SIMON FRASER UNIVERSITY

S.81-16

MEMORANDUM

To: SENATE

From: SENATE COMMITTEE ON UNDERGRADUATE STUDIES

Subject: PROPOSAL FOR A FACULTY OF ENGINEERING AT SIMON FRASER UNIVERSITY

Date: DECEMBER 19, 1980

Action undertaken by the Senate Committee on Undergraduate Studies at its meetingof December 2, 1980 gives rise to the following motion:

MOTION: "That Senate approve and recommend approval to the Board of Governors, as set forth in S.81-16, the proposal for a Faculty of Engineering at Simon Fraser University, including:

Formal action on the group of existing Engineering Mechanics courses offered by the Mechanics group in the Department of Mathematics will be deferred until the Engineering Programs are implemented.

This detailed proposal follows from motion approved by Senate on January 14, 1980, "That approval in principle be given to the establishment of undergraduate and graduate degree programs in Engineering at Simon Fraser University." There have been intensive discussions both with the University and with external groups. The documentation now provided includes much information.

The proposal is for a four year program rather than for a five year requirement as at UBC. UBC is seriously considering introduction of a four year program for 1983. There is provision for operation in the Co-operative Education mode which is expected to be the normal method but which would not be mandatory. The design is professionally oriented for those who wish to practice in fields of engineering but there is also Engineering Science for those who may wish to proceed to graduate school work. The program emphasizes mathematics and science and it also includes emphasis on a number of relatively new areas such as computing. Any program introduced must satisfy the Canadian Accreditation Board which requires at least a half year study in humanities, social sciences and administration.

The principal features of the programs for the Faculty of Engineering are outlined on pp. 19 and 20 of the document. The general admission requirements and degree requirements are outlined on pp. 33 and 34; the Engineering Program requirements are shown on pp. 35 and 36, with elective lists on p. 37; the more detailed outlines for each of Civil Engineering, Electrical Engineering, Mechanical Engineering, Chemical Engineering, Computer Engineering, Engineering Science appear on pp. 38 to 80 inclusive. Information on resources and a proposed schedule for development are given on pp. 81 to 84.

Engineering course descriptions appear on pp. 85 to 122. The Canadian Accreditation requirements for an Engineering Program are shown on pp. 120 and thereafter.

It is understood that there would be no attempt to implement the Faculty of Engineering and these programs unless there is clear assurance of adequate funding.

SIMON FRASER UNIVERSITY

MEMORANDUM

To: Mr. H.M. Evans, Registrar and Secretary to Senate

From: Dr. Thomas W. Calvert, P.Eng. Director of Engineering

Subject: Engineering Curriculum

Date: 8 December 1980

This is to clarify and make explicit the responses to a number of issues raised at SCUS.

1. The Engineering Curriculum specifies a significant number of courses in Mathematics, Physics and Chemistry as core requirements for all students. Most of the courses specified have content which is quite appropriate to the needs of the Engineering Curriculum but in a few instances both the Engineering Committee and the department concerned recognized that the material in the specified courses was not exactly what was needed. The departments have agreed to examine the needs of the Engineering Curriculum and to consider rearranging the course material by the time the curriculum is implemented.

2. A conscious effort has been made to utilize existing S.F.U. courses wherever possible. This has been done both to integrate Engineering with the rest of the university and to achieve maximum economy. Thus the normal engineering courses in Statics, Dynamics, Strength of Materials and Fluid Mechanics are taught by the Mechanics group in the Mathematics Department and the Thermal Physics course (Physics 344) is specified instead of an introductory course in Engineering Thermodynamics. In the case of the courses taught by the Mechanics oriented faculty in Mathematics, we will request that the designation MATH be changed to ENME (for Engineering Mechanics) when the Engineering Curriculum is implemented. (This applies to MATH 262, 263, 265 and 362.)

The important principle which applies to all such courses is that they must directly meet the needs of the Engineering Curriculum. Thus, if for any reason the content or emphasis of any of these courses becomes inappropriate to the needs of the engineering undergraduate, the Faculty of Engineering must reserve the right to institute its own course on that topic. In the light of the extensive consultation which has taken place we have no reason to believe that this will be a problem.

3. In a few instances, non-engineering courses have been designated as required for Engineering students who do not formally meet the pre-requisites. This has been done after consultation and represents an informed judgement that in these cases the pre-requisites can be waived. The

specific courses are:

PHYS 425-3 Electromagnetic Theory in ELEC.
CMPT 201-4 Data and Program Organization in CMPE.
ENME 362-3 Fluid Mechanics I in ENSC.
NUSC 342-3 Introduction to Nuclear Science in ENSC.

Please let me know if there are other issues which require clarification.

T W Calvert

Thomas W. Calvert, P.Eng.
Director of Engineering

TWC:mm

cc A. Sherwood
B. Clayman
Engineering Committee

SIMON FRASER UNIVERSITY SCUS 80-84

MEMORANDUM

To: H. Evans, Secretary
Senate Committee on Undergraduate Studies

From: John S. Chase, Secretary
Senate Committee on Academic Planning

Subject: Undergraduate and Graduate Programs in Engineering

Date: 28 October 1980

Action taken by the Senate Committee on Academic Planning at its meeting on 22 October 1980 gave rise to the following motion:

> "that S.C.A.P. approve the principal features of the proposed program for the Faculty of Engineering, as outlined in SCAP80-19. Approval to be conditional on sufficient operating and capital funding being provided by the Universities Council of British Columbia."

Would you please ensure that the undergraduate component of the proposed program is placed before the Senate Committee on Undergraduate Studies for its consideration. The proposal provided to S.C.A.P. did not contain detailed course information. It is my understanding that this information will be provided directly to you by the Dean of the Faculty of Interdisciplinary Studies. In addition, please note that the principal features of the proposed program as approved by S.C.A.P. are those contained on page 9 of SCAP80-19.

J. Chase

Note: Inclusion of the title "Faculty of Engineering" in the above motion does not constitute a commitment. Subsequent modification may be warranted.

JSC:ld

Registrar's Note: Page 9 of — corresponds to page 18 and 19 of this present document.

SIMON FRASER UNIVERSITY
SCUS 80-84

MEMORANDUM

To: Mr. H.M. Evans, Secretary . the Senate Committee on Undergraduate Studies

From: Dr. Thomas W. Calvert, Dean Faculty of Interdisciplinary Studies

Subject: Engineering Proposal

Date: 18 November 1980

I attach the "Proposal for a Faculty of Engineering at Simon Fraser". This was approved by our internal Engineering Committee at its meeting on November 6, 1980. The principal features of the proposal had previously been approved by SCAP on 22 October, 1980.

Please place the proposal on the agenda of SCUS. I hope that initlal consideration can take place on November 25. The curriculum and course descriptions were circulated to Faculties and relevant departments on 12 November 1980.

Thomas W. Calvert, Dean

TWC:jk

cc: J.M. Munro

Attachment

PROPOSAL FOR A FACULTY OF ENGINEERING

AT

SIMON FRASER UNIVERSITY

November, 1980

SUMMARY

There is an urgent need to increase the educational opportunities for Engineering in British Columbia. This is necessary to meet the needs of industry for qualified engineers, to encourage the establishment of new technology based industries and to provide equitable educational opportunities for the citizens of the Province.

Simon Fraser proposes to develop a high quality four year engineering degree program which will normally be offered in the co-op mode. There will be simultaneous development of a graduate program. The proposed programs are Chemical, Civil, Computer, Electrical and Mechanical Engineering plus Engineering Science. The Computer Engineering Program can be covered without additional faculty or courses by combining the digital systems option in Electrical Engineering with courses in the existing Computing Science Department. Chemical Engineering depends heavily on the existing Chemistry Department and Engineering Science provides an opportunity for in depth study in solid state electronics, energy and mechanics by combining engineering and science courses. All programs share a common core of science, mathematics and societal context courses. In addition all programs have course sequences in computing, systems theory and industrial engineering. Thus the graduating student will be firmly grounded in the fundamentals but will have the sophisticated analysis tools which together with a strong professional orientation, will equip him to tackle the problems of B.C. and Canadian industry in the 1980's and 1990's.

Simon Fraser's physical location is adjacent to a future research park and is in the heart of the industrial and population growth area for the

Province (projected population increase of 350,000 within commuting distance). Simon Fraser Uni' rsity also offers an attractive internal environment for the development of a second school of Engineering. Not only would existing SFU departments (Physics, Chemistry, Computing Science, Kinesiology, Geography and Mathematics) provide strong complementary support to an Engineering Faculty, but the semester system is ideally suited to the co-op program and makes full use of facilities year round. The flexibility of the semester system will also be used to enhance the accessibility of the program to students entering from other university programs, colleges or institutes of technology. Transfer students will enter the engineering program through specially designed transfer semesters which will allow them to complete the engineering degree as expeditiously as possible.

The proposed Faculty of Engineering would grow to have an enrollment of about 825 undergraduate and 100 graduate students after 7-10 years. There would be 40 faculty in the four departments of Chemical, Civil, Electrical and Mechanical Engineering. The detailed budget is currently being prepared but preliminary estimates are that operating costs will rise to $3,500,000 ($5,250,000 with 50% overhead) and that about $20,000,000 will eventually be required for buildings and equipment. It would be desirable to implement all programs simultaneously but since it is estimated that design and construction of a new building will require about 5 years, it may only be possible to mount the programs in Electrical, Computer and Chemical Engineering immediately. They can probably be accommodated on an interim basis in existing laboratories in the Faculty of Science. The third and fourth years of the Civil and Mechanical Engineering programs might have to be delayed for three years unless suitable temporary laboratory space can be found off-campus.

THE NEED FOR ADDITIONAL ENGINEERING PROGRAMS IN B.C.

In spite of the many studies and analyses that bear on the supply and demand of engineers in Canada in general and in B.C. in particular, the exact dimensions of the future supply and demand situation remain elusive. Although there is accurate data on the supply of new engineers within B.C. (i.e., graduates from U.B.C.) and on immigrants from outside Canada, it is quite difficult to estimate the number of migrants from the rest of Canada who come to B.C. each year to take up the practice of engineering. The total demand is also very difficult to estimate. Nevertheless, all of the evidence points to the fact that the annual increase in the number of engineers employed in B.C. exceeds the supply from U.B.C. by about 100% and that this situation has existed for at least 10 years.

The following is a summary of the evidence that supports this conclusion:

1. Participation Rates (per 1000 for 18-24 year age group)

	Canada	B.C.
Total Post-secondary	197.2	140.9
Total University	104.2	86.6
Science	12.4	12.6
Engineering	9.0	4.3

The overall university participation rates is low in B.C., it is clear that engineering is particularly low. In fact B.C. has the lowest engineering participation rate in Canada except for P.E.I., which does not have an engineering school.

2. Engineering Enrollments (1979)

	Canada	B.C.
Undergraduate	30,716	1,456 (4.7%)
Graduate	4,894	194 (3.96%)

These data indicate enrollments at about half of the level that would be expected on the basis of total population.

3. Employment of Engineers

	Canada	B.C.
Managerial and Professional Employment per 1000 of Population (20-24)	772.0	746.8
B.C. Employment of Engineers as a Percentage of Canadian Total (1978)	100%	9.4%
Professional Engineers Registered in 1979	101,227	9,556 (9.4%)

4. Immigration

	Canada	B.C.
Landed immigrant Engineers taking up employment in 1979	817	86 (10.53%)

These data indicate that B.C. employs Engineers at a level that is consistent with the total Managerial and Professional employment and with the total population. Internal migration is difficult to estimate. Approximately 60% of the Registered Professional Engineers in B.C. received their first engineering degree outside B.C. Roughly half of these obtained their qualifications outside Canada.

In summary, it is clear that there is a substantial shortfall in the supply of engineers in B.C. In the last 10 years the province has educated between 4 and 5% of the Canadian total while employing between 9 and 11%. The shortfall is made up by migration from the rest of Canada and immigration from abroad.

To project the future supply/demand situation it is helpful to examine the graph in Figure 1. This shows the numbers of engineering graduates from U.B.C. and an estimate of demand based on the membership in the Association of Professional Engineers of B.C. (APEBC) since 1970. The number of graduates is projected to 1983 based on current enrollments. The net increase in the number of new members in the APEBC (399 in 1979) can be used to estimate the total number of new engineers taking up employment. To estimate this total it must be recognized that there is an attrition due to death, retirement and movement out of engineering into other occupations (principally management). The total attrition rate is probably between 1 and 3% - conservatively an estimate of 2% is used, i.e., 184 in 1979. Beyond this, it is well known that all engineers do not join the Association. The unregistered engineers are estimated at about 30% across Canada. For B.C. we made a conservative estimate of 20% and in 1979 this would amount to 117 unregistered engineers. Thus for 1979 the estimated total number of new engineers would be 399 + 184 + 177 = 700. This estimate is plotted for 1970-1979. It must be recognized that the number taking up employment only gives the demand which has been met. There is consistent anecdotal evidence from employers and more specific indications from Canada Manpower that in some fields of engineering in B.C. there are unfilled positions each year. Thus the true demand is certainly higher than the number taking up employment.

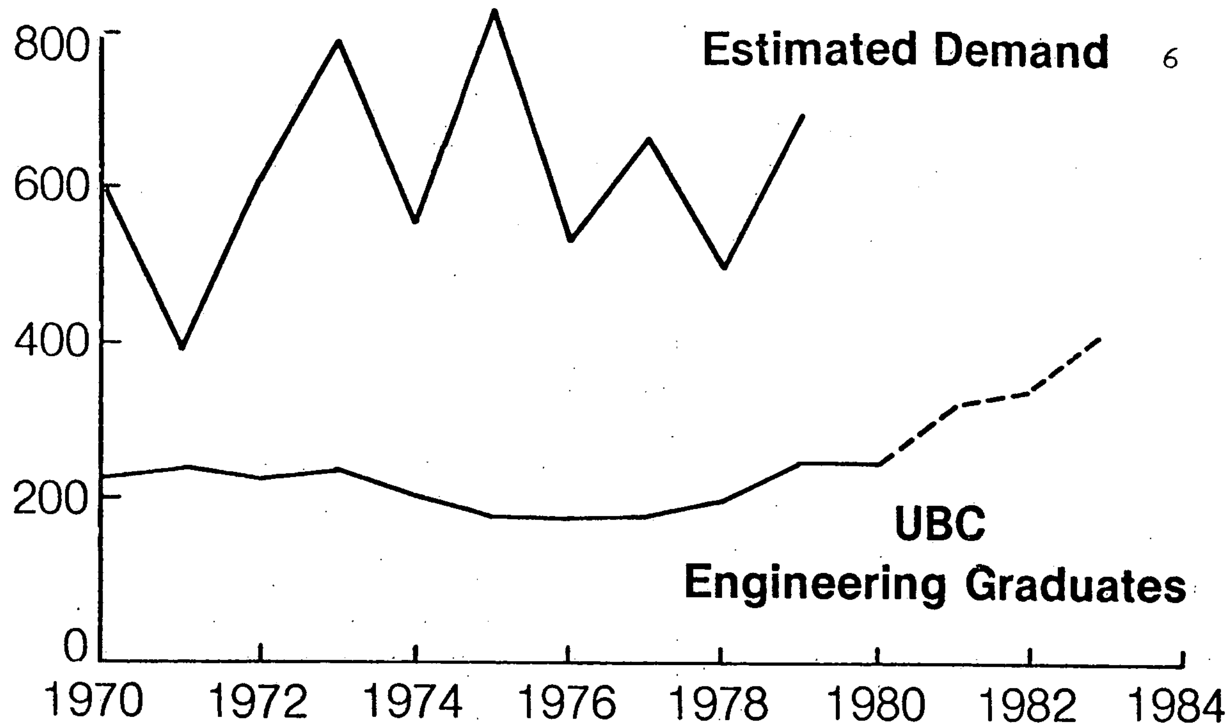


Figure 1. The estimated number of Engineers taking up employment in B.C. compared with the number of UBC Engineering graduates

Conservatively the total shown for 1979 can be assumed as a minimum for the future. There is evidence that the number of engineers employed is related to the gross national product and to the total number in the work force. Both of these are projected to increase in B.C. at rates higher than for Canada as a whole; thus it does not seem unreasonable to project an increase in the demand for engineers in B.C. over the next 10 years. It does not appear feasible for U.B.C. to meet this demand. We understand that the maximum number of graduands possible with existing facilities is about 450/year (for a total enrollment of 2000).

Although the disparity between supply and demand is clear, it is less obvious whether students will enroll in expanded university engineering programs in B.C. Although the U.B.C. enrollment is now approaching their maximum capacity (total enrollment is 1600 in 1980 and maximum capacity is variously estimated as being 1800 and 2000), in recent years it has been well below capacity in spite of an excellent job market. In contrast, in Alberta and Ontario all engineering schools limit their enrollments and turn away qualified applicants (at University of Alberta in September 1980 a total of 500 new students were admitted while 450 qualified applicants were turned away).

The lack of interest in engineering in B.C. can be attributed to a number of factors:

1. The relative unattractiveness of the U.B.C. 5-year program. It is clear that some well qualified students choose to go to the 2-year diploma program at B.C.I.T.
2. The low profile of the engineering profession in providing counselling information to high school students. Specifically, in contrast to B.C., other Associations of Professional Engineers maintain vigorous educational programs with activities such as offering prizes to the best student from each School District who enters a School of Engineering. In the U.K. a vigorous "Schools Liaison Service" is operated jointly by the Institutes of Electrical and Mechanical Engineering.
3. The relative inactivity of the U.B.C. School of Engineering in providing students and counsellors in High Schools with appropriate guidance. This is in direct contrast to the pattern in Ontario.

We believe that an aggressive and forward looking engineering program at Simon Fraser University, which conducted vigorous liaison activities with the high schools, would have no difficulty attracting good students. Many would be attracted by the flexible access provided by the transfer modules designed for students from the colleges and B.C.I.T. In addition, it is known that Engineering faculties traditionally have the lowest enrollment of women of any of the professions. The program at S.F.U. will attempt to attract more women to engineering by hiring women faculty and offering scholarships for women. In this way we hope to interest the 50% of the population, that up to this time, has not found engineering education very attractive.

The Rationale for Establishing a Faculty of Engineering at S.F.U.

Simon Fraser University not only offers an attractive internal and external environment for the development of a second school of engineering, but a strong case can be made that existing programs of the university would benefit from this addition. These points are considered in turn:

1. The External Environment

Simon Fraser University is in an area of major population growth for the province (see Figure 2). Conservative population projections for the next twenty years indicate a rise in population in the lower mainland from its present population of about 1,275,000 to about 1,625,000 in 2001, or an increase of approximately 350,000. This increase represents approximately 40% of the projected population increase for the province. The areas that already have a substantial population and that will experience the largest increases in population will be Richmond, Delta, Surrey, Langley, Maple Ridge, Coquitlam and Burnaby. These areas are within commuting distance to Simon Fraser. In contrast, the increase projected for Greater Victoria is only about 25,000.

In addition, Simon Fraser in located in the center of the major area of industrial development and research in the province (see Figure 3). For example, the MacMillan Bloedel Research Labaoratories are located in Burnaby, and there are definite plans to locate the research laboratories of Microtel Pacific Research, the research arm of B.C. Telephone, in a research park adjacent to the university.

