CLIMATE/SPACE/EARTH 321:
Earth Systems Dynamics

Tuesday, Thursday 12:00 to 1:20pm
Location – In Person: *CSRB 2246*
Instructor: *Dr. Claire Pettersen*
Email: *pettersc@umich.edu*
Office: *CSRB 2543A*
Class Website on Canvas:
https://umich.instructure.com/courses/660594
Class Website on Piazza:
https://piazza.com/umich/winter2024/climate321001wn2024/home

Instructor office hours:

Synchronous:	**In Conference Room (CSRB 2525)**	
	Mondays 3:00 to 4:00pm	(Dr. Pettersen)
	Tuesdays 1:30 to 2:30pm	(IA: Nick Dewhirst)
	Thursdays 3:30 to 5:00pm	(IA: Nick Dewhirst)
Asynchronous:	Piazza, Monday - Friday	

Course Information

Catalog description: Introduction to theory of fluid motions for atmosphere and ocean. Elementary kinematics, fundamental forces, effects of earth's gravity and rotation, concepts and applications of hydrostatic and geostrophic balance.
Credits: 3
Prerequisites: MATH 115, MATH 116
Advisory Prerequisites: CLIM / SPACE 320, MATH 215, MATH 216 (*simultaneous*)
Please consult with the Instructor if these prerequisites are not met

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Apply basic vector mathematics and understand how it is applied to geophysical fluid flows
- Derive and physically interpret the equations of motion
- Recognize and describe the fundamental principles associated with the dynamics of geophysical fluid flows
- Apply multiple coordinate systems and understand their usefulness

- Utilize diagnostic tools to diagnose, describe, and interpret the fundamental dynamical processes at work in large-scale circulations

Course Details

Instructional Modality: In person, synchronous
Meeting time: T TH 12:00pm – 1:20pm Eastern Time Zone
Location: CSRB 2246
Canvas Course URL: https://umich.instructure.com/courses/660594

Required Textbooks/Chapters:

Title: Mid-Latitude Atmospheric Dynamics: A First Course
Chapters 1, 2, 3, and 4
Author: Jonathan E. Martin
ISBN: 978-0-470-86465-4

Title: An Introduction to Dynamic Meteorology
Chapters 1, 2, and 3
Authors: James R. Holton and Gregory J. Hakim
ISBN: 978-0-12-384866-6

Recommended Textbooks/Chapters:

Title: Atmosphere, Ocean, and Climate Dynamics
Authors: John Marshall and R. Alan Plumb
ISBN: 978-0-12-558691-7

Title: Atmospheric Science an Introductory Survey, 2nd Edition
Chapters 7 and 8
Authors: John M. Wallace and Peter V. Hobbs
ISBN: 0127329501

(Books and chapters are provided on Canvas under **Library Tools**)

Class Discussion: This term we will be additionally be using Piazza for online class discussion (please see Participation Expectations below). The system is highly catered to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to the teaching staff, you should post your homework or topic questions on Piazza. I will be active on Piazza Monday through Friday, but only student feedback should be expected on weekends. If you have any problems or feedback for the developers, email team@piazza.com.

If you are not yet signed up, please sign up here:
https://piazza.com/umich/winter2024/climate321001wn2024

Tentative Schedule

This schedule is approximate and will possibly change during the semester. Updates will be reflected on Canvas.

