S.12-169

SFU

OFFICE OF THE ASSOCIATE VICE-PRESIDENT, ACADEMIC AND ASSOCIATE PROVOST

8888 University Drive,
Burnaby, BC
Canada V5A 1S6

TEL: 778.782.4636
FAX: 778.782.5876

avpcio@sfu.ca
www.sfu.ca/vpacademic

MEMORANDUM

ATTENTION	Senate	**DATE**	November 9, 2012
FROM	Gordon Myers, Chair Senate Committee on Undergraduate Studies	**PAGES**	1/3
RE:	Faculty of Applied Sciences (SCUS 12-44)		

For information:

Acting under delegated authority at its meeting of November 8, 2012, SCUS approved the following curriculum revisions effective Summer 2013:

1. The School of Mechatronic Systems Engineering

(i) Creation of MSE as a new acronym for courses within the School of Mechatronics Systems Engineering.

(ii) Deletion of ENSC courses: 104, 106, 182, 226, 231, 282, 283, 311, 312, 329, 331, 332, 381, 382, 384, 388, 430, 432, 436, 441, 442, 442W, 451, 484

(iii) New Course Proposals:

- MSE 100-3, Engineering Graphics and Design
- MSE 102-3, Applied Science, Technology and Society
- MSE 110-3, Mechatronics Design I
- MSE 251-4, Electronic Circuits
- MSE 220-3, Engineering Materials
- MSE 222-3, Kinematics and Dynamics of Rigid Bodies and Mechanisms
- MSE 223-3, Introduction to Fluid Mechanics
- MSE 300-3, The Business of Engineering I
- MSE 400-3, The Business of Engineering II
- MSE 350-4, Introduction to Digital Logic
- MSE 311-3, Introduction to Microelectromechanical Systems
- MSE 351-4, Microprocessors and Interfacing
- MSE 380-3, Systems Modeling and Simulation

- MSE 320-3, Machine Design
- MSE 312-4, Mechatronics Design II
- MSE 321-3, Engineering Thermodynamics and Heat Transfer
- MSE 451-3, Advanced Electronic Circuits
- MSE 480-3, Manufacturing Systems
- MSE 421-3, Advanced Vibration
- MSE 410-3, Capstone Design Technical Project I
- MSE 411W-3, Capstone Design Technical Project II
- MSE 450-4, Real-Time and Embedded Control Systems
- MSE 481-4, Industrial Control Systems
- MSE 193-3, Optional Job Practicum
- MSE 293-3, Industrial Internship I
- MSE 294-3, Special Internship I
- MSE 393-3, Industrial Internship II
- MSE 394-3, Special Internship II
- MSE 493-3, Industrial Internship III
- MSE 494-3, Special Internship III
- MSE 390-3, Special Topics in Mechatronic Systems Engineering
- MSE 391-4, Special Topics in Mechatronic Systems Engineering
- MSE 486-4, Directed studies in Mechatronic Systems Engineering
- MSE 487-4, Directed Studies in Mechatronic Systems Engineering
- MSC 488-4, Directed Studies in Mechatronic Systems Engineering
- MSC 489-4, Directed Studies in Mechatronic Systems Engineering
- MSE 490-4, Special Topics in Mechatronic Systems Engineering
- MSE 491-4, Special Topics in Mechatronic Systems Engineering
- MSE 492-4, Special Topics in Mechatronic Systems Engineering
- MSE 495-2, Special Project Laboratory
- MSE 496-3, Special Project Laboratory
- MSE 497-4, Special Project Laboratory
- MSE 498-3, Mechatronic Systems Engineering Thesis Proposal
- MSE 499-9, Mechatronic Systems Engineering Undergraduate Thesis
- MSE 101W-3, Process, Form, and Convention in Professional Genres
- MSE 250-3, Electric Circuits
- MSE 210-3, Engineering Measurement and Data Analysis
- MSE 221-3, Statics and Strength of Materials
- MSE 401W-1, Project Documentation and Group Dynamics
- MSE 280-3, Linear Systems
- MSE 381- , Feedback Control Systems
- MSE 310-4, Introduction to Electro-Mechanical Sensors and Actuators
- MSE 402-2, Engineering Ethics, Law, and Professional Practice
- MSE 483-4, Modern Control Systems

(iv) Prerequisite change to:

- CMPT 105W, 106
- ENSC 105W, 220, 225, 280, 281, 305W, 380, 383, 387, 406, 483

(v) Deletion of PHYS 344 from the Mechatronic Systems Engineering Major and Honours Curriculum

(vi) Changes to the calendar entries for the Mechatronic Systems Engineering Major and Honours programs and the Mechatronic Systems Engineering, Business Double Degree Program, Systems One Program and the Software Systems Program

Senators wishing to consult a more detailed report of curriculum revisions may do so by going to Docushare: https://docushare.sfu.ca/dsweb/View/Collection-12682
If you are unable to access the information, please call 778-782-3168 or email shelley_gair@sfu.ca.

SCUS 12-44
SCUS 12-44

Mechatronic Systems Engineering Course Initiation

Faculty of Applied Sciences Curriculum Committee

Ahmad Rad and Robert D. Cameron
October 16, 2012

Introduction

The School of Mechatronic Systems Engineering will be officially established on April 1, 2013 taking on responsibility for the existing Mechatronic Systems Engineering Major and Honours programs as well as responsibility (jointly with Beedie School of Business) for the existing Mechatronic Systems Engineering and Business Double Degree Program.

As the standard mnemonic for the School, the MSE label is proposed to be introduced for all Mechatronic Systems Engineering courses. In general, current ENSC courses that are Surrey-based courses used in the MSE curriculum are proposed to be relabelled as MSE courses. Other existing ENSC courses that are used in both the MSE program and the Burnaby ENSC options are proposed to be replicated. As necessary, the individual course descriptions are proposed to be modified to deal with course-credit restrictions, typically that a student having taken an ENSC course for credit may not take it for further credit under its MSE number.

For simplicity and clarity, a two-stage process is proposed for establishing the Fall 2013 curriculum in Mechatronic Systems Engineering.

1. Course renumbering and cloning only, with minimal curriculum content changes, to be effective May 2013 (this proposal).
2. The normal curriculum changes anticipated for the 2013-14 academic year, to be expressed in terms of the new MSE course labels and proposed for the academic calendar effective September 2013.

The remainder of this document thus focuses on the proposal to renumber and replicate ENSC courses to become MSE courses, as well as the consequent changes to calendar text, without any change in underlying content. It is organized into the following sections.

I. ENSC Courses to be Renumbered
II. ENSC Courses to be Replicated
III. Consequential Course Revisions for CMPT and ENSC Courses
IV. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering Major
V. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering Honours Program
VI. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering and Business Double Degree Program
VII. Consequential Changes to the Calendar Text for the Systems One Program
VIII. Consequential Changes to the Calendar Text for the Software Systems Program

I. ENSC Courses to be Renumbered

The following table lists ENSC courses that are to be renumbered as MSE courses, together with necessary changes in prerequisites and course-equivalency constraints. Upon renumbering, the ENSC course is removed from the calendar, leaving only the new version.

One important note: the Mechatronics Major program was originally designed with TechOne as an integral first year course including the B-Soc course TECH 114-3. In the replacement of TechOne with the Sytems One program, ENSC 106-3 was designed to replace TECH 114-3 as a breadth course and has been approved with the B-Hum designation. With the relabelling to MSE 102-3, the intent is that the course still be considered a B-Hum course for Mechatronics Systems Engineering majors, notwithstanding the normal rule that breadth courses must be from outside the student's unit. The University Curriculum Office has been consulted on this and is requested to confirm approval for SCUS.

Current ENSC Course (to be removed)	Renumbered Course
ENSC 104-3 Engineering Graphics and Design The fundamentals of graphical communication in order to help students think and communicate visually in the context of engineering design. The course focuses on concepts such as isometric, multi-view sketches, section view, and auxiliary views, tolerancing and dimensioning, as well as fundamentals of schematics and printed circuit boards design. Various computer aided design software are used. Students with credit for ENSC 104-3 cannot take ENSC 204-1 for further credit. ENSC 104-3 fulfills the requirements of ENSC 204-1, but ENSC 204-1 does not fulfill the requirements of ENSC 104-3.	**MSE 100-3 Engineering Graphics and Design** The fundamentals of graphical communication in order to help students think and communicate visually in the context of engineering design. The course focuses on concepts such as isometric, multi-view sketches, section view, and auxiliary views, tolerancing and dimensioning, as well as fundamentals of schematics and printed circuit boards design. Various computer aided design software are used. **Students with credit for ENSC 104 may not take MSE 100 for further credit.**
ENSC 106-3 Applied Science, Technology and Society Reviews the different modes of thought characteristic of science, engineering and computing. Examines the histories and chief current research issues in these fields. Considers the ethical and social responsibilities of engineering and computing work. Corequisite: ENSC 105W or CMPT 105W. Students who have taken ENSC 100 cannot take this course for credit. ENSC 106 is identical to CMPT 106 and students cannot take both for credit. B-Hum/B-Sci	**MSE 102-3 Applied Science, Technology and Society** Reviews the different modes of thought characteristic of science, engineering and computing. Examines the histories and chief current research issues in these fields. Considers the ethical and social responsibilities of engineering and computing work. Corequisite: **MSE 101W or CMPT 105W. Students with credit for CMPT 106, ENSC 100 or ENSC 106 may not take MSE 102 for further credit.** B-Hum/B-Sci

