

Spring 2023
MECH 4316 (21644) Thermal System Design

Course Description Design, analysis, and optimization of fluid flow, heat transfer, and energy processes of ducts and piping, heat exchangers, fluid machinery, power generation, and environmental control systems. Use of computational fluid dynamics (CFD) tools to synthesize thermo-fluid system designs.
Prerequisite is MECH 4315 Heat Transfer with a grade of “D” or better.

Instructor Miguel Cedenó, Ph.D.
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3D Lockheed Martin Lab Administrator
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Office Hours Booking

Additional Tutoring and Grades Review Teaching Assistant: miners.utep.edu
Office Hours: ACES (Classroom Blvd)

Reference Textbooks No textbook is required for the course. I will be making use of the following texts in some lectures I will give during the semester.

Fundamentals of Thermal-Fluid Sciences Sixth Edition (2021)
by Yunus Cengel, John Cimbala, and Robert Turner
McGraw Hill

Fluid Mechanics: Fundamentals and Applications Fourth Edition (2018)
by Yunus Cengel and John Cimbala
McGraw Hill

Heat and Mass Transfer Sixth Edition (2020)
by Yunus Cengel and Afshin Ghajar
McGraw Hill

Course Content

1. Analytical Solutions
 - a. Heat Exchangers
 - b. Flow Over a Heated Cylinder
2. CFD
 - a. Navier-Stokes Equations
 - b. Introduction to Fluent (See attached video lecture list)

c. Introduction to StarCCM+

3. Engineering Design, Build, Test

a. Thermal Fluid Systems

Quizzes	100
Class Participation	40
Peer Evaluation	60
Projects	300
Possible Points	500

A (500-450): B (449-400): C (399-350): D (349-300): F (299 and Below)

There will be four quizzes and two projects. There will be no makeup for the quizzes.

Major Course Objective

This course is a capstone type of course in the energy systems (or thermal sciences) area. It corresponds to the mechanical design course in the Mechanical Systems area. The course is intended for senior Mechanical Engineering students who intend to practice in the fluid/thermal area.

ABET Program Outcomes Impacted

This class significantly addresses the following ABET objectives:
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to identify, formulate, and solve engineering problems

Technology requirements

Course content is delivered via the Internet through the Blackboard Collaborate ULTRA. Ensure your UTEP e-mail account is working and you have access to the Web and a stable web browser. Google Chrome and Mozilla Firefox are the best browsers for Blackboard; other browsers may cause complications. When having technical difficulties, update your browser, clear your cache, or switch to another browser.

You will need to have access to a computer/laptop, scanner, webcam, and a crophone. You will need to download or update the following software: Microsoft Office, Adobe Acrobat Reader, Windows Media Player, QuickTime. Check that your computer hardware and software are up-to-date and able to access all parts of the course.

If you do not have a word-processing software, you can download Word and other Microsoft Office programs (including Excel, PowerPoint, Outlook and more) for free via UTEP's Microsoft Office Portal. Click the following link for more information about [Microsoft Office 365](#) and follow the instructions.

IMPORTANT: If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP [Help Desk](#) as they are trained specifically in assisting with technological

needs of students. Please do not contact me for this type of assistance.

Course Communication: *How we will stay in contact with each other*

There are several ways we can keep the communication channels open:

- **Office Hours:** My office hours will be held on MS Teams on Fridays 8-9 am. If you need to meet with me at another time, feel free to stop by my office on campus when I'm there.
- **Email:** UTEP e-mail is the best way to contact me. I will make every attempt to respond to your e-mail within 24-48 hours of receipt. **When emailing me, be sure to email from your UTEP student account, and please put the course number in the subject line.** In the body of your e-mail, clearly state your question. At the end of your e-mail, be sure to put your first and last name, and your UTEP ID.
- **Announcements:** Check the Blackboard announcements frequently for any updates, deadlines, or other important messages.

NETIQUETTE

As we know, sometimes communication online can be challenging. It's possible to miscommunicate what we mean or to misunderstand what our classmates mean, given the lack of body language and immediate feedback. Therefore, please keep this netiquette (network etiquette) guidelines in mind. Failure to observe them may result in disciplinary action.

