Department of Mining and materials Engineering

MIME 568: Topics in advanced materials

Winter 2023 (3 credits)

INSTRUCTOR

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PREQUISITES

MIME 362 or permission of instructor

COURSE DESCRIPTION

Functional or advanced materials are materials that combine advantageous structural properties with at least one function, such as an environmental response, detection, energy conversion, filtration, and more. These new materials play an increasingly important role in our lives. Their study involves many interdisciplinary topics in physics, chemistry, engineering, and sometimes even in pharmacy and medicine. This multi-university course is offered by the members of the Centre Québécois sur les Matériaux Fonctionnels (CQMF)/Quebec Center for Advanced Materials (QCAM). The course will introduce students to basic concepts in the field of advanced materials. This course is intended for graduate level students interested in the subject.

LEARNING OBJECTIVES

a) Learn modern concepts on advanced materials, and in particular with modern concepts on polymers, nanoparticles, self-assembly, and materials applications in the field of energy, environment and biomedical.
b) Critically review literature in the field
c) Propose creative solutions to engineering problems
d) Effectively present in front of an audience
e) Effectively work in a team
f) Building a project in science and engineering and measure its impact
g) Provide constructive feedback
h) Take feedback into consideration to improve
i) Present effectively complex problems and solutions
j) Effectively write summaries and reports

TEACHING METHODS

This course is given in several universities at the same time. The course has been developed by the academic committee of QCAM: Profs Duong from UQTR, Cerruti from McGill, Howarth from Concordia, and Ayotte from U Sherbrooke. These four professors (referred to as "course organizers" in this document) oversee the course and participate in several of the activities.

In addition to this, each university has an instructor who deals with logistics, and ensures the smooth running of the course according to the expectations and rules of the university. The course has two parts, one dedicated to the acquisition of knowledge through video lectures, the other to the development of a project related to a field of advanced materials science.

A. **Lectures**

Lectures will be given either in streaming mode or pre-recorded. The live (Zoom) lectures will run on Wednesdays at 1:30 pm from Jan 11-March 8, 2023. There will be a total of 10 lectures, five of them in English and five in French. Each student must study the content of five lectures of their choice, in English and/or French. The acquisition of knowledge of these lectures is evaluated by a quiz of 20 minutes / lecture. The five quizzes will be taken in one session online, in open-book format. The quiz questions are given in both languages and the students are free to answer in either English or French. The list of lectures proposed is in appendix A.

B. The project

The project is completed in a team of three students or four students. The composition of the teams is determined by the course organizers, with the goal of maximizing diversity between student Universities while making sure that language and time of availability is not a barrier among team members. To help team formation, each student will complete a short survey that will guide the organizers in forming the teams.

The teams will have to choose a current problem that has potential to be solved by materials science, falling into the research areas covered by the QCAM (www.cqmf-qcam.ca). Examples of such topics will be covered in the course lectures. The project cannot be directly related to any graduate project of one of the members of the team.

Initial proposal

The team will provide a summary of 3000 characters or less (including spaces) in which the choice of topic will be presented. This summary will briefly present the problem that will be tackled by the team. The solution must be related to the materials science topics covered by the QCAM and cannot correspond to the research projects of the members of the group. The summary will identify what problem the team wants to solve, present the state of the art in the field (e.g., existing solutions), and if possible (but not necessarily) what is the proposed solution. The course organizers will provide quick feedback on this summary, and on the adequacy of the chosen problem with the objectives of the course. Minor or major revisions may be requested.

In this case, a second summary will have to be provided by the team. The final version of the summary will be evaluated based on its clarity and relevance to the field of advanced materials.

Note: along with the summary, students will have to submit a contribution chart that outlines how every member contributed to the submission.

Mid-term 5-minute presentation: speed-dating lecture

Once the abstract is accepted, the team will prepare a five-minute oral presentation. This presentation will highlight the following points:

i. What is the theme of the field of functional materials

ii. What is the problem identified

iii. What are the existing solutions for this problem

iv. What is the new materials-based solution proposed by the team

v. An impact analysis about the solution should be proposed

This presentation will be given to other students at an 'online speed-dating' session. During this session, students will present their presentation to other teams, meeting up virtually in couples that quickly rotate. Each period of speed-dating lasts about 20 minutes: at first, one team presents to another team (5 min); after this, the other team will present their project (5 min). A final period of 10 minutes is allocated for questions and comments. This format may be adjusted depending on number of teams speaking the same language present in the course.