Current ENSC Course (to be removed)	Renumbered Course
ENSC 182-3 Mechatronics Design I First year project course designed to provide students with a first exposure to the challenges of project organization. Students are responsible for designing and constructing a mechanical robot optimized to solve a particular chosen task. The engineering challenges of the project are expected to focus half on mechanical design and half on control algorithm design and implementation.	**MSE 110-3 Mechatronics Design I** First year project course designed to provide students with a first exposure to the challenges of project organization. Students are responsible for designing and constructing a mechanical robot optimized to solve a particular chosen task. The engineering challenges of the project are expected to focus half on mechanical design and half on control algorithm design and implementation. **Students with credit for ENSC 182 may not take MSE 110 for further credit.**
ENSC 226-4 Electronic Circuits Introduces the basic electronic components, amplifiers, diodes, and oscillators. Fundamentals of logic design. Prerequisite: ENSC 220. Students who have taken this course may not take ENSC 225 for further credit.	**MSE 251-4 Electronic Circuits** Introduces the basic electronic components, amplifiers, diodes, and oscillators. Fundamentals of logic design. Prerequisite: **MSE 250 or** ENSC 220. **Students with credit for ENSC 225 or 226 may not take MSE 251 for further credit.**
ENSC 231-3 Engineering Materials Materials, their structures, properties and performance; crystal structures and instruments for structure determination; polymers, ceramics, and composites; quality control and reliability. Prerequisite: CHEM 120 or 121; PHYS 140 or 121. Students who have taken ENSC 330 may not take this course for further credit.	**MSE 220-3 Engineering Materials** Materials, their structures, properties and performance; crystal structures and instruments for structure determination; polymers, ceramics, and composites; quality control and reliability. Prerequisite: CHEM 120 or 121; PHYS 140 or 121. **Students with credit for ENSC 231 or ENSC 330 may not take MSE 220 for further credit.**
ENSC 282-3 Kinematics and Dynamics of Rigid Bodies and Mechanisms Planar and 3D motions kinematics and kinetics of rigid bodies and mechanisms; linkages, gears, cams; synthesis and analysis of mechanisms; consideration of the static and dynamic forces in machines; vibration analysis, response to shock, motion and force transmissibility, vibration isolation. Prerequisite: PHYS 140, MATH 152, and 310.	**MSE 222-3 Kinematics and Dynamics of Rigid Bodies and Mechanisms** Planar and 3D motions kinematics and kinetics of rigid bodies and mechanisms; linkages, gears, cams; synthesis and analysis of mechanisms; consideration of the static and dynamic forces in machines; vibration analysis, response to shock, motion and force transmissibility, vibration isolation. Prerequisite: PHYS 140, MATH 152, and 310. **Students with credit for ENSC 282 may not take MSE 222 for further credit.**

Current ENSC Course (to be removed)	Renumbered Course
ENSC 283-3 Introduction to Fluid Mechanics Physical properties of fluids and fundamental concepts in fluid mechanics. Hydrostatics. Conservation laws for mass, momentum and energy. Flow similarity and dimensional analysis as applied to engineering problems in fluid mechanics. Laminar and turbulent flow. Engineering applications such as flow measurement, flow in pipes and fluid forces on moving bodies. Prerequisite: PHYS 140, MATH 152, and 310.	**MSE 223-3 Introduction to Fluid Mechanics** Physical properties of fluids and fundamental concepts in fluid mechanics. Hydrostatics. Conservation laws for mass, momentum and energy. Flow similarity and dimensional analysis as applied to engineering problems in fluid mechanics. Laminar and turbulent flow. Engineering applications such as flow measurement, flow in pipes and fluid forces on moving bodies. Prerequisite: PHYS 140, MATH 152, and 310. **Students with credit for ENSC 283 may not take MSE 223 for further credit.**
ENSC 311-3 The Business of Engineering I Covers topics in decision theory and engineering economics including: gap analysis, multi-attribute utility theory, discounted cash flow fundamentals, inflation, depreciation, tax, financial analysis, uncertainty and optimization. Prerequisite: More than 50 units. Students who have credit for ENSC 201 may not complete this course for further credit.	**MSE 300-3 The Business of Engineering I** Covers topics in decision theory and engineering economics including: gap analysis, multi-attribute utility theory, discounted cash flow fundamentals, inflation, depreciation, tax, financial analysis, uncertainty and optimization. Prerequisite: More than 75 units. **Students with credit for ENSC 201 or 311 may not take MSE 300 for further credit.**
ENSC 312-3 The Business of Engineering II Concepts covered include entrepreneurship, marketing, financing, business plan, project management skills as well as facilitation, communication and negotiation. Students will experience what it is like to be part of a start-up company with a diverse project team. Prerequisite: ENSC 311.	**MSE 400-3 The Business of Engineering II** Concepts covered include entrepreneurship, marketing, financing, business plan, project management skills as well as facilitation, communication and negotiation. Students will experience what it is like to be part of a start-up company with a diverse project team. Prerequisite: **MSE 300 (or** ENSC 311). **Students with credit for ENSC 312 may not take MSE 400 for further credit.**

Current ENSC Course (to be removed)	Renumbered Course
ENSC 329-4 Introduction to Digital Logic Conveys the essential principles of digital logic systems which are the building blocks of many electronic systems including computer systems. These principles form the basis of the electronics component of the mechatronics curriculum and therefore a good understanding of the material is crucial. Prerequisite: ENSC 226, CMPT 128.	**MSE 350-4 Introduction to Digital Logic** Conveys the essential principles of digital logic systems which are the building blocks of many electronic systems including computer systems. These principles form the basis of the electronics component of the mechatronics curriculum and therefore a good understanding of the material is crucial. Prerequisite: **MSE 251 (or** ENSC 226), CMPT 128. **Students with credit for ENSC 329 may not take MSE 350 for further credit.**
ENSC 331-3 Introduction to Microelectromechanical Systems An introduction to microelectromechanical systems, covering thin film processing technologies, bulk and surface micromachining, and MEMS applications. Prerequisite: ENSC 281, 387 and one of ENSC 231 or ENSC 330.	**MSE 311-3 Introduction to Microelectromechanical Systems** An introduction to microelectromechanical systems, covering thin film processing technologies, bulk and surface micromachining, and MEMS applications. Prerequisite: **MSE 222 (or** ENSC 282), **MSE 251** (or ENSC 226).. **Students with credit for ENSC 331 may not take MSE 311 for further credit.**
ENSC 332-4 Microprocessors and Interfacing Covers basic microcomputer architecture, design and analysis of address decoders and memory systems, design and analysis of assembly language programs and microcomputer system design. Prerequisite: ENSC 329.	**MSE 351-4 Microprocessors and Interfacing** Covers basic microcomputer architecture, design and analysis of address decoders and memory systems, design and analysis of assembly language programs and microcomputer system design. Prerequisite: **MSE 350 (or** ENSC 329). **Students with credit for ENSC 332 may not take MSE 351 for further credit.**

Current ENSC Course (to be removed)	Renumbered Course
ENSC 381-3 Systems Modeling and Simulation Introduction to systems modeling and analysis. Application to engineering systems including: mechanical, electrical, thermal, and fluid systems. Allows the student to acquire, in a time-efficient and uncomplicated manner, knowledge in the formation and construction of dynamic models. The simulation models that the student will design in this course accommodate these analyses, with the construction of realistic hypotheses and elaborate behavior models. Prerequisite: ENSC 226, 281, 282.	**MSE 380-3 Systems Modeling and Simulation** Introduction to systems modeling and analysis. Application to engineering systems including: mechanical, electrical, thermal, and fluid systems. Allows the student to acquire, in a time-efficient and uncomplicated manner, knowledge in the formation and construction of dynamic models. The simulation models that the student will design in this course accommodate these analyses, with the construction of realistic hypotheses and elaborate behavior models. Prerequisite: **MSE 221 (or** ENSC 281), **MSE 222 (or** ENSC 282), **MSE 251 (or** ENSC 226). **Students with credit for ENSC 381 may not take MSE 380 for further credit.**
ENSC 382-3 Machine Design Review of stress and strain in solids, superposition, energy theorems, theories of failure, elastic and inelastic analysis of symmetrical bending, torsion of circular members, and virtual work. Adequacy assessment and synthesis of machine elements with a focus on the design process. Static failure of ductile and brittle materials, fatigue analysis of structures. Topics include the design of welds, bolted connections, springs and shafts. Solution strategies include both analytical and finite element methods. Prerequisite, ENSC 281 and 282.	**MSE 320-3 Machine Design** Review of stress and strain in solids, superposition, energy theorems, theories of failure, elastic and inelastic analysis of symmetrical bending, torsion of circular members, and virtual work. Adequacy assessment and synthesis of machine elements with a focus on the design process. Static failure of ductile and brittle materials, fatigue analysis of structures. Topics include the design of welds, bolted connections, springs and shafts. Solution strategies include both analytical and finite element methods. Prerequisite: **MSE 221 (or** ENSC 281), **MSE 222 (or** ENSC 282). **Students with credit for ENSC 382 may not take MSE 320 for further credit.**

Current ENSC Course (to be removed)	Renumbered Course
ENSC 384-4 Mechatronics Design II Interweaves mechanisms, electronics, sensors, and control strategies with software and information technology to examine the demands and ideas of customers and find the most efficient, cost-effective method to transform their goals into successful commercial products. Most of the term is devoted to a significant design project in which student groups work independently and competitively, applying the design process to a project goal set by the faculty co-ordinator. Prerequisite: ENSC 382, 381, 182. ENSC 332 and 387 can either be taken as prerequisites or concurrently.	**MSE 312-4 Mechatronics Design II** Interweaves mechanisms, electronics, sensors, and control strategies with software and information technology to examine the demands and ideas of customers and find the most efficient, cost-effective method to transform their goals into successful commercial products. Most of the term is devoted to a significant design project in which student groups work independently and competitively, applying the design process to a project goal set by the faculty co-ordinator. Prerequisite: **MSE 110 (or** ENSC 182), **MSE 320 (or** ENSC 382), **MSE 380 (or** ENSC 381). **MSE 320 and MSE 380 may be taken concurrently. Students with credit for ENSC 384 may not take MSE 312 for further credit.**
ENSC 388-3 Engineering Thermodynamics and Heat Transfer Energy transfer as work and heat, the First Law of thermodynamics. Properties and states of simple substances. Control-mass and control-volume analyses. Entropy, the Second Law of thermodynamics. Carnot cycle. Energy conversion systems; internal combustion engines, power plants and refrigeration cycles. Heat transfer by conduction, convection, and radiation. Formulation and solution of steady and transient problems. Cooling of microelectronics, thermal solutions. Prerequisite: MATH 152, 251, PHYS 141. Students with credit for PHYS 344 cannot take this course for further credit.	**MSE 321-3 Engineering Thermodynamics and Heat Transfer** Energy transfer as work and heat, the First Law of thermodynamics. Properties and states of simple substances. Control-mass and control-volume analyses. Entropy, the Second Law of thermodynamics. Carnot cycle. Energy conversion systems; internal combustion engines, power plants and refrigeration cycles. Heat transfer by conduction, convection, and radiation. Formulation and solution of steady and transient problems. Cooling of microelectronics, thermal solutions. Prerequisite: MATH 152, 251, PHYS 141. Students with credit for **ENSC 388 or** PHYS 344 **may** not take **MSE 321** for further credit.
ENSC 430-3 Advanced Electronic Circuits Introduction to advanced topics in electronic circuit design. The emphasis will be on circuits and devices which are needed by mechatronics engineers in practice. Prerequisite: Completion of 80 units including ENSC 226. Students with credit for ENSC 325 cannot complete this course for further credit.	**MSE 451-3 Advanced Electronic Circuits** Introduction to advanced topics in electronic circuit design. The emphasis will be on circuits and devices which are needed by mechatronics engineers in practice. Prerequisite: Completion of 80 units including **MSE 251 (or** ENSC 226). Students with credit for ENSC 325 **or 430 may not take MSE 451** for further credit.

