ME 4670 / ME 5670 Engineering Biomechanics of Human Motion

Learning Outcomes

Dr. Bob Williams

The objectives of this course are to provide a basic introduction to the anatomy and physiology of the human musculoskeletal system and then to cover the kinematics and dynamics of spatial multiple degree-of-freedom human motion. After this course, the student should have general background, mathematical, and computer skills to enable high-fidelity kinematics and dynamics simulation and analysis of general human motions. The methods used in this course are general vector/matrix analysis techniques that can be applied in the future to more complicated examples. A side-objective is to introduce the use of MATLAB as a powerful software tool in programming analysis and simulation equations. The graduate course project is intended to have each graduate student apply the class principles in real-world human motions. This course provides practice in technical writing (weekly homework memos and final project report) and practice in technical presentation (journal articles and final project presented orally to the class). Specific topics include:

1. Introduction to biomechanics including concepts, definitions, facts, and history.

2. Engineering mechanics overview.

3. Students will be able to use the standards, conventions, and methods of human musculoskeletal biomechanics analysis.

4. Students will be able to demonstrate a working knowledge of human skeletal system anatomy and physiology, including all joint types.

5. Students will be able to demonstrate a working knowledge of human muscular system anatomy and physiology, including muscle modeling.

6. Students will be able to perform modeling, derivations, calculations, and simulations for human body statics.

7. Students will be able to perform modeling, derivations, calculations, and simulations for human body kinematics.

8. Students will be able to perform modeling, derivations, calculations, and simulations for human body dynamics.

9. Students will be able to display awareness of commercial biomechanics modeling and analysis software.

10. Additional topics: metrology, humanoid robots, and bipedal locomotion.

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Syllabus and Policy

Dr. Bob, 262 Stocker, 740-593-1096 williar4@ohio.edu people.ohio.edu/williams	Spring 2025 Class # 1148 (ME 4670) Class # 1154 (ME 5670)

Time & Venue

9:30 – 10:50 a.m. Tu Th 3 credit hours ARC 212

Prerequisite PHYS 2051

Description

Overview of human skeletal and muscular anatomy and physiology. Application of engineering mechanics to the human musculoskeletal system. Kinematics, statics, and dynamics of human motions. Human motion metrology.

Office Hours

2:00 – 3:30 p.m. Tu Th and by appointment

Required NotesBook

Engineering Biomechanics of Human Motion, Dr. Bob Productions, 2024

Engineering Biomechanics of Human Motion (lulu.com)

I would NOT use all your Stocker prints for a hardcopy of this required NotesBook.

Required Textbook **none**

ME 4670 / ME 5670 Course Website

people.ohio.edu/williams/html/Courses.html

ME 4670 / ME 5670 NotesBook Supplement

people.ohio.edu/williams/html/PDF/Supplement4670.pdf

Dr. Bob's MATLAB Primer and Matrices Review

people.ohio.edu/williams/html/PDF/MATLABPrimer.pdf

people.ohio.edu/williams/html/PDF/MatricesLinearAlgebra.pdf

Lab Activities

Five Lab Activity Reports are due at the start of class according to the schedule shown. The labs are to be done outside of class with teams up to 3. A memo must be the first page of each report. Safety is very important! No injuries!! Each Lab report is worth 20 pts.

people.ohio.edu/williams/html/PDF/Labs4670.pdf

Quizzes

Five quizzes will be given in class, according to the schedule shown. Quizzes are closed notes and closed ME 4670 / 5670 NotesBook. **Q3** is the midterm quiz and **Q5** is the second midterm quiz; all quizzes are equally weighted (20 pts each).

MATLAB Assignments

Three MATLAB assignments are due (20 pts each), at the start of class according to the schedule shown. A memo must be the first page of each submission. No late assignments will be accepted.

people.ohio.edu/williams/html/PDF/MATLAB4670.pdf

Student Biomechanics Video Day

Each individual must present a short biomechanics-related video in class (as scheduled on the following page) and submit a 1-page memo report on it the same day, Lv, for a one-half Lab grade (10 pts).

Journal Article Presentation(s)

Each lab team must read a current journal article on biomechanics of human motion and give an oral presentation to the class (as scheduled on the following page) and submit a report on it the same day, La, for a full Lab grade (20 pts). Graduate students must do two, as scheduled; graduate students must present as individuals.

people.ohio.edu/williams/html/PDF/ResPapePres4670.pdf

Graduate Students

As required by Ohio University, graduate students must complete extra work in a dual-listed course: 1. An additional journal paper presentation (see above) as scheduled; and 2. A semester-long project must be completed by each individual graduate student (worth 90 pts). You must define your own biomechanics project (from your interests), involving computer simulation.

people.ohio.edu/williams/html/PDF/GradProj5670.pdf

Memo

The first page of each Lab Report (including Lv), MATLAB assignment, and journal article report (La) must be a one-page memo giving the highlights, methods, bottom line results, and a short discussion. Reference may be given to ensuing sections of your report. Assume that I am your boss and you are communicating the results of your recent work to me in this memo. A sample memo is given.

Academic Dishonesty

Cheating in any form will not be tolerated. A grade of zero will be registered for any infraction, and the matter will be referred to University Judiciaries. There will be a zero-tolerance punishment of plagiarism in any form – the assignment in question will receive a zero and you will be referred to University Judiciaries. Cite all references properly and do not copy ANY text (with the exception of an important short quote, in quotation marks, attributed and referenced properly).

