



HPHY 375 – Fall 2022

Biomechanics

Department of Human Physiology

Section 01: TR 9:25 – 10:40 am, 840HSB 210

Janet Zhang-Lea

Office: 840HSB Room 327

Zoom Office: <https://gonzaga.zoom.us/j/9706245962>

Office Hours: Tues 2-4 pm in-person; Wednesday 10-12 am on Zoom.
Or by appointment

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OVERVIEW:

This course will introduce students to the concepts and principles of human motion and its analysis.

SPECIFIC STUDENT OUTCOMES ARE:

Students will demonstrate knowledge and skill development in selected areas:

- 1) Vector Analysis
- 2) Linear and Angular Kinematics
- 3) Torque
- 4) Impulse-Momentum
- 5) Anthropometrics
- 6) Inverse Dynamics

COURSE OBJECTIVES:

1. To understand the terms and concepts used in describing human movement.
2. To understand the physical laws and mechanical aspects governing human movement.
3. To develop a basic understanding of how these physical laws affect human performance.
4. To learn how to analyze and solve qualitative and quantitative problems in the biomechanics of human movement.
5. To apply and demonstrate understanding of the concepts through biomechanical analyses performed in laboratory sessions and as homework.

LEARNING ACTIVITIES:

- A. Classroom lectures
- B. Class discussions
- C. Class problem solving
- D. Homework assignments
- E. Examinations

GRADING:

Weekly quiz	20 %
Midterm Exams (2@ 25% each)	50 %
Final Exam	30 %
	100 %

≥ 92%	A	73-76%	C
90-91%	A-	70-72%	C-
87-89%	B+	67-69%	D+
83-86%	B	60-66%	D
80-82%	B-	< 60%	F
77-79%	C+		

Notes:

- *All assignments are due at the beginning of class. Assignments turned in late will lose 50% if turned in one day late. No credit will be awarded after the second day.*
- *An individual's grade will reflect their contribution to the group's effort based on fellow group member and instructor evaluation.*

Homework

- There will be approximately 10 sets of assigned quiz problems. Each quiz will be posted on Blackboard one week before the due date.
- Quiz is available on each Thursday (referring to the detailed schedule, some weeks do not have quiz) and will be **due by 5 pm next Wednesday**.
- Assignments turned in late will lose 50% if turned in one day late. No credit after the second day.
- Homework will be graded for both completeness and correctness. **Show all work for each problem.** Work to be shown includes:
 - a drawing of the problem,
 - all equations used,
 - all numbers substituted into the equations,
 - all intermediate steps used to arrive at the final answer.
 An answer with no solution steps will receive *no credit!*
- **It is strongly suggested that homework be done on your own.**
- If you choose to work in groups:
 - Each person must turn in his or her own assignment;
 - On the assignment, you must list the name of each person in your group;
 - If you fail to credit your group members, you will lose points.
- If you wish to submit your quiz solution on a paper, solutions can be written on a 8.5 X 11 inch paper (no spiral edges).

Exams

- Each exam may include a mixture of matching, multiple-choice, true-false, short answer, and number problems. Number problems will be similar to those done in lecture and in the homework assignments.
- Exams are to be taken at the assigned time and date. No make-up exams will be given, except under medical/family emergency situations.

*Note: The date of the exam may change based upon the pace of the class and material

REQUIRED TEXT:

No required text. However, there is an optional course textbook that is highly recommended for any student desiring a deeper understanding of biomechanics, or further assistance with class concepts:

- McGinnis, Peter M. (2005). Biomechanics of Sport and Exercise (2nd or 3rd ed.)
Champaign: Human Kinetics.

Lecture materials and the course syllabus are available on Blackboard

(<http://learn.gonzaga.edu/>). Blackboard will also be used for posting class announcements.

Use of Laptops, Mobile Devices, mp3 Players, etc...

Use of these devices is limited to activities related to class. Any student using these devices otherwise (i.e. Facebook, Twitter, texting, phone calls, etc...) during class will be asked to leave immediately. The only exception will be for emergencies. Use of laptop computers is permitted during lecture for note taking purposes only. Should a student need to use a calculator during exams, an actual calculator must be used – not a cell phone, smart phone, tablet, PDA, or any other programmable device of the sort.

Blackboard, e-mail and Web policy:

It is your responsibility to check class announcements on the Blackboard and your Gonzaga e-mail address. On occasion, there might be important messages announced on the Blackboard and/or sent to you via the e-mail so that all students will be kept up-to-date on all pertinent information. It is my assumption that you are aware of and therefore in compliance with this information.

Please correspond with your professor using your Gonzaga e-mail address. Messages from other accounts will not receive a response. Please do not e-mail your professor with questions about course content (i.e. questions to be answered to clarify concepts, etc), or for questions regarding information found in the syllabus. E-mail should be used to schedule meetings with your professor, notify your professor of absence, etc. The goal is to encourage students to discuss content related questions with your professor in person, rather than by e-mail.