Figure 2

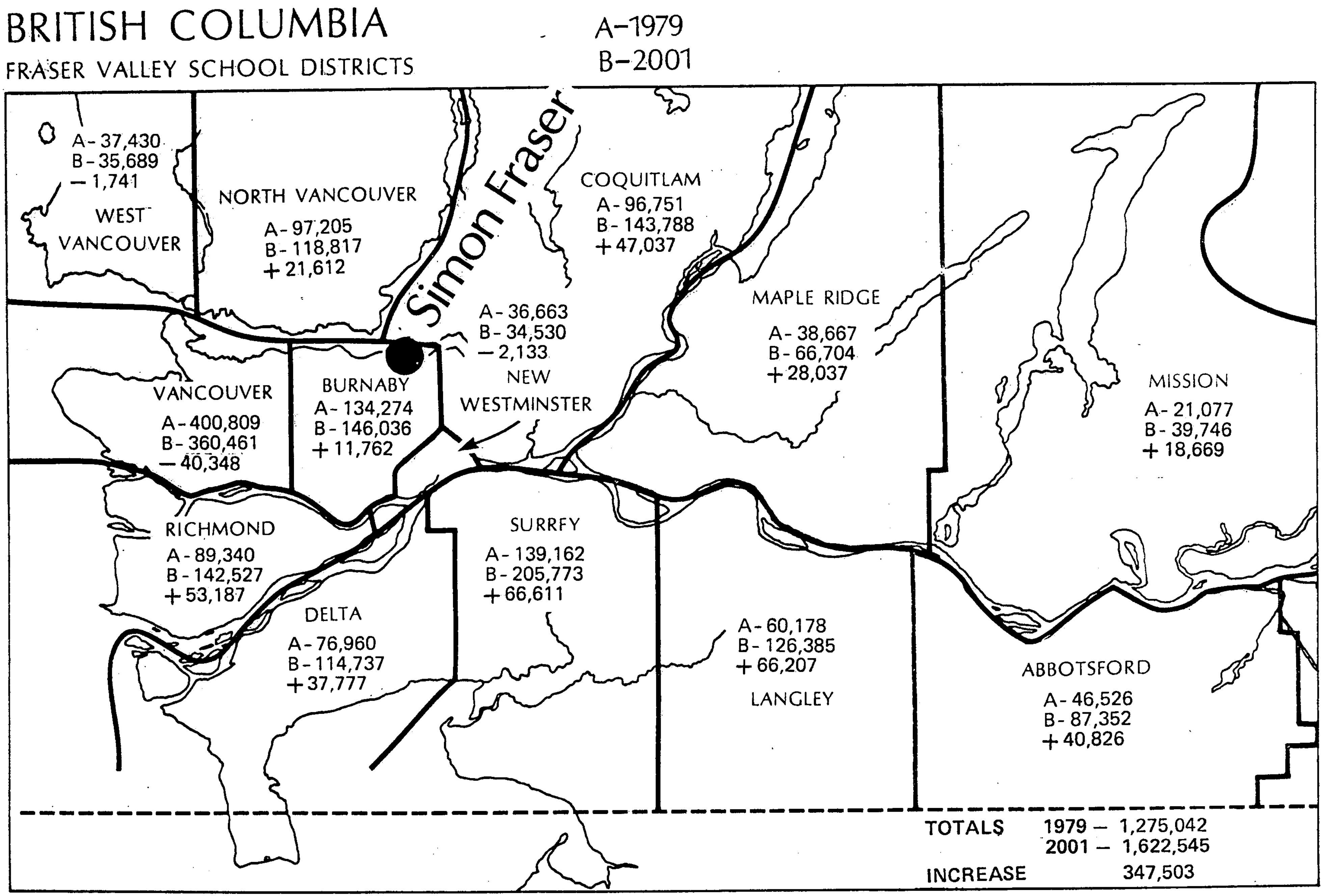
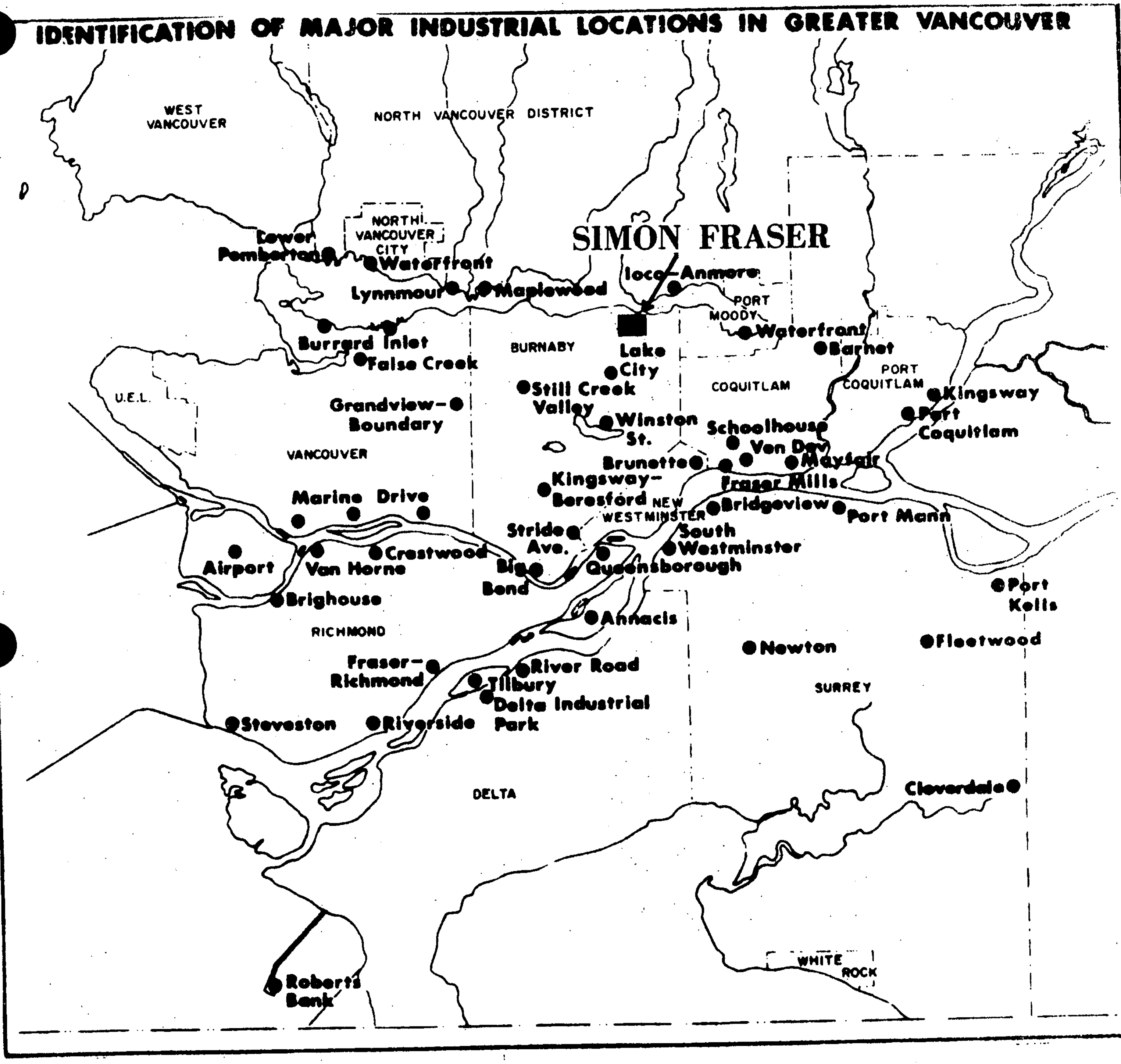

BRITISH COLUMBIA
FRASER VALLEY SCHOOL DISTRICTS
A–1979
B–2001
Simon Fraser
WEST VANCOUVER
A-37,430
B-35,689
–1,741
NORTH VANCOUVER
A-97,205
B-118,817
+21,612
COQUITLAM
A-96,751
B-143,788
+47,037
NEW WESTMINSTER
A-36,663
B-34,530
–2,133
MAPLE RIDGE
A-38,667
B-66,704
+28,037
MISSION
A-21,077
B-39,746
+18,669
VANCOUVER
A-400,809
B-360,461
–40,348
BURNABY
A-134,274
B-146,036
+11,762
RICHMOND
A-89,340
B-142,527
+53,187
DELTA
A-76,960
B-114,737
+37,777
SURRFY
A-139,162
B-205,773
+66,611
LANGLEY
A-60,178
B-126,385
+66,207
ABBOTSFORD
A-46,526
B-87,352
+40,826
TOTALS 1979 – 1,275,042
2001 – 1,622,545
INCREASE 347,503

Figure 3



"Employment forecasts based on a model of the regional economy, indicate an increase of over 50,000 industrial jobs between 1971 and 1986...More than 6,000 gross acres of land will be required to accommodate this industrial growth of over 50,000 jobs...The majority of the land is in the suburban areas of Coquitlam, Richmond, Delta and Surrey."

*Source: Industry and the Livable Region: Guidelines for Industrial Development, published by the Greater Vancouver Regional District, 1978.

2. The Internal Strengths

Simon Fraser has complementary strength in its existing programs that can contribute to the efficient and economical development of a strong engineering program. Several departments (Mathematics, Physics, Computing Science, Kinesiology) have faculty with engineering qualifications who are conducting research and advising graduate students in areas which are normally considered to be engineering, or are closely related to engineering. The specific strengths include:

a. Mathematics has 6 faculty who teach and conduct research in the field of Mechanics. A number of their existing lower division courses can be incorporated directly into the Engineering curriculum (e.g., Statics, Dynamics, Strength of Materials, Fluid Mechanics). Further, the advanced undergraduate and graduate courses in Mechanics provide a rich environment for the more theoretically inclined Engineering student. These courses will be utilized in the Engineering Science major and in the Graduate Program.

b. The Physics Department has a strong solid state orientation. In addition to providing some useful undergraduate courses for the Electrical and Computer Engineering majors, the department has agreed to make its well equipped laboratory facilities available to Electrical and Computer Engineering on an interim basis. The whole undergraduate Physics curriculum is important for the Engineering Science major which emphasizes energy (among other topics). At a research level it is hoped that some Engineering faculty will establish cooperative programs particularly with the newly established Energy Research Institute.

c. Computing Science, since its inception, has given strong emphasis to Computer architecture and hardware. This is now being recognized formally in a proposed Honors Program in Digital Systems Design. This strength in Computing, together with the proposed Electrical Engineering Program will enable an innovative Computer Engineering major to be mounted without additional expense. There are many obvious opportunities for co-operative work in undergraduate course offerings, graduate teaching and research.

d. Kinesiology includes two biomedical engineers on its faculty and for some years has been attracting Engineering students to its graduate program. With the addition of a Faculty of Engineering it will be possible to expand the Biomedical Engineering Graduate Program. Related to the Biomedical Engineering strength is the research group working on environmental physiology. The laboratory facilities include a Hot/Cold Chamber and a Hypo/Hyperbaric Chamber; these facilities together with the faculty and research strength will provide a base for the development of the proposed emphasis on "Engineering in Extreme Environments". There is existing funded research on diving equipment and manipulators for submersibles.

Kinesiology is also expanding its offerings in human factors/ergonomics for a proposed Occupational Health Program. These courses are an important strength for the proposed Industrial Engineering emphasis in Mechanical Engineering.

e. Other Departments. There are a number of other strengths which will be very helpful. Chemistry provides a base for the development of Chemical Engineering and Geography will provide a geology course for Civil Engineers. The Humanities and Social Science Departments are willing to develop innovative courses to provide support to Engineering.

In addition to the specific departmental strengths, the university library already has a substantial collection relevant to Engineering (including serials) and the Computing Centre offers appropriate facilities for at least the initial phases of the Engineering Program.

The Advantages for S.F.U. Establishing a School of Engineering

Engineering education occupies a relatively unique position in Canadian universities - indeed in universities the world over. As a professional school with a large enrollment, its size often exceeds that of traditional arts or science faculties. Law or medicine, in contrast, are small and basically post-baccalaureate. Engineering education encompasses both undergraduate and graduate studies, but the degree accredited for professional registration continues to be the baccalaureate. Graduate degrees - particularly the doctorate - are associated with more advanced theoretical study and with research. The undergraduate engineering curriculum relies heavily on the physical and mathematical sciences, and on at least an equal quantity of Engineering Science. However, the effort and importance placed on design - on the interactive activities of synthesis and analysis - strongly differentiates engineering education from science education.

Another way in which engineering education differs from other undergraduate study is in its breadth. The Canadian Accredidation Board requires at least a half-year's study in humanities, social sciences and administration. Thus engineering students are found in courses in all of the major undergraduate faculties. This is in vivid contrast to the arts, social science and science programs in most universities. The nature of engineering studies and this broad participation in the arts and sciences, together with the characteristic dispersion of engineers into the widest possible range of careers after graduation, have prompted some to claim that Engineering is the only real form of liberal studies in modern universities. Obviously many educators and scholars would dispute that, but engineering programs do provi a unifying and balancing influence within the university. Engineering provides a different intellectual dimension to that found in the pure sciences and humanities at the same time providing programs for students interested in applying their knowledge to practical problems.

Engineering study is available in almost all Canadian universities; excluding the very small institutions only the University of Victoria, Simon Fraser University, York University in Toronto and Dalhousie University in Halifax do not have full engineering programs, and the last situation is different because of proximity to the Technical University of Nova Scotia which houses only Engineering and Architecture. Thus the continued lack of engineering at Simon Fraser would perpetuate an anomolous void which can only partly be filled by quasi-applied programs like Kinesiology and Computing Science.

There are some less abstract benefits for existing departments which will result from the increased enrollment produced by engineering. The engineering curriculum will require at least six courses in (a) the physical sciences, (b) mathematics and (c) the humanities, social sciences and administrative studies. In some cases these additional enrollments will result in proportional increases in expense but in many others, existing resources and course offerings will be more efficiently utilized.

THE PLANNING PROCESS

As a result of a study conducted by an ad-hoc Engineering Committee, in December 1979 Senate gave approval in principle to the development of undergraduate and graduate programs in Engineering at Simon Fraser. The Senate Committee on Academic Planning later approved the formalization of an Engineering Committee comprising T.W. Calvert (Chairman), E. Shoemaker (Mathematics), M. Plischke (Physics), J. D'Auria (Chemistry) and B. Schoner (Business Administration and Economics). Subsequently Dr. T.W. Calvert was appointed Director of Engineering. The Director and the Committee have worked with three Engineering Consultants and an external Planning Advisory Committee in preparing a detailed proposal.

The three consultants, all of whom are former Deans of Engineering at their home institutions are:

Dr. Donald George, P. Eng., Professor of Systems Engineering and Computer Science, Carleton University;

Dr. George Ford, P. Eng., Professor of Mechanical Engineering, University of Alberta;

Dr. D.J.L. Kennedy, P. Eng., Professor of Civil Engineering, University of Windsor.

While all of the consultants have extensive experience and have been involved in heading CAB accreditation teams, it is worth noting that Dr. Ford recently completed a term as Chairman of the Canadian Accreditation Board of the Canadian Council of Professional Engineers.

The external Planning Advisory Committee is chaired by Simon Fraser's Chancellor, Mr. Paul Cote, P. Eng., and has the following membership:

Dr. John Madden, President, Microtel Pacific Research

Mr. T.A. Simons, P. Eng., President, H.A. Simons Ltd.

Mr. J.E. Johnson, P. Eng., Vice-President Operations,
Westcoast Transmission

Mr. C.P. Jones, P. Eng., Jones, Kwong, Kishi

Mr. R. Hunt, P. Eng., Chief Engineer, B.C. Hydro

Mr. R.J. Meyers, President, Dillingham Corporation Canada Ltd.

Dr. J.T. Fyles, P. Eng., Senior Assistant Deputy Minister,
Energy, Mines and Petroleum

Dr. D. Smeaton, President, Anatek Electronics Ltd.

Dr. Gordon Shrum, Pier B.C. Development Board

Mr. K.F. Williams, P. Eng., President, Industrial Engines Ltd.

Mr. R.G. Duthie, P. Eng., President, Placer Development Ltd.

Mr. N.M. Lopianowski, P. Eng., Principal, Cantel Engineering
Associates Ltd.

Mr. E.E. Olson, P. Eng., Municipal Engineer, Burnaby

Mr. J.C. Carlile, P. Eng., President and Chief Executive Officer,
B.C. Telephone

Mr. J.S. Rogers, P. Eng., Vice-President Engineering,
MacMillan Bloedel Ltd.

The Committee met with the internal planning team in June, July, September and November, and a meeting is planned for December 1980.

Having received advice from the external Planning Advisory Committee and working closely with the consultants, the Engineering Committee prepared this proposal.

PRINCIPAL FEATURES OF THE PROPOSED PROGRAMS FOR THE FACULTY OF ENGINEERING

1. A new Faculty of Engineering will be established.
2. The Degrees of Bachelor of Engineering, Master of Engineering, Master of Science in Engineering and Ph.D. will be offered by the Faculty.
3. The B.Eng. Degree will normally be completed in a 8 semester co-op program and will require 160 semester credits (i.e., 20/semester).
4. Admission of undergraduates to the Faculty of Engineering will normally occur at the time of admission to the University. Enrollment will be limited.
5. Admission from High School will require Algebra 12, Physics 12 and Chemistry 12 in addition to other S.F.U. requirements.
6. Admission from College or University Science Programs, from BCIT or from elsewhere will be facilitated by the development of "Conversion Modules" of one or more semesters in length (see Figure 4). These will build on students' strengths to allow them to complete the degree program as expeditiously as possible.
7. Programs are proposed in Chemical, Civil, Computer, Electrical and Mechanical Engineering plus Engineering Science. The curriculum of each program will meet the requirements of the Canadian Accreditation Board. The departments would be Chemical, Civil, Electrical and Mechanical Engineering; Computer Engineering would be based on Electrical Engineering and the existing Computing Science Department and Engineering Science will draw heavily on science courses in addition to those of all Engineering Departments. All programs could be developed simultaneously.

8. Over 50% of the curriculum will be common to all undergraduate programs.
9. Through selection of elec tives, students in each major will be able to emphasize different areas. For example, Civil Engineering will provide options emphasizing either the manufacturing and processing industries or the resource industries, Electrical Engineering will provide three options: Electronics and Communications, Digital Systems and Power Systems. Mechanical Engineering will provide a substantial emphasis on Industrial Engineering and lesser concentrations in Mining, Forest Products, Offshore Engineering and Mechanics. Nevertheless, the most important feature of all of the programs will be the common core courses on systems analysis, industrial engineering and computing which provide the analytic tools required by a practicing engineer in the 1980's.
10. In order to help provide the research environment which is required for any first class undergraduate program, a modest graduate program will be started simultaneously. Initially, M.Sc. degrees with a heavy concentration on research will be offered to selected students. As courses are developed, opportunities will be available for students to give greater emphasis to course work. A professional masters program combining engineering and management courses will be developed when resources permit. The professional degree could be pursued on a part time basis, thus, allowing practicing engineers the opportunity to upgrade their status without taking leave from their job. In addition, special upgrading or "retreading" courses could be offered that will allow practicing engineers to become familiar with new trends and information in engineering. Work to the Ph.D. level will be available by special arrangment as soon as there are suitable faculty supervisors on staff.

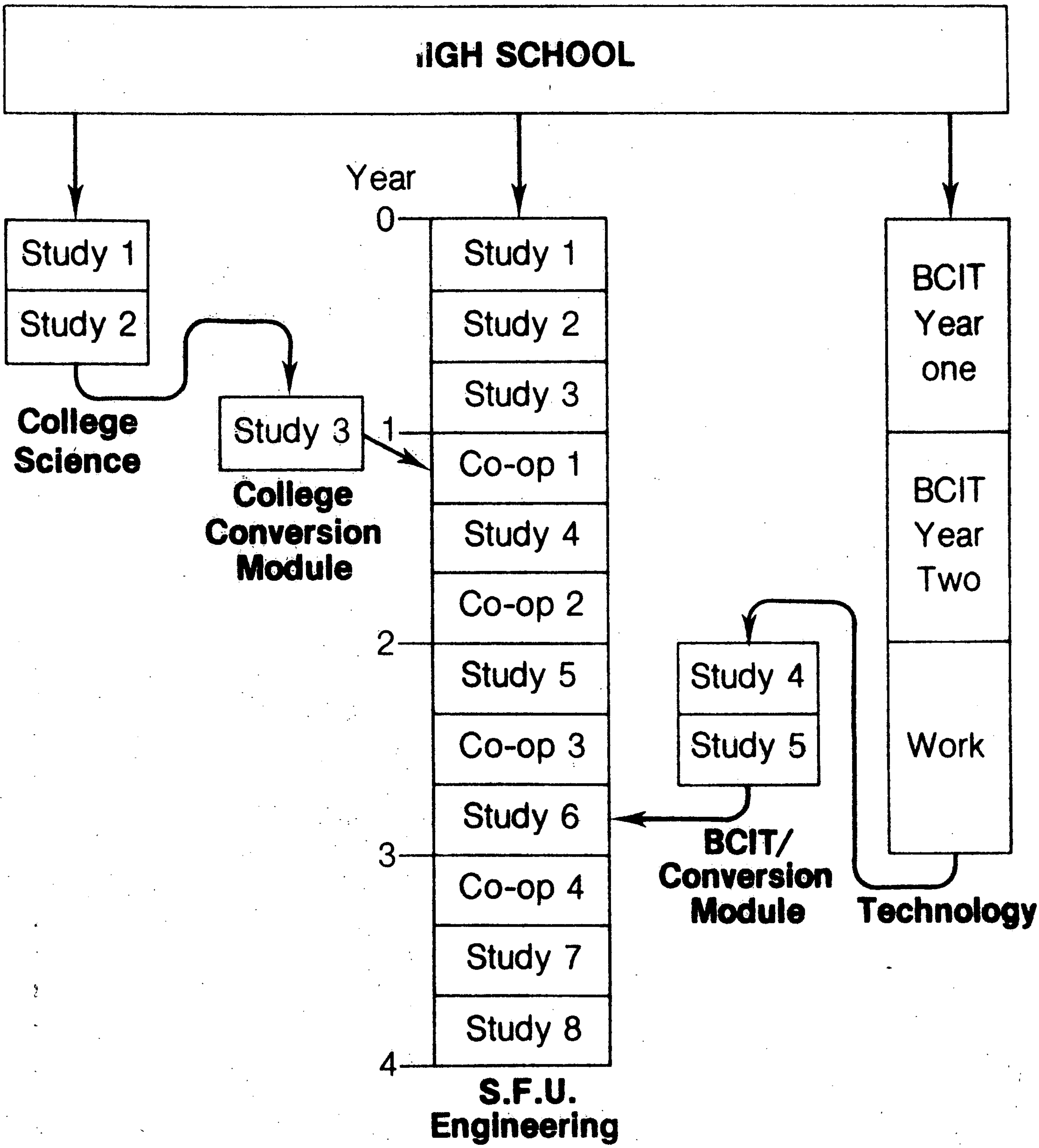
ACCESSIBILITY AND CO-OP

Students entering the Faculty of Engineering directly from High School will normally take the co-op degree program illustrated in Figure 4. This involves 8 study semesters and 4 work semesters spread over 4 calendar years.

Students entering from academic science programs in the colleges or from university science programs will normally get full transfer credit for appropriate courses and will be fed into a special "transfer module" version of the second or third semester as appropriate. These students will normally join the regular program by the 4th semester which is the first co-op work semester.

Students entering with a First Class diploma from an appropriate technology program (BCIT or a college offering technology programs) will receive special consideration. This will involve a special two-semester "transfer module" which includes special mathematics courses. Because of their extensive laboratory and practical experience these students will be given credit for lab courses and will not normally take the co-op program. In this way they will often be able to complete their degrees within two calendar years. Students with unusual backgrounds will receive appropriate special consideration. In order to facilitate entry by students already working, it is anticipated that it will be possible to offer some of the conversion module courses by distance education. In this way students from outside the Lower Mainland will be able to reduce the number of courses they must take on campus.

Figure 4


ıIGH SCHOOL
Year
0
1
2
3
4
Study 1
Study 2
College Science
Study 3
College Conversion Module
Study 1
Study 2
Study 3
Co-op 1
Study 4
Co-op 2
Study 5
Co-op 3
Study 6
Co-op 4
Study 7
Study 8
S.F.U. Engineering
Study 4
Study 5
BCIT/ Conversion Module
BCIT Year one
BCIT Year Two
Work
Technology

Curriculum and Degree Requirements

for the

Faculty of Engineering

Goals for the Engineering Curriculum at Simon Fraser University

Based on advice from members of the Planning Advisory Committee and after a careful study of the engineering needs in the province, the following nine overall goals for an Engineering Program at Simon Fraser University have been identified:

(1) To complement other educational programs in engineering, science and technology and so to contribute to an appropriate spectrum of opportunites in engineering eduction in British Columbia.

(2) To achieve ease of access to this program by students of varied age, education, work experience and social experience.

(3) To provide a rigorous and demanding educational experience requiring that high academic standards be met.

(4) To prepare the student for sound analysis and creative synthesis in the design, construction, operation and management of the productive capability of the province and the country

(5) To develop in the student an appreciation of the economic, business and societal context of engineering work.

