**University of Manitoba**

**Faculty of Engineering**

**Department of Mechanical Engineering**

# COURSE DETAILS

**Course Title & Number:** MECH 4310 Analysis of Composite and Multifunctional Materials

**Number of Credit Hours**: 4

**Class Times & Days of Week:** Lectures T,Th 10:00-11:20, Tutorials: Th 14:30-16:20

**Location for classes/labs/tutorials:** Lectures E2-304, Tutorials E2-304

**Pre-Requisites:** MECH 3502, MECH 3542

# Instructor Contact Information

**Instructor(s) Name:**  Dr. Paul E. Labossiere, P. Eng.

**Office Location:** E2-327F

**Office Hours or Availability:**  M,W,F TBA or by appointment

**Office Phone No.** (204)474-8304

**Email:**  Paul.Labossiere@umanitoba.ca

(All email communication must conform to the Communicating with Students university policy)

**Course Website:**  <http://home.cc.umanitoba.ca/~labossip/4310/>

# Catalogue Description and General Course Content

To give students an introduction to stress and strain analysis of composite and multifunctional materials. Topics include anisotropic elasticity, lamination theory, failure criterion, and design philosophies as applied to continuous fiber structural composites. Analysis of multifunctional materials including smartcomposites and shape memory materials. Failure theories and design applications in the aerospace and the biomedical industries.

The following topics will be covered:

Introduction

General Review of Stress and Strain

Equilibrium, Constitutive, Strain-Displacement and Compatibility Equations

Anisotropic Elasticity

Unidirectional Composite Laminates

Plate Theory and Multidirectional Composites

SmartComposites Design and Performance

Shape Memory and Superelastic Materials

Numerical Modeling of Smart Materials

Failure Theories as Applied to Composites and Smart Materials

Aerospace and Biomedical Applications of Smart Materials

# Course Goals

See above

# Textbook, Readings, Materials

Recommended textbook – Tuttle, Mark E., Structural Analysis of Polymeric Composite Materials, Marcel-Dekker, New York, NY, ISBN 0-8247-4717-8 (2004)

Supplementary readings – TBA

Additional Information - <http://home.cc.umanitoba.ca/~labossip/4310/>

# Class Schedule

See course website for details – subject to change

# Course Evaluation Methods

Methods of Feedback: **F** - *formative* (written comments and/or oral discussion)**, S** - *summative* (number grades)

|  |  |  |  |
| --- | --- | --- | --- |
| Due Date: | Assessment Tool | Value of Final Grade | Feedback Methods |
| Tuesdays at 10:00 | Assignments | 10% | F,S |
| TBA | Design Project #1 | 10% | F,S |
| TBA | Term Test | 10% | S |
| TBA | Design Project #2 | 20% | S |
| TBA | Final Exam | 50% | S |

# Referencing Style

Projects should use the IEEE reference style which can be found at: https://www.ieee.org/documents/ieeecitationref.pdf

# Assignment and Design Project Descriptions

Typically, assignment questions will be taken from the textbook for the course and occasionally additional questions will be provided. Design project topics will be assigned and will be available through the course website.

# Grading Times and Grade Policy

After submission of any work, the following timeframes can be used to determine when grades will be returned:

|  |  |
| --- | --- |
| **Component** | **Grading Timeline** |
| Term Test | Within 2 weeks of submission |
| Assignments | Within 2 weeks of submission |
| Design Projects | Within 3 weeks of submission  |

Note that the Voluntary Withdrawal (VW) date is Nov 19th, 2018 (Fall Term) and March 20th, 2019 (Winter Term).

# Grading

The grade boundaries shown are the historical boundaries for the course and are subject to slight modifications at the conclusion of the course to compensate for class averages and expectations and are subject to departmental review.

|  |  |  |
| --- | --- | --- |
| **Letter Grade** | **Percentage Range** | **Final Grade Point** |
| A+ | ≥90 | 4.5 |
| A | 80-89.9 | 4.0 |
| B+ | 75-79.9 | 3.5 |
| B | 70-74.9 | 3.0 |
| C+ | 65-69.9 | 2.5 |
| C | 60-64.9 | 2.0 |
| D | 50-59.9 | 1.0 |
| F | <50 | 0 |

# Assignment Due Dates and Late Submission Policy

Specific assignment due dates are to be posted on the course website and typically due one week following assignment posting date. Solutions will be available on the website after the assigned homework due date. Unless arranged in advance, late homework will not be accepted for full credit. In this course, students are encouraged to work together on the homework; however, all submitted work must be the student’s own. Note: There will also be periodic in-class and in-tutorial short question assignments which you will be required to complete and will count as part of your homework grade.

# Term Test and Exam Policy

Tests and Exam will be closed book and closed notes. Any necessary formulae will be provided unless derivations are required. Term tests dates and locations will be announced in class. The final exam will be held at the University scheduled time and location. Notification must be given in advance for a missed test or a grade of zero will be awarded. University procedures with respect to deferred exams apply for any missed exam.

# Intended Learning Outcomes

1. Apply composite theory to predict performance of singly ply and laminated structures

2. Explore the development and apply and integrate various failure criteria as applied to composites and assess their accuracy.

3. Understand and incorporate design standards and realistic constraints using analysis tools in open-ended design projects related to composite and multifunctional materials.

