San José State University
Department of Mechanical Engineering

ME 101 Dynamics, Section 04 (43372), Fall 2019

Course and Contact Information

Instructor:	Burford Furman
Office Location:	Engineering 310G
Telephone:	408-924-3817
Email:	burford.furman@sjsu.edu
Office Hours:	M 1330 – 1430, Tu 1330 – 1430, Th 1330 – 1430, or by appointment
Class Days/Time[1]:	MW 1030 – 1145 lecture; M 1230 - 1330 HW Clinic
Classroom:	E327 (lecture); TBD (HW Clinic)
Prerequisites:	CE 95 or CE 99 and Math 32 (with a grade of C- or better in each). Sophomore or upper division standing

[1]Students are highly encouraged to come to the Homework Clinic and office hours.

Course Format

The course will use the Canvas course management system, and will also require the use of computational software, such as MotionGenesis, Wolfram Alpha, Matlab, etc. Purchase of the textbook will come with a three-year advanced student license for MotionGenesis, a fast, compact, highly advanced symbolic manipulator that can be used to formulate and solve equations of motion.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on the Canvas web page for the course. You are responsible for regularly checking with the messaging system through MySJSU at http://my.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.

Course Description

Kinematics and dynamics of particles and rigid bodies. Mass distribution, forces, moments, and torques. Principles of work, power, potential and kinetic energy, impulse, and momentum. Laws of motion. Computational solutions to equations governing dynamic systems. Demonstrations and physical examples.

Course Goals and Learning Outcomes

The goals of this course are to help you:

1. Understand the fundamental concepts of dynamics
2. Apply Newton's Second Law to solve problems in particle and rigid body dynamics
3. Apply energy and momentum methods to solve problems in particle and rigid body dynamics

In the context of the BS Mechanical Engineering program assessment, this course is intended to help students achieve ABET Student Outcome 3a: "an ability to apply knowledge of mathematics, science, and engineering." For more information on ABET Student Outcomes, see https://www.abet.org/accreditation/accreditation-criteria/

Upon successful completion of this course, students will be able to:

1. Apply vectors using consistent and precise notation to generate linear and non-linear equations in the solution of problems of geometry and motion.
2. Compute with vectors using operations of addition, subtraction, magnitude, dot, and cross-products.

3. Set up basis vectors and use them to express and solve for particle position.
4. Set up a direction cosine matrix relating the planar orientation of two reference frames.
5. Express and resolve vectors into reference frames related by direction cosine matrices.
6. Differentiate scalars and differentiate vectors in arbitrary reference frames.
7. Solve kinematic (position/velocity/acceleration) problems when multiple reference frames are involved.
8. Express particle and rigid body constraints for systems involving rolling and sliding (slipping).
9. Calculate the mass center of a system of particles and of a rigid body.
10. Calculate rigid body mass moments/products of inertia (mass properties).
11. Write the linear/angular momentum vectors of a dynamic system.
12. Write the equations of motion of a system by differentiating linear/angular momentum vectors and setting them equal to applied forces/moments.
13. Write the total kinetic energy and use it to solve for the motion/reaction forces, etc. of a dynamic system.
14. Use computational tools, such as MotionGenesis, to develop and solve the equations of motion of a dynamic system.

Required Text

Dynamics for Mechanical, Aerospace, and Biomechanical Engineers: 3D, Computational, Guided (For Undergraduates) by Paul Mitiguy. The textbook is available from motiongenesis.com *only*. It is not carried by the SJSU Bookstore, Amazon, or any other book seller. Important note: this is not a course that you can hope to pass without the textbook! The book can be ordered by credit card by visiting this web page:

http://motiongenesis.com/MGWebSite/MGTextbooks/TextbookDynamicsMechanicalAerospaceBiomechanicsReceipt.html

