COURSE CONTENTS

F. Ü. Engineering Faculty

Department of Metallurgy and Materials Engineering

Graduate Course Contents

	T	A	C	ECTS
MEM 502 MOLD DESIGN	**3**	**0**	**3**	**6**

Effects of part shape and size on solidification time, modulus concept and calculation, temperature gradient and effect of temperature gradient on solidification characteristics of rod and plate parts, feeder concept, unheated feeders and feeder sizing, exothermic feeders and sizing, calculation of feeder neck and crushing cores, coolant application, Inner and outer coolers, effects of cooler on part module, sizing of coolers, use of mold materials with cooling effect, facilitating feeding by filling, exothermic fillings.

	T	A	C	ECTS
MEM 503 SOLIDIFICATION	**3**	**0**	**3**	**6**

Homogeneous nucleation, Nucleation rate, Heterogeneous nucleation, Atomic structure of solid-liquid interface, Effects of kinetic cooling on phase growth rate, Distribution of dissolved atoms in solution, Unbalanced solidification, Dendritic solidification, Eutectic solidification, Rapid solidification.

	T	A	C	ECTS
MEM 504 PHASE TRANSFORMATIONS	**3**	**0**	**3**	**6**

Principles of kinetic theory, Definitions and classifications of transformations, Transformation mechanisms in metals and alloys, Nucleation theories in solid-solid transformations, Heterogeneous nucleation in solid phases, Diffusional transformation and growth theories, Solid state transformation morphology, Morphology and growth kinetics of ferrite, cementite, pearlite and bainite transformations , Basic kinetics of recrystallization, Topology of grain growth, secondary and tertiary recrystalization, Microstructural changes during re-nucleation, Deformation aging, Formation of free regions free of sediment, Phase transformations in ceramic materials.

	T	A	C	ECTS
MEM 506 DEFORMATION ANALYSIS	**3**	**0**	**3**	**6**

Deformation mechanism in solid materials, Microscopic and metallographic examination, Fracture work stages, Brittle and ductile fractures, Fatigue, corrosion, wear and heat treatment deformations, Hydrogen and liquid metal fragility, Metal processing, casting and welding defects, Fracture mechanism maps, Special deformation analysis studies on examples.

	T	A	C	ECTS
MEM 507 ELECTRON MICROSCOPE TECHNIQUES	**3**	**0**	**3**	**6**

Electron microscope, Electron micro analysis, Electron and neutron diffraction, Spectroscopy techniques, Crystal defect analysis, TEM and SEM type electron microscope and error analysis in such microscopes.

	T	A	C	ECTS
MEM 508 CATHODIC PROTECTION	**3**	**0**	**3**	**6**

Principles of cathodic protection, Environmental conditions, Methods of cathodic protection, Measurement of environmental parameters, Electrochemical properties and physical properties of the cathodic protection anode and anode design principles, DC current sources, Cathodic protection systems design, Practical examples.

	T	A	C	ECTS
MEM 509 ADVANCED POWDER METALLURGY	**3**	**0**	**3**	**6**

Production of metal powders, Testing and characterization of powders, Compaction, Sintering and finishing, Powder Metallurgy products, porous metals, non-porous bearing materials, hard carbides and nitrides, electrical contacts and magnetic materials.

	T	A	C	ECTS
MEM 510 NON-DESTRUCTIVE INSPECTION METHODS	**3**	**0**	**3**	**6**

Principles and application advantages of non-destructive testing methods, Criteria for selection of the appropriate method, Basic principles of radiography, X-Rays, gamma rays radiation sources, Photographic film, counter, error detection with radiography and radiographic standards, Fundamentals of ultrasonic analyzer, Ultrasonic test standards, wave mechanics error detection by the method of ultrasound.

	T	A	C	ECTS

MEM 511 DEFORMATION THEORIES **3 0 3 6**

Elastic behavior of plastic flows of crystals, flow criteria, loading conditions under multi-directional loads, deformation energy, Mohr's circle and transformations of stresses, deformation processes and strain metallurgy, Theory and applications of basic shear plane fields.

