COURSE DATA

Data Subject	
Code	34752
Name	Applied Thermodynamics and Heat Transfer
Cycle	Grade
ECTS Credits	6.0
Academic year	2019 - 2020

Study (s)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	School of Engineering	2	Second term

Subject-matter

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	7 - Applied thermodynamics and heat transfer	Obligatory

Coordination

Name	Department
LLADOSA LOPEZ, ESTELA	245 - Chemical Engineering
LORAS GIMENEZ, SONIA	245 - Chemical Engineering

SUMMARY

The course ***Applied Thermodynamics and Heat Transfer*** is a compulsory course taught in the second year of the degree in Chemical Engineering in the second (spring) semester. In the curriculum of the University of Valencia has a total of 6 ECTS.

The theory classes will be taught in Spanish and practical classes as stated in the course information available on the website of the degree.

Thermodynamics is a fundamental science that studies the energy, and, since a long time, it is an essential worldwide part of engineering curricula. The purpose of this subject is to provide students with an introductory treatment of Thermodynamics from the engineering point of view. This science has a universal applicability, as evidence by the fact of being used by both physics and by chemical and engineers; in fact, the thermodynamic principles are the same, but their applications differ. The basic applications from the engineering point of view are determination of the needs of heat and work in the physical and chemical processes, distinguishing two major application areas, power generation and refrigeration.

This subject aims to provide students the ability to design and manage the operation of thermal systems of industrial plants. For this purpose, in this subject is studied the basic knowledge of estimated properties of pure substances, it is treated the actual processes of typical energy transformation of the industry (heat generation process, air conditioning, gas, steam and refrigeration power cycles, among others), and finally, it is analyzed the physical fundamentals of the different forms of heat transfer.

The contents of the subject are: Basics of applied thermodynamics. Heat transfer mechanisms. Basic principles of thermotechnology. Furnaces and boilers. Heat engines. Refrigeration circuits and systems.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The background needed for this subject is basic knowledge of physics, mathematics and chemistry, as well as basic level of English reading.

OUTCOMES

1401 - Degree in Chemical Engineering

- G3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- G4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering.
- G6 - Ability to deal with specifications, regulations and mandatory standards.
- G11 - Knowledge, understanding and ability to apply the necessary legislation for practising professionally as a qualified industrial technical engineer.
- R1 - Knowledge of applied thermodynamics and heat transfer. Basic principles and their application to solve engineering problems.

LEARNING OUTCOMES

Learning results

- Apply the mass and energy conservation principles to the heat transfer operations. (Outcomes G3, G4, R1)
- Know the heat transfer mechanisms: conduction, convection and radiation. (Outcomes G3, G4, R1)

- Identify and distinguish the mechanisms that happen in different heat transfer problems. (Outcomes G3, G4, R1)
- Know how locate in the literature and estimate the physical and thermodynamic values required for the analysis and design of heat transfer operations. (Outcomes G3, G4, G6, R1)
- Apply the mathematical models that describe the heat transfer phenomena. (Outcomes G3, G4, R1)
- Apply the thermodynamic principles to solve heat transfer problems. (Outcomes G3, G4, R1)
- Apply, judiciously, an appropriate state equation to represent the PVT behavior of gases at high pressure and/or liquids. (Outcomes G3, G4, R1)
- Apply the thermodynamic principles to power and refrigeration cycles. (Outcomes G3, G4, R1)
- Know the types and characteristics of the industrial furnaces and boilers. (Outcomes G3, G6, G11)
- Know the operation principles, types and properties of the heat engines and refrigeration systems. (Outcomes G3, G6, G11, R1)
- Know the types and characteristics of equipment used in power and refrigeration cycles. (Outcomes G3, G6, G11, R1)
- Apply the thermodynamic principles to combustion processes. (Outcomes G3, G4, G6, G11, R1)
- Know and be able to select and size the heat transfer equipment and systems used. (Outcomes G3, G4, G6, G11, R1)
- Know and be able to select and size the air conditioning and refrigeration systems. (Outcomes G3, G4, G6, G11, R1)

Skills to be acquired

Students will be able to:

- Calculate the heat and work required of different processes for closed systems, or steady-state flow, make up of pure substances.
- Distinguish between reversible and irreversible processes and apply the efficiency concept for the calculation of work in irreversible processes.
- Calculate the entropy of different processes using the Second Law.
- Define the concept of heat engines.
- Interpret the different types of thermodynamic diagrams of pure substances.
- Use the Thermodynamic Property Tables of pure water to calculate any thermodynamic property variations in different processes.
- Quantify the PVT behavior of pure substances using equations of state.
- List the different variables involved in a combustion process.
- Calculate the composition and temperature of the combustion gases.
- Understand the thermodynamic fundamentals of heat engines used in power cycles.
- Design, thermodynamically, the devices used for power generation.