Current ENSC Course (to be removed)	Renumbered Course
ENSC 432-3 Manufacturing Systems An introduction to manufacturing systems: industrial robotics, manufacturing system components and definitions, material handling systems, production lines, assembly systems, robotic cell design, cellular manufacturing, flexible manufacturing systems, quality control, manufacturing support systems. Prerequisite: ENSC 387.	**MSE 480-3 Manufacturing Systems** An introduction to manufacturing systems: industrial robotics, manufacturing system components and definitions, material handling systems, production lines, assembly systems, robotic cell design, cellular manufacturing, flexible manufacturing systems, quality control, manufacturing support systems. Prerequisite: **MSE 310 (or** ENSC 387). **Students with credit for ENSC 432 may not take MSE 480 for further credit.**
ENSC 436-3 Advanced Vibration Advanced introduction to vibration, free vibration, harmonic excitation of undamped systems, harmonic excitation of damped systems, base excitation, rotating unbalance, impuse response, response to an arbitrary input, response to an arbitrary periodic input, transform method, two degree of freedom model, more than two degrees of freedom, systems with viscous damping, Lagrange's equations, vibrations of string or cable, vibration of rods and bars, torsional vibration, bending vibration of a beam, finite element method. Prerequisite: ENSC 282, 380.	**MSE 421-3 Advanced Vibration** Advanced introduction to vibration, free vibration, harmonic excitation of undamped systems, harmonic excitation of damped systems, base excitation, rotating unbalance, impuse response, response to an arbitrary input, response to an arbitrary periodic input, transform method, two degree of freedom model, more than two degrees of freedom, systems with viscous damping, Lagrange's equations, vibrations of string or cable, vibration of rods and bars, torsional vibration, bending vibration of a beam, finite element method. Prerequisite: **MSE 222 (or** ENSC 282), **MSE 280 (or** ENSC 380). **Students with credit for ENSC 436 may not take MSE 421 for further credit.**
ENSC 441-3 Capstone Design Technical Project I Students will combine their technical, marketing, and entrepreneurship knowledge to conceive, and design a product. Also includes project documentation and project management. At the end of the term a comprehensive report is required, Prerequisite: ENSC 312 and 100 units. Corequisite: ENSC 305.	**MSE 410-3 Capstone Design Technical Project I** Students will combine their technical, marketing, and entrepreneurship knowledge to conceive, and design a product. Also includes project documentation and project management. At the end of the term a comprehensive report is required, Prerequisite: **MSE 400** (or ENSC 312) and 100 units. Corequisite: **MSE 401W. Students with credit for ENSC 441 may not take MSE 410 for further credit.**

Current ENSC Course (to be removed)	Renumbered Course
ENSC 442-3 Capstone Design Technical Project II **ENSC 442W-3 Capstone Design Technical Project II** Students will apply their technical, marketing and entrepreneurship knowledge to develop a product that was designed earlier in ENSC 441. Students will then present and be able to see it to a panel of engineers, business and investment community members. Prerequisite: ENSC 441. Writing.	**MSE 411W-3 Capstone Design Technical Project II** Students will apply their technical, marketing and entrepreneurship knowledge to develop a product that was designed earlier in **MSE 410**. Students will then present and be able to see it to a panel of engineers, business and investment community members. Prerequisite: **MSE 410. Students with credit for ENSC 442 may not take MSE 411W for further credit**. Writing.
ENSC 451-4 Real-Time and Embedded Control Systems Focuses on implementation and design of embedded computer control systems used in mechatronics and other applications. Many of these systems are real-time in nature, meaning that the computer system must discern the state of the world and react to it within stringent response-time constraints. Upon completion of the course, the student will have a basic understanding of how to design, build and integrate hardware and software for an embedded control application. Hands-on experience will be gained by performing laboratory experiments and doing an embedded computer control project on a mechatronic system. Prerequisite: ENSC 332, 383, and completion of 90 units. Students who have taken ENSC 351 cannot take this course for further credit.	**MSE 450-4 Real-Time and Embedded Control Systems** Focuses on implementation and design of embedded computer control systems used in mechatronics and other applications. Many of these systems are real-time in nature, meaning that the computer system must discern the state of the world and react to it within stringent response-time constraints. Upon completion of the course, the student will have a basic understanding of how to design, build and integrate hardware and software for an embedded control application. Hands-on experience will be gained by performing laboratory experiments and doing an embedded computer control project on a mechatronic system. Prerequisite: **MSE 351 (or** ENSC 332), **MSE 381 (or** ENSC 383), and completion of 90 units. Students who have taken ENSC 351 **or 451** cannot take **MSE 450** for further credit.
ENSC 484-4 Industrial Control Systems Examines modern industrial control systems and applications. Topics include: review of industrial sensors and actuators; computer interfacing; ladder logic and programmable logic controllers; industrial computer and programming methods; industrial networks; human-machine interfaces; supervisory control and data acquisition (SCADA); manufacturing execution systems; and enterprise-wide integration. Prerequisite: ENSC 332, 383.	**MSE 481-4 Industrial Control Systems** Examines modern industrial control systems and applications. Topics include: review of industrial sensors and actuators; computer interfacing; ladder logic and programmable logic controllers; industrial computer and programming methods; industrial networks; human-machine interfaces; supervisory control and data acquisition (SCADA); manufacturing execution systems; and enterprise-wide integration. **Prerequisite: MSE 351 (or ENSC 332) and MSE 381 (or ENSC 383). Students with credit for ENSC 484 may not take MSE 481 for further credit.**

