

## Thermodynamics, Heat and Mass Transfer (E039161)

**Course size** (nominal values; actual values may depend on programme)

**Credits** 6.0      **Study time** 180 h      **Contact hrs** 60.0 h

**Course offerings and teaching methods in academic year 2017-2018**

A (semester 1)	seminar: coached exercises	30.0 h
	lecture	30.0 h

**Lecturers in academic year 2017-2018**

Merci, Bart	TW03	lecturer-in-charge
Maragkos, Georgios	TW03	co-lecturer

**Offered in the following programmes in 2017-2018**

	crdts	offering
<a href="#">Bridging Programme Master of Science in Fire Safety Engineering</a>	6	A
<a href="#">International Master of Science in Fire Safety Engineering</a>	6	A
<a href="#">Master of Science in Fire Safety Engineering</a>	6	A

**Teaching languages**

English

**Keywords**

first law of thermodynamics, equation of state, combustion, conduction, convection, radiation, mass transfer

**Position of the course**

This course is situated in the first year of the program.  
 The course provides the scientific basis of the thermodynamics processes, combustion, heat transfer and mass transfer occurring in case of fire.  
 The course supports the key competence of the education program: to master the scientific knowledge in order to understand, to evaluate critically and to analyse the fire phenomenon and its consequences.

**Contents**

Thermodynamics:

- First Law of Thermodynamics: conservation of energy
- Properties of Pure Substances: phase diagram, equation of state, ideal gas
- Real Gas Mixtures: saturated and unsaturated mixtures

Thermochemistry:

- Flue Gas Composition: combustion chemistry, air factor, combustion with moist air, triangle diagram, flue gases dew point
- Flame Temperatures: enthalpy of formation, heat of combustion, adiabatic flame temperature, flue gas temperature

Heat Transfer:

- Conduction: Basic law, multi-dimensional conduction, unsteady conduction
- Convection: Basic law, Convection coefficient - Nusselt number, forced convection, natural convection
- Radiation: Basic laws, Black and real body, Inter-surface radiation, Gas radiation

Mass Transfer: continuity equations, Fick's law

**Initial competences**

To have basic knowledge of mathematics, physics, chemistry and transport phenomena.

**Final competences**

- 1 Understand and apply the first law of thermodynamics.

- 2 Quantify thermodynamic properties of pure substances and mixtures.
- 3 Understand the thermodynamic aspects of combustion.
- 4 Calculate flue gas temperature and composition in case of combustion.
- 5 Understand the mathematical formulation of the physical processes of heat transfer.
- 6 Understand and calculate the consequences of heat transfer in case of fire.
- 7 Solve a new complex problem, involving the thermodynamic processes and the different modes of heat transfer that occur in case of fire.
- 8 Recognize the occurrence of mass transfer in case of fire.

#### **Conditions for credit contract**

This course unit cannot be taken via a credit contract

#### **Conditions for exam contract**

This course unit cannot be taken via an exam contract

#### **Teaching methods**

Lecture, seminar: coached exercises

#### **Learning materials and price**

- Handouts of slides
- Book: Fundamentals of momentum, heat and mass transfer, J.R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer.
- Book: Fundamentals of Engineering Thermodynamics: SI-version, M.J. Moran, H.N. Shapiro.

#### **References**

- H. Baehr, 'Thermodynamik', Springer-Verlag, 1999.
- J.R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, 'Fundamentals of momentum, heat and mass transfer', 4th edition. (ISBN 0-471-38149-7), John Wiley and Sons Ltd.
- M.J. Moran, H.N. Shapiro, 'Fundamentals of Engineering Thermodynamics: SI-version', 5th edition. (ISBN 0-470-03037-2), John Wiley and Sons Ltd.
- Y.A. Cengel, 'Thermodynamics and heat transfer' (ISBN 0-07-114109-X)

#### **Course content-related study coaching**

Personal guidance, after setting an appointment with the teacher or the assistant

#### **Evaluation methods**

end-of-term evaluation

#### **Examination methods in case of periodic evaluation during the first examination period**

Written examination, oral examination

#### **Examination methods in case of periodic evaluation during the second examination period**

Written examination

#### **Examination methods in case of permanent evaluation**

#### **Possibilities of retake in case of permanent evaluation**

not applicable

#### **Extra information on the examination methods**

- Oral examination with written preparation: a number of open questions evaluate the student's understanding of the knowledge obtained in the hearing classes.
- Written open book examination: a number of new, complex problems require calculation by the student.
- In the second examination period, the corresponding oral examination from the first examination period is evaluated by a written examination.

#### **Calculation of the examination mark**

oral exam 50%, written exam 50%