

Draft #3

**Proposal for Amended Program:
Mechanical Engineering Major, Bachelor of Engineering**

RESOURCE IMPLICATIONS

Instructional Costs

This proposal includes one new course. It replaces a course that becomes a required course in Term 6 of three of the four new technical streams. The total number of courses required by all students in the major of Mechanical Engineering remains unchanged. All of the other courses in the four new technical streams are currently offered as technical elective courses. The operation of four technical streams (in the place of the present OOG option) will require one additional teaching task that will be accommodated as part of the overall growth plan for the Faculty.

Library Holdings and/or Other Resources Required

[Does any of the information sources of the University, including holdings at the Queen Elizabeth II Library, the Health Sciences Library, the Ferriss Hodgett Library (Grenfell Campus), the Dr. C.R. Barrett Library (Marine Institute), and the sources on the internet to which the library has leased access, need to be augmented in anticipation of the course/program being proposed? Written evidence of consultation with the relevant librarian and information regarding the currency of the information sources **must** be included - **to follow**].[DELETE]

The costs associated with new program/course(s) can be met from within the existing budget allocation or authorized new funding for the Faculty of Engineering and Applied Science.

Signature of the Dean: _____

Date: _____

EXECUTIVE SUMMARY

The sequence of courses within the existing major of Mechanical Engineering is being adjusted, in order to improve the delivery of the curriculum. The changes will lead to a more logical sequence of courses in mechatronics, controls, fluid mechanics and statistics.

Four "technical streams", using existing courses, will replace the Offshore Oil and Gas Engineering option. This will offer improved flexibility to students in their choice of courses.

The opportunity is being taken to correct a minor inconsistency in the listing of complementary studies electives in the program tables for all majors.

PROGRAM RATIONALE

Approximately one year ago, the Mechanical Engineering Discipline formulated a vision statement and growth plan for the next five years. The mechanical discipline vision for undergraduate education is to instill a solid background in the fundamentals of mechanical engineering as well as practical and applied knowledge in key areas that support the competitive industries that are currently driving the economy of Newfoundland and Labrador. As such, four areas or themes in which the discipline can grow strategically and effectively are proposed:

- Energy Systems
- Mechatronics, Modeling, and Intelligent Systems
- Materials, Mechanics, and Design
- Petroleum Production and Operations

The goal of the proposed changes to the mechanical curriculum is to align the technical electives offered in the undergraduate program with the thematic areas identified in the mechanical engineering vision statement. The four technical streams will be comprised of one technical elective in term six, two in seven, and three in eight.

The proposed changes recognize the fact that the mechanical undergraduate students have been demanding increased flexibility in their choice of technical electives. In recognition of this, students will be permitted to take courses outside of their chosen stream. It is worth mentioning, however, that this will not always be possible due to scheduling conflicts between courses offered in different streams.

The mechanical students currently enrolled in the OOG option have been particularly adamant in their call for increased flexibility in their choice of technical electives. There have been numerous requests to the mechanical discipline chair to authorize technical electives outside the current slate of OOG courses. Due to accreditation issues these requests are frequently denied.

By converting the current OOGÉ option to a technical stream (i.e. Petroleum Production and Operations), students will have greater flexibility in their choice of technical electives. Moreover, students who are not pursuing the Petroleum Production and Operations technical stream will also have access to petroleum related courses without the associated accreditation issues. It is also worth noting that the importance of the energy sector to the province is highlighted in the proposed curricular changes. Two of the proposed technical streams are directly related to energy and all students will have access to energy and petroleum related courses.

Other relatively minor changes to the mechanical curriculum have been proposed in an effort to consolidate the fundamental courses in the earlier semesters. For example, Probability and Statistics (ENGI 4421) moves from term seven to term five. This change results in a better balance of math courses in the program; one math course in each of terms three, four, and five. This change also facilitates the introduction of a required course in instrumentation and design of experiments (DOE) in term seven, the rationale for which is provided with the proposal for that new course.

There are also minor changes to the thermo-fluid and mechatronics streams. These changes yield a more favorable curricular balance and prerequisite structure. For example, Fluid Mechanics I (ENGI 5961) moves to term four while Mechatronics I moves to term five. This change addresses the fact that certain basic fluid mechanics concepts (Reynolds number, laminar pipe resistance) are required in the first mechatronics course.

In an effort to better support the capstone design course in term eight, Mechatronics II moves to term seven and can now build on the Automated Control Engineering course (ENGI 6951) in term six. It is worth noting that mechanical engineering capstone design projects are increasingly of a “mechatronic” nature and frequently involve instrumentation, measurement, and experimental design. In recognition of this, a new required course in instrumentation and experimental design is proposed. This addition helps address one of the new CEAB graduate attributes (3.1.3) related to “Investigations”, which is defined as *“an ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.”*

These changes will take effect with the Class of 2016, which will be in Term 4 in 2013 Spring.