(6) To prepare the student for engineering practice in the 1980's and 1990's, paying particular attention to professional skills.

(7) To be highly compatible with the local engineering community and with Simon Fraser University (and integrated into its modes of operation) and so achieve the programs goals at minimal additional cost.

(8) To develop and use methods of instruction appropriate to the educational objectives of the program and the student.

9) To be associated with research, development and consultative activities which combine the talents of local engineering enterprises with those of the faculty and students.

The basic structure of an engineering program is clearly laid out by the Canadian Accreditation Board of the Canadian Council of Professional Engineers.* The proposed program at Simon Fraser University has followed the CAB requirements closely. CAB requirements and the prerequisite requirements of the upper division courses leave little freedom in the selections of engineering courses in the lower levels. The basic subjects of mathematics and physics have been given an appropriate emphasis in the common or core courses in the lower levels. Courses in chemistry and computing science have been made common requirements for all engineering students in this program. In the interests of economy and the integration of engineering with the basic fabric of S.F.U., the first two semesters have been made essentially common for all engineering students and courses have been chosen from the S.F.U. calendar, where possible, that meet the engineering course requirements.

The remaining science requirements could be met by more courses taken in common by all engineering students covering aspects of physics, chemistry and perhaps geology or biology. However in face of the expanding frontiers

*Appendix A

of knowledge in all engineering disciplines, we have opted for science courses relevant to the student's intended engineering specialization with a minimum of 12 semester hours in relevant sciences included in the core of engineering specialization.

In some universities the programs also provide for a compulsory broad base in engineering science which sees mechanical engineering students taking a number of introductory electrical engineering courses and so on. Following the theme of relevance to the discipline, engineering science courses have been chosen that have a clear relationship to the chosen branch of engineering (i.e., civil, electrical, etc.).

The society and environment core relates as much to attitude as it does to knowledge. This element of the program is called for by the fifth goal and its extent is dictated by CAB. In all, 18 semester hours are involved. While students are free to design their own programs (subject to Faculty approval), an example is provided in which 12 hours are specified in economics, business and technological impact (following the fifth goal) and the remaining 6 hours are left elective to allow the students some freedom to pursue particular interests.

Thus far we have dealt primarily with knowledge and not at all with skills. Much skill development takes place in the laboratories and assignments associated with the regular science and engineering courses but not necessarily enough. Survey after survey has clearly revealed that engineering graduates and their employers place certain skills in position of highest priority. The needs are well known: how to:

(1) learn and study;

(2) access information;

(3) identify and solve problems;

(4) manage time, money, mc rial and people;

(5) think visually and conceptually using mathematics, numbers, diagrams and graphs;

(6) conduct tests, trials, and experiments;

(7) arrive at decisions;

(8) communicate.

Invariably, in all surveys, the question of how to communicate has been the greatest concern. An explicit effort in skill development is a major objective of the core of general engineering. Just what is intended will be discussed in greater detail in a later section.

This group of courses also serves another objective. It is becoming evident that a "systems approach" characterizes the good engineering practitioner, and that this is increasingly significant in engineering education as the "science" orientation of the last two decades fades. Some of the courses provide analytical tools for systems and economic analysis while others consider the more qualitative areas of engineering design and management.

The resulting program is one-half common (80 semester hours) with the remaining 50% of the student's effort directed to specialized study in civil, electrical, mechanical, computer or chemical engineering or engineering science. Common elements of the curriculum are distributed throughout the program with only the eighth semester having no common courses. Some of the common course requirements are met through elective courses, so the engineering students will not take all classes together. Even the first year, while basically the same for all students, contains electives which can relate to the student's intended field of specialization.

Laboratories and Projects

The style of a curriculum or the way it is run, does much to attain a program's educational goals. An identified goal in the S.F.U. program is ease of access which implies flexibility in scheduling and in admission. Our proposal for laboratory operation also relates to the goal of how to arrive at decisions.

Laboratories are not locked to specific courses but have course numbers and credits of their own. Each student in every semester of laboratory registration will arrange and have approved a schedule of particular laboratory projects which will define his laboratory requirement and complement the lecture and project portions of his program. To accommodate the personal schedules of students, the laboratories will remain open from eight in the morning until midnight, seven days a week. As at the University of Exeter, textual and audio-visual materials will be developed so that very little laboratory instruction will be needed except for equipment failure and related difficulties, and some tutorial help. This will reduce the need for laboratory staff to the minimum required for safety and security and allow the extended laboratory hours proposed. Clearly the physical design of the laboratories must accommodate this approach, presumably centralized within the engineering building. Where possible, "take-home labs" of the type developed in a number of institutions would be utilized.

Objectives for student learning in an engineering laboratory are extensive and include reinforcing or supplementing classroom learning, learning how to use equipment and simulators, learning how to conduct scientific experiments, experiencing engineering research and development, practicing engineering design,)osure to "real-world" situations, and practicing communication skills.

Options for types of laboratories range from set experiments with detailed instructions, through "design to a specification and test" projects, to open-ended research and development projects. While students must begin with the first type of laboratory exercises, these should be minimized in favour of those calling for design and innovation. Our bias is also towards learning to use equipment through need rather than experiments designed for that purpose--after all, that is itself a skill worth developing. In all, the options are varied and the objectives of each laboratory project should be carefully thought out.

In conjunction with laboratory work the student will build up a portfolio of engineering reports to be assessed as part of ENGG 100-6 (Engineering Communications), as will be described in greater detail later. This course is designed to satisfy the eighth objective for skill acquisition much more effectively than is usual.

Projects have objectives similar to laboratories but are much more extensive in scope and call for greater planning, organization and attention to the design process. It is common to have a major project as part of the final year of engineering programs, and the explicit preparation of students for the management of their project is a significant aspect of this program.

This preparation has several elements. In the first part of upper division studies, the students have two required courses ENGG 301-3, "Engineering Design", and ENGG 302-3, "Engineering Management". Approximately one-half of ENGG 301 is devoted to a design project, perhaps with competing design teams, and the other half to the formal study of the process of engineering design. ENGG 302 will be modularized and look at various aspects of engineering management from personnel to the scheduling of finances. An important component of this course will be the choice of the engineering project to be undertaken and the preparation of a management proposal for the project. During the project itself, as the curriculum specifies, part of the project registration will be assigned to ENGG 401-1. This explicitly designates part of the project credit to the execution of the management plan, an oral progress report and the final project report. The remaining credit will be based on the technical content and execution of the project.

The objective of these innovations in the operation of the program's laboratories and projects is to prepare the student for creative engineering design and to develop professional skills. Instructional methods are used in a manner which provides for greater flexibility in the student's schedule.

Core Course Objectives

The proposed engineering curriculum can be divided into four basic cores or course groupings as shown on pages 35-36. The role of the basics of the mathematical, physical and computing sciences needs no further elaboration, and the role of the specialized courses in the various engineering disciplines is common to all curricula. The objectives of the courses grouped under Society and Environment and General Engineering do, however, call for some further explanation.

A) Society and Environment

Students are required to elect a minimum of 5 courses chosen from the humanities and social sciences. To ensure that these form a cohesive pattern the courses must receive approval of a faculty advisor. To illustrate the intent of this component of the curriculum a sample program is set out below as an example.

1) ECON 101-3, The Canadian Economy. The intended role of this course is to acquaint the student with the general economic environment in which he will practice his profession.

2) BUS 103-3, Business in Society. While engineering can be regarded as an abstract scientific enterprise, one of the goals of this program is to orient the student towards the economic and business context. Hence the inclusion of this course.

3) One course which deals, at least in part, with interactions between technology and society. Examples at S.F.U. of such courses include S.A. 202-4, Modern Industrial Society, CMNS 230-3, Introduction to Communication Media, CMPT 260-3, Social Implications of a Computerized Society, and G.S. 227-3, On the Seriousness of the Future. The objective of the inclusion of such a course in the curriculum is to ensure that the prospective engineer is aware of the relationships between technological development and society which pose moral, social and political dilemmas.

4) Two additional electives allow the student to further explore the humanities and social sciences. The student is required to select these to make a cohesive pattern of related studies.

B) <u>General Engineering</u>

1) ENGG 100-6, Engineering Communication, is aimed at developing proficiency in communication skills. These skills include graphical and diagrammatic communication and spatial visualization which are part of the rationale for the conventional freshman drafting course. However, we do not

propose traditional courses in technical writing and drafting. Rather, the objective is a mastery-learning situation in which the student's exercises or projects relate to his other work in the program. Thus a laboratory report or an oral project report can be submitted towards the requirements of ENGG 100-6. No formal time is scheduled but a series of workshops, tutorials, mini-courses and the like are maintained along with a resource centre. Detailed course specifications will depend on the student's program in that, for example, the mechanical and electrical degree requirements would differ. The essential features of the course are that all elements of engineering communication are involved, it operates continuously through the four years of the program, and the student is evaluated on a mastery basis so that all graduates have adequate communications skills.

2) ENGG 240-3, Industrial Engineering I, is the first of two courses dealing with basic methods of operations research such as static optimization and critical path scheduling which underly rational, analytic decion making. Such fundamentals are critical in the preparation of the student for practice in the 1980's and 1990's.

3) ENGG 241-3, Industrial Engineering II, is similar to ENGG 240-3 in its objectives, but introduces uncertainty and hence stochastic methods.

4) ENGG 341-3, Systems Dynamics, aims to make the student aware of the dynamical nature of all systems and structures, and to provide the basic tools for linear systems analysis.

5) ENGG 301-3, Engneering Design, is included in the program to give the upper division student an overview of the basic process of engineering design problem solving. Case studies could be utilized, and a team project will account for about one-half the course.

6) ENGG 302-3, Engineerinn Management, aims to acquaint the student with the management side of pro ssional practice and with related legal and ethical considerations. Part of the course credit wll be assigned to the preparation of a management proposal for the student's Engineering Project.

7) ENGG 299-3, Engineering Economics*, is a requirement of CAB and is included to provide the student with the basics of practical economic analysis applicable to engineering endeavours.

At this point, the basic nature of the program is apparent. It has a strong professional orientation with a core in general engineering emphasizing communications skills, systems and economic analysis, and the design and management processes. Basic sciences and mathematics are present in the usual proportion as are broadening studies outside engineering. This accounts for 80 semester hours, or 50% of the curriculum. In the next section we describe the programs in civil, electrical, mechanical, chemical and computer engineering, and engineering science which constitute the remaining 50% of the curriculum.

* The Department of Economics will develop this course, and it will be given an ECON number.

FACULTY OF ENGINEERING

ADMISSION

Students seeking to enter a degree program in Engineering will normally apply for admission to the Faculty at the same time as admission to the University. Admission to the Faculty requires that Physics 12, Chemistry 12 and Algebra 12 (or equivalent) with a grade of not less than C+ be included in the subjects offered when applying for admission to the University. This is a limited enrollment program and when the number of qualified applicants exceeds the places available, the Admissions Committee will select those candidates considered to be best qualified.

Admission to the Faculty normally takes place in the Fall Semester. Students with credit for courses transferrable to the Engineering programs may apply for admission at any time and, if admitted, will be advised on an appropriate "transfer module" program of one or two semesters duration.

DEGREE REQUIREMENTS

The Bachelor of Engineering (B.Eng.) degree is offered with major programs in Chemical, Civil, Computer, Electrical and Mechanical Engineering and Engineering Science. The B.Eng. (Co-op) is available for students who enter the co-operative program.

The degree requirements common to all majors are:

1.	Core I	-	General Engineering	25 credit hours
2.	Core II	-	The Basics	40 credit hours
3.	Core III	-	Society and Environment	15 credit hours
			Total	80 credit hours.

Each major program specifies an additional 80 credit hours of Core IV - specialization, to give a total requirement of 160 credit hours for the degree.

Graduation requires a minimum CGPA of 2.0 and no Engineering course may be taken unless the prerequisite courses (if any) have been completed with a grade of C- or better.

CO-OPERATIVE PROGRAM

Full time students who enter the Faculty without substantial practical experience are normally expected to enroll in the co-operative education program. This requires that students participate in 4 work semesters as identified in Figure 4. Attention is drawn to the Co-operative Education section of the Calendar.

During Co-op work semesters students register sequentially for the following courses: ENGG 290-0, ENGG 390-0, ENGG 391-0, ENGG 490-0.

ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (CO-REQUISITES)
	Core 1 - General Engineering		
ENGG 100-6	Engineering Communications	6	
ENGG 240-3	Industrial Engineering I	3	MATH 152
ENGG 241-3	Industrial Engineering II	3	MATH 272
ENGG 299-3*	Engineering Economics	3	
ENGG 301-3	Engineering Design	3	(Upper Division Standing)
ENGG 302-3	Engineering Management	3	(Upper Division Standing)
ENGG 341-3	Systems Dynamics	3	MATH 252, 310
ENGG 401-1	Engineering Project A	1	(Semester 7)
	TOTAL	25	
	Core II - The Basics		
MATH 151-3	Calculus I	3	
MATH 152-3	Calculus II	3	MATH 151
MATH 232-3	Elementary Linear Algebra	3	MATH 151
MATH 251-3	Calculus III	3	MATH 152
MATH 272-3	Introduction to Probability & Statistics	3	MATH 152
MATH 310-3	Introduction to Ordinary Differential Equations	3	MATH 152
CHEM 104-3	General Chemistry I	3	(MATH 151, CHEM 115)
CHEM 105-3	General Chemistry II	3	CHEM 104, PHYS 120
CHEM 115-2	General Chemistry Laboratory	2	(CHEM 104)
PHYS 120-3	Physics I	3	(MATH 151)
PHYS 121-3	Physics II	3	PHYS 120 (MATH 152)
PHYS 131-2	General Physics Laboratory	2	(PHYS 121)
CMPT 103-3	Introduction to a High Level Programming Language I	3	
CMPT 105-3	Fundamental Concepts of Computing	3	CMPT 103
	TOTAL	40	

*To be developed by the Department of Economics with an ECON number.

ENGINEERING PROGRAM REQUIREMENTS - continued

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (CO-REQUISITES)

Core III - Society and Environment

Students must receive Faculty approval for a pattern of electives totalling at least 15 credit hours. Courses must be chosen from the Humanities and Social Sciences and must not include any courses which are basically technical or mathematical.

Core IV - Specialization

Basic physical, geological, biological, mathematical and engineering sciences	12	Note; nominal credits, total must equal 58 or more
Engineering & Science (Courses)	46	
Engineering & Science (Laboratories and Projects)	22	
TOTAL	80	
GRAND TOTAL	160	

ELECTIVE LIST: SCIENCE

GEOG 112-3	Introductory Geology (Note: A required course in CIVE, prerequisite to CIVE 331-3)
BISC 101-4	Introduction to Biology
BISC 102-4	Introduction to Biology
KIN 100-3	Introduction to Human Structures and Function
ENME 262-4	Engineering Mechanics I (Statics) (Note: a required course in Civil, Mechanical and Chemical Engineering and Engineering Science; prerequisite to ENME 263-4)

Other courses of a scientific, engineering and analytical nature as may be approved.

ELECTIVE LIST: SOCIETY AND ENVIRONMENT

Students must receive Faculty approval for a pattern of electives totalling at least 15 credit hours. Courses must be chosen from the Humanities and Social Sciences and must not include any courses which are basically technical or mathematical. An example of a suggested pattern is set out below:

1) BUS 103-3, Business in Society
2) ECON 101-3, The Canadian Economy
3) A course dealing, at least in part, with the interaction between technology and society (e.g., CMPT 260-3, Social Implications of a Computerized Society)
4) Two other electives which form a sequence.

Civil Engineering

The modern civil engineer is responsible for the planning, design and construction of a broad spectrum of works which enhance the living conditions, economic circumstances and environment of mankind. To carry out these works economically, expeditiously and in harmony with the complete environment requires an education which is soundly based in the fundamentals of the sciences, mathematics, and societal context courses. This must be combined with a professional program, which includes engineering science, design and synthesis, and gives the student the capability to develop and manage complex systems.

The curriculum for the Civil Engineering Program at Simon Fraser University provides the firm basis of science and mathematics on which the technologically based engineering courses are developed. A large portion of the program is common to other engineering programs providing the student with a broad engineering background, yet the options in the fourth year provide the opportunity for selectivity. In the S.F.U. program, familiarity with the computer is developed at an early stage and its mastery comes with application to many aspects of analysis and design. The emphasis on design culminates in the fourth year when the student synthesizes his knowledge to carry out a major design project.

In addition to courses in economics the student is presented with courses to develop business and managerial skills. The civil engineering program emphasises the development of resources that are appropriate for the Province of British Columbia. Students who graduate from this program will have a technological base tied to business management which will allow them to participate professionally in the design and construction of such works as highways, railways, airports, marine structures, buildings, and bridges using the traditional engineering materials of timber, steel and concrete but with the basic understanding to develop new ideas, concepts and forms. The elective courses allow the student to orient himself to either the manufacturing and processing industries or the resource extraction industries.

CIVIL ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (COREQUISITES)
	Core IV - Civil Engineering		
CIVE 211-1	Civil Engineering Laboratory A	1	(Semester 3)
CIVE 212-2	Civil Engineering Laboratory B	2	(Semester 4)
CIVE 220-4	Structural Analysis I	4	MATH 265
CIVE 271-2	Surveying	2	MATH 152
CIVE 311-2	Civil Engineering Laboratory C	2	(semester 5)
CIVE 312-2	Civil Engineering Laboratory D	2	(Semester 6)
CIVE 320-3	Structural Design in Steel and Timber	3	CIVE 220
CIVE 321-3	Reinforced Concrete	3	MATH 265
CIVE 331-3	Soil Mechanics	3	MATH 265, GEOG 112
CIVE 340-3	Hydraulics	3	MATH 362
CIVE 350-3	Transportation Engineering	3	
CIVE 401-2	Engineering Project A	2	(ENG 401-1)
CIVE 402-3	Engineering Project B	3	(Semester 7)
CIVE 411-4	Civil Engineering Laboratory E	4	(Semester 7)
CIVE 412-4	Civil Engineering Laboratory F	4	(Semester 8)
CIVE 420-3	Intermediate Structural Analysis & Design	3	CIVE 331
CIVE 430-3	Soil Engineering	3	CIVE 331
*ENME 262-4	Engineering Mechanics I (Statics)	4	MATH 152, PHYS 120 (15[illegible]
*ENME 263-4	Engineering Mechanics II (Dynamics)	4	MATH 262, 251 or (253)
or			
PHYS 211-3	Intermediate Mechanics Engineering		PHYS 121, (MATH 251)
& PHYS 212-1	Engineering Problems in Dynamics		(PHYS 211)
*ENME 265-4	Engineering Mechanics III (Strength of Materials)	3	MATH 262, 152
*ENME 362-3	Fluid Mechanics I	3	MATH 262, (MATH 314)
MATH 314-3	Boundary Value Problems	3	MATH 252, 310
GEOG 112-3	Introductory Geology	3	
	Engineering & Science Electives	12	
	Total	80	

* Note that ENME 262, 263, 265 and 362 are existing Engineering Mechanics courses offered by the Department of Mathematics with the MATH designation. When the Engineering programs are implemented it will be recommended that the designation of these courses be changed from MATH to ENME to identify them as Engineering Mechanics courses.

ELECTIVE LIST: CIVIL ENGINEERING

COURSE NUMBER	COURSE NAME	OPTION* 1	OPTION* 2	PREREQUISITES (COREQUISITES)
CIVE 421-3	Advanced Structural Analysis & Design	R		CIVE 420
CIVE 423-3	Highway Engineering	R	R	CIVE 331
CIVE 431-3	Geotechnical Design		R	CIVE 430
CIVE 432-3	Rock Mechanics		R	CIVE 331
CIVE 440-3	Hydrology		R	CIVE 340
MECE 230-3	Engineering Materials	R	R	CHEM 105
MECE 410-3	Vibrations and Acoustics	R		MATH 310, 314
MECE 423-3	Heating, Ventilating & Air Conditioning	R		
KIN 480-3	Human Factors in the Working Environment	R	R	
ENGG 420-3	Forest Operations		R	
ENGG 430-3	Engineering in Extreme Environments	R	R	
ENGG 440-3	Mining Methods		R	
ENGG 450-3	Petroleum Extraction		R	
PHYS 344-3	Thermal Physics	R	R	PHYS 121 MATH 251

Plus those on the science elective list and others from engineering and science as approved.

*Recommended courses denoted R; Option 1 lists courses oriented towards Civil Engineering in the manufacturing and processing industries while Option 2 stresses resource extraction.

RECOMMENDED FULL-TIME CIVIL ENGINEERING PROGRAM

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	CONTACT HOURS	PREREQUISITES (CO-REQUISITES)
Semester 1 - All Engineering Students				
*MATH 151-3	Calculus I	3	3-1-0	
*MATH 232-3	Elementary Linear Algebra	3	3-1-0	(MATH 151)
*PHYS 120-3	Physics I	3	3-1-0	(MATH 151)
*CHEM 104-3	General Chemistry I	3	3-1-0	(MATH 151, CHEM 115)
*CHEM 115-2	General Chemistry Laboratory	2	0-0-4	(CHEM 104)
*	Elective I (Society and Environment)	3	2-1-0	
		17	23	
Semester 2 - All Engineering Students				
*MATH 152-3	Calculus II	3	3-1-0	MATH 151
ENME 262-4	Engineering Mechanics I (Statics)	4	3-1-0	(MATH 152), PHYS 120
*PHYS 121-3	Physics II	3	3-1-0	PHYS 120, (MATH 152)
*PHYS 131-2	General Physics Laboratory	2	0-0-3	(PHYS 121)
*CMPT 103-3	Introduction to High Level Programming Language I	3	1-0-5	
*	Elective II (Society and Environment)	3	2-1-0	
		18	24	

NOTE: * Denotes a core course.