- Always consider the audience. This is a college-level course; therefore, all communication should reflect polite consideration of others' ideas.
- Respect and courtesy must always be provided to classmates and the instructor. No harassment or inappropriate postings will be tolerated.
- When reacting to someone else's message, address the ideas, not the person. Post only what anyone would comfortably state in a face-to-face situation.
- **Blackboard is not a public internet venue;** all postings should be considered private and confidential. Whatever is posted in these online spaces is intended for classmates and profesprofessors **Please do not copy documents and paste them to a publicly accessible website, blog, or other space such as Chegg.**

Course Policies: *What do you need to do to be successful in the course?*

Attendance and participation

Attendance on the course is determined by participation in the course's learning activities. Your participation in the course is impoessentialonly for your learning and success but also for creating a community of learners. Participation is determined by the completion of the following activities:

- Reading/Viewing all course materials to ensure understanding of assignment requirements
- Other activities as indicated in the weekly modules, such as HW (Self-study problems)
- Meet regularly with the TA during additional study/simulations sessions posted on BB

Academic dishonesty

Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test (Chegg), or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of

another as one's own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit [HOOP: Student Conduct and Discipline](#).

Reasonable Accommodation Policy: The University is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries of University programs, services, and activities with documented disabilities to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship on the University. Students requesting an accommodation based on a disability must register with the [UTEP Center for Accommodations and Support Services \(CASS\)](#). Contact the Center for Accommodations and Support Services at 915-747-5148, or email them at cass@utep.edu, or apply for accommodations online via the [CASS portal](#).

Quizzes proctoring software

Quizzes/Tests will make use of Respondus Lock Down Browser and Respondus Monitor inside of Blackboard to promote academic integrity. You are encouraged to learn more about how to use these programs prior to the first test. We're using Zoom Meetings to proctor the Tests, so have it ready in your phones.

Please review the following guidelines:

- The assessments will only be available at times identified on the course calendar.
- You may take the test within a given time window.
- A reliable Internet connection is essential to completing the exam. If you must go to a location to take the exam (such as the library), be sure to follow their health and safety requirements.
- Respondus Lockdown Browser will require that all internet tabs are closed prior to the start of the test/quiz.
- Respondus Monitor requires a webcam and microphone.
- You will be required to show at webcam your student ID prior to the start of the test.
- Your face should be completely visible during the test. Blocking the camera will disable the test.
- No notes or textbook materials are permitted during the test. Respondus Monitor requires you to take a video of your surrounding area (desk, chair, walls, etc.)
- You should not have conversations with others and/or leave and return to the area during the test.

Plagiarism detecting software

Some of your course work and assessments may be submitted to SafeAssign, a plagiarism

detecting software. SafeAssign is used to review assignment submissions for originality and will help you learn how to properly attribute sources rather than paraphrase.

Copyright statement for course materials

All materials used in this course are protected by copyright law. The course materials are only for the use of students currently enrolled in this course and only for the purpose of this course. They may not be further disseminated.

Course Resources: Where you can go for assistance UTEP provides a variety of student services and support:

Technology Resources

- [Help Desk](#): Students experiencing technological challenges (email, Blackboard, software, etc.) can submit a ticket to the UTEP Helpdesk for assistance. Contact the Helpdesk via phone, email, chat, website, or in person if on campus.

Academic Resources

- [UTEP Library](#): Access a wide range of resources including online full-text access to thousands of journals and eBooks plus reference service and librarian assistance for enrolled students.
- [University Writing Center \(UWC\)](#): Submit papers here for assistance with writing style and formatting, ask a tutor for help and explore other writing resources.
- [Math Tutoring Center \(MaRCS\)](#): Ask a tutor for help and explore other available math resources.
- [RefWorks](#): A bibliographic citation tool; check out the RefWorks tutorial and Fact Sheet and Quick-Start Guide.

Individual Resources

- [Military Student Success Center](#): Assists personnel in any branch of service to reach their educational goals.
- [Center for Accommodations and Support Services](#): Assists students with ADA-related accommodations for coursework, housing, and internships.
- [Counseling and Psychological Services](#): Provides a variety of counseling services including individual, couples, and group sessions as well as career and disability assessments.

Department of Aerospace and Mechanical Engineering Safety Statement

The Department of Aerospace and Mechanical Engineering at the University of Texas at El Paso is committed to a model of excellence in education that includes providing a safe and healthy environment for its students, staff, faculty, and the general public.

Our goal is to maximize education and research training that can only occur if you, the individual, minimize hazards and risks. This can be done by:

- Providing adequate control of the health and safety risks arising from any and all activities;
- Consulting with employees on matters affecting their health and safety
- Providing and maintaining safe laboratories and equipment;
- Ensuring safe handling and use of substance;

- Ensuring all employees are competent to do their task and have adequate training; and
- Maintaining clean, safe and healthy working conditions

The principal investigator or individual in charge of each laboratory is ultimately responsible for safety in that respective lab. This includes training and ultimate release of the laboratory. Within the Department, we hold every employee (staff, faculty, student) responsible for implementing our safety practices and our departmental safety policy. We hold every employee (staff, faculty, student) responsible for providing leadership within our department to establish effective environmental safety and occupational health standards.

