University of Victoria Engineering

Faculty of Engineering

Department of Mechanical Engineering

COURSE OUTLINE

MECH 580 A05 – Nanomaterials for Biomedical Applications

Term – Fall 2022 (202209)

Instructor	**Office Hours**
Dr. Somayeh Fardindoost	Days: Friday
Phone: 236-882-4132	Time: 10:30- 12 am
E-mail: sfardindoost@uvic.ca	Location: B214

Instructor in Charge
Dr. Mina Hoorfar
Phone: 250-721-8612
E-mail: engrdean@uvic.ca

LECTURE DATE(S)

Section: A05 CRN:13943	Days: Monday Thursday	Time: 8:30-9.50 am	Location: ECS 104

TA Name	**E-mail**	**Office**

Optional Text
Title: Nanostructures and Nanomaterials: Synthesis, Properties and Applications
Author: Guozhong Cao
Publisher/Year: World Scientific Publishing/2011

No required course activities will require students to purchase the Nanostructures and Nanomaterials: Synthesis, Properties and Applications textbook.

COURSE OBJECTIVES:

MECH 580 A05, the Nanomaterials for Biomedical Applications course provides a thorough overview of nanotechnology's impact on advancing medicine and healthcare, including its role in diagnosis and therapy techniques such as biosensing, drug delivery, and imaging systems. The aim of the course is to introduce researchers, to the potential application of engineered devices at the level in the nanometer range in medicine and healthcare, especially in the areas of diagnostics, and therapy. To lay the groundwork/foundation for an understanding of the importance of nanotechnology as a technology/research field, we will begin with a brief

overview of the properties of bulk materials to discuss how and why changes occur in these materials when their sizes approach a billionth of a meter. This review will cover solid-state physics and the movement from classical mechanics to quantum materials. Next, we will discuss the physical and chemical properties of a selected group of materials for a select set of biomedical applications/case studies. We will broadly cover various biosensors, drug delivery systems, and imaging systems based on their mechanisms and the nanomaterials used. To reach this goal, we need to know about the methods for synthesis and fabrication of nanomaterials and explore the instrumentation which enables the visualization and measurement of these nanomaterials and their physical properties.

LEARNING OUTCOMES:

Students who successfully complete this course will be able to:

1. Explain the difference between physical and chemical properties of the bulk and nanoscale materials: such as electric, magnetic, and optical properties of metal, semiconductor, ceramic, polymeric, 0D, 1D, 2D-nanomaterials, size dependence, crystal structure, energy bands of low-dimension materials, quantum effect and potential well model.
2. Describe different biosensing transduction mechanisms as well as the common nanomaterials for biosensing as diagnostic tools including, Electrochemical, Resistive, Impedance spectroscopy, Optical, Mass, and Acoustic based sensing mechanisms.
3. Discuss the applications of different nanomaterials as smart nanocarriers for drug delivery systems and imaging.
4. Know various synthesis and fabrication methods of nanoscale materials (top-down and bottom-up approaches based on chemical methods, and physical techniques).
5. Characterize the principle of the techniques for characterization of nanomaterials and nanostructures (Microscopy and spectroscopy techniques: XRD, XPS, Raman, BET, FTIR, SEM, TEM, AFM).

Weight & Date(s) of Assessments:	**Weight**	**Date**
Assignments:	50%	TBD
Project	20%	TBD
Mid-term	30%	Scheduled by the Office of the Registrar

ASSIGNMENTS

Eight problem sets will be distributed over the course of the term via the MECH 580A05, Brightspace site. Assignments will provide the opportunity for students to discover the subjects discussed in class. All problem sets will be produced on a pdf document downloadable from the Brightspace site. Assignments are submitted as PDFs electronically via the MECH 450A05 Brightspace site. Hardcopy is also acceptable.

Assignment Schedule is tentatively scheduled as follows:

Assignment	Topics	Date Due (before 11:59pm)
1	Introduction to nanotechnology	
2	Biosensors (Electrochemical, Chemo-resistive,	

	Impedance spectroscopy)	TBD
3	Biosensors (optical, Mass, Acoustic)	
4	Nanocarriers for Drug delivery systems	
5	Quantum dots for Imaging systems	
6	Nanomaterials synthesis and fabrication techniques	
7	Nanomaterials Characterization (microscopy)	
8	Nanomaterials Characterization (Spectroscopy)	

Project:

The project is an individual 20 mints presentation based on one of the subjects (optional) from the sections of course schedule that are covered in the class.