Semester 3 - Civil Engineering

*MATH 251-3	Calculus III	3	3-1-0	MATH 152
ENME 263-4	Engineering Mechanics II (Dynamics)	4	3-2-0	MATH 262 (MATH 251)
or				
PHYS 211-3	Intermediate Mechanics		3-1-0	MATH 251
and PHYS 212-1	Engineering Problems in Dynamics		0-2-0	(PHYS 211)
ENME 265-4	Engineering Mechanics III (Strength of Materials)	4	3-1-0	MATH 262, 152
*MATH 272-3	Probability and Statistics	3	3-1-0	MATH 152
CIVE 211-1	Civil Engineering Laboratory A	1	0-0-2	(Semester 3. Civil Engineering)
CIVE 271-2	Surveying	2	1-0-3	MATH 152
*ENGG 240-3	Industrial Engineering I	3	3-0-0	MATH 152
		20	26	

Semester 4 - Civil Engineering

*MATH 310-3	Introduction to Ordinary Differential Equations	3	3-1-0	MATH 152
*ENGG 241-3	Industrial Engineering II	3	3-0-0	MATH 272, ENGG 240
*ENGG 299-3	Engineering Economics	3	3-0-0	
*CMPT 105-3	Fundamental Concepts of Computing	3	3-1-0	CMPT 103
CIVE 212-2	Civil Engineering Laboratory B	2	0-0-4	
CIVE 220-4	Structural Analysis	4	3-1-0	MATH 265
*CHEM 105-3	General Chemistry II	3	3-1-0	CHEM 104, PHYS 120
		21	25	

Semester 5 - Civil Engineering

*ENGG 301-3	Engineering Desig	3	3-0-0	(Upper Division Standing)
MATH 314-3	Boundary Value Problems	3	3-1-0	MATH 252, 310
ENME 362-3	Fluid Mechanics I	3	2-1-0	MATH 262, (314)
GEOG 112-3	Introductory Geology	3	3-0-0	
CIVE 311-2	Civil Engineering Laboratory C	2	0-0-4	(Semester 5, Civil Engineering)
CIVE 320-3	Structural Design in Steel and Timber	3	3-0-0	CIVE 220
	Elective III (Society and Environment)	3	2-1-0	
		20	23	

Semester 6 - Civil Engineering

*ENGG 302-3	Engineering Management	3	3-0-0	(Upper Division Standing)
CIVE 312-2	Civil Engineering Laboratory D	2	0-0-4	(Semester 6, Civil Engineering)
CIVE 321-3	Reinforced Concrete	3	3-0-0	MATH 265
CIVE 331-3	Soil Mechanics	3	3-0-0	MATH 265, GEOG 112
CIVE 340-3	Hydraulics	3	3-0-0	MECE 350
CIVE 350-3	Transportation Engineering	3	3-0-0	
	Elective IV (Society and Environment)	3	2-1-0	
		20	23	

Semester 7 - Civil Engineering

*ENGG 341-3	Systems Dynamics	3	3-0-0	MATH 252, 310
*ENGG 401-1	Engineering Project A	1	0-0-2	(Semester 7, Civil Engineering)
CIVE 401-2	Engineering Project A	2	0-0-4	(ENGG 401-1)
CIVE 411-4	Civil Engineering Laboratory E	4	0-0-8	(Semester 7 Civil Engineering)
CIVE 420-3	Intermediate Structural Analysis and Design	3	3-0-0	ENGG 230
CIVE 430-3	Soil Engineering	3	3-0-0	CIVE 331
	Civil Engineering Elective I	3	3-0-0	
		19	26	

Semester 8 - Civil Engineering

CIVE 402-3	Engineering Project B	3	0-0-6	CIVE 401-2
	Civil Engineering Elective II	3	3-0-0	
	Civil Engineering Elective III	3	3-0-0	
	Civil Engineering Elective IV	3	3-0-0	
CIVE 412-4	Civil Engineering Laboratory F	4	0-0-8	(Semester 8, Civil Engineering)
	Elective V (Society and Environment)	3	2-1-0	
	Total	19	26	

TOTAL CREDITS (including *ENGG 100-6) 160

Electrical Engineering

The proposed curriculum supports specialization in three streams within electrical engineering: electronics and communications, electrical power systems, and digital systems. A minimal but quite sufficient array of courses is suggested to sustain those three streams. More can be added as student numbers grow.

The "high technology" area of electronics and communications has been mentioned often as an area of concentration for the S.F.U. engineering program. Given that orientation, which assumes significant studies in computing and computer systems, and the existing capabilities of the S.F.U. Department of Computing Science, it is but a small step to include a digital systems stream which provides for greater emphasis on computing hardware and software.

Energy is another sphere of engineering activity of great importance in British Columbia. This strongly suggests that power engineering be a further option in electrical engineering. The orientation of the proposed program is towards electrical power systems which shares a broad common basis with the two other "systems" streams within the electrical engineering program. Distributing, controlling and managing electric power is yet another engineering activity in which the role of the computer as a systems component is steadily increasing, and so the computer emphasis of the program is most appropriate.

As the listing of courses by semester shows, much of the curriculum is compulsory in order to give the student a solid background in the fundamental engineering sciences dealing with electromagnetic fields, electric power generation, circuits and electronics, and communications and control. In addition, the program stresses the ever growing role of the computer by expanding on the computer courses in the common portion of the engineering program. Seven courses plus the selected Engineering Project topic provide for yet greater specialization in one of the three streams.

The sequencing of courses is critical because of prerequisite requirements and the eight semester constraint for full-time students. The balance between required and recommended courses is about equal, but this depends on the option chosen. Specialized studies start in semester four.

A detailed study of the prerequisite structure shows that some pairs of courses (ELEC 432 and 435, ELEC 421 and 464) can be taken in either semester six, seven or eight. Hence during the initial years of the program these could be given in alternate years.

By virtue of its tight construction, and utilization of existing S.F.U. courses and other engineering courses, only 18 courses in electrical engineering are required. (This takes into account the two course saving just noted.) Yet both depth and a good range of options are available.

ELECTRICAL ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (COREQUISITES)
	Core IV - Electrical Engineering		
ELEC 211-2	Electrical Engineering Laboratory A	2	(ELEC 250)
ELEC 212-2	Electrical Engineering Laboratory B	2	(Semester 4)
ELEC 221-3	Analog and Digital Electronics	3	PHYS 121, MATH 152
ELEC 250-3	Basic Electrical Engineering	3	PHYS 121, 131, MATH 251
ELEC 260-3	Micro-processor Systems	3	ELEC 221, CMPT 103, 105, computing experience
ELEC 311-3	Electrical Engineering Laboratory C	3	(Semester 5)
ELEC 312-3	Electrical Engineering Laboratory D	3	(Semester 6)
ELEC 322-3	Electronics Design I	3	ELEC 221, 211
ELEC 342-3	Control Systems	3	ENGG 341
ELEC 371-3	Digital Systems	3	ELEC 260 (ELEC 342)
ELEC 401-2	Electrical Engineering Project A	2	ENGG 401
ELEC 402-3	Electrical Engineering Project B	3	ELEC 401
ELEC 411-4	Electrical Engineering Laboratory E	4	(Semester 7)
ELEC 412-4	Electrical Engineering Laboratory F	4	(Semester 8)
ELEC 441-3	Communication Systems	3	ENGG 341, MATH 272
PHYS 221-3	Intermediate Electricity and Magnetism	3	PHYS 121 (MATH 251, 252)
PHYS 425-3	Electromagnetic Theory	3	
MATH 252-3	Vector Calculus I	3	MATH 251
	Nine Electives (Engineering and Science	27	
		80	

ELECTIVE LIST: ELECTRICAL ENGINEERING

COURSE NUMBER	COURSE NAME	OPTION* 1	OPTION* 2	OPTION* 3	PREREQUISITES (COREQUISITES)
ELEC 222-3	Electronics Design I	C	C	C	ELEC 221, 211
ELEC 332-3	Electrical Power Generation and Distribution			C	ELEC 250
ELEC 421-3	Electronics Design II	C	E		ELEC 322
ELEC 425-3	Electronic System Design	C	E		ELEC 322
ELEC 432-3	Power Systems			C	ELEC 231, 332
ELEC 435-3	High Voltage Engineering			C	ELEC 332
ELEC 443-3	Data Communications	C	E		ELEC 441
ELEC 464-3	High Frequency Electronics	C			ELEC 322, PHYS 425
MATH 401-3	Switching Theory & Logical Design	E	C	E	ELEC 221
CMPT 201-4	Data & Program Organization	E	C	E	CMPT 105, 118 or computing experience
CMPT 205-3	Introduction to Formal Topics in Computing Science	E			CMPT 105
CMPT 301-3	System Development Methodology	E			CMPT 201
CMPT 393-4	Systems Software for Mini-computers & Microcomputers	E	C	E	CMPT 201, ELEC 221
CMPT 400-3	Hardware-Software Architecture I		E		CMPT 201, 205, ELEC 221
CMPT 401-3	Hardware-Software Architecture II		E		CMPT 401

Plus those on science elective list and others from engineering and science as approved.

* Option 1 - Electronics and Communications
Option 2 - Digital Systems
Option 3 - Power Systems

C = Compulsory course
E = Recommended elective

RECOMMENDED FULL-TIME ELECTRICAL ENGINEERING PROGRAM

COURSE NUMBER	COURSE NAME	CREDIT	CONTACT HOURS	PREREQUISITE (CO-REQUISITE)
Semester 1 - All Engineering Students				
*MATH 151-3	Calculus I	3	3-1-0	
*MATH 232-3	Elementary Linear Algebra	3	3-1-0	(MATH 151)
*PHYS 120-3	Physics I		3-1-0	(MATH 151)
*CHEM 104-3	General Chemistry I	3	3-1-0	(MATH 151, CHEM 115)
*CHEM 115-2	General Chemistry Laboratory	2	0-0-4	(CHEM 104)
	Elective I (Society and Environment)	3	2-1-0	
		17	23	
Semester 2 - All Engineering Students				
*MATH 152-3	Calculus II	3	3-1-0	MATH 151
*PHYS 121-3	Physics II	3	3-1-0	PHYS. 120 (MATH 152)
*PHYS 131-2	General Physics Laboratory	2	0-0-3	(PHYS 121)
*CMPT 103-3	Introduction to High Level Programming Language I	3	1-0-5	
	Elective II (Society and Environment)	3	2-1-0	
*	Elective (science)	3	3-1-0	
		17	24	

NOTE: * Denotes a core course.

Semester 3 - Electrical Engineering

*MATH 251-3	Calculus III	3	3-1-0	MATH 152
*MATH 272-3	Introduction to Probabilities & Statistics	3	3-1-0	MATH 152
*CMPT 105-3	Fundamental Concepts of Computing	3	3-1-0	CMPT 103
*ENGG 240-3	Industrial Engineering I	3	3-0-0	MATH 152
ELEC 211-2	Electrical Engineering Laboratory A	2	0-0-4	(ELEC 221)
ELEC 221-3	Analog and Digital Electronics	3	3-0-0	PHYS 121, MATH 152
	Elective III (Society and Environment)	3	2-1-0	
		20	25	

Semester 4 - Electrical Engineering

MATH 252-3	Vector Calculus I	3	3-1-0	MATH 251
*MATH 310-3	Introduction to Ordinary Differential Equations	3	3-1-0	MATH 152
*ENGG 241-3	Industrial Engineering II	3	3-0-0	MATH 272
ELEC 212-2	Electrical Engineering Lab B	2	0-0-4	
ELEC 250-3	Basic Electrical Engineering	3	3-0-0	PHYS 121, 131
ELEC 260-3	Micro-processor Systems	3	1-3-0	ELEC 221, CMPT 103, 105, computing experience
	Elective IV (Society and Environment)	3	2-1-0	
		20	25	

Semester 5 - Electrical Engineering

PHYS 221-3	Intermediate Ele. :icity & Magnetism	3	3-1-0	PHYS 121 (MATH 251, 252)
*ENGG 299-3	Engineering Economics	3	3-0-0	
*ENGG 301-3	Engineering Design	3	2-1-0	(Upper Division Standing)
*ENGG 341-3	Systems Dynamics	3	3-0-0	MATH 252, 310
ELEC 311-3	Electrical Engineering Lab C	3	0-0-6	Semester 5, Electrical Engineering
*CHEM 105-3	General Chemistry II	3	3-1-0	CHEM 104, PHYS 120
ONE OF:				
ELEC 332-3	Electrical Power Generation and Distribution	3	3-0-0	ELEC 250
ELEC 322-3	Electronics Design I	3	3-0-0	ELEC 221, 211
CMPT 201-4	Data and Program Organization	4	3-0-0	CMPT 103, 105
		21	26	

Semester 6 - Electrical Engineering

*ENGG 302-3	Engineering Management	3	2-1-0	Upper Division Standing
ELEC 312-3	Electrical Engineering Lab D	3	0-0-6	(Semester 6, Electrical Engineering)
ELEC 342-3	Control Systems	3	3-0-0	ENGG 341
ELEC 371-3	Digital Systems	3	3-0-0	ELEC 260, 342
PHYS 425-3	Electromagnetic Theory	3	3-0-0	
*	Elective V (Society and Environment)	3	2-1-0	
	Electrical Engineering Elective I	3	3-0-0	
		21	24	

Semester 7 - Electrical Engineering

*ENGG 401-1	Engineering Project A	1	0-0-2	as noted (Semester 7 Electrical Engineering)
ELEC 401-2	Electrical Engineering Project A	2	0-0-4	(ENGG 401)
ELEC 411-4	Electrical Engineering Lab E	4	0-0-8	(Semester 7 Electrical Engineering)
ELEC 441-3	Communication Systems	3	3-1-0	ENGG 341 MATH 272
	Electrical Engineering Elective II	3	3-0-0	
	Electrical Engineering Elective III	3	3-0-0	
	Electrical Engineering Elective IV	3	3-0-0	
		19	27	

Semester 8 - Electrical Engineering

ELEC 402-3	Electrical Engineering Project B	3	0-0-6	ELEC 401
ELEC 412-4	Electrical Engineering Lab F	4	0-0-8	(Semester 8 Electrical Engineering)
	Electrical Engineering Elective V	3	3-0-0	
	Electrical Engineering Elective VI	3	3-0-0	
	Electrical Engineering Elective VII	3	3-0-0	
	Electrical Engineering Elective VIII	3	3-0-0	
		19	26	

TOTAL CREDITS (including *ENGG 100-6) 160

Mechanical Engineering

The core program gives students the traditional solid grounding in mathematics and science. Less conventional for mechanical engineers is the inclusion of courses on linear systems, control theory and digital electronics plus a two course sequence on the quantitative tools required for industrial engineering. Beyond the core, the mechanical engineers have required courses in those subjects normally considered central to the field. Specialization and integration is developed through projects and through selection of electives.

The major emphasis available in the department is industrial engineering. This builds on the mathematical tools developed in the two course industrial engineering sequence in the common core and culminates in elective courses on manufacturing processes and production systems (the processes and systems of B.C. industry will be emphasized). Additional strength in the area of ergonomics, workplace design and occupational health comes from courses in the Occupational Health Program being developed in Kinesiology. Other electives allow the mechanical engineering student to concentrate on applications in mining, forest engineering or the engineering problems of extreme environments (off-shore and Northern problems). A unique strength for more theoretically oriented students is the sequence of advanced mechanics courses available in the Mathematics Department. These are particularly suited to students considering research in mechanics.

MECHANICAL ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (CO-REQUISITES)
	Core IV - Mechanical Engineering		
MATH 314-3	Boundary Value Problems	3	MATH 252, 310
*ENME 262-4	Engineering Mechanics I (Statics)	4	MATH 152, PHYS 120 (155)
*ENME 263-4	Engineering Mechanics II (Dynamics)	4	MATH 262, (251)
or			
PHYS 211-3	Intermediate Mechanics		
& PHYS 212-1	Engineering Problems in Dynamics		
*ENME 265-4	Engineering Mechanics III (Strength of Materials)	4	MATH 152, 262
*ENME 362-3	Fluid Mechanics I	3	MATH 262, (MATH 314)
CIVE 220-4	Structural Analysis I	4	ENGG 230
PHYS 344-3	Thermal Physics	3	PHYS 121, MATH 251
ELEC 221-3	Analog and Digital Electronics	3	PHYS 121, MATH 152
ELEC 250-3	Basic Electrical Engineering	3	PHYS 121, 131
ELEC 260-3	Micro-processor Systems	3	ELEC 221, CMPT 103 (125)
ELEC 342-3	Control Systems	3	ENGG 341
MECE 212-1	Mechanical Engineering Laboratory A	1	(Semester 4)
MECE 230-3	Engineering Materials	3	CHEM 105
MECE 310-3	Analysis and Design of Machines	3	MATH 264
MECE 311-2	Mechanical Engineering Laboratory B	2	(Semester 5)
MECE 312-3	Mechanical Engineering Laboratory C	3	(MECE 370)
MECE 320-3	Heat Transfer and Fluid Mechanics	3	PHYS 344, MATH 362
MECE 370-2	Mechanical Measurements	2	MATH 152
MECE 401-2	Mechanical Engineering Project A	2	(ENGG 401)
MECE 402-3	Mechanical Engineering Project B	3	MECE 401
MECE 410-3	Vibrations and Acoustics	3	MATH 310, 314
MECE 411-2	Mechanical Engineering Laboratory D	2	(Semester 7)
MECE 412-4	Mechanical Engineering Laboratory E	4	(Semester 8)
MECE 420-3	Engineering Thermodynamics	3	PHYS 344
MECE 482-3	Design of Machine Components	3	MATH 265, MECE 310
	Electives (Engineering and Science)	6	
	Total	80	

* Note that ENME 262, 263, 265 and 362 are existing Engineering Mechanics courses offered by the Department of Mathematics with the MATH designation. When the Engineering programs are implemented it will be recommended that the designation of these courses be changed from MATH to ENME to identify them as Engineering Mechanics courses.

ELECTIVE LIST: MECHANICAL ENGINEERING

A. Industrial Engineering

MECE 423-3	Heating Ventilating and Air Conditioning
MECE 442-3	Manufacturing Processes
MECE 497-3	Production Systems
OHS 300-3	Introduction to Occupational Health Sciences
OHS 480-3	Ergonomics/Human Factors in the Working Environment
OHS 481-3	Principles of Industrial Hygiene

B. Applications

ENGG 420-3	Forest Operations
ENGG 430-3	Engineering in Extreme Environments
ENGG 440-3	Mining Methods
CIVE 432-3	Rock Mechanics

C. Mechanics

ENME 361-3	Mechanics of Deformable Media
MATH 407-3	Vibrations
ENME 468-4	Continuum Mechanics
ENME 462-4	Fluid Dynamics II

Plus those on the Science elective list and others from Engineering and Science as approved.

RECOMMENDED FULL-TIME MECHANICAL ENGINEERING PROGRAM

COURSE NUMBER	COURSE NAME	CREDIT	CONTACT HOURS	PREREQUISITE (CO-REQUISITE)
Semester 1 - All Engineering Students				
*MATH 151-3	Calculus I	3	3-1-0	
*MATH 232-3	Elementary Linear Algebra	3	3-1-0	(MATH 151)
*PHYS 120-3	Physics I	3	3-1-0	(MATH 151)
*CHEM 104-3	General Chemistry I	3	3-1-0	(MATH 151, CHEM 115)
*CHEM 115-2	General Chemistry Laboratory	2	0-0-4	(CHEM 104)
*	Elective I (Society and Environment)	3	2-1-0	
		17	23	
Semester 2 - All Engineering Students				
*MATH 152-3	Calculus II	3	3-1-0	MATH 151
ENME 262-4	Engineering Mechanics I (Statics)	4	3-1-0	(MATH 152), PHYS 120
*PHYS 121-3	Physics II	3	3-1-0	PHYS 120 (MATH 152)
*PHYS 131-2	General Physics Laboratory	2	0-0-3	(PHYS 121)
*CMPT 103-3	Introduction to High Level Programming Language I	3	1-0-5	
*	Elective II (Society and Environment)	3	2-1-0	
		18	24	

NOTE: * Denotes a core course.

Semester 3- Mechanical Engineering

*MATH 251-3	Calculus III	3	3-1-0	MATH 152
ENME 263-4	Engineering Mechanics II (Dynamics)	4	3-2-0	MATH 262 (MATH 251)
OR:				
PHYS 211-3	Intermediate Mechanics		3-1-0	PHYS 121 (MATH 251)
AND:				
PHYS 212-1	Engineering Problems in Dynamics		0-2-0	(PHYS 211)
ENME 265-4	Engineering Mechanics III (Strength of Materials)	4	3-1-0	MATH 152, 262
*MATH 272-3	Probability and Statistics	3	3-1-0	MATH 152
*ENGG 240-3	Industrial Engineering I	3	3-1-0	MATH 152
*	Elective III (Society and Environment)	3	2-1-0	
		20	24	

Semester 4 - Mechanical Engineering

*MATH 310-3	Introduction to Ordinary Differential Equations	3	3-1-0	MATH 152
*ENGG 241-3	Industrial Engineering II	3	3-0-0	MATH 272
*CHEM 105-3	General Chemistry II	3	3-1-0	CHEM 104, PHYS 120
*CMPT 105-3	Fundamental Concepts of Computing	3	3-1-0	CMPT 103
CIVE 220-4	Structural Analysis I	4	3-1-0	MATH 265
MECE 212-1	Mechanical Engineering Laboratory A	1	0-0-2	(Semester 4)
	Elective IV (Society and Environment)	3	2-1-0	
		20	24	

Semester 5 - Mechanical Engineering

MATH 314-3	Boundary Value Problems	3	3-1-0	MATH 252, 310
ENME 362-3	Fluid Mechanics I	3	3-1-0	MATH 262 (314)
ELEC 221-3	Analog and Digital Electronics	3	3-0-0	PHYS 121, MATH 152
PHYS 344-3	Thermal Physics	3	3-1-0	PHYS 121, MATH 251
*ENGG 301-3	Engineering Design	3	2-1-0	(Upper Division Standing)
MECE 230-3	Engineering Materials	3	3-0-0	CHEM 105
MECE 311-2	Mechanical Engineering Laboratory B	2	0-0-4	
		20	25	

Semester 6 - Mechanical Engineering

MECE 310-3	Analysis and Design of Machines	3	3-0-0	MATH 265
MECE 312-3	Mechanical Engineering Laboratory C	3	0-0-6	(MECE 370)
MECE 320-3	Heat Transfer and Fluid Mechanics	3	3-1-0	PHYS 344, MATH 362
MECE 370-2	Mechanical Measurements	2	2-0-0	
ELEC 250-3	Basic Electrical Engineering	3	3-0-0	PHYS 121, 131
*ENGG 302-3	Engineering Management	3	3-0-0	Upper Division standing
*ENGG 341-3	Systems Dynamics	3	3-0-0	MATH 310
		20	24	

Semester 7 - Mechanical Engineering

*ENGG 401-1	Engineering Proj : A	1	0-0-2	(Semester 7, Mechanical Engineering)
*ENGG 299-3	Engineering Economics	3	2-1-0	
MECE 401-2	Engineering Project A	2	0-0-4	(ENGG 401)
MECE 410-3	Vibrations and Acoustics	3	3-0-0	MATH 310, 314
MECE 411-2	Mechanical Engineering Laboratory D	2	0-0-4	(Semester 7)
MECE 482-3	Design of Machine Components	3	3-0-0	MATH 265, MECE 310
ELEC 260-3	Microprocessor Systems	3	3-0-0	ELEC 221, MECE 311
*	Mechanical Engineering Elective I	3	3-0-0	
		20	25	

Semester 8 - Mechanical Engineering

MECE 402-3	Engineering Project B	3	0-0-6	MECE 401
MECE 412-4	Mechanical Engineering Laboratory E	4	0-0-8	(Semester 8)
MECE 420-3	Engineering Thermodynamics	3	3-0-0	PHYS 344
ELEC 342-3	Control Systems	3	3-0-0	MATH 152
	Mechanical Engineering Elective II	3	3-0-0	
	Elective V (Society and Environment)	3	2-1-0	
		19	26	

TOTAL CREDITS (including ENGG 100-6) 160

Chemical Engineering

This program shares the common core of mathematics, science, societal context and engineering science courses with the other engineering programs but otherwise relies quite heavily on courses in the existing Chemistry Department. Graduates of the program will have a solid systems, computing and industrial engineering base which will particularly orient them to process control and manufacturing processes. Specific electives are available in the areas of extractive metallurgy, process control and biochemical engineering. Because of its reliance on common core courses and on chemistry courses, the Chemical Engineering Department will be quite small (5 faculty). Consideration will be given to whether this unit could be combined administratively with the existing Department of Chemistry.

