SFU Dean of Graduate Studies

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**MEMORANDUM**

| | | | |
|---|---|---|---|
| ATTENTION | Senate | DATE | 6 March 2013 |
| FROM | Wade Parkhouse, Dean of Graduate Studies | No. | GS2013.07 |
| RE: | Faculty of Applied Sciences | | |

**For information:**
Acting under delegated authority at its meeting of 4 March 2013, SGSC approved the following curriculum revision:

**Effective Date is Fall 2013**

**Faculty of Applied Sciences** **[GS2013.07]**

a) Master of Engineering

1. Program Revision:

i) MEng students are no longer required to have full time jobs
ii) International students are allowed admission
iii) Program will have two options with a 30 unit standard:
Project Option
Course Option
iv) Increase in units:
ENSC 896-6 MEng Project (Completion)
ENSC 897-6 MEng Project
v) New course added to the Course Option:
ENSC 870-0 MEng Course Option Portfolio
vi) Removal of course requirements
vii) Specializations within the MEng program are removed
viii) Calendar language replaced with new wording

b) Master of Applied Science and PhD in Mechatronic Systems Engineering

1. New courses related to the replication of the existing MASc and PhD in the School of Engineering. S.13-11:
MSE 711-3 Introduction to MEMS
MSE 720-3 Introduction to Biomechanical Engineering
MSE 721-3 Advanced Vibrations
MSE 722-3 Fuel Cell Systems
MSE 725-3 Nano Manufacturing
MSE 726-3 Introduction to Engineering Design Optimization
MSE 727-3 Finite Element Analysis

MSE 750-3 Real time and Embedded Control
MSE 780-3 Manufacturing Systems
MSE 782-3 Introduction to State Space Control Systems
MSE 801-3 Research and Publication Methods
MSE 811-3 Microdevice Engineering and Characterization
MSE 821-3 Advanced Conduction Heat Transfer
MSE 822-3 Advanced Convection Heat Transfer
MSE 881-3 Analysis and Control of Nonlinear Systems

# Changes to the Master of Engineering (MEng) Program

## Faculty of Applied Sciences Graduate Program Committee

Jie Liang and Robert D. Cameron

February 20, 2013

## 1. Proposed Program Change:

The School of Engineering Science proposes the following major changes to our Master of Engineering (MEng) program:

- MEng students are no longer required to have full-time jobs.
- International students are allowed admission to the program.
- The MEng program will have two options: Project Option and Course Option. Both options are brought to the 30 credit standard for Master's degrees.
- The number of credits of the MEng project course (ENSC-897) is increased from 3 to 6. Accordingly, the number of credits of ENSC 896 (MEng Project Completion) is increased from 1.5 to 6.
- A portfolio course ENSC 870-0 is added to the course option, which describes the work undertaken in each course and how the overall set of courses contributes to students' areas of expertise and future careers.
- Specializations within the MEng program are removed.

## 2. Justification for the Change

### 2.1 How this will benefit the existing program

Currently, the MEng program at the School of Engineering Science only accepts domestic students who have jobs at local companies, and an MEng project is required. However, similar programs at other universities such as UBC and UVic all allow full-time MEng students, international students, and course-only options. The proposed changes will improve our competitiveness, provide flexible options, attract more MEng students, and bring in more revenues to SFU and our school.

### 2.2 How this will benefit students currently in the program

Students currently in the program can complete their MEng studies by following either the old requirement or the new requirement.

The current project-only option requires MEng students to work on an industrial project. However, since there are not many large companies in the Vancouver area, some MEng students

have found it difficult to find a suitable industrial project within their companies. In addition, it usually takes much longer time than expected to finish the project.

We have surveyed the existing MEng students (19 in total) about their preference between the project option and course option. Seven replies have been received, and five students prefer the course option. This is a strong indication that a course-only option is necessary in the MEng program.

In addition, the current MEng project only has 3 units, but most students spent much more time on it than a 3-credit course. Therefore, increasing the credits to six is a more accurate representation of the efforts that the students spent on the project.

### 3. Proposed Calendar Changes

| Current | Proposed |
|---|---|
| **Engineering Science Master of Engineering Program**<br>*School of Engineering Science* \| *Faculty of Applied Sciences*<br><br>The master of engineering science (MEng) program, for part-time study by practising engineers, is based on a course set normally offered in the evenings, and a project performed in industry.<br>The principal areas of study are electronics, communications and signal processing, intelligent systems, and control theory.<br>**Admission Requirements**<br>The normal admission requirement is a bachelor's degree in electrical engineering, computer engineering, engineering science or a related area, with a 3.0 cumulative grade point average (CGPA) (B grade) from a recognized university, or equivalent.<br>**Transfer from MEng to MASc Program**<br>Normally transfer from the MEng to the master of applied science (MASc) program will be considered under the following conditions.<br>• a minimum undergraduate cumulative grade point average (CGPA) of 3.3 is required.<br>• on at least two courses within the master of engineering program, a minimum CGPA of 3.5 is required. | **Engineering Science Master of Engineering Program**<br>*School of Engineering Science* \| *Faculty of Applied Sciences*<br><br>The school offers a Master of Engineering in Engineering Science (MEng) program with a project option (Project MEng) or with a course option (Course MEng). Students in the MEng program are ineligible for university financial support.<br><br>**Admission Requirements**<br>The admission requirement is a bachelor's degree in electrical engineering, computer engineering, engineering science or a related area, with a 3.0 cumulative grade point average (CGPA) (B grade) from a recognized university, or equivalent. International applicants should also meet the university's requirement on English proficiency. |

| Current | Proposed |
|---|---|
| | |
| **Course Requirements**<br>If the subject matter of a required course has been previously completed with graduate credit, the course may not be completed again for credit.<br>**Required Courses**<br>Students complete a total of 21 graduate course units including<br>• ENSC 820-3 Engineering Management for Development Projects<br>• ENSC 896-1.5 MEng Project (Completion)<br>• ENSC 897-3 MEng Project<br>and the specified courses in one of the following specializations.<br>**Communications Specialization**<br>Students who choose this specialization will complete both of<br>• ENSC 805-3 Advanced Digital Communications<br>• ENSC 810-3 Statistical Signal Processing<br>**Electronics Specialization**<br>Students who choose this specialization will complete one of<br>• ENSC 851-3 Integrated Circuit Technology<br>• ENSC 852-3 Analog Integrated Circuits<br>• ENSC 853-3 Digital Semiconductor Circuits and Devices<br>**Intelligent Systems or Control Theory Specializations**<br>Students who choose either one of these specializations will complete<br>• ENSC 801-3 Linear Systems Theory<br>**Elective Courses**<br>The remainder of the 21 required units are comprised of elective courses.<br>Additional courses may be required to correct background deficiencies.<br>**Project Requirements**<br>Students in this program complete a project | **Project MEng Requirements**<br>Project MEng students complete a total of eight graduate courses (with a minimum of 24 units) and ENSC 897-6 MEng Project. The courses must include ENSC 820-3 Engineering Management for Development or an approved alternative and at least four additional regular ENSC graduate courses (not directed studies). Students who do not complete ENSC 897-6 in one term must register for ENSC 896-6 MEng Project (Completion) in all subsequent terms.<br><br>**Course MEng Requirements**<br>Course MEng students complete a total of ten graduate courses (with a minimum of 30 units) and ENSC 870-0 MEng Course Option Portfolio. The courses must include ENSC 820-3 Engineering Management for Development or an approved alternative and at least six additional regular ENSC graduate courses (not directed studies).<br><br>**Elective Course Options**<br>Beyond the minimum requirements for regular ENSC graduate courses in each option above, the following courses can be used towards the remaining requirements:<br>• ENSC 891-3 Directed Studies I;<br>• Up to two regular graduate courses from other academic units in the Faculty of Applied Sciences and Faculty of Sciences, subject to approval of the supervisor.<br><br>International MEng students with Study Permit should register for at least one course each term.<br><br>**Supervisory Committee**<br>The Chair of the Graduate Program Committee is the default senior supervisor of all MEng students. When a faculty member agrees to |

| Current | Proposed |
| --- | --- |
| instead of writing a thesis. The project is expected to take a minimum of two full-time equivalent months. If the project is performed in the student's workplace, the student receives academic supervision from the senior supervisor, and day-to-day supervision from the manager, or designated associate. Industrial supervisors, who are on the supervisory committee, will be appointed by the graduate chair in consultation with the senior supervisor. In very small companies, alternate arrangements will be made for industrial supervision.<br>In addition to submission of a technical report at project completion, the student makes an oral presentation to the supervisory committee and the graduate chair. A grade will be assigned based on the report's quality, the presentation, and the student's understanding of the subject. A grade of 'complete' or 'in progress' will reflect the majority decision. In the case of an 'in progress' grade, the student re-submits the project report and presents it again.<br>**Fees**<br>Students may complete their program before paying the minimum total fee. An additional payment is required prior to graduation to satisfy the minimum fee requirement of six full-time fee units. See Graduate Fees for more details. | supervise a MEng student for the student's ENSC 897-6 MEng Project course, the faculty member becomes the senior supervisor of the MEng student.<br><br>**Transfer from MEng to MASc Program**<br>Transfer from the MEng to the Master of Applied Science (MASc) program will be considered if the student meets all the admission requirements of the MASc program, and if the proposed senior supervisor can provide a financial support that meets the school's minimum requirement for MASc students. |

**SFU Connect** **sheilagh@sfu.ca**

## Re: clarification: MEng revision for SGSC

**From :** Sheilagh MacDonald <sheilagh@sfu.ca> Tue, Feb 19, 2013 01:18 PM
**Subject :** Re: clarification: MEng revision for SGSC
**To :** Rob Cameron <cameron@cs.sfu.ca>

ok. summary will read new entry replaces previous entry; this includes the deletion of the course requirements and list of courses.