In addition, one of the complementary studies electives, ENGI 4102, is being moved from the “Required Courses” column to the “Elective Courses” column of the program charts for all majors. Most students take this complementary studies course in a semester other than Term 4. ENGI 4102 may be taken at any time prior to graduation, as is the case for some of the other complementary studies courses. However, ENGI 3101 and ENGI 7102 will remain in the “Required Courses” column, as they must be taken in Term 3 and Term 7 respectively.

Demand for the Program

Mechanical engineering has been the most popular major since the first class entered Term 3 of the present program in 2009. Students have expressed a wish for more flexibility in their elective courses.

As noted in the rationale, there have been several instances where students in the OUGE option have been denied permission to substitute non-OUGE electives for OUGE electives, due the accreditation requirements of the OUGE option. The technical streams will not have this accreditation problem.

Benefits to Students

Students will benefit from a more logical sequence of subjects, concepts and techniques. They will also benefit from a wider choice of specializations in their later semesters.

CONSULTATIONS

The Office of the Registrar has been involved in the development of this set of Calendar changes.

Consultations with the Faculty of Science, the Grenfell and Marine Institute campuses and the Library are in progress.

PROGRAM TITLE

Bachelor of Engineering

B.Eng.

PROGRAM DESCRIPTION

The sequence of courses in the last five terms of the existing major of Mechanical Engineering is being adjusted, in order to improve the delivery of the curriculum. Greater flexibility will be offered to the students with the replacement of the Offshore Oil and Gas Engineering option by four "technical streams", using mostly existing courses.

One of the complementary studies electives, ENGI 4102, is being moved from the "Required Courses" column to the "Elective Courses" column of the program charts for all majors.

COURSE DELETIONS AND ADDITIONS

No courses will be deleted.

Add the course

ENGI 7931 "Instrumentation and Experimental Design"

Convert the existing graduate special topics course ENGI 9977 to a regular graduate course (not in this proposal) and a new regular undergraduate course

ENGI 8945 "Computational Fluid Dynamics"

Assign undergraduate numbers to the existing regular graduate courses

ENGI 8965 "Advanced Fluid Dynamics" for ENGI 9901 "Fundamentals of Fluid Dynamics" and

ENGI 8946 for ENGI 9496 "Modelling and Simulation of Dynamic Systems"

Renumber the courses

ENGI 4951 "Mechatronics I" as ENGI 5952

ENGI 5927 "Mechanical Component Design I" as ENGI 6929

ENGI 5951 "Mechatronics II" as ENGI 7953

ENGI 6927 "Mechanical Component Design II" as ENGI 7927

ENGI 7928 "Computer Aided Engineering Applications" as ENGI 6928

with no change in the Calendar description (except for credit restrictions).

The prerequisite list for ENGI 6951 will need to be updated as a result.

[Note that ENGI 4421 will **not** be renumbered, as the Civil and Process majors will continue to take this course at the intended time of Term 4. ENGI 5961 and 6961 will **not** be renumbered, as the Process major will continue to take these courses at the intended times of Terms 5 and 6 respectively.]

CHANGES TO CALENDAR REGULATIONS

The Offshore Oil and Gas Engineering (OOG) Option will be replaced by four technical streams within the major of Mechanical Engineering. There will be an adjustment to the sequence of courses in Terms 4 to 8, which will require the renumbering of five courses, the assignment of undergraduate numbers to three existing graduate courses and the addition of one new course.

The complementary studies course ENGI 4102 will be removed from the column "Required Courses" in Term 4 in the program charts of all majors and placed in the column "Elective Courses" as "Complementary Studies Elective".

SUMMARY OF CHANGES

Regulation 3.1.6 (Program of Study): replace OUGE option by technical streams
Regulation 3.3.4: update the description of the major
Regulation 5.4.1: update the program chart for the major and add charts for the technical streams
Regulation 5.4.2: delete the program chart for the OUGE option entirely
Regulations 5.1.1 to 5.6.1: move ENGI 4102 to the elective column
Regulations 9.4, 9.5, 9.6, 9.7: update course descriptions to reflect renumbering and add one new course ENGI 7931 in Regulation 9.7
Regulation 9.8: add three existing graduate courses with Term 8 course numbers

CALENDAR REVISIONS

All references are to the 2012-13 edition of the Calendar.
All additions are denoted by underlining and all deletions by ~~strike through~~.

Regulation 3.1.6 (Program of Study) on page 232

Upon entering Academic Term 6, students in the Mechanical Engineering major may choose to ~~pursue the Offshore Oil and Gas Engineering option (OUGE)~~ one of four technical streams: "Petroleum Production and Operations", "Materials, Mechanics and Design", "Mechatronics, Modelling and Intelligent Systems" and "Energy Systems".

