S.00-8

SIMON FRASER UNIVERSITY

OFFICE OF THE VICE-PRESIDENT, ACADEMIC

MEMORANDUM

To: Senate

From: J. M. Munro, Chair
Senate Committee on Academic Planning

Subject: Faculty of Science -
Curriculum revisions
(SCUS Reference: SCUS 99-26 f)
(SCAP Reference: SCAP 99-46)

Date: December 10, 1999

Action undertaken by the Senate Committee on Undergraduate Studies and the Senate Committee on Academic Planning gives rise to the following motion:

Motion:

"that Senate approve and recommend to the Board of Governors as set forth in S.00 - 8 , the proposed Industrial Mathematics Program including:

New course: MATH 402-4 Industrial Mathematics."

For Information:
Acting under delegated authority of Senate, SCUS approved revisions as set forth in S.00 - 8 as follows:

a) Department of Biological Sciences
b) Department of Chemistry
c) Department of Earth Sciences
d) Environmental Science Program
e) Molecular Biology and Biochemistry Program
f) Department of Mathematics and Statistics
g) Department of Physics

Any Senator wishing to consult the full report of curriculum revisions within the Faculty of Arts should contact Bobbie Grant, Senate Assistant at 291-3168 or e-mail bgrant@sfu.ca

J. M. Munro

Simon Fraser University

Full Program Proposal: Industrial Mathematics

A. Executive Summary

There is a common perception that mathematics is of basic importance in a great many fields, but a degree in mathematics is not that useful for the job market. Historically, mathematicians themselves have done little to counter these perceptions. Recently, though, there has been a growing movement on the part of the mathematical community to respond very positively. Organizations such as SIAM (Society for Industrial and Applied Mathematics) and the NSF Institute for Applied Mathematics at the University of Minnesota have been strongly emphasizing the kinds of directions mathematics must take in order to become a more prominent source of personnel in industry.

There has been a recent surge of activity in Canada and we in the West can take great pride in the fact the major impetus has come from Simon Fraser University and the University of British Columbia. It is no accident this surge started with the creation of the Pacific Institute for the Mathematical Sciences (PIMS). Right from the start PIMS placed industrial interaction at the forefront of its activities. In addition, PIMS was the driving force behind the recently created National Centre of Excellence called MITACS (the Mathematics of Information Technology and Complex Systems). This will result in a great deal of funds going into the interaction of mathematics and industry in the next two decades.

The intended degree program is a natural step towards the goal of producing mathematicians who are better prepared to move into business and industry. They will be better prepared both in terms of their backgrounds and their goals. The intended program parallels the SIAM guidelines for an industrial mathematics program.

The goal of the program is to provide an education with a broad background in computing, mathematics and basic science. Computing skills are necessary because in industry the mathematics involved is realized in computer programs. Basic science is necessary because people working in industry must be able to communicate with other scientists and engineers. Students who complete this degree program will be capable of bringing strong quantitative skills to problems arising in a wide range of business and industrial settings. They also will be able to recognize the mathematical nature of many problems that are often misinterpreted by people who have little background in mathematics.

B. Institutional and Program Identification

1. Institution which will award the degree:

Simon Fraser University

2. Which other institutions, if any, will contribute to this instructional program, and precisely what will each contribute?

None

3. Department(s), Faculty(ies) or School(s) which will be offering the degree:

Department of Mathematics and Statistics

4. Program title and the name of the credential to be awarded to graduates:

Industrial Mathematics leading to B.Sc. and B.Sc. (honors)

5. In what way does this degree program contribute to the mandate and strategic plan of the institution?

This degree program reflects a recent movement within the North American mathematical community to integrate mathematics and its applications into a much broader segment of society. Western Canada has taken the leading role in Canada via the Pacific Institute for the Mathematical Sciences' commitments to interactions with industry and with education. The interaction with industry which will be brought about through the proposed industrial mathematics degree program will promote Simon Fraser University's mandate to interact with the community. Students receiving degrees through this program will be highly marketable thereby promoting the University's mandate to improve employability of its graduates.

