POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

철강대학원

철 강 대 학 원

I. 설립목적

사회의 균형된 발전을 위해서는 미래를 지향하는 첨단분야산업기술 발전을 추구함과 동시에 근간을 담당하는 공업기반산업기술의 발전 또한 필수적이다. 철강산업은 사회발전의 원동력을 구축하는 공업기반산업으로써 기계, 전자, 조선, 자동차 등 제조업과 건설업에 기반소재를 공급하여 생산과 부가가치를 증대시키는 전후방 관련효과가 매우 큰 산업이며, 국제경쟁력 확보의 근간을 이루는 산업이다. 전 세계의 철강산업은 철강 제조업계와 철강 수요업계를 중심으로 중흥의 시대를 맞이하고 있으나, 규모의 대형화에 따른 업체 간 경쟁심화 및 선진 철강사 간 기술보호 확산 등 철강산업의 환경변화에 능동적으로 대응하기 위해서는 신기술 개발 및 창의적 연구능력을 갖춘 글로벌 철강전문 인력의 양성이 절실히 요구되고 있다. 따라서 철강대학원은 21세기 지식기반 경제시대에 철강산업의 미래를 이끌어 나갈 철강기술 전문 인력을 지속적으로 양성하여 공급함으로써, 국내 철강산업의 발전과 국가경제발전에 기여하기 위해 설립되었다.

II. 연 혁

철강대학원은 1995년 개원이래 산업체 근무경력이 있는 엔지니어 및 학사과정을 마친 인력을 대상으로 철강산업에 종사할 의지가 확고한 학생을 선발하여 교육을 실시해 왔으나, 철강산업환경의 변화에 따라 특수대학원 체제에서의 인력양성의 한계를 극복하기 위해 2005년 개원 10주년을 맞이하여 전문대학원으로 체제를 전환하였다. 이에 더하여, 대학의 철강역량 강화를 위한 위원회가 구성되어 우수 철강인력양성과 철강전문 연구기반 구축을 두 축으로 하는 중장기 철강혁신프로그램을 수립하였다.

III. 교육방향

포항공과대학교 철강대학원은 철강에 관한 교육, 기술개발 및 연구분야에서 명실상부한 세계 최고를 지향하는 전문대학원이다. 세계 최고 수준의 철강전문 기술연구인력의 양성을 목표로, 연구와 교육의 질, 국제적 소양, 리더쉽과 비즈니스 마인드를 강화할 수 있는 국제적으로 개방된 새로운 프로그램을 구성하여, 국제경쟁력을 보유한 교육과 연구환경을 제공하고 있다.

학생은 각자가 원하는 세부전공분야에 따라 가장 적합한 전임교원을 지도교수로 정하고 모든 교육과 연구 활동을 지도교수의 지도하에 수행한다. 철강대학원의 교육은 교과목 이수, 논문연구, 실용 연구 참여로 구성되며 철강대학원 및 타대학원에서 개설되는 학과목을 선택하여 이수 할 수 있고, 논문연구 시에는 본인의 관심분야를 중심으로 지도교수와 상의 하에 연구 과제를 정하여 국내외 철강회사 및 관련분야 전문가들의 지도를 받으며 실무적 감각 및 연구의 실용감각을 익힐 기회를 제공받는다. 교수진과 학생의 구성이 국제화됨에 따라 강의, 토론, 행정등 제반업무를 영어를 공용어로 하여 진행한다.

IV. 설치과정

설치과정	이수학점		비고
	교과학점	교과학점	
석사과정	28학점		a. 연구학점은 석사논문연구, 세미나, 외국어 과목을 택하여 이수한다 *세미나 과목은 4학기 이상 이수해야함.
	18학점	10학점	
박사과정	32학점		a. 연구학점은 박사논문연구, 세미나, 외국어 과목을 택하여 이수한다
	12학점	20학점	
통합과정	60학점		a. 연구학점은 박사논문연구, 세미나, 외국어 과목을 택하여 이수한다
	30학점	30학점	