T A C ECTS

MEM 512 CERAMIC COMPOSITES **3 0 3 6**

Production and properties of fibers and whiskers used to increase the strength of the structure in concrete, cement, glass, glass-ceramics, refractories, The mechanism of strengthening ceramic composites and increasing their toughness, Creation of ceramic matrix fiber composites and the development of special techniques, Heat-strengthened, glass and glass -Ceramics properties.

T A C ECTS

MEM 513 ADVANCED MATERIAL SCIENCE **3 0 3 6**

Crystal dynamics, Dislocation theories, Superconductivity, mass transfer theories, Nuclear materials, Advanced electrochemistry, Magnetic materials, Statistical mechanics, Reversible thermodynamics, Non-stoichiometric phenomena, super plasticity.

T A C ECTS

MEM 514 ADVANCED MATERIAL THERMODYNAMICS **3 0 3 6**

Deformation mechanism in solid materials, Microscopic and metallographic examination, Fracture work stages, Brittle and ductile fractures, Fatigue, corrosion, wear and heat treatment deformations, Hydrogen and liquid metal fragility, Metal processing, casting and welding defects, Fracture mechanism maps, Special deformation analysis studies on examples.

T A C ECTS

MEM 515 FRACTURE AND FATIGUE MECHANISMS **3 0 3 6**

Advanced applications in brittle fracture, ductile fracture, fatigue and creep, stress corrosion cracking in engineering materials, hydrogen embrittlement.

T A C ECTS

MEM 516 COMPOSITES AND MECHANICAL BEHAVIOUR **3 0 3 6**

Principles and strengthening of composites, micro level mechanics and fracture behavior of composites, static and time dependent behavior changes of composites.

T A C ECTS

MEM 517 DIFFUSION **3 0 3 6**

Diffusion theory, Thermodynamic rules, Fick rules, Chemical diffusion, Kirkendall effect, Forced diffusion, Atomic theory of diffusion, Atomic motions, Diffusion mechanisms (Grain boundary diffusion, volume diffusion, diffusion across free surfaces, high diffusion paths), Electromagnetic diffusion.

T A C ECTS

MEM 518 HIGH TECHNOLOGICAL MATERIALS **3 0 3 6**

Classification of high-tech ceramics, Colloids, Colloidal dispersion, Gel formation, Production of ceramic powders, Reactions forming ceramics, Synthesis of high temperature materials, High-tech ceramics produced by chemical CVD and PVD methods, Zirconia zirconia production, strip casting, hot isostatic pressing methods. production of technological ceramics, Sintering process and problems, Stabilized zirconia and toughening mechanism, Oxide-free ceramics, Carbon and carbon composites.

T A C ECTS

MEM 519 COMPUTER APPLICATIONS IN MATERIAL SCIENCE **3 0 3 6**

Numerical methods of solutions of engineering problems, Determinants, matrices, simultaneous linear equations and their solutions with MATLAB programming language, Roots of polynomial and algebraic equations, Lagrange's interpolation formula, Curve Fitting Methods, Numerical solutions of ordinary differential equations, Partial differential equations and numerical solutions, Fourier series. Sample applications such as dislocation dynamics, mass transfer, mold design and material selection (for production metallurgy as well as relevant sample applications).

T A C ECTS

MEM 520 HISTORY AND PHILOSOPHY OF SCIENCE **3 0 3 6**

Awareness and importance of history, Classification of sciences, Aristotle and classical logic, Science of the first civilizations, science of the new civilization period, the shaping of contemporary discoveries, the contemporary science

period, the lives of well-known scientists, Theories of science, Discussions around scientific theories, Science The foundation of the theory, The theory of science and human, categorization, reasoning and its forms, the understanding of science today.

	T	A	C	ECTS
MEM 521 ADVANCED WELDING METHODS	**3**	**0**	**3**	**6**

Diffusion welding, Ultrasonic welding, Friction welding, Modern soldering techniques, Powder spray bonding techniques, Bonding, Laser welding, Electron beam welding.

	T	A	C	ECTS
MEM 522 ENGINEERING MATHEMATICS	**3**	**0**	**3**	**6**

Introduction to engineering mathematics, Modeling of stable and unstable states, Mathematical analysis of physical problems with scalar, vector, tensors, Matrices, solutions of simultaneous linear and nonlinear equations, Solutions of ordinary, simultaneous and partial differential equations, Separation and combining techniques of variables Solution of partial differential equations using finite difference method.

