COURSE SYLLABUS
USC VITERBI SCHOOL OF ENGINEERING
DEPARTMENT OF ASTRONAUTICAL ENGINEERING

Course Number & Title:	***ASTE 584 Spacecraft Power Systems***
Course Instructors:	***Steve Lapen & David E. Lee***
Affiliation:	***Northrop Grumman Space Systems***
E-Mail:	**slapen@usc.edu / dlee5827@usc.edu**

CLASS INFORMATION:

Physical: Ronald Tutor Hall 105 (RTH105) / Section 29148
DEN: DEN@Viterbi / Section 29178
Days/Time: Wednesdays, 6:40-9:20 pm
Class Web (USC D2L website): TBD for 2025

PREREQUISITES:

Graduate standing in engineering or science. Registration open to the following class level(s): Master Student, Doctoral Student.

COURSE GOALS AND OBJECTIVES:

- Understand spacecraft power systems' fundamental elements
- Study the underlying physics and engineering for power technologies such as solar cells, solar arrays, batteries, power conversion electronics, dynamic power converters, and power distribution
- Focus on mission requirements that drive the use of specific power technologies
- Evaluate available options for power system elements
- Consider capabilities and limitations of specific power technology approaches
- Learn analysis techniques and practical design considerations for spacecraft power systems
- Track the development of space power systems and their markets
- Explore options for space electrical power generation and distribution such as space solar farms, space-based beamed power grids, power stations on the Moon and other bodies in space

TEXTBOOKS:

The course is taught primarily from lecture slides, but these books support the supplemental reading assignments, and provide useful reference material for the homeworks and exams. We recommend having both:

1. Spacecraft Power Systems, 2nd edition. Makund R. Patel & Omid Beik, CRC Press / Taylor & Francis Group, 2023.
2. Space Mission Engineering: The New SMAD (SME-SMAD or SMAD IV), James R. Wertz, David F. Everett and Jeffery J. Puschell. Microcosm Press, 2011
    - Alternate: Space Mission Analysis and Design, 3rd Edition (SMAD III), 7th Printing, Wiley L. Larson and James R. Wertz

COURSE GRADING:

Class Participation:	10%
Homework:	30%
Midterm Exam:	25%
Final Exam:	35%

Note: The class participation grade is based primarily on posting to the ASTE584 technical discussion boards on the D2L course website. Posting or replying on each major topic is the best way to establish a record of participation. Questions and comments in class or during office hours are also recognized and appreciated.

HOMEWORK:

Due by 6:40 PM on Wednesdays

OFFICE HOURS:

Mon Online: 6:30-7:30 Pacific
Wed 5:30-6:30 Pacific: In person (OHE 530C) and online; See D2L news feed for Webex links

Spring 2025 Course Outline:

#	Date/Topics	*Assignments Due*
1	Jan 15 Electrical Power Subsystems (EPS) vs. Space Power Systems (SPS), Power System Requirements, Power Architectures, Technologies & Examples, Orbital Mechanics Basics	(register for class)
2	Jan 22 Space Environments & Effects on Power Systems	*Assignment #0* *Homework #01*
3	Jan 29 Solar Cells: Photoelectric Effect, PV Cells, Cell Fundamentals, Cell Applications and Uses	*Homework #02*
4	Feb 05 Solar Array Types & Array Trends, Array Components, Packaging & Deployments, Array Parameters & Sizing	*Homework #03*
5	Feb 12 Energy Storage: Storage Considerations, Cells and Batteries, Fuel Cells, Other Storage Technologies	*Homework #04*
6	Feb 19 Radioisotopes and Nuclear 1: Why Bring Your Own Power, Radioisotope-Based Power, Nuclear-Based Power	*Homework #05*
7	Feb 26 Radioisotopes and Nuclear 2: Examples	*Homework #06*
8	Mar 05 *Midterm exam 7:00-9:00pm online via D2L*	*<none>*
9	Mar 12 Power Processing & Conditioning: Direct Energy Transfer, Switchmode Power Conversion, Battery Clamped vs. Regulated Bus	*Homework #07*
10	Mar 19 No Lecture (Spring Break: Mar 16-23)	*<none>*
11	Mar 26 Power Monitoring and Switching, Secondary Converters, Power Electronics Design Considerations Unique to Space	*Homework #08*
12	Apr 02 Power Distribution, Fusing, Grounding, Power Quality, Power System Stability, Electromagnetic Compatibility	*Homework #09*
13	Apr 09 Reliability, Redundancy, Verification, Component Screening	*Homework #10*
14	Apr 16 Power System Optimization and Analysis Techniques	*Homework #11*
15	Apr 23 Putting It Together: Power Architectures for Larger Satellites; I&T and On-Orbit Ops, End-of-Mission Considerations	*Homework #12*
16	Apr 30 Putting It Together: Power Architectures for Smallsats, Novel Power Concepts & SPS, Final Recap	*Homework #13*
17	Week of May 5- May 9 *Final exam online via D2L*	

