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MEMORANDUM

ATTENTION	Senate	**DATE**	June 20, 2023
FROM	Kevin Oldknow, Senior Advisor on Academic Planning on behalf of Wade Parkhouse, Provost and Vice-President Academic *pro tem*, and Chair, SCUP	**PAGES**	1/24
RE:	Full Program Proposal for the Engineering Science, Biomedical Engineering Option Major (SCUP 23-31)		

At its meeting on June 14, 2023, SCUP reviewed and approved the Full Program Proposal for the Engineering Science, Biomedical Engineering Option Major. This program does not require Ministry approval.

Motion: That Senate approve and recommend to the Board of Governors the Full Program Proposal for the Engineering Science, Biomedical Engineering Option Major in the School of Engineering Science within the Faculty of Applied Science.

C: Edward Park, Professor, School of Mechatronic Systems Engineering

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MEMORANDUM

ATTENTION:	Senate Committee on University Priorities
FROM:	Elizabeth Elle, Vice-Chair, Senate Committee on Undergraduate Studies
RE:	Faculty of Arts and Social Sciences (SCUS 23-56)
DATE:	June 2, 2023

For information:

Action undertaken by the Senate Committee on Undergraduate Studies at its meeting of June 1, 2023, gives rise to the following recommendation:

Motion

That SCUP approve and recommend to Senate the Full Program Proposal for the Engineering Science, Biomedical Engineering Option Major in the School of Engineering Science within the Faculty of Applied Sciences.

The relevant documentation for review by SCUP is attached.

SFU SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

Engineering Science,
Biomedical Engineering Option Major

Full Program Proposal

March 22, 2023

School of Engineering Science,
Faculty of Applied Sciences

1 Executive Summary

a) An overview of the institution's history, mission, and academic goals:

As Canada's engaged university, Simon Fraser University is defined by its dynamic integration of innovative education, cutting-edge research and far-reaching community engagement. SFU was founded in 1965 with a mission to bring an interdisciplinary approach to learning, embrace bold initiatives, and engage with communities near and far. Today SFU is consistently ranked amongst Canada's top comprehensive universities and is one of the world's leading teaching and research institutions.

b) Credential to be awarded:

Bachelor of Applied Sciences, Biomedical Engineering Majors Option from the School of Engineering Science.

c) Location of program:

School of Engineering Science, Burnaby campus.

d) Faculty offering the proposed new program:

School of Engineering Science within the Faculty of Applied Sciences.

e) Anticipated program start date:

Spring of 2024.

f) Anticipated completion time:

This program is designed to be a typical 4-year engineering degree program that includes a mandatory three term co-op.

g) Summary of the proposed program

- **Aims, goals, and objectives:**

This program leads to a Bachelor of Applied Science degree with a Biomedical Engineering option.

The program focuses on engineering problems in medical and surgical treatment, in rehabilitation procedures and assistive devices, in medical electronics, in biomedical imaging, and in biophotonics.

Engineering science students develop skills in systems design with a high level of scientific knowledge. The program produces well educated, innovative engineers with entrepreneurial skills and attitudes who are oriented to new technologies. Program entry is competitive.

Students undertake a two-year common core of pure, applied, and engineering sciences followed by studies in a specialized option. The program may be completed in a total of nine academic terms plus a minimum of three co-op terms.

ENSC courses emphasize learning, conceptualization, design, and analysis. Built into the program are courses on social impacts of technology, finance, management, design methods, and entrepreneurship intended to complement scientific studies. Technical communication courses situated in the program ensure that all graduates have the communication skills necessary to be effective engineers.

This program follows our existing Biomedical Engineering Honors Option in terms of the core and elective courses as stipulated and governed by the Canadian Engineering Accreditation board (CEAB). The Major program only requires two changes: 1) removal of the requirement for students to maintain a 3.0 CGPA and 2) removal of the Engineering Science Thesis Proposal (ENSC 498) and Engineering Science Undergraduate Thesis (ENSC 499). These changes do not create any deficiency in terms of Academic Units (AU) count defined by CEAB for graduating a student with an undergraduate degree in engineering.