4. Enhance problem solving and engineering skills through the use of detailed design methodologies.

5. Ability to function effectively in teams to analyze composite and multifunctional material structures and prepare and present engineering design reports

***Expected Competency Level \*\****

|  |  |
| --- | --- |
| **Learning Outcome** | **Attribute\*** |
| **KB** | **PA** | **IN** | **DE** | **ET** | **IT** | **CS** | **PR** | **IE** | **EE** | **EP** | **LL** |
| 1 | D | D |  |  |  |  |  |  |  |  |  |  |
| 2 | A | A |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  | A | D |  |  |  |  |  |  |  |
| 4 |  |  |  | D |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  | D | D |  |  |  |  |  |

I = Introduced, D = Developed (Intermediate), A = Applied (Advanced)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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| --- | --- | --- |
| **\**Attributes*:****KB** A knowledge base for engineering **PA** Problem analysis**IN** Investigation**DE** Design**ET** Use of engineering tools**IT** Individual and team work | **CS** Communication skills**PR** Professionalism**IE** Impact of engineering on society/ environment**EE** Ethics and equity**EP** Economics and project management**LL** Life-long learning |  |

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# Assessment Components, Attributes and Indicators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Value** | **Attributes Covered** | **Indicators being assessed (explicit or implicit)** | **Feedback** |
| Assignments | 10% | 1 Knowledge Base2 Problem Analysis | KB.3: Knowledge base for fundamental engineeringPA.2: Develops or implements a strategyPA.3: Analyzes and solves problems | S |
| Term Test | 10% | 1 Knowledge Base2 Problem Analysis | KB.3: Knowledge base for fundamental engineeringPA.2: Develops or implements a strategyPA.3: Analyzes and solves problems | S, F |
| Project: Report 1 | 10% | 2 Problem Analysis (2%) | PA.1: Identifies and Defines ProblemsPA.2: Develops or implements a strategyPA.3: Analyzes and solves problemsPA.4: Evaluates solution | S,F |
| 4 Design(6%) | DE.1: Understands the complexities and defines appropriate objectives and constraintsDE.2: Uses an appropriate design processDE.3: Develops/implements possible solutions to an open-ended design problem, leading to an appropriate recommendationDE.4: Devises and implements a plan to evaluate a proposed design solution | S,F |
| 7 Communication(2%) | CS.2: Designs and produces appropriate engineering documents | S,F |
| Project: Report 2 | 20% | 2 Problem Analysis (2%) | PA.1: Identifies and Defines ProblemsPA.2: Develops or implements a strategyPA.3: Analyzes and solves problemsPA.4: Evaluates solution | S,F |
| 4 Design(14%) | DE.1-4 | S,F |
| 7 Communication(4%) | CS.2: Designs and produces appropriate engineering documents | S,F |
| 6 Team Work(Grade Shifting) | IT.1 Participates in group activitiesIT.2 Contributes equitably to group work | S (peer evaluation) |
| Final Exam | 50% | 1 Knowledge Base2 Problem Analysis | KB.3: Knowledge base for fundamental engineeringPA.1: Identifies and Defines ProblemsPA.2: Develops or implements a strategyPA.3: Analyzes and solves problemsPA.4: Evaluates solution | S |

**Student Contact Time (Hrs)**

Lectures: 3 hrs lecture × 13 weeks = 37 hrs

Tutorials: 2 hrs tutorial × 12 weeks = 24 hrs

# Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and University guidelines. Copyrighted works, including those created by me, are made available for private study and research and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the *Copyright Act* applies or written permission has been confirmed. For more information, see the University’s Copyright Office website at <http://umanitoba.ca/copyright/> or contact um\_copyright@umanitoba.ca.

# Recording Class Lectures

The instructor and the University of Manitoba hold copyright over the course materials, presentations and lectures which form part of this course.  No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission from Dr. Paul E. Labossiere, P. Eng.  Course materials (both paper and digital) are for the participant’s private study and research.

# Course Technology

It is the general University of Manitoba policy that all technology resources are to be used in a responsible, efficient, ethical and legal manner. The student can use all technology in classroom setting only for educational purposes approved by instructor and/or the University of Manitoba Student Accessibility Services. Student should not participate in personal direct electronic messaging / posting activities (e-mail, texting, video or voice chat, wikis, blogs, social networking (e.g. Facebook) online and offline “gaming” during scheduled class time. If student is on call (emergency) the student should switch his/her cell phone on vibrate mode and leave the classroom before using it.

# Class Communication

The University requires all students to activate an official University email account.  For full details of the Electronic Communication with Students please visit: <http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html>

Please note that all communication between myself and you as a student must comply with the electronic communication with student policy. You are required to obtain and use your U of M email account for all communication between yourself and the university.

# Expectations

Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a final grade. It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the [General Academic Regulations and Requirements](http://crscalprod.ad.umanitoba.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=341&chapterid=4295&loaduseredits=False) of the University of Manitoba dealing with regards to incomplete term work, deferred examinations, attendance and withdrawal. No programmable devices or systems, such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices, are allowed in examinations unless approved by the course instructor. See [Respectful Work and Learning Environment Policy.](http://umanitoba.ca/admin/governance/governing_documents/community/230.html)

**Academic Integrity:**

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, students are reminded that plagiarism or any other form of cheating in examinations, assignments, laboratory reports or term tests is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty.

In addition:

(i) Group projects are subject to the rules of academic dishonesty;

(ii) Group members must ensure that a group project adheres to the principles of academic integrity.

(iii) The limits of collaboration on assignments should be defined as explicitly as possible; and

(iv) All work is to be completed independently unless otherwise specified.

# Students Accessibility Services

**Student Accessibility Services**

If you are a student with a disability, please contact SAS for academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations.  Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

*Student Accessibility Services* <http://umanitoba.ca/student/saa/accessibility/>

520 University Centre

204 474 7423

Student\_accessibility@umanitoba.ca