

North Dakota State University
Department of Mechanical Engineering
ME 468/668 “Introduction to Biomechanics” - Fall 2023

Instructor: Dr. Yechun Wang, Dolve 210, Email: yechun.wang@ndsu.edu

Class: MWF 12 – 12:50 pm, Dolve 204

Office Hours: Fridays, 2 – 2:50 pm

Prerequisites: ME 223, ME 352, and admission to professional program

Course (Bulletin) Description

Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies, stress and strain, transport phenomena, and viscoelasticity, as well as their applications on biomechanics of soft and hard tissues.

Course Objectives

Biomechanics combines engineering and the life sciences via the application of classical mechanics to the study of living systems. Due to the complexities and variety of biological organisms and systems, biomechanics covers a broad range of topics. As an introductory course to Biomechanics, the goals of this course are twofold—to provide background knowledge of approaches and tools that have traditionally been used in several aspects of biomechanics, and then to develop clinical applications, e.g. mechanics of cartilage, ligament, tendon, and muscle, as well as human gait analysis.

Textbook: “Introductory Biomechanics: From cells to organisms” by C. Ross Ethier and Craig A. Simmons, Cambridge, 2008.

References

1. “Biomechanics: Mechanical Properties of Living Tissues” by Fung Y. C., Springer, 1993.
2. “An Introduction to Biomechanics: Solids and Fluids, Analysis and Design” by J.D. Humphrey and S. L. Delange, Springer, 2003.

Evaluation Procedures and Criteria

	Undergraduate	Graduate
Homework and Quizzes	30%	20%
Midterm Exam	25%	25%
Final Exam	25%	25%
Project White Paper	0%	10%
Project	20%	20%

- Homework will be collected at the **beginning** of the class on the due date. There will be a 30% grade deduction if the homework is submitted after the due time and before the solution is posted, unless arrangements are made in advance. After the solution is posted on NDSU blackboard or discussed in class, no homework will be accepted. Copying homework solutions are forbidden. Students involved in copying homework or projects will be penalized.
- Quizzes will take place during classes, usually with a time allocation of 10 - 15 minutes.
- Both the midterm exam and final exam will be conducted **in person** with the exception for graduate students enrolled in the online section.
- Makeups for missed exams or quizzes may be arranged to take place no later than a week after the missed exam/quiz. It is the student’s responsibility to contact the instructor for such an arrangement.
- Students are expected to complete their homework and quizzes independently.
- A project white paper is required for graduate students. Each individual graduate student will propose a research project and present it in the white paper based on his/her literature survey in the areas of terrestrial locomotion, biosolids or biofluids.
- Students will form project teams to work on a project proposed by graduate students or the instructor. A project report and a presentation are required for each group.

Grading Policy

A: 90-100 B: 80-89 C: 70-79 D: 60-69 F: 0-59

Anticipated Course Outcomes and Affected Program Outcomes

At the conclusion of the course, students:

- I. Must have an overview of engineering approaches used to study biomechanics with emphasis on biomedical applications. (1, 2)
- II. Will be familiar with biomechanics problems in various organs in the human body and at various hierarchical levels. (1, 2)
- III. Will be able to apply classical mechanics to the study of living systems. (1, 2)
- IV. Will understand the contribution of biomechanics to physiologic processes. (1,2)
- V. Will obtain background to read journal articles that describe specific research findings and the ability to relate these findings to the overall field of biomechanics. (3,5,7)

This course contributes to the following Department of Mechanical Engineering and Applied Mechanics Program Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Academic Honesty Statement

The academic community is operated on the basis of honesty, integrity, and fair play. All work in this course must be completed in a manner consistent with Code of Academic Responsibility and Conduct, NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Americans with Disabilities Act for Students with Special Needs

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.

Attendance Expectations

According to NDSU Policy 333 (www.ndsu.edu/fileadmin/policy/333.pdf), participation in all classes is expected. Students are expected to attend every class and remain in class for the duration of the session when it is safe to do so. Please **do not come to class** if you are feeling ill, particularly if you are experiencing COVID-19 symptoms. **You will still need to complete the assignments, quizzes, exams, etc.**

necessary to meet class learning objectives. I will be flexible regarding deadlines for students who are experiencing illness or other challenges related to illness. Please contact me as early as possible if you think you may not be able to complete an assignment in time or participate in the course due to illness.

Veterans and student service members with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

If uncontrollable challenges appear, such as isolation, with instructor's permission, virtual participation of classes is possible at <https://ndsu.zoom.us/j/95919081337>, passcode: **Biomech**.

Copyright of Course Materials

In this course recording the lectures is prohibited with your own personal devices without prior express approval from the instructor. In this course recording the lectures for anything other than personal use is prohibited. Please refer to NDSU Policy 190 on Intellectual property.

Additional Resources for Students

As a member of the NDSU community, resources are available for you should you need help in dealing with adverse reactions to things happening in the world today. A variety of resources are listed below:

For students on campus and remotely (telehealth):

- Counseling Services: 701-231-7671; <https://www.ndsu.edu/counseling/>
- Disability Services: 701-231-8463; <https://www.ndsu.edu/disabilityservices/>
- Student Health Service: 701-231-7331; <https://www.ndsu.edu/studenthealthservice/>
- Dean of Students Office: 701-231-7701; <https://www.ndsu.edu/deanofstudents/>

In a crisis or emergency situation:

- Call University Police: 701-231-8998
- Call 9-1-1
- Go to a Hospital Emergency Room
- Go to Prairie St. Johns for a Needs Assessment: 701-476-7216 (510 4th St. S.)
- Call the FirstLink Help Line: 1-800-273- TALK (8255) or 2-1-1
- Call Rape and Abuse Crisis Center: 701-293-7273

Course outline (Tentative)

#	Topics
1	Introduction to the course, significance and relevance of biomechanics
2	Terrestrial locomotion: jumping, walking, running
3	Gait analysis: anthropometry and kinematics
4	Gait analysis: kinetics
5	Skeletal biomechanics: bone and soft tissue
6	Viscoelasticity, stress, strain, & constitutive relations
7	Muscles
	Midterm Exam
8	Circulatory systems
9	Fluid mechanics review
10	Blood flow
11	Mass transfer review
12	Respiratory system
13	Invited speakers on a variety of topics related to Biomechanics
14	Project presentations
	Final Exam: Tuesday, December 12, 10:30 am – 12:30 pm