MAE180 Orbital Mechanics
(Spacecraft Guidance, Navigation and Mission Design)

Text: None. (Since the material to be covered is not contained in any single textbook, I did not assign required textbooks.) However, some potentially useful books are listed further below.

Objective: The course will be directed toward providing you with skills which will enable you to contribute fully to any future project that might arise involving the mission planning and control of a satellite or more general spacecraft.

Grading: [The following is tentative, and we reserve the right to make small changes during the first few weeks.] The final course grade will be calculated as follows:

Homework: 30%
Quiz 1: 20%
Quiz 2: 20%
Quiz 3: 20%
Take-Home Final: 10%
Class Participation Modifier: up to +2%

◦ On select problems, the TAs may not be allowed to provide aid.
◦ Homework will be due at the time indicated on the assignment. Homework handed in up to two hours late will still be accepted but with a loss of 20% of that homework grade. **The policies regarding due time are strict.**
◦ Because of staffing limits, it is likely that not all homework problems will be graded.
◦ One homework assignment grade (that with the lowest percentage) will be dropped.
◦ The overall grade for the homework portion of the class will be computed simply by summing the non-dropped homework scores. For example, with four assignments receiving grades of 45/50, 39/40, 80/100 and 68/70, the overall homework grade would be 232/260 (i.e., 89.2%).

◦ As always, although you may discuss problems together, **the work you hand in must be clearly your own.** This has occasionally led to difficulties in the past, so please take care.

◦ The homework assignments and take-home final will require both numerical analysis **and software implementation.**

Content: The equations of Orbital Mechanics will be discussed with an emphasis on the propagation of spacecraft trajectories. First, the differential equations which describe the motion will be given. This will be followed by the standard solution for the case of two spherical bodies and a discussion of numerical methods appropriate for more complex situations. The relevant coordinate systems and transformations between them will be covered. We will discuss orbital maneuvers at this point, possibly with a short discussion regarding trajectory optimization.

Other possible topics include stationkeeping, flight through planetary atmospheres, navigation (via Kalman filter), stationary-action and interplanetary travel.

References: Bate, Mueller and White; Fundamentals of Astrodynamics, Dover, 1971. (It's ridiculously old, but it's also a very inexpensive and handy source of the classical equations.).

Prussing and Conway – Orbital Mechanics.

Bryson and Ho – Applied Optimal Control. (This is only utilized in the navigation portion.)

Vinh, Busemann and Culp – Hypersonic and Planetary Entry Flight Mechanics (unlikely topic).