II. ENSC Courses to be Replicated

A number of of existing ENSC courses are used both at Surrey in the MSE curriculum as well as at Burnaby in the other engineering options. These include Co-op, special topics, individual project and thesis courses, as well some regular courses Each of these courses is proposed to be replicated in accord with the following table.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 194-3 Optional Job Practicum Four month internship of a non-technical nature. May be taken at any point during the program but will not count toward one of the three mandatory co-op work terms. Credit is awarded as in ENSC 195. Units from this course do not count towards the units required for an SFU degree.	**MSE 193-3 Optional Job Practicum** Four month internship of a non-technical nature. May be taken at any point during the program but will not count toward one of the three mandatory co-op work terms. Credit is awarded as in **MSE 293**. Units from this course do not count towards the units required for an SFU degree.
ENSC 195-3 Industrial Internship I First four month internship in industry. Credit is given as pass/withdraw/fail (P/W/F) only, based on the employer's and co-operative education co-ordinator's evaluations. Units from this course do not count towards the units required for an SFU degree.	**MSE 293-3 Industrial Internship I** First four month internship in industry. Credit is given as pass/withdraw/fail (P/W/F) only, based on the employer's and co-operative education co-ordinator's evaluations. Units from this course do not count towards the units required for an SFU degree.
ENSC 196-3 Special Internship I Four month internship in industry or university research environment. Credit is awarded as in ENSC 195. Prior approval of Internship Co-ordinator required. Units from this course do not count towards the units required for an SFU degree.	**MSE 294-3 Special Internship I** Four month internship in industry or university research environment. Credit is awarded as in **MSE 293**. Prior approval of Internship Co-ordinator required. Units from this course do not count towards the units required for an SFU degree.
ENSC 295-3 Industrial Internship II Second four month internship in industry. Credit is awarded as in ENSC 195. Units from this course do not count towards the units required for an SFU degree. Prerequisite: ENSC 195 or 196.	**MSE 393-3 Industrial Internship II** Second four month internship in industry. Credit is awarded as in **MSE 293**. Units from this course do not count towards the units required for an SFU degree. Prerequisite: **MSE 293 or 294**.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 296-3 Special Internship II Four month internship in industry or university research environment. Credit is awarded as in ENSC 195. Units from this course do not count towards the units required for an SFU degree. Prerequisite: ENSC 195 or 196 and approval of internship co-ordinator required.	**MSE 394-3 Special Internship II** Four month internship in industry or university research environment. Credit is awarded as in **MSE 293**. Units from this course do not count towards the units required for an SFU degree. Prerequisite: **MSE 293 or 294** and approval of internship co-ordinator required.
ENSC 395-3 Industrial Internship III Third four month internship in industry. Credit is awarded as in ENSC 195. Units from this course do not count towards the units required for an SFU degree. Prerequisite: ENSC 295 or 296 and a minimum of 75 units.	**MSE 493-3 Industrial Internship III** Third four month internship in industry. Credit is awarded as in **MSE 293**. Units from this course do not count towards the units required for an SFU degree. Prerequisite: **MSE 393 or 394** and a minimum of 75 units.
ENSC 396-3 Special Internship III Four month internship in industry or university research environment. Approved entrepreneurial projects will also be accepted. Credit is awarded as in ENSC 195. Units from this course do not count towards the units required for an SFU degree. Prerequisite: ENSC 295 or 296, a minimum of 75 units and approval of internship co-ordinator required.	**MSE 494-3 Special Internship III** Four month internship in industry or university research environment. Approved entrepreneurial projects will also be accepted. Credit is awarded as in **MSE 293**. Units from this course do not count towards the units required for an SFU degree. Prerequisite: **MSE 393 or 394**, a minimum of 75 units and approval of internship co-ordinator required.
ENSC 363-3 Special Topics in Engineering Science Prerequisite: permission of the undergraduate curriculum chair.	**MSE 390-3 Special Topics in Mechatronic Systems Engineering** Prerequisite: permission of the undergraduate curriculum chair.
ENSC 364-4 Special Topics in Engineering Science Prerequisite: permission of the undergraduate curriculum chair.	**MSE 391-4 Special Topics in Mechatronic Systems Engineering** Prerequisite: permission of the undergraduate curriculum chair.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 400-4 Directed Studies in Engineering Science Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.	**MSE 486-4 Directed Studies in Mechatronic Systems Engineering** Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.
ENSC 401-4 Directed Studies in Engineering Science Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.	**MSC 487-4 Directed Studies in Mechatronic Systems Engineering** Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.
ENSC 402-4 Directed Studies in Engineering Science Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.	**MSC 488-4 Directed Studies in Mechatronic Systems Engineering** Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 403-3 Directed Studies in Engineering Science Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.	**MSC 489-4 Directed Studies in Mechatronic Systems Engineering** Directed reading and research in a topic chosen in consultation with a supervisor. Admission requires agreement by a proposed faculty supervisor and submission of a proposal to the school at least one month prior to the start of the term in which the course will be taken. Upon completion of a directed study course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: a minimum of 100 units and permission of the chair of the undergraduate curriculum committee.
ENSC 460-4 Special Topics in Engineering Science Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.	**MSE 490-4 Special Topics in Mechatronic Systems Engineering** Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.
ENSC 461-4 Special Topics in Engineering Science Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.	**MSE 491-4 Special Topics in Mechatronic Systems Engineering** Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.
ENSC 462-4 Special Topics in Engineering Science Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.	**MSE 492-4 Special Topics in Mechatronic Systems Engineering** Studies in areas not included within the undergraduate course offerings of the engineering science program. Prerequisite: to be determined by the instructor subject to approval by the department chair.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 492-2 Special Project Laboratory This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.	**MSE 495-2 Special Project Laboratory** This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.
ENSC 493-3 Special Project Laboratory This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.	**MSE 496-3 Special Project Laboratory** This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 494-4 Special Project Laboratory This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.	**MSE 497-4 Special Project Laboratory** This course is intended for students wishing to pursue laboratory research on a specific topic outside the standard course offerings. Each student must be sponsored by a faculty member who will oversee the project. A proposal of the student's special project must be submitted to the school at least one month prior to the start of the term in which the course will be taken. The unit value of the project will be assessed during this review phase and the student will be directed to register in the appropriate course. Upon completion of a special project laboratory course, the student must submit a copy of the 'deliverables' to the chair of the undergraduate curriculum committee. Prerequisite: permission of the undergraduate curriculum committee chair.
ENSC 498-3 Engineering Science Thesis Proposal Supervised study, research and preliminary work leading to a formal proposal for the thesis project work in ENSC 499. This activity can be directly augmented by other course work and by directed study. The locale of the work may be external to the University or within a University laboratory, or may bridge the two locations. Supervision may be by technical personnel at an external organization, or by faculty members, or through some combination. At least one of the supervisors must be a registered professional engineer. A plan for the student's ENSC 498 activities must be submitted to the school at the time of enrolment in the course. Completion of the undergraduate thesis project proposal is the formal requirement of this course and the basis upon which it is graded. Grading will be on a pass/fail basis. Prerequisite: at least 115 units or permission of the academic supervisor.	**MSE 498-3 Mechatronic Systems Engineering Thesis Proposal** Supervised study, research and preliminary work leading to a formal proposal for the thesis project work in **MSE 499**. This activity can be directly augmented by other course work and by directed study. The locale of the work may be external to the University or within a University laboratory, or may bridge the two locations. Supervision may be by technical personnel at an external organization, or by faculty members, or through some combination. At least one of the supervisors must be a registered professional engineer. A plan for the student's **MSE 498** activities must be submitted to the school at the time of enrolment in the course. Completion of the undergraduate thesis project proposal is the formal requirement of this course and the basis upon which it is graded. Grading will be on a pass/fail basis. Prerequisite: at least 115 units or permission of the academic supervisor.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 499-9 Engineering Science Undergraduate Thesis A thesis is based on the research or development project that incorporates a significant level of engineering design. This work is typically undertaken in the student's final year, but in no case before the student has completed 115 units. Registration for ENSC 499 takes place in the term in which the thesis will be presented and defended. The locale of the work, supervision and other arrangements follow those for ENSC 498. Grading of the thesis will be on a pass/fail basis, but recognition will be given to outstanding work. Prerequisite: ENSC 498.	**MSE 499-9 Mechatronic Systems Engineering Undergraduate Thesis** A thesis is based on the research or development project that incorporates a significant level of engineering design. This work is typically undertaken in the student's final year, but in no case before the student has completed 115 units. Registration for **MSE 499** takes place in the term in which the thesis will be presented and defended. The locale of the work, supervision and other arrangements follow those for **MSE 498**. Grading of the thesis will be on a pass/fail basis, but recognition will be given to outstanding work. Prerequisite: **MSE 498**.
ENSC 105W-3 Process, Form, and Convention in Professional Genres The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106 or ENSC 106. This course is identical to CMPT 105W and students cannot take both for credit. This course is equivalent to ENSC 101W-1 and ENSC 102W-1 combined. Students with credit for this course cannot take ENSC 101W or ENSC 102W for further credit. Writing.	**MSE 101W-3 Process, Form, and Convention in Professional Genres** The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106 or MSE 102. **Students with credit for CMPT 105W, ENSC 102W or ENSC 105W may not take MSE 101W for further credit.** Writing.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 220-3 Electric Circuits I This course will cover the following topics: fundamental electrical circuit quantities, and circuit elements; circuits laws such as Ohm law, Kirchoff's voltage and current laws, along with series and parallel circuits; operational amplifiers; network theorems; nodal and mesh methods; analysis of natural and step response of first (RC and RL), as well as second order (RLC) circuits; real, reactive and rms power concepts. In addition, the course will discuss the worker safety implications of both electricity and common laboratory practices such as soldering. Prerequisite: PHYS 121 and 131, or PHYS 126 and 131, or PHYS 141, and MATH 232 and 310. MATH 232 and/or 310 may be taken concurrently. Students with credit for ENSC 125 cannot take this course for further credit. Quantitative.	**MSE 250-3 Electric Circuits** This course will cover the following topics: fundamental electrical circuit quantities, and circuit elements; circuits laws such as Ohm law, Kirchoff's voltage and current laws, along with series and parallel circuits; operational amplifiers; network theorems; nodal and mesh methods; analysis of natural and step response of first (RC and RL), as well as second order (RLC) circuits; real, reactive and rms power concepts. In addition, the course will discuss the worker safety implications of both electricity and common laboratory practices such as soldering. Prerequisite: PHYS 121 and 131, or PHYS 126 and 131, or PHYS 141, and MATH 232 and 310. MATH 232 and/or 310 may be taken concurrently. Students with credit for ENSC 125 **or 220** may not take **MSE 250** for further credit. Quantitative.
ENSC 280-3 Engineering Measurement and Data Analysis An introduction to methods to collect and analyse engineering data. Topics include the Engineering data representation, Discrete and continuous probability density functions, Engineering measurements, Error analysis, Introduction to sensor interfaces, Introduction to physical sensors, Introduction to sensor signal conditioning, Noise, Test of hypotheses, Linear and nonlinear regression, and Design of experiments. Prerequisite: PHYS 141 or equivalent. MATH 150 or MATH 151. Students with credit for PHYS 231 cannot take this course for further credit. Students who have taken and passed ENSC 263 "Special Topics in ENSC: Engineering Measurement and Data Analysis" in Spring 2009 and Spring 2010 cannot take this course for further credit.	**MSE 210-3 Engineering Measurement and Data Analysis** An introduction to methods to collect and analyse engineering data. Topics include the Engineering data representation, Discrete and continuous probability density functions, Engineering measurements, Error analysis, Introduction to sensor interfaces, Introduction to physical sensors, Introduction to sensor signal conditioning, Noise, Test of hypotheses, Linear and nonlinear regression, and Design of experiments. Prerequisite: PHYS 141 or equivalent. MATH 150 or MATH 151. Students with credit for **ENSC 280 or** PHYS 231 may not take **MSE 210** for further credit.

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 281-3 Statics and Strength of Materials Covers basic concepts of mechanics, vectors. Statics of particles. Rigid bodies and force systems, equilibrium of rigid bodies. Analysis of trusses and frames. Distributed forces, centroids and moments of inertia. Friction. Internal shear and bending moments in beams. Strength of material: introduction to mechanical response of materials and stress-strain transformations. Virtual work and energy methods. Prerequisite: PHYS 140, MATH 152.	**MSE 221-3 Statics and Strength of Materials** Covers basic concepts of mechanics, vectors. Statics of particles. Rigid bodies and force systems, equilibrium of rigid bodies. Analysis of trusses and frames. Distributed forces, centroids and moments of inertia. Friction. Internal shear and bending moments in beams. Strength of material: introduction to mechanical response of materials and stress-strain transformations. Virtual work and energy methods. Prerequisite: PHYS 140, MATH 152. **Students with credit for ENSC 281 may not take MSE 221 for further credit.**
ENSC 305W-1 Project Documentation and Group Dynamics This course is integrated with an ENSC project course (either ENSC 340 or 440) that provides practical experience with the design process for development projects. Topics include project management, team writing, project documentation (proposals, functional and design specifications, progress reports, and users manuals), group dynamics and dispute resolution. Prerequisite: Either both of ENSC 101W and ENSC 102 or one of ENSC 105W or CMPT 105W. Corequisite: ENSC 440 or 441. Writing.	**MSE 401W-1 Project Documentation and Group Dynamics** This course is integrated with an **MSE** project course (**MSE 410**) that provides practical experience with the design process for development projects. Topics include project management, team writing, project documentation (proposals, functional and design specifications, progress reports, and users manuals), group dynamics and dispute resolution. Prerequisite: Either both of ENSC 101W and ENSC 102 or one of **MSE 101W**, ENSC 105W or CMPT 105W. Corequisite: **MSE 410. Students with credit for ENSC 305W may not take MSE 401W for further credit.** Writing.
ENSC 380-3 Linear Systems The objectives of this course are to cover the modelling and analysis of continuous and discrete signals using linear techniques. Topics covered include: a review of Laplace transforms; methods for the basic modelling of physical systems; discrete and continuous convolution; impulse and step response; transfer functions and filtering; the continuous Fourier transform and its relationship to the Laplace transform; frequency response and Bode plots; sampling; the Z-transform. Prerequisite: ENSC 220 and MATH 310.	**MSE 280-3 Linear Systems** The objectives of this course are to cover the modelling and analysis of continuous and discrete signals using linear techniques. Topics covered include: a review of Laplace transforms; methods for the basic modelling of physical systems; discrete and continuous convolution; impulse and step response; transfer functions and filtering; the continuous Fourier transform and its relationship to the Laplace transform; frequency response and Bode plots; sampling; the Z-transform. Prerequisite: **MSE 250 (or** ENSC 220) and MATH 310. **Students with credit for ENSC 380 may not take MSE 280 for further credit.**