* 교과목 이수시 유의사항 : 1)대학원 교과학점과목은 다음 과목들을 포함한다
a.철강대학원 교과목, b.타학과 대학원 교과목 (지도교수와 상의하에 한학기 6학점이수가능)
c.학부 400단위 교과목 (6학점까지 인정)

V. 개설과목

1. 개설교과목

학수번호	교 과 목 명	강의-실험(실습)-학점
GIFT501	Seminars in Ferrous Metallurgy Ⅰ	1-0-1
GIFT50201	Master thesis Research Ⅰ	1-0-1
GIFT50203	Master thesis Research Ⅲ	3-0-3
GIFT50301	Doctoral Dissertation Research Ⅰ	1-0-1
GIFT50303	Doctoral Dissertation Research Ⅲ	3-0-3
GIFT504	Seminars in Ferrous Metallurgy Ⅱ	1-0-1
GIFT505	Seminars in Ferrous Metallurgy Ⅲ	1-0-1
GIFT506	Seminars in Ferrous Metallurgy Ⅳ	1-0-1
GIFT508	Technical English	1-0-1
GIFT509	Technical Korean	1-0-1
GIFT600	Metallurgical Thermodynamics	3-0-3
GIFT601	Metallurgical Reaction Mechanisms	3-0-3
GIFT602	Physical Chemistry of Steelmaking	3-0-3
GIFT603	Surface & Interface Physical Chemistry	3-0-3
GIFT604	Convective Heat and Mass Transfer	3-0-3
GIFT605	Texture and Related Phenomena	3-0-3
GIFT609	Special Topic in Clean Steel Production	3-0-3
GIFT610	Ferrous Alloys Solid State Physics	3-0-3
GIFT611	TEM of Steel Microstructures	3-0-3
GIFT612	Fundamental Principles in Steel Design	3-0-3
GIFT613	Crystal Lattice Defects, Mech. Properties	3-0-3
GIFT614	Magnetic Microstructure of Soft Magnetic Materials	3-0-3
GIFT619	Thermodynamics and kinetic Simulation with Matcalc (Special Topic-Materials Design)	1-0-1
GIFT620	Steel Physical Transformation Models	3-0-3
GIFT621	Worked Models in Physical Metallurgy	3-0-3
GIFT622	Worked Models in Mechanical Metallurgy	3-0-3
GIFT623	Essential Physics for Ferrous Technology	3-0-3
GIFT624	Crystallography	3-0-3
GIFT629	Special Topic-Computational Metallurgy	3-0-3
GIFT630	Mechanical Properties of Ferrous Alloys	3-0-3
GIFT631	Special Topics for Ferrous Technology	3-0-3
GIFT632	Advanced X-ray Diffraction Analysis	3-0-3
GIFT633	X-ray Applications	3-0-3
GIFT634	Steel Welding and Joining Technologies	3-0-3

학수번호	교과목명	강의-실험(실습)-학점
GIFT650	Experimental Stress Analysis	3-0-3
GIFT651	Processing of Wide Steel Strip	1-0-1
GIFT652	Crystal Plasticity	1-0-1
GIFT653	Plasticity and Forming	3-0-3
GIFT654	Brittle and Ductile Fracture	3-0-3
GIFT661	Electrical Steels	3-0-3
GIFT671	Corrosion Science and Engineering	3-0-3
GIFT672	Stainless Steels	3-0-3
GIFT673	High Temperature Oxidation and Coatings	3-0-3
GIFT674	Introduction to Organic Coating	3-0-3
GIFT675	Protective Coatings for Steel Corrosion	3-0-3
GIFT678	Special Topic-Surface Engineering	1-0-1
GIFT680	Advanced Control Theory and Applications	3-0-3
GIFT689	Special Topic-Control and Automation	3-0-3
GIFT692	Metallurgical Reaction Kinetics	3-0-3
GIFT693	Blast furnace operation analysis	3-0-3
GIFT694	Structure and properties of molten Slags	3-0-3
GIFT700	Introduction to Metallurgical Engineering	3-0-3
GIFT701	Advanced Characterization & Microanalysis	3-0-3
GIFT702	Solidification Processing	3-0-3
GIFT703	Steel Production Technology	3-0-3

2. 교과과정 및 교과내용

GIFT 501, 504, 505, 506 Seminars in Ferrous Metallurgy

The purpose of this course is to give students the opportunity to obtain information about important issues and recent progress in the steel industry from invited specialists in each field. This course is required of all full-time Ph.D candidates in each semester for which they are registered.