Week	Lectures	Topics	Reading	Assignments
1	Jan 11	Course Logistics Introduction		
2	Jan 16, 18	Review of Vector Calculus Tools	Martin Ch 1.1 – 1.2.1	HW #1
3	Jan 23, 25	Review of Vector Calculus Tools Frameworks	Martin Ch 1.1 – 1.2.1 Martin Ch 1.2.2, 1.2.4	HW #2
4	Jan 30, Feb 1*	Kinematics Forces: Fundamental and Apparent	Martin Ch 1.4 – 1.5 Holton / Hakim Ch 1.5 Martin Ch 2 Holton / Hakim Ch 1.1 – 1.3	HW #3
5	Feb 6, 8	Forces: Fundamental and Apparent	Martin Ch 2 Holton / Hakim Ch 1.1 – 1.3	
6	Feb 13, 15	Forces: Fundamental and Apparent ***Exam Review***	Martin Ch 2 Holton / Hakim Ch 1.1 – 1.3	**Exam 1**
7	Feb 20, 22	Hydrostatic Balance Hypsometric Equation	Martin Ch 3.1 Holton / Hakim Ch 1.4.1	HW #4
Winter Break				
8	Mar 5, 7	Equations of Motion	Martin Ch 3.2 – 3.2.1 Holton / Hakim Ch 2.1 – 2.3	HW #5
9	Mar 12, 14	Scale Analysis Geostrophic Balance	Martin Ch 1.3 Holton / Hakim Ch 1.6, 2.4 Holton / Hakim Ch 2.4.1	HW #6
10	Mar 19, 21	Geostrophic Balance Ageostrophic Wind	Holton / Hakim Ch 2.4.1 – 2.4.3	
11	Mar 26, 28	Ageostrophic Wind ***Exam Review***		**Exam 2**

12	Apr 2, 4	Conservation of Mass Conservation of Energy	Martin 3.2.2 Holton / Hakim Ch 2.7 – 2.7.3	HW #7
13	Apr 9, 11	Potential Temperature Static Stability	Martin Ch 3.3 Holton / Hakim Ch 2.7 – 2.7.3	HW #8
14	Apr 16, 18	Pressure Coordinates Thermal Wind	Martin Ch 4.1 Holton / Hakim Ch 2.4.2 – 2.4.3, 3.1 Martin Ch 4.3 Holton / Hakim Ch 3.4	HW #9
15	Apr 23	Vertical Motions ***Exam Review***	Holton / Hakim Ch 3.5	
Finals Week	Apr 26			**Exam #3**

***** *The dates indicated with an Asterix will have a guest lecturer or recording* ***

GRADING

Exams 1, 2, 3 (12% each)	36%
Homeworks	50%
Class Participation	14%

The following grading scale will be used:

A : [93.3 – 100]
A- : [90.0 - 93.3)
B+ : [86.7 - 90.0)
B : [83.3 - 86.7)
B-: [80.0 - 83.3)
C+: [76.7 - 80.0)
C : [73.3 - 76.7)
C-: [70.0 - 73.3)
D: [60.0 - 70.0)
F: <60

Weekly Time Management

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
CLIMATE/ SPACE/ EARTH 321 Weekly Overview		Lecture		Lecture			
	Office Hours	Office Hours		Office Hours			
	Required Readings, Homework, Write ups						
			Homework Posted 12pm (Week –1)	Homework Due 10pm			
	Piazza Discussions - instructor and students					Piazza Discussions - students	

Exams (36%)

- All exams will be done in class. No working together.
- Exams 1, 2, and 3 will not be cumulative – they will only encompass the topics reviewed between exams. This includes Exam 3, which will be given during the Final Exam time.

Homework (50%)

- Homework is assigned to Canvas on Wednesdays and due the following Thursdays at 10pm (+1 week).
- Questions on the homework may be on concepts presented during the same week it is due or from prior classes.
- Graded homework will be returned the following Tuesday before class.
- Homework should be submitted via Canvas (see notes on Canvas on how to submit and scan)
- **Late Homework Policy:** Homework received after the due date and time will incur a 25% reduction and homework turned in more than 72 hours after the due date will not be accepted (all grading will be done over the following weekends).
- *Please contact me (email or Canvas) if you require additional time due to unforeseen circumstances.*

Participation (14%)

Lecture:

You are expected to attend lecture in person and be alert and engaged. However, if you miss class due to circumstances beyond your control, lecture recordings and the presentations will be posted on the Canvas page. Please let me know if you are expecting a long absence from live lectures.

There will be periodic (*weekly to every other week*) in-person assigned participation exercises and quizzes. These are designed to reinforce key topics from the lectures and readings. These topics often show up on the exams. All in-person / in-class participation will be announced either in lecture or on Canvas with an assignment (due the day of the exercise) prior to the in-class exercise.