CHEMICAL ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (CO-REQUISITES)
	Core IV - Chemical Engineering		
CHME 211-2	Chemical Engineering Laboratory A	2	(CHEM 261)
CHME 212-2	Chemical Engineering Laboratory B	2	CHEM 115 (251)
CHME 311-3	Chemical Engineering Laboratory C	3	(Semester 5)
CHME 312-4	Chemical Engineering Laboratory D	4	(Semester 6)
CHME 370-3	Chemical Measurements	3	CHME 311
CHME 401-2	Chemical Engineering Project A	2	(Semester 7)
CHME 402-3	Chemical Engineering Project B	3	(Semester 8)
CHME 411-4	Chemical Engineering Laboratory E	4	(Semester 7)
CHME 412-4	Chemical Engineering Laboratory F	4	(Semester 8)
CHME 431-3	Chemical Reaction and Process Design I	3	CHEM 251, 261
CHME 432-3	Chemical Reaction and Process Design II	3	CHME 431
MATH 314-3	Boundary Value Problems	3	MATH 252, 310
ENME 362-3	Fluid Mechanics I	3	MATH 314, 262
CHEM 232-3	Chemistry of Nontransition Elements	3	CHEM 105
CHEM 251-3	Organic Chemistry I	3	CHEM 105, (256)
CHEM 252-3	Organic Chemistry II	3	CHEM 251
CHEM 261-3	Physical Chemistry I	3	CHEM 105, MATH 152, PHYS 121
CHEM 332-3	Chemistry of Transition Elements	3	CHEM 232
CHEM 461-2	Chemical Rate Processes	2	CHEM 261
ELEC 221-3	Analog and Digital Electronics	3	PHYS 121, MATH 152
ELEC 260-3	Micro-processor Systems	3	ELEC 221, CHME 311
ELEC 342-3	Control Systems	3	ENGG 341
MECE 320-3	Heat Transfer and Fluid Mechanics	3	PHYS 344, MATH 362
	Electives (Engineering and Science)	12	
		80	

ELECTIVE LIST: CHEMICAL ENGINEERING

CHME 430-3	Introduction to Biochemical Engineering
CHME 440-3	Introduction to Extractive Metallurgy
CHME 450-3	Chemical Process Control
MECE 230-3	Engineering Materials
MECE 442-3	Manufacturing Processes
MECE 497-3	Production Systems
OHS 300-3	Introduction to Occupational Health Sciences
OHS 480-3	Ergonomics/Human Factors in the Working Environment
OHS 481-3	Principles of Industrial Hygiene
BISC 311-3	Introduction to Environmental Toxicology
CHEM 371-3	Chemistry of the Environment

Plus those on the Science elective list and others from Engineering and Science as approved.

RECOMMENDED FULL-TIME CHEMICAL ENGINEERING PROGRAM

COURSE NUMBER	COURSE NAME	CREDIT	CONTACT HOURS	PREREQUISITES (CO-REQUISITES)
Semester 1 - All Engineering Students				
*MATH 151-3	Calculus I	3	3-1-0	
*MATH 232-3	Elementary Linear Algebra	3	3-1-0	(MATH 151)
*PHYS 120-3	Physics I	3	3-1-0	(MATH 151)
*CHEM 104-3	General Chemistry I	3	3-1-0	(MATH 151, CHEM 115)
*CHEM 115-2	General Chemistry Laboratory	2	0-0-4	(CHEM 104)
*	Elective I (Society and Environment)	3	2-1-0	
		17	23	
Semester 2 - All Engineering Students				
*MATH 152-3	Calculus II	3	3-1-0	MATH 151
*PHYS 121-3	Physics II	3	3-1-0	PHYS 120 (MATH 152)
*PHYS 131-2	General Physics Laboratory	2	0-0-3	(PHYS 121)
*CMPT 103-3	Introduction to High Level Programming, Language I	3	1-0-5	
*CHEM 105-3	General Chemistry II	3	3-1-0	PHYS 120, CHEM 104
*	Elective II (Society and Environment)	3	2-1-0	
		17	24	

Semester 3 - Chemical Engineering

*MATH 251-3	Calculus III	3	3-1-0	MATH 152
*CMPT 105-3	Fundamental Concepts of Computing	3	3-1-0	CMPT 103
*ENGG 240-3	Industrial Engineering I	3	3-1-0	MATH 152
CHEM 232-3	Chemistry of Nontransition Elements	3	3-1-0	CHEM 105
CHEM 261-3	Physical Chemistry I	3	3-1-0	CHEM 105, MATH 152, PHYS 121
CHME 211-2	Chemical Engineering Laboratory A	2	0-0-4	(CHEM 261)
*	Elective III (Society and Environment)	3	2-1-0	
		20	27	

Semester 4 - Chemical Engineering

*MATH 272-3	Probability and Statistics	3	3-1-0	MATH 152
*MATH 310-3	Introduction to Ordinary Differential Equations	3	3-1-0	MATH 152
*ENGG 241-3	Industrial Engineering II	3	3-0-0	ENGG 240, MATH 272
*ENGG 299-3	Engineering Economics	3	3-0-0	
CHEM 251-3	Organic Chemistry I	3	3-1-0	CHEM 105, (256)
CHEM 332-3	Chemistry of Transition Elements	3	3-1-0	CHEM 232
CHME 212-2	Chemical Engineering Laboratory B	2	0-0-4	CHEM 115, (251)
		20	26	

Semester 5 - Chemical Engineering

MATH 314-3	Boundary Value F. .blems	3	3-1-0	MATH 152, 310
ENME 362-3	Fluid Mechanics I	3	3-1-0	MATH 314, 262
ELEC 221-3	Analog and Digital Electronics	3	3-0-0	PHYS 121, MATH 152
CHEM 252-3	Organic Chemistry II	3	3-1-0	CHEM 251
*ENGG 301-3	Engineering Design	3	3-0-0	(upper division standing)
*ENGG 341-3	Systems Dynamics	3	3-0-0	MATH 310
CHME 311-3	Chemical Engineering Laboratory C	3	0-0-6	
		21	27	

Semester 6 - Chemical Engineering

ELEC 260-3	Micro-processor Systems	3	3-0-0	ELEC 221, CHME 311
MECE 320-3	Heat Transfer and Fluid Mechanics	3	3-0-0	MECE 220
CHME 312-4	Chemical Engineering Laboratory D	4	0-0-8	CHME 311
CHME 370-3	Chemical Measurements	3	2-0-0	CHME 311 *
*ENGG 302-3	Engineering Management	3	3-0-0	(upper division standing)
CHEM 461-2	Chemical Rate Processes	2	2-1-0	CHEM 261
	Elective (Science)	3	3-0-0	
		21	26	

Semester 7 - Chemical Engineering

*ENGG 401-1	Engineering Project A	1	0-0-2	(Semester 7, Chemical Engineering)
CHME 401-2	Chemical Engineering Project A	2	0-0-4	(ENGG 401)
CHME 411-4	Chemical Engineering Laboratory E	4	0-0-8	
CHME 431-3	Chemical Reaction and Process Design I	3	3-0-0	CHEM 261, 251
	Chemical Engineering Elective I	3	3-0-0	
ELEC 342-3	Control Systems	3	3-0-0	ENGG 341
	Elective IV (Society and Environment)	3	2-1-0	
		19	26	

Semester 8 - Chemical Engineering

CHME 402-3	Chemical Engineering Project B	3	0-0-6	
CHME 412-4	Chemical Engineering Laboratory F	4	0-0-8	
CHME 432-3	Chemical Reaction and Process Design II	3	3-0-0	CHME 431
	Chemical Engineering Elective II	3	3-0-0	
	Chemical Engineering Elective III	3	3-0-0	
	Elective V (humanities, social studies, administration)	3	2-1-0	
		19	26	

Total Credits (including ENGG 100-6) 160

Computer Engineering

A single basic stream in computer engineering is recommended. The graduate will have a background in electronics and both computer hardware and software; the integration of this material will enable him to design systems using computers and other electronic devices as basic components.

Given the electrical engineering program recommended for S.F.U., and the orientations of the existing Department of Computing Science, this program would not require additional lecture courses. Furthermore, assuming the establishment of the proposed honors program in Digital Systems Design, the laboratory courses CMPE 301-3, 411-4, and 412-4 can be integrated with CMPT 391-3, Microcomputer Hardware Workshop, CMPT 495-3, Digital Systems Design and Specification Laboratory and CMPT 496-3, Digital Systems Implementation Laboratory. Once the engineering programs were underway, other detailed changes in both of the proposed programs could be instituted which would strengthen both digital systems design and computer systems engineering. The elective courses available to the students in both programs would likely increase as a result of this co-ordinated development.

Both of these programs are aimed at the ever developing need for computer system designers. They provide a continuum of educational opportunities which moves from conventional electrical engineering to electrical engineering with a digital systems orientation, to computer systems engineering, to computer systems design, to more conventional computing science. Each option has its distinct features and the ensemble of programs represent an economic and educationally innovative way to meet the range of needs of both students and society.

The Computer Engineering Program is the same as for electrical engineering until the end of the third semester; semesters 4 and 5 are also heavily based on the electrical engineering program. The separation is more distinct in the final two semesters. This close relationship is a consequence of the fact that the program is a blend of the major elements of the electronics and communications stream in Electrical Engineering with the "computer design and organization" and "software systems" areas in Computing Science. The elective courses demonstrate that the student can obtain considerable course choice from existing computing science courses and those proposed for electrical engineering.

COMPUTER ENGINEERING PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (CO-REQUISITES)
	Core IV - Computer Engineering		
ELEC 211-2	Electrical Engineering Laboratory A	2	(Semester 3, Electrical Engineering)
ELEC 221-3	Analog & Digital Electronics	3	PHYS 121, MATH 152,
ELEC 260-3	Microprocessor Systems	3	ELEC 221, CMPT 103, 105, computing experience
ELEC 322-3	Electronics Design I	3	ELEC 221, 311
ELEC 342-3	Control Systems I	3	ENGG 341
ELEC 441-3	Communication Systems	3	ELEC 342, MATH 272
CMPT 201-4	Data and Program Organization	4	CMPT 105, computing experience
CMPT 205-3	Introduction to Formal Topics in Computing Science	3	CMPT 105
CMPT 301-3	Systems Development Methodology	3	CMPT 201
CMPT 354-3	File and Database Structures	3	CMPT 201
CMPT 393-4	Systems Software for Minicomputers and Microcomputers	4	CMPT 201, ELEC 221
CMPT 400-3	Hardware-Software Architecture I	3	CMPT 201, 205, ELEC 221
CMPT 404-4	Computer Systems Measurement and Evaluation	4	CMPT 400
CMPE 212-2	Computer Engineering Lab A	2	(Semester 4, Computer Engineering)
CMPE 311-2	Computer Engineering Lab B	2	(Semester 5, Computer Engineering)
CMPE 312-4	Computer Engineering Lab C	4	(Semester 6, Computer Engineering)
CMPE 401-2	Computer Engineering Project A	2	(ENGG 401)
CMPE 402-3	Computer Engineering Project B	3	CMPE 401
CMPE 411-4	Computer Engineering Lab D	4	(Semester 7, Computer Engineering)
CMPE 412-4	Computer Engineering Lab E	4	(Semester 8, Computer Engineering)
MATH 306-3	Introduction to Automata Theory	3	CMPT 105, (Upper Division Standing)
	Electives (Engineering and Science)	15	
	Total	80	
	Grand Total	160	

ELECTIVE LIST: COMPUTER ENGINEERING

COURSE NUMBER	COURSE NAME	PREREQUISITES (COREQUISITES)
CMPT 305-3	Computer Simulation and Modelling	CMPT 201
CMPT 351-3	Introduction to Computer Graphics	CMPT 201
CMPT 401-3	Hardware-Software Architecute II	CMPT 400
CMPT 451-3	Interactive Graphics & Animation Systems	CMPT 205, 351
CMPT 491-3	Computers in Real Time Experiments	ELEC 322, CMPT 301, 305
ELEC 371-3	Digital Systems	ELEC 260, (342)
ELEC 425-3	Electronic System Design	ELEC 322
ELEC 443-3	Data Communications	ELEC 441
MATH 401-3	Switching Theory and Logical Design	CMPT 103, MATH 306
MATH 402-3	Automata and Formal Languages	MATH 306

Plus those on the Science elective list and others from Engineering and Science as approved.

RECOMMENDED FULL-TIME COMPUTER ENGINEERING PROGRAM

COURSE NUMBER	COURSE NAME	CREDIT	CONTACT HOURS	PREREQUISITE (CO-REQUISITE)
Semester 1 - All Engineering Students				
*MATH 151-3	Calculus I	3	3-1-0	
*MATH 232-3	Elementary Linear Algebra	3	3-1-0	(MATH 151)
*PHYS 120-3	Physics I	3	3-1-0	(MATH 151)
*CHEM 104-3	General Chemistry I	3	3-1-0	(MATH 151, CHEM 115)
*CHEM 115-2	General Chemistry Laboratory	2	0-0-4	(CHEM 104)
	Elective I (Society and Environment)	3	2-1-0	
		17	23	
Semester 2 - Computer Engineering				
*MATH 152-3	Calculus II	3	3-1-0	MATH 151
*PHYS 121-3	Physics II	3	3-1-0	PHYS. 120 (MATH 152)
*PHYS 131-2	General Physics Laboratory	2	0-0-3	(PHYS 121)
*CMPT 103-3	Introduction to High Level Programming Language I	3	1-0-5	
	Elective II (Society and Environment)	3	2-1-0	
*	Elective (science)	3	3-0-0	
		17	23	

Semester 3 - Computer Engineering

*MATH 251-3	Calculus III	3	3-1-0	MATH 152
*MATH 272-3	Introduction to Probabilities & Statistics	3	3-1-0	MATH 152
*CMPT 105-3	Fundamental Concepts of Computing	3	3-1-0	CMPT 103
*ENGG 240-3	Industrial Engineering I	3	3-0-0	MATH 152
ELEC 211-2	Electrical Engineering Laboratory A	2	0-0-4	(ELEC 221)
ELEC 221-3	Analog and Digital Electronics	3	3-0-0	PHYS 121, MATH 152
	Elective III (Society and Environment)	3	2-1-0	
		20	25	

Semester 4 - Computer Engineering

*MATH 310-3	Introduction to Ordinary Differential Equations	3	3-1-0	MATH 152
*ENGG 241-3	Industrial Engineering II	3	3-0-0	MATH 272
ELEC 260-3	Micro-processor Systems	3	1-3-0	ELEC 221, CMPT 103, 105 computing exper.
CMPE 212-2	Computer Systems Engineering Laboratory A	2	0-0-4	ELEC 211
CMPT 205-3	Introduction to Formal Topics in Computing	3	3-1-0	CMPT 105
CHEM 105-3	General Chemistry II	3	3-1-0	CHEM 104, PHYS 120
*	Elective IV (Society and Environment)	3	2-1-0	
		20	26	

Semester 5: Computer Engineering

*ENGG 301-3	Engineering Des:	3	2-1-0	(Upper Division Standing)
*ENGG 341-3	Systems Dynamics	3	3-0-0	MATH 310
ELEC 322-3	Electronics Design I	3	3-0-0	ELEC 221, 211
CMPE 311-2	Computer Engineering Lab B	2	0-0-4	(Semester 5, Computer Engineering)
CMPT 201-4	Data and Program Organization	4	3-1-0	CMPT 105, computing experience
MATH 306-3	Introduction to Automata Theory	3	3-1-0	CMPT 105, (Upper Division standing)
*	Elective IV (Society and Environment)	3	2-1-0	
		21	24	

Semester 6: Computer Engineering

*ENGG 302-3	Engineering Management	3	2-1-0	(Upper Division Standing)
CMPE 312-4	Computer Engineering Lab C	4	0-0-8	(Semester 6, Computer Engineering)
ELEC 342-3	Control Systems	3	3-0-0	ENGG 341
CMPT 301-3	System Development Methodology	3	3-0-0	CMPT 201
CMPT 393-4	Systems Software for Minicomputer and Microcomputers	4	3-1-0	CMPT 201, ELEC 221
	Computer Engineering Elective I	3	3-0-0	
		20	24	

Semester 7: Computer Engineering

*ENGG 401-1	Engineering Project A	1	0-0-2	(Semester 7, Computer Engineering)
CMPE 401-2	Computer Engineering Project A	2	0-0-4	(ENGG 401)
CMPE 411-4	Computer Engineering Lab D	4	0-0-8	(Semester 7, Computer Engineering)
ELEC 441-3	Communication Systems	3	3-0-0	ENGG 341, MATH 272
CMPT 354-3	File and Database Structure	3	3-0-0	CMPT 201
CMPT 400-3	Hardware-Software Architecture I	3	3-0-0	CMPT 201, 205, ELEC 221
*	Elective V (Society and Environment)	3	2-1-0	
		19	26	

Semester 8: Computer Engineering

CMPE 402-3	Computer Engineering Project B	3	0-0-6	(CMPE 401)
CMPE 412-4	Computer Engineering Laboratory E	4	0-0-8	(Semester 8, Computer Engineering)
CMPT 404-4	Computer Systems Measurement and Evaluation	4	3-1-0	CMPT 400
	Computer Engineering: Elective II	3	3-0-0	
	Elective III	3	3-0-0	
	Elective IV	3	3-0-0	
		20	27	

Total Credits (including ENGG 100-6) 160

ENGINEERING SCIENCE

The objective of this progr is to combine courses in science and engineering into programs for students with high academic standing who are planning continued study at the graduate level. The program provides two options which can be tailored to the interests of the individual student. To illustrate what is possible with the Engineering Science (General) option, two sample programs have been set out with the following emphases:

(1) Energy

(2) Solid State Electronics.

For students who wish to emphasize Mechanics, the Engineering Science (Mechanics) option provides a more specialized program.

Beyond the core program common to all of the engineering disciplines, students in engineering science undertake further common study in science and engineering, in addition to more specialized courses. The aim is to provide a strong, broad basis tempered with an opportunity to concentrate in an area of particular interest.

The following tables give these overall requirements for engineering science. Because of the wide variety of programs which are possible, the semester by semester programs are not illustrated.

ENGINEERING SCIENCE PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (COREQUISITES)
	Core IV - Engineering Science (General)		
ELEC 221-3	Analog and Digital Electronics	3	PHYS 121, MATH 152
ELEC 250-3	Basic Electrical Engineering	3	PHYS 121 (MATH 251)
MECE 230-3	Engineering Materials	3	CHEM 105
CHEM 232-3	Chemistry of Nontransition Elements	3	CHEM 105
CHEM 251-3	Organic Chemistry I	3	CHEM 105 (256)
CHEM 256-2	Organic Chemistry Laboratory I	2	CHEM 115 (251)
NUSC 342-3	Introduction to Nuclear Science	3	
MATH 252-3	Vector Calculus I	3	MATH 251
ENME 262-4	Engineering Mechanics I (Statics)	4	MATH 152, PHYS 120
ENME 263-4	Engineering Mechanics II (Dynamics)	4	MATH 262, 251 or (253)
ENME 362-3	Fluid Mechanics I	3	
PHYS 221-3	Intermediate Electricity & Magnetics	3	PHYS 121 (MATH 251, 252)
PHYS 344-3	Thermal Physics	3	PHYS 121, MATH 251
PHYS 384-3	Methods of Theoretical Physics I	3	PHYS 211 (or MATH 263), PHYS 221, MATH 252, 310
PHYS 385-3	Quantum Physics	3	PHYS 211 (or MATH 263), PHYS 221, MATH 252
ENSC 212-2	Engineering Science Laboratory A	2	(Semester 4, Engineering Science)
ENSC 311-3	Engineering Science Laboratory B	2	(Semester 5, Engineering Science)
ENSC 312-3	Engineering Science Laboratory C	3	(Semester 6, Engineering Science)
ENSC 401-2	Engineering Science Project A	2	(ENGG 401)
ENSC 402-3	Engineering Science Project B	3	ENSC 401
ENSC 411-3	Engineering Science Laboratory D	3	(Semester 7, Engineering Science)
ENSC 412-4	Engineering Science Laboratory E	4	Semester 8, Engineering Science)
	Electives (Engineering and Science)	15	
	Total	80	

ELECTIVE LIST: ENGINEERING SCIENCE (GENERAL)

Two examples of concentrat' ns which are possible within the Engineering Science (General) option are sei out. Other concentrations may be selected with the approval of the Faculty.