Carefully enter your correct e-mail address, as your electronic receipt is UNIQUE. Print out your receipt, and bring it with you to lecture on the first day of class. I will then exchange your unique receipt for a textbook. Please place your order by August 8, 2019, so we can avoid any last minute drama in getting the right number of books. Your purchase of a textbook includes the MotionGenesis Kane 5.x software. Please download/install MotionGenesis software from:

http://www.motiongenesis.com/MGWebSite/MGDownloads/MGDownloads.html

Once you have purchased the textbook and installed MotionGenesis, request a 3-year license within 3 weeks to avoid the late fee. If you run into problems ordering the book or obtaining the software, you can contact Paul Mitiguy at:

Phone: 650-346-9595 (voice-only, no text)
E-mail: mitiguy@MotionGenesis.com

Course Requirements and Assignments

The course requires weekly homework and a term project. The term project will be done in groups of two to three, and is intended to be an open-ended exploration of the dynamics of a system and opportunity to apply concepts learned in the class. The course will also have two midterm exams and one final exam.

Classroom Protocol

I expect everyone to make their best effort to attend *all* class sessions. Please arrive to the classroom *before* the session begins, so that others are not disturbed by your entry after instruction has begun. Turn off and stow all electronics, such as phones, laptops, and tablet computers for the duration of the class period.

Dropping and Adding

Students are responsible for understanding the policies, procedures, and dates for adding and dropping. Information on adding/dropping is available at http://info.sjsu.edu/home/schedules.html. Information about late drop is available at http://www.sjsu.edu/aars/policies/latedrops/policy/ . Students should be aware of the current deadlines and penalties for adding and dropping classes.

Assignments and Grading Policy

Assessment for the purposes of determining your course grade will consist of evaluating your performance on homework assignments, midterm examinations, term project, and the final examination.

Homework is due in softcopy uploaded to Canvas in the appropriate Assignment area, generally one week after it is assigned (but check the date in Canvas). You will not get credit for late assignments. Problems denoted 'Optional' are not required. Answers to problems denoted with a club (♣) may be entered in the spaces on the problem sheet, but others must be worked out on a separate sheet with steps toward the solution shown. Be sure to add the problem number, a title sentence, and description of what the problem is seeking when you work it out on a separate sheet.

When you choose to use computational tools (e.g., MotionGenesis, Matlab, C, etc.) to avoid tedious calculations, make sure you know what the computer is doing by adding *comments* to each line of your code. Print out and submit the appropriate computational files (e.g., **.html** files for MG) and include both input and output.

Do not wait to the last minute to start on the homework! There are too many problems and too many concepts to absorb if you start only a day or two before the homework is due. Start EARLY, and come prepared with questions to the Homework Clinic or to office hours.

Homework solutions are not posted. Collaborate with your classmates (see section below on Academic Integrity with regard to what I mean by '*collaboration*'), and see your instructor for help. There is a strong correlation between high homework scores and high exam scores - and no reason to do poorly on homework.

The weighting of the course components and criteria for assigning letter grades are given below.

Weighting of Course Components for Determining the Course Grade

HW 20%, Project 20%, Midterms 20% each, Final Exam 20%

Criteria for Assigning Letter Grades

The scores on your homework, exams, term project, and final examination will be combined and totaled using the weighting scheme described above. A final letter grade will be determined from your overall performance (percentage) using the following criteria:
A 100 – 93%; A- 92 – 90%; B+ 89 – 87%; B 86 – 83%; B- 82 – 80%; C+ 79 – 77%; C 76 – 72%;
C- 71 – 69%; D+ 68 – 66%; D 65 – 62%; D- 61 – 59%; F <58%. Note: ME students must earn at least a grade of C- to pass the course.

The final examination for the course will be on Thursday, December 12, 2019 from 0945 – 1200 in E327.

University Policies

Academic Integrity (This section is important, so make sure you read it! You will be held accountable to its stipulations.)

Your commitment as a student to learning is evidenced by your enrollment at San José State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/studentconduct/docs/S07-2.pdf, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source*.[1] Examples of plagiarism include, but are not limited to[2]:

---

[1] Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," http://wpacouncil.org/positions/WPAplagiarism.pdf; and "What is Plagiarism?" https://communitystandards.stanford.edu/policies-and-guidance/what-plagiarism.