	T	A	C	ECTS
MEM 523 ELECTRONIC PROPERTIES OF MATERIALS	**3**	**0**	**3**	**6**

Atomic structure, electron structure, bond structures, electrical conductivity and band theory, control of conductivity, superconductors, semiconductors, insulators and dielectric properties, polarization and pole pairs, piezoelectricity, ferroelectricity, magnetic behavior of materials, magnetic dipoles and magnetic moment, domain structure and hysteresis cycle, magnetic materials, optical behavior of materials, electromagnetic spectrum, interactions of photons with materials, photonic systems, thermal properties of materials, thermal conductivity and thermal expansion.

	T	A	C	ECTS
MEM 524 ADVANCED WELDING METALLURGY	**3**	**0**	**3**	**6**

Weld metal solidification, temperature gradients and turbulence in the weld metal, geometry of the weld metal, epitaxial solidification, grain growth and segragation, cellular and dendritic solidification, phase transformations during weld metal cooling, phase transformation kinetics, modeling of weld metal microstructure and mechanical properties, under the influence of heat remaining zone (HAZ), thermal cycle in HAZ, grain coarsening, reactions on the melting line, phase transformations during cooling, modeling of HAZ's

microstructure and mechanical properties, weld metal and HAZ in multi-pass welds.

	T	A	C	ECTS
MEM 550 POTA METALLURGY	**3**	**0**	**3**	**6**

Summary of steelmaking chemistry, Scope and advantages of ladle metallurgy, Kinetics and thermodynamics of deoxidation, Formation and elimination of products after deoxidation, Re-oxidation, Desulfurization and sulfur residues in steel, Size control of oxide and sulfur residues, Degassing of steels, Mixing and injection processes, ladle furnaces and processes.

	T	A	C	ECTS
MEM 551 SOLUTION THERMODYNAMICS	**3**	**0**	**3**	**6**

Thermodynamic properties of solutions, "Gibbs-Duhem" equations, application to binary or ternary systems for activity determination, Solution models, ideal, regular and dilute solutions, Phase diagrams, free energy and activity relations.

	T	A	C	ECTS
MEM 552 MANUFACTURING FERRO ALLOYS	**3**	**0**	**3**	**6**

Ferrochrome, ferrosilis, ferromanganese, ferromolybdenum, ferrotitan, ferrovanadium production.

	T	A	C	ECTS
MEM 553 PHASE BALANCE IN METALLURGICAL PROCESSES	**3**	**0**	**3**	**6**

Physicochemical properties of metals, mats, slags, acidity, basicity and electrical conductivity, surface tension, explanation of equilibrium conditions in phases depending on process variables, Examples of phase balance calculations in ferrous and non-ferrous metallurgical processes.

	T	A	C	ECTS
MEM 554 REDUCTION ON IRON BASED ORE	**3**	**0**	**3**	**6**

Iron raw material; lump ore, sinter and pellet, Reduction of iron oxides, Reduction mechanism, Effects of impurities on the behavior of reduction of iron oxides, Energy use in reduction of iron oxides, Calculation of optimum coke

ratio, Alternative processes used in iron production, Energy and mass balance in used and alternative processes, Iron energy saving in production.

	T	A	C	ECTS
MEM 555 FLUID DYNAMICS FOR METALLURGISTS	**3**	**0**	**3**	**6**

Fluid dynamics, gas and liquid fluidity, Fluids obeying and not complying with Newton rule, Regular (Laminar) flow, Momentum balance, Navier-Stokes equation, Turbulent flow, Pipe flow problems, Single particle motion in a fluid, Heat and mass transfer to parts. Separation, Flow dynamics of fluids in fluidized beds, Pumps, fans, high speed jets, vacuum, heat conductivity, convection, conduction and radiation heat transfer, Diffusion and mass transfer, Fick's rules, Differential equations, Stable and unstable mass transfer.