6. Intended schedule for implementation of the degree program:

We wish to implement the program as soon as it is approved. This is feasible because only one new course is being introduced.

C. Program Description

1. What economic/industrial/social/cultural goals is this program intended to serve?

This program will serve the goal of producing mathematics graduates who have strong computational skills and an awareness of how mathematics can be used to solve diverse industrial problems. Such individuals will be useful members of problem-solving teams in a variety of industries.

How do these relate to identified market niches or societal needs?

There has been considerable publicity regarding the shortage of people with appropriate technical skills. Engineering firms, oil companies, chemical companies, and consulting firms of various kinds often have to solve problems which require a multidisiciplinary approach involving mathematics and/or statistics. This is the context in which graduates from the program can expect to find employment.

2. What are the anticipated employment destinations for graduates?

Mathematical modeling, discrete optimization, and continuous optimization in industry.

What potential does this program provide for research and development or job creation?

Some research/job opportunities may arise through students' co-op semesters. Contacts with industry will be enhanced by asking outside experts to participate in the teaching of the new course MATH 402.

3. Intended learning outcomes of this program? (Skills, knowledge, attitudes or other attributes). In what way do these outcomes warrant a program of degree status?

Students will acquire a broad background in mathematics with a focus in one of industrial statistics, continuous mathematics or discrete mathematics. There will be an emphasis on mathematical modeling. All students will be required to develop considerable skill in computing and the use of mathematical software such as Maple, Matlab, and Minitab. A minor in a science or engineering will be required so students develop scientific breadth in their approach to problem solving. Co-op work terms (strongly recommended) will develop skills the student needs to flourish in a business or industrial setting.

An actual major entitled "industrial mathematics" is the first step in building an identifiable professional industrial mathematician. There is a long history of mathematicians in industry but it has occurred on a somewhat ad hoc basis, and many companies do not think in terms of hiring mathematicians.

4. Specifically, what are the courses, or other curriculum requirements of the program?

Below are set out the requirements for majors as they will appear in the calendar.

The program requirements consist of core requirements and two area requirements.
The first area requirement is chosen from Group A:

Continuous Mathematics *Discrete Mathematics* *Industrial Statistics*

The second area requirement is chosen from Group B:

Biological Sciences	*Chemistry*	*Computing Science*
Earth Sciences	*Engineering Science*	*Physics*

The core requirements and the details of the options in groups A and B, are listed below.

Core Requirements

Lower Division Core Requirements

One of
- CMPT 101-4 Introduction to Computer Programming
- CMPT 104-2 Computer Programming

plus all of
- CMPT 201-4 Data and Program Abstraction
- MACM 101-3 Discrete Mathematics I
- MACM 201-3 Discrete Mathematics II
- MACM 202-4 Mathematical Modeling and Computation
- MATH 151-3 Calculus I
- MATH 152-3 Calculus II
- MATH 232-3 Elementary Linear Algebra
- MATH 251-3 Calculus III
- STAT 270-3 Introduction to Probability and Statistics

Upper Division Core Requirements

All of
- MATH 310-3 Introduction to Differential Equations
- MATH 322-3 Complex Variables
- MATH 402-4 Industrial Mathematics
- STAT 330-3 Introduction to Statistical Inference

plus two of
- MATH 314-3 Boundary Value Problems
- MATH 343-3 Applied Discrete Mathematics
- STAT 340-3 Statistical Quality Control

plus two of
- CMPT 305-3 Computer Simulation and Modeling
- CMPT 307-3 Data Structures and Algorithms
- MACM 316-3 Numerical Analysis I

MATH 308 may be substituted for MATH 343; STAT 380 may be substituted for STAT 340.