[2] Adapted from, "Avoiding Plagiarism," https://owl.purdue.edu/owl/research_and_citation/using_research/avoiding_plagiarism/index.html.

- copying in whole or in part, a picture, diagram, graph, figure, program code, algorithm, etc. and using it in your work without citing its source
- using exact words or unique phrases from somewhere without acknowledgement
- putting your name on a report, homework, or other assignment that was done by someone else

Students are expected to familiarize themselves with how to avoid plagiarism. Several helpful resources can be found at:

https://communitystandards.stanford.edu/policies-and-guidance/what-plagiarism

I encourage students to collaborate on the homework assignments, however what this means is that you can work together to decide on solution *strategies*, but you ***may not*** copy answers in whole or in part. So for this class, all assignments are to be completed by the individual student unless otherwise specified.

SJSU Senate Policy S12-3 - Federal Regulation of the definition of the credit hour:

Success in this course is based on the expectation that a student will spend, for each unit of credit, a *minimum* of 45 hours over the length of the course (normally three hours per unit per week with one of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practica, etc. Other course structures will have equivalent workload expectations as described in the syllabus. [Thus, for this class, it is expected that you will spend *at least* 6.5 hours outside of class working on homework, project work, test preparation, etc.] See: http://www.sjsu.edu/senate/docs/S12-3.pdf for more information.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the AEC (Accessible Education Center) to establish a record of their disability.

Student Technology Resources

Computer labs for student use are available in the Academic Success Center located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. Additional computer labs are available for engineering students in E390, and for ME students in E213 and E215. Computers are also available in the Martin Luther King Library (see: https://library.sjsu.edu/student-computing-services/student-computing-services-center).

A wide variety of audio-visual equipment is available for student checkout from Media Services located in IRC 112. These items include camcorders, video players, DVD, CD, and audiotape players, sound systems, wireless microphones, projection screens and monitors.

SJSU Writing Center

The SJSU Writing Center is located in Room 126 in Clark Hall. It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The Writing Center website is located at http://www.sjsu.edu/writingcenter/.

Additional Notes:

- We will make extensive use of the Canvas course management system. Make sure that you adjust your settings in Canvas, so you will get notifications in a way that you check frequently.
- If you are going to be absent from class or lab, please give me a call, or send me an email as soon as you know that you will not be able to attend. Don't just not show up!
- Each reading assignment shown in the Course Schedule below should be completed *prior to* the lecture for the week in which the assignment is listed. In other words, read the assigned chapters before the next lecture! Doing so will help prepare you for lecture and will help you maximize your learning efficiency. When you read, summarize the important points and jot down any questions that you have. Bring your questions with you to the lecture.
- Following each lecture, I highly recommend that you *review* any notes you took in lecture along with the

notes that you took from reading. Read back through your notes, and fill in any gaps that you may have missed or that became clearer from the lecture. Write down any questions you have in the margins of your notes. Be sure to come to office hours or ask about your questions in class.

- Please make it a point to ask questions in class or in office hours whenever you don't understand something! If you don't, then you are essentially paying tuition for nothing! Dynamics is a subject that takes time to learn and gain expertise. You won't be able to procrastinate assignments and expect to pass the class!
- The passing grade for this course, for students majoring in Mechanical Engineering, is a C-. Those receiving a grade lower than C- will be placed on probation and will be allowed one more attempt to pass the course with a grade of C- or better. Failure to pass this course in two successive attempts will result in disqualification from the ME program.

References

Textbook resources from motiongenesis.com:

(http://www.motiongenesis.com/MGWebSite/MGTextbooks/MGTextbookDynamicsMechanicalAerospaceBiomechanics/TextbookResourcesDynamicsMechanicalAerospaceBiomechanics.html)

The theory and application of modern dynamics [sound recording] / [lecture by] Thomas R. Kane

Levinson, D. (2016). Dynamics for Engineering Analysis. Available from motiongenesis.com.