You are also encouraged to ask questions during lecture. If you have a question after lecture, please use Piazza and post your question there. I encourage you to ask any and all relevant questions – it is cliché, but there really are no bad questions when it comes to dynamics!

Piazza Forum:
The purpose of the course Piazza is for students to help each other get through difficult homework problems and understand course concepts. ***You are expected to participate in the assigned class discussions on Piazza.*** Some weeks there will be a posted participation or discussion question or topic to be answered/addressed on Piazza. These exercises are meant to help you become familiar with topics in class through the application of online tools and resources. Additionally, these Piazza posts can and will lead to further discussion on topics of particular interest in class.

University of Michigan Policies

DIVERSITY & INCLUSION STATEMENT

Diversity is a source of strength, creativity, and innovation. Our dedication to engineering for the public good is inseparable from our commitment to diversity, equity and inclusion (DEI). We lead with an equity-centered engineering mindset in how we teach, do research and support each other.

The Michigan Engineering community includes people from different races and ethnicities, gender identities, sexual orientations, ages and socio-economic backgrounds. We speak different languages, come from different cultures and countries and practice different religions. We have different abilities and disabilities, different political perspectives and life experiences. We all belong here. (Source: https://www.engin.umich.edu/culture/diversity-equity-inclusion/)

QUARANTINE OR ISOLATION DUE TO COVID-19

As they have throughout the past year and a half, policies around academic and public health are subject to change as this pandemic evolves. This course will follow all policies issued by the University, which are documented on the Campus Blueprint's FAQ (https://campusblueprint.umich.edu/faqs/). These policies may change over the course of the term, so please review the Campus Blueprint's FAQ for the most up to date information.

ACADEMIC CALENDAR & RELIGIOUS OBSERVANCES

- See: https://ro.umich.edu/sites/default/files/calendar/pdfs/Cal_2023-2024.pdf

HONOR CODE

The Honor Code outlines certain standards of ethical conduct for persons associated with the College of Engineering at the University of Michigan. The policies of the Honor Code apply to graduate and undergraduate students, faculty members, and administrators. The Honor Code is based on these tenets:

- Engineers must possess personal integrity both as students and as professionals. They must be honorable people to ensure safety, health, fairness, and the proper use of available resources in their undertakings.
- Students in the College of Engineering community are honorable and trustworthy persons.
- The students, faculty members, and administrators of the College of Engineering trust each other to uphold the principles of the Honor Code. They are jointly responsible for precautions against violations of its policies.
- It is dishonorable for students to receive credit for work that is not the result of their own efforts.

Source: https://ecas.engin.umich.edu/honor-council/honor-code/

SEXUAL AND GENDER-BASED HARASSMENT POLICY

As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. As such, I am dedicated to providing a harassment-free experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. *Sexual and/or gender-based harassment will not be tolerated in any form, including in class discussions, group work (homework and/or projects), or on social media or other online media.*

INDIVIDUAL WITH REPORTING OBLIGATIONS

It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep information that you share with me private to the greatest extent possible. However, due to my role within the University, I am considered an "Individual with Reporting Obligations (IRO)". This means that I am required to share information regarding sexual misconduct or information about a crime that may have occurred on U-M's campus with the University. The University will use this information to inform you of your rights and access to services.

Students may speak to someone confidentially by contacting the Sexual Assault and Prevention Awareness Center's (SAPAC) Crisis Line at (734) 936-3333, or using any of the other confidential resources provided on the following website: https://sexualmisconduct.umich.edu/student-resources/

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

It is the policy of the University of Michigan to maintain an academic and work environment free of discrimination and harassment for all students, faculty, and staff. The University's commitment to diversity and inclusiveness extends to students with disabilities. The University is committed to the academic success, personal development and general well-being of all students.

Source: https://registrar.engin.umich.edu/university-policy-for-students-faculty-and-staff-with-disabilities/

COURSE EVALUATIONS

Students will be provided with an opportunity to anonymously evaluate this course and your learning experience. Student participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

RECORDING OF CLASS LECTURES

Course lectures may be recorded and made available to other students in this course. As part of your participation in this course, you may be recorded. ***If you do not wish to be recorded, please contact me during the first week of class to discuss alternative arrangements.***