Group A Requirements

Students must fulfill the requirements for one of the following three options:

Continuous Mathematics

All of

- MACM 316-3 Numerical Analysis I
- MATH 252-3 Vector Calculus
- MATH 314-3 Boundary Value Problems
- MATH 418-3 Partial Differential Equations

plus two of

- MATH 309-3 Continuous Optimization
- MATH 313-3 Differential Geometry
- MATH 320-3 Advanced Calculus of one Variable
- MATH 415-3 Ordinary Differential Equations
- MATH 416-3 Numerical Analysis II
- MATH 462-3 Fluid Dynamics
- MATH 467-3 Vibrations
- MATH 470-3 Variational Calculus

one of which must be a 400-level course.

Discrete Mathematics

All of

- CMPT 307-3 Algorithms and Data Structures
- MATH 308-3 Linear Programming
- MATH 343-3 Applied Discrete Mathematics

plus two of

- MATH 408-3 Discrete Optimization
- MATH 443-3 Combinatorial Theory
- MATH 445-3 Graph Theory
- MATH 447-3 Coding Theory

Industrial Statistics

All of

- STAT 340-3 Statistical Quality Control
- STAT 350-3 Linear Models in Applied Statistics II
- STAT 430-3 Statistical Design and Analysis of Experiments

plus one of

- STAT 402-3 Generalized Linear and Non-linear Modeling
- STAT 410-3 Statistical Analysis of Sample Surveys
- STAT 420-3 Non-Parametric Statistics
- STAT 450-3 Statistical Theory
- STAT 460-3 Bayesian Statistics

It is recommended that students also take STAT 280-3 Applied Probability Models.

Group B Requirements

Students must fulfill the requirements for a minor in one of

Biological Sciences *Chemistry* *Computing Science* *Earth Sciences* *Physics*

or complete the following courses:

Engineering Science

All of

- ENSC 150-3 (or CMPT 150) Introduction to Computer Design
- ENSC 151-2 Digital and Computer Design Laboratory
- ENSC 220-3 Electric Circuits I
- PHYS 120-3 Modern Physics and Mechanics
- PHYS 121-3 Optics, Electricity and Magnetism
- PHYS 131-2 General Physics Laboratory B

plus two of

- ENSC 320-3 Electric Circuits II
- ENSC 327-3 Communications Systems
- ENSC 380-3 Linear Systems
- ENSC 383-4 Feedback Control Systems

plus one of

- ENSC 429-4 Discrete-Time Systems
- ENSC 483-4 Modern Control Systems
- ENSC 488-4 Introduction to Robotics
- PHYS 484-3 Nonlinear Physics

plus one more upper division ENSC course.

If the Computing Science minor is chosen to satisfy the Group B requirement, then CMPT 275, CMPT 305, CMPT 307, and MACM 316 must be included in the student's overall program.

Honors Program

Honors students must satisfy the requirements for a major. and complete 132 credit hours including:

- at least 48 hours of upper division credit in courses labeled MACM, MATH, STAT excluding STAT 301, 302, 403
- additional hours bringing the total of upper division credit to at least 60 credit hours
- all of the courses
    - CMPT 305-3 Computer Simulation and Modeling
    - CMPT 307-3 Data Structures and Algorithms
    - MACM 316-3 Numerical Analysis I
    - MATH 314-3 Boundary Value Problems
    - MATH 343-3 Applied Discrete Mathematics
    - STAT 340-3 Statistical Quality Control

  MATH 308 may be substituted for MATH 343; STAT 380 may be substituted for STAT 340.

5. By what means are these integrated so as to contribute to the intended goals of the program? Which of these courses already exist at the institution? Which are new?

The courses will be offered as part of the overall course offerings as determined by the various departments and schools. Thus, there already is an existing method of offering courses which attempts to coordinate course offerings so as to help students satisfy program requirements as expeditiously as possible.

All of the courses in the program already exist except for the proposed new course MATH 402 Industrial Mathematics.