Kane, T. R., Levinson, D. A (1985). Dynamics, Theory and Applications. McGraw-Hill, New York, NY. Available online at: https://ecommons.cornell.edu/bitstream/handle/1813/638/Dynamics-Theory_opt.pdf?sequence=10&isAllowed=y

Kane, T. R.; Likins, P. W.; Levinson, D. A. (1983). Spacecraft Dynamics. McGraw-Hill, New York, NY. Available online at: https://ecommons.cornell.edu/bitstream/handle/1813/637/Spacecraft_Dynamics.pdf?sequence=5&isAllowed=y

Kane, T. R. (1959). Analytical Elements of Mechanics, Volume 1. Academic Press, Cambridge, MA. Available online at: https://ecommons.cornell.edu/bitstream/handle/1813/640/Analytical%20Elements%20M%235308D.pdf?sequence=1&isAllowed=y

Kane, T. R. (1961). Analytical Elements of Mechanics, Volume 2: Dynamics. Academic Press, Cambridge, MA. Available online at: https://ecommons.cornell.edu/bitstream/handle/1813/641/kane_vol2.pdf?sequence=4&isAllowed=y

ME 101 (Section 04) COURSE SCHEDULE (approximate)

Note that the schedule is subject to change with fair notice through Announcements made in the Canvas course management system. Chapters listed should be read prior to the corresponding meeting.

Course Schedule

Mtg	Wk	Date	Lecture/Activity	Chap	Due
1	1	08/21	Class overview and review of math and vectors.	1	
2	2	08/26	Vector operations (+, *, -, dot product, cross product, exponentiation).	2	
3	2	08/28	Position vectors and vector geometry, measurements of distance, area, volume, and angles).	3	8/30 Questionnaire HW 1
4	3	09/02	NO CLASS! (Labor Day Holiday)		
5	3	09/04	Vector bases.	4	9/6 HW 2
6	4	09/09	Rotation matrices and direction cosines.	5	
7	4	09/11	Rotation matrices and direction cosines.	5	9/13 HW 3

8	5	09/16	Vector differentiation.	6	
9	5	09/18	Angular velocity.	7	9/20 HW 4
10	6	09/23	Angular acceleration.	7	
11	6	09/25	Points: velocity and acceleration.	8	9/27 HW 5
12	7	09/30	Points: velocity and acceleration. Midterm review	8	
13	7	10/02	Midterm 1	1 – 8	10/4 HW 6
14	8	10/07	Constraints: rods, rolling, gears.	9	
15	8	10/09	Particles (points with mass).	10	10/11 HW 7
16	9	10/14	Mass, center of mass, centroids.	11	
17	9	10/16	Moments of inertia. Products of inertia.	12	10/18 HW 8
18	10	10/21	Dyadics and Inertia dyadics	13, 14	
19	10	10/23	Rigid bodies.	15	10/25 HW 9
20	11	10/28	Forces and resultant force.	16, 18, 19	
21	11	10/30	Moments and torques.	17	11/1 HW 10 & 11
22	12	11/04	Midterm review	1 – 19	
23	12	11/06	Midterm 2	1 – 19	11/8 HW 12
24	13	11/11	NO CLASS! (Veterans Day Holiday)		
25	13	11/13	Newton/Euler dynamics; Impulse, conservation of momentum.	20	11/15 HW 13-14
26	14	11/18	MG roadmaps for efficient statics and dynamics.	21	
27	14	11/20	Energy, power, and work.	22	11/22 HW 15-16
28	15	11/25	Equations of motion and their solution.	20, 21	
29	15	11/27	NO CLASS! (Thanksgiving Holiday)		
30	16	12/02	Term project presentations – Part 1	20 – 21	
31	16	12/04	Term project presentations – Part 2	20 – 21	
32	17	12/09	Course review	1 – 22	
33	17	12/12	**Final Examination**, Thursday, December 12, 2019 from 0945 – 1200 in E327	1 – 22	