While listening to presentations from other teams, students are encouraged to take notes, since after the speed-dating session each student will have to provide feedback to the other teams that they have listened to (see peer feedback section, below).

A few days later, all peer review comments, rendered anonymous, will be compiled, and sent to each team. A revised version of the five-minute presentation will have to be uploaded on the website and will be evaluated.

Note: along with the revised presentation, students will have to submit a contribution chart that outlines how every member contributed to the submitted presentation.

The evaluation criteria of the 5-min presentation are:

a. Clarity of the presentation (clarity of the presentation of the problem, existing solutions, and the proposed materials-based solution) 25%
b. Domain knowledge (possibility to introduce and explain new concepts, reference to recent works) 25%

c. Creativity and originality (demonstration of how the proposed solution addresses the problem, how the proposed solution differs from what already exists) 25%
d. Communication and teamwork (quality of the oral presentation, quality of PowerPoint support, distribution of tasks in the team) 25%

Final presentation

At the end of the course, the team will present their project in more detail via
- A document of 10 pages maximum
- An oral presentation during a presentation day

The document and the presentation should address the following points
i. What are the contributions of each team member
ii. What is the problem? Why is the problem chosen important? How is it relevant to the field of functional materials science?
iii. What are the existing solutions or what are the existing works that at least partially address the identified problem?
iv. What is the materials-based proposed solution? What assumptions are they based on? What are the advantages and disadvantages? How is this solution original and different from existing solutions?
v. What is the methodology for implementing the solution you propose? Can you identify difficulties? What is the level of risk?

Oral presentation

The oral presentation should last exactly 10 minutes followed by 5 minutes of questions. All members of the group must speak during the presentation. It will be evaluated according to the following points:

- Clarity of the presentation of the problem (20%)
- Clarity of the presentation of the solution (20%)
- Critical discussion of the solution (advantages, disadvantages, risks) (20%)
- Use and understanding of contemporary concepts in functional and advanced materials sciences (20%)
- Answers to questions (10%)
- Visual and oral quality of presentation (10%)

Note: along with the presentation, students will have to submit a contribution chart that outlines how every member contributed to the submitted presentation.

Final report

The final report must be 10 pages maximum, written with a 1.5 line spacing, Times New Roman font 12 points (or equivalent), margins 1.5 cm plus. A maximum of 60 references must be used (references do not count in 10 pages). Format the references according to the ACS style (https://libguides.williams.edu/citing/acs). The document will be evaluated according to the following criteria:

- Clarity of the presentation of the problem (20%)
- Clarity of the presentation of the solution (20%)
- Critical discussion of the solution (advantages, disadvantages, risks) (20%)
- Use and understanding of contemporary concepts in functional and advanced materials sciences (20%)
- Organization and didactic character (10%)
- Good use of literature and quality of illustrations (10%)

Note: along with the report, students will have to submit a contribution chart that outlines how every member contributed to the submitted document.

Peer feedback form

This form consists of 4 questions:
i. What is the presentation about?
ii. What are the highlights of the presentation?
iii. What are the weak points of the presentation?
iv. Do you have any other comments or suggestions for your peers?

The comments made will be forwarded to the teams anonymously (see above), but each student will receive a grade relative to their comments, based on their scientific quality and usefulness.

EVALUATION

1. Means of evaluation
a) Five Quizzes
b) Initial proposal summary, 3000 characters
c) Mid-term presentation, 5-min
d) Written assignments from 4 workshops
e) Peer feedback

f) Final report, 10 pages
g) Final oral presentation

2. Weights
a) Quizzes: 5 * 4% = 20% (individual grade)
b) Summary of 10 lines: 5% (adjusted team grade)
c) Midterm presentation: 16% (adjusted team grade)
d) Written assignments from each workshop: 4 * 2% = 8% (adjusted team grade)
e) Peer feedback: 5% (individual grade)
f) 10 pages project proposal: 23% (adjusted team grade)
g) Oral presentation: 23% (adjusted team grade)

Important note: since this class is heavily team based, we will work with you on how you can become an effective team. See details in Appendix B. Also, each component that is marked as "adjusted team grade" will be adjusted according to the team member reviewing system described in appendix C and the peer contribution submitted along each team submission. This means that each individual will have a grade that may be different from that of other team members, and that will depend on their own contributions to the team project.