1. Energy

MECE 320-3	Heat Transfer and Fluid Mechanics - PHYS 344, MATH 362
MECE 420-3	Engineering Thermodynamics - PHYS 344
PHYS 484-3	Methods of Theoretical Physics II - PHYS 384
	- PHYS 211 or MATH 263, PHYS 221, MATH 252, 310
NUSC 442-3	Properties of Nuclear Matter - PHYS 385
ELEC 332-3	Electrical Generation & Distribution - ELEC 250
ELEC 432-3	Power Systems - ELEC 332
ELEC 435-3	High Voltage Engineering - ELEC 332
ENGG 460-3	Energy Distribution and Utilization
ENGG 470-3	Energy Sources
	and other courses as selected

2. Solid State Electronics

PHYS 355-3	Optics - PHYS 221, MATH 252
PHYS 465-3	Solid State Physics - PHYS 385
PHYS 415-3	Quantum Mechanics - PHYS 385, 384
ELEC 322-3	Electronic Design I - ELEC 221, ENSC 211
ELEC 421-3	Electronic Design II - ELEC 322
ELEC 425-3	Electronic System Design - ELEC 322
ELEC 464-3	High Frequency Electronics - ELEC 322, PHYS 425
	and other courses as selected

ENGINEERING SCIENCE PROGRAM REQUIREMENTS

COURSE NUMBER	COURSE NAME	SEMESTER HOURS	PREREQUISITES (COREQUISITES)
	Core IV - Engineering Science (Mechanics)		
ELEC 250-3	Basic Electrical Engineering	3	PHYS 121 (MATH 251)
MECE 230-3	Engineering Materials	3	CHEM 105
MATH 252-3	Vector Calculus I	3	MATH 251
ENME 262-4	Engineering Mechanics I (Statics)	4	MATH 152, PHYS 120
ENME 263-4	Engineering Mechanics II (Dynamics)	4	MATH 262, 251 or (253)
ENME 265-4	Engineering Mechanics III (Strength of Materials)	4	MATH 262, 152
MATH 316-3	Numerical Analysis	3	MATH 252
ENME 361-3	Mechanics of Deformable Media	3	MATH 252, 262 or PHYS 120
ENME 362-3	Fluid Mechanics I	3	MATH 262 (314)
PHYS 221-3	Intermediate Electricity & Magnetics	3	PHYS 121 (MATH 251, 252)
PHYS 344-3	Thermal Physics	3	PHYS 121, MATH 251, 252
ENSC 213-2	Engineering Mechanics Laboratory A	2	
ENSC 313-2	Engineering Mechanics Laboratory B	2	
ENSC 314-2	Engineering Mechanics Laboratory C	2	
ENSC 413-2	Engineering Mechanics Laboratory D	2	
ENSC 401-2	Engineering Science Project A	2	(ENGG 401)
ENSC 402-3	Engineering Science Project B	3	ENSC 401
	Electives (Applied Math)	9	
	Electives (Applied Mechanics and Science)	22	
	Total	80	

ELECTIVE LIST: APPLIED MATHEMATICS (9 credit hours required)

MATH 314-3	Boundary Value Pr ems - MATH 252, 310
or	
PHYS 384-3	Methods of Theoretical Physics I - PHYS 211 or MATH 253, PHYS 221, MATH 252, MATH 310
MATH 322-3	Complex Variables - MATH 251
MATH 415-3	Ordinary Differential Equations - MATH 310, 316
MATH 418-3	Partial Differential Equations - MATH 314 or PHYS 384
MATH 466-4	Tensor Calculus - MATH 252, MATH 232
MATH 416-3	Numerical Analysis II - MATH 310, 316
MATH 470-4	Variational Calculus - MATH 310, 262 or PHYS 211, MATH 313 or PHYS 384
PHYS 484-3	Methods of Theoretical Physics II - PHYS 384 or Instructor's permission

and other courses as approved.

ELECTIVE LIST: APPLIED MECHANICS (22 credit hours required)

MECE 320-3	Heat Transfer and Fluid Mechanics - PHYS 344, ENME 362
MECE 420-3	Engineering Thermodynamics - PHYS 344
MECE 410-3	Vibrations and Acoustics - MATH 310, MATH 314
CIVE 331-3	Soil Mechanics - ENME 362, GEOG 112
CIVE 340-3	Hydraulics - MECE 350
CIVE 432-3	Rock Mechanics - CIVE 331
ENME 467-3	Vibrations and Wave Motion
ENME 468-4	Continuum Mechanics - ENME 361, MATH 314
ENME 462-3	Fluid Mechanics II - ENME 362
PHYS 425-3	Electromagnetic Theory - PHYS 221

and other courses as approved.

RESOURCES AND SCHEDULE FOR DEVELOPMENT

The Faculty of Engineering will be designed to grow to an enrollment of about 825 undergraduate students and 100 graduate students after 7 to 10 years. This would require about 40 faculty with the split between the proposed departments being approximately as set out below:

	Undergraduate Students	Graduate Students	Faculty
Chemical	80	10	5
Civil	240	20	11
Electrical	240	20	14
Mechanical	240	20	10
Engineering Science	25	0	0
	825	70	40

This is comparable in size to the Engineering Schools of the University of Calgary and Carleton University.

The detailed budgetary and space needs are currently being prepared. Preliminary estimates indicate that the operating budget will grow over 7 years to $3,500,000 ($5,250,000 with a 50% overhead included). Capital will be approximately $20,000,000 including $4,000,000 for equipment.

If the program is submitted to U.C.B.C. in January 1981 it could be approved in the summer of 1981 for funding in April 1982. Thus a second year class could enter in September 1982 (we already offer the first year of Engineering). This class could probably be accommodated in existing space. Beyond this point the situation is less clear. The Department of Physics has expressed its willingness to accommodate laboratory classes for

Electrical Engineering, Computer Engineering and Engineering Science, and it is possible that Chemistry could help Chemical Engineering. While these departments might be able to give some help to other areas of engineering they certainly could not accommodate all of the laboratories. Since a new building could probably not be built before 1986 at the earliest (assuming 5 years for planning and construction with approval in 1981), either the 3rd and 4th year Mechanical and Civil programs would have to be delayed by three years or space would have to be found off-campus (e.g. by renovating a disused Burnaby school).

Accordingly, since the availability of off-campus space is uncertain, we have set out two possible schedules for implementation. The first assumes that Civil and Mechanical must be delayed for three years and the second assumes that space can be found for simultaneous development of all programs.

Schedule 1. Delayed Development for Civil and Mechanical Engineering

Year	Activity	Total Faculty	Approximate Operating Budget ($1,000's)
1981	Program approved. Hire Dean and Chairman for Electrical and Chemical Engineering.	3	300
1982	"New" first year program. Second year program for all areas. (Note Civil and Mechanical will have to transfer at the end of the year.) Add 6 Faculty.	9	850
1983	Third year programs in Electrical and Computer Engineering, Chemical Engineering and Engineering Science. Add 6 Faculty.	15	1300
1984	Fourth year program in Electrical and Computer Engineering, Chemical Engineering and Engineering Science. Add 6 Faculty.	21	1800
1985	Add 4 Faculty and Chairman for Civil and Mechanical Engineering	27	2400
1986	Third year programs in Civil and Mechanical Engineering. Add 5 Faculty.	32	2700
1987	Fourth year programs in Civil and Mechanical Engineering. Add 6 Faculty.	38	3200
1988	Add 2 Faculty. Development complete.	40	3500

While the three year delay in implementing Civil and Mechanical Engineering would be unfortunate (and unnecessary if space could be found), the programs proposed for immediate implementation do provide minimal coverage of all areas (through Engineering Science) combined with immediate emphasis on the exciting growth areas in Electrical and Computer Engineering.

Schedule 2. Simultaneous Development of All Programs

Year	Activity	Total Faculty	Approximate Operating Budget ($1,000's)
1981	Program Approved. Hire Dean and 4 Chairmen.	5	600
1982	"New" first year program. Second year program for all areas. Add 6 Faculty.	11	1000
1983	Third year programs in all areas. Add 11 Faculty.	22	2000
1984	Fourth year programs in all areas. Add 9 Faculty.	31	2700
1985	Add 9 Faculty. Development complete	40	3500

Engineering Course

Descriptions

GENERAL ENGINEERING COURSE DESCRIPTIONS

ENGG 100-6 Engineering Communications

Rationale

The objective of this course is to develop the student's written, verbal and graphical communication skills to an acceptable level. The basic premise is that these skills are best learned and demonstrated in the context of the student's work in engineering. Evaluations of laboratory reports, course essays, and project reports will, as a result, be central to this course. Demonstrated competence is required and unsatisfactory work is returned to the student to be done again. Communication skills must be demonstrated at a satisfactory level before the student will receive course credit.

Calendar Description

This course is spread throughout the duration of the engineering program. It is concerned with written, verbal and graphical communications. Course credit is obtained by demonstration of a proficiency in the skills of engineering communication.

For the most part the need for communications will arise in various courses in the program such as in laboratory reports, course essays and project reports. Other activities will be specified for the particular engineering program in which the student is enrolled. The final report and interim oral report on the Engineering Project undertaken during the final semester of the program will b^ ^omponents of ENGG 100. This course will also include essays based on ti guest lecturer series. Visual literacy, utilization of information resources such as libraries and computer graphics are within the scope of this course.

Particular requirements will be specified as the student progresses with his studies. A resource centre, tutorials, self-instructional materials, audio-visual materials, lectures, mini-courses and other instructional methods are utilized to aid the student in acquiring these skills which are considered important in the practice of the engineering profession. The student will formally register for the course in the semester in which all requirements are completed. Normally this will be the eighth semester. The course is graded on a credit/no entry basis.

ENGG 240-3 Industrial Engineering I

Rationale

This course aims to provide the student with an introductory understanding of a number of basic methods of decision making, organization and system optimization. Such techniques are fundamental to the analytic approach to engineering design and management. Only deterministic methods are considered.

Calendar Description

This course introduces the fundamentals underlying rational decision making in large engineering systems and the concepts and the scope of industrial engineering methods. The following topics will be examined: static optimization; steepest descent and quadratic convergence strategies;

linear programming; the simplex method, computational aspects, duality; network analysis; finite graphs; and critical path scheduling. Applications are emphasized and a major computing project is assigned.

Prerequisite: MATH 251-3

Reference: Daellenbach and George, Introduction to Operations Research Techniques

ENGG 241-3 Industrial Engineering II 3-0-0

Rationale

This course has the same objectives as ENGG 240-3, with the methods extended to those which are based on probalistic models.

Calendar Description

Engineering decisions in the face of uncertainty. Application of simple decision trees to probabilistic planning problems. Bayesian estimation. The utility concept. Recursive formulation of multistage decision problems. Introduction to dynamic programmming. Introduction to queues and their application to the operation of engineering systems. A major computing project is assigned.

Prerequisite: MATH 272-3

ENGG 299-3 Engineering Economics 2-1-0

(To be developed by the Department of Economics)

Rationale

This course is a requirem^ of the CAB and covers a widely accepted group of topics relating to the determination of the financial viability of engineering projects. ENGG 299-3 thus complements the courses in industrial engineering, in engineering management and in design by introducing the financial elements of engineering work.

Calendar Description

Cash flow equivalence; analyses of present work, cash flow, rate of returns, depreciation, replacement, income taxes; inflation and deflation; economic decisions.

ENGG 301-3 Engineering Design 3-0-0

Rationale

While an engineering curriculum provides extensively for engineering and science content, the general processes of engineering design and problem solving are usually addressed only implicitly. This course is included to ensure that the student has a basic acquaintence with these processes.

Calendar Description

The student's skills and knowledge focus on the study of several engineering problems through the media of case studies and innovative designs. The studies involve the inter-relationship of such factors as problem definition, feasibility studies, specifications, constraints, modelling, analysis techniques, evaluation and production. A design project is an important component of the course.

Prerequisite: Upper Division Standing

ENGG 302-3 Engineering Management 3-0-0

Rationale

Other courses provide background in the methods of system and economic analysis, and engineering design and problem solving. These courses form the analytical basis for engineering management and decision making. ENGG 302-3, on the other hand, considers the qualitative side of management and engineering practice.

Calendar Description

This is an introductory and overview course on modern management concepts. Material is presented through lectures, seminars, case studies, and historical review. The basic elements, tasks, functions and activities of the management process including planning, organizing, staffing, directing and controlling, dilemmas and constraints and management style will be examined. Guest lecturers will examine topics such as collective bargaining and the psychology of management, etc. An orientation towards the particular problems of engineering practice is provided which includes the legal, ethical and professional factors and project management.

Prerequisite: Upper Division Standing.

ENGG 341-3 Systems Dynamics 3-0-0

Rationale

It is critical that an engineer have a deep appreciation of the dynamical nature of engineering structures and processes and societal and biological systems generally. The objective of this course is to provide the depth of understanding which is associated with a capability to analyse such systems. This study of linear system analysis also provides necessary background for subsequent courses in control systems, and process analysis and design.

Calendar Description

Properties of linear systems. Linear dynamic models of engineering systems. Applications of the Laplace transform. Transfer functions. Block diagrams. Frequency and time response. Effects of feedback on system response. System simulation with analog and digital computers.
Prerequisite: MATH 310-3.

ENGG 401-1 Engineering Project A

Rationale

The Engineering Project provides an opportunity for the student to deepen his knowledge of some specialized area of his chosen field and to sharpen his analysis and synthesis skills. However, the project should also be conducted and managed soundly. To ensure that this aspect receives suitable attention, the management component is separated for special attention as ENGG 401-1. Responsibility for assessing the student's performance in this part of his project work rests with the Faculty of Engineering (or equivalent group) rather than the student's major department.

Calendar Description

This course is taken together with the first part of the Engineering Project. As part of that project the student is required to prepare a management proposal and to deliver an oral progress report. A satisfactory level of performance in these two portions of the Engineering Project constitutes the requirement for ENGG 401-1.

Prerequisite: Concurrent registration in semester 7 of an engineering program.

ENGG 420-3 Forest Operations 3-0-0

A survey of forest operations and engineering. Tree harvesting: felling, off-road transportion, processing, and logging machines. Transportation: off-highway vehicular mobility, selection of vehicles, design of forest roads. Planning, engineering and operations in the forest industries.

Prerequisite: Upper division standing.

ENGG 430-3 Engineering in Extreme Environments 3-0-0

An overview of the problems and special approaches to designing and operating engineering facilities in extreme environments. Attention is given to heat, cold, winds, tides and currents, inaccessibility, lack of power sources, corrosive environments, dust, moisture, high and low barometric pressures, radiation, and other unusual conditions. Visiting lecturers and a project are components of the course.

Prerequisite: Upper division standing.

ENGG 440-3 <u>Mining Methods</u> 3-0-0

A study of various mining thods, both surface and underground mines. Mine development, layouts and methods, equipment selection and operational control. Costs and financial returns.

Prerequisite: Upper division standing.

ENGG 450-3 <u>Petroleum Extraction</u> 3-0-0

Origin, nature and behavior of petroleum reservoir fluids; elements of oil well drilling and completion; engineering of petroleum production and distribution facilities.

Prerequisite: Upper division standing.

ENGG 460-3 <u>Energy Sources</u> 3-0-0

An intensive overview of the sources of energy and their geographic distribution: petroleum, coal, hyro-electric, wind, solar, geothermal, nuclear and chemical. Emphasis will be placed on the processes by which usable fuels are obtained, net energy gains, economic and environmental factors.

Prerequisite: Upper division standing.

ENGG 470-3 <u>Energy Distribution and Utilization</u> 3-0-0

Study of the means by which energy is distributed and the relative effectiveness of energy transportation. Utilization and conservation of energy; interchangebility of various forms of energy. Energy systems.

CO-OP PRACTICUM COURSES

ENGG 290-0 Job Practicum I

This is the first semester of work experience in a Co-operative Education program available to Engineering students.

Prerequisite: Students must apply to the Faculty Co-op Co-ordinator at least one semester in advance. They normally will be required to have completed 50 hours of credit with a G.P.A. of 2.5.

ENGG 390-0 Job Practicum II

This is the second semester of work experience in a Co-operative Education program available to Engineering students.

Prerequisite: ENGG 290 and 70 hours of credit. Students must apply to the Faculty Co-op Co-ordinator at least one semester in advance.

ENGG 391-0 Job Practicum III

This is the third semester of work experience in a Co-operative Education program available to Engineering students.

Prerequisite: ENGG 390. Students must apply to the Faculty Co-op Co-ordinator at least one semester in advance.

ENGG 490-0 Job Practicum IV

This is the fourth semester of work experience in a Co-operative Education program available to Engineering students.

Prerequisite: ENGG 391. Students must apply to the Faculty Co-op Co-ordinator at least one semester in advance.

CIVIL ENGINEERING COURSE DESCRIPTIONS

CIVE 211-1 Civil Engineering Laboratory A 0-0-2

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 3 of the civil engineering program.

CIVE 212-2 Civil Engineering Laboratory B 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 4 of the civil engineering program.

CIVE 220-4 Structural Analysis 3-1-0

Stability and determinacy of structures; analysis of plane and space trusses; deflections of structures by virtual work; Castigliano and conjugate beam methods; Maxwell-Betti reciprocal theorem; cables, suspension bridges and three hinged and layered influence lines, approximate analysis of indeterminate structures. Matrix methods of analysis of determinate structures.

Prerequiste: MATH 265-3

CIVE 271-2 Surveying 1-0-3

Plane surveying; route surveying, practical astronomy, statistical treatment of data, horizontal and vertical curves. Field methods secondary triangulation; base line measurements; cross sectioning and earthwork; highway/railway layouts, electronic distance measurements. Lectures and field work.

Prerequisite: MATH 152

CIVE 311-2 Civil Engineering Laboratory C 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 5 of the civil engineering program.

CIVE 312-1 Civil Engineering Laboratory D 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 6 of the civil engineering program.

CIVE 320-3 Structural Design in Steel & Timber 3-0-0

Loads acting on structures; properties of steel and timber, steel and timber specifications, design of members and structure in steel

Prerequisite: CIVE 220

CIVE 321-3 Reinforced Concrete I 3-0-0

Ultimate strength design of reinforced concrete beams, columns, footings and slabs.

Prerequisite: MATH 265

CIVE 331-3 Soil Mechanics 3-0-0

Soil classifications, site investigation; principle of effective stress; theories of steady seepage and consolidation; compaction of soils; mechanical properties of soils; introduction to the applications of the theories of elasticity and plasticity.

Prerequisites: MATH 265, GEOG 112

CIVE 340-3 Hydraulics 3-0-0

Energy losses due to fric n, change in cross-section and alignment. Water and surge tanks. Open channel flow, sediment transport, erosion and waves. Spillways, weirs and outlet works. Hydraulic models, gravity and arch dams Harbour shore protection, irrigation river works and drainage studies.

Prerequisite: MATH 362-3

CIVE 350-3 Transportation Engineering I 3-0-0

Characteristics of transportation systems; rail, road highway, airway, waterway and pipeline; evaluation of transportation projects and systems, urban transportation analysis and prediction, traffic studies, highway and intersection capacity, characteristics of traffic flow, traffic control principles.

CIVE 401-2 Engineering Project A 0-0-4

As part of the final year program, each student is required to select and complete a major project in engineering analysis, design, development or research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgement. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Each student is required to submit his or her engineering project proposal and the name of the faculty member who has agreed to supervise the work to the Chairman of his or her department within three weeks from the beginning of the semester.

As described elsewhere a portion of the work on this project will constitute part of the requirements for ENGG 100-6 and 401-1.

Corequisite: ENGG 401-1

CIVE 402-3 Engineering Project B 0-0-6

A continuation of CIVE 401-2.

CIVE 411-4 Engineering Laboratory E 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 7 of the civil engineering program.

CIVE 412-4 Engineering Laboratory F 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 8 of the civil engineering program.

CIVE 420-3 Intermmediate Structural Analysis & Design 3-0-0

Analysis of statically indeterminate structures; energy methods, slope-deflection, moment distribution; column analogy, matrix methods, influence lines. Elastic and plastic behaviour, limit states design, design of composite structures.

Prerequisite: CIVE 320-3

CIVE 421-3 Advanced Structural Analysis & Design

Advanced topics in the analysis and design of steel, wood, masonry, and reinforced concrete structural systems.

Prerequisite: CIVE 420-3

CIVE 423-3 Highway Engineering 3-0-0

Geometric design of highw s and roads: drainage; soil engineering including soil stabilization; bituminous materials; rigid and flexible pavement design; construction of pavements.

Prerequisite: CIVE 331-3

CIVE 430-3 Soil Engineering 3-0-0

Stability of natural slopes, cuts and embankments; theories of earth pressure; design of temporary excavations and earth retaining structures; settlements of foundations; bearing capacity of foundations; pile foundations.

Prerequisite: CIVE 331-3

CIVE 431-3 Geotechnical Design 3-0-0

Design and analysis of shallow and deep foundations and retaining structures. Slope stability of embankments and cuts including foundation excavations. Special problems in dewatering and underpinning.

Prerequisite: CIVE 430-3

CIVE 432-3 Rock Mechanics 3-0-0

Cuts and tunnels in rock with mining applications. Rock stability, elastic and plastic deformations. Fault zones, ground water problems.

Prerequisites: CIVE 331-3

CIVE 440-3 Hydrology 3-0-0

Hydrologic cycle, analysis of precipitation and stream flow data, precipitation-runoff relationships, ground water, river behaviour.

Prerequisites: CIVE 340-3

ELECTRICAL ENGINEERING COURSE DESCRIPTIONS

ELEC 211-2 Electrical Engineering Laboratory A 0-0-4

Experiments and laboratory projects appropriate to semester III of the electrical engineering program.

Corequisite: ELEC 250-3

ELEC 212-2 Electrical Engineering Laboratory B 0-0-4

Experiments and laboratory projects appropriate to semester IV of the electrical engineering program.

Corequisite: Registration in semester 4 of the electrical engineering program.

ELEC 221-3 Analog and Digital Electronics 3-0-0

A course which treats the introductory aspects of electronics. Topics covered are: basic properties of semi-conductor diodes and transistors; biasing circuits; linear amplifiers; logic gates; bistable circuits; multi-stage circuits and loading. Applications of digital circuits in computing and control.

