Inhomogeneous Turbulence

A Spring 2022 Special Topic Class for Students Who Want to Predict Chaotic Flows
EGM6934, Class 19096, 3 Credits,
Tuesday 5-6 (11:45 AM - 1:40 PM) & Thursday 6 (12:50 PM - 1:40 PM),
Building MAE-A 327

"Big whorls have little whorls
which feed on their velocity
and little whorls have lesser whorls
and so on to viscosity"
~Lewis Fry Richardson, 1922
(play on Augustus de Morgan's famous paraphrasing of Jonathan Swift)

Professor

Assistant Professor S. A. E. Miller, Ph.D.
University of Florida Department of Mechanical and Aerospace Engineering
MAE-A 220, Gainesville, FL 32611, PO Box 116250
Contact preference - https://ufl.instructure.com
Zoom – https://ufl.zoom.us/my/saemiller - used on occasion for misc. online interactions

Q&A and Office Hours

Thursday at 11:45 – 12:40 PM or by confirmed written appointment.

Teaching Assistants

None.

Course Objectives

A class that covers in depth concepts of the science and mathematics of turbulence modeling with a historical perspective. Examples are given as much as possible involving contemporary approaches. Statistical quantities, averages, correlations, coherence, the Russian school, law of the wall, chaos, compressible NSE, averaging relations, mean kinetic energy, Re stress transport eqn., boundary layer equations, two-dimensional in laminar and turbulent flows, mixing length concepts, Baldwin-Lomax, Cebeci-Smith, 1/2-equations, one-equation models, Prandtl's model, Spalart-Allmarus, k-ω and k-ε, Boussinesq, nonlinear relations, stress transport models, closure, applications and examples, physical considerations, Morkovin hypothesis, studies in particular flows. These topics will be related to turbulent flows that are observed in our daily lives and within various fields of engineering.

Course Description

Course catalogue, "Special Topics in Engineering Mechanics," (Credits 3).

Course Pre-Requisites / Co-Requisites

Graduate class in fluid dynamics and/or turbulence, or permission of the instructor. Some programming knowledge.

Recommended Textbooks and/or Software

Various handout material provided digitally by professor. A scientific calculator is highly recommended. An open source compiler such as C (gcc) or Fortran (gfortran) are required and freely available online.

Supplemental Materials

- Various handout material provided by professor.

Materials, Software, and Supplies

None.

Important Dates
- All deadlines and important dates are introduced in class or through the class website.

Attendance Policy
- Attendance is required and lack of attendance on a regular basis as judged by the professor will result in failure.
- Required statement by the University of Florida: Excused absences are consistent with university policies in the undergraduate catalog and require appropriate documentation. (https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies)

Policy on Deadlines
- Late submission of class material is not accepted. Students are responsible for turning in assignments on time.
- Do not email or contact the professor with explanations for missed deadlines, late work, etc.
- If a tragedy has occurred then instructor notifications are required. See https://care.dso.ufl.edu/instructor-notifications for details. Note that, "Professors have the right to accept or reject the notification."

Policy on Ethics and Cheating
- Any kind of cheating, lying, dishonesty, or any other honor code violation results in a failing grade for the entire course. Violations are reported without student notification per university policy.

Evaluation of Grades and Grading Policy

Course Grade Evaluation Criteria
- A four-part computer programming project will result in a stand-alone marching boundary layer solver. Submissions consist of a short description, results, and source code for each part. The computer projects must be completed or a failing grade will be assigned.
- A short term paper on the order of five pages and on a subject of the students choosing will be written. It will consist of three parts: abstract, outline, and final paper. The details of the assignment, format, and deadline(s) are posted on the class website. The paper must be of AIAA Journal submission quality. The term paper must be submitted or a failing grade will be assigned.
- At the end of the semester each student will present their term paper in the form of a presentation that lasts approximately ten to the class. The presentation must be presented or a failing grade will be assigned.
- Students are expected to attend class and actively participate.
- Weighting of grades (total 1.00)
  - Attendance 0.15
  - Class Participation 0.05
  - Computer Project 0.40
  - Presentation 0.15
  - Term paper 0.25
- The final grade will be assigned via the straight scale:
  - 4.00 (A) $\rightarrow$ [93.33, 100.00],
  - 3.67 (A-) $\rightarrow$ [90.00 to 93.33),
  - 3.33 (B+) $\rightarrow$ [86.67 to 90.00),
  - 3.00 (B) $\rightarrow$ [83.33 to 86.67),
  - 2.67 (B-) $\rightarrow$ [80.00 to 83.33),
  - 2.33 (C+) $\rightarrow$ [76.67 to 80.00),
  - 2.00 (C) $\rightarrow$ [73.33 to 76.67),

- o 1.67 (C-) $\rightarrow$ [70.00 to 73.33),
- o 1.33 (D+) $\rightarrow$ [66.67 to 70.00),
- o 1.00 (D) $\rightarrow$ [63.33 to 66.67),
- o 0.67 (D-) $\rightarrow$ [60.00 to 63.33), and
- o 0.00 (E) $\rightarrow$ [00.00 to 60.00).
- Final grades are rounded to the nearest hundredths place before assignment.
- The final course grades may be curved at the discretion of the professor.
- Students who are active throughout the course, interact regularly, continually ask excellent questions, turn their work in on time, may receive significant letter grade increases at the end of the course at the discretion of the professor.

<u>Grade Corrections</u>

Corrections of grades must be submitted promptly within 3 business days after grade posting. A statement in writing on why there has been an error must be submitted through Canvas.

<u>Required Information by the University, College, and Department</u>

Attendance
Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Grading
More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
· Your academic advisor or Graduate Program Coordinator
· Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
· Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
· Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

> **U Matter, We Care:**
> Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.
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> **Counseling and Wellness Center:** https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.
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> **Sexual Discrimination, Harassment, Assault, or Violence**
> If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu
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> **Sexual Assault Recovery Services (SARS)**
> Student Health Care Center, 392-1161.
>
> **University Police Department** at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

> **E-learning technical suppor***t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.
>
> **Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.
>
> **Library Support**, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.
>
> **Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.
>
> **Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.
>
> **Student Complaints Campus***: https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.
>
> **On-Line Students Complaints***: http://www.distance.ufl.edu/student-complaint-process.