

AE 140: Rigid Body Dynamics

Professor Kamran Turkoglu, Department of Aerospace Engineering, San Jose State University, Spring 2018

Syllabus

Contact Information

Instructor: Kamran Turkoglu
Office Location: ENG 272C
Email: kamran.turkoglu@sjsu.edu
Office Hours: Tuesday, 8-10am
Class Hours: Monday-Wednesday, 1.30pm - 2.45pm
Classroom: Sweeney Hall 100
Prerequisites: "C" or better in AE-138
Class Code:
Website: <http://www.engr.sjsu.edu/kamran/>

TA: (Grader) Elias Reyes - elias.reyes@sjsu.edu

Problem solving hours: TBA
TA/Grader Office Hours: TBA

Mid-term Exam(s):

There will be 2(two) 75min in-class written exams, and 4(four) 15min written Quizes.
 Quizes and (final) exams canNOT be made up without a valid, documented excuse (i.e. Dr.'s note).
 There is NO make up exam policy!!

Final Exam

There will be a final project with a due date of May 22nd, 2018 Tuesday at 2.30pm (with online delivery in Canvas). NO late deliveries wi

Text Book:

- Thomson, Introduction to Space Dynamics, Dover Publications
- Classnotes
- Handouts

(HIGHLY Reccomended) Refference(s):

- Synge and Griffith, Principles of Mechanics, Nabu Press
- Cannon , Dynamics of Physical Systems, Dover Publications
- Greenwood, Principles of Dynamics, Prentice Hall
- Kane and Levinson, Dynamics: Theory and Applications, McGraw Hill

Schedule

Important

*If you miss a lecture, please make sure that you obtain the notes of that specific class from your class-mates.
 'I did not know how to do this problem, because I missed lecture the day this material was covered' is, unfortunately, NOT a valid excuse!*

Important

All Monday classes will be held online, while all Wednesday classes will meet in person, in SH 100!

Important

Students will have 1(one) week grace period where they could share any possible concern about their grade of that specific assignment. After that 1(one)-week grace period, the grades will be final. PLEASE do not come and discuss your HW-01 on Week14

- Week-1:
 - (01/23) Wednesday :
 - Introduction and class material review
- Week-2:
 - (01/29) Monday **ONLINE** :
 - Vector dynamics and review (1/2)
 - **Reading Assignment Week 01: (Thomson) Chapter 1 - Introduction (vector dynamics)**
 - (01/31) Wednesday :

- Vector dynamics and review (2/2)
- Week-3:
 - (02/05) Monday **ONLINE**:
 - Rigid body translational kinematics (1/2)
 - **Reading Assignment Week 02: TBA**
 - (02/07) Wednesday:
 - Rigid body translational kinematics (2/2)
- Week-4:
 - (02/12) Monday **ONLINE**:
 - General motion wrt to the rotating Earth (1/2)
 - **Reading Assignment Week 03: TBA**
 - (02/14) Wednesday:
 - **Quizz_01 !!!**
 - General motion wrt to the rotating Earth (2/2)
- Week-5:
 - (02/19) Monday **ONLINE**:
 - Euler angles (1/2)
 - **Reading Assignment Week 04: TBA**
 - (02/21) Wednesday:
 - Euler angles (2/2)
- Week-6:
 - (02/26) Monday **ONLINE**:
 - Rigid body rotational kinematics (1/2)
 - **Reading Assignment Week 05: TBA**
 - (02/28) Wednesday:
 - Rigid body rotational kinematics (2/2)
- Week-7:
 - (03/05) Monday **ONLINE**:
 - Angular momentum of a rigid body (1/2)
 - **Reading Assignment Week 06: TBA**
 - (03/07) Wednesday:
 - **Quizz_02 !!!**
 - Angular momentum of a rigid body (2/2)
 - **Reading Assignment Week 07: TBA**
- Week-8:
 - (03/12) Monday **ONLINE**:
 - Moments / products of inertia, principal axes (1/2)
 - (03/14) Wednesday:
 - Moments / products of inertia, principal axes (2/2)
 - **Reading Assignment Week 08: TBA**
- Week-9:
 - (03/19) Monday:
 - **Exam_01 !!!**
 - (03/21) Wednesday:
 - Euler moment equations
 - **Reading Assinment Week 09: TBA**
- Week-10:
 - (03/26) Monday:
 - **SPRING BREAK!! No Class!**
 - (03/28) Wednesday:
 - **SPRING BREAK!! No Class!**
- Week-11:
 - (04/02) Monday **ONLINE**:
 - Solution of general gyro equations (1/2)
 - **Reading Assignment: TBA**
 - (04/04) Wednesday:
 - Solution of general gyro equations (2/2)
- Week-12:
 - (04/09) Monday **ONLINE**:
 - General rigid body gyroscopic motion (1/2)

