

# SPST305

**STUDENT WARNING:** This course syllabus is from a previous semester archive and serves only as a preparatory reference. Please use this syllabus as a reference only until the professor opens the classroom and you have access to the updated course syllabus. Please do NOT purchase any books or start any work based on this syllabus; this syllabus may NOT be the one that your individual instructor uses for a course that has not yet started. If you need to verify course textbooks, please refer to the online course description through your student portal. This syllabus is proprietary material of APUS.

## Course Summary

**Course :** SPST305 **Title :** Introduction to Orbital Mechanics

**Length of Course :** 8

**Prerequisites :** MATH111, SPST200, SPST300 **Credit Hours :** 3

## Description

**Course Description:** Students taking this course compute and calculate satellite orbits, planetary orbits, solar system orbits, and other essential space orbits. Designed for the non-scientist student, this course provides a fundamental understanding of how orbital mechanics works in space. (Prerequisites: MATH111 and SPST200 or SPST300)

### Course Scope:

Upon completion of this course the student will have a basic understanding of orbital mechanics and be able to discuss simple principles with engineers and scientists involved in the more complex details of launching, tracking, maneuvering, and maintaining spacecraft orbits in daily operations.

## Objectives

Upon completion of this course, the student will be able to:

- **CO-1** Describe the laws of planetary motion and gravitation that illustrates the effects that gravity has on two-body mechanics.
- **CO-2** Identify the four different types of orbits and their special characteristics.
- **CO-3** Calculate the orbital components and perturbations for elliptical and circular orbits.
- **CO-4** Determine orbital elements and organize them into two-line element sets given an orbit's radius and velocity vectors.
- **CO-5** Analyze spacecraft maneuvers including transfer orbits and rendezvous.
- **CO-6** Compute the  $\Delta V$ , escape trajectories, impact requirements, and time-of-flight required for a patched-conic section transfer orbit from Earth to another planet.

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# Outline

## Week 1:

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### Objectives

- List and describe the unique advantages of space and some of the missions that capitalize on them.
- Identify the elements that make up a space environment.
- Recall the contributions of early space explorers.
- Explain the beginnings of the Space Age and the significant events that have led to current capabilities in space.
- Describe emerging space trends, to include the growing commercialization of space.
- Explain where space begins.
- List and describe the major hazards of the space environment and their effects on spacecraft.
- List and describe the major hazards of the space environment that pose a problem for humans living and working in space.

### Readings/Assignments

Readings: Sellers - Chapters 1-4 Assignments: Homework 1 (Due end of Week 1)

## Week 2:

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### Objectives

- Explain the basic concepts of orbital motion and describe how to analyze them.
- Explain and use Newton's basic laws of motion, including mathematical and geometric representation of orbits.
- Define a coordinate system and use the Motion Analysis Process to describe two-body orbital motion.
- Use two constants of orbital motion (specific mechanical energy and specific angular momentum) to determine important orbital variables.

### Readings/Assignments

Readings: Sellers – Chapter 4 Assignments: Homework 2

## Week 3:

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### Objectives

- Define the classical orbital elements (COEs) used to describe the size, shape, and orientation of an orbit and the location of a spacecraft in that orbit.
- Determine the COEs given the position,  $R$ , and velocity,  $V$ , of a spacecraft at one point in its orbit.
- Explain the use of orbital ground tracks.

### Readings/Assignments

Readings: Sellers – Chapter 5 Assignments: Homework 3

## Week 4:

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### Objectives

- Explain the Hohmann Transfer.

- Determine the velocity change ( $\Delta V$ ) needed to perform a Hohmann Transfer between two orbits.
- Explain plane changes and how to determine the required  $\Delta V$  to accomplish them.
- Explain orbital rendezvous and how to determine the required  $\Delta V$  and wait time needed to start one.

