

Faculty of Engineering**CBE 4421A –Introduction to Biomaterials Engineering****Description**

An introduction of materials science and engineering topics. The four materials classes (metals, ceramics, polymers, composites) will be addressed with emphasis upon the material types and material properties pertinent to their use in implanted medical devices. The structure and properties of biologic tissues and biocompatibility. Specific implant applications will be addressed.

Prerequisites

ES 1021A/B

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course, and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Corequisites

None

Antirequisites

None

Contact Hours

3 lecture hours, 1 tutorial hour, 0.5 course.

Lectures notes will be posted on OWL under course content.

Assignments will be submitted in Dropbox.

Instructor

Dr. A. S. Rizkalla (TEB 337/D0025) Tel: 519-661-2111 ext.: 82212/86086; email: arizkall@uwo.ca

Undergraduate Assistant

(TEB 477) Telephone: 519-661-2111 ext.: 82131 email: Brandy Hunter <brandy.hunter@uwo.ca>

Required Texts

Biomaterials: an introduction. Park, Joon, Lakes, R. S., Springer, NY. 2007.

Course Notes

Course notes will be available for download from OWL

Units

SI and other engineering units will be used.

General Learning Objectives

- Understand metallic, ceramic, and polymer materials used for surgical and dental implants; biomaterials processing and selection, implant design, physical and mechanical testing; corrosion and wear in the body.
- Understand the aspects of biocompatibility that determine how the body responds to implanted biomaterials and devices.
- Understand the physical and mechanical properties of tissue as related to microstructure.
- Understand some applications of biomaterials.

Note: The four above learning objectives **align with and are selected for the assessment of Graduate Attribute: Knowledge base** (Advanced level) KB4 Demonstrate competence in specialized engineering knowledge such as implant behavior in body environment and the physicochemical and mechanical concepts that govern implant reliability

The above learning objectives also **align with and are selected for the assessment of Graduate Attribute: Problem Analysis** (Advanced level) PA4 Demonstrate the ability to evaluate the physical, chemical, and mechanical properties of biomaterials and formulate a strategy to design a biomaterial for a specific biomedical application.

Specific Learning Objectives

Topics (topics and outline are subject to adjustments and changes)

Biomaterials and Biocompatibility

- Introduction to biomaterials
- Biocompatibility, materials, and host response
- Biocompatibility testing

Structure and Properties of Artificial Biomaterials

- Bonding and crystal structure of metals and ceramics
- Biopolymers and types of polymerization
- Composite materials
- Physical, chemical, and mechanical properties of biomaterials

Degradation of Biomaterials

- Corrosion/Degradation of Metals and ceramics
- Degradation of polymers
- Mechanisms of degradation of biodegradable ceramics and polymers

Structure and Properties of Biological Materials

- Extracellular matrix
- Hard and soft tissues
- Interaction between cells and materials

Biomaterials Design and Characterization

- Metallic Implant Materials
- Ceramic Implant Materials
- Polymeric Implant Materials
- Composite Implant Materials
- Scaffolds for tissue engineering

Application of Biomaterials

- Cardiovascular Medical Devices
- Orthopedic implants
- bone cements and adhesives

- Dental implants
- Ophthalmic Applications
- Tissue Engineering (hard tissue)
- Tissue Engineering (soft tissue)

Evaluation

The final course mark will be determined as follows:

2 Quizzes and 4 assignments	25%
Project	25%
Final examination	50%

Final examination will be cumulative, closed book and 3.0 h duration. Only non-programmable pocket calculators will be permitted. Smart phones should be turned off

Final examination in this course will be conducted the remote proctoring service, Proctortrack.

Proctortrack will require you to provide **personal information** (including some biometric data). The session will be **recorded**. By taking this course, you are consenting to the use of this software. More information about remote proctoring is available in the Online Proctoring Guidelines at the following link:

<https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf>.

Completion of this course will require you to have a reliable internet connection and a device that meets the system and technical requirements for both Zoom and Proctortrack. Information about the system and technical requirements are available at the following links:

<https://www.proctortrack.com/tech-requirements/>,

<https://support.zoom.us/hc/en-us>.

Notes

1) Students must pass the final examination to pass this course. Students who fail the final examination will be assigned 48% if the aggregate mark is higher than 50%, or the examination mark, whichever is less.

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 and laboratories cannot be resubmitted for grading by the student in subsequent years

Use of 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.

Attendance

Attendance in all lectures, tutorials and laboratories is mandatory. Any student, who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

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.

Conduct

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

Sickness and Other Problems

Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

Notices

Students are responsible for regularly checking their Western email and notices posted on Instructors' doors.

Consultation

Students are encouraged to discuss problems with their teaching assistant and/or instructors in tutorial sessions. Office hours will be arranged for the students to see the instructors and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Accreditation (AU) Breakdown

Engineering Design = 35%
Engineering Science = 65%

Aug 17, 2023/BH

EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**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 next page 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 next page 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=>

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