- (04/11) Wednesday:
 - **Quizz_03 !!!**
 - Gyroscopic instruments
 - **Reading Assignment :TBA**
- Week-13:
 - (04/16) Monday **ONLINE**:
 - Stable platform for inertial guidance
 - **Reading Assignment : TBA**
- (04/18) Wednesday:
 - 6-DOF Rigid Body Equations of Motion (1/2)
 - **Reading Assignment: TBA**
- Week-14:
 - (04/23) Monday:
 - **Exam_02 !!**
- (04/25) Wednesday:
 - **NO CLASS !!**
- Week-15:
 - (04/30) Monday **ONLINE**:
 - 6-DOF Rigid Body Equations of Motion (2/2)
- (05/02) Wednesday:
 - Satellite Motion and Despin
 - **Reading Assignment: TBA**
- Week-16:
 - (05/07) Monday **ONLINE**:
 - Lagrange's equations (1/2)
 - **Reading Assignment: TBA**
- (05/09) Wednesday:
 - **Quizz_04 !!!**
 - Lagrange's equations (2/2)
- Week-17:
 - (05/14) Monday **Will meet in person!:**
 - Final project presentations.

Course Description

Co-ordinate frames and descriptions of absolute and relative motion. Particle motion with respect to the rotating Earth. General equations of rotational motion and Lagrangian formulations. Spinning body motions. Gyroscopic instruments. Stable platform for inertial guidance. Applications to aerospace vehicles.

Course Goals

- To provide the fundamentals of intermediate dynamics of rigid bodies using Newtonian, Lagrangian and Eulerian dynamics.
- To provide a review of point-mass dynamics.
- To show the different approaches available in analyzing an equation of motion.
- To demonstrate the connection between modeling, simulation, numerical solution and analytical solutions to equations of motion.

Student Learning Objectives

- Develop a direction-cosine matrix and use it to transform vectors among reference frames.
- Differentiate a vector in multiple reference frames.
- Choose the appropriate reference frames for writing equations of motion.
- Derive point-mass equations of motion using Newton's or Lagrange's method.
- Write equations which define the motion of a particle with respect to the rotating Earth; identifying Coriolis and centripetal contributions.
- Integrate Earth-relative particle equations to determine particle position.
- Predict Earth-relative particle position using engineering judgment.
- Describe the differences between northern- and southern-hemisphere motion, e.g. rotation of lowpressure systems.
- Calculate rigid body mass properties and transform them among reference frames.
- Compose the angular momentum vector and differentiate it inertially.
- Write rigid body equations of motion using Newtonian and Lagrangian methods.
- Apply concepts of nutation and precession in describing the motion of aerospace vehicles.
- Compute and draw the orientations of the space & body cones.
- Distinguish between direct and retrograde motion; understand and predict the differences in dynamic response from the equations of motion.
- Understand and predict the motion of a top.

- Apply the principles of rigid body motion to gyroscopic instruments.

Exams

- 2(Two) 75minutes in-class Mid-term exams
- Final project.

Grading

- 4(Four) Quizzes 20%
- Two 75min Exams 50%
- Final Project 30%

Important !!

All exams must be taken to receive a passing grade.

