

**CBE 4428 – Introduction to Nanoengineering /
MME 4428 – Fundamentals of Nanoengineering Science**

COURSE OUTLINE – 2023-2024

CALENDAR DESCRIPTION: An introduction to fundamental concepts in nanoengineering, emphasizing limitations of macroscale models and presenting alternative molecular approaches to the engineering of nanoscale systems.

COURSE INFORMATION: Instructor: Dr. Michael Boutilier, P.Eng.
Office: TEB 437
Phone: 519-661-2111, ext. 84361
email: michael.boutilier@uwo.ca
Office hour: Email for an appointment until a regular time is scheduled.

PREREQUISITE: AM 2277 or AM 2276
CBE 2214 or MME 2204

ANTIREQUISITE: You can receive credit for either CBE 4428 or MME 4428, but not for both.

EVALUATION: The final mark will be calculated as follows:

Weekly assigned problems (total of 9)	10%
Project (due Nov. 29)	15%
Midterm (Thu. Oct. 26, 3:30-5:30 pm)	32%
Final exam (during exam period)	43%

The midterm and final exams are **open book / open notes**. Only your highest 7 weekly assigned problem scores will count. The tentative schedule for assessments is as follows:

Evaluation Format	Weight	Effort Type	Assigned	Due
Assigned problem 1	~1%	Individual	Sept 14	Sept 20
Assigned problem 2	~1%	Individual	Sept 21	Sept 27
Assigned problem 3	~1%	Individual	Sept 28	Oct 4
Assigned problem 4	~1%	Individual	Oct 5	Oct 11
Assigned problem 5	~1%	Individual	Oct 12	Oct 18
Midterm	32%	Individual	–	Oct 26
Assigned problem 6	~1%	Individual	Oct 26	Nov 8
Assigned problem 7	~1%	Individual	Nov 9	Nov 15
Assigned problem 8	~1%	Individual	Nov 16	Nov 22
Project	15%	Individual	Oct 26	Nov 29
Assigned problem 9	~1%	Individual	Nov 30	Dec 6
Exam	43%	Individual	During exam period	

**COURSE
DELIVERY:**

This course is planned for in-person delivery. Each week, students will attend 3 hours of lectures and a 1 hour tutorial. Lecture slides will be posted on the OWL website, but most of the lecture notes will be written on the board in class. An assigned problem will be posted to OWL on Thursday afternoons most weeks and will usually be due the following Wednesday during class. Additional problem sets will be posted for practice but will not be collected. Tutorial and lecture times may be interchanged without notice.

TOPICS:

1. Introduction to nanotechnology
 - Overview of current and emerging applications of nanotechnology.
 - Unique properties of nanomaterials.
 - Common tools for nanostructure fabrication and characterization.
2. Molecular viewpoint
 - Characteristic magnitudes encountered in nanoscale systems.
 - Models for interatomic forces and energy.
3. Statistical thermodynamics
 - The molecular origins of thermodynamic properties and the second law of thermodynamics.
 - Applications predicting phase change, thermodynamic properties, and reaction rates.
4. Molecular simulations
 - Overview of available simulation tools for nanoscale systems.
 - Case studies calculating diffusion coefficients, molecular structure, and activation energy.
5. Quantum mechanics
 - The implications of quantization and the wave nature of matter for small systems.
 - Examples in thermal radiation, gas properties, and microscopy.
6. Nanofluidics
 - Fluid flow at the nanoscale and the collapse of continuum fluid mechanics.
 - Molecular origins of transport coefficients.
 - Applications in nanopore flow and separation processes.

**LEARNING
OUTCOMES:**

At the end of this course, students should:

- Recognize the limitations of macroscale descriptions in analyzing nanoscale systems and the conditions under which molecular approaches are needed.
- Be familiar with the order of magnitude of engineering parameters at the nanoscale.
- Understand the molecular origins of thermophysical properties and transport phenomena.
- Appreciate classical property models and the second law of thermodynamics as large system limits, and entropy as a measure of disorder.
- Be able to analyze small thermodynamic systems.