4. Important dates

Winter 2023 Wednesday	**Mandatory activities**	**Individual Assignments (due at 5 pm of the day, unless otherwise specified)**	**Team Assignments (due at 5 pm of the day, unless otherwise specified)**
Jan. 11	Intro	Get to know you form.	
Jan. 11	Lecture 1 - 2:00 pm		
Jan. 18	Workshop 1 - Building effective teams for research and innovation		Team values and expectation form
Jan.25	Lecture 2 - 1:30 pm		
Feb.1	Workshop 2 – Impact in research and innovation		Impact assessment document due at 5 pm **on Feb 3rd**
Feb.8	Lecture 3 - 1:30 pm		Initial proposal
Feb.8	Lecture 4 - 3:00 pm	Team member review #1	
Feb.15	Lecture 5 - 1:30 pm		Revision of initial proposal
Feb.15	Lecture 6 - 3:00 pm		
Feb.22	Lecture 7 - 1:30 pm		

Feb.27-Mar.3	Spring break		
March 8	Workshop 3 – Presenting your research project effectively		Guided reflection document
March 15	Quiz		
March 15	Speed dating	Team member review #2 (due at 5 pm of **3/17**) + Peer feedback on midway proposals (due at 5 pm of **3/17**)	Midway proposal presentations
March 29	Workshop 4 – Writing an effective research proposal		2 page pitch document draft to be **ready by 1 pm.** Final 2 page pitch document due at 5 pm **on March 31st**.
March 29			Revision of midway proposal presentations
April 7-10	Easter		
April 19		Team member review #3	
April 19	Final presentation discussion		Final report + oral presentation

SPECIFIC DISPOSITIONS

Classes
Five lectures are given in English, and five in French. The student must choose 5 lectures (French English mix acceptable). All lectures will be online (streamed or pre-recorded).

Communications
The course will be offered on the mycourses McGill secure platform. All communications (submission of exams, survey, etc.) will be via this website. Each student enrolled in their reference university will receive an identifier via email that will enable them to access it.

Project preparation
Project preparation may require travel between major cities in Quebec. The CQMF / QCAM can reimburse your travel related to the project preparation.
For students in Montreal (Varennes), Quebec City, Trois-Rivières and Sherbrooke, the rules are as follows: only day trips can be reimbursed. The train, bus, sharing services (Amigo Express, for example) are refundable with a sum not exceeding $100 per round trip. A maximum of two trips per student is refundable. Evidence (bus tickets, etc ...) must be provided. For other students, please contact the QCAM coordinator, Mr. Petr Fiurasek (petr.fiurasek@mcgill.ca) to schedule a trip.

Quiz and speed-dating day (March 15, 2023)
In the morning you will take a quiz on five lectures of your choice and speed dating will take place during the afternoon. This day will be held at one of the participating universities. Travel between your university and this one will be organized in due time. Travel expenses will be reimbursed by the QCAM for all students. Meals and a coffee break will be provided.

Project presentation day (April 19 2023)
This day will be held at one of the participating universities. Travel between your university and this one will be organized in due time. Travel expenses, meals and coffee break will be provided by the QCAM.

Absences and notifications
A single team rating is assigned to the summary, project, 10-page document and 3-min presentation. No exceptions can be made. Thus, an absence of one of the members of the team on the speed-dating day or on the project presentation day does not entail the postponement of the three minute presentation or the final presentation.

Delays

1) A penalty of 10% per hour of delay is applied to the delivery of all the team assignments mentioned above and on the individual assignment "Peer feedback on midway proposal".
2) A penalty of 0.05 will be applied to the individual weighing factor per each 24-hour cycle of delay in submission of the Team member reviews 1, 2 and 3.

Right to submit in English or in French

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

Academic integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/integrity for more information).

Part of academic integrity is following instructions relative to online quizzes: in quiz 1, you are allowed to look at your course notes, but you cannot communicate with anyone during the time of the quiz.