GIFT 50201~50203 Masters Thesis Research

This course is required to perform research projects for the M.S. degree under the supervision of a faculty advisor.

GIFT 50301~50303 Doctoral Dissertation Research

This course is required to perform Ph.D research projects under the supervision of a faculty advisor.

GIFT 508 Technical English

Improvement of overall English ability with a focus on productive skills of enhancement.

GIFT 509 Technical Korean

Improvement of overall Korean ability with a focus on productive skills of enhancement.

GIFT 600 Metallurgical Thermodynamics

In this course the laws of thermodynamics will be applied to gas, liquid, solid and crystalline systems. Phase equilibria and phase stability of fluid and stressed crystalline systems will be examined. Thermochemisty and the application of thermodynamics to surfaces and interfaces will also be introduced. The theory of thermodynamics and developing the foundation of thermodynamics for application to new situations, as well as its application to real problems, will be emphasized.

GIFT 601 Metallurgical Reaction Mechanims and Processes

This course deals with reaction mechanisms and kinetics of metallurgical systems and discussion on reaction processes. In particular, this course addresses the important rate controlling processes in high-temperature reactions, including gas phase mass transfer, free vaporization, liquid phase mass transfer and heat transfer. On completion of this course, students are expected to be confident of dealing with heterogeneous reactions occurring in steelmaking, refining, casting, reheating and hot rolling.

GIFT 602 Physical Chemistry of Metallurgical Reactions

The objective of this course is to provide an understanding, in specific industrial situations, of how chemical thermodynamics and heterogeneous kinetics are combined to describe steelmaking high temperature reactions. Case studies concern slag metal reactions, gas-metal reactions and degassing phenomena, alloy dissolution in liquid steel and scrap melting, inclusions formation, elimination and transformations.

GIFT 603 Physical Chemistry of Surfaces and Interfaces

This course deals with the physical chemistry of surfaces and interfaces in high temperature reaction environments. It covers surfaces and interfaces of gas, as well as liquid and solid materials. The principles underlying the phenomena occurring at surfaces and interfaces will be discussed from a thermodynamics perspective. Examples of important metallurgical processes will be cited.

GIFT 604 Convective Heat and Mass Transfer

This course is intended to provide students with the fundamentals and tools needed to model, analyze and solve the various kinds of problems involving "flow induced transport" phenomena in Iron & Steel making process. Starts from discussions about basic concepts and equations in convection, this course will cover analytic solution methods, boundary layer theory, empirical solutions and numerical simulations.

On completion of this course, students are expected to be confident of how to solve the transport and fluids problems analytically and numerically.

GIFT 605 Texture and Related Phenomena

Texture, or preferred orientation, is a fundamental phenomenon resulting from the microstructure evolution that takes place during various processes including casting, thin film fabrication, and thermomechanical processing of materials. A strong texture developed in material results in anisotropy in properties of the material. Therefore, 'texture and related phenomena' has been a subject of teaching and research because of its technological importance and scientific interest. The object of this course is to teach texture and related phenomena focusing on steels and related materials.

GIFT 610 Ferrous Alloys Solid State Physics

The course is intended for students who wish to acquire a more fundamental knowledge of the basic properties of Fe, ferrous alloys and steels. Fundamental solid state properties of ferrous alloys are discussed in depth, and specific attention is given to concepts related to phase stability, crystallography of alloy phases, thermodynamics, and defects.

