7 Polytech Equivalent Course: CIRC-1005 DC Circuits AND CIRC-2002 AC Circuits AND PROJ-3000 Final Project

RRC8 Polytech Equivalent Course: DCOM-1000 Digital Communications AND DCOM-2001 Routing & Switching

RRC9 Polytech Equivalent Course: EMBD-3000 Embedded Systems 2 AND MANU-2009 Printed Circuit Board Manufacturing and Layout

RRC10 Polytech Equivalent Course: COMM-1152 Technical Communications AND COMM-3005 Technical Thesis AND PROJ-3000 Final Project

RRC11 Polytech Equivalent Course: STAT 1001 Statistics and Quality Assurance

Instrumentation and Control Engineering Technology Diploma Program

Course	Title	Hours
Preliminary Engineering Program		
CHEM 1100	Introductory Chemistry 1: Atomic and Molecular Structure and Energetics	3
CHEM 1122	Introduction to Chemistry Techniques for Engineering 1	1.5
COMP 1012	Computer Programming for Scientists and Engineers	3
ENG 1430	Design in Engineering	3
ENG 1440	Introduction to Statics	3
ENG 1450	Introduction to Electrical and Computer Engineering RRC1	3
ENG 1460	Introduction to Thermal Sciences RRC2	3
MATH 1210	Techniques of Classical and Linear Algebra	3
MATH 1510	Applied Calculus 1 RRC3	3
MATH 1710	Applied Calculus 2 RRC4	3
PHYS 1050	Physics 1: Mechanics RRC5	3
"W" Elective - One course that satisfies the university "writing" requirement		3
CS Elective 1 - One complementary studies elective [1]		3
Program courses and electives taught by the department		
ECE 2160	Electronics 2E RRC6	5
ECE 2220	Digital Logic Systems RRC7	5
ECE 2240	Numerical Methods for Electrical Engineers	4
ECE 2262	Electric Circuits RRC8	4
ECE 3540	Advanced Circuit Analysis and Design	4
ECE 3580	Foundations of Electromagnetics	4
ECE 3590	Electromagnetic Theory	4
ECE 3600	Physical Electronics	4
ECE 3610	Microprocessing Systems	4
ECE 3670	Electronics 3E	4
ECE 3720	Electric Power and Machines	4
ECE 3730	Principles of Embedded System Design	4
ECE 3780	Signal Processing 1	4
ECE 4150	Control Systems	4
ECE 4260	Communications Systems	4
ECE 4600	Group Design Project [2]	6
"A" Elective 1 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 2 - Technical elective from the "Group A" list of qualified electives		4
"A" Elective 3 - Technical elective from the "Group A" list of qualified electives		4
ECE 4850	Topics in Electrical and Computer Engineering 1 (Tech Elective 1) RRC9	4
ECE 4860	Topics in Electrical and Computer Engineering 2 (Tech Elective 2) RRC10	4
Tech Elective 3 - Technical elective from either "Group A" list or "Group B" list		3-5
Tech Elective 4 - Technical elective from either "Group A" list or "Group B" list		3-4
Program courses taught by other academic departments		
ANTH 2430	Ecology, Technology and Society [3]	3
ENG 2040	Engineering Communication: Strategies, Practice and Design RRC11	3
ENG 3000	Engineering Economics	3
MATH 2130	Engineering Mathematical Analysis 1	3
MATH 2132	Engineering Mathematical Analysis 2	3
MATH 3132	Engineering Mathematical Analysis 3	3
PHYS 2152	Modern Physics for Engineers	3
STAT 2220	Contemporary Statistics for Engineers [4]	3
Electives taught by other departments		
CS Elective 2 - Complementary studies elective [1]		3
NS Elective - Natural science elective course from the approved list		3
Total Hours		**161.5-164.5**

1 The complementary studies electives can be any course at the 1000 level or above from either the faculties of Arts or Management. However. ARTS 1110 may not be used from credit in the Price Faculty of Engineering.

2 Course continues through both terms with credit given upon completion.

3 ANTH 2430 is an Indigenous Knowledge course.

4 STAT 2220 is the recommended statistics course within this program, however STAT 1000 and STAT 2000 together are considered equivalent to STAT 2220.

RRC1 RRC Polytech Equivalent Course: CIRC-1005 DC Circuits AND DIGI-1003 Digital Logic

RRC2 RRC Polytech Equivalent Course: INST-2001 Heat Transfer and Thermodynamics

RRC3 RRC Polytech Equivalent Course: MATH-2013 Calculus

RRC4 RRC Polytech Equivalent Course: MATH-2013 Calculus AND MATH-3006 Applied Calculus

RRC5 RRC Polytech Equivalent Course: PHYS-1001 Physics 1 AND PHYS-2001 Physics 2

RRC6 RRC Polytech Equivalent Course: DEVC-2004 Semiconductor Devices AND PROJ-3003 Final Project and Technical Thesis

RRC7 RRC Polytech Equivalent Course: DIGI-1003 Digital Logic AND DIGI-2224 Digital Systems

RRC8 RRC Polytech Equivalent Course: CIRC-1005 DC Circuits AND CIRC-2002 AC Circuits AND PROJ-3003 Final Project and Technical Thesis

RRC9 RRC Polytech Equivalent Course: PLCS-1002 Instrumentation PLCs 1 AND PLCS-2002 Instrumentation PLCs 2 AND INST-2004 Process Measurements 2

RRC10 RRC Polytech Equivalent Course: DCOM-1009 Data Acquisition AND DCOM-2003 Electrical Systems 2 AND INST-1008 Robotics and Automation

RRC11 RRC Polytech Equivalent Course: PROJ-1004 Project Management AND PROJ-3003 Final Project and Technical Thesis

Concentrations

Electrical Engineering Focus Areas

Students wishing to pursue more focused studies in an Electrical Engineering subject/research area have the choice of doing so through a recognized Focus Area. Courses taken towards a Focus Area take the place of some or all of the Technical Electives required in the Electrical Engineering program. Please refer to the Faculty website (http://

umanitoba.ca/ece/curr_students/undergrad/ee-focus-areas.html) for a detailed description of each area and the courses required.

