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***
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CLASS INFORMATION:

Physical: Tutor Hall 109 (RTH109) / Section 29148R / Session 048
DEN: DEN@Viterbi / Section 29178R / Session 034
Days/Time: Wednesdays, 6:40-9:20 pm
Class Web (USC D2L website): https://courses.uscden.net/d2l/home/25461

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

PRIMARY TEXTBOOK:

The course is taught from lecture slides, but having a copy of either #1 or #2 will support the supplemental reading assignments.

1. Recommended: Spacecraft Power Systems, Patel, 2004
    - (available at Amazon in Kindle ebook format for $51; Kindle app is free)
2. Alternate: Spacecraft Power Technologies, Hyder, 2000/2003

SECONDARY TEXTS:

Space Mission Engineering: The New SMAD (SME-SMAD or SMAD IV), James R. Wertz, David F. Everett and Jeffrey J. Purschell
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%

HOMEWORK:

Due by 6:40 PM on Wednesdays

OFFICE HRS:

Mon online: 6:30-7:30 pacific
Wed 5:30-6:30 pacific, in person in OHE 530C and online
See D2L news feed for Webex links

SPRING 2023 COURSE OUTLINE:

#	DATE/TOPICS	*ASSIGNMENTS DUE*
1	**Jan 11** **Space & Space Architectures, Electrical Power Subsystems (EPS) vs. Space Power Systems (SPS), Power System Requirements, Power Architectures, Technologies & Examples**	**(register for class)**
2	**Jan 18** **Orbits and Orbital Mechanics Basics, Mission Geometry**	***Assignment #0*** ***Homework #01***
3	**Jan 25** **Space Environments & Effects on Power Systems**	***Homework #02***
4	**Feb 01** **Solar Cells: Photoelectric Effect, PV Cells, Cell Fundamentals, Cell Applications and Uses**	***Homework #03***
5	**Feb 08** **Solar Array Types & Array Trends, Array Components, Packaging & Deployments, Array Parameters & Sizing**	***Homework #04***
6	**Feb 15** **Energy Storage: Storage Considerations, Cells and Batteries, Fuel Cells, Other Storage Technologies**	***Homework #05***
7	**Feb 22** **Radioisotopes and Nuclear: Why Bring Your Own Power, Radioisotope-Based Power, Nuclear-Based Power**	***Homework #06***
	Mar 01 ***Midterm 7:00-9:00pm online via D2L***	***<none>***
8	**Mar 08** **Power Processing & Conditioning: Power Architectures, Direct Energy Transfer, Switchmode Power Conversion, Battery Clamped vs. Regulated Bus**	***Homework #07***
	Mar 15 – no lecture (Spring recess Mar 12-19)	
9	**Mar 22** **Power Monitoring and Switching, Secondary Converters, Power Electronics Design Considerations Unique to Space**	***Homework #08***
10	**Mar 29** **Power Distribution, Fusing, Grounding, Power Quality, Power System Stability, Electromagnetic Compatibility**	***Homework #09***
11	**Apr 05** **Reliability, Redundancy, Verification, Qualification**	***Homework #10***
12	**Apr 12** **Power System Optimization and Analysis Techniques**	***Homework #11***
13	**Apr 19** **Putting It Together: Sizing and Power Architectures for Larger Satellites; I&T and on-orbit ops**	***Homework #12***
14	**Apr 26** **Putting It Together: Sizing and Power Architectures for Smallsats, Novel Power Concepts & SPS, Final Recap**	***Homework #13***
	May 03 ***Final 7:00-9:00pm online via D2L***	

ASSIGNMENT #0:

Due ***January 18:***

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

B. Take the initial class survey at: https://s.surveyplanet.com/x610rx70

Reading list, by lecture:

Lect	USC ASTE 584 Lectures	Patel SC Pwr Sys 2004 (Recommended)	Hyder SC Pwr Tech 2003 (Alternate)	New SMAD 2011
1	Space & Space Architectures, Electrical Power Subsystems (EPS) vs. Space Power Systems (SPS), Power System Requirements, Power Architectures, Technologies & Examples	Ch 1.1, 1.2, Ch3, Ch6	Ch 1	Ch 1, Ch 6
2	Orbits and Orbital Mechanics Basics, Mission Geometry	Ch 1.3 - 1.11	Ch 2	Ch 8, Ch 9
3	Space Environments & Effects on Power Systems	Ch 2, Ch 5, Ch 19	Ch 2	Ch 7
4	Solar Cells: Photoelectric Effect, PV Cells, Cell Fundamentals, Cell Applications and Uses	Ch 8	Ch 3 p71-118	Ch 21.2
5	Solar Array Types & Array Trends, Array Components, Packaging & Deployments, Array Parameters & Sizing	Ch 8, Ch 12.2	Ch 3 p119-136	Ch 21.2
6	Energy Storage: Storage Considerations, Cells and Batteries, Fuel Cells, Other Storage Technologies	Ch 9, Ch 24	Ch 4	Ch 21.2
7	Radioisotopes and Nuclear: Why Bring Your Own Power, Radioisotope-Based Power, Nuclear-Based Power	Ch 20, Ch 21	Ch 5 Ch 6, 7 (esp. 287-294)	Ch 21.2
	Midterm			
8	Power Processing & Conditioning: Power Architectures, Direct Energy Transfer, Switchmode Power Conversion, Battery Clamped vs. Regulated Bus	Ch 4.1-4.11 Ch 10.1-10.6.2	Ch 8	Ch 21.2
9	Power Monitoring and Switching, Secondary Converters, Power Electronics Design Considerations Unique to Space	Ch 10.6.4, 10.6.5 Ch 11, 12.6, 12.9	Ch 8, Ch 9	Ch 21.2
10	Power Distribution, Fusing, Grounding, Power Quality, Power System Stability, Electromagnetic Compatibility	Ch 11.2, 11.8, 11.10 12.11, 14.6, 14.10 Ch 15.1-15.2, 15.4	Ch 8	Ch 21.2
11	Reliability, Redundancy, Verification, Qualification	Ch 17, Ch 18	NA	Ch 23.3, 23.4, Ch 24
12	Power System Optimization and Analysis Techniques	Ch 7, 13.1-13.2, 14.11-14.12	NA	Ch 21.2
13	Putting It Together: Sizing and Power Architectures for Larger Satellites; Integration and Testing, On-Orbit Ops	Ch 7, review Ch 6 & 18	Ch8 p404-411	Ch 21.2, 23.3
14	Putting It Together: Sizing and Power Architectures for Smallsats, Novel Power Technologies & SPS, Interplanetary missions, Final recap	Ch 7, Ch19, review Ch 6	NA	Ch 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.