MODULE INFORMATION SHEET

Name of Module Unit	**Materials engineering**
Name in polish language	Materiałoznawstwo
Module type	compulsory / ~~elective~~
Form of studying	full-time day courses
Level of study	undergraduate course (B.Sc. level)
Type of study (for extra-mural courses)	-
Programme	Environmental Engineering
Speciality	Environmental Engineering
Responsible department	Department of District Heating and Gas Systems
Responsible person	Dr inż. F.E. Uilhoorn

Semester	Lectures	Tutorials	Laboratory	Computer Exercises	Projects	ECTS
2	15	-	-	-	30	3

Objectives (summary)

Develop an awareness of the structure, properties, processing, and performance of materials. To introduce basic concepts, nomenclature, and testing of materials. To develop ideas behind materials selection and design.

Prerequisites

Background in physics and chemistry

Rules of integrated grade setting

Final test grade (60%), Laboratory grade (40%)

Recommended readings

1. Callister, W.D. and Rethwisch, D.G., Fundamentals of Materials Science and Engineering, An Integrated Approach, 3th ed.
2. Shackelford, J.F., Introduction to Materials Science for Engineers, 6th ed.

Contents of lectures (syllabus)

	Topics	**Time** (hrs.)	**Scope** (S / Ex)
1	Introduction – classification and properties of materials.	1	S
2	Atomic structure and bonding – Bohr versus quantum mechanical model, electronic structure, bonding force, primary and secondary bonding.	1	S
3	Crystal structure of materials – unit cells, Bravais crystal lattices, SC, BCC, FCC and HCP structure, polymorphism, polycrystals.	1	S
4	Imperfections in solids – type of defects, Hume – Rothery rules, slip systems, strengthening mechanisms.	1	S
5	Diffusion in solids – describe the atomic mechanisms of diffusion. Maxwell-Boltzmann distribution, Fick's first and second law, Arrhenius model.	1	S
6	Mechanical properties of solids – Hooke's law, common state's of stress, stress-strain curve, ductility, resilience, toughness, hardness and testing methods.	1	S
7	Thermal behaviour – heat capacity, Debye temperature, vibrational energy, Dulong-Petit law, thermal expansion, conductivity, Wiedemann–Franz law, thermal stresses, thermal shock resistance.	1	S
8	Phase equilibrium – solubility limit, equilibrium and meta-stable state, derivation of Lever rule, binary eutectic systems, microstructures in eutectic systems, hypoeutectic and hypereutectic compositions, Gibbs phase rule, Fe-C diagram, influence of alloying elements	3	S
9	Phase transformations – classification of transformations, nucleation and growth of crystals, properties of pearlite, bainite, martensite, spheroidite, eutectoid transformation rate, Isothermal Transformation Diagram (TTT), transformations with proeutectoid materials.	1	S
10	Structures of polymers – thermoplast, thermosets, elastomers, linear, branched, chain and network polymers, molecular shape, crystallinity, polymerization (addition and condensation), molding methods.	1	S
11	Ceramic materials – taxonomy of ceramics, whitewares, refractory materials, amorphous ceramics, glass processing, cements, advanced ceramics, Abrasives ceramics, sintering, mechanical properties.	1	S
12	Material selection in mechanical design – link between materials, function, shape and process, Material index, cost of materials, Ashby charts.	1	S
13	Final test	1	S
	Total	**15**	**hours**

S – topics listed in the legal study programme standards from 12.07.2007
Ex – extended topics

Lecturers

Dr inż. F.E. Uilhoorn

Assessment method

Final test

Contents of guided projects

	Topics	Time (hrs)	Scope (S / Ex)
1	*Surface hardening of steels.* In this part the student is asked to deploy Fick's law for steady-state and transient situations. First formulation of the solution to Fick's second law for diffusion into a semi-infinite solid when the concentration of diffusing species at the surface is held constant. Identifying the initial and boundary conditions. Next, solving the linear PDE including the Gaussian error function. The first task is the determine the diffusion flux via iron plate exposed to a carbon rich environment. The second task is a design example and requires to specify the appropriate heat treatment in terms of temperature and time in order to improve the wear resistance of a steel gear via nitriding.	30	S
2	*Mechanical properties of solids.* – In this task the student is asked to determine for a given engineering stress–strain data, the yield strength (0.002 strain offset), tensile strength, ductility, Young's modules and modulus of resilience. For a given stress-strain curve calculating the toughness of the material. Applying Poisson's ratio. Computing the maximum length without plastic deformation for an alloy under stress.		S
3	*Phase diagrams*. The student is asked to determine for a given binary phase diagram, the composition of an alloy, its temperature, and assuming that the alloy is at equilibrium, what phases are present, the compositions of the phases and the mass fractions of the phases. For some given binary phase diagram locating, the temperatures and compositions of all eutectic, eutectoid, peritectic, and congruent phase transformations and write reactions for all these transformations for either heating or cooling. Given the composition of an iron–carbon alloy containing between 0.022 wt% C and 2.14 wt% C, be able to specify whether the alloy is hypoeutectoid or hypereutectoid, name the proeutectoid phase, compute the mass fractions of proeutectoid phase and pearlite and make a schematic diagram of the microstructure at a temperature just below the eutectoid.		S
	Total	**30**	**hours**

S – topics listed in the legal study programme standards from 12.07.2007
Ex – extended topics

Persons responsible for guided projects

dr inż. F.E. Uilhoorn

Assessment method for guided projects

Reports and their successful defend.