Assignment #0:

Due ***January 22:***

A. Please send an e-mail to our usc.edu accounts to establish communication

B. Take the class survey at: (TBD for 2025)

Reading list, by lecture:

Lect	USC ASTE 584 Lectures	SC Pwr Sys 2nd ed Patel & Beik 2023	New SMAD 2011
1	Electrical Power Subsystems (EPS) vs. Space Power Systems (SPS), Power System Requirements, Power Architectures, Technologies & Examples, Orbital Mechanics Basics	Ch 1.1-1.5, Ch3.1-3.7	Ch 1, 6.1, 8.1, 9.1, 9.5, 9.6, Appendix C
2	Space Environments & Effects on Power Systems	Ch 1.6-1.9, Ch 2	Ch 7
3	Solar Cells: Photoelectric Effect, PV Cells, Cell Fundamentals, Cell Applications and Uses	Ch 4.1-4.3, Ch 6.1-6.5	Ch 21.2
4	Solar Array Types & Array Trends, Array Components, Packaging & Deployments, Array Parameters & Sizing	Ch 5.7, Ch 6.6-6.9,	Ch 21.2
5	Energy Storage: Storage Considerations, Cells and Batteries, Fuel Cells, Other Storage Technologies	Ch 5.8, Ch 7, Ch 18	Ch 21.2
6	Radioisotopes and Nuclear 1: Why Bring Your Own Power, Radioisotope-Based Power, Nuclear-Based Power	Ch 14, Ch 15	Ch 21.2
7	Radioisotopes and Nuclear 2: Examples	Ch 14, Ch 15	Ch 21.2
	Midterm		
8	Power Processing & Conditioning: Power Architectures, Direct Energy Transfer, Switchmode Power Conversion, Battery Clamped vs. Regulated Bus	Ch 4.1-4.3 Ch 8	Ch 21.2
9	Power Monitoring and Switching, Secondary Converters, Power Electronics Design Considerations Unique to Space	Ch 10	Ch 21.2
10	Power Distribution, Fusing, Grounding, Power Quality, Power System Stability, Electromagnetic Compatibility	Ch 9, Ch 12.3-12.9, Ch 13.1-13.5	Ch 21.2
11	Reliability, Redundancy, Verification, Component Screening	N/A	Ch 23.3, 23.4, Ch 24
12	Power System Optimization and Analysis Techniques	Ch 11	Ch 21.2, 6.2, 6.3
13	Putting It Together: Power Architectures for Large Satellites; Integration and Testing, On-Orbit Ops, End-of-Mission Considerations	Ch 4.4, 4.5, 5.4-5.13	Ch 21.2, 23.3
14	Putting It Together: Power Architectures for Smallsats, Novel Power Technologies & SPS, Final recap	Ch 3.5, 3.7, 3.8, 4.5	Ch 6.7, 25.3- 25.4
	Final		

STATEMENT FOR STUDENTS WITH DISABILITIES

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to both instructors as early in the semester as possible. DSP is located in GFS 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website for DSP (https://dsp.usc.edu/) and contact information: (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) dspfrontdesk@usc.edu.

STATEMENT ON ACADEMIC INTEGRITY

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, contains the University Student Conduct Code (see University Governance, Section 11.00) with recommended sanctions are located in Appendix A.

EMERGENCY PREPAREDNESS/COURSE CONTINUITY IN A CRISIS

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies. See the university's site on Campus Safety and Emergency Preparedness.