**From:** "Rob Cameron" <cameron@cs.sfu.ca>
**To:** "Sheilagh MacDonald" <sheilagh@sfu.ca>
**Sent:** Tuesday, February 19, 2013 9:00:38 AM
**Subject:** Re: clarification: MEng revision for SGSC

Yes, a complete replacement should be easiest.

----- Original Message -----
> Hi Rob,
> Thank you for clarifying. You are operating on a much more elevated
> level.
>
>
> I just need the nuts and bolts of the calendar change. This is a
> simple reference guide for me and for Kris who will be cutting and
> pasting your entry into the new calendar.
>
>
> To get down to it...
> are you replacing the entire calendar entry?
>
>
> does this mean:
> you are deleting the course requirements
> you are deleting the list of courses
>
>
>
>
>
>
> ----- Original Message -----
>

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# Graduate Course Minor Change Form

This form is for an SFU department or program to request a minor change to an existing graduate course. After approval and signature by the faculty graduate studies committee, this form should be forwarded to the Dean of Graduate Studies for approval by the Senate Graduate Studies Committee (SGSC). SGSC will forward the approval to Senate for information.

## DEPARTMENT

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| ENSC | Jie Liang | jiel@sfu.ca |

Please revise the following elements of the indicated graduate course:
☐ Catalogue number ✓ Units ☐ Title ☐ Description ☐ Other: _____

## CURRENT COURSE

*Please complete only the fields to be changed.*

| Program (eg. LBST) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| ENSC | 896 | 1.5 |

Course title (max 80 characters)

Short title (appears on transcripts, max 25 characters)

Course description for SFU Calendar ☐ see attached

Available course components ☐ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Practicum work done in this class will involve children or vulnerable adults (If the "Yes" box is checked, all students and instructors will require criminal record checks)
☐ Yes ☐ No

Grading basis ☐ Graded ☐ Satisfactory / Unsatisfactory ☐ In Progress / Complete ☐ _____

Prerequisites (if any)

This is combined with an undergrad course. ☐ Yes ☐ No

Course number and units: _____

Additional course requirements for graduate students

## REVISED COURSE

*Please complete only the fields to be changed.*

| Program (eg. LBST) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| ENSC | 896 | 6 |

Course title (max 80 characters)

Short title (appears on transcripts, max 25 characters)

Course description for SFU Calendar ☐ see attached

Available course components ☐ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Practicum work done in this class will involve children or vulnerable adults (If the "Yes" box is checked, all students and instructors will require criminal record checks)
☐ Yes ☐ No

Grading basis ☐ Graded ☐ Satisfactory / Unsatisfactory ☐ In Progress / Complete ☐ _____

Prerequisites (if any)

This is combined with an undergrad course. ☐ Yes ☐ No

Course number and units: _____

Additional course requirements for graduate students

## APPROVALS

| | | |
|---|---|---|
| R. CAMERON | | Feb. 22 2013 |
| Faculty graduate studies committee name | Signature | Date |
| Peter Liljedahl | | Mar 6, 2013 |
| Senate graduate studies committee name | Signature | Date |

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# Graduate Course Minor Change Form

This form is for an SFU department or program to request a minor change to an existing graduate course. After approval and signature by the faculty graduate studies committee, this form should be forwarded to the Dean of Graduate Studies for approval by the Senate Graduate Studies Committee (SGSC). SGSC will forward the approval to Senate for information.

## DEPARTMENT

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| ENSC | Jie Liang | jiel@sfu.ca |

Please revise the following elements of the indicated graduate course:
☐ Catalogue number ✓ Units ☐ Title ☐ Description ☐ Other: _____

## CURRENT COURSE

*Please complete only the fields to be changed.*

| Program (eg. LBST) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| ENSC | 897 | 3 |

Course title (max 80 characters)

Short title (appears on transcripts, max 25 characters)

Course description for SFU Calendar ☐ see attached

Available course components ☐ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Practicum work done in this class will involve children or vulnerable adults (If the "Yes" box is checked, all students and instructors will require criminal record checks)
☐ Yes ☐ No

Grading basis ☐ Graded ☐ Satisfactory / Unsatisfactory ☐ In Progress / Complete ☐ _____

Prerequisites (if any)

This is combined with an undergrad course. ☐ Yes ☐ No

Course number and units: _____

Additional course requirements for graduate students

## REVISED COURSE

*Please complete only the fields to be changed.*

| Program (eg. LBST) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| ENSC | 897 | 6 |

Course title (max 80 characters)

Short title (appears on transcripts, max 25 characters)

Course description for SFU Calendar ☐ see attached

Available course components ☐ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Practicum work done in this class will involve children or vulnerable adults (If the "Yes" box is checked, all students and instructors will require criminal record checks)
☐ Yes ☐ No

Grading basis ☐ Graded ☐ Satisfactory / Unsatisfactory ☐ In Progress / Complete ☐ _____

Prerequisites (if any)

This is combined with an undergrad course. ☐ Yes ☐ No

Course number and units: _____

Additional course requirements for graduate students

## APPROVALS

R. CAMERON
Faculty graduate studies committee name

R. Cameron
Signature

Feb. 22, 2013
Date

Peter Liljedahl
Senate graduate studies committee name

P. Liljedahl
Signature

Mar 6, 2013
Date

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

RECEIVED
FEB 27 2013
DEAN OF GRADUATE STUDIES OFFICE

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) ENSC | Number (eg. 810) 870 | Units (eg. 4) 0 |
|---|---|---|

Course Title (max 80 characters)
MEng Course Option Portfolio
6 academic progress units.

Short Title (appears on transcripts, max 25 characters)
MEng Course Portfolio

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Students in the course option of the MEng program develop a portfolio of their MEng graduate work. This includes a brief report submitted to the Graduate Program Committee that describes the work undertaken in each course and how the overall set of courses contributes to their areas of expertise and future careers.

Available Course Components: ☐ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☑ Section

Grading Basis ☐ Letter grades ☐ Satisfactory/Unsatisfactory ☑ In Progress/Complete | This is a capstone course ☑ Yes ☐ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Students may only register for the ENSC 870-0 during their final term.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☐ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 4 | Sept. 2013 | |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

This provides a capstone review of work carried out for the course option of the MEng program of the School of Engineering Science.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☐ information about their competency to teach the course is appended
The Engineering Science Graduate Program Chair (currently Jie Liang).

Number of additional faculty members required in order to offer this course
None

Additional space required in order to offer this course ☐ see attached document
None

Additional specialized equipment required in order to offer this course ☐ see attached document
None

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
None

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) ENSC | Number (eg. 810) 870 | Units (eg. 4) 0 |
|---|---|---|
| Course title (max 80 characters)<br>MEng Course Option Portfolio | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| | | |
|---|---|---|
| Department Graduate Program Committee<br>JIE LIANG. | Signature | Date 2/22/2013 |
| Department Chair<br>JOHN JONES | Signature | Date 22 FEB 2013 |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Program Committee<br>R. CAMERON | Signature<br>R. Cameron | Date<br>Feb. 22, 2013 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| | | |
|---|---|---|
| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| ENSC | Jie Liang | jiel@sfu.ca |

**SFU Connect** **sheilagh@sfu.ca**

## Fwd: Library Assessment: ENSC 870 MEng Course Option Portfolio

**From :** Rob Cameron <cameron@cs.sfu.ca> Mon, Feb 18, 2013 03:54 PM

**Subject :** Fwd: Library Assessment: ENSC 870 MEng Course Option Portfolio

**To :** Sheilagh MacDonald <sheilagh@sfu.ca>

Hi, Sheilagh.

Here is the assessment for ENSC 870-0.

----- Forwarded Message -----
From: "Megan Crouch" <mcrouch@sfu.ca>
To: "Rob Cameron" <cameron@sfu.ca>
Cc: "Yolanda Koscielski" <ysk6@sfu.ca>, "Christine Manzer" <cmcconne@sfu.ca>, "Patty Gallilee" <plg@sfu.ca>
Sent: Monday, February 18, 2013 3:44:46 PM
Subject: Library Assessment: ENSC 870 MEng Course Option Portfolio

Dear Rob,

I have reviewed the proposal for ENSC 870 MEng Course Option Portfolio and concluded that no additional library resources will be required to support it.

The course will therefore be added to the appropriate list at
http://www.lib.sfu.ca/collections/course-assessments
This will be enough to indicate library sign-off as it moves through the approval process.