- Calculate the thermal efficiency in steam and gas turbines.
- Apply the thermodynamic principles to refrigeration cycles.
- Know the different mechanisms of heat transfer and its rate equations.
- Solve the equations of heat transport by conduction and apply for determining the temperature distribution in a material and for calculating the thickness of insulation.
- Solve the equations of heat transport by convection and apply it to the determination of temperature variations and heat flows.

- Determine the heat transfer by radiation in different ways and in combination with other energy transport mechanisms.
- Know the industrial equipment base mainly on radiation: boilers and furnaces.

In addition to the specific objectives mentioned above, the course will encourage the development of several **social and technical skills**, among which include:

- Capacity for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to communicate ideas, problems and solutions.
- Ability to argue from rational and logical criteria.
- Ability to speak properly and organized.
- Ability to develop a problem in a systematic way and organized.
- Ability to critically analyze the results of a problem.
- Ability to work independently.
- Ability to integrate and actively participate in group tasks.
- Ability to properly distribute the time to develop individual and group tasks.

DESCRIPTION OF CONTENTS

1. INTRODUCTION

Thermodynamic state and its surroundings. Internal energy. The first law of thermodynamics. State function. Enthalpy. The steady-state steady-flow process. The reversible process. The second law of thermodynamics. Entropy. Heat engines.

2. VOLUMETRIC BEHAVIOUR (or PVT) OF PURE SUSBSTANCES

PVT diagrams and properties tables. Equations of state. Generalized correlations for gases and liquids.

3. THERMODYNAMICS OF STEAM

Liquid and vapour saturated. Superheated steam. Thermodynamic diagrams. Thermodynamic tables.

4. COMBUSTION

Fuels. Energy and mass balances in the combustion process. Adiabatic flame temperature.

5. VAPOR POWER CYCLES

Thermal power plant performance. Carnot cycle. Rankine cycle. Cogeneration systems.

6. GAS POWER CYCLES

Internal combustion engines. Otto cycle. Diesel cycle. Gas turbines. Brayton cycle.

7. REFRIGERATION CYCLES

Vapor-compression refrigeration systems. Class of refrigerants. Cascade vapor-compression refrigeration systems. Gas refrigeration systems. Reversed Brayton cycle. Absorption refrigeration. Circuits and industrial refrigeration systems.

8. HEAT TRANSFER BY CONDUCTION AND CONVECTION

Heat transfer mechanism. Rate equation in molecular heat transport: Fourier´s law. Heat conduction in solids. Heat conduction through composite walls. Rate equation in turbulent flow: individual coefficient. Heat flow between phases: overall heat transfer coefficient.

9. RADIATION

Fundamental equation of radiation. Radiation Exchange between surfaces. Individual heat transfer coefficient by radiation. Radiation in the presence of other mechanisms of heat transfer. Furnaces and boilers.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	35,00	100
Classroom practices	25,00	100
Development of individual work	20,00	0
Preparation of evaluation activities	25,00	0
Preparing lectures	25,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the course is structured in lectures on the theory together with the resolution of related problems, and carrying out works.

In the lectures, master classes will be the basic methodology. The professor will present by means of presentation and/or explanation of the contents highlighting those key aspects for understands them. The main competences worked with these activities will be G3, G4, G6, G11 and R1.

Practical sessions of problems will be developed following two models. Some of the classes will be the professor who solves a series of sample problems in order to help the students to identify the essential elements of the way the problem is set out and its solution. In other practical sessions will be the students, individually or in team, who should solve similar problems under the supervision of the professor. After the work, the problems will be collected, analyzed and corrected by the professor. The main competences worked with these activities will be G3, G4, G6, G11 and R1.