6. The structure and expected class sizes of courses in this program:

The courses in the program which already exist at Simon Fraser University will not change. The new modeling course will draw on expertise from the university as well as from industry. Students will have three or four industrial projects to work on in a team setting during the course. We will use people from industry to help with problem formulation and problem solving techniques. The class size for MATH 402 is expected to be 15 initially.

7. Specialties, majors, or minors to be offered:

There will be both a major and honors degree in Industrial Mathematics through the Faculty of Science making them B.Sc. degrees. There will be no minor.

8. What programs exist at other B.C. institutions which contain similar content or have similar objectives, and, if similar, what is the rationale for duplication?

This program will be the first Industrial Mathematics degree program at the undergraduate level in B.C. The University of Victoria has an M.Sc. program in Industrial Mathematics, and the University of British Columbia is proposing an M.Sc. program in Industrial Mathematics. There is some discussion about having the latter program jointly offered by the University of British Columbia and Simon Fraser University.

9. How does this program relate to other programs offered at this institution (shared or related expertise, other resources, etc.)?

The Industrial Mathematics program will draw heavily on courses in Computing Science, and also will use courses from other science departments and the School of Engineering Science.

10. What, if any, other programs will be reduced or eliminated in order to initiate the new program?

There is no intention to reduce offerings for other programs in the Department of Mathematics and Statistics.

11. What, if any, are the research expectations or implications of this program?

There are no research expectations or implications.

D. Admission and Transfer

1. What are the admission requirements for direct entry students and transfer students?

The standard requirements for admission into the Faculty of Science apply.

2. What institutional regulations apply to this program (residency requirements, etc.)?

The usual institutional regulations apply.

3. Who are the intended students?

Any students who have an interest in mathematics. We are particularly interested in those students who are good at mathematics but do not see career opportunities in the field, and therefore often major in other subjects thinking teaching is the only direction one can move with a degree in mathematics.

What is the evidence that these students are not presently served reasonably within existing B.C. offerings?

Part of the reason for starting this program is to begin the process of building a highly visible career profile entitled "Industrial Mathematician". Since this presently does not exist at all, it is not being served at all.

4. What initiatives, if any, address low participation groups (e.g. aboriginal students)?

There are no specific initiatives. However, the department has been seeking to improve the participation of women through measures to improve support for women undergraduate and graduate students and to provide female role models.

5. What enrolments are anticipated? How many of these are expected to represent a new client group (to be additional {new} enrolments) for this institution?

We anticipate small enrolments at the beginning of the program. If students see graduates having success in employment, enrolments will increase. Since it will be one of the only undergraduate programs of its type, some new students will be attracted to the university.

6. What articulation arrangements with other programs and institutions now exist and are planned?

There is a long-standing articulation organization, the BCCUPM, in British Columbia which has led to a smooth transfer of information regarding mathematics programs between the post-secondary organizations of British Columbia. It will function well for this program too.

7. What provision is made to enable students to receive credit for learning previously achieved outside the B.C. post-secondary system?

The University routinely assesses relevant learning from other jurisdictions and admits students from other Canadian provinces (secondary schools, CEGEP, institutes of technology, universities, and degree holders), as well as students from other countries. In addition, students may obtain credit through course challenge procedures.

E. Learning Methodologies

1. What learning environment and methodologies will be developed so as to achieve the intended outcome of the program?

Most of the courses in the program already exist at SFU so that the question does not pertain to them outside of the influence success in the Industrial Mathematics modeling courses might exert. The new modeling course will be taught differently from other mathematics courses. The course will be team taught using faculty members from the Department of Mathematics and Statistics and people from industry. There will be several projects during the semester and students will work in teams.

2. What use will be made of:

- ***experimental learning (cooperative education, clinical, etc.)?***

Students in the Industrial Mathematics Program will be strongly advised to earn a co-op designation for their degree by completing four co-op work terms while completing the academic requirements for the degree. Also, students will be urged to take two of the four work terms consecutively after completing 85 credit hours towards the major. This will enable students to gain real working experience.

