
ME 2205: DYNAMICS OF RIGID BODIES IN THREE DIMENSIONAL MOTION

Fall 2026

Credit Hours:	1-0-1
Catalog Description:	Kinematics and kinetics of particles and rigid bodies in one, two, and three dimensions. Newton-Euler equations. Work-energy and impulse-momentum principles
Class Time and Location:	TuTh 9:30a-10:45a, Whitaker 1103
Instructor:	Dr. David E. Torello (He/Him/His), Eighth St. West Apartments, Office W011 Email: david.torello@me.gatech.edu
Office Hours:	Office hours will be conducted in-person. Time: TBD Location: Love Building 2 nd floor atrium
Graders/TA's:	<i>Graders:</i> <ul style="list-style-type: none">• TBD <i>Learning Assistants:</i> <ul style="list-style-type: none">• TBD
Prerequisites:	COE 2001 Statics, CEE 2040 Dynamics or equivalent
Instruction Mode:	In-person
Textbook:	J. L. Meriam, L.G. Kraige, J. N. Bolton, Engineering Mechanics: Dynamics, 9 th Edition, Wiley, 2018. ISBN: 978-1118885840
Online Videos:	Coursera MOOCs: Engineering Systems in Motion: Dynamics of Particles and Bodies in 2D Motion and Advanced Engineering Systems in Motion: Dynamics of Three Dimensional (3D) Motion, both by Dr. Wayne Whiteman, Georgia Tech. Videos available here through Coursera: http://www.coursera.org/ NOTE: You are NOT required to take the Coursera class! Just use it to access the videos.

1. INTRODUCTION:

Welcome to ME 2205, Dynamics of Rigid Bodies in Three Dimensional Motion! The purpose of this course is to provide you the opportunity to learn and apply the fundamental principles of general engineering dynamics. Dynamics is the study of **motion**, as contrasted to Statics, which is the study of forces and moments in equilibrium. While these appear to be vastly different subjects at first glance, they share many of the same fundamental concepts and mathematical operations. It is highly advised for students to make sure they are comfortable with their vector algebra from Statics, as we will NOT be covering that material in this abbreviated course. You are also expected to be familiar

with basic Newton-Euler dynamics in planar problems, and we will only do a brief review of that material before jumping into general problems.

2. TOPICS:

1. Planar Kinetics
 - 1.1. Newton-Euler Equations
2. General Kinematics of rigid bodies in 3D motion
 - 2.1. Velocity and acceleration in moving reference frames
 - 2.2. Rotation matrices
3. General Kinetics of rigid bodies in 3D motion
 - 3.1. Transformation of inertia properties
 - 3.2. Principal axes and moments of inertia
 - 3.3. Angular momentum and moment of angular momentum

3. COURSE STRUCTURE:

This course will progress through the topics listed above in a logical order, starting with a brief review of planar Newton-Euler kinetics. We will then begin a treatment of three-dimensional, or general, kinematics, which is the study of positions, velocities and accelerations in general space. Then we will use this to help us analyze the kinetics of three-dimensional systems in general motion, which is particularly challenging, as several of our intuitions break down when forces and moments are applied in all three directions of space. In other words... this is the fun stuff.

This course is all about getting you as much experience doing dynamics as possible. This section of ME 2205 will be taught in a *flipped classroom* mode, with lecture material being supplied in the form of online video modules. Class time will consist almost exclusively of working problems or discussing the finer points of details covered in the modules that I think are particularly important. If students are having a common issue, we will stop class and have a mini-lecture on that concept to clear up confusion, addressing challenging conceptual issues as they arise in the classroom. The flipped environment provides you with the ability to spend more time doing and applying concepts with guided help instead of alone in your living quarters, and this guided practice is what will help you understand this course practically and conceptually.

3.1. ATTENDANCE POLICY:

This course does not have mandatory attendance, but you will absolutely be responsible for material and activities that occur during class time, whether you are in attendance or not. Therefore, **attendance during class time is highly encouraged.** When you attend class, I expect you to treat both your fellow classmates and the teaching staff with respect. This means that you are expected to show up on time, participate fully and authentically with each assignment, and meet the criteria for satisfactory achievement outlined later in this syllabus. If you cannot make class, please let me know via email as soon as possible and we can discuss any issues that may arise.

3.2. COURSE SOFTWARE:

This course will utilize two major software platforms, all free of charge to students:

1. Canvas – This will be used to post material, worksheets, and for the first submissions of review problems. Additionally, all announcements made on Canvas are considered official course policy and **it is expected that you will check Canvas regularly and have email notifications enabled.**
2. Gradescope – This is where you will upload your all of worksheet submissions and resubmissions as well as your review problem resubmissions.