The proposed work to the student will be divided into two types: complete Problems, with a similar complexity to the problem exams, and Tests, designed to prepare the most important concepts of each unit. Part of these activities will be made during the lectures, and the rest of them will be optional deliveries for a proper preparation of the course by the students. After its correction, the students will be informed of their results and a summary of the most consolidated and frequent failures. The main competences worked with these activities will be G3, G4, G6, G11 and R1.

EVALUATION

The assessment of student learning will be carried out using two models:

Model A: The assessment of student learning is based on a continuous assessment taking account the works (tests and proposed problems) and two objective exams according to two parts (Part I: Units 1 to 4 and Part II: Units 5 to 9). The exam of Part I will be when these contents finish and the exam of Par II will be on the official date for first convocation. If the student chooses this type of evaluation, must obtain in each of the objective exams a mark equal or higher than 4 (out of 10). The final mark will be calculated as the greater one of:

- the weighting between the average mark of the tests (20%), delivered problems (15%) and the average grade of the of two objective exams (65%). Or
- the average mark of the two objective exams plus a 10% of the weighting average mark of the works (tests and proposed problems)

Model B: The assessment of the course with this model will be realized through an exam of all contents of the course in the official date. The final mark with this model will be obtained as the greater one of:

- the weighting between the average mark of activities (20%) and the mark of the exam (80%). Or
- the mark of the exam

If a minimum mark of 4 (out of 10) is not gotten in the exam, the final mark will be the grade obtained in the exam.

The exams will have theoretical and practical questions and problems. Achievement of competences G3, G4, G6 and R1 will be evaluated.

The subject will be passed when the average final mark is equal or greater than 5 (out of 10).

Anyhow, the evaluation system will be based on the guides stated in the "Reglament d'Avaluació i Qualificació de la Universitat de València per a Graus i Màsters" (http://links.uv.es/7S40pjF).

REFERENCES

Basic

- SMITH, J.M., VAN NESS, H.C. y ABBOTT, M.M., 2014, Introducción a la Termodinámica en ingeniería Química (séptima edición). McGraw-Hill Interamericana (http://links.uv.es/A3RmkY0)
- ÇENGEL, Y.A. y BOLES, M.A., 2012, Termodinámica (séptima edición). McGraw-Hill Interamericana (http://links.uv.es/t1BJ24x)
- MORAN, M.J. y SHAPIRO, H.N., 2004, Fundamentos de Termodinámica Técnica, 2ª ed (4ª original), Reverté, Barcelona.
- SANCHOTELLO, M. y ORCHILLÉS, A.V., 2007, Transmissió de calor, 1ª ed., PUV, Valencia. ebook en UV
- HOLMAN, J.P., 2000, Transferencia de calor, 1ª ed. Español, McGraw-Hill, Madrid

Additional

- DE LUCAS, A., 2004, Termotecnia Básica para Ingenieros Químicos: Bases de Termodinámica Aplicada, Universidad de Castilla-La Mancha.
- DE LUCAS, A., 2004, Termotecnia Básica para Ingenieros Químicos: Procesos Termodinámicos y Máquinas, Universidad de Castilla-La Mancha.
- POLING, B.E., PRAUSNITZ, J.M., O'CONNELL, J.P., 2001, The properties of gases and liquids. McGraw-Hill, New York.
- YAWS, C.L., 2014, Thermophysical Properties of Chemicals and Hydrocarbons (Second Edition), Elsevier Science, Amsterdam. (http://www.sciencedirect.com/science/book/9780323286596)

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

1. Contenidos

Se mantienen todos los contenidos inicialmente programados en la guía docente para las sesiones teóricas.

2. Volumen de trabajo y planificación temporal de la docencia

La guía docente preveía 35 horas de clases de teoría y 25 horas de prácticas en el aula de las que restaba el 48% (15 horas de teoría + 10.5 horas de prácticas) en el momento de inicio de la docencia no presencial.

Reducción de las 15 horas de clases de teoría restantes a 6 para acortar la duración de los vídeos locutados de teoría.

Traslado de esas 9 horas al tiempo de aprendizaje autónomo del estudiante con los materiales subidos al aula virtual (apuntes y vídeos).

Mantenimiento de las 10.5 horas de sesiones prácticas sustituyendo la resolución de problemas en el aula por vídeos grabados con problemas resueltos, junto con una videoconferencia semanal de 1.5 horas para resolver dudas de los vídeos.