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 383 Feedback Control Systems This course is an introduction to the analysis, design, and applications of continuous time linear control systems. Topics include transfer function representation of open and closed loop systems, time domain specifications and steady state error, sensitivity analysis, time and frequency response, and stability criteria. It includes a treatment of methods for the analysis of control systems based on the root locus, Bode plots and Nyquist criterion, and their use in the design of PID, and lead-lag compensation. Lab work is included in this course. Prerequisite: ENSC 380.	**MSE 381 Feedback Control Systems** This course is an introduction to the analysis, design, and applications of continuous time linear control systems. Topics include transfer function representation of open and closed loop systems, time domain specifications and steady state error, sensitivity analysis, time and frequency response, and stability criteria. It includes a treatment of methods for the analysis of control systems based on the root locus, Bode plots and Nyquist criterion, and their use in the design of PID, and lead-lag compensation. Lab work is included in this course. Prerequisite: **MSE 280 (or** ENSC 380). **Students with credit for ENSC 383 may not take MSE 381 for further credit.**
ENSC 387-4 Introduction to Electro-Mechanical Sensors and Actuators This course provides an introduction to sensors and actuators for electromechanical, computer-controlled machines and devices. Topics include operating principles, design considerations, and applications of analog sensors, digital transducers, stepper motors, continuous-drive actuators, and drive system electronics. Component integration and design considerations are studied through examples selected from applications of machine tools, mechatronics, precision machines, robotics, aerospace systems, and ground and underwater vehicles. Laboratory exercises strengthen the understanding of component performance, system design and integration. Prerequisite: ENSC 380.	**MSE 310-4 Introduction to Electro-Mechanical Sensors and Actuators** This course provides an introduction to sensors and actuators for electromechanical, computer-controlled machines and devices. Topics include operating principles, design considerations, and applications of analog sensors, digital transducers, stepper motors, continuous-drive actuators, and drive system electronics. Component integration and design considerations are studied through examples selected from applications of machine tools, mechatronics, precision machines, robotics, aerospace systems, and ground and underwater vehicles. Laboratory exercises strengthen the understanding of component performance, system design and integration. Prerequisite: **MSE 280 or** ENSC 380. **Students with credit for ENSC 387 may not take MSE 310 for further credit.**

Existing ENSC Course (To be Retained)	Replicated MSE Course
ENSC 406-2 Engineering Ethics, Law, and Professional Practice This course provides an introduction to the engineering profession, professional practice, engineering law and ethics, including the issues of worker and public safety. It also offers opportunities to explore the social implications and environmental impacts of technologies, including sustainability, and to consider engineers' responsibility to society. Prerequisite: 100 units including one of ENSC 100W, ENSC 106, or CMPT 106.	**MSE 402-2 Engineering Ethics, Law, and Professional Practice** This course provides an introduction to the engineering profession, professional practice, engineering law and ethics, including the issues of worker and public safety. It also offers opportunities to explore the social implications and environmental impacts of technologies, including sustainability, and to consider engineers' responsibility to society. Prerequisite: 100 units including one of **MSE 102**, ENSC 100, ENSC 106, or CMPT 106. **Students with credit for ENSC 406 may not take MSE 402 for further credit.**
ENSC 483-4 Modern Control Systems Analytical representation of the finite dimensional linear systems, analysis and design of linear feedback control systems based on the state space model, and state/output feedback. Topics include: review of the linear spaces and operators, mathematical modelling, state space representation and canonical forms, controllability, observability, realization of transfer function, and solution of the state equation. Applications include: stability concepts and definitions. Lyapunov's Direct Method, design of the state and output feedback control systems, eigenspectrum assignment, and state estimator design. Prerequisite: ENSC 383.	**MSE 483-4 Modern Control Systems** Analytical representation of the finite dimensional linear systems, analysis and design of linear feedback control systems based on the state space model, and state/output feedback. Topics include: review of the linear spaces and operators, mathematical modelling, state space representation and canonical forms, controllability, observability, realization of transfer function, and solution of the state equation. Applications include: stability concepts and definitions. Lyapunov's Direct Method, design of the state and output feedback control systems, eigenspectrum assignment, and state estimator design. Prerequisite: MSE 381 or ENSC 383. **Students with credit for ENSC 483 may not take MSE 483 for further credit.**

SCUS 12-44 (iii)

III. Consequential Course Revisions for CMPT and ENSC Courses

The following revisions to course equivalency statements for CMPT and ENSC courses reflect the relationships with new MSE courses.

Current	Proposed
CMPT 105W-3 Process, Form, and Convention in Professional Genres The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106 or ENSC 106. This course is identical to ENSC 105W and students cannot take both for credit. Writing.	**CMPT 105W-3 Process, Form, and Convention in Professional Genres** The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106 or **MSE 102. Students with credit for ENSC 102, ENSC 105W or MSE 101W may not take CMPT 105W for further credit.** Writing.
CMPT 106-3 Applied Science, Technology and Society Reviews the different modes of thought characteristic of science, engineering and computing. Examines the histories and chief current research issues in these fields. Considers the ethical and social responsibilities of engineering and computing work. Corequisite: CMPT 105W or ENSC 105W. Students who have taken ENSC 100 cannot take this course for credit. CMPT 106 is identical to ENSC 106 and students cannot take both for credit.	**CMPT 106-3 Applied Science, Technology and Society** Reviews the different modes of thought characteristic of science, engineering and computing. Examines the histories and chief current research issues in these fields. Considers the ethical and social responsibilities of engineering and computing work. Corequisite: CMPT 105W or **MSE 101W. Students wwith credit for ENSC 100, ENSC 106 or MSE 102 cannot take this course for further credit.**

Current	Proposed
ENSC 105W-3 Process, Form, and Convention in Professional Genres The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106 or ENSC 106. This course is identical to CMPT 105W and students cannot take both for credit. This course is equivalent to ENSC 101W-1 and ENSC 102W-1 combined. Students with credit for this course cannot take ENSC 101W or ENSC 102W for further credit. Writing.	**ENSC 105W-3 Process, Form, and Convention in Professional Genres** The course teaches fundamentals of informative and persuasive communication for professional engineers and computer scientists in order to assist students in thinking critically about various contemporary technical, social, and ethical issues. It focuses on communicating technical information clearly and concisely, managing issues of persuasion when communicating with diverse audiences, presentation skills, and teamwork. Corequisite: CMPT 106, ENSC 100 or ENSC 106. **Students with credit for CMPT 105W, ENSC 102 or MSE 101W may not take ENSC 105W for further credit.** Writing.
ENSC 220-3 Electric Circuits I This course will cover the following topics: fundamental electrical circuit quantities, and circuit elements; circuits laws such as Ohm law, Kirchoff's voltage and current laws, along with series and parallel circuits; operational amplifiers; network theorems; nodal and mesh methods; analysis of natural and step response of first (RC and RL), as well as second order (RLC) circuits; real, reactive and rms power concepts. In addition, the course will discuss the worker safety implications of both electricity and common laboratory practices such as soldering. Prerequisite: PHYS 121 and 131, or PHYS 126 and 131, or PHYS 141, and MATH 232 and 310. MATH 232 and/or 310 may be taken concurrently. Students with credit for ENSC 125 cannot take this course for further credit. Quantitative.	**ENSC 220-3 Electric Circuits I** This course will cover the following topics: fundamental electrical circuit quantities, and circuit elements; circuits laws such as Ohm law, Kirchoff's voltage and current laws, along with series and parallel circuits; operational amplifiers; network theorems; nodal and mesh methods; analysis of natural and step response of first (RC and RL), as well as second order (RLC) circuits; real, reactive and rms power concepts. In addition, the course will discuss the worker safety implications of both electricity and common laboratory practices such as soldering. Prerequisite: PHYS 121 and 131, or PHYS 126 and 131, or PHYS 141, and MATH 232 and 310. MATH 232 and/or 310 may be taken concurrently. Students with credit for ENSC 125 **or MSE 250** cannot take this course for further credit. Quantitative.

