San José State University
Department of Mechanical Engineering
ME 240 – Rigid Body Dynamics, Fall 2022

Course and Contact Information

Instructor: Dr. Feruza Amirkulova

Office Location Engineering Building, Room 310J

Lecture: Monday, Wednesday 6:00pm – 7:15pm (PT)

Classroom: E303

Telephone: (408) 924-2045

Email: feruza.amirkulova@sjsu.edu

Office Hours: Monday, Wednesday 3 pm to 4 pm

Prerequisite: ***Graduate standing in mechanical/aerospace engineering or consent of instructor***

Course Format and Classroom Protocol
The course relies on lecture materials presented in class. Class participation and attendance are strongly encouraged. Students should attend all classes and take class notes to support their reading assignments. Use of cell-phones is not allowed except during taking quizzes using iClicker (see https://www.iclicker.com/students for instructions). Laptop computers and tablet are allowed for taking lecture notes on the front row only.

Course Materials
Copies of the course materials including the syllabus, homework solutions, slides, and MATLAB codes will be available on course webpage at Canvas

Course Description
Introduction to Newtonian mechanics, General kinematics and kinetics, rotating frames, variational principles, Lagrange's equations, Hamilton's equations, Euler angles, Euler equations, and Kane's method. Three-dimensional dynamics in vector and tensor notation. Multi-body dynamics. The stability and response of dynamical systems, including vibration analysis, analysis of the principles of dynamics and vehicle motions analysis. Vibration study and analysis of ground vehicles. Application to engineering problems including numerical solutions. Several Computer Projects will be assigned including Final Project.

Learning Objectives:
1. to develop efficient formulation and solution of equations of motion for complex 3D multi-body dynamic systems.
2. to facilitate advanced graduate research and professional work.
3. to develop precise definitions, equations, words, precise notation, and descriptive language to facilitate the definition of complex 3D multi-body dynamic systems.
4. to gain a greater understanding of how key components work using realistic examples from everyday life, including sports (motion of balls in air or during impact) and vehicle motions.
5. to be able to use numerical methods to solve vibration problems.

Required Text books: **Applied Dynamics** by *Haim Baruh, CRC Press, 2015. 850 pages.* The book is available online via our SJSU library.

Other Reference Books:

1) Dynamics of Particles and Rigid Bodies: A Systematic *Approach* *by Anil V. Rao, Cambridge University Press; Reissue edition, 2011 (optional)*
2) Engineering Vibrations, *William J. Bottega*, *Second Edition, CRC Press/Taylor & Francis Group, 2015;* book is available online via our SJSU library *(optional)*
3) **Mechanical Vibration: Analysis, Uncertainties, and Control** *by Haym Benaroya, Mark Nagurka, Seon Han. 4th Edition. CRC Press, 2017, 579 Pages, ISBN 9781498752947,* electronic book is available at our SJSU library. *(optional)*

Library Liaison
Engineering library liaison: Jane Dodge, jane.dodge@sjsu.edu, Phone number: 408-808-2087
See also Mechanical Engineering LibGuide at: https://libguides.sjsu.edu/me

Assignments and Grading Policy
Course grade will be based on homework assignments, exams, final computer project and class participation. Homework assignments consist of regular written assignments and a couple of computer projects with MATLAB coding.

Homework and Computer Projects: 20%
Exam-1: 25%
Exam-2: 25%
Final Project: 25% (5% - Presentation (video and slides), 5% - Codes & Simulation Model, 15% - Report)
Class participation: 5% (Class discussions, participation, group solving problems, iClicker quizzes)

Homework will be assigned weekly on each Tuesday and is due on next Tuesday. Homework will be graded and retuned the following week.
Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of forty-five hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction or preparation, studying or course related activities including but not limited to internships, labs, clinical practical. Other course structures will have equivalent workload expectations as described in the syllabus.

Dropping and Adding
Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html. Add/drop deadlines can be found on the current academic calendar web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/. The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/**.** Students should be aware of the current deadlines and penalties for dropping classes.
Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.
Last Day to Drop Class: August 31 2022

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Last Day to Add Class: September 8 2022

Holidays: November 1 2022, *Veteran's Day* (Observed) - Campus Closed
November 24 2022, *Thanksgiving Holiday* (Observed) - Campus Closed

Last Day of Instructions: December 06 2022

Examinations

Two 75-minute exams and one final computer project.

Class Protocol

Class participation and attendance are strongly encouraged. Use of cell-phones is not allowed except during taking quizzes using iClicker (see https://www.iclicker.com/students for instructions).

Software

- In this course, students will study how to use MATLAB to simulate different mechanical phenomena that arise in engineering applications. They will also explore how to use various MATLAB embedded functions and solvers to tackle different engineering problems. MATLAB is installed in COE computer labs, and may have access to it via VPN on their computers.
- San Jose State University provides MATLAB, Simulink and add-on toolboxes free to students for coursework and academic research. Campus-wide license allows installation of MATLAB on personal computers of SJSU students and faculty. Go to: San Jose State University's MATLAB Portal here to download the software to your personal computer. Training and Help resources can also be found on the MATLAB Portal: http://www.mathworks.com/academia/tah-portal/san-jose-state-university-31511582
- Along with MATLAB, San Jose State University also provides Educational Licenses for COMSOL Multiphysics and ANSYS commercial software which can be used to perform simulations for Final Projects.