	T	A	C	ECTS
MEM 556 ADVANCED ELECTROMETALURGY	**3**	**0**	**3**	**6**

Basic principles of electrochemistry, Thermodynamic approach, Electrochemical kinetics, Mutual relations of suggestions and equations of mass and charge transfer in electrochemistry, Calculation of cell performance and technical applications, Energy saving systems in closed type arc furnaces.

	T	A	C	ECTS
MEM 557 PROJECTING METALLURGICAL FACILITIES	**3**	**0**	**3**	**6**

Planning of metallurgical facilities, Selection of production processes, capacity and location of the facility, Determination of process flow diagram and appropriate tools, Calculation of mass and energy balance calculations, Feasibility and economic reports.

	T	A	C	ECTS
MEM 558 ADVANCED HYDROMETALLURGY	**3**	**0**	**3**	**6**

Material resources in hydrometallurgical processes, 'Leach' application in ores, concentrates and second products, Separation, purification and enrichment processes for processing of saturated leaches in waste solutions, Precipitation process during the extraction of solutions, metals and separation of metals, Purification and extraction of metals for electrolyte processes.

	T	A	C	ECTS

MEM 559 REFRACTORIES AND USE IN INDUSTRIAL OVENS **3 0 3 6**

Refracter raw material, production process techniques, Minerological, physical and chemical properties of different types of refractory materials, Refracter applications in ferrous and non-ferrous metallurgy, Monolithic refracters, insulating refractories and developments in the refractory industry.

	T	A	C	ECTS
MEM 560 ALTERNATIVE IRON AND STEEL PRODUCTION METHODS	**3**	**0**	**3**	**6**

(OBM, AOD, LBE) Advances in oxygen converters, Control of the chemical composition of liquid metal taken from the blast furnace, New developments in electric arc furnaces (EAF), Selection, classification and preparation of metal scrap as raw material, Principles and technologies of obtaining billet iron, Direct steel acquisition processes; for example the plasma method.

	T	A	C	ECTS
MEM 561 THE KINETICS OF METALLURGICAL PROCESSES	**3**	**0**	**3**	**6**

Homogeneous and heterogeneous reactions, Reaction rate equations in homogeneous reactions, activation energy, theories of reaction rate, Heterogeneous reactions: Heterogeneous reaction that forms the basis on the nature of the solid reaction products on the interface nature, area effect, interface geometry, boundary layer, temperature effect and reaction rate. Solid-gas, solid-liquid, solid-solid, liquid-gas, liquid-liquid reactions and examples from metallurgical applications.

	T	A	C	ECTS
MEM 563 AGLOMERATION	**3**	**0**	**3**	**6**

Nature of ores and minerals, Lump ores and powders, Sintering, Purposes of sintering, Preparation of sinter mixture, System variables, Kinetics and mechanism of sintering, Relationship between raw material mixture and sinter quality, Economics in sintering, Pelleting, Proper pellet production, Pellet ball obtaining mechanism, Using additives in pelleting, Drying and firing of suitable pellets, Bonding mechanism in pelleting, Behavior of pellets during reduction, Agglomeration of other materials.

	T	A	C	ECTS
MEM-571 ADVANCED TECHNOLOGY MATERIALS	**3**	**0**	**3**	**6**

Investigation of physical, chemical properties and production methods of advanced technology materials used in defense, aerospace, micro-electronics, communications and automotive industries.

	T	A	C	ECTS
MEM-572 NANO-COMPOSITE MATERIALS	**3**	**0**	**3**	**6**

The properties, usage areas and main production methods of nano-sized composite materials with technological importance are within the scope of the course. For this purpose, metal-based nano-composites, ceramic-based nano-composites and polymer-based nano-composites will be discussed in general and then nanocomposites with application areas for each composite group will be examined in detail.

	T	A	C	ECTS
MEM-573 NANOMATERIALS AND PRODUCTION PROCESSES	**3**	**0**	**3**	**6**

Properties of nanomaterials: electrical and optical, superconductivity, magnetic, mechanical properties. Usage areas of nanomaterials. Production process of nanomaterials: sol-gel method, CVD method, PVD method, powder metallurgy method, thermal spray method, electrochemical precipitation method and investigation of nanomaterials production processes.

T : Theoric

A : Application

C : Credit