EP 410 – Space Physics
Embry-Riddle Aeronautical University
Spring 2017

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office hours: MWF 1:00-2:00; TuTh 3:30-4:30

Required texts: *Fundamentals of Space Physics*, by Hughes (online)
Introduction to Plasma Physics, by Chen (online)

Supplementary texts: *The solar-terrestrial environment*, by Hargreaves (`QC879.H278 1992`)
Introduction to Space Physics, by Kivelson and Russell
Physics of Solar System Plasmas, by Cravens
Physics of Space Plasmas, by Parks
Modern Plasma Physics, by Fried (online)
Basic Space Plasma Physics, by Baumjohann and Treumann

Percentage system:

1 final test	20%
1 midterm test	20%
Problem sets	20%
Projects	40%

Grading scale:

A	90% –
B	75% – 89%
C	60% – 74%
D	50% – 59%

IMPORTANT NOTE

Listening to lectures is not enough (*you retain only 10% of what you hear …*). All processes of learning are somehow connected to active participation, and the learning of physics is no exception. Therefore, it is imperative that you work diligently at your own desk (*… 80% of what you practice …*). However, this does not mean that you should only work alone. I encourage you to form study groups and collaborate with your classmates (*… and 90% of what you teach to others!*).

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* This syllabus incorporates all existing University policies, especially those sections of the *Student Handbook* pertaining to academic integrity, civility, and respect. *

Course Description: Origin, evolution, and structure of neutral and ionized terrestrial atmosphere. Effect of sun's electromagnetic radiation on ozone shield. Photoionization and thermal structure of the neutral atmosphere as well as the ionosphere and magnetosphere. Solar disturbances and their effects on satellite orbit decay and on long-distance communication. Studies of composition, thermodynamics, and physical processes of the near-Earth space environment. Rocket and satellite monitoring and remote sensing. Numerical and instrument design projects.
Prerequisites: PS 320; **Co-requisites**: EP 440;

Course Content (subject to change)

1. *Fluid mechanics*
2. Solar structure
3. *Plasma physics*
4. Solar wind
5. *Particle dynamics*
6. Magnetosphere
7. Ionosphere
8. Atmosphere
9. Earth's structure/geology
10. Miscellaneous topics

RULES
1. Arrive on time; depart on time.
2. Take notes, and bring calculator to each class.
3. No eating, no cell phones.

Final Test

75 minutes; closed book; closed notes.
Tools: pen or pencil, calculator.
Date: Mon 12 Dec, 17:00 – 19:00.

Midterm Test

75 minutes; closed book; closed notes.
Tools: pen or pencil, calculator.
Dates: TBD.

Problem Sets

Problems due each Thursday. Problems must be turned in on 8.5" x 11", lined or unlined, white 20lb paper. Problem number must be in the upper right, stapled in the upper left. Start each problem on a new sheet. No graph paper. No card stock. No notebook paper (7.5" x 10.5"). Write neatly.

Projects

30 points – Essay, 2 pages.
60 points – Sunspot report, some numerics.
120 points – Particle tracing report, lots of numerics.
60 points – journal article presentation.

General study habits

Repetition is critical for creating long-term memories. A good method for learning is the following sequence: read, listen, write, re-read, re-write, practice, and review. The textbook should be read THREE times: read once before class, read deeply (at least) once after class, and once as a review. In addition, you do not read textbooks as you would the newspaper. You must work through the examples, all mathematical steps should be confirmed, and you should write notes in the margins (it is your book, you can write in it!).

Notes

Taking notes during lecture is important – but you must review and re-copy those notes after class (within a few hours) for them to be useful. Notes that are never reviewed are less than worthless: they give you a false sense of security. It is important that you get into the habit studying every day.

Study Groups

I strongly suggest that you form study groups. "For most individuals, learning is most effectively carried out via social interactions." (Ed Redish)

Problem Solving

Solving problems is **critical** to your success in this course. An excellent method to prepare for the exams is to attempt problems at home in an exam-type environment. That is, once you have solved a group of problems, put aside the solutions and pretend that they are questions on an exam – attempt to solve them again, but without any help. Solve problems according to the following rules of coherence and readability:

- Describe *briefly*, but in clear and complete sentences, the basic principles used to solve the problem and explain the basic equations that are used in the solution [DO NOT simply rewrite the question]. This is the most important component of coherence and full credit will not be given for any problem solution that does not contain such a description.
- If a physical situation is discussed in the problem, draw an appropriate diagram.
- Identify in words, or by clear references to the diagram, all the symbols you use.
- Work through the problem symbolically, getting a simplified symbolic answer, and only substitute numbers (if appropriate at all) at the very end.
- If you obtain an explicit numerical solution, comment on whether the value you get is reasonable.
- Put boxes around your final answers.
- Write up the problem sets neatly.

Do not simply copy another student's work, and do not simply copy from the solutions manual, but I recommend that you form study groups and work together. This can help you through difficult sections and problems. I encourage you to discuss, argue, arm-wrestle, and finally master the problems. However, I expect you to write up your solutions individually, showing your own insights.

Projects:

Essay (30)
Read Habbal and Woo, "The solar wind and the Sun-Earth link," 2004. Online.
Write a two-page essay – see course website for further details.
Deadlines (points in parentheses):
Thu 19 Jan 2017 - draft: brief overview + 2 paragraphs (10)
Thu 26 Jan 2017 - final report due (20)

Project 1 – Sunspot number analysis (60)
Perform numerical analysis of the sunspot number record and write a report – see course website for further details.
Deadlines (points in parentheses):
Tue 24 Jan 2017 - run code and submit figures (5)
Tue 31 Jan 2017 - 3 figures on smoothing + text (10)
Tue 7 Feb 2017 - Fourier transform figure + text (15)
Tue 14 Feb 2017 - final report (30)

Project 2 – Charged particle dynamics (120)
Solve Newton's second law for charged particle trajectories in various magnetic field configurations, and write a report – see course website for further details.
Deadlines (points in parentheses):
Tue 21 Feb 2017 – cyclotron motion plot + 2 paragraphs text (5)
Tue 28 Feb 2017 – grad B drift plot + 4 paragraphs text (10)
Tue 7 Mar 2017 – mirror motion plot + 6 paragraphs text (15)
Tue 21 Mar 2017 – motion in a dipole field plot + 8 paragraphs text (30)
Tue 28 Mar 2017 – final report (60)

Journal article presentation (60)
Read a current journal article on some aspect of space physics and give a conference-style presentation – see course website for further details.
Deadlines (points in parentheses):
Tue 4 Apr 2017 – choose an article (5)
Tue 11 Apr 2017 – write one paragraph summary (10)
week of Tue 18 Apr 2017 – practice presentation for me (15)
week of Tue 25 Apr 2017 – presentation (30)