Mantenimiento de la planificación temporal docente tanto en días como en horario.

3. Metodología docente

Subida al aula virtual de los mismos materiales previstos en la guía original para la docencia presencial: apuntes y enunciados de problemas para cada tema, material complementario y problemas autocorrectivos. Además, para los temas que se han impartido de forma no presencial, se han añadido videos de presentaciones locutadas para sustituir las clases presenciales tanto teóricas como prácticas.

Programación semanal de una videoconferencia síncrona mediante creación de tareas “Videoconferencia” en el aula virtual y ejecución de éstas por Blackboard Collaborate coincidiendo día y hora de una clase presencial. En estas videoconferencias se resuelven dudas de los videos subidos.

Suministro de un problema propuesto a entregar en un plazo establecido, mediante la herramienta “Cuestionario” del aula virtual. Este problema consiste en la resolución de un ciclo termodinámico completo (ciclo de potencia de vapor o de gas, o de refrigeración). El problema tendrá un enunciado común, pero se generarán diferentes versiones del mismo modificando los datos entre versiones. La herramienta “Cuestionario” asignará aleatoriamente a cada estudiante una versión del problema.

Realización de una prueba tipo test mediante un “Cuestionario” del aula virtual donde se evalúan conceptos teórico-prácticos de los temas impartidos de forma no presencial. Este cuestionario virtual complementa a los cuestionarios tipo test presenciales ya realizados en la primera parte de la asignatura.

Sistema de tutorías. Se sustituye el programa de tutorías presenciales por la atención mediante correo electrónico y videoconferencia (Blackboard collaborate) a demanda de los estudiantes.

4. Evaluación

Mantenimiento de las notas obtenidas en las actividades (cuestionarios y problema entregado) de evaluación continua realizadas antes de la entrada en vigor del estado de alarma, aunque su peso cambia.

Eliminación del sistema de evaluación mediante dos modalidades planteado en la guía docente original.

Planteamiento de una única modalidad de evaluación basada en una prueba de evaluación final y en actividades de evaluación continua. Esta modalidad de evaluación se aplicará a las dos convocatorias. La nota de la asignatura se obtendrá como la mayor de:

- la ponderación entre la nota media de los cuestionarios realizados presencialmente (10%), problema entregado presencialmente (10%), cuestionario realizado virtualmente (10 %), problema entregado virtualmente (25 %) y examen final (45 %)

- la nota del examen final.

Si el estudiante no obtiene en el examen final una nota mínima de 4 (sobre 10), la nota final será la obtenida en el examen. La asignatura se considerará superada cuando la nota resultante sea igual o superior a 5 (sobre 10).

El examen final consistirá en la resolución de cuestiones teórico-prácticas sobre los contenidos de todos los temas de la asignatura y se subirá al aula virtual como Tarea a la hora prevista para el inicio del examen. El examen resuelto deberá subirse al aula virtual con un margen de 2 minutos respecto a la hora de finalización del examen. Será la hora que figure en la actividad Tarea del aula virtual como hora de entrega la que se tenga en cuenta para entender que se ha entregado en plazo. Los estudiantes deberán estar conectados mediante videoconferencia BBC con la cámara activada y el micrófono silenciado.

Si una persona no dispone de los medios para establecer esta conexión y acceder al aula virtual, deberá contactar con el profesorado por correo electrónico en el momento de publicación de este anexo a la guía docente.

5. Bibliografía

La bibliografía básica se mantiene, dado que los dos principales manuales son accesibles en línea:

- SMITH, J.M., VAN NESS, H.C. y ABBOTT, M.M., 2014, Introducción a la Termodinámica en ingeniería Química (séptima edición). McGraw-Hill Interamericana (http://links.uv.es/A3RmkY0)

- ÇENGEL, Y.A. y BOLES, M.A., 2012, Termodinámica (séptima edición). McGraw-Hill Interamericana (http://links.uv.es/t1BJ24x)

Adicionalmente también se ha elaborado material fundamental para el entorno de la docencia no presencial como: vídeos locutados de clases teóricas y de resolución de problemas. En este sentido, cabe recordar que la propiedad intelectual de este material es de titularidad exclusiva del profesorado.