Regulation 3.3.4 (Mechanical Engineering) on page 233

Mechanical engineering is a highly diversified discipline encompassing the design, analysis, testing and manufacture of products that are used in every facet of modern society. Mechanical engineers analyse and design using the principles of motion, energy, and force to ensure that the product functions safely, efficiently, reliably, and can be manufactured at a competitive cost. This activity requires a thorough knowledge of materials, mathematics, and the physical sciences, and an ability to apply this knowledge to the synthesis of economical and socially acceptable solutions to engineering problems.

Mechanical Engineering is designed to provide students with a knowledge in the following four areas: design and dynamics area, emphasizing solid mechanics, material science, dynamics, vibrations and machine component design; thermo-fluids area, focussing on thermodynamics, heat transfer and fluid mechanics; mechatronics area, dealing with electro-mechanical systems, control, robotics, and automation; and manufacturing/industrial area, which encompasses CAD/CAM, production and operation management. In Academic Term 6, students may select ~~the Offshore Oil and Gas option (OUGE)~~ one of four technical streams, which provide focus to the ~~Students may choose from a wide range of electives in various specialty areas in academic terms 7 and 8.~~

Regulation 5.4 (Mechanical Engineering Program Regulations) on page 239
 5.4.1 Mechanical Engineering Major – ~~General Option~~

Amend the table header
 Table 4 Mechanical Engineering Major – ~~General Option~~
 and the table

Term	Required Courses	Elective Courses
Engineering One	Chemistry 1050 English 1080 ENGI 1010 ENGI 1020 ENGI 1030 ENGI 1040 Mathematics 1000 Mathematics 1001 Mathematics 2050 Physics 1050 Physics 1051	Students who are expecting to complete the Engineering One requirements during the first two semesters may apply to undertake a work term during the Spring semester. In this case, the prerequisite course ENGI 200W must be completed during the Winter semester.
Fall Academic Term 3	ENGI 3101 ENGI 3424 ENGI 3901 ENGI 3911 ENGI 3934 ENGI 3941	ENGI 200W (if not completed during Engineering One).
Winter	001W or 002W	
Spring Academic Term 4	ENGI 4102 ENGI 4312 ENGI 4430 ENGI 4901 ENGI 4932 ENGI 4951 <u>ENGI 5961</u>	<u>Complementary Studies Elective</u>
Fall	001W or 002W or 003W	

Regulation 5.4.1 (continued)

Winter Academic Term 5	<u>ENGI 4421</u> <u>ENGI 5911</u> ENGI 5927 <u>ENGI 5931</u> ENGI 5951 <u>ENGI 5952</u> ENGI 5961 <u>ENGI 6961</u>	Complementary Studies Elective
Spring	002W or 003W or 004W	
Fall Academic Term 6	<u>ENGI 6901</u> ENGI 6927 <u>ENGI 6933</u> <u>ENGI 6951</u> ENGI 6961 <u>ENGI 6929</u>	Complementary Studies Elective <u>3 credit hours from Technical Stream Courses</u>
Winter	003W or 004W or 005W (optional)	
Spring Academic Term 7	ENGI 4421 <u>ENGI 7102</u> <u>ENGI 7926</u> ENGI 7928 <u>ENGI 7931</u>	6 credit hours from: ENGI 7901, 7903, 7911, 7934, 7952, other courses as specified by the Discipline Chair <u>Technical Stream Courses</u>
Fall	004W or 005W (optional) or 006W (optional)	
Winter Academic Term 8	<u>ENGI 8926</u>	Complementary Studies Elective One free elective which must be a 5000-level or higher Engineering course, or a 2000-level or higher course either from the Faculty of Arts or the Faculty of Science, or a 3000-level or higher course from the Faculty of Business Administration. Selection of a course must be approved by the Discipline Chair. 9 credit hours from: ENGI 8903, 8911, 8933, 8935, 8937, 8945, 8964, other courses as specified by the Discipline Chair <u>Technical Stream Courses</u>

Regulation 5.4.1 (continued)

and add:

The Technical Streams are

<u>1. Petroleum Production and Operations</u>	
<u>Term 6</u>	
<u>ENGI 6602</u>	<u>Offshore Petroleum Geology and Technology</u>
<u>Term 7</u>	
<u>ENGI 8690</u>	<u>Reservoir Engineering</u>
<u>ENGI 8691</u>	<u>Advanced Petroleum Production Engineering</u>
<u>Term 8</u>	
<u>ENGI 8607</u>	<u>Business Planning and Strategy in an Entrepreneurial Environment</u>
<u>ENGI 8676</u>	<u>Design of Natural Gas Handling Equipment</u>
<u>ENGI 8694</u>	<u>Downstream Processing</u>
<u>ENGI 8911</u>	<u>Corrosion and Corrosion Control</u>
<u>ENGI 8935</u>	<u>Pressure Vessel and Piping</u>
<u>ENGI 8964</u>	<u>Fluid Structure Interactions</u>