CLASS SCHEDULE
MEETING TIME: TR 130-2.50pm
MEETING LOCATION: Chemistry Computer Sci Bldg 1.0202

Week	Dates	Topic(s)	Scheduled and DUE
1	January 17, 2023	Introduction	-
	January 19, 2023	Heat Exchanger Types	-
2	January 24, 2023	Overall Heat Transfer Coefficient	-
	January 26, 2023	Log Mean Temperature Difference (LMTD) Method	Quiz 1 Covering Overall Heat Transfer Coefficient
3	January 31, 2023	Log Mean Temperature Difference (LMTD) Method Cont.	-
	February 2, 2023	The NTU Method	Quiz 2 Covering LMTD Method
4	February 7, 2023	The NTU Method Cont.	Project 1 (Posted on BB)
	February 9, 2023	Continuity Equation Momentum Equation including Cauchy's and Navier-Stokes Equations	Quiz 3 Covering NTU Method
5	February 14, 2023	Introduction to ANSYS Fluent	In-class exercises and practice with Fluent
	February 16, 2023	ANSYS Fluent in Class Lectures	**Please see video list at end of this document**
6	February 21, 2023	ANSYS Fluent in Class Lectures	Project 2 (Posted on BB)
	February 23, 2023	ANSYS Fluent in Class Lectures	Work on Project 1 In-class exercises Watch Videos

7	February 28, 2023	ANSYS Fluent in Class Lectures	Work on Project 1 In-class exercises Watch Videos
	March 2, 2023	-	Quiz 4 Covering CFD
8	March 7, 2023	STARCCM+ In Class Lectures	-
	March 9, 2023	STARCCM+ In Class Lectures	SUBMIT PROJECT 1 by 1159pm
9	March 14, 2023	Spring Break	
	March 16, 2023		
10	March 21, 2023	STARCCM+ In Class Lectures	-
	March 23, 2023	STARCCM+ In Class Lectures	SUBMIT ABSTRACT by 1159pm
11	March 28, 2023	Work on Project 2	No In-class meeting this week
	March 30, 2023	Work on Project 2	No In-class meeting this week
12	April 4, 2023	Work on Project 2	No In-class meeting this week
	April 6, 2023	Work on Project 2	No In-class meeting this week
13	April 11, 2023	Work on Project 2	No In-class meeting this week
	April 13, 2023	Work on Project 2	No In-class meeting this week
14	April 18, 2023	In Class Presentations See Presentation Schedule	Class Presentations for Design and Cost Estimation

	April 20, 2023	In Class Presentations See Presentation Schedule	Class Presentations for Design and Cost Estimation
15	April 25, 2023	In Class Presentations See Presentation Schedule	Class Presentations for Design and Cost Estimation
	April 27, 2023	In Class Presentations See Presentation Schedule	Class Presentations for Design and Cost Estimation
16	May 2, 2023	-	-
	May 4, 2023	SUBMIT FINAL DESIGN BY MIDNIGHT	

MECH 4316 YouTube Videos Table of Contents

Topic	Video Title	Link
Introduction to ANSYS Fluent	Tutorial 1 Part 1	https://www.youtube.com/watch?v=v-jUz_TOcMo&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=46
Geometry Functions in ANSYS	Tutorial 1 Part 2	https://www.youtube.com/watch?v=4Ks44_4_SVU&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=47
2-D Geometry Development	Tutorial 1 Part 3	https://www.youtube.com/watch?v=9lOXFXs1Uhc&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=48
3-D Geometry Development	Tutorial 1 Part 4	https://www.youtube.com/watch?v=WwkYybm8PRA&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=49
Importing of Geometry from Third Party Software More Features of the ANSYS Geometry	Tutorial 1 Part 5	https://www.youtube.com/watch?v=t1bK4jV2uQ&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=50
Meshing Functions in ANSYS Development of Geometry and Meshing Example	Tutorial 2 Part 1	https://www.youtube.com/watch?v=VjnaWge5lO8&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=51
Size Refinement of Mesh 3D Meshing	Tutorial 2 Part 2	https://www.youtube.com/watch?v=0VpVTyc7qbQ&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=52
Inflation Layer Tutorial	Tutorial 2 Part 3	https://www.youtube.com/watch?v=CO_nOw46KX_w&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=53
Introduction to Fluent CASE and Model Setup	Tutorial 3 Part 1	https://www.youtube.com/watch?v=SM9Eh_gXGTc&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=54
Solution Options in Fluent	Tutorial 3 Part 2	https://www.youtube.com/watch?v=q4SaFdvNoMg&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=55