Power and Energy Systems Focus Area

To complete the Power and Energy Systems Focus the four prescribed courses must be taken. One of the three Power and Energy Systems Technical Elective courses must also be taken. To complete the program requirements two additional courses must be selected from the elective courses listed in the Electrical Engineering Standard Program. (https://catalog.umanitoba.ca/undergraduate-studies/engineering/electrical-computer-engineering/electrical-engineering-bsc/#degreerequirementstext)

Prescribed Power and Energy Systems Courses

Course	Title	Hours
ECE 3650	Electric Machines	5
ECE 4300	Electrical Energy Systems 1	4
ECE 4370	Power Electronics	4
One additional course from the list of Group A Qualified Design Elective Courses found in the Electrical Engineering Standard Program		4
Electives		
One Power and Energy Systems Technical Elective		4
Two additional courses from the Elective Courses found in the Electrical Engineering Standard Program		6-9
Total Hours		**27-30**

Power and Energy Systems Technical Electives

Course	Title	Hours
ECE 4310	Electrical Energy Systems 2	4
ECE 4360	High Voltage Engineering	4
ECE 4580	Optoelectronics	4
ECE 4830	Signal Processing 2	4
Total Hours		**20**

Communication Devices Focus Area

To complete the Communication Devices Focus the three prescribed courses must be taken. Two of the five Communication Devices Technical Elective courses must also be taken. To complete the program requirements two additional courses must be selected from the elective courses listed in the Electrical Engineering Standard Program. (https://catalog.umanitoba.ca/undergraduate-studies/engineering/electrical-computer-engineering/electrical-engineering-bsc/#degreerequirementstext)

Prescribed Communication Devices Courses

Course	Title	Hours
ECE 4270	Antennas	4
ECE 4290	Microwave Engineering	4
ECE 4250	Digital Communications	4
or ECE 4830	Signal Processing 2	
Electives		
Two Communication Devices Technical Electives		8
Two additional courses from the Elective Courses found in the Electrical Engineering Standard Program		6-9
Total Hours		**26-29**

Communication Devices Technical Electives

Course	Title	Hours
ECE 4250	Digital Communications	4
ECE 4280	Engineering Electromagnetics	4
ECE 4430	Design of RF Devices and Wireless Systems	4

Biomedical Focus Area

To complete the focus area, students are required to take a total of six (6) courses as indicated below. Of these, five (5) replace general technical electives and one (1) is in place of the Natural Science Elective in the Electrical Engineering program. To complete the program requirements two (2) additional courses must be selected from the technical electives listed in the Electrical Engineering Standard Program. (https://catalog.umanitoba.ca/undergraduate-studies/engineering/electrical-computer-engineering/electrical-engineering-bsc/#degreerequirementstext)

Biomedical Courses

Course	Title	Hours
ECE 4610	Biomedical Instrumentation and Signal Processing	4
ECE 4830	Signal Processing 2	4
BIOL 1410	Anatomy of the Human Body	3
Electives		
One Biomedical Group A Elective Course		3-4
One Biomedical Group A or Group B Elective Course		3-4
One additional course from the list of Group A Qualified Design Elective Courses found in the Electrical Engineering Standard Program		4
Two additional courses from the list of Technical Elective Courses found in the Electrical Engineering Standard Program		6-9
Total Hours		**27-32**

Biomedical Group A Elective Courses

Course	Title	Hours
ECE 4860	Topics in Electrical and Computer Engineering 2 [1]	4
PHYS 3220	Medical Physics and Physiological Measurement	3
PHYS 4300	Topics in Physics	3

[1] Topic Title: ECE 4860 Biomedical Optics

Biomedical Group B Elective Courses

Course	Title	Hours
BIOL 1412	Physiology of the Human Body	3
MBIO 1220	Essentials of Microbiology	3
BIOE 3320	Engineering Properties of Biological Materials	4
BIOE 4610		4

Engineering Physics Focus Area

In the standard Electrical Engineering program, seven Technical Elective Courses and one Natural Science Elective are required. To complete the Engineering Physics focus area, students are required to take a total of seven courses as indicated below, including the four prescribed Engineering Physics courses. Three further courses must be taken from the list of Engineering Physics Elective courses. To complete the program requirements a course must be selected from the technical electives listed in the Electrical Engineering Standard Program (https://catalog.umanitoba.ca/undergraduate-studies/engineering/electrical-computer-engineering/electrical-engineering-bsc/#degreerequirementstext).

Prescribed Engineering Physics Courses

Course	Title	Hours
ECE 4270	Antennas	4
ECE 4580	Optoelectronics	4
PHYS 2386	Introduction to Quantum Mechanics and Special Relativity	3
PHYS 2650	Classical Mechanics 1	3
Electives		
Three Engineering Physics Technical Elective Courses		9-13
One additional course from the list of Technical Elective Courses found in the Electrical Engineering Standard Program		3-5
Total Hours		**26-32**

Engineering Physics Technical Elective Courses

Course	Title	Hours
ECE 4860	Topics in Electrical and Computer Engineering 2 [1]	4
PHYS 2260	Optics	3
PHYS 3220	Medical Physics and Physiological Measurement	3
PHYS 3386	Quantum Mechanics 2	3
PHYS 3430	Honours Physics Laboratory	6
PHYS 3570	Physics of Materials 1	3
PHYS 4646	Electro - and Magnetodynamics and Special Relativity	3
PHYS 3650	Classical Mechanics 2	3
PHYS 3670	Classical Thermodynamics	3
PHYS 4680	Statistical Mechanics	3
PHYS 4520	Introduction to Solid State Physics	3
PHYS 4590	Advanced Optics	3

1 Topic Title: ECE 4860 Materials Characterization

Mechatronics FOCUS Area

To complete the Mechatronics Focus the two (2) prescribed courses must be taken. Two (2) of the five Mechatronics Technical Elective courses must also be taken. To complete program requirements, students must select three (3) additional electives from the Qualified Engineering Design Electives and/or Technical Electives in the Electrical Engineering standard program.