- ***distance education ?***

None.

- ***independent study, computer-assisted instruction, etc. ?***

None

F. Faculty

1. How many faculty and other staff are required, and with what qualifications?

One third of a new faculty position is required in order to avoid having to reduce other course offerings. This is accounted for by offering the new modeling course once a year.

In addition, one third of a new faculty position in the School of Computing Science is required. Without new resources the School of Computing Science may not be able to continue offering CMPT 305-3 (Computer Simulation and Modeling) which is important for the proposed major.

2. Will there be any differentiation of faculty roles (instruction, curriculum, research, innovation, etc.)?

No.

What are the percentages of time spent on teaching, research, and/or other roles?

The normal breakdown in time between these areas of responsibilities is: teaching 40%; research and scholarship 40%; and service/administration 20%. There is a 50% reduction in teaching responsibilities for new faculty during their first year of work.

G. Program resources

What resources will be required to assure a program of acceptable quality?

(a) Operating Funds

One third of a faculty position for the Department of Mathematics and Statistics and one third of a faculty position .for the School of Computing Science.

(b) Library/Media/Computing/Communications

We will need a software licence to allow Matlab to be used by the students in this course..

(c) Facilities

Nothing additional.

(d) Equipment

Nothing additional.

(e) Special Resources (institutional, community, natural/environmental, etc.)

People from industry will be used to assist in teaching the new course MATH 402 Industrial Mathematics.

(f) Start-up or Development Needs

We will seek alternative funding to help support the use of industrial scientists/engineers/mathematicians to assist in teaching of the mathematical modeling course.

H. Program Consultations and Evaluation

1. What consultations have occurred with professional associations, employers, educational institutions? Please attach any written endorsements or comments.

We discussed the program with several industrial people in B.C. who represent small and large companies (letters from several of these people are appended at the end of the proposal). We also discussed the general outline of the program with Dr. Avner Friedman of the NSF Applied Mathematics Institute in Minneapolis. We relied heavily on the publication (*How To Start an Industrial Mathematics Program*) published by the Society for Industrial and Applied Mathematics in Philadelphia.

Who else was involved, and how, in the collection and evaluation of information leading to the development and submission of this proposal?

Drs. Brian Alspach and Michael Monagan jointly formulated this proposal after consulting with colleagues at SFU and people from industry.

2. What suggestions would your institution make to assist the DPRC in evaluating this proposal (names of appropriate program experts, sources of supplementary data or information, etc)

Dr. Avner Friedman at the Institute for Applied Mathematics at the University of Minnesota is an expert in the area. He is also one of the authors of the booklet "How To Start an Industrial Mathematics Program" mentioned above. Thus, this booklet is a good source of information.

3. After the program is implemented, what procedures are planned for ensuring adequate depth and breadth of ongoing review and evaluation?

Simon Fraser University has a cyclical procedure for reviewing programs and departments. This program would be evaluated as part of the normal process. The department will monitor the program very closely in its early stages.

4. What provision is made for ongoing membership on advisory committees to this program, or what other means are provided for maintaining extra-institutional perspectives?

There will be an Industrial Mathematics Program Advisory Panel. The proposed membership is: three members from the Department of Mathematics and Statistics, one member from the School of Computing Science, one member from Biological Sciences/Chemistry (alternating terms of two years each), one member from Engineering/Physics (alternating terms of two years each), and one member from industry.

5. What is the nature of the ongoing involvement of professional or other certifying or accrediting organizations?

There is no such organization at this time, but this brings up an interesting point. There is some sentiment towards creating a certification process for an industrial mathematician designation. If such action takes place, such an organization would have considerable effect on the program. There is a good chance Simon Fraser University will play a leading role in the creation of any certification procedure.

I. Other

What additional information is relevant to an explanation of the need for, and the educational merits of, this program proposal (special features, equity considerations, etc.)?

