University: University of Žilina in Žilina	
Faculty: Faculty of Mechanical Engineering	
Subject code: 2Y002	**Subject name:** Thermomechanics
Profile subject: yes	
Type, scope and method of educational activities:	
Weekly number of teaching hours in the form of lectures, exercises, seminars, clinical practice.	3 - 2 - 0 (lectures-exercises-laboratory exercises) hours
The method by which the educational activity is carried out	The teaching takes place in person.
Methods of achieving educational results	**Lectures:** systematic theoretical problem interpretation of the issue, problem-oriented teaching, interactive lecture with multimedia support, semester written work, consultations in connection with feedback **Exercises:** model examples, motivational demonstration, explanation, problem-based teaching, continuous written examination
Number of credits: 5.0	
Student workload: *5h * 13 (full-time teaching) + 62h (self-study) = 130 hours*	
Recommended semester / trimester study: winter semester	
Degree of study: 1. degree	
Prerequisites:	

Conditions for passing the subject:
The subject Thermomechanics is evaluated by points. During the semester, students take two written tests, each with a maximum score of 10 for every one. Team work will be evaluated in the exercises when solving the given examples with a max. the number of points is 10. The maximum number of points that a student will be able to get for his work during the semester is 30.

Final rating:
The exam consists of a written part, which includes the elaboration of introduction test, solving given example and oral exam with theoretical question with a total maximum number of points 70. The oral part of the exam is evaluated for a maximum of 30 points. The sum of the points obtained during the exam and during the semester determines the final evaluation of the completed course.

The resulting classification of the subject:
Rating A: 93 - 100 points
Rating B: 85 - 92 points
Rating C: 77 - 84 points
Rating D: 69 - 76 points
Rating E: 61 - 68 points
FX rating: less than 61 points.

The specific method of evaluating the student's work during the semester and the exam will be specified at the beginning of the semester by the subject teacher. The final evaluation of the student's study results for completing the course - expressed by a grade - is governed by Art. 9 Directive no. 209 Study Regulations for the first Degree of University Studies at the University of Žilina in Žilina.

Learning Outcome Scoreboard:

Forms and methods of evaluation	Scale	Area of knowledge, skills, competences
Exercise activity	10%	Team work, professional knowledge
2 tests	20%	Professional knowledge, independent work with professional literature
Introduction exam test	10%	Professional knowledge, independent work with professional literature
Written part of the exam - examples	30%	Professional knowledge
Oral exam	30%	Professional knowledge

Learning outcomes:

By completing the course Thermomechanics, the student will be able to:

- define and explain knowledge about the basic laws of thermodynamics, about energy, the conversion of thermal energy into work, the efficiency of energy conversions, changes in the state of liquids, thermodynamics of gases and vapors, moist air, the principle and working cycles of thermal machines and cooling devices, the laws of heat transfer, gas flow and a couple supplemented with selected aspects of the latest knowledge of thermomechanics
- analyze and reproduce the basic methods of calculating physical events associated with changes in the state of physical quantities, including knowledge of practical contexts and relationships,
- independently use and apply procedures for solving practical engineering tasks
- interpret the essence of physical events in changes of state quantities and energy conversion.
- identify the working principles of thermal machines with regard to efficiency and work done
- independently acquire new knowledge and actively expand their knowledge
- solve various thermal processes in mechanical engineering and in related fields.

Course contents:

Lectures

- Units of physical quantities used in thermomechanics.
- Energy. Exergy. Anergy. Heat. Energy conversion.
- Boyle-Marriott and Gay-Lussac laws.
- Clapeyron's equation of state. Van der Waals equation of state.
- Bulk work, technical work.
- Zero theorem of thermodynamics. I. thermodynamic theorem, enthalpy, internal energy.
- Specific heat of an ideal gas, specific heat capacity, Mayer's equation. Specific heat of real gases, liquids and solids.

