Syllabus for ME 595 Orbital Mechanics

Fall 2018

Instructor: Dr. Chris Hall **Email:** Use Course Messages

Office Location: MECH 430 **Office Phone:** (505) 277-0210

Office Hours: By Appointment **Course Credits:** 3 hours

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Lectures and Course Materials Online: http://www.learn.unm.edu

Technical Requirements

- A high speed Internet connection is highly recommended, and is required for the three Exams.
- Supported browsers include: Chrome, Edge, Firefox, Internet Explorer, and and Safari.
- Chrome is specifically required for using Proctorio when taking Exams
- Detailed Supported Browsers and Operating Systems: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support
- Check your browser configuration at: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support/Browser_Checker

  Any computer capable of running a recently updated web browser shouldbe sufficient to access your online course. However, bear in mind that processor speed, amount of RAM and Internet connection speed can greatly affect performance.
- Online courses perform best on a high-speed Internet connection. Those using dial-up connections will experience longer page load times and much slower performance when accessing their online course. Many locations offer free high-speed Internet access including UNM's Computer Pods or one of UNM's many Statewide Centers

• **For UNM Learn Technical Support: (505) 277-5757 (M-F 8am - 5pm)**

or learn@unm.edu.

Text: *Fundamentals of Astrodynamics*, Bate, Mueller, & White, Dover, 1971

Orbital Mechanics. Application of Newton's Laws to the dynamics of spaceflight. Two-body problem, Kepler's Laws, energy and time relations, orbit specification and determination. Orbital maneuver and transfer, patched conic approximations, relative motion, and elements of optimal maneuvering. This course is offered in an 8-week online format. It involves six hours of classes per week and is worth three semester credits. ME 306 or MATH 316 is a prerequisite.

Goal: Students know how to formulate and solve the problems associated with analyzing, predicting, and controlling the orbital dynamics of spacecraft.

Objectives: Students can apply the two-body problem to satellite orbital motion.
Students can apply simple perturbations to solve non-Keplerian satellite orbital motion problems.
Students can apply orbit determination methods.
Students can apply patched-conic techniques to solve interplanetary mission planning problems.

Discussions: Each module includes one or more discussion topics. Participation in discussion is graded and is required. For most discussions, your initial response must be submitted by Wednesday at 11:59 PM (1 point), and you will not see other students' submissions until you have submitted your thread. For most discussions, you must make a substantive response to the initial submissions of three other students (3 points), and these responses are due by Friday at 11:59 PM. Late submissions will receive 0 points. A sample Initial Thread and sample Substantive Responses are provided in the material for the first week.

Each week, by 11:59 PM Friday, I will upload either a brief video or a text discussion of my observations of your discussions for that week.

Homework Policy: There are homework assignments each week, and each assignment specifies the due date (11:59 PM Monday of the following week, unless otherwise specified). Homework must be uploaded as a single pdf file by the due date. Late homework will not normally be accepted and will receive a grade of 0. In the event of family or work emergency, please contact me before the due date to make an arrangement for late submission. Each homework assignment will require some Matlab programming.

Each homework submission must be presented neatly, using complete sentences, and explanations for each step in the solution. You do not have to typeset your homework, but you should consider it to be a technical report. An example Homework "report" is presented with the material for the first week.

I will post a detailed solution to each homework assignment after the due date. Usually, I will have the homework assignment graded within 24 hours. If for some reason I am unable to meet that commitment, I will let you know by way of an announcement.

Quizzes: There are quizzes between the lectures. You will not be allowed to proceed to the next lecture until you have made at least one attempt for the preceding quiz. You are allowed two attempts, and your grade for each quiz will be the average of your attempts. All quiz attempts must be completed by 11:59 PM on Monday of the following week. Thus, Week Two's quiz attempts must be completed before 11:59 PM on Monday of Week Three. Quizzes not attempted by the due date will receive 0 points. Most quizzes are graded immediately. Some quizzes include brief essays and will be graded within 24 hours.

Exams: There are two mid-term exams and one final exam. The exams will be online and will be similar in format to the quizzes. The exams are scheduled for Thursday evening

6-8 PM in the 3rd, 6th, and 8th weeks of the course. Please identify conflicts at your earliest opportunity, and we can work together to arrange an alternate time. Grades on Exams will be available within 24 hours of all students having completed the exam. Also, for each Exam, there will be Pre- and Post-Exam Discussion Fora. The Post-Exam Discussion will include a detailed summary of each problem.

Grading Policy:

Discussions	10%
Quizzes	15%
Homework	15%
Midterm Exam I	15%
Midterm Exam II	15%
Final Exam	20%
Wild Card	10%

The "wild card" 10% is added to the grade for Midterm Exam I or II or Final Exam, whichever is highest. For example, if you have a higher grade on Final Exam than for any other grade category, then your Final Exam will count for 30% instead of 20%.