<u>2. Materials, Mechanics, and Design</u>	
<u>Term 6</u>	
<u>ENGI 6928</u>	<u>Computer Aided Engineering Applications</u>
<u>Term 7</u>	
<u>ENGI 7911</u>	<u>Industrial Materials</u>
<u>ENGI 7927</u>	<u>Mechanical Component Design II</u>
<u>Term 8</u>	
<u>ENGI 8607</u>	<u>Business Planning and Strategy in an Entrepreneurial Environment</u>
<u>ENGI 8911</u>	<u>Corrosion and Corrosion Control</u>
<u>ENGI 8933</u>	<u>Fatigue and Fracture Mechanics</u>
<u>ENGI 8935</u>	<u>Pressure Vessel and Piping</u>
<u>ENGI 8937</u>	<u>Machine Dynamics</u>
<u>ENGI 8964</u>	<u>Fluid Structure Interactions</u>

Regulation 5.4.1 (continued)

3. Mechatronics, Modelling, and Intelligent Systems	
<u>Term 6</u>	
<u>ENGI 6928</u>	<u>Computer Aided Engineering Applications</u>
<u>Term 7</u>	
<u>ENGI 7854</u>	<u>Industrial Machine Vision</u>
<u>ENGI 7927</u>	<u>Mechanical Component Design II</u>
<u>ENGI 7952</u>	<u>Robotics and Automation</u>
<u>Term 8</u>	
<u>ENGI 8607</u>	<u>Business Planning and Strategy in an Entrepreneurial Environment</u>
<u>ENGI 8937</u>	<u>Machine Dynamics</u>
<u>ENGI 8946</u>	<u>Modelling and Simulation of Dynamic Systems</u>

4. Energy Systems	
<u>Term 6</u>	
<u>ENGI 6928</u>	<u>Computer Aided Engineering Applications</u>
<u>Term 7</u>	
<u>ENGI 7901</u>	<u>Heat Transfer II</u>
<u>ENGI 7903</u>	<u>Mechanical Equipment</u>
<u>Term 8</u>	
<u>ENGI 8607</u>	<u>Business Planning and Strategy in an Entrepreneurial Environment</u>
<u>ENGI 8903</u>	<u>Mechanical Systems</u>
<u>ENGI 8945</u>	<u>Computational Fluid Dynamics</u>
<u>ENGI 8965</u>	<u>Advanced Fluid Mechanics</u>

Students may experience scheduling difficulties if courses are selected from more than one technical stream.

The selection of a course as a technical stream course from outside these lists requires the approval of the discipline chair.

Delete

Regulation 5.4.2 Mechanical Engineering Major - Offshore Oil and Gas Engineering Option (page 240) **in its entirety.**

In **all program charts in regulations 5.1.1 to 5.6.1** inclusive (pages 236 to 242), delete ENGI 4102 from the column "Required Courses" and add "Complementary Studies Elective" to the column "Elective Courses", as illustrated here:

Term	Required Courses	Elective Courses
Spring Academic Term 4	ENGI 4102 [<i>other courses</i>]	<u>Complementary Studies Elective</u> [<i>other courses</i>]

Regulation 9.4 Academic Term 4 Courses (page 248)

~~**4951 Mechatronics I** focuses on sensors and instrumentation. The topics covered in the course are: electric circuits; electronic sensors; signal conditioning and instrumentation. There is a sensors project and 4 laboratory exercises.
LH: at least four 1-hour sessions per semester
PR: ENGI 1040~~

Regulation 9.5 Academic Term 5 Courses (page 249)

~~**5927 Mechanical Component Design I** examines adequacy assessment and synthesis of machine elements with a focus on failure prevention, safety factors, and strength; static failure of ductile and brittle materials, fatigue analysis of components. Topics include the design of power screws, bolted connections, welds, springs, and shafts.~~

~~CR: the former ENGI 5926~~

~~LH: at least eight 3-hour sessions per semester~~

~~PR: ENGI 4312~~

~~**5951 Mechatronics II** focuses on drives and controllers. The topics covered in the course are: electric motors; actuators; control circuits. There is a motors project and 4 laboratory exercises.~~

~~LH: at least four 1-hour sessions per semester~~

~~PR: ENGI 4951~~

5952 Mechatronics I focuses on sensors and instrumentation. The topics covered in the course are: electric circuits; electronic sensors; signal conditioning and instrumentation. There is a sensors project and 4 laboratory exercises.

CR: the former ENGI 4951

LH: at least four 1-hour sessions per semester

PR: ENGI 1040

Regulation 9.6 Academic Term 6 Courses (page 250)

6928 Computer Aided Engineering Applications introduces a variety of Computer Aided Engineering (CAE) applications based on advanced 3D CAD modelling. The fundamentals of 3D modelling are covered including parametric and feature-based design. CAE applications include assembly modelling, mechanism animation and finite element analysis. Further applications include Computer Aided Manufacturing (CAM); model based inspection (i.e. Coordinate Measurement Machines); reverse engineering; document/drawing production; data exchange; and data management. The course has a significant lab component, which provides exposure to solid modelling and CAE applications based on an industrial CAD/CAM/CAE package.