Course	Title	Hours
ECE 4180	Introduction to Robotics	4
MECH 4900	Mechatronics System Design	4
Two Mechatronics Electives [1]		8
Three additional courses from the Elective Courses found in the Electrical Engineering Standard Program [1]		10-13
Total Hours		**26-29**

Mechatronics Electives List

Course	Title	Hours
ECE 4160	Control Engineering [1]	4
ECE 4240	Microprocessor Interfacing	4
ECE 4370	Power Electronics [1]	4
ECE 4440	Computer Vision	4
ENG 4110	Operational Excellence	4

[1] Of the five (5) elective courses taken, three (3) MUST be selected from the Qualified Engineering Design Electives list found in the Electrical Engineering Standard Program.

Entrepreneurship Focus Area

To complete the Entrepreneurship Focus the two (2) prescribed courses and two (2) of the five Entrepreneurship Elective courses must be taken. To complete program requirements, students must select three (3) additional electives from the list of Qualified Engineering Design Electives and one (1) further Technical Elective from the Electrical Engineering standard program.

Course	Title	Hours
MECH 3170	Project Management	4
ENTR 2020	Starting a New Business [1]	3
Two Entrepreneurship Electives		6-7
Three courses from the list of Group A Qualified Design Elective Courses found in the Electrical Engineering Standard Program		12
One additional course from the Elective Courses found in the Electrical Engineering Standard Program		3-5
Total Hours		**28-31**

[1] In addition to satisfying focus area requirements, ENTR 2020 also satisfies the general program requirement for one complementary studies elective.

Entrepreneurship Electives List

Course	Title	Hours
ENG 4110	Operational Excellence	4
ENTR 3060	Creativity and Entrepreneurial Thinking	3
ENTR 3070	Innovation Management	3
ENTR 3102	Technological Entrepreneurship	3
ENTR 4100	New Venture Analysis	3

Preliminary Engineering Program

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Telephone: (204) 474 9167
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Website: umanitoba.ca/engineering (https://umanitoba.ca/engineering/)

The Preliminary Engineering Program is common to all programs in engineering. Students must complete a minimum of eight (**excluding CHEM 1122**) to be eligible to apply to one of the five degree granting engineering programs. A student must complete the following list of 13 courses as part of their engineering program in order to graduate with a BSc degree in engineering.

Course	Title	Hours
CHEM 1100	Introductory Chemistry 1: Atomic and Molecular Structure and Energetics [1]	3
CHEM 1122	Introduction to Chemistry Techniques for Engineering 1 [1]	1.5
COMP 1012	Computer Programming for Scientists and Engineers	3
ENG 1430	Design in Engineering	3
ENG 1440	Introduction to Statics	3

ENG 1450	Introduction to Electrical and Computer Engineering	3
ENG 1460	Introduction to Thermal Sciences	3
MATH 1210	Techniques of Classical and Linear Algebra [2]	3
MATH 1510	Applied Calculus 1 [3]	3
MATH 1710	Applied Calculus 2 [3]	3
PHIL 1290	Critical Thinking [4]	3
PHYS 1050	Physics 1: Mechanics	3
Written English Course [5,6]		3
Total Hours		**37.5**

1. The former CHEM 1300 may be used in lieu of the combination of CHEM 1100 and CHEM 1122.
2. MATH 1300 is not an acceptable equivalent to MATH 1210.
3. Students intending to obtain a degree in Engineering are strongly advised to complete MATH 1510 and MATH 1710. However, MATH 1500 or MATH 1230 may be taken in lieu of MATH 1510; MATH 1700 or MATH 1232 may be taken in lieu of MATH 1710. MATH 1524 is not an acceptable equivalent to MATH 1510.
4. PHIL 1290 is the recommended complementary studies elective. Students may; however, select any course from the Faculties of Arts or Management (Asper School of Business) at the 1000 level or above, except for ARTS 1110.
5. Course selected from the list of approved Written English Courses for Engineering students.
6. Three credit hours are required to satisfy the Written English course requirement. Should a student complete a six credit hour course, the additional three credit hours may be used to satisfy general complementary studies requirements within a student's program.
7. Equivalent courses offered through Université de Saint-Boniface may be used to satisfy program requirements.

Courses

Electrical and Computer Engineering

ECE 2160 Electronics 2E 5 cr
(Lab required) Characteristics of integrated circuits and transistors; design of DC and AC amplifiers in the steady state.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2262.

ECE 2220 Digital Logic Systems 5 cr
(Lab required) Boolean algebra and logic primitives, net-work simplification techniques, physical realizations, number systems and codes; analysis and design of asynchronous and synchronous sequential circuits; applications to computation, measurements, and control.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 1450
Mutually Exclusive: COMP 3090

ECE 2240 Numerical Methods for Electrical Engineers 4 cr
(Lab required) Numerical methods applied to Electrical Engineering problems; mathematical models of physical systems, solutions of linear and non-linear equations, numerical differentiation and integration methods and associated errors, introduction to solution analysis. May not be held with MATH 2120.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2262, COMP 1012, MATH 2132
Equiv To: MATH 2120

ECE 2262 Electric Circuits 4 cr
(Lab required) The application of circuit concepts; network theorems and formal methods, steady state analysis, frequency and transient response, application of the Laplace transform in the analysis of linear time-invariant networks.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: [ENG 1450. Pre- or corequisite: MATH 2132 or [MATH 2100 and MATH 2110].
Equiv To: ECE 2260

ECE 2400 Engineering Algorithms 1 4 cr
(Lab required) An introduction to common engineering algorithmic problem-solving approaches. Students will develop the ability to evaluate, analyze, design, and implement a wide array of generally useful algorithmic paradigms, for example, divide-and-conquer, dynamic programming, and greedy algorithms. May not be held with the former ECE 3790.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 2132. Pre- or corequisite: COMP 2140 and MATH 2136.
Equiv To: ECE 3790

ECE 3400 Engineering Algorithms 2 4 cr
(Lab required) An exploration of common engineering algorithmic problem-solving approaches, focused primarily on numerical analysis problems. Students will develop the ability to evaluate, analyze, design, and implement a wide array of generally useful paradigms, for example solving linear and non-linear equations (linear algebra and root finding), curve fitting, numerical integration and differentiation, solving differential equations, and introduction to optimization and machine learning.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2400 or the former ECE 3790.

