Spring 2024
AE 6220: Rotorcraft Structural Dynamics and Aeroelasticity
School of Aerospace Engineering, Georgia Institute of Technology
Atlanta Campus and Distance Learning

COURSE GOALS
To introduce students to the fundamentals of rotorcraft structural dynamics and aeroelasticity. To provide the necessary background for students to perform research and analysis in the field of vertical lift.

RECOMMENDED TEXTS
These texts are recommended, but not required:

- Bielawa, Richard L., *Rotary Wing Structural Dynamics and Aeroelasticity*, 2nd edition, AIAA, Reston, VA, 2006.
- Johnson, Wayne, *Helicopter Theory*, Princeton University Press, Princeton, NJ 1980 (Note: A more cost-effective copy is available through Dover Publications, 1994)
- Johnson, Wayne, *Rotorcraft Aeromechanics*, Cambridge University Press, NY NY, 2013.
- Hodges, Dewey and Pierce, Al,

INSTRUCTOR Dr. Marilyn J. Smith, (404) 894-3065
Office Hours: TBD. Plus, telecons through appointment via email; will be set up using schedules from both professor and student
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GRADING		
	Individual Home Assignments	70%
	Midterm	30%
	Optional Final (Replaces 30% of lowest grade)	

There will be the opportunity to rework the midterm and *some* assignments for extra credit. Additional extra credit may be offered to ensure that students have mastered various concepts introduced in the course. The professor reserves the right to have homework, projects, or other graded material other than a quiz due during the final class instruction days at the end of the semester.

All grades are final. Unless an error has been made in grading the quiz/assignment, no additional partial credit will be given.

Students are guaranteed the published grade based on the following system*:
A: 90 – 100%; B: 80 – 89%; C: 70 – 79%; D: 60 – 69%; F: 59 and below.
*The professor reserves the right to increase margins beyond the 10 percentage points

HONOR CODE

All assignments submitted for a grade should be the student's own work. There will be examples provided and opportunities in office hours to ask questions of the professor to help the students master the material. Copying from another student, working together, or using a service such as Chegg on an individual assignment is a violation of the GT Honor Code, and violators will be reported to the Office of Student Integrity. If an assignment requires that a code be written, that code should be the work of the student and not from any other source, including but not limited to the internet, open source githubs, or from any individual or group. While one might find pdf copies of the various recommended textbooks on line, these websites are illegal and constitute violation of US copyright laws, which can be prosecuted by the author or publisher. Downloading or using these illegal websites is also a violation of the GT Honor Code, and students will be reported to the Office of Student Integrity. In other words – don't do it! Don't risk your career for a few points or saving a few dollars. If you are not sure if something might contravene the honor code – ask before you use it! If you have technical or fiscal issues, talk to the professor.

For any questions involving these or any other Academic Honor Code issues, please consult the professor or www.honor.gatech.edu.

LEARNING ACCOMMODATIONS

If needed, classroom accommodations for students with documented disabilities will be made. These accommodations must be arranged in advance and in accordance with the ADAPTS office (http://www.adapts.gatech.edu).

HEALTH AND WELL-BEING

Georgia Tech and the School of Aerospace Engineering understand that many students experience stress through a variety of academic, financial and personal experiences. We value you and want to make you aware of resources available to you should you need them. Your well-being and mental health are important, and we are here for you.
Center for Assessment, Referral and Education (CARE) https://care.gatech.edu/
Campus Police (any emergency): 404-894-2500 http://www.police.gatech.edu/
Counseling Center: 404-894-2575 https://counseling.gatech.edu/
Dean of Students Office: 404- 894-6367 https://studentlife.gatech.edu/
Georgia Crisis and Access Line: 800-715-4225 Crisis Text Line: Text HOME to 741741
National Suicide Prevention Lifeline: 800-273-TALK (8255) https://suicidepreventionlifeline.org/
VOICE: Victims Survivor Support: (404) 385-4464 (or 4451)
http://healthinitiatives.gatech.edu/well-being/voice
Stamps Health Services https://health.gatech.edu/contact

Course Outline

Note: The professor reserves the right to change the order and depth of the topics

