

**Fall 2019**

**MECH 4316 THERMAL SYSTEM DESIGN**

<b>Course Description</b>	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.
<b>Prerequisite</b>	MECH 4315
<b>Instructor</b>	Md Mahamudur Rahman, PhD Assistant Professor NASA MICRO cSETR Department of Mechanical Engineering Engineering Building# A118 E-mail: <a href="mailto:mrahman15@utep.edu">mrahman15@utep.edu</a> Phone: (915) 747-8305
<b>Office Hours</b>	Thursday 03:00 – 04:00 P.M
<b>TA</b>	Omar Hernandez Rodriguez Graduate Student Department of Mechanical Engineering University of Texas at El Paso <a href="mailto:ohernannde21@miners.utep.edu">ohernannde21@miners.utep.edu</a>
<b>Reference Textbooks</b>	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.  <i>Fundamentals of Momentum, Heat and Mass Transfer</i> Fifth Edition (2016) by James R. Welty, Charles E. Wicks, Robert E. Wilson, and Gregory L. Rorrer Wiley  <i>Heat Transfer</i> 2nd edition (1999) by A. F. Mills and V. Ganesan Pearson Education
<b>Course Content</b>	<ul style="list-style-type: none"><li>○ Conduction, Convection and Radiation heat transfer</li><li>○ Boiling and Condensation</li><li>○ Friction Factor, Head Loss, Pipe Flow Analysis</li><li>○ Fluid Machinery</li><li>○ Introduction to Heat Exchangers</li><li>○ Introduction to CFD</li><li>○ Introduction to Fluent</li><li>○ Introduction to Design Review</li></ul>

<b>Grading</b>	Quizzes	25
	Exam	10
	Class Participation	5
	Projects	60
	Total	100

*A (100-90): B (89-80): C (79-70): D (69-60): F (59 and Below)*

There will be six quizzes, one exam and two projects. There will be no makeups for the quizzes and exam.

**Major Course Objective** This course is a capstone type of course in the energy systems (or thermal sciences) area. It corresponds to the machine design course in the Mechanical Systems area. This course 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

### **Academic dishonesty**

All graded materials must represent the student’s individual work. Scholastic dishonesty is the attempt of any student to present as his or her own work of another, or any work which he has not honestly performed, or attempting to pass any examination by improper means. Scholastic dishonesty is a serious offense and will not be accepted. Academic misconducts will be handled according to the current university policy.

**Reasonable Accommodation Policy:** If you need classroom accommodation, please contact The Center for Accommodations and Support Services (CASS) at 915-747-5148, or by email to [cass@utep.edu](mailto:cass@utep.edu) , or visit the office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at [www.sa.utep.edu/cass](http://www.sa.utep.edu/cass).

## **Department of Mechanical Engineering Safety Statement**

The Department of 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.

**TENTATIVE CLASS SCHEDULE**  
**MEETING TIME: MW 1:30-2:50pm**  
**MEETING LOCATION: Physical Science Building 208**

<b>Week</b>	<b>Dates</b>	<b>Topic(s)</b>	<b>Scheduled and DUE</b>
1	08/26 – 08/28	Introduction  Fundamentals of Heat Transfer: Conduction, Convection and Radiation	Nothing due this week
2	09/02 – 09/04	<b>UNIVERSITY CLOSED</b> <b>SEPTEMBER 2 LABOR DAY</b>  Single Phase, Boiling and Condensation Heat Transfer	Nothing due this week
3	09/09 – 09/11	Flow in Closed Conduits: Friction Factor and Head Loss, Pipe Flow Analysis	Quiz 1- 09/11
4	09/16 – 09/18	Fluid Machinery: Pumps and Fans  Types of Heat Exchangers	Quiz 2- 09/18
5	09/23 – 09/25	Overall Heat Transfer Coefficient  Single Pass Heat Exchanger Analysis: The Log Mean Temperature Difference	Quiz 3- 09/25
6	09/30 – 10/02	Crossflow and Shell-and-Tube Heat Exchanger Analysis  The Number-of-Transfer-Units (NTU) Methods of Heat Exchanger Analysis and Design	<b>PROJECT 1 ASSIGNMENT</b>  Quiz 4- 10/02
7	10/07 – 10/09	Differential Equations of Fluid Flow	Quiz 5- 10/09
8	10/14 – 10/16	Introduction to CFD  Introduction to Fluent (please see video list at the end of the syllabus)	<b>PROJECT 2 ASSIGNMENT</b>  <b>Exam- 10/16</b>
9	10/21 – 10/23	Work on Project 1 In-class exercises Watch Videos	Nothing due this week
10	10/28 – 10/30	Continue to Watch Videos  Finish Project 1	Quiz 6- 10/30  <b>SUBMIT PROJECT 1 10/30</b>