GIFT 611 TEM of Steel Microstructures

The course is an introduction to the use of the transmission electron microscope for the analysis of steel microstructures. It emphasizes the practical aspects of the operation of the TEM to obtain quantitative microstructural information which is useful for understanding the properties of steel. The course focuses mainly on conventional TEM, based on diffraction contrast. The theoretical concepts of the TEM contrast arising form linear and planar defects in steels are treated in depth. The principles of other commonly used methods are also presented. These include Energy Dispersive Spectroscopy, Electron Energy Loss Spectroscopy, Convergent Beam Electron Diffraction, High Resolution TEM, and Dark Field Weak Beam Microscopy. Ample time is devoted to the use of these techniques for the understanding of the sub-micron structure and composition of the decomposition products of austenite, pearlite, bainite and martensite.

GIFT 612 Fundamental Principles in Steel Design

In this course, concepts of strengthening mechanisms in ferrous alloys are developed, integrating Fe deformation mechanism and steel dislocation theory. Industrial processing concepts such as reheating, hot- and cold - rolling, batch annealing, continuous annealing, and hot-dip galvanizing are given an overview. The course includes practical applications by case studies, testing static mechanical properties of steels, etc.

GIFT 613 Crystal Lattice Defects, Mech. Properties

To introduce graduate students to the crystal lattice defects and their effect on the mechanical properties of metallic materials, particularly ferrous ones

GIFT 614 Magnetic Microstructure of Soft Magnetic Materials

The objective of the course is to give the students an in depth introduction to the magnetic microstructure, i.e. the arrangement of domains and domain walls, in soft magnetic materials in general with an emphasis on Fe-Si alloys. The lectures provide both an understanding of magnetic domains and magnetization processes in soft magnetic materials, including electrical steel, and a solid knowledge of the domains and their reaction to magnetic fields.

GIFT 619 Thermodynamics and Kinetics Simulation with MATCALC(Special Topic: Materials Design,)

MatCalc is a complex software, and thermodynamics and kinetics are complex topics. Consequently, there is a million possibilities to make things wrong. Since we know about this problem, we have started to offer training on the MatCalc software and courses on basic thermodynamics and kinetics as related to problems which can be solved with MatCalc.

GIFT 620 Steel Physical Transformation Models

The objective of this course is two-fold, firstly to provide a fundamental understanding of solid-state transformation from austenite in steels, and secondly examination of the techniques by which microstructure can be calculated. It is important that calculations are based on physical mechanisms as far as they are known.

GIFT 621 Worked Classical Models of Physical Metallurgy

The objective of the course is to provide a fundamental understanding of physical metallurgy through worked classical models that have paved the way for modern material science. During the course, students may learn not only the models and the fundamentals behind the models but also problem solving ideas from such great scientists as Gibbs and Zener.

GIFT 622 Worked Classical Models of Mechanical Metallurgy

The objective of the course is to provide a fundamental understanding of mechanical metallurgy through worked classical models that have paved the way for material science. During the course, students may learn not only the models and the fundamentals behind the models but also problem solving ideas from such great scientists as Cottrell and Orowan.

GIFT 623 Essential Physics for Ferrous Technology

Currently opened course, "Ferrous Alloys Solid State Physics" (GIFT 610), requires comprehensive understanding on modern physics, especially, quantum physics and statistical physics. Students without Physics background, feel difficulties to understand GIFT 610 course, because they have very little knowledge of quantum/statistical physics. This course is providing a compact introduction of all fundamental aspects of modern physics for helping understand the contents of GIFT 610. Many parts given in this lecture will also helpful for understanding principles of measuring instruments.

GIFT 624 Crystallography

The course is intended for candidates who have a zero knowledge of crystallography, who by the end of the course should be able to deal both with the elements of modern crystallography and mathematical aspects dealing with diffraction, interfaces, texture, phase transformations and deformations.

GIFT 630 Mechanical Properties of Ferrous Alloys

The objective of this course is to make students familiar with the fundamental concepts of mechanical properties of structural steels by introducing the theories of deformation, hardening, and failure. It also deals with texture and tribological effects in forming processes utilizing the finite element method. Extensive analysis of industrial deformation processes will be performed using several case studies. In addition, mechanical deformation theory of steels studied will be applied to strain analysis of sheets using the circle grid method.