Best,
Megan

Megan L. Crouch
Health Sciences Librarian
Collections Librarian

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 711 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Introduction to MEMS

Short Title (appears on transcripts, max 25 characters)
Intro MEMS

Course Description for SFU Calendar ☑ see attached document ☐ Learning outcomes identified

Analytical tools to understand basics of fabrication, operation, and design of MEMS (microelectromechanical systems). Fundamental microfabrication techniques and process flow design. Principles of energy transduction, sensing, and actuation at microscopic scales. Advantages and disadvantages of scaling on performance of MEMS. Analysis and modelling of behaviour of simple MEMS. Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 311-3: Introduction to MEMS

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students will have to work on a research project in order to design a specific MEMS device. A formal report has to be handed in with details on literature survey, design problems and solutions proposed by the student. Operation of the device has to be verified through computer simulations.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Summer 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Behraad Bahreyni

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 711 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Introduction to MEMS | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Gosine | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date |
|---|---|---|
| | P. Liljedahl | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 711**

**Course title: Introduction to MEMS**

**Instructor: Dr Behraad Bahreyni**

**Frequency of course offering: Annual**

Course description:

Analytical tools to understand the basics of the fabrication, operation, and design of MEMS (microelectromechanical systems). Fundamental microfabrication techniques and process flow design. Principles of energy transduction, sensing, and actuation at microscopic scales. Advantages and disadvantages of scaling on performance of MEMS. Analysis and modelling of behaviour of simple MEMS. Students are required to complete a project.

Syllabus:

1. Microfabrication (6 weeks):
   Overview of crystals, Lithography, Oxidation, Wet etching, Doping, Introduction to plasma,
   Physical vapour deposition, Chemical vapour deposition, Dry etching, Packaging.
2. Transduction mechanisms (3 weeks):
   Electrostatic, Electromagnetic, Thermal, Piezoelectric, Piezoresistive, Optical, Resonance.
3. Modelling of microdevices (2 weeks):
   Modelling of statics and dynamics of microstructures, FEA.
4. MEMS applications (2 weeks):
   Sensors: Pressure, Inertial, Magnetic field, Microphone;
   Actuators: Micromirrors; BioMEMS.

Textbook:

Introductory MEMS: Fabrication and application

By T. Adams and R. Layton, New York: Springer, 2010.

Recommended readings:

Microsystem Design, by Stephan D. Senturia

Prerequisites:

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Midterm exam | 20% |
| Final exam | 30% |
| Course project | 20% |
| Project report | 20% |
| - | - |

The midterm and final exams will be common with the undergraduate students. The assignments are specifically given to the graduate students. Graduate students are exempted from attending the lab sessions.

Does the course have a project? Yes

If yes, please provide details:

The project includes an actual device design based on surveyed literature. A formal report in addition to all the relevant design files is handed in by the students.

Teaching competency:

Dr Bahreyni (PhD, PEng) is an expert in the area of the design and fabrication of MEMS and their interface electronics. His past research has spanned several relevant areas including the development of numerous microsensors and resonant microdevices. He has published extensively in the area and has authored a book on the subject of microresonator design and fabrication. At SFU, he has developed two courses related to the engineering of microdevices (one at graduate level and one at undergraduate/graduate level).

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 720 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Introduction to Biomechanical Engineering

Short Title (appears on transcripts, max 25 characters)
Intro Biomech Eng

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Overview of biomechanical engineering. Mechanical theory, impact analysis, and optimization methods with specific application to the study of human movement and injury. Medical device design, assessment, patenting, and government regulation (FDA/Health Canada). Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☑ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 420-4

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students will work on a research project that they design to complement their thesis project. They are expected to design and conduct experiments using computation or physical models. A formal report will be submitted that details the research question, methods, data generated, and analysis.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Summer 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program, especially to those who studies biomedical engineering and biomechanics. This course has been offered annually since Summer 2011 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Carolyn Sparrey

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 720 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Introduction to Biomechanical Engineering | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
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| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R Cameron | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

**Date**: 23 January 2013

Course number: **MSE 720**

**Course title: Introduction to Biomechanical Engineering**

**Instructor: Dr Carolyn Sparrey**

**Frequency of course offering: Annual**

Course description:

Overview of biomechanical engineering. Mechanical theory, impact analysis and optimization methods with specific application to the study of human movement and injury. Medical device design, assessment, patenting and government regulation (FDA/Health Canada). Students are required to complete a project.

Syllabus:

The course will be divided into three main themes: Skeletal Force and Motions, Tissue Mechanics, and Device Design and Analysis. Students will be expected to integrate material from all three themes in their final project.

Theme 1: Skeletal Forces and Motions (5 weeks)

a) Introduction to Human Anatomy
b) Static Analysis of Skeletal Systems
c) Kinematics and Dynamics of Human Movement
d) Optimization methods
e) Joint Contact Forces – Hertz Contact Theory

Theme 2: Tissue Mechanics (5 weeks)

a) Impact Analysis and Human Injury
b) Viscoelasticity of Biological Tissues
c) Composite Beam Theory (including asymmetry)
d) Beam on Elastic Foundation

Theme 3: Device Design and Analysis (3 weeks)

a) Design of Intervertebral Discs
b) Design of Hip Replacements
c) Regulatory Issues (Health Canada/FDA Device approval)
d) Patents and Legal Responsibilities

Textbook:

Bartel DL, Davy DT, and Keaveny TM: *"Orthopaedic Biomechanics: Mechanics and Design in Musculoskeletal Systems"* Pearson Prentice Hall, New Jersey, 2006.

Recommended readings:

N/A

Prerequisites:

**Grading:**

| | |
|---|---|
| Project | 50% |
| Midterm Exam | 20% |
| Final Exam | 30% |
| - | - |
| - | - |
| - | - |

The midterm and final exams are in common with the undergraduates. The graduate students are exempt from quizzes and assignments. The graduate students will work on a research project that they design to complement their thesis project. They are expected to design and conduct experiments using computation or physical models. A formal report will be submitted that details the research question, methods, data generated, and analysis.

Does the course have a project? Yes

If yes, please provide details:

The project topics are proposed at the beginning of the semester by the graduate student and approved by the instructor. Project topics are to be related to the student's research interests when possible. The project includes a research question, a computational or experimental study, and an analysis of the results.

Teaching competency:

Dr Sparrey (PhD, PEng) is an expert in biomechanics and human injury. Her research interests are in human injury thresholds, medical device design and optimization. She has published several research papers in this area as well as worked for five years as a Senior Engineering Consultant doing accident reconstruction and injury analysis for litigation. Dr Sparrey previously taught an Introduction to Biomechanics course at UC Berkeley and teaches two undergraduate mechanics focused courses at SFU.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 721 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Advanced Vibrations

Short Title (appears on transcripts, max 25 characters)
Advanced Vibrations

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Free vibration; Harmonic excitation; Base excitation; Rotating unbalance; Impulse response; Response to an arbitrary input; Response to an arbitrary periodic input; Transform method; Multiple degree of freedom model; Lagrange's equations; Vibrations of string or cable; Vibration of rods and bars; Torsional vibration; Bending vibration of beams; Finite element method; and Nonlinear vibration.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 421-4

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Undergraduate students will be exposed to introductory and intermediate topics in vibration, while graduate students will be introduced to advanced topics such as nonlinear vibration. The midterm and final exams for graduate students will cover the advanced materials, which will be excluded from the undergraduate exams.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 15 | Fall 2008 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. Vibration analysis is one of the core subject areas of MSE, and the knowledge is required in order to design mechanical systems and structures for enhanced or suppressed vibration. This course has been offered annually since Fall 2008 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Siamak Arzanpour

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 721 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Advanced Vibrations | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
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| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Cameron | 2013-03-07 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date |
|---|---|---|
| | P. Liljedahl | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

**Date**: 24 January 2013

Course number: **MSE 721**

**Course title: Advanced Vibrations**

**Instructor: Siamak Arzanpour**

**Frequency of course offering: Annual**

Course description:

Free vibration; Harmonic excitation; Base excitation; Rotating unbalance; Impulse response; Response to an arbitrary input; Response to an arbitrary periodic input; Transform method; Multiple degree of freedom model; Lagrange's equations; Vibrations of string or cable; Vibration of rods and bars; Torsional vibration; Bending vibration of beams; Finite element method; and Nonlinear vibration.

Syllabus:

1. Introduction to Vibration
    - 1.1. Free vibration
    - 1.2.Harmonic motion
    - 1.3. Viscous Damping
    - 1.4. Energy methods
2. Response to Harmonic Excitation
    - 2.1. Harmonic excitation of undamped systems
    - 2.2. Harmonic excitation of damped systems
    - 2.3. Base excitation
    - 2.4. Rotating unbalance
3. General Forced Response
    - 3.1. Impulse response
    - 3.2. Response to an arbitrary input
    - 3.3. Response to an arbitrary periodic input
    - 3.4. Transform method
4. Multiple Degree of Freedom

4.1. Two degree of freedom model
4.2. Eigen values and natural frequencies
4.3. Modal analysis
4.4. More than two degrees of freedom
4.5. Systems with viscous damping
4.6. Modal analysis with forced response
4.7. Lagrange's equations

5. Distributed Parameter Systems
5.1. Vibrations of string or cable
5.2. Modes and natural frequencies
5.3. Vibration of rods and bars
5.4. Torsional vibration
5.5. Bending vibration of a beam

6. Finite Element Method
6.1. The bar
6.2. Three-element bar
6.3. Beam element

7. Introduction to Nonlinear Systems
7.1. Phase planes
7.2. Method of Multiple Scales
7.3. Method of averaging
7.4. Nonlinear damped systems
7.5. Nonlinear distributed systems

Textbook:

"Engineering Vibration" by Daniel J. Inman

"Nonlinear Oscillations" by Ali H. Nayfeh and Dean T. Mook

Recommended readings:

"Mechanical Vibrations" by Singiresu S. Rao

Prerequisites:

**Grading:**

| | |
|---|---|
| Quizzes | 20% |
| Midterm Exam | 30% |
| Final Exam | 50% |
| - | - |

- -

- -

Both graduate and undergraduate students are required write quizzes, midterm and final exams. The quizzes will be the same for all students, but the midterm and final exams for graduate students will cover the advanced materials that will be excluded from the undergraduate exams.