ECE 3540 Advanced Circuit Analysis and Design 4 cr
(Lab required) Application of the Laplace Transform in the analysis of linear time-invariant networks, poles, zeros and frequency response; natural frequencies; general network theorems; two ports; energy and passivity; transmission lines; time and frequency domain.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2262 and MATH 2132.

ECE 3580 Foundations of Electromagnetics 4 cr
(Lab required) (Formerly ECE 2130) Fundamental laws of field theory; Maxwell's equations in integral and point form.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2240, PHYS 2152, and MATH 3132 (MATH 3100).
Equiv To: ECE 2130

ECE 3590 Electromagnetic Theory 4 cr
(Lab required) Maxwell's equations; plane electromagnetic waves; transmission line theory; electromagnetic radiation and introduction to antennas.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3580 (or the former ECE 2130.)

ECE 3600 Physical Electronics 4 cr
(Lab required) Basic solid state theory; properties of semi-conductors; principles of metal-semiconductor junctions, p-n junctions and transistors; optoelectronic processes.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 2152 (or PHYS 1070) and (MATH 2136 or MATH 3132) and ECE 2160.

ECE 3610 Microprocessing Systems 4 cr
(Lab required) Fundamentals of microprocessors and microcomputers; data flow; machine programming; architectures and instructions sets; stacks, subroutines, I/0, and interrupts; interfacing fundamentals; designing with microprocessors.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2220.
Mutually Exclusive: COMP 2280

ECE 3630 Real-time Embedded Systems 4 cr
(Lab required) Design of embedded systems with real-time requirements. File, memory, I/O, and process management. Real-time operating system considerations, including multitasking, thread communication, and real-time scheduling. Debugging and testing of embedded real-time systems. May not be held with COMP 3430.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3610 and ECE 3740.
Mutually Exclusive: COMP 3430

ECE 3650 Electric Machines 5 cr
(Lab required) Continuation of ECE 3720 , including steady state and transient performance and introductory power systems theory.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3720

ECE 3670 Electronics 3E 4 cr
(Lab required) Continuation of ECE 2160, including device models, feedback, regulators, frequency effects, oscillators, and bistability and gates.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160.

ECE 3700 Telecommunication Network Engineering 4 cr
(Lab required) This course will introduce modem concepts in telecommunications, including LANs, WANs, telephone networks, wireless and mobile networks, and Internet networks. Focus will be on design engineering, and management of networks, and on network programming for client server architectures.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: COMP 2140.
Mutually Exclusive: COMP 3720, COMP 4300

ECE 3720 Electric Power and Machines 4 cr
(Lab required) Principles and applications of electric power, energy conversion and machines.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2262.

ECE 3730 Principles of Embedded System Design 4 cr
(Lab required) This course will introduce students to the design and implementation of embedded systems. Topics include introduction to UML and data structures, A-to-D, D-to-A, serial bus architectures, embedded computing, bus-based computer systems, program design and analysis, networks, and hardware-software co-design.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2160, ECE 3610 and (COMP 1010 or COMP 1012).

ECE 3740 Systems Engineering Principles 1 4 cr
(Lab required) Complexity and other system measures and analysis, system architectures and architectural elements for embedded systems, hardware and software, incremental design elaboration. Coding, testing, debugging, verification and validation. Project planning, cost analysis and maintenance. Real-time systems, graphical user interfaces and computational models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: COMP 2140.

ECE 3750 Systems Engineering Principles 2 4 cr
(Lab required) Reliability measures and analysis, software system architectures, system metrics, system verification for embedded systems. Coding practices for large scale embedded system development. Real- time systems, graphical user interfaces, and computational models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3740.

ECE 3760 Digital Systems Design 1 4 cr
(Lab required) Design methodologies for the development of digital hardware, including system specification, component allocation, functional partitioning, specification refinement, implementation, verification, and testing. Hardware-software co-design.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240.
Mutually Exclusive: COMP 4550

ECE 3770 Digital Systems Design 2 4 cr
(Lab required) Executable system specification and a methodology for system partitioning and refinement into system-level components. Models and architectures, specification languages, translation to an HDL, system partitioning, design quality estimation, specification refinement into synthesizable models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240 and MATH 3120.

ECE 3780 Signal Processing 1 4 cr
(Lab required) Introduction to signals and systems; spectral analysis (Fourier Series) of continuous-time periodic signals; spectral analysis of aperiodic signals (Fourier Transform); the impulse response and convolution operator; frequency analysis of linear time-invariant systems; applications to filtering, communications systems, and biological systems; A/D conversion; sampling. Laboratory periods will be used to give students hands-on experience in programming many of the techniques covered in the theoretical parts of the course.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2262 and (MATH 2136 or MATH 3132).

ECE 4100 Introduction to Microelectronic Fabrication 4 cr
(Lab required) Introduction to the fabrication of integrated circuits (ICs). Emphasis is on silicon based devices. Topics include water preparation, oxidation, thin film deposition, diffusion and ion implantation, lithography, wet and dry etching and metallization. An introduction to MEMS and micromachining technology is given.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 (B+) or ECE 3670.

ECE 4150 Control Systems 4 cr
(Lab required) Principal methods of analysis and design for feedback control systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 and ECE 3780.

ECE 4160 Control Engineering 4 cr
(Lab required) Design of control systems by frequency domain and root locus method; state equations; introduction to nonlinear analysis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4150.

ECE 4180 Introduction to Robotics 4 cr
(Lab required) This course provides fundamental concepts of robotics, including robot classification and applications, robot kinematics, sensor and actuators, sensor interfacing, motor control, trajectory planning, and robot programming.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4150 and (ECE 4240 or ECE 3730).