GIFT 631 Special Topics for Ferrous Technology

This course provides students the general knowledge of the electrical steels for the fundamentalphysics of magnetism as well as the physical metallurgy of fabrication processes. The fundamental physics will be treated magnetism, magnetic phenomena, and testing of magnetism. The physical metallurgy of fabrication will be covered texture formation by rolling, recrystallization and grain growth. The concept of the electrical machine design will also be introduced to develop a new electrical steel.

GIFT 634 Steel Welding and Joining Technologies

To provide principal understanding of various welding and joining technologies commonly applied for steel products. Both conventional and new joining processes including their applications are to be introduced. Weldability of C–Mn steels and stainless steels are also to be discussed with various issues in welds.

GIFT 650 Experimental Stress Analysis

This course emphasizes conventional theoretical mechanics verification through experimental practices. It discusses experimental methods of evaluating the mechanical properties of ferrous alloys such as stress, deformation, fracture toughness, etc. It also covers two- and three-dimensional photoelasticity and surface strain measurement.

GIFT 651 Processing of Wide Steel Strip

This course gives an overview in applications for wide strip production, needed for the understanding of the technical process. It mainly focuses on hot strip mills (HSMs). A basic overview and refreshing in stress and strain, strain hardening and properties and flow of steel strip will be given. Description and special emphasis will be taken for specific layouts of HSMs. The wear of rolls will be discussed as well as the use of roll gap lubrication in HSM. For CR route, different layouts and modernizations will be presented and discussed. Heat and surface treatment facilities will be introduced.

This lesson is required and used as an introduction for the planned (not yet decided!) laboratory lesson in the Spring 2010, "Simulation of a hot and/or cold rolling mill using HYBREX", where the students will be able to create a mill and simulate it running, checking limits and borderlines in processing; on material properties as well as equipment.

GIFT 652 Crystal Plasticity

Polycrystal models represent the material as an aggregate of grains with different orientations, and predict the material's response as an average over the constituent grains. As a consequence, they capture the mechanical anisotropy associated with the texture. In addition, they are based on the physical mechanisms acting at the grain level (i.e.: dislocation slip systems). In these lectures we review and compare available polycrystal models. We discuss the basic elements, assumptions and range of applicability of the models. We discuss hardening and texture evolution associated with several strain paths (rolling, torsion, compression) and provide hands-on training on how to simulate polycrystal plastic forming using the Visco-Plastic Self-Consistent (VPSC) Polycrystal Code.

GIFT 653 Plasticity and Forming

This course is an introduction to the theory of plasticity and its application to metal forming. The course will emphasize the continuum description of plasticity, which is more suitable for the analysis of forming processes compared to micro-scale descriptions. However, the macroscopic properties of materials, in particular for steels, will be interpreted in terms of microscopic deformation mechanisms. The course will start with an introduction of mathematical tools necessary to understand the continuum concepts of stress and strain, and to describe the fundamental equations of continuum mechanics. The relationship between stress and strain will be established first for a linear elastic solid. The non linear relationship between these quantities for a plastic solid will be covered in detail through the classical flow theory of plasticity. The concepts of isotropic and anisotropic behavior will be introduced. Material properties relevant to forming analyzes will be described together with microstructures and deformation conditions. The notion of formability will be discussed in connection with plastic instability and fracture phenomena. The flow theory of plasticity will be applied to the analysis of bulk and sheet forming operations through the upper bound and other methods. A few specific processes will be studied in more details: Rolling, extrusion and forging for bulk forming; Drawing, stamping and hydroforming for sheet forming.