There is nothing to add.

Industrial Mathematics Program

Advisors

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This program is an interdisciplinary one which combines a broad education in mathematics with courses in science or engineering and strong computational skills. Industry is looking for mathematicians with a basic training in science or engineering who can communicate effectively with scientists and engineers, and who can tackle industrial problems whose solution requires substantial mathematics and/or statistics. The program aims to meet this need.

In addition to the program requirements set out below, general university and faculty of science regulations for a major or honors degree, as the case may be, must be satisfied.

Major Program

The program requirements consist of core requirements and two area requirements.

The first area requirement is chosen from Group A:

Continuous Mathematics   *Discrete Mathematics*   *Industrial Statistics*

The second area requirement is chosen from Group B:

Biological Sciences   *Chemistry*   *Computing Science*

Earth Sciences   *Engineering Science*   *Physics*

Students should seek advice as to which options from Groups A and B fit well with their eventual career goals. The following combinations are expected to be the more applicable ones for industry:

- Industrial Statistics and Biology
- Continuous Mathematics and Chemistry
- Discrete Mathematics and Computing Science
- Discrete Mathematics and Engineering Science
- Continuous Mathematics and Earth Sciences
- Continuous Mathematics and Engineering Science
- Continuous Mathematics and Physics

Similar care should be exercised in choosing the courses used to satisfy the Group B requirement.

Except in the case of Engineering Science, electing an option in Group B requires admission to the corresponding minor which must be sought from the relevant department or school. Admission to the Computing Science minor program is highly competitive; see the Admission section of the Computing Science entry to be found in the Faculty of Applied Sciences part of the calendar.. For the Engineering Science option students must meet the same GPA requirements as required of students in the BASc program by the the School of Engineering Science.

The core requirements and the details of the options in groups A and B, are listed below.

Core Requirements

Lower Division Core Requirements

One of

- CMPT 101-4 Introduction to Computer Programming
- CMPT 104-2 Computer Programming

plus all of

- CMPT 201-4 Data and Program Abstraction
- MACM 101-3 Discrete Mathematics I
- MACM 201-3 Discrete Mathematics II
- MACM 202-4 Mathematical Modeling and Computation
- MATH 151-3 Calculus I
- MATH 152-3 Calculus II
- MATH 232-3 Elementary Linear Algebra
- MATH 251-3 Calculus III
- STAT 270-3 Introduction to Probability and Statistics

Upper Division Core Requirements

All of

- MATH 310-3 Introduction to Differential Equations
- MATH 322-3 Complex Variables
- MATH 402-4 Industrial Mathematics
- STAT 330-3 Introduction to Statistical Inference

plus two of

- MATH 314-3 Boundary Value Problems
- MATH 343-3 Applied Discrete Mathematics
- STAT 340-3 Statistical Quality Control

plus two of

- CMPT 305-3 Computer Simulation and Modeling
- CMPT 307-3 Data Structures and Algorithms
- MACM 316-3 Numerical Analysis I

MATH 308 may be substituted for MATH 343; STAT 380 may be substituted for STAT 340.

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Group A Requirements

Students must fulfill the requirements for one of the following three options:

Continuous Mathematics

All of

- MACM 316-3 Numerical Analysis I
- MATH 252-3 Vector Calculus
- MATH 314-3 Boundary Value Problems
- MATH 418-3 Partial Differential Equations

plus two of

- MATH 309-3 Continuous Optimization
- MATH 313-3 Differential Geometry
- MATH 320-3 Advanced Calculus of one Variable
- MATH 415-3 Ordinary Differential Equations
- MATH 416-3 Numerical Analysis II
- MATH 462-3 Fluid Dynamics
- MATH 467-3 Vibrations
- MATH 470-3 Variational Calculus

one of which must be a 400-level course.