Attendance

Attendance is required. Poor attendance ***will*** affect your grade.

Grading

The weighting for all quizzes and assignments was stated previously. Based on the following percentages, the following final grades will be assigned:

93.3-100	90-93.3	86.7-90	83.3-86.7	80-83.3	76.7-80	73.3-76.7	70-73.3	66.7-70	63.3-66.7	60-63.3	< 60
A	A–	B+	B	B–	C+	C	C–	D+	D	D–	F

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Schedule, Spring Semester 2025

Week	Date	Day	Topic	Notes	Lab	Quiz	Matlab
1	14-Jan	Tu	Syllabus and Introduction	1.2			
		Th	Engineering mechanics review	1.4			
2	21-Jan	Tu	Conventions	1.5			
		Th	Human skeletal anatomy	2.1			
3	28-Jan	Tu	Human skeletal physiology	2.2	L1		
		Th	Human skeletal physiology	2.2			
4	4-Feb	Tu	Quiz 1			Q1	
		Th	Human muscular anatomy, Grad project signup	3.1			
5	11-Feb	Tu	Human muscular anatomy	3.1	L2		
		Th	Human muscular physiology	3.2			
6	18-Feb	Tu	Quiz 2			Q2	
		Th	Human muscular physiology	3.2			
7	25-Feb	Tu	Kinematics	4.1	L3		
		Th	Grad Journal Article Presentations		La		
8	4-Mar	Tu	Quiz 3 - midterm			Q3	
		Th	Grad Term Project Presentations, Interim Report				
9	11-Mar	Tu	Spring Break				
		Th					
10	18-Mar	Tu	Human arm FPK, MATLAB	4.2	L4		
		Th	Human arm IPK, MATLAB	4.2			
11	25-Mar	Tu	Statics	5.1			
		Th	Human arm statics - general, biceps	5.2			1. Kin
12	1-Apr	Tu	Quiz 4			Q4	
		Th	Human arm statics - triceps, opt, acceptable, MAT	5.2			
13	8-Apr	Tu	Dynamics	6.1	L5		
		Th	Human arm dynamics, MATLAB	6.2			2. Stat
14	15-Apr	Tu	Quiz 5 - second midterm			Q5	
		Th	Student biomechanics video day		Lv		
15	22-Apr	Tu	Journal Article Presentations		La		
		Th	Grad Term Project Presentations, Final Report				3. Dyn

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Lab Activities Policy

Dr. Bob

The Lab Activities are assigned on the course website. Each is to be completed with a partner or two outside of class – we have no formal biomechanics lab, so please do your best. Choose the same partner(s) all semester if possible. See the grade-dropping policy stated earlier. A *MEMO* summarizing the lab experiment must be the first page of each submission.

1. No late assignments will be accepted. Each lab is due at the start of class as shown in the schedule.

2. No computer excuses will alter deadlines. In the event of problems, do your best. Don't e-mail your lab to me or ask me to print it out.

3. Your work must be neat, with answers clearly noted and supporting information provided.

4. The cover sheet must be a 1-page memo, carefully and thoughtfully written to summarize what you did and what you learned. An example memo is given on the next page.

5. Turn in one report with both names – both partners earn the same grade.

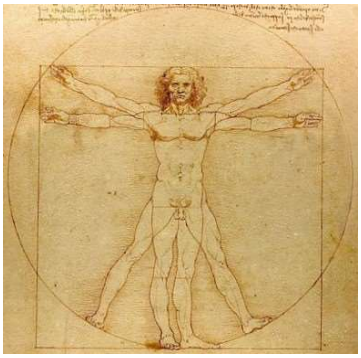
6. Do NOT separate the writing between partners week-by-week. Instead, all partners must contribute equally to each weekly assignment.

7. For many labs, you may have to look ahead in the notes since we may not have reached those topics in the class yet. You may use any other valid sources to help with labs (reference your sources).

8. There may often be multiple ways to answer many of the lab questions. Think in terms of primary effects and secondary effects. Justify all responses.

9. Grading – For full marks, you must certainly answer everything and correctly; in addition:

    a. Include significant, meaningful discussion – this is where a lot of learning occurs.
    b. Use concise yet complete technical writing.
    c. Type it up unless your handwriting is better than most padawan engineers.
    d. Liberally include graphics, diagrams, and sketches, etc.
    e. Connect the lab to what we are learning in class, when possible (sometimes the lab comes prior to the lecture on certain subjects).
    f. Go the extra mile for full marks.



OHIO UNIVERSITY

Russ College of Engineering & Technology
Biomedical Engineering Program

DATE: January 31, 2025

TO: Dr. Bob

FROM: Humans in Motion

SUBJECT: Lab Experiment #1 Results

Dr. Bob,

The purpose of this memo is to present the basic experimental results for Lab #1. The assignment was (*briefly summarize here*).

Some sample results are given here: (*give results; not always appropriate or possible here*). My sketches and equation derivations appear on p. 2 (*if appropriate*). For a complete set of results, following the suggested Lab #1 report format, please see pp. 3-7. The discussion follows on page 8.

(*Summary of roadblocks, issues, or learning here, if appropriate*).

If you have any questions on my work, please contact me.

Sincerely,

Humans in Motion
thing1@ohio.edu
thing2@ohio.edu
thing3@ohio.edu