CR: the former ENGI 7962

LH: at least ten 3-hour sessions per semester

PR: ENGI 1030

CO: ENGI 6929 or the former 5926 or 5927

6929 Mechanical Component Design I examines adequacy assessment and synthesis of machine elements with a focus on failure prevention, safety factors, and strength; static failure of ductile and brittle materials, fatigue analysis of components. Topics include the design of power screws, bolted connections, welds, springs, and shafts.

CR: the former ENGI 5926 or 5927

LH: at least eight 3-hour sessions per semester

PR: ENGI 4312

~~**6927 Mechanical Component Design II** is a continuation of the ENGI 5927 course in analysis and synthesis of machinery, including advanced analysis of machine elements such as clutches, brakes, couplings, journal bearings and gears. Advanced machine design concepts are examined, such as reliability, optimization and techniques for stimulating innovative design. A synthesis project involving the machine elements studied is usually included.~~

~~CR: the former ENGI 6926~~

~~LH: at least ten 3-hour sessions per semester~~

~~PR: ENGI 5927~~

6951 Automatic Control Engineering examines the performance of feedback control systems. The topics covered in the course are: feedback control concept; control system performance; control system stability; nonlinear phenomena. There is a project which makes use of a peripheral interface controller or PIC. There are 3 laboratory exercises. Extensive use is made of MATLAB.

CR: the former ENGI 6925

LH: at least three 1-hour sessions per semester

PR: ENGI 5952 or the former 5951

Regulation 9.7 Academic Term 7 Courses (page 252)

7927 Mechanical Component Design II is a continuation of the ENGI 6929 course in analysis and synthesis of machinery, including advanced analysis of machine elements such as clutches, brakes, couplings, journal bearings and gears. Advanced machine design concepts are examined, such as reliability, optimization and techniques for stimulating innovative design. A synthesis project involving the machine elements studied is usually included.

CR: the former ENGI 6926 or 6927

LH: at least ten 3-hour sessions per semester

PR: ENGI 6929 or the former 5927

~~**7928 Computer Aided Engineering Applications** introduces a variety of Computer Aided Engineering (CAE) applications based on advanced 3D CAD modelling. The fundamentals of 3D modelling are covered including parametric and feature-based design. CAE applications include assembly modelling, mechanism animation and finite element analysis. Further applications include Computer Aided Manufacturing (CAM); model based inspection (i.e. Coordinate Measurement Machines); reverse engineering; document/drawing production; data exchange; and data management. The course has a significant lab component, which provides exposure to solid modelling and CAE applications based on an industrial CAD/CAM/CAE package.~~

~~CR: the former ENGI 7962~~

~~LH: at least ten 3-hour sessions per semester~~

~~PR: ENGI 1030, ENGI 6927~~

7931 Instrumentation and Experimental Design involves instrumentation and measurement techniques, sensors for motion and process control, data acquisition and signal conditioning; the design, conduct, and analysis of engineering, scientific, and numerical experiments; design of experiments: factorial design and analysis; and response surface methodology (RSM).

LH: five 3-hour sessions per semester

PR: ENGI 4421

7953 Mechatronics II focuses on drives and controllers. The topics covered in the course are: electric motors; actuators; control circuits. There is a motors project and 4 laboratory exercises.

CR: the former 5951

LH: at least four 1-hour sessions per semester

PR: ENGI 5952 or the former 4951

Regulation 9.8 Academic Term 8 Courses (page 254)

8945 Computational Fluid Dynamics begins with a review of the equations governing viscous fluid flows and heat transfer. The course includes heat conduction, convection-diffusion, and fluid flow equations; gridding, dependent variable interpolation, discretized equations, solution of the discretized equations, transients and nonlinearities; testing and validation of CFD codes, standard test problems.

PR: ENGI 6901, 6961

8946 Modelling and Simulation of Dynamic Systems has an emphasis on interdisciplinary system models, equation formulation and structure, and model complexity. The bond graph modelling language will be introduced to simulate systems containing mechanical, electrical, thermal, hydraulic, and magnetic components.

PR: ENGI 5952

8965 Advanced Fluid Dynamics includes fluid kinematics; equations of fluid dynamics: Navier-Stokes equations, Eulers equations, Stokes' equations, vorticity transport; low Reynolds flows; unsteady viscous flows; boundary layer flows; potential flows; introduction to turbulent flow; free shear flows.

PR: ENGI 6961

Consultations

These Calendar changes affect students in the Faculty of Engineering and Applied Science only. Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library. **[in progress]**

[letter requesting comments here]

[responses here]

NEW COURSE

ENGI 7931 "Instrumentation and Experimental Design"

Executive Summary

ENGI 7931 "Instrumentation and Experimental Design" is a new required course for all students in Term 7 of the Mechanical Engineering major. It addresses the need identified by the discipline for a course that builds on the introductory statistics course and applies it to experimental design in the various sub-disciplines of mechanical engineering.