This course will NOT be utilizing Wiley Plus. If you decide to buy the textbook for this course, please do not buy any materials relating to Wiley Plus as that money will be wasted. That being said, this course is taught from the video modules and they are **completely sufficient as a reference**; therefore purchasing the course text is optional.

3.3. COURSE GRADING POLICIES:

3.3.1. SPECIFICATIONS GRADING

This course is graded based on your in-class worksheet assignments, a selection of review problems designed to test your understanding of major course concepts, and a final exam which is a review of the course material. The grading in this course is likely something you aren't used to – we are grading this course using **specifications grading**.

In specifications grading...

- Each assignment includes a clear list of specifications that we will use to evaluate the quality of your work and that reflect the learning outcomes for the material.
- Every assignment will receive one of three marks – Success, Retry, or Incomplete.
- You will be able to resubmit many assignments in the course at least once (more on that later) as long as it doesn't receive a mark of incomplete
- In this grading scheme, we will be able to spend more time giving you qualitative feedback. A large part of this course is reflecting on this feedback and using it to help you develop your skills.
- Completion of collections of material maps onto a standard grading scheme of A, B, C, D, or F, which is clearly enumerated in a following table.

The motivation here is simple – shift the focus of learning and work effort from the “getting of points” to the material itself, encouraging learning the material according to the more concrete idea of *skill competency*. What I am saying is this: “If you pass this assignment, I'm comfortable that you know this material to a degree that you can use it as a practicing engineer in later courses as well as your career”. What is not stressed here is mastery – that comes with far more experience and continual, life-long learning.

3.3.2. ASSIGNMENT TYPES:

3.3.2.1. IN-CLASS WORKSHEETS

There is a famous saying by librarian and learning science pioneer John Dewey (not Melvil Dewey of Dewey Decimal System... the other Dewey):

Give [students] something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results”

Most class periods will involve giving you something to do - working problems in the form of in-class worksheets. These problems are meant to serve as introductions to the material discussed in the modules and a brief mini-lecture for that day. **These worksheets are the primary means through which you will interact with the material, and it is expected that you will approach them seriously and with rigor.** They are meant to be solvable during the class period, but they will be due online via Gradescope **24 hours after they are assigned** (which would be the same time as the start of class the next day) to give you more time to work on them if you don't finish during lecture. Each worksheet will have listed specifications for a passing grade. It is important to stress that these are learning tools, and thus *complete* correctness is not a required passing specification. **No late in-class worksheets will be accepted.**

The same John Dewey is also responsible for this little gem:

“We do not learn from experience... we learn from reflecting on experience”

I cannot stress enough how useful and correct this statement is. The amount of feedback that goes ignored in academia is truly depressing from an instructor’s perspective. I promise you that by reflecting on your work performance you will achieve three things: (1) you will gain practice in the skill of organizing your content knowledge in useful and accessible ways in your brain, (2) you will see how concepts connect throughout the course, and (3) you will fix ideological misconceptions you may have developed.

You will be given detailed feedback on your work if necessary. From this feedback, you will be permitted to resubmit your worksheets according to the resubmission schedule shared in this document. **My expectation is that everyone will pass 100% of the worksheets.** I understand that things come up and life can be difficult. Therefore, I will **drop up to two (2) worksheets** over the course of the semester when calculating your final grade.

3.3.2.2. FINAL EXAM

There will be a final exam in this class. Per the Georgia Tech final examination rules, you are hereby informed that the exam will take place. This exam will be administered in accordance with GT policies for scheduling conflicts. Note that personal trips, previously bought flights, cruises, etc. will not be accommodated. Requests for alternate exam accommodations must be received as soon as the conflict is discovered by the student. We are trusting that you will be honest with us in application of this policy.

There will be four problems on the final exam, with each of these problems representing one or more of the major topics in this course. Each problem will be graded via specifications grading with the same requirements as the worksheets. Passing a number of these problems will lead to a final grade per the conditions given in the grading table given later in this document.

3.3.3. PASSING GRADES

All assignments will have a clear threshold for passing. In no case will passing require perfection, but it will require complete work that displays strong academic rigor. Passing indicates competency in the skills and knowledge appropriate for the specific assignment, and some assignments will separately define and address conceptual and numerical categories of mistakes. Conceptual mistakes are flaws in the core learning objectives at the heart of an assignment (e.g., you decided to use Newton-Euler to solve a collision problem instead of applying the Impulse-Momentum Theorem, misinterpreted ‘plastic’ vs. ‘elastic’ collision, etc.), while numerical mistakes affect the assignment quality but do not disrupt your basic understanding of the topic (e.g. $2+2=5$, also known as a “Torello Special”). In general, worksheets must contain no more than one conceptual mistake to receive a passing grade. Additionally, all submitted assignments in this course must be scanned neatly, and work must be arranged clearly. **We will not penalize for poor handwriting, but we will absolutely assign a non-passing grade to submissions that lack professionalism.** Get your thumbs out of the scan.