Grading Policy

- 100 - 95% A
- 94.99 - 90% A-
- 89.99 - 85% B+
- 84.99 - 80% B
- 79.99 - 75% B-
- 74.99 - 70% C+
- 69.99 - 65% C
- 64.99 - 60% C-
- 59.99 - 56% D+
- 55.99 - 53% D
- 52.99 - 50% D-
- < 50% F

Important !!

This is only a rough scale. This scale may be adjusted depending on the performance of the class. Any adjustments to the scale will only lower the cut-offs to achieve a specified grade; cut-offs will not be raised beyond those listed here.

Academic Success

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 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 intern practica. Other course structures will have equivalent workload expectations as described in the syllabus.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on my faculty web page at <http://www.engr.sjsu.edu/kamran> responsible for regularly checking with the messaging system through MySJSU (or other communication system as indicated by the instructor) to learn any

University Policies

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 Policy <http://info.sjsu.edu/static/catalog/policies.html>. Add/drop deadlines can be found on the current academic year calendars document on the Academic Calendar http://www.sjsu.edu/provost/services/academic_calendars/. 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>. Consent for Recording of Class and Public Student Material University Policy S12-7, <http://www.sjsu.edu/senate/docs/S12-7.pdf>, requires students to obtain instructor's permission to record the course.

- Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission for audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the intellectual property of the instructor; you have not been given any rights to reproduce or distribute the material.
- Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not share or upload instructor generated material for this course such as exam questions, lecture notes, or homework solutions without instructor consent.

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University Academic Integrity Policy So7-2 at <http://www.sjsu.edu/senate/docs/So7-2.pdf> requires you to be honest in all your academic course work. Faculty members are required to report all infraction Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at <http://www.sjsu.edu/studentconduct/>. 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

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 like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Integrity Policy requires the 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 at <http://www.sjsu.edu/president/docs/directives/PE> requires that students with disabilities requesting accommodations must register with the Accessible Education Center (AEC) at <http://www.sjsu.edu/aec> at the time of their disability. In 2013, the Disability Resource Center changed its name to be known as the Accessible Education Center, to incorporate a philosophy of support for students with disabilities. The new name change reflects the broad scope of attention and support to SJSU students with disabilities and the University's commitment to increasing accessibility and inclusivity on campus.

Student Technology Resources

Computer labs for student use are available in the Academic Success Center at <http://www.sjsu.edu/at/asc/> located on the 1st floor of Clark Hall and in the Lab on the 2nd floor of the Student Union. Additional computer labs are available in engineering department. Computers are also available in the Martin Luther King Center.

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

SJSU Peer Connections

Peer Connections, a campus-wide resource for mentoring and tutoring, strives to inspire students to develop their potential as independent learners while they successfully navigate through their university experience. You are encouraged to take advantage of their services which include course-content based tutoring and time management skills, more effective critical thinking strategies, decision making and problem-solving abilities, and campus resource referrals.

In addition to offering small group, individual, and drop-in tutoring for a number of undergraduate courses, consultation with mentors is available on a drop-in appointment basis. Workshops are offered on a wide variety of topics including preparing for the Writing Skills Test (WST), improving your learning and managing procrastination, surviving your first semester at SJSU, and other related topics. A computer lab and study space are also available for student use in Room 600 of the Services Center (SSC).

Peer Connections is located in three locations: SSC, Room 600 (10th Street Garage on the corner of 10th and San Fernando Street), at the 1st floor entrance of the Living Learning Center (LLC) in Campus Village Housing Building B. Visit Peer Connections website at <http://peerconnections.sjsu.edu> for more information.

Consent for Recording of Class and Public Sharing of Instructor Material

University Policy S12-7, requires students to obtain instructor's permission to record the course.

- Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission for audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the property of the instructor; you have not been given any rights to reproduce or distribute the material.
 - It is suggested that the greensheet include the instructor's process for granting permission, whether in writing or orally and whether for the whole class or by class basis.
 - In classes where active participation of students or guests may be on the recording, permission of those students or guests should be obtained as well.
- Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not share or upload instructor generated material for this course such as exam questions, lecture notes, or homework solutions without instructor consent.