Rationale

Beginning in 2014, engineering programs in Canada will be evaluated by CEAB using an outcome based approach (CEAB, 2010). Institutions must demonstrate that their graduates possess 12 specific graduate attributes at the time of graduation. One of the graduate attributes (3.1.3) is "Investigations" which is defined as "*an ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.*"

The current mechanical engineering curriculum at MUN fails to directly address this attribute. It is almost impossible for our graduates to possess that stated attribute unless a compulsory course with appropriate labs and projects is introduced to specifically teach the proper methodologies for the design and analysis of experiments. This course directly addresses the current shortcoming in the mechanical engineering curriculum related to graduate attribute 3.1.3.

Consultations

These Calendar changes affect students in the Faculty of Engineering and Applied Science only. Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library.

Course Number and Title

7931 Instrumentation and Experimental Design

Abbreviated Course Title

Instrum & Experiment Design

Calendar Description

7931 Instrumentation and Experimental Design involves instrumentation and measurement techniques, sensors for motion and process control, data acquisition and signal conditioning; the design, conduct, and analysis of engineering, scientific, and numerical experiments; design of experiments: factorial design and analysis; and response surface methodology (RSM).

LH: five 3-hour sessions per semester

PR: ENGI 4421

Course Outline and Method of Evaluation

Topics:

1. Instrumentation and measurement techniques
2. Sensors for motion control: displacement, velocity, and acceleration transducers.
3. Force, strain, and pressure measurement.
4. Temperature, humidity, flow, and level sensors.
5. Data acquisition and signal conditioning.
6. What is meant by Design of Experiments and strategies for experimentation
7. Factorial vs. one-factor-at-a-time (OFAT) experiments
8. Review of one-factor experiments, regression, and ANOVA
9. General factorial experiments
10. Design and analysis of 2-level factorial experiments
11. Concepts of confounding and partial confounding
12. Fractional factorial design and analysis
13. Response Surface Methodology (RSM)
14. Hard-to-change factors

Grading Scheme:

Labs:	15
Assignments:	15
Term Project:	20
Midterm exam:	10
Final:	40

Texts

Montgomery, D. G. (2009): Design and Analysis of Experiments, 7th Edition, Wiley.

Myers, R. and Montgomery, D.C. (2009): Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 3rd Edition, Wiley.

Mason, R. L., Gunst, R. F., and Hess, J. L. (2003): Statistical Design and Analysis of Experiments With Applications to Engineering and Science, 2nd Edition, Wiley.

Library Holdings and/or Other Resources

[Library holdings and/or other resources required for the course - to follow].[DELETE]

Instructor(s)

Dr. L. Lye
Dr. N. Krouglicof
Dr. L. Rolland

Consultations

Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library. [in progress]

[letter requesting comments here]

[responses here]

[Note: in order to save some space, the summary pages for the four new courses are omitted. These summary pages repeat the Calendar entry, consultation list and rationale.]

NEW COURSE
ENGI 8945 "Computational Fluid Dynamics"

Executive Summary

ENGI 9977 "Computational Fluid Dynamics" is a graduate special topics course which undergraduate students in the Mechanical Engineering major have been able to choose as a technical elective in Term 8 with the consent of the discipline chair. It is proposed to convert this course into a pair of regular courses, one graduate (in a separate proposal) and this new undergraduate course ENGI 8945 "Computational Fluid Dynamics". ENGI 8945 will be an elective course in the technical stream "Energy Systems" of the Mechanical Engineering major.

Rationale

Computational fluid dynamics (CFD) is commonly used in design, analysis and optimization of mechanical equipment and systems. It is also used to minimize the number of required physical experiments and in cases where physical experiments would be impractical. The codes used in CFD are quite complex and usually proprietary, however, there are concepts used for the simulation of viscous fluid flows that must be used in all codes.

The purpose of this course is to provide students with a good understanding of the fundamentals used in the simulation of viscous fluid flows such that they would be well-prepared to develop CFD codes or efficiently use commercial codes for research and design. The course will be taught using the finite volume method (FVM) which is commonly used in commercial CFD codes. Students will learn the principles used to develop and solve discretized equations used in an FVM for heat conduction, convection-diffusion, and the Navier-Stokes equations. Students will be required to write code to implement the FVM for one- and two-dimensional problems.

This course will provide the necessary background so that students would understand the concepts of variable storage and interpolation, solution algorithms, equation solvers, and turbulent flows.

Consultations

These Calendar changes affect students in the Faculty of Engineering and Applied Science only. Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library.

Course Number and Title

ENGI 8945 Computational Fluid Dynamics

Abbreviated Course Title

Computational Fluid Dynamics

Calendar Description

8945 Computational Fluid Dynamics begins with a review of the equations governing viscous fluid flows and heat transfer. The course includes heat conduction, convection-diffusion, and fluid flow equations; gridding, dependent variable interpolation, discretized equations, solution of the discretized equations, transients and nonlinearities; testing and validation of CFD codes, standard test problems.