- Have knowledge of various molecular simulation methods, their underlying modeling approximations, and the essential details of their implementation.
 - Note: this learning objective aligns with and is selected for the assessment of the graduate attribute “use of engineering tools” (ET1 and/or ET2, LEVEL: applied): An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.
- Be able to choose appropriate simulation tools to resolve the important details of nanoscale systems and to carry out such calculations.
- Realize the implications of quantization and wave properties on system behavior, formulate quantum mechanical models, and glean insight into real system response through the analysis of simple systems.
- Be able to choose appropriate models for nanoscale fluid flow and predict flow rates through nanoscale geometries.
 - Note: this learning objective aligns with and is selected for the assessment of the graduate attribute “problem analysis” (PA1, PA2, and/or PA3, LEVEL: applied): An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

***EXPECTATIONS /
KEYS TO SUCCESS:***

- Solve problems sets the week they are assigned.
 - Attempt problems independently first.
 - Review in-class examples and tutorial problems then discuss with classmates if you get stuck.
 - Bring your work to office hours or email a photo of your work to the instructor for further guidance.
- Attend all lectures and tutorials and take notes.
 - Routinely review class notes.
 - Ask questions during class, at office hours, or by email.
 - In the rare case that you miss class, get the notes from a classmate and study the material that you missed. Note that lecture slides are intended to be visual aids but are not a complete set of notes.

***REFERENCE
TEXTBOOK:***

Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience, 2nd edition. K. A. Dill & S. Bromberg. Garland Science, 2010.

***CONSULTATION
HOURS:***

Students are encouraged to ask questions during lectures and tutorials. Weekly office hours will be scheduled for students to meet with the instructor. Other individual consultation can be arranged by appointment with the instructor.

***COURSE
POLICIES:***

The following course-specific policies will be strictly enforced throughout the course:

Emergency Contingency Plans

- Course policies, class delivery method, and the number/format of assessments may change at any time in response to difficulties that emerge as a result of pandemics or other emergencies.

- If circumstances prevent in-person instruction from continuing as planned, some or all of the remaining course content will be delivered entirely online, synchronously (i.e., at the times indicated in the timetable) and/or asynchronously (e.g., posted on OWL for students to view at their convenience). Any remaining assessments will also be conducted online at the discretion of the course instructor.

Weekly Assigned Problems

- Over the term, students will be assigned a total of 9 “weekly assigned problems” to submit for credit. These problems will be posted to OWL on Thursday evening and will be due at 10:30 am the following Wednesday.
- Weekly assigned problem solutions are individual submissions, but group discussions are encouraged provided students complete all calculations independently.
- You may only discuss weekly assigned problems with those in the class. Communicating with others or seeking help from tutors not associated with the course is prohibited.
- No credit will be given for late weekly assigned problem submissions.
- Separate problem sets will also be posted for your practice, but these will not be collected or graded.
- Only your highest 7 weekly assigned problem scores will count toward your grade.
- If you have excused absences during the period that 1 or 2 of the 9 weekly assigned problems are due, your weekly assigned problems grade will still be calculated using your 7 highest scores. Each excused absence from a weekly assigned problem submission beyond this will result in one seventh of the weekly assigned problems grade being shifted to the final exam.

Project

- The project report is an individual submission, but group discussions are allowed provided students complete all calculations and write the report independently.
- Students may be assigned different datasets for the project so must download the project from their own OWL account.
- You may only discuss the project with those in the class. Communicating with others or seeking help from tutors not associated with the course is prohibited.
- No credit will be given for late project report submissions.

Examinations

- The midterm and final exams are open book / open notes.
- The midterm examination will be 2 hours and the final examination will be 3 hours.
- If you are unable to write the midterm for medical or compassionate reasons, you must provide the appropriate documentation. Failure to provide adequate documentation will result in a mark of zero. A make-up midterm will be scheduled later in the term.

- In the event of changes to the course delivery method due to a pandemic or other emergency, the midterm and exam may need to be administered online. By enrolling in this course, you are consenting to the use of online proctoring software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded.

Course Absences due to Daily COVID Screening Questionnaire

- Missed assessments (e.g., presentations, essays, quizzes, tests, midterms, etc.) require formal academic considerations (typically academic counselling). Methods for dealing with missed work and course content are at the discretion of the instructor. Students should be aware that some learning outcomes cannot be easily made up and may need to be completed in a subsequent year.
- Students who demonstrate a pattern of routinely missing coursework due to self-reported COVID symptoms, and therefore do not demonstrate mastery of the learning outcomes of the course, will not receive credit for the course.

Absences from Final Examinations

- If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a make-up Final Exam).
- You may also be eligible to write the Special Exam if you are in a “Multiple Exam Situation” (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).
- **Note:** missed work can only be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is not sufficient on its own.