- **Contribution to the mandate and strategic plan of the institution:**

The School of Engineering Science (ENSC) is already offering an Honors degree through a Biomedical Engineering option. Currently, this option requires a CGPA of at least 3.0 and the completion of an undergraduate honors thesis. Owing to the higher CGPA requirement, numerous students who come into this program drop out of this option by the time they reach the third year. Additionally, feedback from students entering our school also suggests that students are not entering this option because of the honor requirements. This option is currently undersubscribed, which is unfortunate because there is a considerable demand for engineering undergraduates in the newly emerging biomedical instrumentation manufacturing sector. Moreover, biomedical engineering is an area that typically has higher enrollment of women compared to other engineering disciplines.

Removing the honors requirements for the proposed Major will create an additional pathway to graduation, where students in this option can choose whether

to complete a Major or Honors degree. We anticipate that this change will draw more students into this option and will allow more students to complete it.

- **Linkages between program outcomes and curriculum design:**

This new biomedical Major's program is a seamless addition to the existing choices offered by the School of Engineering Science. ENSC already offers Majors and Honors choices for three options: Electronics Engineering, Computer Engineering, and Systems Engineering. Only the Engineering Physics and Biomedical Engineering options are designed to be Honors only. It is extremely easy to offer the non-thesis Major's choice for the students in the biomedical engineering with practically no change to the course-sequence or curriculum requirement. As stated earlier, removing the CGPA requirement and the Thesis does not create any deficiency in the curriculum or AU requirements as established by CEAB. Adding this new option does not cost anything to the school in terms of course sequencing or other resources. We are simply removing the honors requirements to create an additional pathway to graduation.

- **Potential areas/sectors of employment for graduates or opportunities for further study:**

Students choosing this new option will be able to utilize the newly emerging biomedical devices manufacturing industry for their profession. Also, students with a good CGPA, after a few years of industrial experience, may choose to pursue graduate studies.

- **Delivery methods:**

This program will follow the course/curriculum delivery as the existing Biomedical Engineering Honors option for all core and elective courses.

h) Contact information:

School of Engineering Science, Simon Fraser University, Burnaby BC, V5A 1S6.

2 Credential Recognition and Nomenclature

2.1 Post-secondary recognition

If desired, students graduating with a Biomedical engineering Major's degree can pursue graduate study if they have sufficient CGPA to meet graduate program requirements. This possibility for further study, will be similar to our other Major's programs we currently offer, such as Electronics Engineering , Systems Engineering, and Computer Engineering.

2.2 Industry/employer recognition

There is a considerable number of biomedical devices industries that are emerging, and those industries will be able to employ the graduates from this new program.

3 Curriculum/Program Content

3.1 Program structure

The program focuses on engineering problems in medical and surgical treatment, in rehabilitation procedures and assistive devices, in medical electronics, in biomedical imaging, and in biophotonics.

Engineering science students develop skills in systems design with a high level of scientific knowledge. The program produces well educated, innovative engineers with entrepreneurial skills and attitudes who are oriented to new technologies. Program entry is competitive.

Students undertake a two-year common core of pure, applied, and engineering sciences followed by studies in a specialized option. The program may be completed in a total of nine academic terms plus a minimum of three co-op terms.

ENSC courses emphasize learning, conceptualization, design, and analysis. Built into the program are courses on social impacts of technology, finance, management, design methods, and entrepreneurship intended to complement scientific studies. Technical communication courses situated in the program ensure that all graduates have the communication skills necessary to be effective engineers.

Admission Requirements

The program begins each fall term; however, admitted students may enter in any term. For detailed University admission requirements, visit www.sfu.ca/students/admission/admission-requirements.html. For more detailed School of Engineering Science admission information, visit www.sfu.ca/engineering.html, or send an email to asadvise@sfu.ca.