L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples renseignements, veuillez consulter le site www.mcgill.ca/integrity).

Appendix A: list of lecture topics, professors teaching them, and language

Lecture	En/Fr	Given	Title
Marta Cerruti (McGill)	En	Jan. 11	Bioactive scaffolds
Linda Reven (McGill)	En	Jan. 25	Liquid Crystalline Nanomaterials
Jean-Louis Bobet – (U. de Bordeaux)	Fr	Feb. 8	Stockage/production d'hydrogène
Theo van de Ven (McGill)	En	Feb. 8	Cellulose-based Advanced Materials
Corinne Hoesli (McGill)	En	Feb. 15	Cell Encapsulation
Jonathan Gagnon (UQAR)	Fr	Feb. 15	Chitosane
Guillaume Goubert (UQAM)	Fr	Feb. 22	La spectroscopie Raman
Ashlee Howarth (Concordia)	En	Recorded	MOF
Élodie Boisselier (U.Laval)	Fr	Recorded	Dendrimères
Philippe Dauphin Ducharme (UdS)	Fr	Recorded	Microscopie électrochimique à balayage

APPENDIX B : How to become an effective team

When you start your work with your classmates, you may not realize yet that you are a team, and not merely a group of individuals. Groups of individuals may tend to work independently and simply pool work together with no discussion and may spend a lot of time in conflict over work-related or personal issues.

Team members instead always work together (in person or apart, but aware of who is doing what). They take different roles and responsibilities, help each other, resolve conflicts amicably, and keep personal issues from interfering with team functioning.

When you look for a job, teamwork skills, along with communication skills, are at the top of the list of your to-be employer. In this class we will help you develop this crucial skill through these workshops.

Workshop 1 – Building impactful teams for research and innovation

In this workshop, we will discuss what are the characteristics of a good team and reflect on questions to start working as a team from the first hour. Teams will be invited to reflect on the fundamental rules and values they want to place in their projects. Team building activities will be on the menu (as well as a brainstorming session on the science project by defining the goal of their project with the objective of solving one of the many challenges in the functional materials field).

Outcome valued at 2%: team values and expectation document

Workshop 2 – Impact in research and innovation (open to interested QCAM students for the first 1 h)

In this workshop, students will be introduced to project and self-analysis tools for a technology to be developed. In addition to discussing how to do an effective literature search, the tools presented will allow students to measure the impact of their project according to the objectives of sustainable development and to consider their project in a development context.

In the last half an hour, team challenges will be discussed.

Outcome valued at 2%: fill out an impact assessment document

Workshop 3 – Presenting your research project effectively (open to interested QCAM students for the first 1 h)

This workshop will provide tips and tricks for presenting a project orally in an interdisciplinary context.

During the last 30 minutes, each group will go through the guided Q&A document and reflect on how they want to give a good presentation and divide the work.

Outcome valued at 2%: guided reflection on what they learned

Workshop 4 – Writing an effective research proposal (open to interested QCAM students for the first 1 h)

Students will learn how to produce a concise document that can effectively convey the benefits of a research plan proposal. The document will include a description of the research, research objectives, and the analysis of the impact of the project in a sustainable development context and its integration into an industrial or societal issue. Students are invited to come to this workshop with a draft of the document. The draft should be 2 page long, with the first page relative to introduction to the problem, and second one relative to solutions proposed.

During the last 30 minutes, students will work in teams to revise their draft based on what learned during the workshop.

Outcome valued at 2%: 2-page written pitch document.

APPENDIX C. Peer evaluation

1. Overview

Peer evaluations form an integral part of MIME 568, both in terms of team process and course evaluation. Your evaluations will be anonymous and will allow you to give both quantitative and qualitative feedback to your teammates, with two goals:

1) Help your team grow throughout the class
2) Allow individual's contribution to team work to be properly evaluated

The evaluations consider five criteria:

1. **Assignment contributions:** to what degree did the teammate assume responsibility for their work and participate equitably in the assignment?
2. **Quality of work**: to what degree did the quality of the teammate's work meet overall team expectations?
3. **Communication**: to what degree did the teammate communicate effectively and constructively with other team members, in and out of class?
4. **Equity**: to what degree did the teammate contribute to creating a positive and inclusive team environment?
5. **Professionalism**: to what degree did the teammate act with professional behavior and communication etiquette?