ECE 4240 Microprocessor Interfacing 4 cr
(Lab required) Interfacing of microcomputers to the external world: interfacing of I/0 devices with minimum hardware and software; data acquisition with and without microprocessors; data communication, transmission and logging with small computers.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 and ECE 3610.
Mutually Exclusive: COMP 4550

ECE 4250 Digital Communications 4 cr
(Lab required) Transmission of digital data; error rates, interference. Information measures, information rate and channel capacity. Coding.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4260 and ECE 3780.

ECE 4260 Communications Systems 4 cr
(Lab required) Development and applications of random processes. Analysis and comparison of modulation schemes: AM, FM, PM, PCM.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3780 and [STAT 2220 preferred or (STAT 1000 and STAT 2000)].

ECE 4270 Antennas 4 cr
(Lab required) Radiation fundamentals, linear antennas, point source arrays, aperture antennas, antenna impedance, antenna systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4280 Engineering Electromagnetics 4 cr
(Lab required) Plane, cylindrical and spherical waves, introduction to scattering and diffraction, waveguides, transmission line applications.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4290 Microwave Engineering 4 cr
(Lab required) Microwave circuit analysis; passive and active devices; communication system power budget and signal-to-noise ratio calculations.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4300 Electrical Energy Systems 1 4 cr
(Lab required) Power system component modelling and computational methods for system problems such as load flow, faults, and stability.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3650.

ECE 4310 Electrical Energy Systems 2 4 cr
(Lab required) Generating stations. Power system stability and optimal operation. EHV-ac and HVDC power transmission. Power system protective relaying and reliability evaluation.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4150 and ECE 4300.

ECE 4360 High Voltage Engineering 4 cr
(Lab required) The course serves as an introduction to high voltage engineering, including basics of electrical breakdown, high voltage generation, high voltage test systems, measurement and analysis techniques as applied to power system apparatus, such as cables, insulators, transformers, and generators.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3580, ECE 3720.

ECE 4370 Power Electronics 4 cr
(Lab required) Thyristor device theory and operation, controlled rectifiers and line-commuted inverters, and forced commutation as applied to d/c choppers and a/c variable frequency and voltage inverters.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3720 and ECE 2160.

ECE 4390 Engineering Computations 4E 4 cr
(Lab required) Development and application of numerical methods for the solution of electrical and computer engineering problems. Optimization techniques. Finite difference, finite element and boundary element methods. Solution of large systems of linear and non-linear equations.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 3132, ECE 2240.

ECE 4420 Digital Control 4 cr
(Lab required) Mathematical modelling of sampling switches. Z-transforms. Response and stability of systems involving sampling. Design of digital compensators.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4830 and ECE 4150.

ECE 4430 Design of RF Devices and Wireless Systems 4 cr
(Lab required) Techniques for the system level design, simulation, fabrication,and testing of RF devices and microwave circuits, including the basics of radar and RFID technology. May not be held with ECE 4860 when titled " Design of RF Devices and Wireless Systems".
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.
Mutually Exclusive: ECE 4860

ECE 4440 Computer Vision 4 cr
(Lab required) Image formation and sensing, image compression, degradation and restoration, geometrical and topological properties, pattern classification, segmentation procedures, line-drawing images, texture analysis, 3-D image processing.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3780.

ECE 4450 Applied Computational Intelligence 4 cr
(Lab required) Computational intelligence and machine learning algorithms and their application in solving complex engineering problems. May not be held with COMP 4360 or EGE 4850 when titled "Applied Computational Intelligence."
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: STAT 2220 and (ECE 2240 or ECE 3400).
Mutually Exclusive: COMP 4360, ECE 4850

ECE 4460 Applied Probability and Stochastic Processes 4 cr
(Lab required) Probability theory and stochastic processes are heavily used in many engineering disciplines, such as risk assessment, data networks, operations research, information/communication theory, control theory, quantum theory. This course introduces probabilistic modeling, including random processes and the basic elements of statistical inference, as well as relevant models, skills, and tools that are key to analyzing data and making scientifically sound predictions under uncertainty. May not be held with ECE 4860 when titled "Stochastic Processes."
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: STAT 2220 or [(STAT 1000 or STAT 1001) and (STAT 2000 or STAT 2001)].
Mutually Exclusive: ECE 4860

ECE 4520 Simulation and Modelling 4 cr
Monte Carlo Methods, random processes, simulation of complex systems in the design of computer systems. Use of statistical interference and measures of performance in hardware and software systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [STAT 2220 preferred or (STAT 1000 and STAT 2000)] and COMP 2140.

ECE 4530 Parallel Processing 4 cr
(Lab required) This course provides an overview of parallel processing (classification of parallel processing architectures and other select topics), parallel programming strategies (embarrassingly parallel partitioning, divide-and-conquer, and other select topics), applied design and implementation of parallel software solutions (including distributed computing, shared memory computing, and GPGPU computing), and evaluation of parallel performance (time and memory complexity, speedup, efficiency, Amdahl's law, Gustafson's law). May not be held with COMP 4510.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: (COMP 2140 and (ECE 2400 or the former ECE 3790)) or (ECE 2240 and ECE 3730).
Mutually Exclusive: COMP 4510

ECE 4540 Wireless Networks 4 cr
(Lab required) Introduction to wireless communications systems, network architectures, protocols and applications. Topics include mobile computing systems, signals propagation, channel modelling, modulation, and networking standards.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3700 and ECE 3780.

ECE 4560 Modern Computing Systems 4 cr
(Lab required) Advanced topics in computer architecture and organization, such as instruction set architecture, performance measures, pipeline processor design, data and instruction cache, data dependencies, branch prediction and penalties, superscalar architecture, multithreading, out-of-order execution, speculative execution, overlapping register windowing, and multiprocessor system design. May not be held with ECE 4850 when titled" Modern Computing Systems".
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3610.
Mutually Exclusive: ECE 4850

ECE 4570 Sensors, Instrumentation, and the loT 4 cr
(Lab required) This course presents the fundamental concepts and application of sensors and instrumentation. This will include discussion of sensor characteristics such as precision, error, uncertainty, sensitivity, calibration, accuracy, linearity, and hysteresis. Circuitry and methods for measuring and representing sensor outputs will also be presented, together with techniques for analysing those measurements. May not be held with ECE 4860 when titled "Sensors, Instrumentation and the loT."
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160.
Mutually Exclusive: ECE 4860

ECE 4580 Optoelectronics 4 cr
(Lab required) Basic theory of quantum mechanics; solution of Schrodinger equations; interaction of radiation with matter; masers and lasers; propagation, modulation, excitation and detection in optical waveguides; introduction to fiber and integrated optics.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3600.