Prerequisite: PHYS 121-3, MATH 152-3

ELEC 222-3 Electronic Design I 3-0-0

This course builds upon the material of ELEC 221-3 with increasing emphasis on design as the course progresses. Associated laboratory work is design oriented and includes project activities. Topics: Bipolar and field-effect transistors; characteristics, biasing, temperature effects and compensation. Linear amplifiers, single and cascaded stages; differential stage; frequency response, tr ient response and bandwidth considerations. Power amplifier stages and frequency multipliers. Linear integrated circuits. Feedback and oscillation; oscillator design. Bipolar and MOS transistor switches; logic gates; flip-flops and trigger circuits. Timing and waveform processing circuits; multivibrators. Memory circuits, registers and counters.

Prerequisites: ELEC 221-3, 212-2

ELEC 250-3 Basic Electrical Engineering 3-0-0

Nature and properties of electrical circuits; basic circuit elements; voltage and current sources; Kirchoff's laws; linearity and superposition; Thevenin and Norton Theorems. AC signals and phasors. AC steady state circuit analysis: impedance, admittance and transfer properties; frequency response; detailed treatment of first order (RL and RC) circuits; properties of LCR circuits. DC circuits. Basic characteristics of electrical generators, motors, transformers and transmission lines. Electrical power distribution; power factor.

Prerequisite: PHYS 121-3, 131-3, Corequisite: MATH 251-3

ELEC 260-3 Microprocessor Systems 1-3-0

A workshop course taken in association with appropriate laboratory work which aims to apply the student's basic background in electronics and computing to the design of mini and micro-processors for process and system control. Lectures stress topics in real-time computing: input/output via program control, priority and vectored interrupts, direct memory access, peripherals; system architecture.

Prerequisites: CMPT 103-3, 105-3, computing experience, ELEC 221-3

ELEC 311-3 Electrical Engineering Laboratory C 0-0-6

Experiments and laboratory projects appropriate to semester 6 of the electrical engineering program.

Corequisite: Registration in semester 5 of the electrical engineering program.

ELEC 312-3 Electrical Engineering Laboratory D 0-0-6

Experiments and laboratory projects appropriate to semester VI of the electrical engineering program.

Corequisite: Registration in semester 6 of the electrical engineering program.

ELEC 332-3 Electrical Power Generation and Distribution 3-0-0

Review of AC circuits, power factor, electrical generators and motors. Synchronous and induction motors (single and three-phase), d.c. motors: equations, equivalent circuits, operating characteristics, starting, speed control. Power transformers: characteristics, selection and design. Power semi-conductors: characteristics and ratings. Power conversion. Transmission lines: characteristics, losses. Distribution system configuration.

Prerequisite: ELEC 250-3

ELEC 342-3 Control Systems I 3-0-0

Review of Laplace transfo. techniques. Effects of feedback: frequency response, pole-zero positions. Compensation design: root locus, Bode plots. State variables: formulation, solution of linear systems. Examples of simple second-order non-linear systems. Discrete time systems, Z-transforms, signal reconstruction, sample-and-hold circuits. Introduction to optimum control solution of linear quadratic problem.

Prerequisite: ENGG 341-3

ELEC 371-3 Digital Systems 3-0-0

Discrete-time systems, the Z-transform. Analog-to-digital and digital-to-analog conversion. Digital system architectures. Applications in control, filtering, electronics, signal processing.

Prerequisites: ELEC 260-3, corequisite ELEC 342

ELEC 401-2 Electrical Engineering Project A 0-0-4

As part of the final year program, each student is required to select and complete a major project in engineering analysis, design, development or research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgement. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Each student is required to submit his or her engineering project proposal and the name of the faculty member who has agreed to supervise the work to the Chairman of his or her department within three weeks from the beginning of the semester.

As described elsewhere a portion of the work on this project will constitute part of the requirements for ENGG 100-6 and 401-1.

Corequisite: Registration in semester 7 of the electrical engineering program, ENGG 401.

ELEC 402-3 Electrical Engineering Project B 0-0-6

A continuation of ELEC 401-2.

Prerequisite: ELEC 401-2.

ELEC 411-4 Electrical Engineering Laboratory E 0-0-8

Experiments and laboratory projects appropriate to semester 7 of the electrical engineering program.

Corequisite: Registration in semester 7 of the electrical engineering program.

ELEC 412-4 Electrical Engineering Laboratory F 0-0-8

Experiments and laboratory projects appropriate to semester 8 of the electrical engineering program.

Corequisite: Registration in semester 8 of the electrical engineering program.

ELEC 421-3 Electronic Design II 3-0-0

The transistor is described in terms of its major characteristics when employed as a linear active device in signal amplification. Biasing, temperature compensation and bandwidth limitations are treated as well as class A, class B and class C amplifiers. Frequency multipliers, feedback leading to the design of oscillators, and modulation and demodulation completes the linear part of th course. The use of the transistor as a switch in Schmitt Triggers, multi-vibrators, NOR and NAND gates is discussed. Frequency division, shift registers and counters are treated. The application of other devices, such as four-layer diodes, SCR and UJT's is included. Associated laboratory work is completely project-oriented and each student is expected to design and construct four circuits to meet given specifications.

Prerequisite: ELEC 222-3

ELEC 425-3 Electronic System Design 3-0-0

Aspects of design of digital and analog integrated circuits as circuit blocks for the realization of required system functions are treated, with project activities in the laboratory. Topics include differential amplifiers; operational amps - non-ideal aspects; slew rate, gain error, sensitivities. Active filter design. D/A and A/D conversion. MSI and LSI digital circuits, combinational and sequential: decoders, encoders, multiplexers, ROM's, counters, controllers.

Prerequisite: ELEC 322-3

ELEC 432-3 Power Systems 3-0-0

Introduction to system concepts; aspects of power system planning and operation. Energy sources; environmental and resource implications. Per-unit and coordinate systems. Representation of equipment such as generators, transformers and transmission lines in system analysis. Analysis of imbalanced systems and faults. Voltage and reactive power control. Load/frequency control. Power transfer and system stability. Introduction to load flow methods. High voltage dc transmission.

Prerequisites: ELEC 231-3, 332-3

ELEC 435-3 <u>High Voltage Engineering</u> 3-0-0

Nature and origin of high voltage surges encountered on power systems. Travelling waves on transmission systems; insulation engineering; electrostatic fields in high voltage apparatus, insulation failure; corona; insulation testing; circuit breakers and surge protection devices; insulation ordination.

Prerequisite: ELEC 332-3

ELEC 441-3 <u>Communication Systems</u> 3-0-0

Representation of signals; Fourier series; Fourier transforms; Laplace transforms; time and frequency convolution. Amplitude modulation theory, circuits and systems; single sideband; vestigal sideband. Operational mathematics for non-stochastic signals; correlation; energy spectra. Sampling theorem; time division multiplexing; discrete Fourier transforms. Angle modulation; phase and frequency modulation theory, circuits and systems. Television and facsimile waveforms, spectra and modulation methods. Characteristics and uses of classical, transversal and recursive filters. Noise in circuits and systems. Pulse code modulation and delta modulation.

Prerequisites: ENGG 341-3, MATH 272-3

ELEC 443-3 Data Communications 3-0-0

Review of probability anc ındom variables. Digital modulation and transmission: modems, signal-to-noise ratios and error rates. Data networks: circuit/message/packet switching. Data codes. Network functions: modulation, multiplexing, concentration, polling. Synchronous and asynchronous transmission. Error detection. Protocols: SNA, HDLC, X.25. Examples of public data networks.

Prerequisite: ELEC 441-3

ELEC 464-3 High Frequency Electronics 3-0-0

Frequency domain, signal analysis, modulation theory (AM, FM, Pulse), transmission lines and waveguides, microwave devices, travelling wave devices. An introduction to the theory of radiation, antennae and wave propagation, and microwave scattering theory. The design of complete communication systems incorporating microwave, optical and sattelite channels.

MECHANICAL ENGINEERING COURSE DESCRIPTIONS

MECE 212-1 Mechanical Engineering Laboratory A 0-0-2

Experiments, laboratory projects, supervised analysis and design session, appropriate to semester 4 of the mechanical engineering program. Corequisite: Registration in semester 4 of the mechanical engineering program.

MECE 230-3 Engineering Materials 3-0-0

Introduction to the science of materials relating their mechanical, thermal, electronic and chemical properties to atomic, molecular and crystal structure. Ceramic and metallic crystals, glasses, polymers and composite materials. Multi-phase materials, strengthening processes. Laboratories include mechanical properties of metals and polymers, micro structure, heat treatment of steel, corrosion.

MECE 310-3 Analysis and Design of Machines 3-0-0

Velocities and acceleration in plane mechanisms. Balancing of rotating and reciprocating machinery. Gears and gear trains. Introduction to the selection of components and machine design.

Prerequisite: MATH 265-4

MECE 311-2 Mechanical Engineering Laboratory B 0-0-4

Experiments, laboratory projects, supervised analysis and design session, appropriate to semester 5 of the mechanical engineering program. Corequisite: Registration in semester 5 of the mechanical engineering program.

MECE 312-3 Mechanical Engineering Laboratory C 0-0-6

Experiments, laboratory p jects, supervised analysis and design session, appropriate to semester 6 of the mechanical engineering program. Corequisite: Registration in semester 6 of the mechanical engineering program; MECE 370-2.

MECE 320-3 Heat Transfer and Fluid Mechanics 3-0-0

Review of the fundamental equations for one-dimensional ideal fluid flow, dimensional analysis and similarity, introduction to boundary layers, causes of drag, one dimensional steady isentopic flow, normal shock waves, open channel flow. One-dimensional steady heat conduction, elements of potential theory for steady two-dimensional heat conduction and fluid flow, analog methods, introduction to convection and radiation heat transfer. Prerequisites: PHYS 344-3, ENME 362-3

MECE 370-2 Mechanical Measurements 2-0-0

Characterization and behavior of typical measuring systems. Transducers and their response to steady and transient phenomena. Selected experiments in various fields of mechanical engineering to illustrate typical measurement situations.

Prerequisite: MATH 152-3

MECE 401-2 Mechanical Engineering Project A 0-0-4

As part of the final year program, each student is required to select and complete a major project in engineering analysis, design, development or research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgement. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Each student is required to submit his or her engineering project proposal and the name of the faculty member who has agreed to supervise the work to the Chairman of his or her department within three weeks from the beginning of the semester.

As described elsewhere a portion of the work on this project will constitute part of the requirements for ENGG 100-6 and 401-1.

Corequisite: Registration in semester 7 of the mechanical engineering program, ENGG 401.

MECE 402-3 Mechanical Engineering Project B 0-0-6

A continuation of MECE 401-2.

Prerequisite: MECE 401-2.

MECE 410-3 Vibrations and Acoustics 3-0-0

Free and forced vibration of single degree of freedom systems with and without damping, vibration isolation. Free vibration of two degrees of freedom lumped mass systems; vibration absorption; beam vibrations. Sound waves, sound sources; subjective aspects of noise.

Prerequisites: MATH 310, 314

MECE 411-2 Mechanical Engineering Laboratory D 0-0-4

Experiments, laboratory projects, supervised analysis and design session, appropriate to semester 7 of the mechanical engineering program.

Corequisite: Registration in semester 7 of the mechanical engineering program.

MECE 412-4 Mechanical Engineering Laboratory E 0-0-8

Experiments, laboratory projects, supervised analysis and design session, appropriate to semester 8 of the mechanical engineering program. Corequisite: Registration in semester 8 of the mechanical engineering program.

MECE 420-3 Engineering Thermodynamics 3-0-0

Mixtures of perfect gases and vapours, psychometry, combustion processes, differences between real and ideal cycles, gas cycles and vapour cycles for power and refrigeration plant, principles of turbomachines. Prerequisite: PHYS 344-3

MECE 423-3 Heating, Ventilating and Air Conditioning 3-0-0

Concepts and techniques in refrigeration and heating. Moisture and temperature control. The removal of pollutants. Prerequisite: ENME 362

MECE 442-3 Manufacturing Processes 3-0-0

The principles of manufacturing unit processes including casting, forming, machining and joining. Interactions between design, materials (metals, polymers, ceramics) and processes. Advantages and limitations, relative costs and production rates of competitive processes. Prerequisite: upper division standing.

MECE 482-3 <u>Design of Machine Components</u> 3-0-0

Analysis and design of machine components, belts, brakes, clutches, gears, cams, springs, governors, Design Project.

Prerequisite: MATH 265, MECH 310

MECE 497-3 <u>Production Systems</u> 3-0-0

The meaning of production. The economist's and engineer's approach to production; the systems approach. Production as materials processing and information processing. Characteristics of production operations: their energy, space, material yield, environmental, control and scale implications. Introduction to the basic features of production systems and methods of modelling their operation; the material flow, information and control systems. Forecasting, inventories, service level and its measurement, periodic and continuous review inventory models, ABC analysis, aggregate inventory models. The role of inventories in physical distribution. Inventories in manufacturing: requirements planning vs order point control. Planning production capacity. Production control and scheduling.

Prerequisite: upper division standing.

CHEMICAL ENGINEERING COURSE DESCRIPTIONS

CHME 211-2 Chemical Engineering Laboratory A 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 3 of the chemical engineering program. Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Prerequisite: CHEM 201

CHME 212-2 Chemical Engineering Laboratory B 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 4 of the chemical engineering program. Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Prerequisite: CHEM 115, (CHEM 251)

CHME 311-3 Chemical Engineering Laboratory C 0-0-6

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 5 of the chemical engineering program. Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Corequisite: Registration in semester 5 of chemical engineering.

CHME 312-4 Chemical Engineering Laboratory D 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 6 of the chemical engineering program.

Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Corequisite: Registration in semester 6 of chemical engineering.

CHME 370-3 Measurement of Chemical Processes 3-0-0

An introduction to instrumental methods of chemical analysis including optical, electrochemical, radiochemical, chromatographic and spectroscopic methods.

Prerequisites: CHME 311-3

CHME 401-2 Chemical Engineering Project A 0-0-4

As part of the final year program, each student is required to select and complete a major project in engineering analysis, design, development or research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgement. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Each student is required to submit his or her engineering project proposal and the name of the faculty member who has agreed to supervise the work to the Chairman of his or her department within three weeks from the beginning of the semester.

As described elsewhere a portion of the work on this project will constitute part of the requirements for ENGG 100-6 and 401-1.

Prerequisite: registration in semester 7 of the chemical engineering program.

[illegible] Chemical Engineering Project [illegible] [illegible]

[illegible] [illegible] 401 [illegible]

[illegible] [illegible]

[illegible] Chemical Engineering [illegible] [illegible]

[illegible] projects, supervised analysis and design [illegible]

[illegible] [illegible]

[illegible] the chemical engineering content [illegible]

[illegible] taken in other departments.

[illegible] registration in semester [illegible] of chemical engineering [illegible]

[illegible] 0-6-6

[illegible] projects, supervised analysis and design

[illegible] semester [illegible] the chemical engineering program.

[illegible] on developing the chemical engineering content [illegible]

[illegible] other departments.

[illegible] semester [illegible] chemical engineering.

[illegible] Introduction to Biochemical Engineering [illegible]

[illegible] microbiology and biochemistry

[illegible] process industries and environmental pollution.

[illegible] characteristics of microorganisms.

[illegible] metabolism and

[illegible]

[illegible]

CHME 402-3 Chemical Engineering Project B 0-0-6

A continuation of CHME 401-2.

Prerequisite: CHME 401-2.

CHME 411-4 Chemical Engineering Laboratory E 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 7 of the chemical engineering program. Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Corequisite: Registration in semester 7 of chemical engineering.

CHME 417-4 Chemical Engineering Laboratory F 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 8 of the chemical engineering program. Particular emphasis is placed on developing the chemical engineering context and application of subjects taken in other departments.

Corequisite: Registration in semester 8 of chemical engineering.

CHME 430-3 Introduction to Biochemical Engineering 3-0-0

An introduction to those aspects of microbiology and biochemistry relevant to biological process industries and environmental pollution. Classification and growth characteristics of microorganisms. Physico-chemical properties of biological compounds. Metabolism and biochemical kinetics.

Prerequisite: CHEM 252, CHME 431.

CHME 431-3 <u>Chemical Reaction and Process Design I</u> 3-0-0

Mass transfer by diffusion and convection; applications to both stage-wise and continuous separation processes such as distillation, extraction and absorption; analogies between momentum, energy and mass transport. Design examples.

Corequisite: Registration in semester 7.

CHME 432-3 <u>Chemical Reaction and Process Design II</u> 3-0-0

Homogeneous reactors: batch, CSTR, tubular flow systems, ideal models, residence time distributions in ideal reactors, temperature effects, steady states, semi-batch systems, non-ideal behavior. Hetrogenious catalysis: mass transfer effects, catalytic rate equations, fixed and fluidized bed reactors. Design considerations.

Prerequisites: CHME 431-3

CHME 440-3 <u>Introduction to Extractive Metallurgy</u> 3-0-0

The physical and chemical characteristics of ores and intermediates. An introduction to pyrometallurgy, hydrometallurgy and electrometallurgy. A survey of extraction processes. The principles of thermodynamics and kinetics applied to metallurgical processes.

Prerequisite: CHEM 361, CHME 431.

CHME 450-3 <u>Chemical Process Control</u> 3-0-0

Modelling of chemical process systems, simulation, linear and nonlinear analysis, process control equipment, sampled data systems, computer control.

Prerequisites: ELEC 342, ELEC 260, CHME 431.

ENGINEERING SCIENCE COURSE DESCRIPTIONS

ENSC 212-2 Engineering Science Laboratory A 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 4 of the Engineering Science Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 4 of engineering science program.

ENSC 311-2 Engineering Science Laboratory B 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 5 of the Engineering Science Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 5 of engineering science program.

ENSC 312-3 Engineering Science Laboratory C 0-0-6

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 6 of the Engineering Science Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 6 of engineering science program.

ENSC 401-2 Engineering Science Project A 0-0-4

As part of the final year program, each student is required to select and complete a major project in engineering analysis, design, development or research. The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgement. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. Each student is required to submit his or her engineering project proposal and the name of the faculty member who has agreed to supervise the work to the Chairman of his or her department within three weeks from the beginning of the semester.

As described elsewhere a portion of the work on this project will constitute part of the requirements for ENGG 100-6 and 401-1.

Corequisite: Registration in semester 7 of the engineering science program, ENGG 401.

ENSC 402-3 Engineering Science Project B 0-0-6

A continuation of ENSC 401-2.

Prerequisite: ENSC 401-2.

ENSC 411-3 Engineering Science Laboratory D 0-0-6

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester 7 of the Engineering Science Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 7 of engineering science program.

ENSC 412-4 Engineering Science Laboratory E 0-0-8

Experiments, laboratory p jects, supervised analysis and design sessions appropriate to semester 8 of the Engineering Science Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 8 of engineering science program.

Engineering Science (Mechanics) Course Descriptions

ENSC 213-2 Engineering Mechanics Laboratory A 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester of the Engineering Mechanics Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 4 of the Engineering Science (Mechanics) Program.

ENSC 313-2 Engineering Mechanics Laboratory B 0-0-4

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester of the Engineering Mechanics Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 5 of the Engineering Science (Mechanics) Program.

ENSC 314-3 Engineering Mechanics Laboratory C 0-0-6

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester of the Engineering Mechanics Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 6 of the Engineering Science (Mechanics) Program.

ENSC 413-4 Engineering Mechanics Laboratory D 0-0-8

Experiments, laboratory projects, supervised analysis and design sessions appropriate to semester of the Engineering Mechanics Program. Particular emphasis is placed on developing the engineering science context and application of the subjects taken in various departments.

Corequisite: Registration in semester 7 of the Engineering Science (Mechanics) Program.

Engineering Mechanics Course Descriptions

The course descriptions of existing Engineering Mechanics courses offered by the Mechanics group in the Department of Mathematics are included for information. These courses are currently designated MATH; when the Engineering Programs are implemented, a change of designation to ENME (for Engineering Mechanics) will be requested.

ENME 262-4 Engineering Mechanics I (Statics) 3-2-0

Vectors. Reduction of force systems, equipollent systems of forces. Plane statics, free body diagram trusses, frames, friction. Statics in space. Beams and cables. Kinematics of particles.
Prerequisite: MATH 152-3.

ENME 263-4 Engineering Mechanics II (Dynamics) 3-2-0

Centroids, moments of inertia. Principles of dynamics; work and energy. Newton's laws. Kinematics and kinetics of rigid bodies, plane motion of rigid bodies (dynamics of rigid bodies is the main topic for this course).
Prerequisite: ENME 262-4; MATH 251-3.

ENME 265-4 Engineering Mechanics III (Strength of Materials) 3-1-0

An introductory course dealing with fundamental concepts of stress, strain and constitutive equations and applications to torsion, beam bending and column buckling.
Prerequisite: MATH 152-3; ENME 262-4.

ENME 362-3 Fluid Mechanics T 3-1-0

Fluid properties, fluid p. .ssure, hydrostatics. Equations of motion, Bernoulli equation, rotational and irrotational flow, similarity and dimensional analysis of fluid flows, laminar and turbulent flows, flow measurement.

Prerequisite: ENME 263; MATH 252.

APPENDIX A

Canadian Accreditation Board

Requirements for an Engineering Program

g) Numbers of students enrolled (i) in all of the engineering programs within the institution, (ii) in the program being evaluated, with breakdowns by level (year) over the latest five-year period, and (iii) class sizes and sectioning policies.

h) Descriptions of unique features such as enrolments in cooperative industry-university programs, engineering apprenticeship programs and other practical experience opportunities for students.

2.3 QUALITATIVE ASSESSMENT

The institution shall assist a visiting accreditation team to make a qualitative evaluation by providing:

2.3.1 The institution's own statement of goals, and evaluation of curricula relative to its own goals for engineering education in particular and for the program being evaluated.

2.3.2 A statement normally prepared by the Dean of how the engineering academic unit is developing the student's understanding of the role and perspective of the professional engineer: the organization, the means and methods, the people responsible and their qualifications (if not otherwise provided) and how the achievement of the objectives is being assessed. Separate departments might identify these roles in different ways, and the statement of the Dean should indicate how each department perceives the role and perspective of the professional engineer.

2.3.3 Opportunities for face-to-face interviews with administrative officers such as the Dean or Director of Engineering, Department Head or Chairman, Chief Librarian, to evaluate directions of leadership.