Topic Schedule

Note: Both topic dates and Exam dates are tentative and depend upon the pace and material covered in lecture.

WEEK	TOPIC
1	Intro to Biomechanics <ul style="list-style-type: none"> ▪ Overview of the field of Biomechanics ▪ Examples of research in Biomechanics Vectors <ul style="list-style-type: none"> ▪ Review of vectors ▪ Direction and Magnitude ▪ Addition and Subtraction of Vectors ▪ Coordinates and vectors ▪ Multiplication and Vectors ▪ Numerical and Graphical mathematical operations ▪ Example problems Human Motion <ul style="list-style-type: none"> ▪ Linear/Angular/General Motion ▪ Reference Frames ▪ 2D vs 3D ▪ Absolute vs. Relative motion ▪ In-plane vs. Out-of-plane motion ▪ Degrees of Freedom
2 & 3	Linear Kinematics <ul style="list-style-type: none"> ▪ Absolute vs. Relative Position ▪ Displacement ▪ Distance ▪ Movement Efficiency ▪ Linear Velocity ▪ Speed ▪ Relative Velocity ▪ Instantaneous Velocity ▪ Graphical calculations
3 & 4	Linear Acceleration <ul style="list-style-type: none"> ▪ Change in Velocity ▪ Linear Acceleration formulae & computing ▪ Change in speed ▪ Change in direction ▪ Average vs. Instantaneous Acceleration ▪ Graphical calculation of acceleration ▪ Propulsive, Braking & Static ▪ Gait cycle ▪ Laws of constant linear acceleration ▪ Computing linear kinematics

- 5 Angular Kinematics
- Angular motion and kinematics definitions
 - Measuring angles: degrees/radians
 - Positive vs. Negative Angles
 - Absolute Angles
 - Relative angles
 - Joint angles
 - Measuring Joint Angles
 - Range of Motion
 - Angular Displacement
 - Angular Velocity
 - Average vs. Instantaneous Angular Velocity
 - Angular Acceleration
 - Propulsive and Braking Phases
 - Laws of Constant Angular Acceleration
 - Graphical Calculation of Angular V & A
- 6 Angular Kinematics
- Exam #1 (tentatively 6 October)***
- 6 & 7 Linear and Angular Motion
- Angular and Linear Distance
 - Linear and Angular Velocity
 - Tangential Direction
 - Radius of Rotation distance and velocity
 - Radial and tangential velocity changes
 - Radial and tangential Accelerations
 - Linear acceleration in angular motion
 - Releasing a rotating object
- 8 General Motion
- Defining General Motion
 - Relative linear velocity
 - Relative Angular velocity
 - Rotation about a moving axis
 - Kinematic Chains
- 8 & 9 Kinetics
- Inertia and Mass
 - Center of Mass
 - Force
 - Actions of forces
 - Concentrated vs. Distributed force
 - Weight
 - Compression/Tension/Shear
 - Deformations
 - Stress & Pressure

- Bending
 - Torsion
 - Response to stress
- 9 & 10 Newton's Laws
- Linear Kinetics
 - Internal vs. External Forces
 - 1st law, 2nd law, 3rd law
 - Analyzing effects of forces
- 10 Forces acting on Humans
- Contact forces & Non-contact forces
 - Forces from outside the body
 - Normal Forces
 - Static Friction
 - Kinetic Friction
 - Elastic and Viscous forces
 - Forces from Inside the body
 - Joint Contact forces
- 11 ***Exam #2 (tentatively 8 November)***
- Torque
- Angular kinetics
 - Torque (moment)
 - Line of Action
 - Moment arm
 - Computing torque
 - Direction of torque
 - Anatomical torques
 - Resultant torques
 - Static equilibrium
- 12 Anthropometrics
- Joint Loading
 - Example calculation
 - Anthropometry
 - Body Segments
 - Assumptions
 - Anthropometric tables
 - Calculating joint loads
- 13 & 14 Inertia and Momentum
- Linear and Angular Kinetics
 - Inertia
 - Moment of Inertia
 - Factors affecting moment of inertia
 - Body position and moment of inertia

- Computing Mol
- Angular Momentum
- Conservation of Angular Momentum
- Axes of rotation
- Multi-segment angular momentum
- Transfer of Angular momentum

14 & 15

Inverse Dynamics

- Definition of Inverse Dynamics
- Value and Use of ID
- Gait cycle
- Normal gait
- Ground Reaction forces
- Gait problems
- Inverse dynamics for gait
- Steps of ID
- Calculations for ID

Final Exam: Wednesday December 14th 1:00 pm – 3:00 pm

Supplemental material:

- Hall, S.J. (2003). Basic Biomechanics (4th ed.). Boston: McGraw-Hill.
- Zatsiorsky, V.M. (1998). Kinematics of Human Motion. Champaign, IL: Human Kinetics.
- Zatsiorsky, V.M. (2002). Kinetics of Human Motion. Champaign, IL: Human Kinetics.
- Winter, D.A. (1990). Biomechanics and Motor Control of Human Movement (2nd ed.). New York: Wiley and Sons Inc.
- Stergiou, N. (2004). Innovative Analyses of Human Movement. Champaign, IL: Human Kinetics.
- Robertson, D.G.E., et al. (2004). Research Methods in Biomechanics. Champaign, IL: Human Kinetics.