Review/take the Midterm Exam (available at the beginning of Week 4 but due by the end of Week 5)

Readings/Assignments

Readings: Sellers – Chapter 6 Assignments: Homework 4

Midterm Exam (Covers all of the above)

### Week 5:

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Objectives

- Describe the basic steps involved in getting from one planet in the solar system to another.
- Determine the required  $\Delta V$  needed for interplanetary transfer.
- Explain how we can use the gravitational pull of planets to get “free” velocity changes, making interplanetary transfer faster and cheaper.
- Determine the time of flight between two spacecraft positions within a given orbit.
- Determine a spacecraft’s future position using Kepler’s Equation.
- Describe the effects of perturbations on orbits and explain their practical applications.
- Describe the overall problem of tracking spacecraft and predicting orbits.

Readings/Assignments

Readings: Sellers – Chapters 7-8 Assignments: Homework 5

### Week 6:

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Objectives

- Describe launch windows and how they constrain when we can launch into a particular orbit.
- Determine when and where to launch, as well as the required velocity and direction, to reach a specific orbit.
- Demonstrate how mission planners determine when, where, in what direction, and with what velocity to launch spacecraft into their desired orbits.

Readings/Assignments

Readings: Sellers – Chapter 9 Assignments: Homework 6

### Week 7:

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Objectives

- Describe the competing design requirements for re-entry vehicles.
- Describe the process for analyzing re-entry motion.
- Describe the basic trajectory options and trade-offs in re-entry design.
- Describe the basic vehicle options and trade-offs in re-entry design.
- Describe how a lifting vehicle changes the re-entry problem.

Readings/Assignments

Readings: Sellers – Chapter 10 Assignments: Homework 7

## Week 8:

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Objectives

Review/take the Final Exam

(Available at the beginning of Week 7 but due by the end of Week 8)

Readings/Assignments

Final Exam (Covers all of above)

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## Evaluation

Grades for this course will be based upon four grading instruments. You must complete all assigned tasks in order to pass the course.

### Homework Assignments

Homework assignments make up 50 percent of your overall course grade. Questions will require you to have previously read the chapter(s) assigned in order to comprehend and correctly respond. Each homework assignment will be posted in the Assignments area of the classroom at the end of the week listed in the Course Outline (below). *Be sure to work through the practice problems/sets provided in the book before working on your homework problems!!!*

### Midterm/Final Exams

The Midterm and Final Exams are both open book/open note exams. You will have 24 hours to upload your responses from the time you access the exams. You can access the exams multiple times but will only be allowed to submit your answers once, so make sure you are complete with your exam before submitting.

### Forums/Class Participation

10 percent of your course grade is earned through participation with other students in the Forum area of the classroom. Your knowledge of assigned readings will be reflected in your ability to actively participate and discuss key course concepts. Postings will occur every week throughout the course. You must respond to each Forum posting within *seven* days of the original posting date in order to receive full credit.

All assignments in this course are given to you prior to the due date. The “due date” for all assignments is the week in which the assignment is due. For the purposes of this course, a “**week**” is defined as the time period between Monday–Sunday. The **first week** begins on the first day of the semester and ends on midnight (*your* local time) the following **Sunday**.

During this course, we can maintain contact in several ways. The best will be through email; next will be the online Chat Room; last will be phone. Don’t get me wrong – I don’t mind phone calls, however most questions are best answered in writing so that the information can be referred to again in the future.

## Grading:

Name	Grade %
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## Materials

**Book Title:** Understanding Space, 3rd Ed - The VitalSource e-book is provided via the APUS Bookstore

**Author:** Sellers

**Publication Info:** McGraw-Hill

**ISBN:** 9780073407753

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**Book Title:** You must validate your cart to get access to your VitalSource e-book(s). If needed, instructions are available here - <http://apus.libguides.com/bookstore/undergraduate>

**Author:** N/A

**Publication Info:** N/A

**ISBN:** N/A

### Software Requirements

- Microsoft Word

*A Note to Students using MS Office 2007: To ensure that your assignments can be shared across platforms, please save your documents as a Word 97-2003 document (.doc).*

- Adobe Acrobat Reader

### Selected Bibliography

There are numerous online sources to help you in better understanding the objectives outlined in this course. Besides the author's website (at <http://www.understandingspace.com>), other websites that may be of help are listed below:

[http://liftoff.msfc.nasa.gov/academy/rocket\\_sci/orbmech/orbmech.html](http://liftoff.msfc.nasa.gov/academy/rocket_sci/orbmech/orbmech.html)