Does the course have a project? No

If yes, please provide details:

Teaching competency:

Dr Arzanpour (PhD, PEng) is an expert in dynamic systems modeling, vibration analysis, smart materials and structures, and nonlinear systems. In his research, he has been actively involved in designing vibration systems including engine mounts, energy harvesting using vibration, and dental material recognition from vibration. He has many publications in the area of vibration design and analysis.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 722 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Fuel Cell Systems

Short Title (appears on transcripts, max 25 characters)
Fuel Cell Systems

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Scientific and engineering principles of fuel cell systems, including fundamental electrochemistry, applied thermodynamics, and transport phenomena. Types of fuel cells: low temperature and high temperature fuel cell systems and applications. Students are required to complete a project.

Available Course Components: ☑ Lecture ☑ Seminar ☑ Laboratory ☑ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 422-4

Additional course requirements for graduate students ☑ See attached document (if this space is insufficient)

Graduate students will work on a research project closely related to the course material. They are expected to design and conduct numerical and/or experimental analysis of fuel cells. A formal report will be submitted.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Summer 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to those who studies sustainable energy systems. This course has been offered annually since Summer 2010 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Erik Kjeang

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 722 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Fuel Cell Systems | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
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**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Cameron | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date |
|---|---|---|
| | P. Dy | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 24 January 2013

Course number: **MSE 722**

**Course title: Fuel Cell Systems**

**Instructor: Dr Erik Kjeang**

**Frequency of course offering: Annual**

Course description:

Scientific and engineering principles of fuel cell systems, including fundamental electrochemistry, applied thermodynamics, and transport phenomena. Types of fuel cells: low temperature and high temperature fuel cell systems and applications. Students are required to complete a project.

Syllabus:

1. Introduction
2. Fundamental electrochemistry and thermodynamics
3. Fuel cells, operating principles, and performance
4. PEM fuel cells
5. Transport phenomena
6. Micro fuel cells
7. Solid oxide fuel cells
8. Fuel infrastructure
9. Systems and auxiliary equipment
10. Field trip

Textbook:

*Fuel Cell Engines*, Matthew M. Mench, Wiley, 2008

Recommended readings:

*Fuel Cell Systems Explained*, 2nd Ed., James Larminie and Andrew Dicks, Wiley, 2003

Prerequisites:

**Grading:**

| | |
|---|---|
| Assignments | 10% |

| | |
|---|---|
| Lab Reports | 10% |
| Project | 30% |
| Final Exam | 50% |
| - | - |
| - | - |

Does the course have a project? Yes

If yes, please provide details:

This course includes an individual term project. The students will select a research topic closely related to the course material and prepare a **project proposal** (max one page), including defined objectives and/or milestones, due during the third week of classes (10% of project mark). The second phase of the project will include a full **literature review** on the selected topic, to be presented in class during the sixth week of classes (10 min, 20% of project mark). The focus of the third phase is on **analysis**. The analysis portion may include mathematical modeling, numerical simulations, design, prototyping, experimentation, and/or testing of fuel cells, and should leverage the findings of the literature review. The analysis work is normally conducted during the second half of the term, and written reports (max 10 pages) are due at the last class of the term (50% of project mark). In addition, each student will give a 10 min oral presentation during the last week of classes (20% of project mark).

Teaching competency:

Dr Kjeang (PhD, PEng) has more than ten years of experience in fuel cell R&D from leading organizations in Canada and Europe. Before joining SFU, Kjeang worked at Ballard Power Systems, the world's leading fuel cell developer and manufacturer, and has ongoing research collaboration with the fuel cell industry. He has taught fuel cell science, technology, and engineering to both undergraduate and graduate students at SFU since 2009 and given several invited lectures and seminars at the leading international conferences in this field.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| Nano Manufacturing | MSE 725 | 3 |

Course Title (max 80 characters)
Nano Manufacturing

Short Title (appears on transcripts, max 25 characters)
Nano Manufacturing

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Overview of nano manufacturing methods for the next-generation micro/nano-patterning. Nano lithography and other nano fabrication techniques, including: nano fabrication by photons, nano fabrication by charged beams, nano fabrication by scanning probes, nano fabrication by replication and imprint, picoliter printing, nanoscale pattern transfer, indirect nano fabrication, nano fabrication by self-assembly, directed assembly of nano structures, and polymeric nano manufacturing. Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 425-4

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students are required to answer different (advanced) problems on final exam. Graduate students are exempted from attending the lab sessions. Instead, they are required to complete project, which includes an actual nano manufacturing process implementation based on surveyed recent literature. They will submit a final report on their project.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Summer 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. It can also provide depth of knowledge required for students with specific research interests in fabrication of devices at micro- and nano-scales. This course has been offered annually since Summer 2011 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Woo Soo Kim

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| Nano Manufacturing | MSE 725 | 3 |

Course title (max 80 characters)
Nano Manufacturing

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
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| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee | Signature | Date |
|---|---|---|
| Dr Ed Park | | |
| Department Chair | Signature | Date |
| Dr Ed Park | | |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Cameron | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee | Signature | Date |
|---|---|---|
| Peter Liljedahl | | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 22 January 2013

Course number: **MSE 725**

**Course title: Nano Manufacturing**

**Instructor: Dr Woo Soo Kim**

**Frequency of course offering: Annual**

Course description:

Overview of nano manufacturing methods for the next-generation micro/nano-patterning. Nano lithography and other nano fabrication techniques, including: nano fabrication by photons, nano fabrication by charged beams, nano fabrication by scanning probes, nano fabrication by replication and imprint, picoliter printing, nanoscale pattern transfer, indirect nano fabrication, nano fabrication by self-assembly, directed assembly of nano structures, and polymeric nano manufacturing. Students are required to complete a project.

Syllabus:

1. Basic Nano Lithography
   - Week 1: Introduction
   - Week 2: Nanofabrication by Photons
   - Week 3: Nanofabrication by Charged Beams
   - Week 4: Electron Beam Lithography of Nanostructures
2. Advanced Nano Lithography
   - Week 5: Nanofabrication by Scanning Probes
   - Week 6: Nano fabrication by Replication & Imprint
   - Week 7: Picoliter Printing
   - Week 8: Nanoscale Pattern Transfer
   - Week 9: Indirect Nanofabrication
3. Other Nano Fabrication Techniques
   - Week 10: Term Project Presentation
   - Week 11: Nanofabrication by Self-Assembly
   - Week 12: Directed Assembly of Nanostructures
   - Week 13: Polymeric Nanomanufacturing

Textbook:

Nanofabrication by Zheng Cui, Springer

Recommended readings:

Handbook of Nanofabrication by Gary Wiederrecht, Academic Press

Prerequisites:

**Grading:**

| | |
|---|---|
| Homework/Assignments | 15% |
| Midterm Exam | 30% |
| Project | 15% |
| Final Exam | 40% |
| - | - |
| - | - |

The midterm exam will be common to both graduate and undergraduate students. However, graduate students are required to answer different (advanced) problems on the final exam. Graduate students are exempted from attending the lab sessions. Instead, they are required to complete project (see below for more information).

Does the course have a project? Yes

If yes, please provide details:

The project includes an actual nano manufacturing process implementation based on surveyed recent literature. Students will submit a final report on their project.

Teaching competency:

Dr Kim (PhD) has extensive experience on nano manufacturing and fabrication for more than 10 years in both cutting-edge academic and industrial research settings. At SFU, he developed and taught the proposed course in Summer 2011, in addition to MSE 220 (ENSC 231 previously) - Engineering Materials.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) | Number (eg. 810) | Units (eg. 4) |
|---|---|---|
| MSE | 726 | 3 |

Course Title (max 80 characters)
Introduction to Engineering Design Optimization

Short Title (appears on transcripts, max 25 characters)
Intro Design Optimization

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Theories, methods, and applications of optimization in support of engineering design. Topics include classic optimization methods, metaheuristics and evolutionary algorithms, Design of Experiments, and metamodel-based design optimization approaches. Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☑ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 426-4 (Planned)

Additional course requirements for graduate students ☑ See attached document (if this space is insufficient)

Graduate students have an additional project, which requires students delve into the state-of-the-art in design optimization to either apply the recent optimization methods to field problems or develop new ideas for the advancement of the field.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 15 | Fall 2013 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. This course has been offered annually since Spring 2011 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☐ information about their competency to teach the course is appended
Dr Gary Wang

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 726 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Introduction to Engineering Design Optimization | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee<br>Rob Cameron | Signature<br>R. Cameron | Date<br>2013-03-02 |
|---|---|---|

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>~~Dr Ed Park~~ Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 28 January 2013

Course number: **MSE 726**

**Course title:** Introduction to Engineering Design Optimization

**Instructor: Dr Gary Wang**

**Frequency of course offering: Annual**

Course description:

Theories, methods, and applications of optimization in support of engineering design. Topics include classic optimization methods, metaheuristics and evolutionary algorithms, Design of Experiments, and metamodel-based design optimization approaches. Students are required to complete a project.