GIFT 654 Brittle and Ductile Fracture

This course is an introduction to the fracture analysis of brittle and ductile solids. Metals deformed at low temperature are usually fragile and remain essentially elastic even when a crack propagates. Ductile materials, such as many metals deformed at room temperature or most metals deformed a high temperatures are ductile. In steels, there is a transition temperature under which the material is brittle and above which it is ductile. In brittle metals, cracks propagate as a result of the separation of inter-atomic planes, or cleavage, while in a ductile materials, the mechanism of fracture occurs by an increasing degradation of the material, damage, during plastic deformation. Ductile fracture is a sequence of three distinct phenomena: 1) Nucleation of micro-voids by decohesion from the matrix of in-homogeneities such as second phases and inclusions, or by cracking of these particles; 2) Growth of micro-voids due to plastic flow in the matrix and; 3) Coalescence of voids through the processes of micro-localization of ligaments linking neighboring voids. Fracture occurs in a part either during forming or during service. During forming, fracture is ductile and occurs after damage accumulation while, in service, it can be either brittle or ductile. In service, fracture occurs by cracks nucleation, due to material cycling fatigue, and crack propagation through the structure. In this class, the different types and mechanisms of fracture will be described. Fracture occurring in forming will be analyzed based on theories of void nucleation, growth and coalescence, and using constitutive descriptions of plasticity for materials containing small amounts of porosity. Fracture in service will be discussed after an introduction to fracture mechanics where stress and strain fields around a crack tip are analyzed. Stress, strain and energy criteria for crack propagation will be introduced and concepts such as fracture toughness and fatigue crack growth will be discussed.

GIFT 661 Electrical Steels

This course introduces fundamental theory of electric and magnetic fields applied to materials. It discusses microstructure and electrical/magnetic properties of grain-oriented silicon steels. This course explains the effect of hot rolling on microstructure and properties of silicon steels. It addresses the effect of cold rolling on secondary recystallization in silicon steels and high temperature deformation of silicon steels. The course covers the structure and texture of electrical steels. Examples of various kinds of electrical steels will be cited together with current and future electrical steel technology.

GIFT 671 Corrosion Science and Engineering

This course focuses on application of electrochemical theories to corrosion of ferrous alloys. Subjects will include various kinds of corrosion type mechanisms such as environmental corrosion, spot corrosion, grain boundary corrosion, and stress corrosion cracking. The course will provide students with the principles underlying corrosion control using corrosion Inhibitors, cathodic protection, and surface treatment. The course also examines current and future corrosion controlling technology.

GIFT 672 Stainless Steels

This course begins with an overview of general features of stainless steels. It briefly introduces students to the melting and refining processes of stainless steel production together with alloy design concepts. The class will be directed towards understanding important surface treatment, microstructure- and corrosion control of stainless steels, integrating process-controlling factors and microstructural features and mechanical properties of stainless steels. Examples of several grades of stainless steels will be discussed together with current and future technology of stainless steel production.

GIFT 673 High Temperature Oxidation and Coatings

In this class, the principle of high temperature oxidation mechanism is discussed for various engineering materials including steels. The basic concepts of alloy design for high temperature applications are introduced. Various engineering practices for protective coating technologies are reviewed.

GIFT 674 Introduction to Organic Coatings

This course is intended to provide current scientific understanding in the field of organic coatings with a summary of the applied technology of the field. The objective of this course is to introduce coatings chemistry in a way that would fulfill the purpose of providing the beginner, involved in and having interset in organic coatings, with an easy-to-understand primer that might broaden his understanding of the

subject later. This course introduces general science from a paint point of view, colloidal aspects of the subject, flow and dispersion of coatings, basics about paint compositions including organic film formers, solvents, pigments and additives. Introduction to corrosion and corrosion protection by coatings will also be addressed during this course. In addition, surface treatment and some special coatings for metallic substrates will be touched in this course.

GIFT 675 Protective Coatings for Steel Corrosion

This class teaches the basic principle of various protective coating technologies commonly applied for steel products. Both organic and metallic coating technologies are discussed with various process parameters which determine the property of the coatings. The corrosion resistance of the coated steel products is studied in various corrosive environments. This course will also introduce general science from a paint point of view, colloidal aspects of the subject, flow and dispersion of coatings, basics about paint compositions including organic film formers, solvents, pigments and additives. Introduction to corrosion and corrosion protection by organic coatings which are currently employed in industries will also be addressed during this course.

GIFT 678 Special Topic-Surface Engineering

To discuss the major corrosion control and engineering strategies. The students will be taught how to protect metals for corrosion using inhibitors, coatings or cathodic protection. They will also learn about materials selection and the specific weaknesses and strengths of engineering metals and alloys.