Midterm Exam:

The Midterm exam will be completed during the week of Monday December 5. Depending on how the course is progressing the midterm may be in-lecture period, or in tutorial period or outside scheduled class time. The material eligible for testing on the Midterm will be announced in class closer to the date.

NOTES:

NOTES
The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

COURSE LECTURE NOTES
This course will be taught in-person using scheduled lecture and tutorial times. All learning materials will be made available on Brightspace. We will also collect assignment submissions and distribute graded work via the Brightspace platform. The course has an optional textbook and students can use that text as a primary information source. Supplemental powerpoint slides and example problems will be presented in class time. Lecture periods are Monday & Thursday 8:30am-9:50 am in ECS 104. Students are responsible for attending class, monitoring our progression through the sections of the course, the Course Schedule included below. In setting that schedule, the pace of the class has been set to allow for time to address student led discussion and questions - please take advantage of that opportunity by attending the lecture periods.

Unless otherwise noted, all course materials supplied to students in this course are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Course Schedule

(May be subject to change)

Module	Topics	Date/Week
1	Introduction to nanotechnology	2 weeks
2	Bio-sensors (from methodologies to nanomaterials, challenges and future perspective)	5 weeks
3	Drug delivery systems (from methodologies to nanomaterials, challenges and future perspective)	4 weeks
4	Bio-imaging and Tissue engineering (from methodologies to nanomaterials, challenges and future perspective)	1 weeks
5	Nanomaterials synthesis techniques (up-down and bottom-up approaches)	2 weeks
6	Nanomaterials characterization techniques (spectroscopies and microscopic based techniques)	2 weeks

General Information

Note to Students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Assistant to the Chair to set up an appointment.

Centre for Accessible Learning (CAL) https://www.uvic.ca/services/cal/

Accommodation of Religious Observance (AC1210) Read it here

Discrimination and Harassment Policy (GV0205) Read it here

Sexualized Violence Prevention and Response at UVic:
UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting https://www.uvic.ca/sexualizedviolence/. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:
Where: Sexualized violence resource office in EQHR; Sedgewick C119
Phone: 250.721.8021
Email: svpcoordinator@uvic.ca
Web: https://www.uvic.ca/sexualizedviolence/

Office of the Ombudsperson:
The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The

Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.
Phone: 250-721-8357
Email: ombuddy@uvic.ca
Web: https://uvicombudsperson.ca/

Electronic devices in labs and lectures: No unauthorized audio or video recording of lectures is permitted.

Electronic devices in midterms and exams: Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests unless explicitly authorized.

Faculty of Engineering, University of Victoria Standards for Professional Behavior
It is the responsibility of all members of the Faculty of Engineering, students, staff, and faculty, to adhere to and promote standards of professional behavior that support an effective learning environment that prepares graduates for careers as professionals...
You are advised to read the Faculty of Engineering document *Standards for Professional Behavior* which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Graduate Students' Society
The Graduate Students' Society (GSS) serves all students registered in a Graduate degree program. For information on GSS activities, events and services navigate to https://gss.uvic.ca/

Grading System
The University of Victoria follows a percentage grading system in which the instructor will submit grades in percentages. The University will use the following Senate approved standardized grading scale to assign letter grades. Both the percentage mark and the letter grade will be recorded on the academic record and transcripts. Read the policy here

Course Experience Survey (CES)
We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to me regarding the course and my teaching, as well as to help the department improve the overall program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to the http://ces.uvic.ca

You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. I will remind you closer to the time, but please be thinking about this important activity, especially the following three questions, during the course.

- What strengths did your instructor demonstrate that helped you learn in this course?
- Please provide specific suggestions as to how the instructor could have helped you learn more effectively.
- Please provide specific suggestions as to how this course could be improved.

Attendance

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time...
An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.
Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course. Read the policy here.

Academic Integrity

Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

The responsibility of the institution Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

The responsibility of the student Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the severity of the case, penalties include a warning, a failing grade, a record on the student's transcript, or a suspension.
It is your responsibility to understand the University's policy on Academic Integrity

Equality

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning (formerly the Resource Centre for Students with a Disability) located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.