Discrete Mathematics

All of

- CMPT 307-3 Algorithms and Data Structures
- MATH 308-3 Linear Programming
- MATH 343-3 Applied Discrete Mathematics

plus two of

- MATH 408-3 Discrete Optimization
- MATH 443-3 Combinatorial Theory
- MATH 445-3 Graph Theory
- MATH 447-3 Coding Theory

Industrial Statistics

All of

- STAT 340-3 Statistical Quality Control
- STAT 350-3 Linear Models in Applied Statistics II
- STAT 430-3 Statistical Design and Analysis of Experiments

plus one of

- STAT 402-3 Generalized Linear and Non-linear Modeling
- STAT 410-3 Statistical Analysis of Sample Surveys
- STAT 420-3 Non-Parametric Statistics

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- STAT 450-3 Statistical Theory
- STAT 460-3 Bayesian Statistics

It is recommended that students also take STAT 280-3 Applied Probability Models.

Group B Requirements

Students must fulfill the requirements for a minor in one of

Biological Sciences *Chemistry* *Computing Science* *Earth Sciences* *Physics*

or complete the following courses:

Engineering Science

All of

- ENSC 150-3 (or CMPT 150) Introduction to Computer Design
- ENSC 151-2 Digital and Computer Design Laboratory
- ENSC 220-3 Electric Circuits I
- PHYS 120-3 Modern Physics and Mechanics
- PHYS 121-3 Optics, Electricity and Magnetism
- PHYS 131-2 General Physics Laboratory B

plus two of

- ENSC 320-3 Electric Circuits II
- ENSC 327-3 Communications Systems
- ENSC 380-3 Linear Systems
- ENSC 383-4 Feedback Control Systems

plus one of

- ENSC 429-4 Discrete-Time Systems
- ENSC 483-4 Modern Control Systems
- ENSC 488-4 Introduction to Robotics
- PHYS 484-3 Nonlinear Physics

plus one more upper division ENSC course.

Students choosing an option other than Engineering Science should seek approval for their minor from the relevant department or school.

If the Computing Science minor is chosen to satisfy the Group B requirement, then CMPT 275, CMPT 305, CMPT 307, and MACM 316 must be included in the student's overall program. Further, the upper division courses used for the minor should not overlap with the courses used to satisfy the core requirements set out above.

Honors Program

Honors students must satisfy the requirements for a major. and complete 132 credit hours including:

- at least 48 hours of upper division credit in courses labeled MACM, MATH, STAT excluding STAT 301, 302, 403
- additional hours bringing the total of upper division credit to at least 60 credit hours
- all of the courses
  - CMPT 305-3 Computer Simulation and Modeling
  - CMPT 307-3 Data Structures and Algorithms
  - MACM 316-3 Numerical Analysis I
  - MATH 314-3 Boundary Value Problems
  - MATH 343-3 Applied Discrete Mathematics
  - STAT 340-3 Statistical Quality Control

  MATH 308 may be substituted for MATH 343; STAT 380 may be substituted for STAT 340.

Co-operative Education Program

Students in the Industrial Mathematics Program are encouraged to enter co-operative education, a program which integrates work experience with academic study --- the advantage of taking a co-op degree has been strongly endorsed by representatives from industry. For further details students should refer to the *Co-operative Education* section of the calendar. To obtain a co-op designation for the degree students are required to complete four co-op work terms while completing the academic requirements for the degree.

Students are strongly advised to complete two consecutive work terms after completing 85 credit hours towards the major.

Second Bachelor's Degree

If the Industrial Mathematics Major is taken as part of a second bachelor's degree, then the Group B requirement may be waived if the student's previous degree contains an approved major. Approvals will be given on an individual basis and the majors approved will not be limited to the five disciplines listed in Group B.