PR: ENGI 6961

Course Outline and Method of Evaluation**Topics:**

- Review of the mathematical description of physical phenomena
 - Casting of the various conservation laws into a general control volume conservation equation
- Discussion of the various methods used to discretize the equations (eg. finite element, finite difference, boundary element, finite volume).
- Conduction heat transfer (finite volume formulation)
 - Gridding, storage of data, construction of control volumes
 - Interpolation of the dependent variables and properties
 - Derivation of the discretized equations
 - Solution of the discretized forms of the governing equations
 - Transients
 - Nonlinearities
- Convection-diffusion equations (finite volume formulation)
 - Interpolation of the dependent variables (the necessity for upwinding and various methods used to achieve it)
 - Derivation of the discretized equations
 - Solution techniques
- Fluid flow (finite volume formulation)
 - Methods used to avoid physically unrealistic solutions (grid staggering, unequal-order interpolation, co-location)
 - Derivation of the discretized equations
 - Solution algorithms (e.g. SIMPLE and its variants, CELS, SIP, Direct matrix inversion)

- Turbulent flows
- Buoyancy and thermally driven flows
- Compressible flows
- Special topics
 - How to test fluid flow programs
 - Solutions to particular problems
 - Extensions of finite volume methods to a control volume finite element method

Grading Scheme

Assignments	25%
Quiz	25%
Exam	50%

Texts

An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd edition, Versteeg, H.K. and Malalasekera, W., Pearson-Prentice Hall, 2007.

Numerical Heat Transfer and Fluid Flow, Patankar, S.V., Taylor & Francis, 1980.

Computational Fluid Mechanics and Heat Transfer, Tannehill, S.C., Anderson, D.A. and Pletcher, R.H., Taylor & Francis, 1997.

Library Holdings and/or Other Resources

[Library holdings and/or other resources required for the course - to follow].[DELETE]

Instructor(s)

Dr. Michael Hinchey
Dr. Neil Hookey
Dr. Greg Naterer

Consultations

Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library. [in progress]

[letter requesting comments here]

[responses here]

NEW COURSE
ENGI 8946 "Modelling and Simulation of Dynamic Systems"

Executive Summary

ENGI 9496 "Modelling and Simulation of Dynamic Systems" is a regular graduate course which undergraduate students in the Mechanical Engineering major have been able to choose as a technical elective in Term 8 with the consent of the discipline chair. It is proposed to recognize the "piggy-backed" nature of this course by assigning an undergraduate course number ENGI 8946 "Modelling and Simulation of Dynamic Systems". ENGI 8946 will be an elective course in the technical stream "Mechatronics, Modeling, and Intelligent Systems" of the Mechanical Engineering major.

Rationale

The ability to generate dynamic models of complex systems consisting of mechanical, electrical, thermal, hydraulic, and magnetic elements is fundamental to the field of mechatronics. This course is therefore essential to students pursuing the Mechatronics, Modeling, and Intelligent Systems technical stream.

Consultations

These Calendar changes affect students in the Faculty of Engineering and Applied Science only. Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library.

Course Number and Title

ENGI 8946 "Modelling and Simulation of Dynamic Systems"

Abbreviated Course Title

Model & Sim Dynamic Systems

Calendar Description

8946 Modelling and Simulation of Dynamic Systems has an emphasis on interdisciplinary system models, equation formulation and structure, and model complexity. The bond graph modelling language will be introduced to simulate systems containing mechanical, electrical, thermal, hydraulic, and magnetic components.

PR: ENGI 5952

Course Outline and Method of Evaluation

TOPICS COVERED:

- Introduction: Stages of modelling, uses of dynamic models
- Mechanical, electrical and fluid system dynamic elements
- Multi-domain system models
- Standard forms for system models
- Energy-based multi-port modelling and generalized variables
- Bond graphs: generalized dynamic elements and variables
- Generating state equations
- Linearization
- Linear system analysis and time response
- Field structures in dynamic systems
- Eliminating derivative causality (from DAE's to ODE's)
- Understanding multibody dynamics with bond graphs
- Distributed parameter systems
- Proper Modeling

EVALUATION SCHEME:

Problem Sets	5 x 5%	25%
Midterm		20%
Project		25%
Final exam		30%

Texts

System Dynamics – Modeling and Simulation of Mechatronic Systems (4th ed.) by Karnopp et al. (2006), published by John Wiley and Sons, Inc.