Syllabus:

1. Introduction to Optimization
   - Elements of optimization
   - Basic mathematical concepts
   - Classification of optimization problems
   - Problem formulation
2. Optimum Design Concepts with Graphical Solution
3. Single-variable Optimization Techniques
4. Single-variable Optimization with Programming in Matlab
5. Unconstrained Multivariable Optimization
   - Principles of search in n-Dimensions
   - Gradient methods
6. Unconstrained Multivariable Optimization
   - Newton's method
   - Quasi-Newton methods
7. Constrained Optimization
   - Lagrange's method
   - Penalty method
8. Constrained Optimization
   - KKT optimality condition
   - Feasible directions

- Transformation methods for constrained optimization

9. Global Optimization
   - Local and global optimum
   - Stochastic global optimization (Genetic Algorithm)
10. Basics of Design of Experiments (DOE)
11. Response Surface Method
12. Metamodel-based Design Optimization
    - General procedure
    - Mode pursuing sampling method
    - Pareto-set pursing method
13. Other Design Optimization Topics
    - Multi-objective Optimization
    - Multidisciplinary Design Optimization
    - Probabilistic Optimization

Textbook:

Arora, J. S., *Introduction to Optimum Design*, McGraw-Hill, New York, 2nd Edition, 2004.

Recommended readings:

1. Montgomery, D., *Design and Analysis of Experiments*, 7th edition, Wiley, 2009.
2. Papalambros, P. Y., and Wilde, D., *Principles of Optimal Design*, Cambridge University Press, 2000

Prerequisites:

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Labs | 15% |
| Term Tests | 30% |
| Project 1 | 15% |
| Project 2 | 30% |
| - | - |

Project 2 is just for graduate students. Undergraduate students only need to do Project 1, which is focused on problem formulation and application of optimization tools to solve the formulated problem. Project 2 requires research content and novelty, which could be either the application of the recent advanced design optimization method to students' field problem, or

development of new ideas to advance the field of design optimization. Research process and method will be the training objective.

Does the course have a project? Yes

If yes, please provide details:

**Project 1: Application of design optimization**

This project focuses on the application of what you learn in the course to your domain problems. You could consult with the instructor, however not mandatory, to define a problem of a minimum of 5 to 10 design variables, choose an optimization technique, and apply optimization to solve the problem.

**Project 2: Research report on design optimization**

This project has to be research based. Candidate topics will be given later in class; students can also initiate topics of research nature. Continuation of Project 1, if of research nature, may also be accepted. Students may be grouped to teams for this project. Project 2 topics have to be approved by the instructor and should start as early as possible.

Teaching competency:

Dr Wang's lab is among the top three world-leading research labs in the area of design optimization, especially on metamodel-based design optimization. A series of methods and tools have been developed from his lab. This area presents his core competence and his team has successfully applied design optimization in many fields including aerospace, automotive, new energy, healthcare, and many other industries.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 727 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Finite Element Analysis

Short Title (appears on transcripts, max 25 characters)
FEA

Course Description for SFU Calendar ☑ see attached document ☐ Learning outcomes identified

Overview of the finite element method (FEM) and its use in industry; finite element procedures with applications to the solution of general problems in 2-D and 3-D solid, structural, fluid mechanics, and heat and mass transfer; continuum mechanics equations; Galerkin and other residual methods; potential energy method; practice with FEA software tools with guidelines for real-world application. Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☑ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Students who have taken ENSC 888 may not take this course for further credit.

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 427-4 (Planned)

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students will work on research related projects that are beyond the content taught in the class. A formal report will be required on detailed literature survey, the specific research issue, solutions and methods applied in solving the problems, and result analysis.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 15 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. This course is being offered for the first time in Spring 2013 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Gary Wang

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
This course requires software ANSYS, which needs to be renewed annually and shared with the combined undergraduate course.

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 727 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Finite Element Analysis | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**

The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**

Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature R. Cameron | Date 2013-03-02 |
|---|---|---|

**Senate Graduate Studies Committee Approval**

SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee Peter Liljedahl | Signature P. Liljedahl | Date Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 24 January 2013

Course number: **MSE 727**

**Course title: Finite Element Analysis**

**Instructor: Dr Gary Wang**

**Frequency of course offering: Biennial**

Course description:

Overview of the finite element method (FEM) and its use in industry; finite element procedures with applications to the solution of general problems in 2-D and 3-D solid, structural, fluid mechanics, and heat and mass transfer; continuum mechanics equations; Galerkin and other residual methods; potential energy method; practice with FEA software tools with guidelines for real-world application. Students are required to complete a project.

Syllabus:

1. **Introduction**
2. **Stiffness (displacement) method**
3. **Truss and beam equations**
4. **Computer program for truss and beam analysis**
5. **Frame and grid equations**
6. **Plane stress and strain stiffness equations**
7. **Modeling and interpreting FEA results**
8. **Introduction to ANSYS**
9. **3D stress analysis**
10. **Heat transfer and fluid problems**
11. **Practical application of FEA**

Textbook:

A First Course in the Finite Element Method, 2012, 5th edition, by Daryl L. Logan, CL-Engineering

Recommended readings:

1. An Introduction to the Finite Element Method, by J. N. Reddy, McGraw-Hill
2. The Finite Element Method for Engineers, by Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, Wiley

3. The Finite Element Method Using MATLAB, by Young W. Kwon, Hyochoong Bang, CRC

Prerequisites: Students who have taken ENSC 888 may not take this course for further credit.

**Grading:**

| | |
|---|---|
| Labs | 10% |
| Term Tests | 20% |
| Project | 30% |
| Final Exam | 40% |
| - | - |
| - | - |

The components of grading are the same for undergraduate students, but the weighting for the project component is heavier for graduate students.

Does the course have a project? Yes

If yes, please provide details:

All students are required to identify a practical engineering problem that could be solved by using FEA methods or tools. Students can either develop the FEA program by themselves or solve the problem with commercial tools. Graduate students will work on research related projects that are beyond the content taught in the class. A formal report will be required on detailed literature survey, the specific research issue, solutions and methods applied in solving the problems, and result analysis.

Teaching competency:

Dr. Gary Wang (PhD, PEng) has been using finite element analysis through most of his career. In 2009, he and his student developed a FEA tool in Matlab that has been used in ENSC 281 and ENSC 384 for simple truss and beam systems.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 750 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Real Time and Embedded Control

Short Title (appears on transcripts, max 25 characters)
Real Time & Emb Control

Course Description for SFU Calendar ☑ see attached document ☐ Learning outcomes identified

Implementation and design techniques for embedded systems with a focus on control applications: design methodologies, fundamental programming skills, hardware components, interfacing, real-time operating systems, and implementation issues. Students are required to complete a project related to a mechatronic application.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 450-4

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students will perform a major project, which is very different from lab projects given to undergraduate students. Graduate students are exempted from attending the lab sessions.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Summer 2010 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program, especially to those who studies control systems. This course has been offered biennially since Spring 2009 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr M. Moallem

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 750 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Real Time and Embedded Control | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**

The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| | | |
|---|---|---|
| Department Graduate Program Committee<br>Dr. Ed Park | Signature | Date |
| Department Chair<br>Dr. Ed Park | Signature | Date |

**Faculty Approval**

Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| | | |
|---|---|---|
| Faculty Graduate Program Committee | Signature<br>R. Cameron | Date<br>2013-03-02 |

**Senate Graduate Studies Committee Approval**

SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| | | |
|---|---|---|
| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 750**

**Course title: Real Time and Embedded Systems**

**Instructor: Dr Mehrdad Moallem**

**Frequency of course offering: Biennial**

Course description:

Implementation and design techniques for embedded systems with a focus on control applications: design methodologies, modular software/hardware components, interfacing, real-time design and implementation issues. Students are required to complete a project related to a mechatronic application.

Syllabus:

- Introduction to embedded systems, design methodologies, formalisms for system design.
- Embedded processors, programming model, data operations, flow of control, Assembly vs C.
- I/O, Input and output mechanisms, Interrupts, CPU performance, Pipelining, CPU power consumption, embedded design case studies
- Introduction to multi-tasking and concurrent programming: Cyclic executive systems, preemptive systems, real-time operating systems, scheduling techniques, rate monotonic and earliest deadline first algorithms.
- Implementation issues in computer controlled systems: The sampling process, approximation of continuous time controllers, anti-aliasing filters, control discretization, real time design and implementation issues.

Textbook:

Computers as Components: Principles of Embedded Computing System Design, Wayne Wolf, Morgan Kaufmann Publishers (2008). ISBN 1-55860-541-X

Recommended readings:

- A short course on computer control, by B. Wittenmark, K.J. Astrom, and K-E Arzen (downloadable file: http://www.control.lth.se/~kursdr/ifac.pdf).
- Handouts, articles, application notes, etc, given in class, emailed to students, or available online.

Prerequisites:

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Midterm Exam | 20% |
| Final Exam | 40% |
| Project | 30% |
| - | - |
| - | - |

The midterm and final exams will be common with undergraduate students. Graduate students will perform a major project, which is very different from lab projects given to undergraduate students.

Does the course have a project? Yes

If yes, please provide details:

The project includes implementation of an embedded control system for a mechatronic application.

Teaching competency:

Dr Moallem (PhD, PEng) is an expert in the area of control systems. His past and current research has spanned several areas related to the course material including the development of control systems for mechatronic applications. He has published extensively in the above areas.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 780 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Manufacturing Systems

Short Title (appears on transcripts, max 25 characters)
Manufacturing Systems

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Overview of manufacturing systems: industrial robotics, numerical control and metal cutting, manufacturing system components and definitions, material handling systems, production lines, assembly systems, robotic cell design, cellular manufacturing, flexible manufacturing systems, quality control, and manufacturing support systems. Students are required to complete a project.

