

MSE 59700: Materials for Biomedical Devices

CRN 28963 | Tue Thu 3:00 PM - 4:15 PM | BHEE 234

Instructor Prof. Lia Stanciu	Email lstanciu@purdue.edu
Office hours By appointment or as announced	Format Materials-focused lectures, device studios, and a semester project
Credits 3	Background Introductory biomaterials or equivalent is recommended
Final exam No cumulative final exam planned	Schedule note This draft follows the projected Purdue Fall 2026 calendar and may be revised

Course description

This dual enrollment special-topics class is focused on understanding how materials are selected, processed, manufactured, tested, and evaluated for use in biomedical devices. The course is materials-centered and it is not a second survey of introductory biomaterials. The class concentrates on processing-microstructure-property-performance relationships, wear and tribology, coatings, sterilization effects, additive manufacturing, reliability, and failure analysis in the context of real biomedical devices.

Learning outcomes

- Translate device function and use environment into material and processing requirements.
- Select candidate materials for biomedical devices using mechanical, chemical, tribological, and manufacturability factors.
- Explain how manufacturing route and post-processing influence device performance and reliability.
- Identify the best verification tests, standards, and characterization methods for a given device material system.
- Analyze most encountered failure modes in biomedical devices and propose redesign strategies.
- Communicate materials decisions clearly in written and oral engineering formats.

Course format

Most weeks follow a two-part sequence. Tuesday meetings introduce the week's materials problem through a lecture and case study framing. Thursday meetings run as Device Studio sessions in which student teams analyze a device, complete a worksheet, and discuss materials decisions in class. No traditional weekly homework is planned. Several late-September meetings use asynchronous modules plus studio-equivalent submissions. The class content include:

- Materials-forward device case studies and not a repeat of Introductory Biomaterials
- In-class Device Studio worksheets in lieu of routine homework sets
- One in-class midterm
- Group Materials Design Dossier put together by the students throughout the semester

Texts and reference materials

Required textbook: none.

- Optional background text: Lia Stanciu and Susana Diaz Amaya, Introductory Biomaterials: An Overview of Key Concepts.
- Recommended reference: Michael Ashby, Materials Selection in Mechanical Design.
- Recommended reference: Ratner et al., Biomaterials Science.
- Recommended reference: ASM Handbook, Volume 23, Materials for Medical Devices.
- Reference sources used throughout the semester include FDA CDRH Learn modules, FDA device guidance documents, ASTM and ISO standards, and selected review articles.

Assessment and grading

Component	Weight	Notes
Device Studio worksheets	30%	In-class submissions. Lowest two scores dropped.
In-class midterm	20%	Tentatively scheduled for late October. Closed notes unless announced otherwise.
Materials Design Dossier	30%	Semester-long team project that includes design rationale, testing strategy, and failure analysis.
Final presentation and oral defense	20%	Team presentation during the final weeks of class with instructor questions.

Letter grades follow the standard Purdue scale unless otherwise announced in writing. No cumulative final exam is planned.

Attendance and missed work

Because much of the graded work occurs in class, regular attendance is important. Students are expected to arrive prepared and to contribute to their studio team. The two lowest Device Studio scores will be dropped to absorb ordinary conflicts or minor illness. Additional make-up options, when warranted, are at the instructor's discretion.

Use of AI and outside assistance

Generative AI tools may be used for limited idea generation, outlining, or editing on out-of-class project work only if their use is disclosed by the student team. AI tools may not be used during in-class Device Studio work, quizzes, or the midterm unless explicitly permitted. Students remain responsible for checking technical accuracy and must be able to explain and defend submitted work orally.

Academic integrity

Purdue expects students to uphold high standards of academic integrity in all course activities. Unauthorized collaboration, copying, fabrication, plagiarism, or unauthorized AI use on restricted work will be treated as violations of course policy and university policy.

Accessibility and support

Students who need accommodations should contact the Disability Resource Center and communicate with the instructor as early as possible. Students experiencing significant personal, medical, or wellness challenges are encouraged to reach out early so that a workable plan can be discussed.

Every member of our course should be able to access, use, and learn from the materials we share. This includes all course-related digital content that you and I share in the course. This approach helps promote equal access for everyone at Purdue and is mandated federally by [Title II of the Americans with Disabilities Act \(ADA\)](#). We will work together to provide this access within our Brightspace course.

- My part, as instructor, is to make sure all course materials shared to Brightspace, such as documents, slides, videos and audio, and images, meet accessibility guidelines and to assist you in making sure anything you share is accessible.
- Your role, as a student, is to make sure anything you post for other students to engage with is also accessible, such as peer grading, peer feedback, and discussion board posts. This expectation is built into all course assignments that require you to post to Brightspace.
- A good starting place for you is to bookmark and review the [Innovative Learning Accessibility Checklist](#) for guidance on creating accessible materials.
- When selecting materials to share on our Brightspace from Purdue Libraries catalog or databases, best practices include choosing items that:
 - Can be downloaded in full
 - Are available in EPUB or HTML formats
 - Include alternative text for written materials or captions for audio/visual content

Academic Dishonesty

Academic Regulations & Student Conduct are linked to the 2026-2027 [University Catalog](#).

