EM 344 THERMODYNAMICS
IES Abroad Madrid

DESCRIPTION:
This course provides a comprehensive introduction to the principles of thermodynamics and their application in engineering. Students will explore the fundamental concepts of energy, heat, and work, and how they relate to different systems and processes. Key topics include the laws of thermodynamics, properties of pure substances, the behavior of gases and gas mixtures, phase equilibria, and the analysis of energy conversion systems.

CREDITS: 3 credits

CONTACT HOURS: 45 hours

LANGUAGE OF INSTRUCTION: English

INSTRUCTOR: Instructor Name

PREREQUISITES: Basic knowledge of physics and calculus. Prior coursework in introductory engineering principles is recommended.

ADDITIONAL COST: None

METHOD OF PRESENTATION:
Lectures
Discussion sessions
Project work

REQUIRED WORK AND FORM OF ASSESSMENT:
- Class participation 10%
- Midterm Exam 30%
- Final Exam 30%
- Assignments 30%

Course Element
- **Final exam:** The Final Exam will be comprehensive. It consists of a section to provide solution to exercises and multiple-choice questions.
- **Midterm Exam:** The midterm exam covers the content of weeks 1-6. It consists of worked-out exercises and multiple-choice questions.
- **Homework Assignments:** Referred to as problems in the syllabus. Different readings, problem solving and lab projects that will be proposed in the different sessions that will be assigned weekly. The completion of the assignment (reading and writing) should take 3-4 hours. No late homework will be accepted. Each written assignment must include results and conclusions. Students are invited to work together on the assignments, but each student must complete and hand-on his/her own assignment.

- **Participation:** This includes the interaction of the student in the classroom, the ability to answer questions made by the instructor and the general interest shown in the course. Some of the in-class assignments will use tools such us Kahoot verifying understanding of concepts.

LEARNING OUTCOMES:

By the end of the course, students will be able to:

- Understand and apply the first and second laws of thermodynamics
- Analyze thermodynamic processes and cycles
- Evaluate the properties of substances and mixtures
- Design and assess energy conversion systems
- Develop proficiency in engineering communication and teamwork skills

ATTENDANCE POLICY:

As a member of our class community, you are expected to be present and on time every day. Attending class has an impact on your learning and academic success. For this reason, attendance is mandatory for all IES Madrid classes, including course-related excursions. Absences will only be excused in cases of documented medical or family emergencies. You are allowed a maximum of one unexcused absence for once-a-week courses and two unexcused absences for twice-a-week courses. Each additional unexcused absence will result in a deduction of 3 percentage points from your final grade and/or disciplinary action. Accumulating 7 or more unexcused absences in twice-a-week courses, or 4 or more in once-a-week courses, may result in a failing grade for the course.

Late or missed submission of assessed work: any assessed work, including exams, tests, and presentations, will be rescheduled only if the absence is justified; otherwise, it will be graded as zero.

Punctuality is critical: three instances of being over 10 minutes late will be counted as one absence and being more than 15 minutes late will also count as one absence.

On museum days, students must arrive exactly at the scheduled entrance time. If a student arrives late, they are responsible for entering the museum independently by presenting their student ID and passport to verify their identity as a student at the entrance and purchasing their own ticket. Once inside, they must consult the syllabus to identify their assigned class and locate their group. Students are expected to take responsibility for locating the class, this includes reviewing the syllabus, Moodle and class information, and considering having alternative means of contact. In such cases, the student will be marked as late. Failure to join their group after arriving late will be recorded as an absence.

For more information, please refer to the full Attendance and Punctuality Policy document.

CONTENT:

Week	Content	Assignments
Week **THERMODYNAMICS PROPERTIES**	**Introduction to course** **Introduction to Basic Concepts**	• Chapter 1
Week	**Dimensions and Units** **Properties, States, and Processes** **Equilibrium** **Pressure Problem-Solving Technique**	• Chapter 1 Assignment(s) and/or Reading(s)

Week	Content	Assignments
Week	**Introduction to Energy, Heat, Work: Changing the State of a System** **First Law of Thermodynamics: Conservation of Energy.** **Energy and Environment**	• Chapter 2
Week **PURE SUBSTANCES & EQUATIONS OF STATE FOR IDEAL GASES**	**Pure Substance** **Phases of a Pure Substance** **Phase-Change Processes of Pure Substances** **Ideal Gas Law** **The Ideal-Gas Equation of State**	• Chapter 3
Week **MULTIPHASE SUBSTANCES AND EQUATIONS OF STATE FOR NON-IDEAL GASES**	**Nonideal gases: Van der Waals EOS & generalized compressibility** **Multi-phase substances: phase boundaries, quality, T-v diagrams**	• Chapter 3
Week **STEADY FLOW PROCESSES AND DEVICES**	**Conservation of Mass** **Steady-Flow Processes** **Steady Flow Devices**	• Chapter 5
Week **THE SECOND LAW OF THERMODYNAMICS**	**Midterm exam** **Introduction to 2nd Law of Thermodynamics**	• Chapter 6
Week	**Heat Engines** **Refrigerators and Heat Pumps** **Perpetual-Motion Machines** **Reversible and Irreversible Processe** **Carnot Cycle & Efficency**	• Chapter 6

Week	Content	Assignments
Week	**Entropy** **Isentropic & Polytropic Processes** **Isentropics Efficencies of Steady-Flow Devices** **The T ds Relations**	• Chapter 7
Week **GAS POWER CYCLES**	**Overview of GAS POWER CYCLES**	• Chapter 9
Week **VAPOR AND COMBINED POWER CYCLES**	**Overview of VAPOR AND COMBINED POWER CYCLES**	• Chapter 10
Week	**REVISION**	Assignment(s) and/or Reading(s)

COURSE-RELATED TRIPS:

None

REQUIRED READINGS:

Yunus Çengel & Michael A. Boles (2023. Thermodynamics – An Engineering Approach 10th edition. McGraw Hill

RECOMMENDED READINGS:

- List of recommended readings. If there are different categories (films, etc.) use a bold header (e.g. Filmography) followed by another unordered list.