Current	Proposed
ENSC 225-4 Microelectronics I This course teaches analog/digital electronics and basic device physics in the context of modern silicon integrated circuits technology. Topics include: qualitative device physics and terminal characteristics; implementations and models of basic semiconductor devices (diodes, BJTs and MOSFETs); circuit simulation via SPICE; basic diode circuits; transistors as amplifiers and switching elements; temperature effects and compensation; single-stage transistor amplifiers; biasing, current sources and mirrors. Prerequisite: ENSC 150 or CMPT 150, ENSC 220, MATH 232, and MATH 310. Students taking or with credit for ENSC 226 may not take ENSC 225 for further credit. Quantitative.	**ENSC 225-4 Microelectronics I** This course teaches analog/digital electronics and basic device physics in the context of modern silicon integrated circuits technology. Topics include: qualitative device physics and terminal characteristics; implementations and models of basic semiconductor devices (diodes, BJTs and MOSFETs); circuit simulation via SPICE; basic diode circuits; transistors as amplifiers and switching elements; temperature effects and compensation; single-stage transistor amplifiers; biasing, current sources and mirrors. Prerequisite: ENSC 150 or CMPT 150, ENSC 220, MATH 232, and MATH 310. Students taking or with credit for ENSC 226 **or MSE 251** may not take ENSC 225 for further credit. Quantitative.
ENSC 280-3 Engineering Measurement and Data Analysis An introduction to methods to collect and analyse engineering data. Topics include the Engineering data representation, Discrete and continuous probability density functions, Engineering measurements, Error analysis, Introduction to sensor interfaces, Introduction to physical sensors, Introduction to sensor signal conditioning, Noise, Test of hypotheses, Linear and nonlinear regression, and Design of experiments. Prerequisite: PHYS 141 or equivalent. MATH 150 or MATH 151. Students with credit for PHYS 231 cannot take this course for further credit. Students who have taken and passed ENSC 263 "Special Topics in ENSC: Engineering Measurement and Data Analysis" in Spring 2009 and Spring 2010 cannot take this course for further credit.	**ENSC 280-3 Engineering Measurement and Data Analysis** An introduction to methods to collect and analyse engineering data. Topics include the Engineering data representation, Discrete and continuous probability density functions, Engineering measurements, Error analysis, Introduction to sensor interfaces, Introduction to physical sensors, Introduction to sensor signal conditioning, Noise, Test of hypotheses, Linear and nonlinear regression, and Design of experiments. Prerequisite: PHYS 141 or equivalent. MATH 150 or MATH 151. Students with credit for **MSE 210 or** PHYS 231 cannot take this course for further credit. Students who have taken and passed ENSC 263 "Special Topics in ENSC: Engineering Measurement and Data Analysis" in Spring 2009 and Spring 2010 cannot take this course for further credit.

Current	Proposed
ENSC 281-3 Statics and Strength of Materials Covers basic concepts of mechanics, vectors. Statics of particles. Rigid bodies and force systems, equilibrium of rigid bodies. Analysis of trusses and frames. Distributed forces, centroids and moments of inertia. Friction. Internal shear and bending moments in beams. Strength of material: introduction to mechanical response of materials and stress-strain transformations. Virtual work and energy methods. Prerequisite: PHYS 140, MATH 152.	**ENSC 281-3 Statics and Strength of Materials** Covers basic concepts of mechanics, vectors. Statics of particles. Rigid bodies and force systems, equilibrium of rigid bodies. Analysis of trusses and frames. Distributed forces, centroids and moments of inertia. Friction. Internal shear and bending moments in beams. Strength of material: introduction to mechanical response of materials and stress-strain transformations. Virtual work and energy methods. Prerequisite: PHYS 140, MATH 152. **Students with credit for MSE 221 may not take ENSC 281 for further credit.**
ENSC 305W-1 Project Documentation and Group Dynamics This course is integrated with an ENSC project course (either ENSC 340 or 440) that provides practical experience with the design process for development projects. Topics include project management, team writing, project documentation (proposals, functional and design specifications, progress reports, and users manuals), group dynamics and dispute resolution. Prerequisite: Either both of ENSC 101W and ENSC 102 or one of ENSC 105W or CMPT 105W. Corequisite: ENSC 440 or 441. Writing.	**ENSC 305W-1 Project Documentation and Group Dynamics** This course is integrated with an ENSC project course (either ENSC 340 or 440) that provides practical experience with the design process for development projects. Topics include project management, team writing, project documentation (proposals, functional and design specifications, progress reports, and users manuals), group dynamics and dispute resolution. Prerequisite: Either both of ENSC 101W and ENSC 102 or one of ENSC 105W, **CMPT 105W or MSE 101W**. Corequisite: ENSC 440 or 441. **Students with credit for MSE 401W may not take ENSC 305W for further credit.** Writing.
ENSC 380-3 Linear Systems The objectives of this course are to cover the modelling and analysis of continuous and discrete signals using linear techniques. Topics covered include: a review of Laplace transforms; methods for the basic modelling of physical systems; discrete and continuous convolution; impulse and step response; transfer functions and filtering; the continuous Fourier transform and its relationship to the Laplace transform; frequency response and Bode plots; sampling; the Z-transform. Prerequisite: ENSC 220 and MATH 310.	**ENSC 380-3 Linear Systems** The objectives of this course are to cover the modelling and analysis of continuous and discrete signals using linear techniques. Topics covered include: a review of Laplace transforms; methods for the basic modelling of physical systems; discrete and continuous convolution; impulse and step response; transfer functions and filtering; the continuous Fourier transform and its relationship to the Laplace transform; frequency response and Bode plots; sampling; the Z-transform. Prerequisite: ENSC 220 (or MSE 250) and MATH 310. **Students with credit for MSE 280 may not take ENSC 380 for further credit.**

Current	Proposed
ENSC 383 Feedback Control Systems This course is an introduction to the analysis, design, and applications of continuous time linear control systems. Topics include transfer function representation of open and closed loop systems, time domain specifications and steady state error, sensitivity analysis, time and frequency response, and stability criteria. It includes a treatment of methods for the analysis of control systems based on the root locus, Bode plots and Nyquist criterion, and their use in the design of PID, and lead-lag compensation. Lab work is included in this course. Prerequisite: ENSC 380.	**ENSC 383 Feedback Control Systems** This course is an introduction to the analysis, design, and applications of continuous time linear control systems. Topics include transfer function representation of open and closed loop systems, time domain specifications and steady state error, sensitivity analysis, time and frequency response, and stability criteria. It includes a treatment of methods for the analysis of control systems based on the root locus, Bode plots and Nyquist criterion, and their use in the design of PID, and lead-lag compensation. Lab work is included in this course. Prerequisite: ENSC 380 (or MSE 280). **Students with credit for MSE 381 may not take ENSC 383 for further credit.**
ENSC 387-4 Introduction to Electro-Mechanical Sensors and Actuators This course provides an introduction to sensors and actuators for electromechanical, computer-controlled machines and devices. Topics include operating principles, design considerations, and applications of analog sensors, digital transducers, stepper motors, continuous-drive actuators, and drive system electronics. Component integration and design considerations are studied through examples selected from applications of machine tools, mechatronics, precision machines, robotics, aerospace systems, and ground and underwater vehicles. Laboratory exercises strengthen the understanding of component performance, system design and integration. Prerequisite: ENSC 380.	**ENSC 387-4 Introduction to Electro-Mechanical Sensors and Actuators** This course provides an introduction to sensors and actuators for electromechanical, computer-controlled machines and devices. Topics include operating principles, design considerations, and applications of analog sensors, digital transducers, stepper motors, continuous-drive actuators, and drive system electronics. Component integration and design considerations are studied through examples selected from applications of machine tools, mechatronics, precision machines, robotics, aerospace systems, and ground and underwater vehicles. Laboratory exercises strengthen the understanding of component performance, system design and integration. Prerequisite: ENSC 380. **Students with credit for MSE 310 may not take ENSC 387 for further credit.**

Current	Proposed
ENSC 406-2 Engineering Ethics, Law, and Professional Practice This course provides an introduction to the engineering profession, professional practice, engineering law and ethics, including the issues of worker and public safety. It also offers opportunities to explore the social implications and environmental impacts of technologies, including sustainability, and to consider engineers' responsibility to society. Prerequisite: 100 units including one of ENSC 100W, ENSC 106, or CMPT 106.	**ENSC 406-2 Engineering Ethics, Law, and Professional Practice** This course provides an introduction to the engineering profession, professional practice, engineering law and ethics, including the issues of worker and public safety. It also offers opportunities to explore the social implications and environmental impacts of technologies, including sustainability, and to consider engineers' responsibility to society. Prerequisite: 100 units including one of ENSC 100, ENSC 106, or CMPT 106, **or MSE 102. Students with credit for MSE 402 may not take ENSC 406 for further credit.**
ENSC 483-4 Modern Control Systems Analytical representation of the finite dimensional linear systems, analysis and design of linear feedback control systems based on the state space model, and state/output feedback. Topics include: review of the linear spaces and operators, mathematical modelling, state space representation and canonical forms, controllability, observability, realization of transfer function, and solution of the state equation. Applications include: stability concepts and definitions. Lyapunov's Direct Method, design of the state and output feedback control systems, eigenspectrum assignment, and state estimator design. Prerequisite: ENSC 383.	**ENSC 483-4 Modern Control Systems** Analytical representation of the finite dimensional linear systems, analysis and design of linear feedback control systems based on the state space model, and state/output feedback. Topics include: review of the linear spaces and operators, mathematical modelling, state space representation and canonical forms, controllability, observability, realization of transfer function, and solution of the state equation. Applications include: stability concepts and definitions. Lyapunov's Direct Method, design of the state and output feedback control systems, eigenspectrum assignment, and state estimator design. Prerequisite: ENSC 383 or MSE 3833. **Students with credit for MSE 483 may not take ENSC 483 for further credit.**

IV. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering Major

The following changes reflect the adaptation of the MSE Major curriculum for the new course labels and school title. In addition, PHYS 344-3 is deleted from the curriculum reflecting a change that should have been made some time ago.

Current	Proposed
Minimum Grade Requirement A C- grade or better in prerequisite courses is required to register in engineering science courses.	**Minimum Grade Requirement** A grade of C- or better in prerequisite courses is required to register in **mechatronic systems engineering** courses.
Co-operative Education Work Experience Every engineering science student completes a three term co-operative education program of practical experience in an appropriate industrial or research setting leading to a project under the technical direction of a practising engineer or scientist. The goal is a complementary combination of work in an industrial or research setting and study in one of the engineering options. The internship may be within the University but in most cases the work site is off campus. After the first year, students typically alternate between academic and work terms. At least two of the three mandatory work terms must be completed in industry (ENSC 195, 295, 395). Students may participate in additional work terms but are encouraged to seek diversity in their experience. The three mandatory work terms may include one special co-op term (ENSC 196, 296, 396). Special co-op may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required. An optional non-technical work term (ENSC 194) is also available through the engineering science co-operative education office and is often completed after the first two study terms. ENSC 194 does not count toward the mandatory three course requirement.	**Co-operative Education Work Experience** Every **mechatronic systems engineering** student completes a three term co-operative education program of practical experience in an appropriate industrial or research setting leading to a project under the technical direction of a practising engineer or scientist. The goal is a complementary combination of work in an industrial or research setting and study in one of the engineering options. The internship may be within the University but in most cases the work site is off campus. After the first year, students typically alternate between academic and work terms. At least two of the three mandatory work terms must be completed in industry (**MSE 293, 393, 493**). Students may participate in additional work terms but are encouraged to seek diversity in their experience. The three mandatory work terms may include one special co-op term (**MSE 294, 394, 494**). Special co-op may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required. An optional non-technical work term (**MSE 193**) is also available through the engineering science co-operative education office and is often completed after the first two study terms. **MSE 193** does not count toward the mandatory three course requirement.