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" (Part 5, Section III-B-2-a, **Student Regulations**). Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" (University Senate Document 72-18, December 15, 1972).

Academic dishonesty will have consequences (potentially up to automatic failure of the course).

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on the Academic Resources table on your Brightspace homepage.

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in the Academic Resources table on your Brightspace homepage.

Tentative weekly schedule

Schedule follows the projected Fall 2026 Purdue calendar. University calendar changes, guest availability, or course pacing may require adjustment.

Week	Dates	Tuesday	Thursday	Notes
1	Aug 25, 27	Course overview. Biomaterials to devices. Course structure and project overview.	Device selection and team formation. Requirements extraction exercise.	Studio
2	Sep 1, 3	Materials selection for biomedical devices. Ashby-style constraints and trade-offs.	Build a materials selection matrix for one device component.	Studio
3	Sep 8, 10	Standards and verification testing. ASTM and ISO mindset for device materials.	Standards scavenger hunt for the selected device.	Studio
4	Sep 15, 17	Metals in biomedical devices. Fatigue, corrosion, tribocorrosion, and surfaces.	Failure case study involving metal component degradation.	Studio
5	Sep 22, 24	Asynchronous module. Additive manufacturing of implants.	Asynchronous studio equivalent. Porous structures and mechanical reliability.	Asynchronous
6	Sep 29, Oct 1	Asynchronous module. Sterilization as a materials problem.	Asynchronous studio equivalent. Packaging and shelf life.	Asynchronous
7	Oct 6, 8	Failure analysis workshop using images, papers, and case evidence.	Design controls and documenting materials decisions.	Light re-entry week
8	Oct 13, 15	No class. Fall break.	Ceramics reliability. Flaw populations, zirconia, and brittle fracture.	Break / lecture
9	Oct 20, 22	Tribology and wear couples in implants.	Design a wear testing plan for a device interface.	Studio
10	Oct 27, 29	Surface engineering and coatings for biomedical devices.	Tentative in-class midterm.	Midterm
11	Nov 3, 5	Medical polymers in devices. Processing, additives, and sterilization damage.	Materials compatibility exercise for polymer tubing or catheter systems.	Studio
12	Nov 10, 12	Membranes and transport devices. Dialysis and filtration examples.	Design membrane performance and fouling mitigation strategy.	Studio
13	Nov 17, 19	Bioresorbable materials. PLLA, PLGA, magnesium, and strength retention.	Design a degradation testing plan for a bioresorbable device.	Studio
14	Nov 24, 26	Design review presentations I.	No class. Thanksgiving break.	Presentation / break
15	Dec 1, 3	Design review presentations II.	Course synthesis. Materials lessons learned across device classes.	Presentation
16	Dec 8, 10	Emerging materials for biomedical devices. Smart materials, coatings, and future directions.	Final Materials Design Dossier due. Course wrap-up.	Wrap-up

Reference material bank for lecture preparation

Source type	Examples	Use in this course
Background texts	Stanciu and Diaz Amaya, Introductory Biomaterials; Ratner et al., Biomaterials Science; Ashby, Materials Selection in Mechanical Design; ASM Handbook Vol. 23	Background review, figures, and discipline framing
Regulatory and device resources	FDA CDRH Learn; FDA device guidance documents; FDA MAUDE and recall databases	Case studies, failures, testing expectations, and terminology
Standards resources	ASTM medical device and implant standards portal; FDA recognized consensus standards database	Studio worksheets on verification testing and standards
Primary literature	Review papers and selected case studies for AM titanium, tribology, coatings, polymers, membranes, and bioresorbables	Lecture figures, case studies, and student project support

Useful starting points: [FDA CDRH Learn](#) | [ASTM medical device standards](#) | [Purdue projected academic calendar](#)

Emergency Preparedness

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

See Purdue's Information on [Emergency Preparation and Planning](#). This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. I encourage you to download and review the [Emergency Preparedness for Classrooms document](#).

The first day of class, I will review the **Emergency Preparedness plan for our specific classroom**. Please make note of items like:

- The location to where we will proceed after evacuating the building if we hear a fire alarm.
- The location of our Shelter in Place in the event of a tornado warning.
- The location of our Shelter in Place in the event of an active threat such as a shooting.

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately evacuate the building. Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

• **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.

- “Shelter in place” means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, an active threat including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

**In both cases, you should seek additional clarifying information by all means possible...Purdue Emergency Status page, text message, Twitter, Desktop Alert, Albertus Beacon, digital signs, email alert, TV, radio, etc....review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html*

This syllabus is a working draft for planning purposes. Adjustments to readings, studio topics, schedules or deadlines may occur as the semester approaches.