Minimum Admission Requirements

Applicants must be eligible for University admission, must submit a University application, and must have successfully completed the following high school courses: Physics 12, Mathematics 12, Chemistry 12, and English 12.

External Transfer from Another Post-Secondary Institution

Admission is competitive. A minimum of 24 units of transferable coursework is required, including:

- *at least one Mathematics course chosen from: MATH 152, MATH 232 (or 240);*
- *at least one computing course chosen from: CMPT 128 (or 135; or (125 and 127)), 225 and ENSC 151;*
- *at least one Physics course chosen from: PHYS 121 (or 141), PHYS 221, and PHYS 321;*

Please see www.sfu.ca/students/admission/admission-requirements.html for further information.

Internal Transfer from Another Simon Fraser University Program

Simon Fraser University students who wish to transfer to Engineering Science from another program should formally apply for an internal transfer. The qualification for internal transfer is calculated based on the following four criteria: CGPA, engineering related grade point average (ERGPA) at Simon Fraser University, no more than five repeated courses, and the course load during the term prior to the application deadline. In regards to the course load, we require the term prior to requesting the transfer to the School of Engineering Science that the student must have been enrolled in at least 12 Simon Fraser University course load units and have earned an overall CGPA of 2.5 or higher.

Further, Simon Fraser University students applying for admission to the School of Engineering Science are competitively selected for admission based on an engineering-related grade point average (ERGPA). Typically, we expect the ERGPA to be as high as 2.8, and the ERGPA is determined based on the number of seats available.

Therefore, meeting the minimum requirements does not guarantee admission. The ERGPA is calculated over all courses the student has taken from this list, where a minimum of three courses from this list is required, such that:

- *at least one Mathematics course chosen from MATH 151 (or 150), MATH 152, MATH 232 (or 240), MACM 101, MACM 201*

- *at least one Computing Science course chosen from CMPT 128 or 135 or (125 and 127), 225, and 275 and ENSC151*
- *at least one Physics courses chosen from PHYS 120 (or 140), PHYS 121 (or 141), PHYS 221, PHYS 321, PHYS 365*
- *additional courses may include: CHEM 121*

All three courses must be completed prior to application. For complete information, contact an Applied Sciences Advisor. If a course is a duplicate of any previous course completed at Simon Fraser University or elsewhere, only the last attempt will be included in the average.

Admission is competitive and the admission average is established on a per term basis, depending on the number of spaces available.

Second Degree

Please see:

www.sfu.ca/students/calendar/programs/engineering-science-seconddegree/bachelor-of-applied-science.html

for information on the requirements for admission to the second-degree program. Program requirements for the Biomedical Engineering Option are listed below.

Minimum Grading Requirements

A C- grade or better in prerequisite courses is required to enroll in engineering science courses. In addition, students are required to have a minimum CGPA of 2.4 to enroll in 300 and 400 level engineering science courses. Engineering science students with a CGPA below 2.4 need to see an advisor to obtain approval before enrolling. Students outside the Faculty of Applied Science may not enroll with a CGPA below 2.4. Please see https://www.sfu.ca/students/calendar/faculties-research/faculty-applied-sciences.html for information on the minimum CGPA required to remain in the engineering science program.

Co-operative Education Work Experience

Every Engineering Science student must complete three (3) co-op work terms 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; however, they are encouraged to seek diversity in their experience. The three mandatory work terms may include one special coop term (ENSC 196, 296, 396). A 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 it is often completed after the first two study terms. ENSC 194 does not count toward the mandatory three course requirement.

Program Requirements

Students complete the Engineering Science core course requirements as shown below, which includes additional course requirements for the Biomedical Engineering option. These courses provide basic science, general studies, engineering science, specialized engineering and science, and project and laboratory work. This program's core course requirements also consist of non-technical courses, which broaden education and develop awareness of social, economic, and managerial factors affecting engineering and scientific work.