Current	Proposed
Program Requirements Students complete all of • CMPT 130 Introduction to Computer Programming I (3) • ENSC 104 Engineering Graphics and Design (3) • ENSC 105W Process, Form, and Convention in Professional Genres (3) • ENSC 106 Applied Science, Technology and Society (3) • ENSC 182 Mechatronics Design I (3) • ENSC 220 Electric Circuits I (3) • ENSC 231 Engineering Materials (3) • ENSC 226 Electronic Circuits (4) • ENSC 280 Engineering Measurement and Data Analysis (3) • ENSC 281 Statics and Strength of Materials (3) • ENSC 282 Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • ENSC 283 Introduction to Fluid Mechanics (3) • ENSC 305 Project Documentation and Team Dynamics (1) • ENSC 311 The Business of Engineering I (3) • ENSC 312 The Business of Engineering II (3) • ENSC 329 Introduction to Digital Logic (4) • ENSC 331 Introduction to Microelectromechanical Systems (3) • ENSC 332 Microprocessors and Interfacing (4) • ENSC 380 Linear Systems (3) • ENSC 381 Systems Modeling and Simulation (3) • ENSC 382 Machine Design (3) • ENSC 383 Feedback Control Systems* (4) • ENSC 384 Mechatronics Design II* (4) • ENSC 387 Introduction to Electro-Mechanical Sensors and Actuators (4) • ENSC 406 Engineering Ethics, Law, and Professional Practice (2) • ENSC 442 Capstone Design Technical	**Program Requirements** Students complete all of • CMPT 130 Introduction to Computer Programming I (3) • MACM 316 Numerical Analysis I (3) • MATH 152 Calculus II (3) • MATH 251 Calculus III (3) • MATH 232 Applied Linear Algebra (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • **MSE 100** Engineering Graphics and Design (3) • **MSE 101W** Process, Form, and Convention in Professional Genres (3) • **MSE 102** Applied Science, Technology and Society (3) • **MSE 110** Mechatronics Design I (3) • **MSE 210** Engineering Measurement and Data Analysis (3) • **MSE 220** Engineering Materials (3) • **MSE 221** Statics and Strength of Materials (3) • **MSE 222** Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • **MSE 223** Introduction to Fluid Mechanics (3) • **MSE 250** Electric Circuits I (3) • **MSE 251** Electronic Circuits (4) • **MSE 280** Linear Systems (3) • **MSE 300** The Business of Engineering I (3) • **MSE 310** Introduction to Electro-Mechanical Sensors and Actuators (4) • **MSE 311** Introduction to Microelectromechanical Systems (3) • **MSE 312** Mechatronics Design II* (4) • **MSE 320** Machine Design (3) • **MSE 350** Introduction to Digital Logic (4) • **MSE 351** Microprocessors and Interfacing (4) • **MSE 380** Systems Modeling and Simulation (3) • **MSE 381** Feedback Control Systems* (4) • **MSE 400** The Business of Engineering II

Current	Proposed
Project II (3) • ENSC 451 Real-Time and Embedded Control Systems (4) • ENSC 441 Capstone Design Technical Project I (3) • ENSC 484 Industrial Control Systems (4) • MACM 316 Numerical Analysis I (3) • MATH 251 Calculus III (3) • MATH 152 Calculus II (3) • MATH 232 Applied Linear Algebra (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4) • PHYS 344 Thermal Physics (3) *strongly recommended to be completed concurrently and one of • MATH 150 Calculus I with Review (4) • MATH 151 Calculus I (3) and one of • CHEM 120 General Chemistry I (3) • CHEM 121 General Chemistry and Laboratory I (4)	(3) • **MSE 401W** Project Documentation and Team Dynamics (1) • **MSE 402** Engineering Ethics, Law, and Professional Practice (2) • **MSE 410** Capstone Design Technical Project I (3) • **MSE 411W** Capstone Design Technical Project II (3) • **MSE 450** Real-Time and Embedded Control Systems (4) • **MSE 481** Industrial Control Systems (4) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4) • *strongly recommended to be completed concurrently and one of • MATH 150 Calculus I with Review (4) • MATH 151 Calculus I (3) and one of • CHEM 120 General Chemistry I (3) • CHEM 121 General Chemistry and Laboratory I (4)

V. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering Honours Program

The following changes reflect the replacement of ENSC courses by their renumbered MSE equivalents. The PHYS 344-3 course is removed from the calendar text to reflect a previous curriculum change that fell through the cracks.

Current	Proposed
Minimum Grade Requirement A C- grade or better in prerequisite courses is required to register in engineering science courses.	**Minimum Grade Requirement** A grade of C- or better in prerequisite courses is required to register in **mechatronic systems engineering** courses.
Co-operative Education Work Experience Every engineering science student completes a three term co-operative education program of practical experience in an appropriate industrial or research setting leading to a project under the technical direction of a practising engineer or scientist. The goal is a complementary combination of work in an industrial or research setting and study in one of the engineering options. The internship may be within the University but in most cases the work site is off campus. At least two of the three mandatory work terms must be completed in industry (ENSC 195, 295, 395). Students may participate in additional work terms but are encouraged to seek diversity in their experience. The three mandatory work terms may include one special co-op term (ENSC 196, 296, 396). Special co-op may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required. An optional non-technical work term (ENSC 194) is also available through the engineering science co-operative education office and is often completed after the first two study terms. ENSC 194 does not count toward the mandatory three course requirement. A member of the external organization and a school faculty member jointly supervise the project.	**Co-operative Education Work Experience** Every **mechatronic systems engineering** student completes a three term co-operative education program of practical experience in an appropriate industrial or research setting leading to a project under the technical direction of a practising engineer or scientist. The goal is a complementary combination of work in an industrial or research setting and study in one of the engineering options. The internship may be within the University but in most cases the work site is off campus. At least two of the three mandatory work terms must be completed in industry (**MSE 293, 393, 493**). Students may participate in additional work terms but are encouraged to seek diversity in their experience. The three mandatory work terms may include one special co-op term (**MSE 294, 394, 494**). Special co-op may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required. An optional non-technical work term (**MSE 193**) is also available through the engineering science co-operative education office and is often completed after the first two study terms. **MSE 193** does not count toward the mandatory three course requirement. A member of the external organization and a school faculty member jointly supervise the project.

Current	Proposed
The engineering science co-operative education program will also seek opportunities for students wishing to complete their thesis requirements in an industrial setting. The honours thesis work can be done on or off campus, either integrated with an optional (or mandatory) work term, or as independent work with appropriate supervision.	The **mechatronic systems engineering** co-operative education program will also seek opportunities for students wishing to complete their thesis requirements in an industrial setting. The honours thesis work can be done on or off campus, either integrated with an optional (or mandatory) work term, or as independent work with appropriate supervision.
Program Requirements Students complete all of • CMPT 130 Introduction to Computer Programming I (3) • ENSC 104 Engineering Graphics and Design (3) • ENSC 105W Process, Form, and Convention in Professional Genres (3) • ENSC 106 Applied Science, Technology and Society (3) • ENSC 182 Mechatronics Design I (3) • ENSC 220 Electric Circuits I (3) • ENSC 231 Engineering Materials (3) • ENSC 226 Electronic Circuits (4) • ENSC 280 Engineering Measurement and Data Analysis (3) • ENSC 281 Statics and Strength of Materials (3) • ENSC 282 Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • ENSC 283 Introduction to Fluid Mechanics (3) • ENSC 305 Project Documentation and Team Dynamics (1) • ENSC 311 The Business of Engineering I (3) • ENSC 312 The Business of Engineering II (3) • ENSC 329 Introduction to Digital Logic (4) • ENSC 331 Introduction to Microelectromechanical Systems (3) • ENSC 332 Microprocessors and Interfacing (4) • ENSC 380 Linear Systems (3) • ENSC 381 Systems Modeling and Simulation (3)	**Program Requirements** Students complete all of • CMPT 130 Introduction to Computer Programming I (3) • MACM 316 Numerical Analysis I (3) • MATH 152 Calculus II (3) • MATH 251 Calculus III (3) • MATH 232 Applied Linear Algebra (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • **MSE 100** Engineering Graphics and Design (3) • **MSE 101W** Process, Form, and Convention in Professional Genres (3) • **MSE 102** Applied Science, Technology and Society (3) • **MSE 110** Mechatronics Design I (3) • **MSE 210** Engineering Measurement and Data Analysis (3) • **MSE 220** Engineering Materials (3) • **MSE 221** Statics and Strength of Materials (3) • **MSE 222** Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • **MSE 223** Introduction to Fluid Mechanics (3) • **MSE 250** Electric Circuits I (3) • **MSE 251** Electronic Circuits (4) • **MSE 280** Linear Systems (3) • **MSE 300** The Business of Engineering I (3) • **MSE 310** Introduction to Electro-Mechanical Sensors and Actuators (4) • **MSE 311** Introduction to Microelectromechanical Systems (3) • **MSE 312** Mechatronics Design II* (4) • **MSE 320** Machine Design (3)