Sometimes students run out of time or get so stuck that, without help, they cannot proceed with a problem. If you submit a work product that does not represent a good-faith effort to provide a complete problem solution, your work will be marked “incomplete”. No feedback will be provided in these cases, but you will still have a chance to resubmit your work should you decide to try again. I encourage you to start your work early and ask questions during class or office hours to avoid this circumstance.

3.3.4. REGRADING AND RESUBMITTING

3.3.4.1. REGRADING

Regrading specifically refers to when you believe we have made an error in grading, not resubmission of an assignment. Regrading is important to us because we believe correctly grading your work is our responsibility and a sign of respect for you. If you would like us to regrade an assignment, please do the following:

All regrades must be submitted via a written email to the course instructor (Dr. Torello) no later than one week after feedback on that assignment is returned to you. You must include in the request a reason you would like a regrade. That reason should clearly identify the specification(s) you think we made a mistake on, as well as where in the assignment we should look. Note that if you wish to request a regrade, the entire assignment will be regraded.

3.3.4.2. RESUBMITTING

Resubmitting specifically means submitting a new version of your work based on feedback provided after an initial grading assessment. Resubmitting is a very important part of this course – **you are not expected to get your worksheets correct on your first attempt**. Many students view this as failing, but this could not be further from the truth. By attempting to do your best work and receiving feedback from the teaching team, you will learn how your original attempt was flawed conceptually and will be able to revise not only your on-paper submission but also the scaffold of connections and ideas in your head. This is a crucial part of this course and should be expected for all in-class worksheets. **As such, you will be able to resubmit all worksheets assigned in this course.**

Before discussing resubmission guidelines, I want to be clear about something. **As a general policy, the due dates and times listed on Canvas and Gradescope are completely final.** There is a large window available to you for all submissions in this course, and it is expected that you will budget the time necessary to collect, edit, clean, organize, and scan your work in your workflow. **Something submitted even one-tenth of a second beyond the due date is considered late** – if I am submitting a grant online to the NSF grant applications portal and the server gives the cutoff as 12a on Monday, it will not accept anything submitted after 12:00:00a on Monday. It is up to me to have things ready with a safety factor, as it is up to you to have your submissions ready with a safety factor.

If something goes horribly wrong and you lose internet or there is some sort of other server-side glitch, I will require proof that you submitted on time in the form of screenshots or confirmation emails. **Any pleas not supported with concrete evidence will not be heard.** Every faculty has their pet peeves... this one is mine.

All worksheets may be resubmitted on Gradescope within one week from being assigned, and all submissions are due before class begins the following corresponding session (the following Tuesday for a Tuesday class, and similarly the following Thursday for a Thursday class). Your initial submission will be graded and returned to you a few days after your first submission, at which point you will be able to ask questions about your work, revise it, and resubmit based on the feedback from the course graders. **You must detail what corrections you made so that graders understand what you were asked to fix from your previous submission.** This is the primary learning loop in this class – **Attempt, Submit, Reflect, Revise**. Quite frankly, this is how the vast majority of learning occurs; we are just pulling that loop out into plain relief and making it the focal point of the course. Take it seriously and you will see profound growth.

3.3.5. TOPIC MODULES AND GRADING SCALE

In total, this class has 11 lessons during which we will have assigned worksheets (1 worksheet per lesson), a take-home project, and a final exam. You will receive a final letter grade based on the collection of passing work you submit using the following scale. You must satisfy the requirements of all columns to receive the corresponding letter grade.

Grade	In-class Worksheets		Final Exam + Module 10 Problem		
A	No more than 1 non-passing worksheet	AND	3/4 Passed Problems + Passed Module 10 Problem	OR	4/4 Passed Problems
B	No more than 2 non-passing worksheet	AND	2/4 Passed Problems + Passed Module 10 Problem	OR	3/4 Passed Problems
C	No more than 3 non-passing worksheets	AND	1/4 Passed Problems + Passed Module 10 Problem	OR	2/4 Passed Problems
D	No more than 4 non-passing worksheets	AND	0/4 Passed Problems + Passed Module 10 Problem	OR	1/4 Passed Problems
F	> 4 non-passing worksheets	AND	No Passed Problems	OR	No Passed Problems

4. ACADEMIC HONOR CODE:

I expect full compliance with Georgia Tech's Academic Honor Code. Please read and understand this document if you have not already done so. You are allowed to work in groups on all worksheets, but all work you turn in must be written in your own hand. Review problems are to be your own work and no collaboration is allowed. Any cases of cheating or violations of the honor code will be reported to the Office of Student Integrity (OSI). Please refer to the honor code here: <http://osi.gatech.edu/content/honor-code>.

