Introduction to our Graduate Course in Dynamics

Course Culture

- Be Curious
  - Ask Questions
  - Answer Questions
- Make Connections
  - Connect to real world
  - Connect to your job/research
  - Connect to other courses
- Build Community
  - Share information
  - Share skills

Course Culture – some random thoughts

- I would like to focus on
  - Curiosity
    - Ask questions
    - Try to answer questions
    - Knowledge is gained by the above
      - Teaching and Research are the two other ways to gain knowledge
  - Connection
    - Try to connect what you learn to EVERYTHING else in your life
      - Your other courses
      - Your jobs/research
      - Day to day activities and observations
      - Things on the news and your interests
    - Connect also with people
      - How they learn
      - What are their interests and why
      - What are their skillset – how can you gain the skillset
  - Community
    - We have broadly similar technical backgrounds
      - But we can have a range of backgrounds, experiences, interests, skillset, knowledge base
    - We can and should help each other – helping is growing
    - Building a network is important for your professional and personal life
    - Unrelated: Quals – lets plan to meet weekly/biweekly for Dynamics/ASD/Qual chat/discussion/practice

Connecting with our Community

- Please watch movie: Gravity
  - Shared experience and discussion
  - Suggest other movies relevant for Dynamics
- Please bring to class any events, news stories, especially from around the world that are relevant to Dynamics/Aerospace
- Please bring to class any interesting happenings in your professional life
- Please bring to class any interesting cultural happenings in your life
- I want to try and set aside time every class for us to chat
- My lectures do get tedious over time and the assignments do get very detailed
  - I want to make sure you do not loose the forest for the trees

What is Dynamics? Why is it Important?

- What:
  - Moving things – bodies, parts, vehicles, people within vehicles, mechanisms, satellites, celestial bodies
  - Things are a function of time! F = ma = Ldot!! Eqs of Motion

- Why
  - Dynamics helps predict how things move
  - Then we can make sure our design does what we want it to do
    - Travel from ATL to BOM
    - Launch satellite into LEO
    - Put JWST in L2
  - Dynamics can also help us calculate loads – stresses – failure
  - Dynamics helps us calculate requirements from actuators – all the way from actuating control surfaces to thrust requirements etc

How do we Analyze Dynamics Problems?

- Find or derive Equations of Motion
  - Ordinary Differential Equations (at least for RBD)
    - Initial conditions
    - Solution/Simulation of Diff Eqs
      - Analytical solutions can be difficult, simulation is typically trivial for a majority of case(and most of the cases in this course) (MATLAB ODE45)
    - Two ways we use EoM ODEs
      - Simulation (given initial condition and forcing as a function of time, calculate the solution/trajectory etc)
      - Given the required trajectory, calculate the required forcing

How would we use the Analysis?

- To figure out where to and where we can put a satellite
- Come up with budgets for vehicle/component size, weight, power
  - To size and place actuators/control surfaces
- To check if the redesign meets the design criteria better
- Analysis -> Optimization