11	11/04 – 11/06	Work on Project 2	<b>SUBMIT ABSTRACT 11/06</b>
12	11/11 – 11/13	PDR Presentation Project 2	<b>CONCEPT PAPER DUE 11/13</b>
13	11/18 – 11/20	Design and Cost Estimation Project 2	Class Presentations <b>BUDGET REPORT DUE 11/20</b>
14	11/25 – 11/27	Work on Project 2	Nothing due this week
15	12/02 – 12/04	Finish Project 2  Project Demonstrations	<b>PROJECT 2 FINAL REPORT DUE 12/13</b>

## MECH 4316 YouTube Videos Table of Contents

<b>Topic</b>	<b>Video Title</b>	<b>Link</b>
Introduction	Introduction to Thermal System Design	<a href="http://youtu.be/dW4pBornU2I">http://youtu.be/dW4pBornU2I</a>
Introduction to ANSYS Fluent	Tutorial 1 Part 1	<a href="http://youtu.be/tK34chMvqEQ">http://youtu.be/tK34chMvqEQ</a>
Geometry Functions in ANSYS	Tutorial 1 Part 2	<a href="http://youtu.be/zEJt38vNdU8">http://youtu.be/zEJt38vNdU8</a>
2-D Geometry Development	Tutorial 1 Part 3	<a href="http://youtu.be/EuZEOfNoTw">http://youtu.be/EuZEOfNoTw</a>
3-D Geometry Development	Tutorial 1 Part 4	<a href="http://youtu.be/jlleSodGwyo">http://youtu.be/jlleSodGwyo</a>
Importing of Geometry from Third Party Software	Tutorial 1 Part 5	<a href="http://youtu.be/fQI25EypuQ">http://youtu.be/fQI25EypuQ</a>
More Features of the ANSYS Geometry	Tutorial 1 Part 6	<a href="http://youtu.be/NO4anlcTVzM">http://youtu.be/NO4anlcTVzM</a>
Meshing Functions in ANSYS	Tutorial 2 Part 1	<a href="http://youtu.be/eLOADM8rJJY">http://youtu.be/eLOADM8rJJY</a>
Development of Geometry and Meshing Example	Tutorial 2 Part 2	<a href="http://youtu.be/jIqbhQn3aZ8">http://youtu.be/jIqbhQn3aZ8</a>
Size Refinement of Mesh	Tutorial 2 Part 3	<a href="http://youtu.be/3QoQitUHWR8">http://youtu.be/3QoQitUHWR8</a>
3D Meshing	Tutorial 2 Part 4	<a href="http://youtu.be/Tqf9WDeF9MQ">http://youtu.be/Tqf9WDeF9MQ</a>
Inflation Layer Tutorial	Tutorial 2 Part 5	<a href="http://youtu.be/15M0xKDGPA0">http://youtu.be/15M0xKDGPA0</a>
Introduction to Fluent	Tutorial 3 Part 1	<a href="http://youtu.be/CTYF6uVYqu0">http://youtu.be/CTYF6uVYqu0</a>
CASE and Model Setup	Tutorial 3 Part 2	<a href="http://youtu.be/vJcgCdt88vA">http://youtu.be/vJcgCdt88vA</a>