In addition, 1.5 hours is reserved for the midterm

1. Introduction – 3 hours
    a. The role of dynamics and aeroelasticity in modern rotorcraft aeromechanics
    b. Approaches and review of methods
2. Rotating Blade Structural Dynamics and Stability – 8 hours
    a. Review of dynamics of rotating bodies
    b. Rigid blade flapping in hover
    c. Rigid blade flap-lag analysis in vacuo
    d. Calculation of shear forces and bending moments
    e. Review of the concept of stability
    f. Derivation of flap-lag aerodynamic generalized forces
    g. Analysis of flap-lag stability
3. Introduction of the analysis of rotating elastic blades – 8 hours
    a. Theory and concepts
    b. Modal analysis, including Rayleigh-Ritz & Galerkin methods
    c. Finite element method
4. Aeromechanic Concepts for Aeroelasticity – 9 hours
    a. Classic aerodynamic methods: Theodorsen, Indicial, Lifting-Line
    b. Dynamic inflow in hover and forward Flight
    c. Floquet theory
    d. Harmonic balance and trim procedures
5. Rotor aeroelastic analysis – 8.5 hours
    a. Review of the theory of finite rotations in nonlinear kinematics
    b. Derivation of elastic blade equations in vacuo for planar bending
    c. Dynamic stall
    d. Blade vortex interactions
    e. Modern solution approaches: Comprehensive codes vs CFD/CSD coupling
6. Advanced Rotorcraft Configurations – 7 hours
    a. Coordinate transformations for multi-rotor systems
    b. Ground resonance
    c. Whirl Flutter
    d. Advanced Topics (as time permits)

Georgia Tech School of Aerospace Engineering Values

Discussion Points

1. **Honesty:** The School of Aerospace Engineering values honesty and integrity of all members of our community. An important element of this value is the academic honor code.

   Georgia Tech Honor Challenge Statement: I commit to uphold the ideals of honor and integrity by refusing to betray the trust bestowed upon me as a member of the Georgia Tech community.

   Honor Code: http://policylibrary.gatech.edu/student-affairs/academic-honor-code#Article_I:Honor_Agreement

2. **Well Being:** The School of Aerospace Engineering values the complete well-being of all members of its community, which includes professional, physical, spiritual, emotional, and social dimensions. There are numerous resources to support the health and well-being of all members of our community: https://gatech.instructure.com/courses/108574

   Mental Health Resources:
   Emergencies: Can either Call 911 or call Campus Police at 404.894.2500 http://www.police.gatech.edu/
   Center for Assessment, Referral, & Ed. (CARE): https://care.gatech.edu/ 404.894.3498 (Counselor On-Call)
   Counseling Center: https://counseling.gatech.edu/ 404.894.2575
   Stamps Health Services: https://health.gatech.edu/ 404.894.1420
   Student Life and Dean of Students: https://studentlife.gatech.edu/content/get-help-now 404.894.6367
   Victim-Survivor Support (VOICE): https://healthinitiatives.gatech.edu/well-being/voice 404-385-4464/(or 4451)
   National Suicide Prevention Lifeline: 1.800.273.TALK (8255)
   Georgia Crisis and Access Line: 1.800.715.4225

   COVID-19 Safety: Vaccinate, Mask, Test
   GT Safety Guidelines: https://health.gatech.edu/tech-moving-forward
   Current guidance is summarized below, but continue to follow the site above and other Institute communications in case changes occur:

- If there is one thing each one of us can do to protect ourselves and keep others safe, it is to get vaccinated. The new vaccines have proven to be extraordinarily effective at preventing severe illness. Getting vaccinated at Georgia Tech easy and free.
- At Georgia Tech, everyone is encouraged to wear a mask or face covering while inside campus facilities.
- The free asymptomatic surveillance testing program remains available to all students and employees. You may participate in regular testing even if you have been fully vaccinated. We especially encourage those who have not been vaccinated to get tested weekly.

3. **Social Justice:** The School of Aerospace Engineering values social justice for all members of the Georgia Tech community and the larger society. Social justice means that everyone's human rights are respected and protected. We stand committed in the fight against racism, discrimination, racial bias, and racial injustice. Our shared vision is one of social justice, opportunity, community, and equity. We believe that the diversity and contributions from all of our members are essential and make us who we are. We believe that our impact must reach beyond the classroom, research labs, our campus, and the technology we create, but must also improve the human condition where injustice lives. We will continue to work to understand, value, and celebrate all people and create an inclusive educational and work environment that welcomes all.

   As a matter of policy, Georgia Tech is committed to equal opportunity, a culture of inclusion, and an environment free from discrimination and harassment in its educational programs and employment. Georgia Tech prohibits discrimination, including discriminatory harassment, on the basis of race, ethnicity, ancestry, color, religion, sex (including pregnancy), sexual orientation, gender identity, national origin, age, disability, genetics, or veteran status in its programs, activities, employment, and admissions.

   http://policylibrary.gatech.edu/equal-opportunity-nondiscrimination-and-anti-harassment-policy