University Policies

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, 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.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) 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.

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 Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Clicker Technology:

In this course, we will be using clicker technology to collect student responses to questions posted in class. Points will be awarded based on participation. Please do not purchase any clicker technologies, as they are free to SJSU students from iClicker.

Students are responsible for creating a free student account at www.iClicker.com, and adding this course to their account. Detailed instructions are available on the SJSU eCampus website. Please contact eCampus with any questions or issues with the iClicker technology.

iClicker Cloud

I will be using iClicker Cloud this semester to conduct polls, quizzes, and/or attendance in class. This will help me understand what you know and give everyone a chance to participate in class. This will also give you feedback on how well you are comprehending course concepts, help you master the challenging material in this class, and allow you to review material after class.

You are required to bring a device to participate in my iClicker sessions during class. I will be allowing the use of iClicker Reef on a smartphone, tablet or laptop OR iClicker remotes.

It is your responsibility to properly register your iClicker Reef device and/or iClicker remote in a timely fashion. It is also your responsibility to regularly check your iClicker grades for any discrepancies and bring them to my attention quickly.

Registration Instructions:

Regardless of which device you use in class, you must create an iClicker Reef account–or use your existing Reef account if you already have one–to ensure that your grades sync to my iClicker gradebook. You can do this by downloading the mobile app via the App Store or Google Play, or by visiting iclicker.com.

It is your responsibility to make sure your account is in working order, and to regularly check your grades for any discrepancies and bring them to my attention immediately. If you already have a Reef account, simply add my course to it. **Do not create a duplicate account.**

Grading Information

Class attendance/polls will be worth X% of your final grade. You will earn X points for each correct question you answer.

Academic Integrity Information

iClicker activities fall under the provisions of our campus's academic honesty policy. Students must not engage in academic dishonesty while participating in iClicker activities. This includes but is not limited to answering polling questions while not physically in class, looking at other students' devices while answering live questions, or using more than one iClicker remote or account at a time. Any student found to be in violation of these rules will lose polling points for the entire term and may be reported to the Dean of Student Discipline.

Need Help?

You can contact eCampus or check their website for more information. Contact information: Email= ecampus@sjsu.edu Phone= (408)924-2337 Building/Room= IRC206
Website: www.sjsu.edu/ecampus

You may also find the answers to many of your questions by visiting iclicker.com/support.

ME 240 – Rigid Body Dynamics, Fall 2022 Course Schedule/Outline

NOTE: This is not a firm list. There may be additions or deletions during the semester

Week	Date	Lecture Topics	Sections in Text
1	08/22, 08/24	Course organization. Principles of Mechanics. Introductory Concepts. Dif. Equations. Numerical Integration. Kinematics Fundamentals: Introduction, Position, Velocity, Acceleration. Column Vector representation. Commonly used coordinate systems. Moving Frames. Selection of Rotation Parameters.	Chapter 1
2	08/29, 08/31	Angular acceleration. Relative motion. Instantaneous center of Zero velocity. Kinematics applications: Rolling, Bicycle model of a Car	Chapter 2-3
3	**9/05**	**No Class, Labor Day Holiday**	
3	09/07	Kinetics fundamentals: RB Geometry, Mass Moment of Inertia, Center of Mass, Linear and angular momentum	Chapters 4, Chapter 10
4	09/12, 09/14	Kinetics applications: Rolling, Bicycle model of a Car	Chapter 5
5	09/19, 09/21	Response of Dynamical systems	Chapter 6
6	09/26, 09/28	Response of Multi-Degree-of-Freedom systems	Chapter 7
7	10/03, 10/05	Analytical Mechanics: Generalized coordinates and constraints, Velocity representation, Virtual Displacement and Virtual Work, Generalized forces	Chapter 8
8	10/10	Exam-1 Review	
	10/12	**EXAM-1**	
9	10/17, 10/20	Analytical Mechanics: D'Alembert's Principle, Hamilton's Principle, Lagrange's equations. Constrained systems	Chapter 8
10	10/24, 10/26	Analytical Mechanics: Kane's equations, Rayleigh's dissipation function	Chapter 8
11	10/31, 11/02	3D Kinematics of RB: Basic Kinematics of RB, Euler Angles,	Chapter 9
12	11/07, 11/09	3D Kinematics of RB: Axisymmetric bodies, Rolling	Chapter 9
13	11/14	Exam-2 Review	
13	**11/16**	**EXAM-2**	
14	11/21	3D Kinematics of RB: Euler Parameters, Rodrigues Parameters, Mass Moment of Inertia: Intro	Chapter 9
14	11/23	**No Class on campus, due to upcoming Thanksgiving holiday**	
15	11/28, 11/30	Dynamics of 3D RB motion: Linear and angular momentum. General describing equations. Description in terms of body fixed coordinates. angular momentum for axisymmetric bodies	Chapter 11
16	12/05	Dynamics of 3D RB motion: Impulse and Momentum, Energy and Work, Analytical equations for RB	Chapter 11
	12/09, 5:15-7:30 PM	**FINAL SIMULATION PROJECT Presentations**	