		x=55
Post Processing in Fluent and ANSYS	Tutorial 3 Part 3	https://www.youtube.com/watch?v=zW Mk5LEB4Zk&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=56
Laminar Flow Over a Heated Cylinder Problem Statement, Geometry, and Meshing	Tutorial 4 Part 1	https://www.youtube.com/watch?v=Kmkz03CatIM&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=57
Laminar Flow Over a Heated Cylinder Import and Setup in Fluent	Tutorial 4 Part 2	https://www.youtube.com/watch?v=ZInjMRUEOYU&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=59
Laminar Flow Over a Heated Cylinder Results	Tutorial 4 Part 3	https://www.youtube.com/watch?v=OCFs5Q6mli4&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=60
Laminar Flow Over a Heated Cylinder Line Plots	Tutorial 4 Part 4	https://www.youtube.com/watch?v=dn1KnysjMos&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=61
Laminar Flow Over a Heated Cylinder Comparison to Analytical Calculations	Tutorial 4 Part 5	https://www.youtube.com/watch?v=gm1gqP89D70&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=62
Turbulent Flow Over a Heated Cylinder Problem Statement, Geometry, and Meshing	Tutorial 5 Part 1	https://www.youtube.com/watch?v=3gyl_Y4pta4&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=63
Turbulent Flow Over a Heated Cylinder Import and Setup in Fluent Results	Tutorial 5 Part 2	https://www.youtube.com/watch?v=_UOejxCyWtM&list=PLr9AwDvt-4aBXZcWJAHPY3djTAxz9IlnH&index=64
2-D Laminar Flow Through a Pipe Problem Statement and Geometry	Tutorial 6 Part 1	http://youtu.be/Y89gTRIS_SQ
2-D Laminar Flow Through a Pipe Meshing, Import, and	Tutorial 6 Part 2	http://youtu.be/HxsMkiXUPaI

Setup in Fluent		
2-D Laminar Flow Through a Pipe Results and Post-Processing	Tutorial 6 Part 3	http://youtu.be/zrZXhr6XeSY
3-D Laminar Flow Through a Pipe Problem Statement, Geometry, and Meshing	Tutorial 6 Part 4	http://youtu.be/Q7cohWwQI6M
3-D Laminar Flow Through a Pipe Results and Post-Processing	Tutorial 6 Part 5	http://youtu.be/K-1YKU8F2x0
Transient Heat Transfer in a Mixing Channel Problem Statement and Geometry	Tutorial 7 Part 1	http://youtu.be/ZDoKlany0Kc
Transient Heat Transfer in a Mixing Channel Meshing and Fluent Setup	Tutorial 7 Part 2	http://youtu.be/EBZfob-8q_Y
Transient Heat Transfer in a Mixing Channel Results and Post-Processing	Tutorial 7 Part 3	http://youtu.be/YT56-O4bLlw
Transient Heat Transfer in a Mixing Channel Movie Animation	Tutorial 7 Part 4	http://youtu.be/epyBiVCq4RY
Co-Flow Heat Exchanger Problem Statement and Geometry	Tutorial 8 Part 1	http://youtu.be/pVx3-xaBDBU
Co-Flow Heat Exchanger Meshing	Tutorial 8 Part 2	http://youtu.be/aENSe6-DOO4
Co-Flow Heat Exchanger Fluent Setup	Tutorial 8 Part 3	http://youtu.be/h_rpnPs-0Nk

Co-Flow Heat Exchanger Results and Post-Processing	Tutorial 8 Part 4	http://youtu.be/VLdyi9NmOOo
Counter Flow Heat Exchanger Meshing, Fluent Setup, Results, and Post-Processing	Tutorial 8 Part 5	http://youtu.be/gC6DcuL5Gtw
BELOW <u>NOT</u> REQUIRED FOR COURSE		
Gaseous Methane Combustion Problem Statement and Geometry	Tutorial 9 Part 1	http://youtu.be/nUx0f6rODRg
Gaseous Methane Combustion Meshing	Tutorial 9 Part 2	http://youtu.be/5YRSuLanir8
Gaseous Methane Combustion Fluent Setup	Tutorial 9 Part 3	http://youtu.be/yUL3T_an4wI
Gaseous Methane Combustion Results	Tutorial 9 Part 4	http://youtu.be/AQLNE7kXplc
Water-Air Multiphase Flow Problem Statement and Geometry	Tutorial 10 Part 1	http://youtu.be/TS1t-THqWz8
Water-Air Multiphase Flow Meshing and Fluent Setup	Tutorial 10 Part 2	http://youtu.be/Tpk6kFdodmE
Water-Air Multiphase Flow Results, Post-Processing, and Movie Animation	Tutorial 10 Part 3	http://youtu.be/kW9YEZXbQQo