Use of artificial intelligence (AI) tools

- Any use of artificial intelligence (AI) to produce course work that is submitted for grading is considered cheating and/or plagiarism and is not permitted. This applies to work including, but not limited to, assignment solutions, projects, and midterm/exam problem solutions.

***INSTRUCTIONS
FOR STUDENTS
UNABLE TO WRITE
TESTS OR
EXAMINATIONS
OR SUBMIT
ASSIGNMENTS AS
SCHEDULED:***

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions provided by the Faculty of Engineering. You should understand that academic relief will not be granted automatically on request. You must demonstrate to the Undergraduate Services Office that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments.

For further information, please consult the University’s medical illness policy at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodati_on_medical.pdf.

The Student Medical Certificate is available at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

- UNITS:** SI units will be the primary units used in lectures and tutorials. However, other units, such as Å and eV, will be encountered regularly.
- ENGLISH:** In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.
- CHEATING:** University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).
- PLAGIARISM:** Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).
- The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.
- ACCESSIBILITY:** Please contact the course instructor if you require material in an alternative format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education (formerly SSD) at 661-2111 x 82147 for any specific questions regarding an accommodation.
- ILLNESS AND OTHER PROBLEMS:** Students should immediately consult with the instructor or Associate Chair (Undergraduate) if they have problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Undergraduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Undergraduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.
- NOTICES:** Students are responsible for regularly checking their Western email and notices posted on the OWL course site.
- EMAIL POLICY:** Students wishing to communicate with the instructor by email should include “CBE4428” or “MME4428” at the start of the subject line. Email responses should not be expected in less than 2 business days.

REPEATING ALL COMPONENTS OF THE COURSE:

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments, projects, and laboratories cannot be resubmitted by the student for grading in subsequent years.

GRADUATE ATTRIBUTE ASSESSMENT FOR ACCREDITATION BY THE CANADIAN ENGINEERING ACCREDITATION BOARD:

Graduate Attribute	Indicator	Assessment tool	Assessment Level
Problem Analysis	PA2: Demonstrate ability to formulate a strategy to solve an engineering problem.	Exam	A: Applied
Engineering Tools	ET2: Demonstrates ability to apply appropriate engineering tool(s) and resources	Project	A: Applied

ACCREDITATION (AU) BREAKDOWN

Natural Science = 50%
Engineering Science = 50%

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

A. GENERAL REGULATIONS & PROCEDURES

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.
3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see Section G for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office **PRIOR TO THE SCHEDULED EXAMINATION TIME** to report your absence using the [Academic Consideration Request Form](#) and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see Section G for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must submit an "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to submit the [Academic Consideration Request Form](#) and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean,

Undergraduate Studies. Documentation is mandatory.

- ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2023 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness:

https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_135

Academic Accommodations for Students with Disabilities:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Academic Accommodations for Religious or Holy Days:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

Course Withdrawals:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75

Examinations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page_78

Scheduling of Term Assignments:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78

Scholastic Offences:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

Student Medical Certificate:

<https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

Engineering Academic Regulations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Add Deadlines:

First term half course (i.e. “A” or “F”)	September 15, 2023
Full courses and full-year half course (i.e. “E”, “Y” or no suffix)	September 15, 2023
Second term half course (i.e. “B” or “G”)	January 16, 2024

Drop Deadlines:

First term half course without penalty (i.e. “A” or “F”)	November 13, 2023
Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)	November 30, 2023
Second term half or second term full course without penalty (i.e. “B” or “G”)	March 7, 2024

Contact Information:

Undergraduate Services Office:	SEB 2097 Phone: 519-661-2130	E-mail: engugrad@uwo.ca
Chemical & Green Process Engineering:	TEB 477 Phone: 519-661-2131	E-mail: cbeugrad@uwo.ca
Civil Engineering:	SEB 3005 Phone: 519-661-2139	E-mail: civil@uwo.ca
Computer, Electrical, Mechatronic Systems & Software Engineering	TEB 279 Phone: 519-661-3758	E-mail: eceugrad@uwo.ca
Integrated Engineering	ACEB 2410 Phone: 519-661-6725	E-mail: engceli@uwo.ca
Mechanical Engineering:	SEB 3002 Phone: 519-661-4122	E-mail: mmeundergraduate@uwo.ca