Available Course Components: ☑ Lecture ☐ Seminar ☑ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 480-4

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students are required to complete a comprehensive research project involving the identification of a manufacturing system from the recent literature. This includes analysis, modeling and simulation to reproduce results. In addition, graduate students are required to answer additional (advanced) problems on course midterm and final exams.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. Graduate students in the MSE program often require an understanding of manufacturing systems for their research. This course has been offered annually since Spring 2011 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Kevin Oldknow or Dr. Ed Park

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
Laboratory space (currently established in SRY 4328)

Additional specialized equipment required in order to offer this course ☐ see attached document
Laboratory setups (small scale robotic arm / vision systems - already in place)

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 780 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Manufacturing Systems | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
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| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature R. Cameron | Date 2013-03-02 |
|---|---|---|

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

**Date**: 24 January 2013

Course number: **MSE 780**

**Course title: Manufacturing Systems**

**Instructor: Dr Kevin Oldknow or Dr Ed Park**

**Frequency of course offering: Annual**

Course description:

Overview of manufacturing systems: industrial robotics, numerical control and metal cutting, manufacturing system components and definitions, material handling systems, production lines, assembly systems, robotic cell design, cellular manufacturing, flexible manufacturing systems, quality control, and manufacturing support systems. Students are required to complete a project.

Syllabus:

1. Introduction and Overview of Manufacturing (1 week)
   Manufacturing Operations, Manufacturing Models and Metrics

2. Automation and Control Technologies (1 week)
   Introduction to Automation, Industrial Control Systems, Hardware Components for Automation and Process Control, Discrete Control

3. Numerical Control (2 weeks)
   Metal Cutting Operations (Turning, Milling), Servo Axis Control in Machining

4. Industrial Robotics (5 weeks)
   Introduction to Robotics, Rigid Motions and Homogeneous Transformations, Forward and Inverse Kinematics, Velocity Kinematics

5. Material Handling and Identification Technologies (2 weeks)
   Material Transport Systems, Storage Systems, Automatic Identification and Data Capture

6. Manufacturing Systems (2 weeks)
   Introduction to Manufacturing Systems, Single-Station Manufacturing Cells, Manual Assembly Lines, Automated Production Lines, Automated Assembly Lines, Cellular Manufacturing, Flexible Manufacturing Systems

Textbook:

Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd Edition, Mikell P. Groover, Pearson-Prentice Hall, 2007, ISBN: 0-13-239321-2

Recommended readings:

Robot Modelling and Control, Mark W. Spong, Seth Hutchinson and M. Vidyasagar, Wiley, 2005, ISBN: 0-471-64990-2

Metal Cutting, 4th Edition, Edward M. Trent and Paul K. Wright, Butterworth-Heinemann, 2000, ISBN: 9780750670692

Prerequisites:

**Grading:**

| | |
|---|---|
| Problem Sets | - |
| Labs | 20% |
| Research Project | 20% |
| Mid-Term Exam | 20% |
| Final Exam | 40% |
| - | - |

Mid-term and final exams will be held in conjunction with the undergraduate students; however, graduate students will be required to answer one or more additional (higher level) questions. Graduate students are required to complete a comprehensive research project including identification of a manufacturing system from the recent literature, analysis, modelling and simulation. Undergraduate students are not required to complete the research project. Both graduate and undergraduate students are required to attend the lab sessions.

Does the course have a project? Yes

If yes, please provide details:

Graduate students are required to complete a comprehensive research project including identification of a manufacturing system from the recent literature, analysis, modelling and simulation.

Teaching competency:

Dr Oldknow (PhD) is an expert in the area of manufacturing controls, dynamics and metal cutting. His research has included work in the areas of dynamically reconfigurable machining systems, and the development of novel control architectures and algorithms for the incorporation of process feedback in high speed motion control. He has published several papers in these areas, both in conference proceedings and refereed journals such as the International Journal of Machine Tools and Manufacture, and IEEE Transactions on Mechatronics. In addition, Dr Oldknow's academic work has been augmented by more than 10 years of industrial experience including extensive experience in the fields of manufacturing and automation, as well as having direct responsibility for manufacturing facilities in the capacity of Vice President and Kelsan Technologies Corp. (subsequently Portec Rail Products Inc. and L.B. Foster Co.).

Dr Park (PhD, PEng) is an expert in the areas of mechatronics, robotics, and automated manufacturing. He has published extensively in these areas over the past 10 years. At SFU, he has developed two courses related to manufacturing systems, the proposed course itself that was initially offered as a Special Topic (ENSC 894, Spring 2011) and MSE 310 (ENSC 387 previously) -Sensors and Actuators.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 782 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Introduction to State Space Control Systems

Short Title (appears on transcripts, max 25 characters)
Intro State Space Control

Course Description for SFU Calendar ☑ see attached document ☐ Learning outcomes identified

Overview of state space methods used for design and analysis of feedback control systems: system modeling concepts, state-space modeling, controllability and observability, stability concepts, state feedback control design, observers, and observer-based compensators, and introduction to optimal control.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Recommended: MSE 381 or equivalent.

☑ This proposed course is combined with an undergrad course: Course number and units: MSE 482-4 (Planned)

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Graduate students will perform a major project, which is very different from lab projects given to undergraduate students. Graduate students are exempted from attending the lab sessions.

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program, especially to those who studies control systems. This course is being offered in Spring 2013 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☐ information about their competency to teach the course is appended
Dr Mehrdad Moallem

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 782 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Introduction to State Space Control Systems | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Cameron | 2013-03-07 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date |
|---|---|---|
| | | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 782**

**Course title: Introduction to State Space Control Systems**

**Instructor: Dr Mehrdad Moallem**

**Frequency of course offering: Biennial**

Course description:

Overview of state space methods used for design and analysis of feedback control systems: system modeling concepts, state-space representation, controllability and observability, stability concepts, state feedback control design, observers, observer-based compensators, and introduction to optimal control.

Syllabus:

- Review of dynamical system modeling concepts and introduction to state-space modeling
- State space fundamentals: Solution of state equations, state-space realization, coordinate transformations
- Controllability
- Observability
- Minimal realizations
- Dynamic behavior and stability concepts: Internal, Input/Output, and Asymptotic Stability
- Linear State Feedback Control Design
- Observers and observer-based compensators
- Introduction to optimal control

Textbook:

Robert L. Williams, II, Douglas A. Lawrence, *Linear State-Space Control Systems*, John _ Wiley and Sons, 2007.

Recommended readings:

K.J. Astrom and R.M. Murray, *Feedback Systems, An Introduction for Scientists and Engineers*, Princeton University Press, 2012

Lecture notes: Will be a combination of the material from above textbooks and other texts and papers.

Prerequisites:

Recommended: MSE 381 or equivalent.

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Midterm Exam | 20% |
| Final Exam | 40% |
| Course Project | 30% |
| - | - |
| - | - |

The midterm and final exams will be common with the undergraduate students. Graduate students will perform a major project which is very different from lab projects given to undergraduate students.

Does the course have a project? Yes

If yes, please provide details:

The project includes simulation and analytical study of a state space control system

Teaching competency: Dr Moallem (PhD, PEng) is an expert in the area of control systems. His past and current research has spanned several areas related to the course material including the development of control systems for mechatronic applications. He has published extensively in the above areas.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 801 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Research and Publication Methods

Short Title (appears on transcripts, max 25 characters)
Research & Pub Methods

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

This course is designed to improve the ability of graduate students to successfully complete graduate-level research by equipping them with knowledge and strategies related to technical writing and research methods. Topics relate to the publication process, including qualitative and quantitative research, technical writing, and presentations. Assessments consist primarily of writing and presentation assignments that simulate the research and writing cycle in an academic engineering context.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Students who have taken ENSC 803 may not take this course for further credit.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 20 | Fall 2013 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. The ability to conduct research and disseminate research findings are fundamental skills needed by researchers. This course is designed to improve the ability of graduate students to successfully complete graduate-level research by equipping them with knowledge and strategies related to technical writing and research methods in an academic publication context. The Publication Methods part of this course has been offered in MSE since Fall 2011 as ENSC 803.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Maureen Hindy and Dr Ed Park

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 801 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Research and Publication Methods | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
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**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | L. Cameron | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date |
|---|---|---|
| | P. Liljedahl | Mar 6, 2013 |

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 22 January 2013

Course number: **MSE 801**

**Course title: Research and Publication Methods**

**Instructors: Maureen Hindy and Dr Ed Park**

**Frequency of course offering: Annual**

Course description:

This course is designed to improve the ability of graduate students to successfully complete graduate-level research by equipping them with knowledge and strategies related to technical writing and research methods. Topics relate to the publication process, including qualitative and quantitative research, technical writing, and presentations. Assessments consist primarily of writing and presentation assignments that simulate the research and writing cycle in an academic engineering context.

Syllabus:

1. **The Writing Process (1 week):**
   **Planning & Organizing, Drafting Strategies, Revising Strategies.**
2. **Principles of Informing and Persuading (1 week):**
   **Rhetorical Strategies, Proposals, Technical Reports.**
3. **Writing for Publication (2 weeks):**
   **Abstracts and Paragraphing, Vocabulary, Sentence Structure, Literature Review.**
4. **Style Issues (3 weeks):**
   **Understanding Conventions, Order, Connection, Conciseness, Clarity, Principles of Punctuation.**
5. **Presentations (3 weeks):**
   **Oral presentations, Using multi-media, Poster Presentations, Graphics.**

6. **Research Methods (3 weeks):**
   **Quantitative and qualitative research, the scientific method, experimental design, performance evaluation and statistics.**

Textbook:

None.