ECE 4600 Group Design Project 6 cr
The engineering curriculum must culminate in a significant design experience which is based on the knowledge and skills acquired in earlier course work and which gives students an exposure to the concepts of team work and project management.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [ENG 2040 or the former ENG 2030] and ECE 3780 and [(ECE 3580 (or the former ECE 2130), ECE 3720, ECE 3670 and ECE 3610) or (ECE 3700, ECE 3760 and ECE 3740)].

ECE 4610 Biomedical Instrumentation and Signal Processing 4 cr
(Lab required) Introduction to biological systems and the application of engineering principles to medical problems. Students design systems to acquire and analyze biological signals in the laboratory. Content includes introduction to relevant physiology and anatomy of cells, skeletal muscles, heart and cardiovascular systems, human balance and biomechanics, recording and analyzing biological signals (ECG, EMG,respiratory sounds), design of instrumentation amplifiers for signal conditioning, medical instrumentation safety and health hazards.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2160 and ECE 3780.

ECE 4740 Digital Systems Implementation 4 cr
(Lab required) Implementation methodologies and technologies for digital systems, including VLSI implementations, PCB implementations, and rapid prototyping (FPGA). Not to be held with ECE 4500.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240.

ECE 4830 Signal Processing 2 4 cr
(Lab required) Representation of discrete-time signals and systems in the time and frequency domains; the z-transform; application to various discrete-time linear time-invariant systems; design of digital filters. Laboratory periods will be used to give students hands-on experience in programming many of the techniques covered in the theoretical parts of the course.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3780.

ECE 4850 Topics in Electrical and Computer Engineering 1 4 cr
(Lab required) This course will cover contemporary topics in Electrical and Computer Engineering via lectures and laboratory sessions. The specific topics and a detailed course outline will be available at the time or registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.
Mutually Exclusive: ECE 4450, ECE 4560

ECE 4860 Topics in Electrical and Computer Engineering 2 4 cr
(Lab required) This course will cover contemporary topics in Electrical and Computer Engineering via lectures and laboratory sessions. The specific topics and a detailed course outline will be available at the time or registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.
Mutually Exclusive: ECE 4430, ECE 4460, ECE 4570

ECE 4870 Topics in Electrical and Computer Engineering 3 3 cr
This lecture based course will cover contemporary topics in Electrical and Computer Engineering. The specific topics and a detailed course outline will be available at the time of registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.

ECE 4880 Topics in Electrical and Computer Engineering 4 3 cr
This lecture based course will cover contemporary topics in Electrical and Computer Engineering . The Specific topics and a detailed course outline will be available at the time of registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.

Engineering Courses

ENG 1420 Engineering Processes for Non-Engineering Students 3 cr
Develops a basic understanding of the engineering profession with emphasis on basic technical principles, Systems Engineering, and Project Management. Special emphasis will be placed upon the interface between management and engineering and the role management plays in the conduct of technical projects and manufacturing. NOTE: This course is not available for credit to students registered in the Price Faculty of Engineering.

ENG 1430 Design in Engineering 3 cr
(Lab required) The creative process; the design process; working in a team. The engineering profession from the perspective of students and professionals. Academic, legal and ethical considerations.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [Pre-Calculus Mathematics 40S (60%) (or one of MATH 0401, MATH 1018, MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1524, MATH 1525, MSKL 0100, or the former MATH 1520, or the former MATH 1680)] and [Physics 40S (60%) (or PHYS 0900 (P) or PSKL 0100 (P) or PHYS 1018, PHYS 1050, or PHYS 1051)] and [Chemistry 40S (60%) (CHEM 0900 (P) or CSKL 0100 (P) or CHEM 1018, CHEM 1100, CHEM 1301, or the former CHEM 1300)] or their equivalents.
Attributes: Recommended Intro Courses

ENG 1440 Introduction to Statics 3 cr
(Lab required) Statics of particles; rigid bodies, equilibrium of rigid bodies; analysis of structures; distributed forces. Not to be held with ENG 1441.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [Pre-Calculus Mathematics 40S (60%) (or one of MATH 0401, MATH 1018, MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1524, MATH 1525, MSKL 0100, or the former MATH 1520 or the former MATH 1680)] and [Physics 40S (60%) (or PHYS 0900 (P) or PSKL 0100 (P) or PHYS 1018, PHYS 1050, or PHYS 1051)] and [Chemistry 40S (60%) CHEM 0900 (P) or CSKL 0100 (P) or CHEM 1018, CHEM 1100, CHEM 1301, or the former CHEM 1300)] or their equivalents.
Equiv To: ENG 1441
Attributes: Recommended Intro Courses

ENG 1450 Introduction to Electrical and Computer Engineering 3 cr
(Lab required) Part I: Current, voltage, energy, potential, power Ohm's law; independent sources; capacitor, inductor, ideal diode, op-amp; Kirchoff's law; simple circuits (Resistive, RC, RL, OP-Amp; Diode); introduction to ac theory (Sinusoidal waveform, phase relations of voltage and current waveforms for R,L,C. RL and RC circuits). Part II: Applications (Digital Logic, motors).
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [Pre-Calculus Mathematics 40S (60%) (or one of MATH 0401, MATH 1018, MATH 1230, MATH 1500 , MATH 1501, MATH 1510, MATH 1524, MATH 1525, MSKL 0100, or the former MATH 1520 or the former MATH 1680)] and [Physics 40S (60%) (or PHYS 0900 (P) or PSKL 0100 (P) or PHYS 1018, PHYS 1050 or PHYS 1051)] and [Chemistry 40S (60%) (or CHEM 0900 (P) or CSKL 0100 (P) or CHEM 1018, CHEM 1100 or CHEM 1301 or the former CHEM 1300)] or their equivalents.
Attributes: Recommended Intro Courses