Each criterion is evaluated on a 5-point scale based on the following general guidelines:

0. Unacceptable: Took away from team's ability to perform in the criterion

1. Emerging: Showed some effort, but created an impediment for the team to grow in the criterion

2. Marginally acceptable: Provided minimum contribution expected in the criterion; may have created an annoyance for the team the criterion

3. Accomplished: Performed individually at a high level in the criterion

4. Exemplary: Performed individually at a high level ***and*** helped other teammates to also perform at a high level in the criterion

2. When will you be requested to fill out a peer evaluation form?

Throughout the class, you will fill out 3 peer evaluations, i.e. every time your team has gone through a crucial team assignment:

a. After the initial project proposal submission
b. After the mid-way project proposal discussion

c. At the end of the class

3. Filling out peer evaluation forms

When an evaluation is available to you, the TA will send you a link to an Office Form that you will be able to fill online. ***You will have to fill out one peer evaluation form for each of your teammates***; in these forms, you will provide written feedback for each person and evaluate them on the five criteria above. In each evaluation, you will indicate to what degree each teammate performed in each criterion. A sample of the evaluation rubric is shown at the end of this document (again, the actual evaluation is done online using Office forms). Each peer evaluation event will be open for one week. Late evaluations will be accepted up to one week late but submitting a late evaluation will reduce your evaluation score received by 2% per day late.

4. Determining team score contributions

Your evaluation of each teammate will generate a raw score out of 20 (five criteria each with a maximum score of four). After the evaluation due date, each person will receive anonymous, randomly ordered comments and ratings from their teammates. Scores given by each person will be normalized to an average of 100.

Ex. 1: if the raw total evaluation scores you gave to your 5 teammates were 18, 18.5, 19, 19.5, and 20 (average of 19) these would be normalized, respectively, to 95, 97, 100, 103, and 105 (average of 100).

Ex. 2: if you gave every teammate a perfect score in every criterion, each teammate would receive a raw total evaluation score of 20 from you, the average would be 20, and each teammate would receive 100 for the evaluation (everyone is average).

Ex. 3: if you gave every teammate a score of 1 in every criteria, each teammate would receive a raw total evaluation score of 6 from you (1 pt per 6 criteria), the average would be 6, and each teammate would still receive 100 for the evaluation (everyone is average).

With this system, differences in evaluation standard between individuals are removed. Similarly, individuals do not penalize themselves by giving their teammates high evaluations, nor do they benefit by giving their teammates low evaluations.

The final peer evaluation score for each individual will be the average of all peer evaluations they receive from their teammates. Some individuals may have scores above 100 and some below, but the average evaluation score each person gives will be 100, and therefore the average final evaluation score for the whole team will be 100. These evaluations will be used as a multiplication factor to evaluate individual team grades.

For example: if the normalized scores in Example 1 were representative for the five team members shown, then ALL the items marked as adjusted team grade would be multiplied by 0.95, 0.97, 1, 1.03 and 1.05. So, if for example the team grade for the final project presentation was 80%, those five students would receive team grade components of 76% (i.e. 80% * 0.95), 78%, 80%, 82%, and 84%, respectively. The same would be true for all other evaluation items marked as adjusted team grades.

The individual contribution to each item that is stated as "adjusted team grade" in the table showing evaluation items in the syllabus will be determined using the multiplication factor calculated as

discussed above, adjusted (+/- 0.1) by the professors based on the contributions described on the contribution charts submitted along with each team assignment.

You will see your raw "multiplication factor" as it evolves throughout the course on mycourses.

5. Final remarks

We encourage you to use the peer evaluation forms as only one tool for giving/receiving feedback in your team, in addition to in-class workshops, team clinics with the TA, and out-of-class teamwork time you will schedule. These forms often help bring issues forward before they might otherwise be discussed, and their anonymous nature makes it easier and more comfortable for some people to raise issues related to team dynamics. However, these evaluations alone are likely not sufficient for resolving complicated team issues, and some people find the anonymous nature awkward. Be prepared for this. Try to make sure that the feedback you give in your peer evaluation forms (and face-to-face) is constructive and balanced – let your teammates know what they are doing well in addition to where they might be able to improve.