Current	Proposed
• ENSC 382 Machine Design (3) • ENSC 383 Feedback Control Systems* (4) • ENSC 384 Mechatronics Design II* (4) • ENSC 387 Introduction to Electro-Mechanical Sensors and Actuators (4) • ENSC 406 Engineering Ethics, Law, and Professional Practice (2) • ENSC 442 Capstone Design Technical Project II (3) • ENSC 451 Real-Time and Embedded Control Systems (4) • ENSC 441 Capstone Design Technical Project I (3) • ENSC 484 Industrial Control Systems (4) • ENSC 498 Engineering Science Thesis Proposal (3) • ENSC 499 Engineering Science Undergraduate Thesis (9) • MACM 316 Numerical Analysis I (3) • MATH 251 Calculus III (3) • MATH 152 Calculus II (3) • MATH 232 Applied Linear Algebra (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4) • PHYS 344 Thermal Physics (3) • and one of • MATH 150 Calculus I with Review (4) • MATH 151 Calculus I (3) *strongly recommended to be completed concurrently and one of • CHEM 120 General Chemistry I (3) • CHEM 121 General Chemistry and Laboratory I (4)	• **MSE 350** Introduction to Digital Logic (4) • **MSE 351** Microprocessors and Interfacing (4) • **MSE 380** Systems Modeling and Simulation (3) • **MSE 381** Feedback Control Systems* (4) • **MSE 400** The Business of Engineering II (3) • **MSE 401W** Project Documentation and Team Dynamics (1) • **MSE 402** Engineering Ethics, Law, and Professional Practice (2) • **MSE 410** Capstone Design Technical Project I (3) • **MSE 411W** Capstone Design Technical Project II (3) • **MSE 450** Real-Time and Embedded Control Systems (4) • **MSE 481** Industrial Control Systems (4) • **MSE 498 Mechatronic Systems** Engineering Thesis Proposal (3) • **MSE 499 Mechatronic Systems** Engineering Undergraduate Thesis (9) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4) • *strongly recommended to be completed concurrently and one of • MATH 150 Calculus I with Review (4) • MATH 151 Calculus I (3) and one of • CHEM 120 General Chemistry I (3) • CHEM 121 General Chemistry and Laboratory I (4)

VI. Consequential Changes to the Calendar Text for the Mechatronic Systems Engineering and Business Double Degree Program

The following changes to program text are required.

Current	Proposed
Co-operative Education Work Experience This double degree program includes a mandatory co-operative education program of at least three and up to five terms of practical work experience. During the first two years, students may complete up to two optional co-op terms including one non-technical engineering experience (ENSC 194) and one business practicum (BUS 225). After the first two years, students complete three mandatory work terms, and it is strongly recommended that at least one is in engineering industry (ENSC 195, 295, 395), one is in business (BUS 225, 325, 326, 327) and a third is in industry, business or in a special co-op term (ENSC 196 , 296 ,396). Special co-op terms may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required.	**Co-operative Education Work Experience** This double degree program includes a mandatory co-operative education program of at least three and up to five terms of practical work experience. During the first two years, students may complete up to two optional co-op terms including one non-technical engineering experience (**MSE 193**) and one business practicum (BUS 225). After the first two years, students complete three mandatory work terms, and it is strongly recommended that at least one is in engineering industry (**MSE 293, 393, 493**), one is in business (BUS 225, 325, 326, 327) and a third is in industry, business or in a special co-op term (**MSE 294 ,394, 494**). Special co-op terms may include, but is not restricted to, self-directed, entrepreneurial, service or research co-op work terms. Permission of the engineering science co-op office is required.
Program Requirements Students complete a total of 197-201 units including all of • BUS 251 Financial Accounting I (3) • BUS 254 Managerial Accounting I (3) • BUS 272 Behavior in Organizations (3) • BUS 312 Introduction to Finance (4) • BUS 336 Data and Decisions II (4) • BUS 343 Introduction to Marketing (3) • BUS 360W Business Communication † (4) • BUS 381 Introduction to Human Resource Management (3) • BUS 393 Commercial Law (3) • BUS 478 Strategy †† (3) • BUEC 232 Data and Decisions I (4)	**Program Requirements** Students complete a total of 197-201 units including all of • BUS 251 Financial Accounting I (3) • BUS 254 Managerial Accounting I (3) • BUS 272 Behavior in Organizations (3) • BUS 312 Introduction to Finance (4) • BUS 336 Data and Decisions II (4) • BUS 343 Introduction to Marketing (3) • BUS 360W Business Communication † (4) • BUS 381 Introduction to Human Resource Management (3) • BUS 393 Commercial Law (3) • BUS 478 Strategy †† (3) • BUEC 232 Data and Decisions I (4)

• CHEM 120 General Chemistry I (3) • CMPT 128 Introduction to Computing Science and Programming for Engineers (3) • ECON 103 Principles of Microeconomics (4) • ECON 105 Principles of Macroeconomics (4) • ENSC 104 Engineering Graphics and Design (3) • ENSC 105W Process, Form, and Convention in Professional Genres (3) • ENSC 106 Applied Science, Technology and Society (3) • ENSC 182 Mechatronics Design I (3) • ENSC 220 Electric Circuits I (3) • ENSC 226 Electronic Circuits (4) • ENSC 231 Engineering Materials (3) • ENSC 280 Engineering Measurement and Data Analysis (3) • ENSC 281 Statics and Strength of Materials (3) • ENSC 282 Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • ENSC 283 Introduction to Fluid Mechanics (3) • ENSC 305 Project Documentation and Team Dynamics (1) • ENSC 329 Introduction to Digital Logic (4) • ENSC 331 Introduction to Microelectromechanical Systems (3) • ENSC 332 Microprocessors and Interfacing (4) • ENSC 380 Linear Systems (3) • ENSC 381 Systems Modeling and Simulation (3) • ENSC 382 Machine Design (3) • ENSC 383 Feedback Control Systems* (4) • ENSC 384 Mechatronics Design II* (4) • ENSC 387 Introduction to Electro-Mechanical Sensors and Actuators (4) • ENSC 388 Engineering Thermodynamics and Heat Transfer (3) • ENSC 406 Engineering Ethics, Law, and Professional Practice (2) • ENSC 441 Capstone Design Technical Project I (3)	• CHEM 120 General Chemistry I (3) • CMPT 128 Introduction to Computing Science and Programming for Engineers (3) • ECON 103 Principles of Microeconomics (4) • ECON 105 Principles of Macroeconomics (4) • MACM 316 Numerical Analysis I (3) • MATH 151 Calculus I (3) • MATH 152 Calculus II (3) • MATH 232 Applied Linear Algebra (3) • MATH 251 Calculus III (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • **MSE 100** Engineering Graphics and Design (3) • **MSE 101W** Process, Form, and Convention in Professional Genres (3) • **MSE 102** Applied Science, Technology and Society (3) • **MSE 110** Mechatronics Design I (3) • **MSE 210** Engineering Measurement and Data Analysis (3) • **MSE 220** Engineering Materials (3) • **MSE 221** Statics and Strength of Materials (3) • **MSE 222** Kinematics and Dynamics of Rigid Bodies and Mechanisms (3) • **MSE 223** Introduction to Fluid Mechanics (3) • **MSE 250** Electric Circuits I (3) • **MSE 251** Electronic Circuits (4) • **MSE 280** Linear Systems (3) • **MSE 310** Introduction to Electro-Mechanical Sensors and Actuators (4) • **MSE 311** Introduction to Microelectromechanical Systems (3) • **MSE 312** Mechatronics Design II* (4) • **MSE 320** Machine Design (3) • **MSE 321** Engineering Thermodynamics and Heat Transfer (3) • **MSE 350** Introduction to Digital Logic (4) • **MSE 351** Microprocessors and Interfacing (4) • **MSE 380** Systems Modeling and Simulation (3) • **MSE 381** Feedback Control Systems* (4)

• ENSC 442 Capstone Design Technical Project II (3) • ENSC 451 Real-Time and Embedded Control Systems (4) • ENSC 484 Industrial Control Systems (4) • MACM 316 Numerical Analysis I (3) • MATH 151 Calculus I (3) • MATH 152 Calculus II (3) • MATH 232 Applied Linear Algebra (3) • MATH 251 Calculus III (3) • MATH 310 Introduction to Ordinary Differential Equations (3) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4)	• **MSE 401W** Project Documentation and Team Dynamics (1) • **MSE 402** Engineering Ethics, Law, and Professional Practice (2) • **MSE 410** Capstone Design Technical Project I (3) • **MSE 411W** Capstone Design Technical Project II (3) • **MSE 450** Real-Time and Embedded Control Systems (4) • **MSE 481** Industrial Control Systems (4) • PHYS 140 Studio Physics - Mechanics and Modern Physics (4) • PHYS 141 Studio Physics - Optics, Electricity and Magnetism (4)

VII. Consequential Changes to the Calendar Text for the Systems One Program

The following changes reflect the change to use MSE course numbers.

Current	Proposed
Within the Systems One common core, students complete a total of 12 units, including both of • CMPT 130 Introduction to Computer Programming I (3) • ENSC 182 Mechatronics Design I (3) and one of • CMPT 105W Process, Form, and Convention in Professional Genres (3) • ENSC 105W Process, Form, and Convention in Professional Genres (3) and one of • CMPT 106 Applied Science, Technology and Society (3) • ENSC 106 Applied Science, Technology and Society (3)	Within the Systems One common core, students complete a total of 12 units, including both of • CMPT 130 Introduction to Computer Programming I (3) • **MSE 110** Mechatronics Design I (3) and one of • CMPT 105W Process, Form, and Convention in Professional Genres (3) • **MSE 101W** Process, Form, and Convention in Professional Genres (3) and one of • CMPT 106 Applied Science, Technology and Society (3) • **MSE 102** Applied Science, Technology and Society (3)

VIII. Consequential Changes to the Calendar Text for the Software Systems Program

The following changes reflect the change to use MSE course numbers.

Current	Proposed
Students complete at least 18 units, including all of • CMPT 150 Introduction to Computer Design (3) • CMPT 250 Introduction to Computer Architecture (3) • CMPT 300 Operating Systems I (3) • ENSC 182 Mechatronics Design I (3)	Students complete at least 18 units, including all of • CMPT 150 Introduction to Computer Design (3) • CMPT 250 Introduction to Computer Architecture (3) • CMPT 300 Operating Systems I (3) • **MSE 110** Mechatronics Design I (3)