ENG 1460 Introduction to Thermal Sciences 3 cr
(Lab required) Properties of pure substances; first law for closed systems; first law for open systems; second law; examples of power cycles and refrigeration cycles.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [Pre-Calculus Mathematics 40S (60%) (or one of MATH 0401, MATH 1018, MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1524, MATH 1525, MSKL 0100, or the former MATH 1520 or the former MATH 1680)] and [Physics 40S (60%) (or PHYS 0900 (P) or PSKL 0100 (P) or PHYS 1018, PHYS 1050 or PHYS 1051)] and [Chemistry 40S (60%) (or CHEM 0900 (P) or CSKL 0100 (P) or CHEM 1018, CHEM 1100 or CHEM 1301 or the former CHEM 1300)] or their equivalents.
Attributes: Recommended Intro Courses

ENG 1900 Occupational Health and Safety Awareness 3 cr
Occupational health and safety will be discussed from the perspectives of various professions to understand 1) the issues relevant to individual professions and 2) how these individual perspectives may conflict. The overall goal for the course is to ensure that the student gains an appreciation for the importance of occupational health and safety to society.

ENG 2022 Engineering CAD Technology for Biosystems 3 cr
(Lab required) Instruction in the use of current CAD technology for conveying design through the use of graphics. Students will gain knowledge in technical drawing, 3D modelling techniques, production technology, and visual communication. Registration restricted to students in Engineering.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: BIOE 2900 or the former BIOE 2580.
Mutually Exclusive: MECH 2112

ENG 2040 Engineering Communication: Strategies, Practice and Design 3 cr
This team-based course focuses on a rhetorical approach, communication strategies and guided practice in the design of engineering communications. May not be held with the former ENG 2010.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ENG 1430 and one of the courses from the list of Written English Courses for Engineering Students.
Mutually Exclusive: ENG 2010

ENG 2400 Decolonizing and Indigenizing Engineering 3 cr
(Tutorial required, Field Trip required) This course engages students to critically examine engineering and reflect on current perspectives and practices in decolonizing and Indigenizing the profession. We will examine how Western ideologies, knowledge systems, and biases in engineering have impacted Indigenous lands, waters, cultures, and communities and re-frame Indigenous peoples as engineers. May not be held with ENG 4100 when titled "Decolonizing and Indigenizing Engineering."
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 1430.
Mutually Exclusive: ENG 4100

ENG 3000 Engineering Economics 3 cr
This course offers an introduction to the economic aspects of the engineering discipline. It covers applied economic concepts such as: time value of money, taxation in cash flows, breakeven points, inflation of goods, cost/benefit ratios, income and depreciation, and general microeconomic concepts. The focus includes analysis techniques such as: cash flow analysis, cost-based analysis, rate of return analysis, sensitivity analysis, replacement analysis, and risk mitigation. Concepts are introduced in the context of sustainability and project management fundamentals in a professional practice setting. May not be held with CIVL 4050.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 1510 (or MATH 1230, or MATH 1500, or MATH 1501).
Equiv To: CIVL 4050

ENG 3020 Technology, Society and the Future 3 cr
Impact of technology and technological change on society-past, present, future; specific technologies, e.g. construction. Machine power, computers, communications, medical, military: the process of technological change; invisible effects of technology; technology and resource use; sustainable development, limits to growth and the role of technology. May not be held with CIVL 4460 or ANTH 2430.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 2040 or the former ENG 2030 or BIOE 2900.
Equiv To: CIVL 4460
Mutually Exclusive: ANTH 2430

ENG 4010 Practicing Professional Engineering in Manitoba 3 cr
An introduction to the practice of professional engineering in Manitoba, including culture, professional organization and regulation, employability aspects, engineering ethics and law.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Must be enrolled in the Internationally-Educated Engineers Qualification Program (IEEQ).
Mutually Exclusive: ENG 4020

ENG 4012 IEEQ CO-OP ASSIGNMENT 1 cr
Professional work assignment in business, industry, or government for cooperative education students in the IEEQ Program. Requires submission of a written report covering the work completed during a minimum 16-week work period. (Pass/Fail grade only).
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: enrolled in IEEQ Program with 80% of courses complete, including ENG 4010; good academic standing.

ENG 4020 Professional Engineering Practice in Manitoba 4 cr
(Lab required) An introduction to the practice of professional engineering in Manitoba. Professional culture, organization and regulation; industry topics; engineering ethics and law. Emphasis on professional communication development. Restricted to students enrolled in the IEEQ Program. May not be held with ENG 4010.
Mutually Exclusive: ENG 4010

ENG 4100 Contemporary Topics in Engineering Practice 4 cr
This course will cover contemporary topics relating to the practice of professional engineering. The specific topics and a detailed outline will be available prior to the start of the registration period for the session in which the course will be offered. As the course content will vary from year to year, students may take this course more than once for credit.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Centre for Engineering Professional Practice and Engineering Education.
Mutually Exclusive: ENG 2400, ENG 4400

ENG 4110 Operational Excellence 4 cr
(Lab required) Methodical application of operational excellence and engineering principles and theory to address real industry problems, with emphasis on the data and fact-based engineering method of problem solving. Grounded in the Plan-Do-Study-Act system. Covers the seven step problem solving method (problem definition, examine the current situation, root cause analysis, action planning and testing, study the results, standardize the changes, and draw conclusions), applied concepts (Lean Six Sigma Management) and the fundamentals of teamwork, team dynamics and change management. It is expected that students will be challenged in terms of their understanding of the method, concepts, analytics, and the tools, and their application to solving 'real' operational problems. Students must attend both lecture and tutorial. Students will be required to attend meetings at industrial partner facilities. May not be held with MECH 4342 where the topic is Operational Excellence.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Pre- or Co-requisites: STAT 2220 or (STAT 1000 and STAT 2000).