Syllabus Statements

Class Attendance Policy

Gonzaga University presumes that students have sufficient maturity to recognize their responsibility for regular class engagement, and we maintain a general expectation that students will attend courses.

Gonzaga's standard policy on absences applies in this course, that the maximum allowable absence is two class hours (100 minutes) for each class credit. For three-credit classes, the maximum absence is, therefore, six class hours (300 minutes). The grade given for excessive absences is a "V," which has the same effect as "F" (Fail) and is counted in the GPA. This

outcome can be appealed to the Dean of the College/School in which the course is offered. Academic support will be provided for students who are impacted by COVID-19 related sickness and periods of quarantine or isolation on a case-by-case basis. Please notify me in-person, via a phone call (5093134798) or email me (lea@gonzaga.edu) if you will miss a class and need academic assistance. **If you will miss an exam, please notify me at least 2 weeks before the date of the exam for me to arrange accommodations.**

Class Recordings

In class sessions will not be recorded. This may change depending on the number of Covid-19 related absences and classroom technology to allow recording. This course may make use of pre-recorded material that will be available to you for each topic in the course. **You may not duplicate or distribute these prerecorded materials.** Your compliance with the terms of this syllabus regarding use of class recordings is subject to the [Student Code of Conduct](#); violations will be reviewed according to the provisions in the [Administration of Student Code of Conduct](#).

Academic Integrity Policy

All members of the Gonzaga community are expected to adhere to principles of honesty and integrity in their academic endeavors, and this course will abide strictly by procedures and guidelines of the University's Academic Integrity Policy, which can be found in full [here](#) or at the [Academic Integrity Policy Resources webpage](#). Students and faculty are governed by this policy. Familiarize yourself with its scope and procedures. Ignorance of the policy shall not serve as a defense against any violations.

Students with Disabilities/Medical Conditions and Accessible Documents (EITA)

The Americans with Disabilities Act is a federal anti-discrimination statute that provides civil rights protection for persons with disabilities and requires that students with disabilities be guaranteed a learning environment that provides reasonable accommodations. As COVID-related challenges persist, students with qualifying disabilities and/or medical conditions, as per [CDC recommendations for higher education](#), are eligible for and may request reasonable accommodations through established procedures. Students should contact the [Disability Access Office](#) to begin the process. In addition, Gonzaga University seeks to provide equal access to electronic content consistent with applicable federal and state laws, such that when possible "Accessible Documents" will be created with the proper formatting tools to maximize communication of content regardless of what device or adaptive equipment he or she is using; see [Electronic Information Technology Accessibility \(EITA\)](#).

Statement Regarding Course Expectations

As a Jesuit university that seeks to provide an equal opportunity to learn for all students, this course is offered with the expectation that students are here voluntarily, and understand that the university expects all interactions relating to its courses to occur in the context of a professional academic work environment that is welcoming and accessible to all students regardless of gender, race, ethnicity, religion, disability, sexual orientation or identity and any other non-merit factor in educational programs or activities. This environment includes virtual course environments, such as Blackboard, and any course-related communications via e-mail

and social media. We strive to create a healthy environment conducive to intellectual honesty and free inquiry; as such, behaviors which constitute harassment, discrimination, or hostile and/or inappropriate conduct will not be tolerated, and faculty, staff and administrators will take action to ensure such matters are addressed promptly and appropriately.

Notice of Non-Discrimination

Gonzaga University does not discriminate against any person on the basis of race, color, religion, national origin, sex, marital status, sexual orientation, gender identity, age, disability, military status, or any characteristic protected by local, state, or federal law, or any other non-merit factor in employment, educational program, or activities that it operates.

Harassment & Discrimination Policy

Consistent with its mission, Gonzaga seeks to assure that all community members learn and work in a welcoming and inclusive environment (please review [Harassment & Discrimination Policy](#)). Title VII, Title IX and Gonzaga's policy prohibit gender-based harassment, discrimination and sexual misconduct, including sexual assault, dating and domestic violence, and stalking. Gonzaga encourages anyone experiencing gender-based harassment, discrimination or sexual misconduct to talk to someone from Gonzaga's reporting and support resources list found here: [Title IX | myGU \(my.gonzaga.edu\)](#).