Although there is no strict requirement to complete the curriculum in the sequence that is strongly suggested by the School, deviating from the course completion schedule may lead to scheduling and prerequisite problems in subsequent terms. To view the suggested course schedule, visit http://www.sfu.ca/engineering/current-students/undergraduatestudents/programs-and-requirements/biomedical-engineering/curriculum-revised.html

3.2 Core courses

The following core courses are required by the Engineering Science Majors program in Biomedical Engineering and cannot be substituted for 'equivalent' courses in other areas without prior approval by the School. 'Equivalent' courses taken without prior approval will not be applied to graduation requirements. Students should consult an academic advisor within their program for details on obtaining permission.

BPK 201 - Biomechanics (3)

BPK 208 - Introduction to Physiological Systems (3)

BPK 308 - Experiments and Models in Systems Physiology (3)

CHEM 121 - General Chemistry and Laboratory I (4)

CHEM 180 - The Chemistry of Life (3)

ENSC151 – Introduction to Software Development for Engineers (4)

ECON 103 - Principles of Microeconomics (4)

ENSC 100W - Engineering, Science and Society (3)

ENSC 105W - Process, Form, and Convention in Professional Genres (3)

ENSC 120 - Introduction to Electronics Laboratory Instruments Operation and Measurement Techniques (2)

ENSC 180 - Introduction to Engineering Analysis (3)

ENSC 204 - Graphical Communication for Engineering (1)

ENSC 220 - Electric Circuits I (4)

ENSC 225 - Microelectronics I (4)

ENSC 251 - Software Design and Analysis for Engineers (4)

ENSC 252 - Fundamentals of Digital Logic & Design (4)

ENSC 254 - Introduction to Computer Organization (4)

ENSC 280 - Engineering Measurement and Data Analysis (4)

ENSC 316 - Engineering Electromagnetics I (3)

ENSC 320 - Electric Circuits II (4)

ENSC 327 - Communication Systems (4)

ENSC 351 - Embedded and Real Time System Software (4)

ENSC 370 - Biomedical Engineering Directions (3)

ENSC 380 - Linear Systems (3)

ENSC 383 - Feedback Control Systems (4)

ENSC 405W - Capstone A: Project Design, Management, and Documentation (3)

ENSC 406 - Engineering Ethics, Law, and Professional Practice (2)

ENSC 410 - The Business of Engineering (3) or ENSC 411 - The Business of Entrepreneurial Engineering (4)

ENSC 440 - Capstone B: Engineering Design Project (3)

ENSC 474 - Digital/Medical Image Processing (4)

ENSC 475 - Biomedical Instrumentation (4)

ENSC 476 - Biophotonics and Microscopy Techniques (4)

ENSC 477 - Biomedical Image Acquisition (4)

*MATH 151 - Calculus I (3) ***

MATH 152 - Calculus II (3)

MATH 232 - Applied Linear Algebra (3)

MATH 251 - Calculus III (3)

MATH 254 - Vector and Complex Analysis for Applied Sciences (3)

MATH 260 - Introduction to Ordinary Differential Equations (3)

PHYS 120 - Mechanics and Modern Physics (3)

PHYS 121 - Optics, Electricity and Magnetism (3)

*** or MATH 150 Calculus I with Review if you do not meet the MATH 151 prerequisites*

3.3 Elective and other course requirements

Complementary Studies Elective Courses

Students must also complete one complementary studies course chosen from the complementary studies list that is available at

http://www.sfu.ca/engineering/currentstudents/undergraduate-students/requirements-and-policies/electives.html.

Note: students must complete an acceptable Breadth-Humanities course and should choose this elective course with that in mind. A pre-approved complementary studies course list is available at:

http://www.sfu.ca/engineering/current-students/undergraduatestudents/requirements-and-policies/electives.html.

Other courses may be acceptable with undergraduate curriculum committee chair approval.