GIFT 680 Advanced Control Theory and Its Applications

This class provides students with advanced control theory as well as general industrial applications.Characteristics of varioussystems are analyzed and synthesized for efficient controller design based on state space representation. Topics includefuzzy sets and systems, optimal control systems, nonlinear controland adaptive control systems, and their industrial

GIFT 692 Metallurgical Reaction Kinetics

Kinetics is one of most essential tools to understand iron and steelmaking processes as well as thermodynamics. This course deals with an introduction to the theory of interfacial reaction kinetics and its application to Fe-C-O system, such as decarburization, carburization and oxidation reactions. Since most of reactions in iron and steelmaking processes involve the transfer of substances across interfaces, the processes can be strongly influenced by the structure of interface or the presence of strongly chemisorbed species at interfaces. Thus, the course focuses the effect of absorption phenomena on interfacial reactions in metallurgical processes. This course presents a unified treatment of phenomenological and atomistic kinetic processes in reactions. The course emphasizes analysis and development of rigorous comprehension of fundamentals and provides the foundation for the advanced understanding of practical metallurgical processes.

GIFT 693 Blast furnace operation analysis

The most common method of studying a process is to make a heat and material balance. This is necessary also because by doing this one is forced to find in and outgoing amounts of material and heat. It is very useful if it is possible to divide the balance in smaller steps. In this way it is easier to describe which parts in a process that are critical and thus determining for the process. Such divided balances have been proposed by Prof. Andre Rist and he has furthermore shown his results in clearly arranged diagram, so called Rist-diagrams. P. Reichardt showed that heat balance could be portrayed in a similar manner and Rist has used the models of Reichardt and combined the two types of diagrams. A. Rist has made use of the diagram for the illustration of the blast furnace process, but the diagram can be used also for the description of other processes such as pure coal gasification, smelting reduction, the cupola etc.

This course presents a method how to make and how to use Rist diagram to analyze BF and other processes. The course will provides the foundation for the advanced understanding of practical metallurgical processes.

GIFT 694 Structure and properties of molten Slags

In iron and steelmaking, the use of slag is of essential importance. The refining process are controlled by metal/slag systems and nearly all reaction steps in iron and steel production are closely related to the use of metallurgical slag.

Knowledge of the properties of the slag is needed to enable assessment of the various reactions and optimal process control. The physico-chemical properties of slag are controlled principally by their structures. The physical properties can be estimated from knowledge of structural characteristics such as the NBO/T ratio and valency and size of the cations. The aime of this class is to provide an introductory treatise on theatomic scale structure as well as various thermodynamical models and physicochemicalproperties of oxide melts, mainly silicates, from both the basic science and engineeringpoints of view.

GIFT 700 Introduction to Metallurgical Engineering

Course is intended for students who have not studied materials science and/or engineering at the undergraduate level. That is, this course is designed for beginners in iron and steel engineering in order to study structure, properties and performance of basic engineering materials and to improve the ability of their applications to ferrous materials with microstructural control of steels for their desired performance by compositional, thermal, mechanical, magnetic and surface treatments.

GIFT 701 Advanced Characterization and Microanalysis

This course begins with an overview of fundamental physical and electronic theories underlying chemical- and instrumental analysis for the determination of composition and structure of materials. The class will be directed towards systematically understanding the approximate principles of each instrument operation by combining the results of practical analysis, measurement, and testing and their application methods. Each student in the course is required to submit a modular report on a special experiment closely related to metallurgical processes and research with a special emphasis on how to interpret and utilize experimental results.

GIFT 702 Solidification Processing

The goal of this course is to enable the student to solve practical solidification processing problems through the application of solidification theory. The objectives of this course are to: (1) Develop solidification theory so that the student can understand solidification structure; (2) Develop a strong understanding of the role of heat transfer in castings; (3) Develop an appreciation for the strengths and weaknesses of a variety of casting processes. The first half of the course will be theoretical, covering nucleation, growth, instability, and solidification microstructure: cells, dendrites, eutectic and peritectic structures, solute redistribution, inclusion formation and separation, and defects and heat transfer problems. The second part of the course will be process oriented and will include conventional and near-net-shape casting, rapid solidification and spray casting with emphasis on process design to avoid defects.