[http://liftoff.msfc.nasa.gov/academy/rocket\\_sci/orbmech/state/2line.html](http://liftoff.msfc.nasa.gov/academy/rocket_sci/orbmech/state/2line.html)

<http://www.resa.net/nasa/mechanics.htm>

<http://www.celestrak.com/columns/v04n03/>

<http://www.jpl.nasa.gov/basics/bsf4-1.html>

<http://celestrak.com/columns/>

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## Course Guidelines

### Citation and Reference Style

- Attention Please: Students will follow the APA Format as the sole citation and reference style used in

written work submitted as part of coursework to the University. Assignments completed in a narrative essay or composition format must follow the citation style cited in the APA Format.

## **Tutoring**

- [Tutor.com](https://www.tutor.com) offers online homework help and learning resources by connecting students to certified tutors for one-on-one help. AMU and APU students are eligible for 10 free hours\* of tutoring provided by APUS. Tutors are available 24/7 unless otherwise noted. Tutor.com also has a SkillCenter Resource Library offering educational resources, worksheets, videos, websites and career help. Accessing these resources does not count against tutoring hours and is also available 24/7. Please visit the APUS Library and search for 'Tutor' to create an account.

## **Late Assignments**

- Students are expected to submit classroom assignments by the posted due date and to complete the course according to the published class schedule. The due date for each assignment is listed under each Assignment.
- Generally speaking, late work may result in a deduction up to 15% of the grade for each day late, not to exceed 5 days.
- As a working adult I know your time is limited and often out of your control. Faculty may be more flexible if they know ahead of time of any potential late assignments.

## **Turn It In**

- Faculty may require assignments be submitted to Turnitin.com. Turnitin.com will analyze a paper and report instances of potential plagiarism for the student to edit before submitting it for a grade. In some cases professors may require students to use Turnitin.com. This is automatically processed through the Assignments area of the course.

## **Academic Dishonesty**

- Academic Dishonesty incorporates more than plagiarism, which is using the work of others without citation. Academic dishonesty includes any use of content purchased or retrieved from web services such as CourseHero.com. Additionally, allowing your work to be placed on such web services is academic dishonesty, as it is enabling the dishonesty of others. The copy and pasting of content from any web page, without citation as a direct quote, is academic dishonesty. When in doubt, do not copy/paste, and always cite.

## **Submission Guidelines**

- Some assignments may have very specific requirements for formatting (such as font, margins, etc) and submission file type (such as .docx, .pdf, etc) See the assignment instructions for details. In general, standard file types such as those associated with Microsoft Office are preferred, unless otherwise specified.

## **Disclaimer Statement**

- Course content may vary from the outline to meet the needs of this particular group.

## **Communicating on the Forum**

- Forums are the heart of the interaction in this course. The more engaged and lively the exchanges, the more interesting and fun the course will be. Only substantive comments will receive credit. Although there is a final posting time after which the instructor will grade comments, it is not sufficient to wait until the last day to contribute your comments/questions on the forum. The purpose of the forums is to actively participate in an on-going discussion about the assigned content.
- “Substantive” means comments that contribute something new and hopefully important to the discussion. Thus a message that simply says “I agree” is not substantive. A substantive comment contributes a new idea or perspective, a good follow-up question to a point made, offers a response to

a question, provides an example or illustration of a key point, points out an inconsistency in an argument, etc.

- As a class, if we run into conflicting view points, we must respect each individual's own opinion. Hateful and hurtful comments towards other individuals, students, groups, peoples, and/or societies will not be tolerated.

### **Identity Verification & Live Proctoring**

- Faculty may require students to provide proof of identity when submitting assignments or completing assessments in this course. Verification may be in the form of a photograph and/or video of the student's face together with a valid photo ID, depending on the assignment format.
  - Faculty may require live proctoring when completing assessments in this course. Proctoring may include identity verification and continuous monitoring of the student by webcam and microphone during testing.
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## **University Policies**

### [Student Handbook](#)

- [Drop/Withdrawal policy](#)
- [Extension Requests](#)
- [Academic Probation](#)
- [Appeals](#)
- [Disability Accommodations](#)

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