Engineering Science Design Electives

Engineering Science and Design (ESD) Electives may be offered by departments other than the School of Engineering Science, but they must satisfy the Canadian Engineering Accreditation Board (CEAB) engineering science and engineering design requirements. Generally, Engineering Science has roots in mathematics and basic sciences, but carries knowledge further toward creative applications that could include simulation, experimental procedures, modelling and the development of mathematical or numerical techniques. Application to the identification and solution of practical engineering problems is stressed. Engineering Design requires students to demonstrate an ability to design solutions for complex, open-ended engineering problems, and to design systems, components, or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural, and societal considerations. Each option has a pre-approved list of electives that may include one or more pre-approved ESD electives. Note that these courses may have pre-requisites not required for the option; these pre-requisites would still need to be taken in order to enrol in the elective.

Students in the Biomedical Engineering Option must complete a minimum of 8 units from the engineering science & design elective course list available at:

http://www.sfu.ca/engineering/current-students/undergraduate-students/programsand-requirements/biomedical-engineering/curriculum-revised.html.

Writing, Quantitative, and Breadth Requirements

Students admitted to Simon Fraser University must meet writing, quantitative and breadth requirements as part of any degree program they may undertake. See Writing, Quantitative, and Breadth Requirements for university-wide information.

A grade of C- or better is required to earn W, Q or B credit.

Residency Requirements and Transfer Credit

- *At least half of the program's total units must be earned through Simon Fraser University study.*
- *At least two thirds of the program's total upper division units must be earned through Simon Fraser University study.*

Please see Faculty of Applied Sciences Residency Requirements for further information.

3.4 Work experience/field/practicum placement

Please see the Co-operative Education Work Experience described above in section 3.1.

4 Program Resources

4.1 Target audience and enrolment plan

Typical yearly intake of our program is approximately 200 to 240 students, mainly from BC12 graduates. About two dozen students come into our program through the BC-College transfer and internal to SFU transfer. Currently, seven percent of students in third and fourth year have chosen the biomedical engineering option. The historical high for this option was approximately 15 percent. Our enrolment plan by introducing a Major in this option is to increase enrollment to 20 percent.

4.2 Resources

No additional resources are required to run this program. All the necessary core and elective courses are part of the existing ENSC undergrad program.

5 Program Review and Academic/Administrative Oversight

This will be part of the already existing School of Engineering Science's undergraduate program. All existing administrative structure will govern this program.

6 Program Consultation

This program is simply a modified version of the existing Biomedical Engineering Honors program. In this new program, the CGPA and thesis requirement are removed from the Honors version of the program. All the other components remain the same.

7 Evidence of Student Interest and Labour Market Demand

As described earlier, because the Biomedical Engineering option is currently honors only, we have seen students who are unable to complete this option because they do not meet the CGPA requirement. Additionally, we have received feedback that students may not want to start in this option because they are worried about maintaining a high enough CGPA. The uptake for this option was as a high as 15 percent in the 2007/2008 academic year. The program had steady enrollment for several years, and then the enrollment decreased, levelling off to approximately seven percent of students selecting this option. Creating a Major for this option should entice more students to start, and removing the 3.0 CGPA requirement should allow more students to complete this option. Having both a Major and Honors degree in this option mirrors the pathways for three of our existing options. We have recently analyzed our curriculum and have removed several constraints that were impeding student progress. The change proposed of removing the honors criteria in order to create Major in the Biomedical Engineering option provides an additional pathway to graduate for students.

8 Appendices

8.1 Calendar entry

See attached document.

Engineering Science, Biomedical Engineering Option Major

BACHELOR OF APPLIED SCIENCE

The program focuses on engineering problems in medical and surgical treatment, in rehabilitation procedures and assistive devices, in medical electronics, in biomedical imaging, and in biophotonics.

Engineering science students develop skills in systems design with a high level of scientific knowledge. The program produces well educated, innovative engineers with entrepreneurial skills and attitudes who are oriented to new technologies. Program entry is competitive.