Modeling and Analysis of Dynamic Systems (3rd ed.) by Close, Frederick and Newell (2002), published by John Wiley and Sons, Inc. (C)

Library Holdings and/or Other Resources

[Library holdings and/or other resources required for the course - **to follow**].[DELETE]

Instructor(s)

Dr. G. Rideout

Consultations

Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library. [**in progress**]

[**letter requesting comments here**]

[**responses here**]

**NEW COURSE
ENGI 8965 "Advanced Fluid Dynamics"**

Executive Summary

ENGI 9901 "Fundamentals of Fluid Dynamics" is a regular graduate course which undergraduate students in the Mechanical Engineering major have been able to choose as a technical elective in Term 8 with the consent of the discipline chair. It is proposed to recognize the "piggy-backed" nature of this course by assigning an undergraduate course number and name ENGI 8965 "Advanced Fluid Dynamics". ENGI 8965 will be an elective course in the technical stream "Energy Systems" of the Mechanical Engineering major.

Rationale

This course is a clear choice for mechanical engineering students seeking to further their knowledge in the thermo-fluid sciences; specifically in the area of theoretical fluid dynamics. This course complements the Computational Fluid Dynamics course and is targeted towards students in the Energy stream. It may also be of interest to students pursuing the Petroleum Production and Operations stream.

Consultations

These Calendar changes affect students in the Faculty of Engineering and Applied Science only. Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library.

Course Number and Title

ENGI 8965 Advanced Fluid Dynamics

Abbreviated Course Title

Advanced Fluid Dynamics

Calendar Description

8965 Advanced Fluid Dynamics includes fluid kinematics; equations of fluid dynamics: Navier-Stokes equations, Eulers equations, Stokes' equations, vorticity transport; low Reynolds flows; unsteady viscous flows; boundary layer flows; potential flows; introduction to turbulent flow; free shear flows.

PR: ENGI 6961

Course Outline and Method of Evaluation

1. Review of Equations of Fluid Motion

- 1.1 Kinematics of Fluid Flow
 - 1.1.1 Lagrangian Viewpoint
 - 1.1.2 Eulerian Viewpoint
- 1.2 Navier-Stokes Equations
 - 1.2.1 Continuity and Momentum Equations
 - 1.2.2 Constitutive Equations
 - 1.2.3 Orthogonal Curvilinear Coordinates
- 1.3 Boundary Conditions
- 1.4 Eulers Equations (Inviscid Flows)
- 1.5 Stokes Equations (Creeping Flows)
- 1.6 Vorticity Equations

2. Low Reynolds Number (Creeping) Flows

- 2.1 Introduction
- 2.2 Poiseuille Flows
- 2.3 Couette Flows
- 2.4 Creeping Flow Past Bodies
- 2.5 Lubrication Flows (Reynolds Equation)

3. Boundary Layer Flows

- 3.1 Similarity Transformations
 - 3.1.1 Blasius Flow
 - 3.1.2 Himenz Flow
 - 3.1.3 Falkner-Skan Flows
- 3.2 Integral Methods
 - 3.2.1 Karman-Pohlhausen Method
 - 3.2.2 Method of Thwaites
 - 3.2.3 Linearization Methods
- 3.3 Boundary Layer Flows with Suction

4. Unsteady Viscous Flow

- 4.1 Impulsively Started Motion
- 4.2 Unsteady Poiseuille Flow
- 4.3 Unsteady Couette Flows
- 4.4 Unsteady Boundary Layer Flow
- 4.5 Fluid Flow Due to Oscillatory Motion

5. Ideal (Potential) Flows

- 5.1 Stream Function and Velocity Potential
- 5.2 Ideal Flow Past a Cylinder and Sphere
- 5.3 Superposition of Complex Potentials
- 5.4 Joukowski Transformation
- 5.5 Schwarz-Chistoffel Transformation

6. Introduction to Turbulence

- 6.1 Stability of Laminar Flows
- 6.2 Transition to Turbulence
- 6.3 Reynolds Averaged Navier-Stokes Equations
- 6.4 Turbulence Modeling
- 6.5 Turbulent Boundary Layer Flow

7. Jets, Wakes, and Shear Layers

- 7.1 Plane and Circular Jets
- 7.2 Plane and Circular Wakes
- 7.3 Drag Prediction from Wake Measurements
- 7.4 Mixing of Parallel Streams

Grading Scheme

Assignments	20%
Mid Term	20%
Take Home Final Exam	60%
Total	100%

Texts

- Incompressible Flow*, Third Edition, R.L. Panton
- Viscous Fluid Flow*, Third Edition, F.M. White
- Fluid Mechanics*, Third Edition, P. Kundu and I. Cohen
- Fundamental Mechanics of Fluids*, Second Edition, I. Currie

Library Holdings and/or Other Resources

[Library holdings and/or other resources required for the course - **to follow**].[DELETE]

Instructor(s)

Dr. Y.S. Muzychka
Dr. M. Hinchey
Dr. N. Hookey
Dr. G. Naterer

Consultations

Consultation requests were sent to the Faculty of Science, the Grenfell and Marine Institute campuses and to the Library. [**in progress**]

[letter requesting comments here]

[responses here]