Resources and Reporting Options for Incidents of Sexual Misconduct

It may be helpful for students to talk about what happened in order to get the support needed and for Gonzaga to respond appropriately. There are options for support and resolution, namely confidential support resources and campus reporting and support options are available [here](#). Gonzaga will respond to all reports of sexual misconduct in order to stop the harassment, discrimination, or misconduct; prevent its reoccurrence; and address its effects. Responses may vary from support service referrals to formal investigations.

Faculty members can connect students to resources on campus, including those who are specially trained in and experienced in assisting in such complaints, and therefore will report all incidents of gender-based harassment, discrimination and sexual misconduct to Title IX to provide the Title IX Director with all relevant details, including names and identifying information, of the incident reported. A representative from that office will reach out to the student via phone and/or email to explore options for support, safety measures and reporting. For more information about policies and resources or reporting options, please visit the [Equity, Diversity & Inclusion at Gonzaga Webpage](#) and [Title IX](#). To make a report of harassment, discrimination or sexual misconduct directly:

- Contact the Title IX Coordinator by phone, email, or in person:
Stephanie Thomas, Title IX Coordinator, 509-313-6910, thomassn@gonzaga.edu, Business Services Building, Office 18
- Or complete an [online reporting form](#).

Students with Disabilities/Medical Conditions and Accessible Documents (EITA)

The Americans with Disabilities Act is a federal anti-discrimination statute that provides civil rights protection for persons with disabilities and requires that students with disabilities be guaranteed a learning environment that provides reasonable accommodations. As COVID-related challenges persist, students with qualifying disabilities and/or medical conditions, as per [CDC recommendations for higher education](#), are eligible for and may request reasonable accommodations through established procedures. Students should contact the [Disability Access Office](#) to begin the process. In addition, Gonzaga University seeks to provide equal access to electronic content consistent with applicable federal and state laws, such that when possible “Accessible Documents” will be created with the proper formatting tools to maximize communication of content regardless of what device or adaptive equipment he or she is using; see [Electronic Information Technology Accessibility \(EITA\)](#).

FERPA and Privacy

Under [FERPA](#) (Family Educational Rights and Privacy Act), your educational records are confidential and protected. Under most circumstances your records will not be released without your written and signed consent, which must be documented through the Registrar’s Office. Instructors are not allowed to publicly post grades by student name, social security number, GU student identification number, or any other identifiable means, without written consent from the student. The FERPA policy does not apply to third party online applications that may be used in courses such that it is the student’s responsibility to read the privacy documentation at each site.

Course Evaluations

At Gonzaga, we take teaching seriously. We ask our students to evaluate their courses and instructors so that we can improve our classes and programs and provide the best possible learning experience. Near the end of the semester, students will be asked to complete the course/instructor evaluation on-line to provide feedback on their classroom experience (see the [Course Evaluations website](#) for more information). This feedback is important and appreciated.

Diversity, Equity and Inclusion

Our human differences contribute to the richness of our academic community life. In partnership with the [Office of Diversity, Equity & Inclusion](#), we expect everyone to cultivate an academic environment that is welcoming and accessible to students, staff, and instructors regardless of gender, race, ethnicity, religion, disability, and sexual orientation or identity. The [Bias Incident Assessment and Support \(BIAS\) Team](#) exists to foster a campus environment where everyone feels safe and respected. Those who experience or witness a bias incident should visit the [BIAS Report site](#).

Religious Accommodations for Students

In compliance with Washington State law, Gonzaga University will reasonably accommodate students who, due to the observance of religious holidays, expect to be absent or endure a significant hardship during certain days of their academic course or program. Gonzaga University prohibits discrimination, harassment, and retaliation on the basis of religion. The

Religious Accommodations for Students policy as well as the process by which students can request accommodations can be found on the [Academic Policies and Procedures Webpage](#).

Table of associated links for university and academic policy statements that are relevant to classroom learning and syllabi.

University and Academic Policy Statements	Associated Links
Diversity, Equity and Inclusion	Visit Equity, Diversity & Inclusion at Gonzaga Page Bias Incident Assessment and Support (BIAS) Team
Harassment and Discrimination Policy	Harassment & Discrimination Policy Title IX I myGU (my.gonzaga.edu)
Academic Integrity Policy	Visit Academic Integrity Policy Resources Page
Students With Disabilities/Medical Conditions and Accessible Documents (EITA)	Disability Access Office EITA Office
Religious Accommodations for Students	Visit Academic Policies and Procedures Page
FERPA and Privacy	FERPA
Class Attendance Policy	Visit Academic Policies and Procedures Page
* Class Recording Policy (audio, video, and photos)	Visit Academic Policies and Procedures Page GU Student Code of Conduct
Course Evaluations	Accessing and Timing of Course Evaluations