Grading Scale: The grading scale is given below, where the numbers are the percentage of the total weighted grades as defined in the Grading Policy above.

98-100	A+
93-97.99	A
90-92.99	A-
87-89.99	B+
83-86.99	B
80-82.99	B-
77-79.99	C+
73-76.99	C
70-72.99	C-
67-69.99	D+
63-66.99	D
60-62.99	D-
Below 60	F

Attendance Policy: Regular and punctual attendance is required. UNM Pathfinder policies apply, which in part means instructor drops based on non-attendance are possible. This policy applies regardless of the grading option you have chosen. UNM Learn automatically records all students' activities including: your first and last access to the course, the pages you have accessed, the number of discussion messages you have read and sent, web conferencing discussion text, and posted discussion topics. I access this data regularly to evaluate class participation and to identify students having difficulty. If you are "absent" from the course for three consecutive days, I will contact you. If you are "absent" from the course for one full week, I will contact you about dropping from the course.

Drop Policy: This course falls under all UNM policies for last day to drop courses, etc. Please see
http://www.unm.edu/studentinfo.html
or the UNM Course Catalog for information on UNM services and policies. Please see the UNM academic calendar for course dates, the last day to drop courses without penalty, and for financial disenrollment dates.

Academic Integrity: The University of New Mexico believes that academic honesty is a foundation principle for personal and academic development. All University policies regarding academic honesty apply to this course. Academic dishonesty includes, but is not limited to, cheating or copying, plagiarism (claiming credit for the words or works of another from any type of source such as print, Internet or electronic database, or failing to cite the source), fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. The University's full statement on academic honesty and the consequences for failure to comply is available in the college catalog and in the *Pathfinder*.

Topics: (text reference) *Learning Outcomes*

Formulation of the two body problem (Ch. 1)

Students can explain the assumptions and principles that lead to the two-body equations of motion and their solution.
Students can apply principles of energy and angular moment to solve orbital mechanics problems.

Constants of the motion and orbital elements (Chs. 1–2)

Students can use the relationships between position, velocity, energy, angular momentum, and the classical orbital elements to solve orbital mechanics problems.

Coordinate systems and sidereal time (Ch. 2)

Students can derive and use rotation matrices to relate various coordinate systems.
Students can use the relationship between time and coordinates.

Basic orbital maneuvers (Ch. 3)

Students can identify the classes of orbits.
Students can apply methods of transferring from one orbit to another, including changing the plane of the orbit.

The time-of-flight problem (Ch. 4)

Students can apply the relationship between time-of-flight and orbital geometry to solve time-of-flight problems.
Students can apply numerical methods to solve a variety of mission analysis problems involving time-of-flight.

Orbit determination methods (Ch. 5)

Students can determine a satellite's orbit given position and/or velocity observations.

Launch windows and orbital rendezvous (lecture notes)

Students can calculate launch windows for a particular mission.
Students can calculate simple orbital rendezvous and phasing maneuvers.

Restricted Three-Body Problem (TBD)

Students can describe the restricted three-body problem as motivation for studying lunar and interplanetary trajectories.

Lunar and Interplanetary Trajectories (Chs. 7-8)

Students can develop simple Earth-Moon and interplanetary trajectories using the patched conic approximation.

Supplementary References:

- H. D. Curtis, *Orbital Mechanics for Engineering Students,* 2005, Elsevier.
- M. H. Kaplan, *Modern Spacecraft Dynamics & Control*, 1976, Wiley.
- J. E. Prussing and B. A. Conway, *Orbital Mechanics*, 1993, Oxford U. Press.
- W. T. Thomson, *Introduction to Space Dynamics*, 1986, Dover.
- D. A. Vallado, *Fundamentals of Astrodynamics and Applications*, 1997, McGraw-Hill.
- W. E. Wiesel, *Spaceflight Dynamics*, 1989, McGraw-Hill.

Accommodation Statement: Accessibility Services (Mesa Vista Hall 2021, 277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to assure your needs are met in a timely manner. If you need local assistance in contacting Accessibility Services, see the Bachelor and Graduate Programs office.

Title IX Statement: In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered "responsible employees" by the Department of Education (see pg 15 of http://www2.ed.gov/about/offices/list/ocr/docs/qa-201404-title-ix.pdf). This designation requires that any report of gender discrimination that includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (oeo.unm.edu). For more information on the campus policy regarding sexual misconduct, see: https://policy.unm.edu/university-policies/2000/2740.html

UNM Resources:

CAPS Tutoring Services http://caps.unm.edu/programs/online-tutoring/
CAPS is a free-of-charge educational assistance program available to UNM students enrolled in classes. Online services include the Online Writing Lab, Chatting with or asking a question of a Tutor.

UNM Libraries http://library.unm.edu

Student Health & Counseling (SHAC) Online Services
http://online.unm.edu/help/learn/support/shac