In the past I have had several students find answers to problems on Chegg, Course Hero, etc. and submit those to me. I am extremely familiar with these solution sets (as are my graders), and if we suspect you of submitting copied work then you will immediately be referred to OSI, as I refuse to handle the process of cheating disputes without official backup. I will not make any exceptions to this policy.

5. DISABILITY SERVICES AND COURSE ACCOMMODATIONS:

The Georgia Institute of Technology has policies regarding disability accommodation, which are administered through the Office of Disability Services (<http://disabilityservices.gatech.edu/>). If you require special accommodations (ADAPTS), please notify me ASAP.

Additionally, we all need some accommodations in education because we each learn differently. Those accommodations might include video captions, a low distraction place to think during class, or extra time on certain assignments. We are committed to supporting accommodations when it is at all feasible. **Asking for help when you need it is an important life and engineering skill. It is also a skill that we want to help you develop through this course.**

6. DIVERSITY, EQUITY, AND INCLUSION:

The teaching team expects our classroom and virtual spaces to be a place where you, and everyone else, are treated with respect. Our class will welcome individuals of all backgrounds, beliefs, bodies, and identities both visible and invisible. All members of this class are expected to cooperate in the creation of a respectful, welcoming, and inclusive environment for every other member of the course. If there are things the teaching team or others have done to degrade that environment we encourage you to bring them to our attention and we will work to correct them. By including this statement, we mean to express our values as your instructor and supporting teaching staff members. While many of us are used to entering spaces (physical or otherwise) where we automatically feel

welcome, not everyone experiences that. For many reasons, explicitly stating that people are welcome, and how we want to make them feel welcome is valuable to the learning environment we want to create.

7. SAFE ZONE:

I am a member of a Safe Zone Ally community network and am committed to listening and supporting you in a safe and confidential manner. As a Safe Zone Ally, I can help you connect with resources to address problems you may face that interfere with your ability to engage in academic and social pursuits on campus as it relates to issues of sexual orientation, gender identity, and other elements of your identity and life experience. Our goal is to help you be successful and to maintain a safe and equitable campus. If we or someone else can help you, our door is open.

Similarly, the teaching team will gladly use an alternate name or gender pronoun of your choice. Please advise us of this preference as early as possible so that we may make appropriate changes to our records. At your preference, we will use preferred names publicly or privately.

COURSE OBJECTIVES:

Objective 1: To teach students the basic principles underlying the dynamics of rigid bodies in planar and 3D motion.

1.1 Students will demonstrate an understanding of Newtonian-Eulerian physics and basic equations underlying kinematics and kinetics of rigid bodies in 2D and 3D motion.

Objective 2: To educate students to identify, formulate and solve engineering problems in rigid body dynamics.

2.1 Students will demonstrate the ability to isolate rigid bodies and to draw clear and appropriate free body diagrams.

2.2 Students will demonstrate an ability to identify kinematic and kinetic knowns and unknowns.

2.3 Students will demonstrate an ability to identify and effectively account for kinematic constraints such as rolling and/or sliding, and their kinetic consequences.

2.4 Students will demonstrate that they can apply and combine the appropriate principles referred to in Objective 1 to the solution of problems.

2.5 Students will demonstrate that they can combine the appropriate principles referred to in Objective 1 to the solution of problems.

2.6 Students will demonstrate that they can determine the mass moments and products of inertia for arbitrary rigid bodies.

2.7 Students will demonstrate that they can calculate the principal coordinates and the principal moments of inertia for arbitrary rigid bodies.

Objective 3: To introduce students to the concepts of work-energy and impulse-momentum for rigid body systems.

3.1 Students will demonstrate an understanding of work-energy principles as applied to rigid bodies in 2D and 3D motion.

3.2 Students will be able to evaluate the kinetic energy of rigid bodies as well as the potential energy associated with gravity and spring forces.

3.3 Students will demonstrate an understanding of conservation laws for momentum and energy.

3.4 Students will demonstrate an ability to apply impulse-momentum relations where appropriate.

3.5 Students will demonstrate that they can utilize coefficient of restitution data in the solution of impact problems in rigid-body dynamics.