Solution Options in Fluent	Tutorial 3 Part 3	<a href="http://youtu.be/JeUdh5y0JCY">http://youtu.be/JeUdh5y0JCY</a>
Post Processing in Fluent and ANSYS	Tutorial 3 Part 4	<a href="http://youtu.be/dXIFFv04mFk">http://youtu.be/dXIFFv04mFk</a>
Laminar Flow Over a Heated Cylinder Problem Statement, Geometry, and Meshing	Tutorial 4 Part 1	<a href="http://youtu.be/_G0VJA4Gybg">http://youtu.be/_G0VJA4Gybg</a>
Laminar Flow Over a Heated Cylinder Import and Setup in Fluent	Tutorial 4 Part 2	<a href="http://youtu.be/TeZKtDI3PBU">http://youtu.be/TeZKtDI3PBU</a>
Laminar Flow Over a Heated Cylinder Results	Tutorial 4 Part 3	<a href="http://youtu.be/TTprBXSmezug">http://youtu.be/TTprBXSmezug</a>
Laminar Flow Over a Heated Cylinder Line Plots	Tutorial 4 Part 4	<a href="http://youtu.be/uDNfaqotzLU">http://youtu.be/uDNfaqotzLU</a>
Laminar Flow Over a Heated Cylinder Comparison to Analytical Calculations	Tutorial 4 Part 5	<a href="http://youtu.be/K5J1KZyKEPs">http://youtu.be/K5J1KZyKEPs</a>
Turbulent Flow Over a Heated Cylinder Problem Statement, Geometry, and Meshing	Tutorial 5 Part 1	<a href="http://youtu.be/aIWLZqmHfuk">http://youtu.be/aIWLZqmHfuk</a>
Turbulent Flow Over a Heated Cylinder Import and Setup in Fluent	Tutorial 5 Part 2	<a href="http://youtu.be/reG7I8sNXi4">http://youtu.be/reG7I8sNXi4</a>
Turbulent Flow Over a Heated Cylinder Results	Tutorial 5 Part 3	<a href="http://youtu.be/ghkTNzi_7yU">http://youtu.be/ghkTNzi_7yU</a>
2-D Laminar Flow Through a Pipe Problem Statement and Geometry	Tutorial 6 Part 1	<a href="http://youtu.be/Y89gTRIS_SQ">http://youtu.be/Y89gTRIS_SQ</a>

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



Co-Flow Heat Exchanger Fluent Setup	Tutorial 8 Part 3	<a href="http://youtu.be/h_rpnPs-0Nk">http://youtu.be/h_rpnPs-0Nk</a>
Co-Flow Heat Exchanger Results and Post- Processing	Tutorial 8 Part 4	<a href="http://youtu.be/VLdyi9NmOOo">http://youtu.be/VLdyi9NmOOo</a>
Counter Flow Heat Exchanger Meshing, Fluent Setup, Results, and Post-Processing	Tutorial 8 Part 5	<a href="http://youtu.be/gC6DcuL5Gtw">http://youtu.be/gC6DcuL5Gtw</a>
<b>BELOW <u>NOT</u> REQUIRED FOR COURSE</b>		
Gaseous Methane Combustion Problem Statement and Geometry	Tutorial 9 Part 1	<a href="http://youtu.be/nUx0f6rODRg">http://youtu.be/nUx0f6rODRg</a>
Gaseous Methane Combustion Meshing	Tutorial 9 Part 2	<a href="http://youtu.be/5YRSuLanir8">http://youtu.be/5YRSuLanir8</a>
Gaseous Methane Combustion Fluent Setup	Tutorial 9 Part 3	<a href="http://youtu.be/yUL3T_an4wI">http://youtu.be/yUL3T_an4wI</a>
Gaseous Methane Combustion Results	Tutorial 9 Part 4	<a href="http://youtu.be/AQLNE7kXplc">http://youtu.be/AQLNE7kXplc</a>
Water-Air Multiphase Flow Problem Statement and Geometry	Tutorial 10 Part 1	<a href="http://youtu.be/TS1t-THqWz8">http://youtu.be/TS1t-THqWz8</a>
Water-Air Multiphase Flow Meshing and Fluent Setup	Tutorial 10 Part 2	<a href="http://youtu.be/Tpk6kFdodmE">http://youtu.be/Tpk6kFdodmE</a>
Water-Air Multiphase Flow Results, Post- Processing, and Movie Animation	Tutorial 10 Part 3	<a href="http://youtu.be/kW9YEZXbQQo">http://youtu.be/kW9YEZXbQQo</a>