Recommended readings:

Whitmore, S. and Stevenson, S. 2002. *Strategies for Engineering Communication.* John Wiley & Sons Inc. (Available at the SFU bookstore and the SFU Library.)

Prerequisites:

Students who have taken ENSC 803 may not take this course for further credit.

**Grading:**

| | |
|---|---|
| Participation/in-class assignments and quizzes | 20% |
| Research Proposal | 15% |
| Journal Article | 20% |
| Peer Review | 10% |
| Presentation | 20% |
| Poster | 15% |

Does the course have a project? No

If yes, please provide details:

Teaching competency:

Hindy (BA, LLB) has 8 years experience teaching writing intensive courses within Legal, Business and Engineering post-secondary educational programs, including: *Legal Research*

*and Writing, Communications for the Legal Profession, Professional Responsibility & Legal Ethics, Introduction to Professional Communications,* ENSC 105W (*Process, Form, and Convention in Professional Genres*), ENSC 305W (*Project Documentation and Group Dynamics*), ENSC 803 (*Writing for Publication*). She will cover the Publication Methods part of the proposed course.

Dr Park (PhD, PEng) is an expert in the area of (bio)mechatronics with over 10 years of experience in researching as PI and supervising graduate students. Dr Park has a vibrant and cutting edge research program that draws equally on experimentation (laboratory and clinical), modeling, and product development, and has published extensively in the above area. He will cover the Research Methods part of the proposed course.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 811 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Microdevice Engineering and Characterization

Short Title (appears on transcripts, max 25 characters)
Microdevice Eng & Char

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Analytical methods used in design of microdevices. Exact and approximate methods for analysis of static, dynamic, and thermal behaviour of microdevices. Techniques for electro-mechanical conversions and development of reduced order models. Principles for computer simulation of microdevices. Common material and device characterization techniques, including atomic force microscopy, thin film stress/thickness measurement, and scanning electron microscopy.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Recommended: MSE 311, MSE 711 or equivalent.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program. It can also provide depth of knowledge required for students with specific research interests in design, fabrication and characterization of devices at micro- and nano-scales. This course has initially been offered in Spring 2010 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Behraad Bahreyni

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 811 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Microdevice Engineering and Characterization | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
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| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date<br>2013-03-07 |
|---|---|---|

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 811**

**Course title: Microdevice Engineering and Characterization**

**Instructor: Dr Behraad Bahreyni**

**Frequency of course offering: Biennial**

Course description:

Analytical methods used in the design of microdevices. Exact and approximate methods for the analysis of static, dynamic, and thermal behaviour of microdevices. Techniques for electro-mechanical conversions and development of reduced order models. Principles for computer simulation of devices. Common material and device characterization techniques, including atomic force microscopy, thin film stress/thickness measurement, and scanning electron microscopy.

Syllabus:

1. Fabrication (1 week):
   Overview of crystals; Lithography; Oxidation; Wet etching; Doping; Introduction to plasma;
   Physical vapour deposition; Chemical vapour deposition; Dry etching.
2. Transduction mechanisms (2 weeks):
   Electrostatic, Electromagnetic, Thermal, Piezoelectric, Piezoresistive, Optical, Resonance.
3. Modelling of microdevices (3 weeks):
   Modeling of statics and dynamics of beams and plates; Thermal conduction and convection;
   Approximate methods; Electro-mechanical conversions; FEA.
4. Process characterisation (3 weeks):
   Thin film stress/thickness measurement; AFM; SEM; STM; XRD; XPS.

5. Characterisation of microdevices (2 weeks):
Electrical measurement techniques(e.g., using VNA, Lock-in-Amplifier); Mechanical
characterisation (e.g., using vibration tables and test structures); Optical (e.g., Interferometry,
Beam bounce, Doppler) measurement techniques.
6. Micromachined transducers (2 weeks):
Sensors: Pressure, Inertial, Magnetic field, Electric field, Chemical, Thermal, Optical;
Actuators: Micromirrors, Motors, Microfluidic pumps.

Textbook:

N/A

Recommended readings:

MEMS and Microsystems by Tai-Ran Hsu, Wiley, 2008.

MEMS Mechanical Sensors by Steve P. Beeby et al, Artech House, 2004.

Microsystem Design by Stephen D. Senturia, Kluwer, 2001.

Fundamentals of Microfabrication by Marc J. Madou, CRC, 2009.

Prerequisites:

Recommended: MSE 311, MSE 711 or equivalent.

**Grading:**

| | |
|---|---|
| Assignments | 20% |
| Final exam | 40% |
| Research project | 20% |
| Design project | 20% |
| - | - |
| - | - |

The final exam is an open book examination of the course material.

There will be two to four invited lectures to discuss state of the art in specific areas towards the end of the term.

Does the course have a project? Yes

If yes, please provide details:

The research project will be about a particular family of devices or technology chosen according to the student background.

The design project is tied to the research project and will be about the complete design, modeling, and fabrication (process flow design) of a micro-device.

Each student will present his/her project to the class and submits a paper-like report on it (covering both the research and design parts).

Teaching competency:

Dr Bahreyni (PhD, PEng) is an expert in the area of the design and fabrication of MEMS and their interface electronics. His past research has spanned several relevant areas including the development of numerous microsensors and resonant microdevices. He has published extensively in the area and has authored a book on the subject of microresonator design and fabrication. At SFU, he has developed two courses related to the engineering of microdevices (one at graduate level and one at undergraduate/graduate level).

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 821 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Advanced Conduction Heat Transfer

Short Title (appears on transcripts, max 25 characters)
Adv Conduction Heat Trans

Course Description for SFU Calendar ☑ see attached document ☐ Learning outcomes identified

Advanced course on conduction heat and mass transfer. Fundamental elements of heat conduction. Laplace's equation and its applications. Analysis and modelling of engineering systems involving conduction heat transfer. Experimental methods related to conductive heat transfer. Introduction to cooling systems commonly used in microelectronics industry.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Recommended: MSE 223 and MSE 321 or their equivalents.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to energy-related research projects involving advanced heat and mass transfer. This course has been offered since Spring 2008 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Majid Bahrami

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 821 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Advanced Conduction Heat Transfer | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 821**

**Course title: Advanced Conduction Heat Transfer**

**Instructor: Dr Majid Bahrami**

**Frequency of course offering: Biennial**

Course description:

Advanced course on conduction heat and mass transfer. Fundamental elements of heat conduction. Laplace's equation and its applications. Analysis and modelling of engineering systems involving conduction heat transfer. Experimental methods related to conductive heat transfer. Introduction to cooling systems commonly used in microelectronics industry.

Syllabus:

1. Steady and transient heat conduction in isotropic media
2. Review of fundamental principles of heat conduction and boundary conditions
3. Introduction to the concept of thermal resistance of systems and of thermal constriction resistance
4. Derivation of gradient, divergence, Laplacian, conduction equation, boundary conditions and thermal resistance in general orthogonal curvilinear co-ordinates
5. Solutions of conduction equations in several co-ordinate systems
6. A review on contact mechanics and thermal joint resistance
7. Thermal interstitial materials (TIM) and experimental methods
8. Asymptotic solutions and blending methods

Textbook:

Notes and selected papers will be provided.

Recommended readings:

1) Conduction Heat Transfer, Vedat S. Arpaci, Addison-Wesley Pub. Co, 1966, ISBN 0201003597, 9780201003598, 550 pages.

2) Analytical Methods in Conduction Heat Transfer, Glen E. Myers, McGraw-Hill, 1971, ISBN 0070442150, 9780070442153, 508 pages.

Prerequisites:

Recommended: MSE 223 and MSE 321 or their equivalents.

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Midterm Exam | 20% |
| Final Exam | 50% |
| Project | 20% |
| - | - |
| - | - |

Does the course have a project? Yes

If yes, please provide details:

Students will work on a research project in order to design and analyze a conduction/diffusion problem. A formal technical report will be handed in with details on literature survey, the targeted issues, and solutions proposed by the student. Student will also present their work in a seminar-like session at the end of the course.

Teaching competency:

Dr Bahrami (PhD, PEng) is an expert in the area of heat transfer, fluid flow and energy conversion systems. His past research has spanned several relevant areas including the development of numerous thermal solutions for power electronics and electronic systems. He has published extensively in the area all in prestigious journals. At SFU, he has developed three undergraduate courses related to the thermo-fluidic engineering and two graduate courses.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 822 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Advanced Convection Heat Transfer

Short Title (appears on transcripts, max 25 characters)
Adv Convection Heat Trans

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Advanced course on convection heat and mass transfer. Fundamental elements of fluid flow and heat transfer using conservation principles. Analysis and modelling of engineering systems involving convective heat transfer. Experimental methods related to convective heat transfer. Heat/mass transfer and cooling/heating systems commonly used in energy management systems such as microelectronics industry, HVAC systems, fuel cell technologies, and automotive industry.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Recommended: MSE 223 and MSE 321 or their equivalents.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to energy-related research projects involving advanced heat and mass transfer. This course has initially been offered in Spring 2012 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Majid Bahrami

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 822 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Advanced Convection Heat Transfer | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature | Date |
|---|---|---|
| | R. Cameron | 2013-03-02 |

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University

## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 822**

**Course title: Advanced Convection Heat Transfer**

**Instructor: Dr Majid Bahrami**

**Frequency of course offering: Biennial**

Course description:

Advanced course on convection heat and mass transfer. Fundamental elements of fluid flow and heat transfer using conservation principles. Analysis and modelling of engineering systems involving convective heat transfer. Experimental methods related to convective heat transfer. Heat/mass transfer and cooling/heating systems commonly used in energy management systems such as microelectronics industry, HVAC systems, fuel cell technologies, and automotive industry.