Students undertake a two-year common core of pure, applied, and engineering sciences followed by studies in a specialized option. The program may be completed in a total of nine academic terms plus a minimum of three co-op terms.

ENSC courses emphasize learning, conceptualization, design, and analysis. Built into the program are courses on social impacts of technology, finance, management, design methods, and entrepreneurship intended to complement scientific studies. Technical communication courses situated in the program ensure that all graduates have the communication skills necessary to be effective engineers.

Admission Requirements

The program begins each fall term. However, admitted students may enter in any term.

For detailed University admission requirements, visit www.sfu.ca/students/admission/admission-requirements.html. For more detailed School of Engineering Science admission information, visit www.sfu.ca/engineering.html, or send an email to asadvise@sfu.ca.

Minimum Admission Requirements

Applicants must be eligible for University admission, must submit a University application, and must have successfully completed the following high school courses: Physics 12, Mathematics 12, Chemistry 12, and English 12.

External Transfer from Another Post-Secondary Institution

Admission is competitive. A minimum of 24 units of transferable coursework is required, including:

- at least one mathematics course chosen from: MATH 152, MATH 232 (or 240);
- at least one computing course chosen from: CMPT 128 (or 135; or (125 and 127)), 225 and ENSC 151;
- at least one physics course chosen from: PHYS 121 (or 141), PHYS 221, and PHYS 321

Please see www.sfu.ca/students/admission/admission-requirements.html for further information.

Internal Transfer from Another Simon Fraser University Program

Simon Fraser University students who wish to transfer to Engineering Science from another program should formally apply for an internal transfer. The qualification for internal transfer will be calculated based on the following four criteria: CGPA, engineering related grade point average (ERGPA) at Simon Fraser University, no more than five repeated courses, and the course load during the term prior to the application deadline. In regards to the course load, we require the term prior to requesting the transfer to the School of Engineering Science, that the student must have been enrolled in at least 12 Simon Fraser University course load units and earned an overall CGPA of 2.5 or higher. Further, Simon Fraser University students applying for admission to the School of Engineering Science are competitively selected for admission on the basis of an engineering-related grade point average (ERGPA). Typically, we expect the ERGPA to be as high as 2.8, and the ERGPA is determined based on the number of seats available. Therefore, meeting the minimum requirements does not guarantee admission. The ERGPA is calculated over all courses the student has taken from this list, where a minimum of three courses from this list is required, such that:

- at least one mathematics course chosen from MATH 151 (or 150), MATH 152, MATH 232 (or 240), MACM 101, MACM 201;
- at least one computing course chosen from CMPT 128 or 135 or (125 and 127), 225, 275 and ENSC 151;
- at least one physics courses chosen from PHYS 120 (or 140), PHYS 121 (or 141), PHYS 221, PHYS 321, PHYS 365;
- additional courses may include: CHEM 121

All three courses must be completed prior to application. For complete information, contact an Applied Sciences Advisor. If a course is a duplicate of any previous course completed at Simon Fraser University or elsewhere, only the last attempt will be included in the average. Admission is competitive and the admission average is established on a per term basis, depending on the number of spaces available.

Second Degree

Please see www.sfu.ca/students/calendar/programs/engineering-science-second-degree/bachelor-of-applied-science.html for information on the requirements for admission to the second degree program. Program requirements for the Biomedical Engineering Option are listed below.

Minimum Grading Requirements

A C- grade or better in prerequisite courses is required to enroll in engineering science courses. In addition, students are required to have a minimum CGPA of 2.4 to enroll in 300 and 400 level engineering science courses. Engineering science students with a CGPA below 2.4 need to see an advisor to obtain approval before enrolling. Students outside the Faculty of Applied Science may not enroll with a CGPA below 2.4. Please see https://www.sfu.ca/students/calendar/faculties-research/faculty-applied-sciences.html for information on the minimum CGPA required to remain in the engineering science program.