ENG 4400 Transdisciplinary Land-Based Design and Build 4 cr
(Lab required) An interdisciplinary design-build course involving engineering, architecture and Indigenous design, physical and digital experimentation, prototyping, teamwork, and a build. Students will work with their peers and instructors to design and build a predetermined project. The course will be delivered in studio and on the land. Each student will be required to create a portfolio and deliver a presentation of their experiences with the design project. May not be held with ENG 4100 when titled "Design and Build with Shoal Lake 40" or "The Space for Gathering/Design and Build."
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 1430.
Mutually Exclusive: ENG 4100

ENG 4800 Co-operative Work 1 1 cr
Work assignment in business, industry, or government for the Price Faculty of Engineering co-operative education stream students. Requires submission of a written report covering the work completed during the four- month professional assignment. Those registering for this course must apply for and be accepted into the Price Faculty of Engineering co-operative stream. May not be held with BIOE 2000, CIVL 2900, ECE 4720, MECH 2050 or ENG 4012. This course is graded on a pass/fail basis.
Equiv To: BIOE 2000, CIVL 2900, ECE 4720, ENG 4012, MECH 2050

ENG 4810 Co-operative Work 2 1 cr
Work assignment in business, industry, or government for the Price Faculty of Engineering co-operative education stream students. Requires submission of a written report covering the work completed during the four-month professional assignment. Those registering for this course must apply for and be accepted into the Price Faculty of Engineering co-operative education stream. May not be held with: BIOE 3000, CIVL 3910, ECE 4720, or MECH 3050. This course is graded on a pass/fail basis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 4800
Equiv To: BIOE 3000, CIVL 3910, ECE 4720, MECH 3050

ENG 4820 Co-operative Work 3 1 cr
Work assignment in business, industry, or government for the Price Faculty of Engineering co-operative education stream students. Requires submission of a written report covering the work completed during the four-month professional assignment. Those registering for this course must apply for and be accepted into the Price Faculty of Engineering co-operative education stream. May not be held with: BIOE 4000, CIVL 4920, ECE 4720, or MECH 4050. This course is graded on a pass/fail basis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 4810.
Equiv To: BIOE 4000, CIVL 4920, ECE 4720, MECH 4050

ENG 4830 Co-operative Work 4 1 cr
Work assignment in business, industry, or government for the Price Faculty of Engineering co-operative education stream students. Requires submission of a written report covering the work completed during the four-month professional assignment. Those registering for this course must apply for and be accepted into the Price Faculty of Engineering co-operative education stream. May not be held with: CIVL 4930, ECE 4720, or MECH 4060. This course is graded on a pass/fail basis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 4820.
Equiv To: CIVL 4930, ECE 4720, MECH 4060

ENG 4840 Co-operative Work 5 1 cr
Work assignment in business, industry, or government for the Price Faculty of Engineering co-operative education stream students. Requires submission of a written report covering the work completed during the four-month professional assignment. Those registering for this course must apply for and be accepted into the Price Faculty of Engineering co-operative education stream. May not be held with: CIVL 4940. This course is graded on a pass/ fail basis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 4830.
Equiv To: CIVL 4940

Co-operative Education and Industrial Internship Programs

Contact and Program Information

Director: Carolyn Geddert, P.Eng., Engineer-in-Residence
Tel. 204 474 8948
Email: carolyn.geddert@umanitoba.ca
Cooperative Education Administrator: Megan Johnson
Telephone: 204 480 1069
Email: megan.johnson@umanitoba.ca

The Price Faculty of Engineering offers a Co-operative education and Industrial Internship Program (Co-op/IIP) designed to complement and enrich the academic program with work experience. The work terms provide students with practical experience, assistance in financing their education, and guidance for future career specialization.

Applications are accepted for Co-op/IIP every fall. Co-op/IIP supports the application and participation of all students who meet the requirements and wish to apply. Application to Co-op/IIP is a process. The Co-op/IIP Office will work with you. Please connect with our staff via email: engineeringcoop@umanitoba.ca and refer to the web site (https://umanitoba.ca/engineering/co-operative-education) for the benefits of Co-op/IIP.

Successful applicants to Co-op/IIP have:

- Attended an information session.
- Been accepted as an undergraduate student into an Engineering Department.
- Completed all 13 Preliminary Engineering Program courses before their first work term.
- Completed 42 credit hours towards your degree by the end of the Fall term. Students must return for at least one academic term following the completion of their final work term placement. (Application early in a student's degree program will support the completion of 3 work terms.)
- Been assessed as in Good Academic standing (GPA above 2.0). I.E. not on Probation or Academic Warning.
- Agree to follow all rules and regulations of the program as detailed in the Rules and Regulations

Work placements must be confirmed to be appropriate by the Co-op/IIP office in order be credited as a Co-op/IIP work term.

Upon securing a job placement, Engineering students enroll in the course ENG 4800 and subsequently the specific work term of employment ENG 4810, ENG 4820, ENG 4830, ENG 4840.

Students who are unable to maintain the standards of the Co-op/IIP will be transferred back into the regular program.

The course and grade requirements for completion of the Co-op/IIP are the same as those required for the regular program. However, in order to satisfy course prerequisite requirements, timetables may differ from the regular program. Co-op/IIP students are evaluated in the same manner as regular students and all rules and regulations of the Price Faculty of Engineering apply.

Students who are placed on Academic Probation may either be removed from Co-op/IIP or have their acceptance deferred until they have completed two consecutive terms with an Academic Standing of "Satisfactory".

Students who are Required to Withdraw will immediately become ineligible for Co-op/IIP and will remain ineligible after re-instatement to the Price Faculty of Engineering.

Written reports must be completed at the end of each four-month work term. Each successfully completed four-month work term and its

corresponding report receives a Pass/Fail grade and is rated at one credit hour. Graduates who successfully complete at least three work terms and the required work term reports will have the Co-operative Education Option acknowledged on their B.Sc. graduation parchment.

For more information regarding the Co-op/IIP rules, benefits, regulations and requirements, please refer to the web site (https://umanitoba.ca/engineering/co-operative-education).