2.3.4 Opportunities for face-to-face interviews with individuals and groups of faculty members, to evaluate professional attitudes, motivations, morale, and the balance of opinions concerning theoretical and practical elements of curriculum.

2.3.5 Opportunities for face-to-face interviews with individuals and groups of senior students; examples of recent examination papers, laboratory instruction sheets, student reports and theses, student records, models or equipment constructed by students, and other evidence of teaching competence.

2.3.6 Opportunities for tours of physical facilities such as laboratories, libraries and computing facilities, to evaluate the effectiveness of utilization of facilities.

2.4 PROGRAM CONTENT

In order to be considered for accreditation, engineering programs must be designed to prepare for the practice of engineering at a professional level. To assist in the identification and recognition of characteristics of engineering programs for accreditation purposes the criteria that follow have been adopted by the Board.

g) Effectif total des étudiants (i) dans l'ensemble des programmes de génie de l'université, (ii) dans le programme à évaluer, par niveau (année) pour les cinq dernières années et, (iii) taille des classes et politique de division en sections.

h) Descriptions de caractéristiques particulières telles qu'inscriptions selon des plans coopératifs industrie-université, programmes d'apprentissage en génie, et toute autre innovation tendant à favoriser les étudiants sur le plan de l'expérience pratique.

2.3 EVALUATION QUALITATIVE

L'établissement coopérera avec l'équipe d'accréditation, pour ce qui est de l'évaluation qualitative, en fournissant ce qui suit:

2.3.1 Un énoncé des objectifs qu'il se propose d'atteindre et une évaluation de ses cours par rapport à ses objectifs concernant la formation en génie et en particulier, le programme à évaluer.

2.3.2 Un énoncé, préparé par le Doyen, décrivant comment la faculté s'efforce de développer chez l'étudiant la compréhension du rôle et des objectifs de l'ingénieur: l'organisation, les méthodes, les personnes responsables et leurs qualifications (si ces dernières ne sont pas déjà disponibles) ainsi que les moyens d'évaluation des résultats obtenus dans la poursuite des objectifs. Par suite de la diversité des vues des départements, le Doyen devra indiquer dans son énoncé la façon dont chaque département perçoit le rôle et la portée des objectifs de l'ingénieur.

2.3.3 L'occasion d'interviewer personnellement les cadres supérieurs tels que le Doyen ou le directeur du génie, le chef de département et le bibliothécaire-en-chef de façon à évaluer les lignes de pensée des autorités.

2.3.4 L'occasion d'interviewer personnellement des membres du corps professoral individuellement ou collectivement afin d'en évaluer le comportement, la motivation et le moral professionnel ainsi que leurs diverses opinions sur les aspects théoriques et pratiques du programme.

2.3.5 L'occasion d'interviewer personnellement des étudiants finissants, individuellement ou collectivement; des exemplaires d'examens récents, des feuilles d'instructions de laboratoire, des rapports et des thèses d'étudiants, des maquettes ou des appareils montés par des étudiants et tout autre exemple de compétence pédagogique.

2.3.6 L'occasion de visiter les installations telles que laboratoires, bibliothèques et salles des ordinateurs, afin d'évaluer l'efficacité de leur utilisation.

2.4 LE CONTENU DU PROGRAMME

Pour être susceptibles d'une accréditation, les programmes de formation en génie doivent être conçus de façon à préparer à l'exercice de cette profession. Pour faciliter l'identification des caractéristiques des programmes de formation aux fins de l'accréditation, le Bureau a adopté les critères qui suivent.

These criteria are intended to assure an adequate foundation in science, mathematics, the humanities, social sciences and administrative studies, engineering science, engineering methods as well as preparation in a higher engineering specialization appropriate to the challenge presented by today's complex and difficult problems. They are intended to afford sufficient flexibility in science requirements so that programs requiring special backgrounds, such as in the life or earth sciences, can be accommodated. They are designed to be flexible enough to permit the expression of an institution's individual qualities and ideals. They are to be regarded as a statement of principles to be applied with judgement in each case rather than as rigid and arbitrary standards. Finally, they are intended to encourage and stimulate and not to restrain creative and imaginative programs. In any case in which the Board is convinced that well-considered experimentation in engineering education programs is under way, it shall give sympathetic consideration to departures from the criteria.

An accredited degree program (based on a normal four year Bachelor's degree program) should normally include the following:

2.4.1 **Mathematical Foundations** - *A minimum equivalent to* **one half year** *of mathematical foundations which should include elements of matrix algebra, differential and integral calculus, difference equations and differential equations, probability and statistics, and numerical analysis, it being recognized that some of the elements may have been covered at the pre-university level and considered in university entrance requirements and/or advanced standing policies*

2.4.2 **Basic Sciences** - *A minimum equivalent to* **one half year** *of basic sciences appropriate to the degree program.*

Basic science subjects are those which present in an expository way the fundamental natural sciences, the objective being an understanding of natural phenomena and relationships with little or no reference to application or exploitation, or which present deeper analytical or experimental treatments of those fundamental subjects, the objective being a more profound understanding of natural laws and relationships. These subjects will normally be based on appropriate elements of physics, chemistry, the life sciences and the earth sciences.

2.4.3 **Engineering Sciences and Design and Synthesis** - *A minimum equivalent to* **two years** *of a combination of engineering sciences and design and synthesis. Within this two year combination, engineering sciences should not be less than one half year, and also design and synthesis should not be less than one half year. This leaves one year free in which to allocate such various combinations of engineering science, design and synthesis as may be deemed desirable. (Considerable flexibility is permitted within this broad two year category. For example, on one extreme there may be one half year of engineering sciences and one and one half years of design and synthesis, or on the other extreme, there may be one and one half years of engineering sciences and one half year of design and synthesis).*

L'objectif de ces critères est d'assurer que l'étudiant recevra une formation appropriée en sciences, en mathématiques, dans les humanités et les sciences sociales et administratives, en sciences et méthodologie du génie, de même qu'une préparation de haut niveau dans sa spécialité de façon à lui permettre de faire face aux problèmes complexes et difficiles d'aujourd'hui. Il est dans l'esprit de ces critères d'assurer suffisamment de flexibilité dans les exigences en sciences, pour couvrir le cas de programmes aux besoins spéciaux comme, par exemple, en sciences de la vie ou du globe. Ils sont conçus de façon à permettre à chaque établissement de faire valoir ses qualités et ses idéaux particuliers. On doit les considérer comme un énoncé de principes qu'il faut appliquer avec discernement dans chaque cas particulier et non comme des normes rigides et arbitraires. On espère enfin qu'ils stimuleront et encourageront l'élaboration de programmes novateurs et bien imaginés. Devant l'évidence d'une expérimentation judicieuse déjà engagée sur des programmes de formation, le Bureau considèrera favorablement des écarts des normes.

Sur la base d'une durée normale de quatre ans pour un programme conduisant au grade de bachelier, un programme accrédité devrait comprendre en principe:

2.4.1 **Mathématiques de base** - Equivalence minimale d'**une demi-année** de mathématiques de base comprenant des éléments d'algèbre matricielle, de calcul différentiel et intégral, d'équations aux différences finies et d'équations différentielles, de probabilités et statistique et d'analyse numérique, étant entendu que certaines de ces matières peuvent avoir été vues au niveau pré-universitaire et reconnues lors des formalités d'inscription universitaire selon une politique d'équivalences.

2.4.2 **Sciences fondamentales** - Equivalence minimale d'**une demi-année** de sciences fondamentales appropriées au programme.

Les cours de sciences fondamentales sont ceux qui présentent de façon descriptive les sciences naturelles et physiques dans le but d'en arriver à la compréhension des lois et des phénomènes sans insister sur leur application ou leur exploitation, ou encore ceux qui, par un traitement analytique ou expérimental plus poussé du sujet, tendent vers une compréhension plus complète des lois et des phénomènes. Normalement, ces cours comportent des éléments appropriés de chimie, de physique, de biologie et de sciences du globe.

2.4.3 **Sciences du génie, conception et synthèse** - Equivalence minimale de **deux années** de cours de sciences du génie et de cours de conception et de synthèse. De ces deux années, au moins une demi-année doit être consacrée aux sciences du génie et une demi-année à la conception et à la synthèse. A l'intérieur de cette période minimale de deux ans, une année peut donc être répartie de façon à ce que l'on puisse offrir diverses combinaisons de cours de sciences de génie et de cours de conception et de synthèse. Cette catégorie (deux ans) offre une forte mesure de flexibilité. Par exemple, il y a possibilité d'offrir un ensemble d'une demi-année de cours de sciences de génie et d'une année et demie de cours de conception et de synthèse, et d'un autre côté il y a aussi possibilité d'offrir un ensemble d'une année et demie de sciences de génie et d'une demi-année de cours de conception et de synthèse.

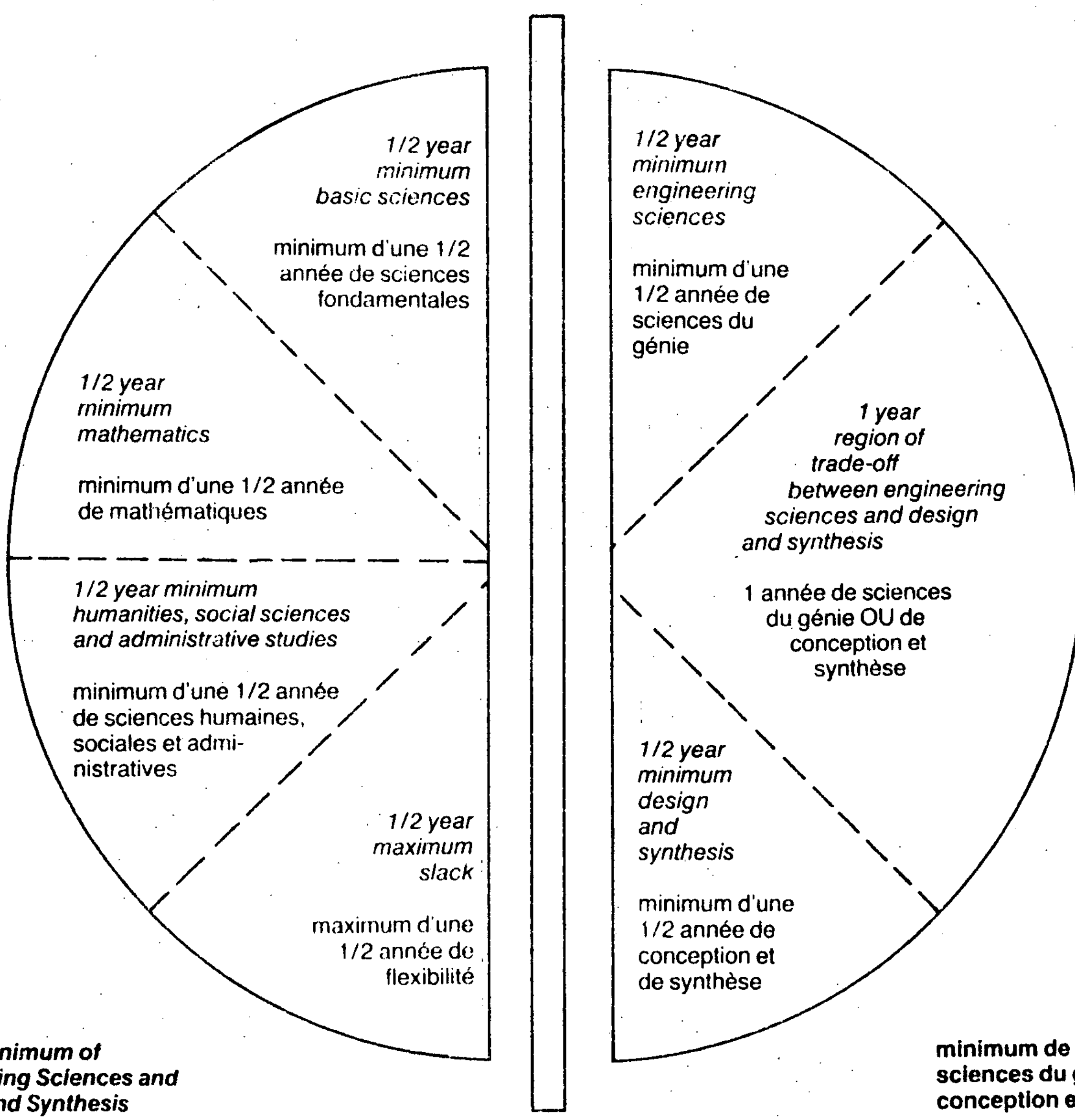
2.4.6 *In judging whether the guidelines in the various categories have been met, the nature and the quality of the work being done will be considered. To assist the Board, institutions should clearly identify in terms of the adopted definitions, the mathematical foundations, basic sciences, engineering sciences, design and synthesis and the humanities and social sciences and administrative studies components of each course being evaluated.*

2.4.7 *In assessing the time assigned to various components of the degree program, one year will be taken to consist of 26 weeks of instruction, over and above periods allotted to examinations.*

2.4.6 Afin de déterminer si les normes pour chaque catégorie sont respectées, on examinera la nature et la qualité des travaux. Pour faciliter la tâche du Bureau, les établissements devront identifier clairement dans le contexte des définitions adoptées, les composantes de mathématiques de base, de sciences fondamentales, de sciences du génie et de conception et synthèse, et d'humanités, sciences sociales et d'études administratives pour chaque cours évalué.

2.4.7 Pour l'évaluation du temps consacré aux diverses composantes, on considèrera qu'une année consiste en 26 semaines d'enseignement, à l'exclusion des périodes consacrées aux examens.

INTERPRETATION OF CAB CRITERIA
INTERPRETATION DES NORMES D'ACCREDITATION DU BCA



2-year minimum of Engineering Sciences and Design and Synthesis

minimum de 2 années de sciences du génie et de conception et synthèse

The engineering sciences are those that consist of extensions of the basic sciences through the development of (a) systematic mathematical or numerical methods, (b) representations by general models or theories, or (c) simulation, instrumentation or other experimental procedures, which are designed for application to the identification and solution of practical engineering problems. They should include mechanics (statics and dynamics), fluid mechanics, thermodynamics, engineering economics and they may also include various other fields such as computer programming, AC circuits, electronics, materials science, automatic control, aerodynamics, soil mechanics, transport phenomena, engineering oceanography and other subjects depending upon the discipline.

Design and synthesis is defined according to section 2.1.4 above and should be conducted in the spirit and with special attention to 2.1.7.

2.4.4 **Humanities, Social Sciences and Administrative Studies** - *A minimum of* **one half year** *of appropriate humanities, social sciences and administrative studies. Within the limited time available and in the spirit of section 2.1.6, care must be taken to ensure the student participates in courses which deal with some of the central issues, methodologies and thought processes of the humanities and social sciences at a level which challenges the students.*

The courses chosen must also at some time explicitly address the issues put forward in section 2.1.7a) and b).

It is also desirable that the course selection be such that the student is provided with an introductory capability to apply economics and social sciences to the synthesis and design activity as laid out in section 2.1.4.

Care must be taken that engineering science subjects which have a close relationship with the social sciences, such as operations research, human factors engineering, transportation planning, etc . . . , not encroach on this one half year component.

Because of the variety of approaches which can be taken, and the evolving nature of these studies, it is important that the administrative structure of the program be such that effectiveness can be monitored without inhibiting innovation and development of this part of the program content.

2.4.5 *The balance of the normal four years required to achieve an integrated and well-rounded engineering curriculum should be used to expand the foundations beyond the minimal limits, and to build special courses for the various branches of engineering on these foundations.*

Les sciences du génie sont des prolongements des sciences fondamentales obtenus par l'élaboration (a) de méthodes systématiques, mathématiques ou numériques, (b) de représentation au moyen de théories ou de modèles généraux ou (c) de procédures expérimentales comme la simulation, l'instrumentation ou d'autres encore, lesquelles sont conçues en vue de l'identification et de la solution de problèmes pratiques de génie.

Ceci devrait inclure la mécanique (statique et dynamique), la mécanique des fluides, la thermodynamique, l'économique du génie et peut également couvrir divers autres domaines tels que la programmation d'ordinateurs, la mécanique des solides, les circuits CA, l'électronique, la science des matériaux, les servo-mécanismes, l'aérodynamique, la mécanique des sols, les phénomènes de transfert, le génie océanographique, etc., selon la nature de la discipline.

La synthèse et la conception sont définies selon l'article 2.1.4 et doivent être enseignées dans l'optique de l'article 2.1.7 et avec un soin particulier.

2.4.4 **Humanités, sciences sociales et études administratives** - Période minimale d'**une demi-année** d'humanités, de sciences sociales et d'études administratives pertinentes. Compte tenu de la limitation du temps disponible et dans l'optique de l'article 2.1.6, on s'assurera que l'étudiant suit des cours qui traitent de quelques-unes des questions fondamentales, des méthodologies et des cheminements intellectuels des humanités et des sciences sociales, à un niveau qui l'oblige à un effort satisfaisant de compréhension.

Les cours choisis doivent également s'attaquer à un moment ou à l'autre aux sujets explicités à l'article 2.1.7, a) et b).

Il est également souhaitable que le choix des cours soit tel qu'il donne à l'étudiant une certaine capacité d'appliquer des notions d'économique et de sciences sociales aux travaux de synthèse et de conception décrits à l'article 2.1.4.

L'on doit éviter que les cours de sciences du génie qui ont une relation étroite avec les sciences sociales, comme la recherche opérationnelle, l'ergonomie, l'organisation des transports, etc..., empiètent sur cette composante du programme.

Par suite de la grande variété des méthodes pédagogiques disponibles et de la nature évolutive de ces études, il est important que la structure administrative du programme soit telle qu'elle permette le contrôle de leur efficacité sans empêcher les innovations et le développement de cette composante.

2.4.5 La demi-année restante d'un programme de quatre ans, période requise afin de compléter un programme bien équilibré dans le domaine du génie, peut être utilisée au développement des matières fondamentales au delà des limites minimales et servir de base pour des cours appliqués aux diverses branches du génie.

2.4.8 The above criteria are regarded as desirable long-term standard criteria for engineering sciences and design and synthesis, to be applied to all engineering Bachelor's degree programs. However, from time to time the Board may make a short-term downward adjustment of the minimum requirements for engineering sciences and design and synthesis, in individual cases of new experimental programs. In no case will the Board relax the requirement to less than one and one half years of engineering sciences and design and synthesis combined.

2.5 ENGINEERING REGISTRATION

In the weighing of considerations for accreditation, the Board attaches central importance to.

(i) the process of educational experience of the student, as it is shaped by the curriculum and work experience,

(ii) the quality of the educational experience, as reflected by the quality of students, faculty, overall administration and facilities and

(iii) the distinguishing character of the educational experience, as reflected by the engineering competence and outlooks of faculty and advisors.

In particular, this distinguishing character is considered vital to the accreditation of any engineering degree program. The Board expects this character to be clearly exhibited.

2.5.1 The Dean of Engineering (or equivalent executive officer) is expected to provide a high order of leadership in engineering education and to be a registered engineer of high standing among his peers.

2.5.2 The Chairman of an Engineering Department (or equivalent administrative officer) is expected to provide a high order of leadership in engineering education and to be a registered engineer of high standing among his peers.

2.5.3 The Engineering Faculty Council or equivalent legislative body is expected to have effective control of all engineering degree programs, including accreditable programs such as Agricultural Engineering, Geological Engineering, Engineering Physics, and Engineering Chemistry which may be administered within other Faculties.

2.5.4 Members of an Engineering Faculty are expected to be dedicated to the maintenance and improvement of engineering education. Professors of courses in the engineering sciences or engineering design and synthesis in an accreditable engineering degree program, whether members of a Faculty of Engineering or not, are expected to have a high level of competence and to be dedicated to the aims of engineering education and the profession; in almost all cases such a dedication is expected to be reflected in their being registered engineers.

2.4.8 Dans le cas des sciences du génie et de la conception et de la synthèse, les normes ci-dessus sont considérées comme souhaitables à long terme et en principe; elles s'appliquent à tous les programmes de génie conduisant au grade de bachelier. Le Bureau pourra diminuer, à court terme, ses exigences minimales au sujet de l'ensemble comprenant les sciences du génie et la conception et la synthèse, dans des cas individuels de nouveaux programmes expérimentaux. Toutefois, le Bureau n'abaissera pas à moins d'une année et demie, sous aucun prétexte, ses exigences minimales pour l'ensemble précité.

2.5 APPARTENANCE A L'ASSOCIATION/ORDRE

Dans la pondération des exigences de l'accréditation, le Bureau met l'emphase principale sur:

(i) la formation que fournissent à l'étudiant son programme d'études et son apprentissage pratique.

(ii) la qualité de cette formation qui découle de celle des étudiants, du corps professoral, de la direction universitaire et des installations matérielles et

(iii) le caractère distinctif que confèrent à cette formation la compétence du corps professoral et la perception qu'il a de la profession.

On considère ce caractère distinctif comme une condition essentielle de l'accréditation. Le Bureau juge que ce caractère doit apparaître clairement.

2.5.1 Le Doyen de la faculté de génie ou son équivalent devrait être un chef de file reconnu dans le domaine de l'éducation et jouir comme ingénieur de la plus haute estime de ses pairs;

2.5.2 Le Directeur de département ou son équivalent devrait également être un chef de file reconnu dans le domaine de l'éducation et jouir comme ingénieur de la plus haute estime de ses pairs;

2.5.3 La faculté de génie, ou l'unité pédagogique et administrative équivalente, doit, par son conseil ou tout autre corps correspondant, exercer un contrôle effectif sur l'esprit et le contenu de tous les programmes susceptibles d'une accréditation, y compris le génie rural, le génie géologique, le génie physique, la chimie appliquée ou autres qui pourraient relever, administrativement, de facultés différentes;

2.5.4 Les membres du corps professoral de la faculté de génie doivent faire preuve d'un engagement global envers le progrès de la formation en génie. En particulier, les professeurs chargés des cours de synthèse et de conception ainsi que des enseignements en sciences de génie dans un programme susceptible d'accréditation, qu'ils appartiennent ou non à la faculté de génie, doivent faire preuve d'une grande compétence et souscrire aux objectifs de la profession et de la formation de l'ingénieur; dans pratiquement tous ces cas, cet engagement devrait normalement se manifester par l'appartenance à l'Association/Ordre des ingénieurs.

Appendix B

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