- Change in the state of an ideal gas at a constant volume. Change of state of an ideal gas at constant pressure.
- Change of state of an ideal gas at a constant temperature. Adiabatic change of state of an ideal gas. Polytropic change of state of an ideal gas.
- Direct heat cycle, Reverse heat cycle.
- II. thermodynamic theorem. III. thermodynamic theorem. Entropy.
- Carnot's direct comparative cycle. Carnot irreversible cycle.
- Reversed Carnot cycle. Entropy of a thermally insulated and non-insulated system.
- Principle of state T-s diagram. T-s state diagram of an ideal gas - how to calculate and draw it.
- Peculiar changes in the T-s diagram of an ideal gas.
- Change of state – basic concepts and ideas, definition.
- Phase p, v diagram. Phase T, s diagram. Phase i, s diagram.
- Water heating. Boil water. Wet water vapor. Overheating of water vapor.
- Isothermal, isochoric, isobaric and adiabatic change of state of water vapor.
- Carnot cycle in the area of wet steam.
- Clausius – Rankine cycle.
- Clausius – Rankine cycle with superheating of steam. Clausius – Rankine cycle with superheating and reheating steam.
- Humid air. Mollier's i – x diagram.
- Humid air conditioning. Modifications of moist air in Mollier's i – x diagram.
- Internal combustion engines. Otto cycle. Diesel cycle.
- Sabbath cycle. Real combustion engine cycles.
- Combustion turbines. Brayton cycle. Humphrey cycle. Comparison of combustion turbine cycles with the Carnot cycle.
- Division of compressors. Parameters of compressors.
- Ideal single-stage reciprocating compressor without harmful space with adiabatic, isothermal and polytropic compression.
- Multi-stage compression.
- Compressor with harmful space. The circuit of a real compressor.
- Cooling devices.
- Heat pumps.
- Heat conduction through a flat wall. Heat conduction through the cylindrical wall.
- Heat transfer from the liquid to the wall and vice versa. Newton's equation.
- Heat transfer from fluid to fluid through a plane wall. Heat transfer from fluid to fluid through the cylindrical wall.
- Basic laws of heat radiation.
- Heat exchangers.
- Thermodynamics of flowing gases and steam. Continuity equation. Basic equation of motion for steady flow of a compressible ideal fluid.
- Tapering nozzle. Speed of sound. Mach number. Laval nozzle.

Exercises

- Boyle-Marriott and Gay-Lussac laws, Clapeyron's equation of state. Van der Waals equation of state. Bulk work, technical work. Specific heat of an ideal gas, specific heat capacity.
- Change of state of an ideal gas at constant volume. Change of state of an ideal gas at constant pressure. Change of state of an ideal gas at constant temperature. Adiabatic change of state of an ideal gas. Polytropic change of state of an ideal gas.
- Carnot's direct comparative cycle. Carnot irreversible cycle. State T-s diagram of an ideal gas. Change of state - basic concepts and ideas, definition. Water heating. Boil water. Wet water vapor. Overheating of water vapor.
- Isothermal, isochoric, isobaric and adiabatic change of state of water vapor. Carnot cycle in the wet steam region. Clausius – Rankine cycle.
- Humid air. Mollier's i – x diagram.
- Internal combustion engines. Otto cycle. Diesel cycle. Sabbath cycle.
- Ideal single-stage reciprocating compressor without harmful space with adiabatic, isothermal and polytropic compression.
- Compressor with harmful space. The circuit of a real compressor.
- Heat conduction through a flat wall. Heat conduction through the cylindrical wall. Heat transfer from the liquid to the wall and vice versa. Heat transfer from fluid to fluid through a plane wall. Heat transfer from fluid to fluid through the cylindrical wall.
- Laval nozzle.
- The exercises follow up thematically on the program of lectures

Recommended reading:

ČARNOGURSKÁ, M., LAZÁR M.: Termomechanika, Zbierka príkladov. Vydavateľstvo Technická univerzita v Košiciach, 256s., 2015. (učebnica)

PAVELEK, M. a kol.: Termomechanika. Akadem. nakladatelství CERM, s.r.o. Brno, 2011. (učebnica)

ANTAL Š.: Termodynamika. Vydavateľstvo STU. Bratislava, 255s., 2009 (učebnica)

P. KRIŠŠÁK, J. MULLEROVÁ: Úvod do termomechaniky. Vydavateľstvo EDIS ŽU, Žilina 2006. (skriptá)

KALČÍK, J.: Technická termodynamika. Praha: Nakladatelství Československé akademie věd, 565 s., 1963 (učebnica)

CENGEL, Y. A. – BOLES, M. A.: Thermodynamics, an engineering approach. 8th edition, McGraw-Hill Education, 2 Penn Plaza, New York, 2015 (knižná publikácia)

R. E. SONNTAG, C. BORGNAKKE: Fundamentals of Thermodynamics 10th Edition. Wiley. 592 s., Londýn 2020. (knižná publikácia)

A language whose knowledge is required to complete the course: english

Notes:

Course evaluation

Total number of evaluated students: 0

A	B	C	D	E	FX
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Person securing the subject (subject guarantor):

doc. Ing. Michal Holubčík, PhD.

Teaching: doc. Ing. Michal Holubčík, PhD. doc. Ing. Peter Ďurčanský, PhD.	
Name and surname of the teacher, titles	**Organizational form provided by the university teacher** (Lectures, exercises, laboratory work, field exercises)
doc. Ing. Michal Holubčík, PhD.	Lectures
doc. Ing. Peter Ďurčanský, PhD.	exercises
Date of last change: 16.11.2021 10:05	
Approved: prof. Ing. Jozef Jandačka, PhD.	