Co-operative Education Work Experience

Every engineering science student completes three (3) work terms of practical experience in an appropriate industrial or research setting leading to a project under the technical direction of a practicing 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.

Upper Division Enrollment Requirements

To be eligible to enroll in upper division engineering courses, excluding ENSC 320, students must have declared their option. There is an absolute minimum of 80 units completed to

enroll in 400-level courses. Please note that specific courses may have higher requirements.

Program Requirements

Students complete the engineering science core course requirements as shown below, which includes additional course requirements for this biomedical engineering option. These courses provide basic science, general studies, engineering science, specialized engineering and science, and project and laboratory work.

This program's core course requirements also consist of non-technical courses which broaden education and develop awareness of social, economic and managerial factors affecting engineering and scientific work.

Although there is no strict requirement to complete the curriculum in the sequence that is strongly suggested by the school, deviating from the course completion schedule may lead to scheduling and prerequisite problems in subsequent terms. To view the suggested course schedule, visit http://www.sfu.ca/engineering/current-students/undergraduate-students/programs-and-requirements/biomedical-engineering/curriculum-revised.html.

Core Course Requirements

The following core courses are required by the Engineering Science Majors program in Biomedical Engineering and cannot be substituted for 'equivalent' courses in other areas without prior approval by the School. 'Equivalent' courses taken without prior approval will not be applied to graduation requirements. Students should consult an academic advisor within their program for details on obtaining permission.

BPK 201 - Biomechanics (3)
BPK 208 - Introduction to Physiological Systems (3)
BPK 308 - Experiments and Models in Systems Physiology (3)
CHEM 121 - General Chemistry and Laboratory I (4)
CHEM 180 - The Chemistry of Life (3)
ENSC151 – Introduction to Software Development for Engineers (4)
ECON 103 - Principles of Microeconomics (4)
ENSC 100W - Engineering, Science and Society (3)
ENSC 105W - Process, Form, and Convention in Professional Genres (3)
ENSC 120 - Introduction to Electronics Laboratory Instruments Operation and Measurement Techniques (2)
ENSC 180 - Introduction to Engineering Analysis (3)
ENSC 204 - Graphical Communication for Engineering (1)
ENSC 220 - Electric Circuits I (4)
ENSC 225 - Microelectronics I (4)
ENSC 251 - Software Design and Analysis for Engineers (4)

ENSC 252 - Fundamentals of Digital Logic & Design (4)
ENSC 254 - Introduction to Computer Organization (4)
ENSC 280 - Engineering Measurement and Data Analysis (4)
ENSC 316 - Engineering Electromagnetics I (3)
ENSC 320 - Electric Circuits II (4)
ENSC 327 - Communication Systems (4)
ENSC 351 - Embedded and Real Time System Software (4)
ENSC 370 - Biomedical Engineering Directions (3)
ENSC 380 - Linear Systems (3)
ENSC 383 - Feedback Control Systems (4)
ENSC 405W - Capstone A: Project Design, Management, and Documentation (3)
ENSC 406 - Engineering Ethics, Law, and Professional Practice (2)
ENSC 410 - The Business of Engineering (3) or ENSC 411 - The Business of Entrepreneurial Engineering (4)
ENSC 440 - Capstone B: Engineering Design Project (3)
ENSC 474 - Digital/Medical Image Processing (4)
ENSC 475 - Biomedical Instrumentation (4)
ENSC 476 - Biophotonics and Microscopy Techniques (4)
ENSC 477 - Biomedical Image Acquisition (4)
MATH 151 - Calculus I (3) **
MATH 152 - Calculus II (3)
MATH 232 - Applied Linear Algebra (3)
MATH 251 - Calculus III (3)
MATH 254 - Vector and Complex Analysis for Applied Sciences (3)
MATH 260 - Introduction to Ordinary Differential Equations (3)
PHYS 120 - Mechanics and Modern Physics (3)
PHYS 121 - Optics, Electricity and Magnetism (3)

