Syllabus for ME 594 Introduction to Space Situational Awareness

Instructor: Dr. Alan Lovell **Email:** Use the "Inbox" feature in Canvas

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

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Prerequisites: None, although ME 595/equivalent is recommended as a prerequisite or corequisite. Also, a working knowledge of Matlab, Python, or other computational programming language is assumed.

Text: *Fundamentals of Astrodynamics*, Bate, Mueller, and White, Dover, 1971/2016

Course Description: This course introduces engineering students to the space environment, the space object population, and methods used for space object description and motion prediction.

Objectives: The following are the objectives for the course. Each module will have specific learning objectives listed on the Overview Page. The activities in that module (i.e. discussions, assignments and assessments) are developed so you can demonstrate you have met these objectives:

1. Convey the history of the artificial space object population and actions taken to predict the population evolution to have situational awareness of the population in the changing space weather environment (Week 1, 8)
2. Evaluate the use of different coordinate systems for propagating, determining, and predicting orbital motion of space objects (Week 2)
3. Analyze, compare, and contrast the use of different sensing devices for identifying and tracking space objects (Week 3)
4. Demonstrate a thorough knowledge of orbit determination methods for various measurement types (Week 4, 5)
5. Explain various types of perturbation forces in different orbit regimes, and how they affect a space object's motion and the estimation thereof (Week 6)
6. Describe the types of images taken by optical sensors and analyze the processing of these images to identify space objects (Week 7)

Module Dates: Each module begins on MONDAY and ends on SUNDAY.

Technical Requirements

- Any computer capable of running a recently updated web browser should be sufficient to access your online course. However, bear in mind that processor speed, amount of RAM and Internet connection speed can greatly affect performance. Many locations offer free high-speed Internet access including UNM's Computer Pods.
- Microsoft Office products are available free for all UNM students (more information on the UNM IT Software Distribution and Downloads page: http://it.unm.edu/software/index.html)
- MATLAB is available free for all UNM students under "Support & Links" on the left-hand side of the course website.

Coursework and Participation

Instructor Response Time: I will endeavor to respond to any inquiries I receive in 48hrs or less. If you do not receive a response in 48hrs, feel free to re-send your inquiry (in case I may have missed it).

Assignments: Assignments in the course consist of quizzes (weekly), homeworks (nearly every week), a Midterm Project, and a Final Project.

- Quizzes are 5-10 questions to test your understanding of the weekly lecture material.
- Homeworks consist of detailed problems to be solved, pertinent to that week's lecture material. Each homework must be submitted by compiling all work as a single pdf file and uploading it via Canvas (scanning or photographing written work is fine).
- The Midterm and Final will each be administered like a homework and will be submitted in the same fashion.
- Using tools such as Matlab or Python to complete an assignment is highly encouraged, and in fact necessary for most assignments. In such cases, students are still expected to show all of their work. This includes writing all assumptions, governing equations, values to be inserted in the equations, and each step of calculation. While students may include their Matlab or Python code with an assignment, this is not meant to be a replacement for showing their work.
- All assignments are expected to be turned in by their due date, unless prior contact is made with the instructor. Late homework will be accepted up to one week after the due date, with 10 points taken off for each day late.

Grading Procedures

Rubric: A grading rubric is posted in the course for each assignment.

Grading Policy: Your overall grade for the course will be weighted based on your individual assignment grades as follows:

Quiz Avg	25%
Homework Avg	25%
Midterm Project	25%
Final Project	25%

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

Grading Response Time: My goal is to post solutions to an assignment (HW, Midterm, or Final) and your grade on the assignment by the end of the following week after it is assigned.

Supplementary References:

- General (Time, Sensing, Element Representations)

    - Vallado, D.A., *Fundamentals of Astrodynamics and Applications*, 3rd Ed, 2007, Microcosm
- Dynamical Analysis (Inertial-Body Transformations, Variation of Parameters)
    - Schaub, H. and Junkins, J., *Analytical Mechanics of Space Systems*, 2003, AIAA.
- Estimation
    - Crassidis, J. and Junkins, J., *Optimal Estimation of Dynamic Systems,* 2004, CRC
- Perturbation Modeling (Force Magnitude Comparison, High Accuracy Force Modeling)
    - Montenbruck, O. and Gill, E., *Satellite Orbits: Models, Methods, and Applications*, 2012, Springer.
- Journal / Conference / Periodical Databases (not complete)
    - American Institute of Aeronautics and Astronautics Conference and Journal Publications
        - www.aiaa.org
    - American Astronautical Society Conference and Journal Publications
        - Published by Springer
        - http://www.springer.com/us/
    - SpaceNews Periodical
        - www.spacenews.com
    - ScienceDirect (published by Elsevier)
        - https://www.elsevier.com/solutions/sciencedirect
    - NASA Technical Reports Server and Orbital Debris Program Office
        - https://www.sti.nasa.gov/
        - https://www.orbitaldebris.jsc.nasa.gov/
- Two Line Element Databases
    - https://celestrak.com
    - https://www.space-track.org

UNM Policies

Title IX: Gender Discrimination: 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 http://www2.ed.gov/about/offices/list/ocr/docs/qa-201404-title-ix.pdf). This designation requires that any report of gender discrimination which 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

Copyright Issues: All materials in this course fall under copyright laws and should not be downloaded, distributed, or used by students for any purpose outside this course.

Academic Misconduct: You should be familiar with UNM's Policy on Academic Dishonesty and the Student Code of Conduct which outline academic misconduct defined as plagiarism, cheating, fabrication, or facilitating any such act.

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.

UNM Resources

CAPS Tutoring Services: http://caps.unm.edu/services/online-tutoring/olc.php

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