Syllabus:

1. Derivation of the general continuity, momentum, and energy equation.
2. Parameters required for determination of heat transfer in laminar and turbulent flows.
3. Fully numerical solutions, exact solutions, scale analysis, similarity solutions, and approximate solutions for internal flows
4. Asymptotic solutions and blending methods
5. External natural convection, scale analysis, similarity solutions and heatsink design
6. Internal natural convection, transient heating, enclosures
7. Special topics such as microscale heat transfer, heat transfer in microstructured (and porous) materials, and thermal management of lithium-ion batteries will be discussed.

If interest is indicated, heat transfer by boiling, condensation and evaporation will be discussed.

Textbook:

Notes and selected papers will be provided.

Recommended readings:

1) Convection Heat Transfer, Adrian Bejan, John Willey, 2004, 694 pages.

2) Convection Heat Transfer, Louis Burmeister, John Willey, 1993, 619 pages

3) Convective Heat and Mass Transfer, Kays, Crawford, and Weigand, McGraw-Hill, 2005, 546 pages.

Prerequisites:

Recommended: MSE 223 and MSE 321 or their equivalents.

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Midterm Exam | 20% |
| Final Exam | 50% |
| Project | 20% |
| - | - |
| - | - |

Does the course have a project? Yes

If yes, please provide details:

Students will work on a research project in order to design and analyze a convection problem. A formal technical report will be handed in with details on literature survey, the targeted issues, and solutions proposed by the student. Students will also present their work in a seminar-like session at the end of the course.

Teaching competency:

Dr Bahrami (PhD, PEng) is an expert in the area of heat transfer, fluid flow and energy conversion systems. His past research has spanned several relevant areas including the development of numerous thermal solutions for power electronics and electronic systems. He has published extensively in the area all in prestigious journals. At SFU, he has developed three undergraduate courses related to the thermo-fluidic engineering and two graduate courses.

SFU SIMON FRASER UNIVERSITY
DEAN OF GRADUATE STUDIES

# New Graduate Course Proposal Form

## PROPOSED COURSE

| Subject (eg. MAPH) MSE | Number (eg. 810) 881 | Units (eg. 4) 3 |
|---|---|---|

Course Title (max 80 characters)
Analysis and Control of Nonlinear Systems

Short Title (appears on transcripts, max 25 characters)
Anal & Cont Nonlin Syst

Course Description for SFU Calendar ☐ see attached document ☐ Learning outcomes identified

Analysis and design techniques for nonlinear systems with a focus on control applications. Dynamical systems and modelling equations. Describing functions. Lyapunov stability theory. Sliding mode control. Linearizing state feedback control. Applications of nonlinear control. Introduction to adaptive control.

Available Course Components: ☑ Lecture ☐ Seminar ☐ Laboratory ☐ Practicum ☐ Online ☐ _____

Grading Basis ☑ Letter grades ☐ Satisfactory/Unsatisfactory ☐ In Progress/Complete | This is a capstone course ☐ Yes ☑ No

Prerequisites (if any) ☐ see attached document (if more space is required)

Recommended: MSE 381 and MSE 782 or their equivalents.

☐ This proposed course is combined with an undergrad course: Course number and units: _____

Additional course requirements for graduate students ☐ See attached document (if this space is insufficient)

Campus at which course will be offered (check all that apply) ☐ Burnaby ☐ Vancouver ☑ Surrey ☐ GNW ☐ _____

| Estimated enrolment | Date of initial offering | Course delivery (eg. 3 hrs/week for 13 weeks) |
|---|---|---|
| 10 | Spring 2014 | 3 hrs/week for 13 weeks |

☐ Yes ☑ No Practicum work done in this class will involve children or vulnerable adults
(If the "Yes" box is checked, all students will require criminal record checks)

Justification ☐ See attached document (if more space is required)

The Senate has recently approved the new MSE graduate program. The next logical step is to establish a list of new regular courses as a part of this new offering. This course covers topics that are relevant to a broad range of research interests in the program, especially to those who studies control systems. This course has been offered annually since Spring 2011 as a Special Topics course.

## RESOURCES

If additional resources are required to offer this course, the department proposing the course should be prepared to provide information on the source(s) of those additional resources.

Faculty member(s) who will normally teach this course ☑ information about their competency to teach the course is appended
Dr Mehdad Moallem

Number of additional faculty members required in order to offer this course
N/A

Additional space required in order to offer this course ☐ see attached document
N/A

Additional specialized equipment required in order to offer this course ☐ see attached document
N/A

Additional Library resources required (append details) ☐ Annually $_____ ☐ One-time $_____
N/A

## PROPOSED COURSE *from first page*

| Program (eg. MAPH) MSE | Number (eg. 810) 881 | Units (eg. 4) 3 |
|---|---|---|
| Course title (max 80 characters)<br>Analysis and Control of Nonlinear Systems | | |

## APPROVAL SIGNATURES

When a department proposes a new course it must first be sent to the chairs of each faculty graduate program committee where there might be an overlap in course content. The chairs will indicate that overlap concerns have been dealt with by signing the appropriate space or via a separate memo or e-mail (attached to this form).

The new course proposal must also be sent to the Library for a report on library resources.

Once overlap concerns have been dealt with, signatures indicate approval by the department, home faculty and Senate Graduate Studies Committee.

**Other Faculties**
The signature(s) below indicate that the Dean(s) or designate of other Faculties affected by the proposed new course support(s) the approval of the new course.

| Name of Faculty | Signature of Dean or Designate | Date |
|---|---|---|
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**Departmental Approval** (non-departmentalized faculties need not sign)

| Department Graduate Program Committee<br>Dr Ed Park | Signature | Date |
|---|---|---|
| Department Chair<br>Dr Ed Park | Signature | Date |

**Faculty Approval**
Faculty approval indicates that all the necessary course content and overlap concerns have been resolved, and that the Faculty/Department commits to providing the required Library funds and any other necessary resources.

| Faculty Graduate Program Committee | Signature<br>R. Comeau | Date<br>2013-03-02 |
|---|---|---|

**Senate Graduate Studies Committee Approval**
SGSC approval indicates that the Library report has been seen, and all resource issues dealt with. Once approved, new course proposals are sent to Senate for information.

| Senate Graduate Studies Committee<br>Peter Liljedahl | Signature<br>P. Liljedahl | Date<br>Mar 6, 2013 |
|---|---|---|

## CONTACT

Upon approval of the course, the Office of the Dean of Graduate Studies will consult with the department or school regarding other course attributes that may be required to enable the proper entry of the new course in the student record system.

| Department / School / Program | Contact name | Contact email |
|---|---|---|
| MSE | Dr Ed Park | ed_park@sfu.ca |

# Graduate Course Information Form

## Simon Fraser University
## Mechatronic Systems Engineering

Date: 21 January 2013

Course number: **MSE 881**

**Course title: Analysis and Control of Nonlinear Systems**

**Instructor: Dr Mehrdad Moallem**

**Frequency of course offering: Biennial**

Course description:

Analysis and design techniques for nonlinear systems with a focus on control applications. Dynamical systems and modelling equations. Describing functions. Lyapunov stability theory. Sliding mode control. Linearizing state feedback control. Applications of nonlinear control. Introduction to adaptive control. Advanced topics in nonlinear control.

Syllabus:

- Review of dynamical systems and modeling equations
- Analysis of modeling equations, state-plane analysis, linearization and linear systems, describing functions
- Review of basic concepts in linear control systems: Controllability, observability, state estimators, state feedback control
- Lyapunov Stability Theory: Basic stability and instability theorems, LaSalle's theorem, Lyapunov methods for stability analysis
- Sliding mode control
- Feedback linearization
- Advanced topics in nonlinear systems: Adaptive control, averaging, perturbation methods, neural computing, etc

Textbook:

Stanislaw H. Zak, *Systems and Control,* Oxford University Press, USA, 2003

Recommended readings:

- Slotine, J.J.E., and Li, W., *Applied Nonlinear Control,* Prentice-Hall, 1991.
- Mark W. Spong, Seth Hutchinson M. Vidyasagar, *Robot Modeling and Control,* Wiley 2006.
- Hassan K. Khalil, *Nonlinear Systems,* Prentice Hall, 2002.
- Other references: Articles, books, lecture notes.

Prerequisites:

Recommended: MSE 381 and MSE 782 or their equivalents.

**Grading:**

| | |
|---|---|
| Assignments | 10% |
| Final Exam | 65% |
| Project | 35% |
| - | - |
| - | - |
| - | - |

Does the course have a project? Yes

If yes, please provide details:

The students will perform a final project/case-study which would involve theoretical studies and/or simulations related to applications in nonlinear control systems. The project topic should be discussed with the instructor and approved beforehand. There will be presentations at the end of semester on the topics by each student.

Teaching competency:

Dr Moallem (PhD, PEng) is an expert in the area of control systems. His past and current research has spanned several areas related to the course material including the development of control systems for mechatronic applications. He has published extensively in the above areas.