** or MATH 150 Calculus I with Review if you do not meet the MATH 151 prerequisites

Elective Course Requirements

COMPLEMENTARY STUDIES ELECTIVE COURSES

In addition, students must also complete one complementary studies course chosen from the complementary studies list that is available at http://www.sfu.ca/engineering/current-students/undergraduate-students/requirements-and-policies/electives.html. Note that students must complete an acceptable Breadth-Humanities course and should choose this elective course with that in mind. A pre-approved complementary studies course list is available at http://www.sfu.ca/engineering/current-students/undergraduate-students/requirements-and-policies/electives.html. Other courses may be acceptable with undergraduate curriculum committee chair approval.

ENGINEERING SCIENCE AND DESIGN ELECTIVES

Engineering Science and Design (ESD) Electives may be offered by departments other than the School of Engineering Science, but they must satisfy the Canadian Engineering Accreditation Board (CEAB) engineering science and engineering design requirements. Generally, Engineering Science has roots in mathematics and basic sciences, but carries knowledge further toward creative applications that could include simulation, experimental procedures, modelling and the development of mathematical or numerical techniques. Application to the identification and solution of practical engineering problems is stressed.

Engineering Design requires students to demonstrate an ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards and economic, environmental, cultural and societal considerations.

Each option has a pre-approved list of electives that may include one or more pre-approved ESD electives. Note that these courses may have pre-requisites not required for your option; these pre-requisites would still need to be taken in order to enrol in the elective. Students interested in taking an ESD elective course that does not appear on this list should contact the Chair of their option/Undergraduate Curriculum Committee and obtain his/her approval in writing before proceeding with the course.

Students in the Biomedical Engineering Option must complete a minimum of 8 units from the engineering science & design elective course list available at http://www.sfu.ca/engineering/current-students/undergraduate-students/programs-and-requirements/biomedical-engineering/curriculum-revised.html.

NOTE: SFU students accepted in the accelerated master's within the School of Engineering Science may apply a maximum of 10 graduate course units, taken while completing the bachelor's degree, towards the upper division electives of the bachelor's program and the requirements of the master's degree. For more information go to: https://www.sfu.ca/gradstudies/apply/programs/accelerated-masters.html or please contact the Engineering Science Graduate Program Committee Chair.

Writing, Quantitative, and Breadth Requirements

Students admitted to Simon Fraser University beginning in the fall 2006 term must meet writing, quantitative and breadth requirements as part of any degree program they may undertake. See Writing, Quantitative, and Breadth Requirements for university-wide information.

WQB Graduation Requirements

A grade of C- or better is required to earn W, Q or B credit.

Requirement	Units	Notes	
W - Writing	6	Must include at least one upper division course, taken at Simon Fraser University within the student's major subject	
Q - Quantitative	6	Q courses may be lower or upper division	
B - Breadth	18	Designated Breadth	Must be outside the student's major subject, and may be lower or upper division 6 units Social Sciences: B-Soc 6 units Humanities: B-Hum 6 units Sciences: B-Sci
	6	Additional Breadth	6 units outside the student's major subject (may or may not be B-designated courses, and will likely help fulfil individual degree program requirements) Students choosing to complete a joint major, joint honours, double major, two extended minors, an extended minor and a minor, or two minors may satisfy the breadth requirements (designated or not designated) with courses completed in either one or both program areas.

WQB Requirement Modifications for Engineering Science Students

For engineering science students, these university requirements are modified as follows.

- for students in the biomedical engineering option, the total number of Breadth Social Sciences (B-Soc) and Breadth Humanities (B-Hum) courses is reduced to two courses, with at least one course in each category.

Residency Requirements and Transfer Credit

- At least half of the program's total units must be earned through Simon Fraser University study.
- At least two thirds of the program's total upper division units must be earned through Simon Fraser University study.

Please see Faculty of Applied Sciences Residency Requirements for further information.

Elective Courses

In addition to the courses listed above, students should consult an academic advisor to plan the remaining required elective courses.