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 a)
(SCAP Reference: SCAP 99 – 46)

a) Department of Biological Sciences

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) New courses:
- BISC 425-3 Biology and Society
- BISC 439-3 Industrial Microbiology
- BISC 499-3 Undergraduate Research !!

ii) Change of prerequisite: BSC 101, 102, 305, 307, 366, 367
Change of vector: BISC 329
Change of title: BISC 498

iii) Change of lab course requirements in Biology streams

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 b)
(SCAP Reference: SCAP 99 – 46)

b) Department of Chemistry

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) New courses:
- CHEM 464-3 Quantum Chemistry
- CHEM 468-3 Selected Topics in Physical Chemistry
- CHEM 483-5 Honors Research
- CHEM 340-3 Materials Chemistry

Deletion of:
- CHEM 331-4 Practical Aspects of Inorganic Chemistry
- CHEM 363-5 Kinetics and Mechanism
- CHEM 465-3 Electrochemistry
- CHEM 472-3 Special Topics in Theoretical Chemistry

ii) Change of title, description and prerequisite: CHEM 332, 336
Change of number and prerequisite: CHEM 357
Change of number, title, description and prerequisite: CHEM 362
Change of prerequisite: CHEM 366, 367, 462
Change of description: CHEM 469, 481

iii) Change of requirements for Chemistry Major Program
Change of requirements for Chemistry Honors Program
Change of requirements for Chemical Physics Program

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 c)
(SCAP Reference: SCAP 99 – 46)

c) Department of Earth Sciences

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) New course:
EASC 416-3 Field Techniques in Hydrogeology
ii) Change of vector: EASC 101
Change of prerequisite: EASC 102
Change of description: EASC 499
iii) Change of requirements for Earth Sciences Major Program
Change of requirements for Earth Sciences Minor Program
Change of requirements for Earth Sciences Honors Program

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 d)
(SCAP Reference: SCAP 99 – 46)

d) Environmental Science Program

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) New course:
EVSC 491-3 Advanced Field Studies in Environmental Science

ii) Correction to Calendar entry under Year Two requirements of Biology emphasis
Change of requirements for Honors Program

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 e)
(SCAP Reference: SCAP 99 – 46)

e) Molecular Biology and Biochemistry Program

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) Change of prefix for all courses in Biochemistry Program:
From BICH to MBB
Change of number and description: 221, 222, 311, 312, 321, 322, 403, 412, 413, 420, 421, 422, 423, 426, 435, 490, 491, 492, 493

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 f)
(SCAP Reference: SCAP 99 – 46)

f) Department of Mathematics and Statistics

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) Change of title and description: STAT 460

ii) Change of requirements for Major Program
Deletion of special option Honors program

iii) Deletion of:

MATH 262-3	Applied Mathematics – Statistics
MATH 263-3	Applied Mathematics – Rigid Body Dynamics

Change of requirements for Applied Mathematics Major Program
Change of requirements for Applied Mathematics Honors Program

iv) Change of requirements for Actuarial Science Major Program
Change of requirements for Actuarial Science Honors Program

v) Revision of Mathematics and Statistics Department Calendar preamble.

FOR INFORMATION

(SCUS Reference: SCUS 99 – 26 g)
(SCAP Reference: SCAP 99 – 46)

f) Department of Physics

Acting under delegated authority, SCUS approved curriculum revisions as follows:

i) New courses:
- PHYS 285-3 Introduction to Relativity and Quantum Mechanics
- PHYS 490-3 General Relativity and Gravitation

Deletion of:
- PHYS 325-3 Relativity and Electromagnetism

ii) Change of description: PHYS 100, 211, 384
Change of title: PHYS 130, 131, 233, 234, 332
Change of number: PHYS 244, 345
Change of description and prerequisite: PHYS 385, 425
Change of prerequisite: PHYS 395

iii) Change of requirements for Applied Physics Major Program
Change of requirements for Applied Physics Honors Program
Change of requirements for Chemical Physics Major Program
Change of requirements for Chemical Physics Honors Program
Change of requirements for Mathematical Physics Honors Program
Change of requirements for Physics and Physiology Honors Program
Change of requirements for Physics Major Program
Change of requirements for Physics Honors Program