Gateway To Space

ASEN / ASTR 2500
\[ \frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2} = 0 \]

\[ \sum_{k=1}^{n} k^2 = \frac{n(n + 1)(2n + 1)}{6} \]

\[ \frac{d}{dx} f(x) = \lim_{\Delta \to 0} \frac{f(x + \Delta) - f(x)}{\Delta} \]

\[ \cos x = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!} \]

\[ \int \tan(ax)dx = -\frac{1}{a} \ln |\cos(ax)| + c \]

\[ \int u \frac{dv}{dx}dx = uv - \int \frac{du}{dx}v dx \]

\[ \lim_{x \to c} \frac{f(x)}{g(x)} = \lim_{x \to c} \frac{f'(x)}{g'(x)} \]

\[ \lim_{x \to -\infty} \tan^{-1}(x) = -\frac{\pi}{2} \]
PID Control Law

- Proportional, Integral, Derivative (PID)
  - Used to control single axis
  - One PID controller for each axis

\[
\begin{align*}
\omega_{err} & = \text{rate error} \\
\theta_{err} & = \text{attitude error} \\
\theta_i_{err} & = \text{integrated attitude error}
\end{align*}
\]
PID Control Law Response Times

- Zero Rate Gain = No Damping
- Small Rate Gain = Light Damping
- Large Rate Gain = Heavy Damping

Attitude Error (Deg) vs. Time (sec)
The $150 Edge-of-Space Camera: MIT Students Beat NASA On Beer-Money Budget

By Charlie Sorrel  September 15, 2009 | 7:54 am | Categories: Cameras
Gateway To Space

ASEN 1400 / ASTR 2500

Class #1

Colorado Space Grant Consortium
Today

- Introductions
- What to expect from this course
- Format for this course
- “How to get an A”
- Pictures
Class Size
Who’s Out There?
Who's Out There?
What this class takes...
How was the first day?
What to expect...
What to Expect?

- 16th time teaching this course

- I have a unique teaching style
  - I teach like I wish I had been taught
  - Sense of humor
What to Expect?

- What you imagine this class will be like...
What to Expect?

- What it is like...
What to Expect?

- What it is like…
What to Expect?

- What it is like…
What to Expect?

- What it is like...
What to Expect?

- What it is like…
What to expect from this class:

- If you are not here because you \textit{want to be here}, then leave…

- If you are here because you think this will be \textit{easier} than GEEN 1400, then leave…

- If you are here because you think this will be \textit{easier} than \textit{Physics III}, then leave…

- If you are \textit{a slacker}, then leave…

- \textit{But if you want to work hard and achieve something great}, then stay…
The Class:

Learn the basics of atmospheric and space sciences, space exploration, spacecraft design, rocketry, and orbits.
The Class:

Hear about the current research in space through lectures from Lockheed Martin, Ball Aerospace, LASP, NOAA, NCAR, and CASA.
**The Class:**

**Launch** a mini-satellite on a high altitude balloon that is designed and built by you and a team of students.
The Class:

- Interactive
- Interesting
- Applicable
- Fun
What to expect from this class:

- Plan on being here for the full class (75 minutes)
- Be ON-TIME
- 1 Minute Reports Each Class
- Attendance
- Homework (Only 9)
- No cell phones or laptops
- A lot of work
Wordle from Comments Last Year:

time
thought
good
fun
process
end
well
future
expect
learn
build
working
really
team
met
expected
work
learned
much
work
like
feel
aerospace
Space
Sat
ram
workload
rewarding
put
mission
Gateway
better
exactly
took
know
learning
amount
projects
enjoy
things
now
completely
getting
knowledge
honestly
expecting
far
opportunity
mostly
take
idea
school
simply
life
entire
world
"
Syllabus
Syllabus:

14 - Lecture
07 - Guest
11 - Teams
04 - Extra
08 - Attention
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture and Activity</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>74</td>
<td>Class Introduction and Pictures (So starts the rollercoaster)</td>
<td>HW 01 Assigned, HW 08 Assigned</td>
</tr>
<tr>
<td>93</td>
<td>72</td>
<td><strong>Guest Lecture – “Solar System Exploration Missions”</strong></td>
<td>HW 02 Assigned</td>
</tr>
<tr>
<td>88</td>
<td>67</td>
<td>Spacecraft Overview – Part I</td>
<td></td>
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<tr>
<td>86</td>
<td>65</td>
<td>Spacecraft Overview – Part II &amp; BalloonSat Overview</td>
<td>HW 01 &amp; HW 02 DUE</td>
</tr>
<tr>
<td>81</td>
<td>60</td>
<td>BalloonSat Hardware – Cameras, Hobos, Foam Core, Heaters, Insulation, sensors and Arduino</td>
<td>HW 03 Assigned (? 1 - 2)</td>
</tr>
<tr>
<td>79</td>
<td>58</td>
<td>HANDS-ON: Team Forming &amp; Team Activity</td>
<td>HW 03 Assigned (? 3 - 10)</td>
</tr>
<tr>
<td>74</td>
<td>53</td>
<td>Request for Proposals - <em>Overview of Mission Statements, Functional Block Diagrams, Requirements Flow Down Process, Design Documents</em></td>
<td>PROPOSAL Assigned (14 days)</td>
</tr>
<tr>
<td>72</td>
<td>51</td>
<td>HANDS-ON: Soldering 101 (Build and Blink)</td>
<td>HW 03 DUE (ALL ?s), HW 04 Assigned</td>
</tr>
<tr>
<td>67</td>
<td>46</td>
<td>HANDS-ON: Arduino – Part I (Type and Blink) &gt; Multiple, Button, Fade, and Potentiometers</td>
<td>Passwords today</td>
</tr>
<tr>
<td>65</td>
<td>44</td>
<td>HANDS-ON: Arduino – Part II (Sensors) &gt; Temperature, Pressure, Accelerometers, and Shields</td>
<td>HW 04 DUE, HW 05 Assigned</td>
</tr>
<tr>
<td>60</td>
<td>39</td>
<td>HANDS-ON: Arduino – Part III (Memory) &gt; SD Cards and Samples</td>
<td>PROPOSALS DUE 12:00 PM, HW 06 Assigned</td>
</tr>
<tr>
<td>58</td>
<td>37</td>
<td>REVIEWS: Conceptual Design Review (CoDR)</td>
<td>Presentations DUE 7:00 AM, DD Rev A/B Assigned</td>
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<tr>
<td>#</td>
<td>Topic</td>
<td>Due Date/Notes</td>
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<tr>
<td>53</td>
<td>Presentation and Proposal Feedback</td>
<td>HW 05 DUE</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Rocket History</td>
<td>HW 06 DUE at appointments HW 07 Assigned</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Launch Vehicles</td>
<td></td>
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<tr>
<td>39</td>
<td>Gateway to Space Movie Night – Food provided (RSVP required)</td>
<td>ITLL 1B50 6:00 PM</td>
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<tr>
<td>44</td>
<td>Guest Lecture – “Systems Engineering”</td>
<td>HW 07 DUE</td>
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<tr>
<td>37</td>
<td>REVIEWS: pre-Critical Design Review (pCDR)</td>
<td>ALL DD Rev A/B and CDR Presentations DUE 7:00 AM</td>
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</tr>
<tr>
<td>32</td>
<td>Guest Lecture – “Spacecraft Propulsion”</td>
<td>DD Rev C Assigned</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Orbits and Mission Design – Part I</td>
<td>MID-Semester Team Evaluations Assigned</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Orbits and Mission Design – Part II</td>
<td>Mid Semester Team Evals DUE</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Guest Lecture – “Spacecraft Attitude Determination and Control”</td>
<td></td>
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<tr>
<td>23</td>
<td>Guest Lecture – “Spacecraft Structures”</td>
<td>HW 08 DUE FRI @ 4:00 PM</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>DEMO - In-Class Mission Simulation Test</td>
<td>DD Rev C DUE 8:00 AM DD Rev D Assigned</td>
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<td></td>
<td>- Payload will run for 30 minutes and data will be retrieved in class</td>
<td></td>
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<tr>
<td></td>
<td>Team Hours with Chris (Optional)</td>
<td>ITLL 1B50 5 – 8 PM</td>
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<tr>
<td>Date</td>
<td>Event</td>
<td>Details</td>
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<td>-------------------------------------------------------------------------------------------</td>
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<tr>
<td>11-09</td>
<td>Fall Break – NO CLASSES – Fall Break</td>
<td></td>
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<tr>
<td>04</td>
<td>REVERSES: Launch Readiness Review (LRR)</td>
<td>LLR Presentations due 7:00 AM</td>
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</tr>
<tr>
<td>02</td>
<td>Launch Logistics</td>
<td></td>
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<tr>
<td>01</td>
<td>Final BalloonSat Weigh-in and TURN IN</td>
<td>Chris' Office by 2:00 PM</td>
<td></td>
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<td>*By appointment 8:00 AM to 1:00 PM</td>
<td>DLC 270A &amp; LRR Cards DUE</td>
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<td>00</td>
<td>Launch Day @ 6:50 AM @ Windsor, Colorado</td>
<td>Bad Weather Dates</td>
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<td></td>
<td><em>(Leave Boulder at 4:45 AM!)</em></td>
<td><em>(12/02, 12/08, or 11/09)</em></td>
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<tr>
<td>+3</td>
<td>Guest Lecture – <em>“Spacecraft Power” and Career Advice</em> + Launch Recap and Report and Data Analysis Guidance</td>
<td>Bring Your Raw Flight Data</td>
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</tr>
<tr>
<td>+5</td>
<td>Guest Lecture – <em>“The Future of Space Exploration”</em></td>
<td></td>
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</tr>
<tr>
<td>+7</td>
<td>ITLL Design Expo (9:00 AM – 4:00 PM)</td>
<td>DD Rev D DUE @ Judging Team Videos DUE @ Judging</td>
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<tr>
<td></td>
<td><em>Open to the general public from 12:30 to 3:00 PM</em></td>
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<tr>
<td>+10</td>
<td>Space Grant Opportunities and Class Survey</td>
<td>DD Rev D DUE @ 8:00 AM</td>
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<td></td>
<td></td>
<td>All DATA DUE in class</td>
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<tr>
<td></td>
<td>Final Presentations and Reports = 6:00 – 9:00 PM</td>
<td>Presentations DUE @ 3:00 PM</td>
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<td></td>
<td><em>(In place of Final Exam scheduled on 12-17-12)</em></td>
<td>Bring all hardware</td>
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<tr>
<td>+12</td>
<td>Final Class – Review and Discussion + Final Team Evaluations</td>
<td>HW 09 DUE</td>
<td></td>
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</table>
How to get an A?
How to get an A:

“Everyone starts out with an A”

You have to try really hard to get anything lower than C-

Not in the business of giving bad grades…

…But you get the grade you earn

Please, Please, Don’t Cheat
How to get an A:

Grades are based on a normal 100 point scale

There is no curve

Team project and participation are based on your team evaluation and instructor evaluation

Feedback may be slow

Grader – Katie Brissenden
Fall 2009
How to get an A:

Grade Breakdown

- 40% Coursework
  - Attendance (33)
  - 1 Minute Reports (~30)
  - Homework (1-7,9)
  - Community service (1)

- 05% Homework 8

- 10% Team Proposal
- 08% Team Presentations (3)
- 7.5% Team Design Document (2 Revs)
- 13% Team Project and Participation
- 16.5% Final Team Report & Presentation

45% You 55% Team
Community Service:

- Everyone must do a community service activity

- Something you are not doing for any other class

- Preferred if it is related to this class, your college major, or your interest in space

- Community service must be completed before last day of class

- Form is on the class website and must be approved before completed
Community Service:

Community Service Approval (must be completed and signed before activity)
Description of planned activity:

Proposed date and location of activity:

Approved by _______________ on _______________

(Chris Koehler)
Community Service Completion
Description of how the actual activity went:

Actual date ___________ and location ______________________ of activity:

Number of those affected through your activity? _______________________________

Name of Point of Contact of the activity: _________________________________

Point of Contact signature: _________________________________

Point of Contact email and/or phone number: _______________________________ 

Signature of student performing the activity: _________________________________

Picture from actual activity attached to this form? ___________________________
Miscellaneous:

- Attendance will be taken (Signing for friends)

- Coming in late…

- Communications via email and this class

- Travel and sick policy
Guest Speakers
Guest Speakers:

- Be attentive and present

- Applaud

- Thank you letters

- Ask questions – I will try to keep track who asks questions and could help your participation grade
Miscellaneous:

- **Mutual Respect** “Shut up and be quiet”

- **Office hours** 10:45-11:45 T & Th or by appointment

- **Where to Find Me…** DLC 270A

- **Notes** – Take them

- **Book(s) for course**
The Book
Miscellaneous:

Book(s) for course

- Typical engineering book cost $100, $90, $80, $70

This Book…

- $13.95

- Rocket Boys
  Homer Hickam

Also…Set aside $25 for batteries and dry ice
Miscellaneous:

Book(s) for course

This Book...
- $11.66
- Moondust – In search of the men who fell to Earth
  Andrew Smith

Also...Set aside $25 for batteries
1 Minute Reports:

- Everyone has a unique number

- Use your uniquely numbered sheet each class

- Turn in at end of class

- Must be this format and not your own “I forget my forms” paper

- I read each of them

- Great feedback as the class goes forward
1 Minute Report:

Name:
Date:
Lecture Title:

1. Key points of today's lecture?

2. What wasn't clear and/or what questions do you wish you had asked?

3. What personal contributions have you made to your team this week?

4. What grade would you give today's lecture?

5. Other comments, concerns, or suggestions?
Homework
Homework:

Submit via email

- Subject should be in this format
  “HW XX Lastname Firstinitial”

- Send all items to Prof.Koehler@gmail.com

- Get from Website

First Homework is…
Gateway To Space
ASEN 1400 & ASTR 2500
Fall 2012

Syllabus
Presentations
Homework
Grades
Teams
Files
Media
Suggestion Box
Links
email Instructor
Class Email List

HOME

Taught as part of the Colorado Space Grant student experience and funded by the Department of aerospace Engineering Sciences at the University of Colorado at Boulder.

Site last updated on 08/27/2012 04:32 PM
Questions?
Introductions
Who is this Guy?
Who is this Guy?
What Experience Do You Have?

Intern at Ball
summer of 1991

Worked with
Bob Poley

Worked on
RADARSAT
Who is this Guy?

Graduated from CU in December 1992 with B.S. in Aerospace Engineering

Graduated from CU in December 1994 with M.S. in Mechanical Engineering
What Did You Do After College?

Worked at Lockheed Martin from March 1995 until May 2000
What Did You Do At Martin?

- Classified satellite
- 1,000 people on program
- Youngest
- Reaction Control System
- Mechanical Design Lead
- Design done in IDEAS
- Released over 100 engineering drawings

- Supervised manufacture, assembly, integration and test for 5 satellite builds
- Last two years, Mechanical Design Lead for the Antenna systems
What Did You Do At Martin?

- Also worked on Stardust and Genesis

- Worked with many different disciplines and people
Why Did You Leave?

- Many reasons

1. Coming back here was a great opportunity

2. Pictures on the wall

3. Mentor

4. Change
Why Did You Leave?
- Many reasons
  1. Coming back here was a great opportunity
  2. Pictures on the wall
  3. Mentor
  4. Change
Why Did You Leave?

- Many reasons
  - Coming back here was a great opportunity
  - Pictures on the wall
  - Mentor
  - Change
Why Did You Leave?
- Many reasons
  1. Coming back here was a great opportunity
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  3. Mentor
  4. Change
Why Did You Leave?

- Many reasons
  1. Coming back here was a great opportunity
  2. Pictures on the wall
  3. Mentor
  4. Change
Students Statewide:
Vision:

Providing a diverse group of Colorado students with experiences in space to prepare them for our Nation’s future space programs

COSGC = Workforce Development
Weaknesses:
RocketSat IV:
- Highest greenhouse gas measurement
- The tubing is vacated at apogee
- Air is forced into the tube, compresses, and remains in the order that it was sampled
- Sample is analyzed using laser analyzer after the flight
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?
Who is this Guy?

I love to laugh
Who is this Guy?

I do crazy things
Who is this Guy?

I love to read
Who is this Guy?

I love to write
Who is this Guy?

I love to play video games
Who is this Guy?

I love to make videos

New Videos from Waiting Children

Hear in their own words who they are and what sort of family they would like to be a part of.

Colorado Missouri

The Adoption Exchange
Connecting Children and Families Since 1983

DONATE NOW

About Us
Children & Families
Wednesday's Child
Education
Get Involved

Name: Justin
Location: CO
Profile: Have you heard the one about...? Justin will enjoy telling you his latest joke! This young m...

High Speed

Name: Kristeena
Location: CO
Profile: This extremely likeable and friendly girl will bring a brightness to your home! An artist in the...
Who is this Guy?

I love to play guitar
Who is this Guy?

I love space

- 10 large satellites
- 6 small satellites
- 100 rocket payloads
- 1014 BalloonSats
Who is this Guy?

42 My age
28* The age I feel
6 Hours I get to sleep a night
42 Hours I get to sleep a week
50 Average number hours I work a week
7 Hours per week I am paid to teach this course
16 Average hours per week I actually spend on class
16 Times I have taught this course
134 Emails I get each day
30 Emails I respond to each day
1 Me
66 You
So why are you here?
Why You Are Here:

- You want to get a good job after college
- Good School
- Good Grades
- Good Experience

- This course and Space Grant gets you all three
- Unique point in your life
Space in Colorado:

- 142,500 Coloradoans
- Expected to double in the next few years
- “Graying of the workforce”
Final Word

You’ll Never...
Space Grant
Open House
August 30, 2012
5:30 PM
DLC 1B70
Next Time:

- Jim Paradise

- “The Future of Space Exploration”
Pictures?