COURSE STRUCTURE INTERNATIONAL UNDERGRADUATE METALLURGY & MATERIALS ENGINEERING

KODE	SUBJECT	SKS
	1st Semester	
ENGE 6 1 0001	Calculus 1	3
UIGE 6 1 0002	Academic Writing	3
ENGE 6 1 0005	Physics (Mechanic & Heat)	3
ENGE 6 1 0006	Physics (Mechanic & Heat) Laboratory	1
ENGE 6 1 0009	Basic Chemistry	2
ENMT 6 1 1 001	Engineering Drawing	2
ENMT 6 1 1 002	Introduction to Engineering Materials	2
ENMT 6 1 1 003	Thermodynamics of Materials	3
ENMT 6 1 1 004	Basic Chemistry Laboratory	1
	Sub Total	**20**
	2nd Semester	
ENGE 6 1 0004	Linear Algebra	4
ENGE 6 1 0002	Calculus 2	3
ENGE 6 1 0007	Physics (Electric, Magnet, Wave & Optic)	3
ENGE 6 1 0008	Physics (Electric, Magnet, Wave & Optic) Laboratory	1
ENGE 6 1 0010	Statistics & Probability	2
ENMT 6 1 2 005	Polymer Chemistry	4
ENMT 6 1 2 006	Transport Phenomenon	3
	Sub Total	**20**
	3rd Semester	
ENGE 6 1 0012	Health, Safety & Environment	2
ENMT 6 1 3 007	Chemical Characterization of Materials	2
ENMT 6 1 3 008	Electro-Chemistry	3
ENMT 6 1 3 009	Heat Treatment & Surface Engineering	3
ENMT 6 1 3 010	Physical Metallurgy 1	4
ENMT 6 1 3 011	Polymer Technology	3
ENMT 6 1 3 012	Static & Mechanic of Materials	3
	Sub Total	**20**
	4th Semester	
ENMT 6 1 4 013	Corrosion & Protection of Metals	3
ENMT 6 1 4 014	Iron & Steel Making Process	2
ENMT 6 1 4 015	Mineral Processing	4
ENMT 6 1 4 016	Numerical Computation	2
ENMT 6 1 4 017	Physical Metallurgy 2	3
ENMT 6 1 4 018	Tech. of Microstructural Analysis	2
ENMT 6 1 4 019	Testing of Materials	2
ENMT 6 1 4 020	Chemical Characterization of Materials Laboratory	1
ENMT 6 1 4 021	**Corrosion & Protection of Metals Laboratory**	**1**
	Sub Total	**20**
	5th Semester	
UIGE 6 1 0004	Integrated Character Building Subject B	6
ENMT 6 1 5 022	Industrial Management	2
ENMT 6 1 5 023	Metal Manufacturing Process	4

ENMT 6 1 5 024	Non Ferrous Extractive Metallurgy	3
ENMT 6 1 5 025	Tech. of Microstructural Analysis Laboratory	1
ENMT 6 1 5 026	Testing of Materials Laboratory	1
	Sub Total	**17**
	6th Semester	
UIGE 6 1 0001	Integrated Character Building Subject A	6
UIGE 6 1 0005-9	Religious Studies	2
UIGE 6 1 0003	Sport & Art	1
ENMT 6 1 6 027	Ceramic Technology	3
ENMT 6 1 6 028	Composite Technology	3
ENMT 6 1 6 029	Materials Joining	3
ENMT 6 1 6 030	Extractive Metallurgy Laboratory	1
ENMT 6 1 6 031	Metal Manufacturing Process Laboratory	2
	Sub Total	**21**
	7th Semester	
ENMT 6 1 7 032	Capita Selecta	2
ENMT 6 1 7 033	Engineering Design of Products	3
ENMT 6 1 7 034	Fracture Mechanics & Failure Analysis	4
ENMT 6 1 0 035	Internship	2
ENMT 6 1 0 036	Seminar of Final Project Proposal	1
	Elective 1	2
	Elective 2	2
	Sub Total	**16**
	8th Semester	
ENMT 6 1 0 037	Final Project	4
	Elective 3	2
	Elective 4	2
	Elective 5	2
	Sub Total	**10**
	TOTAL	**144**

Curriculum of 2016 – Subjects Syllabus
Bachelor Degree International
Dept. of Metallurgy & Materials Engineering

ENMT 611001 - ENGINEERING DRAWING – (2 Credit Points)
Illustration: Function and benefit of Engineering Drawing; SAP; Measurement and Evaluation; Introduction to drawing equipment; Basic definition of geometric, paper format, draw regulation, line, fild, line confiuration, basic geometric form; Visualization geometric: Skew projection and isometric, function and line types, confiuration geometric form; Orthogonal Projection: Projection standard, viewing concept, width display principle; Advanced orthogonal projection: Circle region concept, special region concept, trimming concept, display width, refraction.
Prerequisite: -

ENMT 611002 - INTRODUCTION TO ENGINEERING MATERIALS – (2 Credit Points)
(1) Types of engineering materials and their applications; (2) Structures of engineering materials; (3) Properties of material; (4) Manufacturing and Processing of Metallic Materials; (5) Steel and iron: production and properties; (6) Aluminium: production and properties;(7) Other non-ferrous alloys: production and properties; (8) Polymer: processing and properties; (9) Ceramic: processing and properties; (10) Composite: processing and properties
Prerequisite: -

ENMT 611003 - THERMODYNAMICS OF MATERIALS – (3 Credit Points)
Definition of thermodynamics, first, second, and third law of thermodynamics, statistical interpretation of entropy, auxiliary functions, heat capacity, enthalpy and entropy, phase equilibrium in a component, gas and solution behavior, free energy, binary system composition, reaction of pure condensation phase and gas phase, equilibrium reaction of a system in a solution component
Prerequisite: -

ENMT 611004 - BASIC CHEMISTRY LABORATORY – (1 Credit Point)
Physical and chemical properties; Separation and purification of the substance; Identification of alkali metal ions, alkaline earth, ammonium, sulfate, iodid, bromide and nitrate; acid-base titration; metal and acid reaction; Water crystals
Prerequisite: -

ENMT 612005 - POLYMER CHEMISTRY – (4 Credit Points)
Fundamentals of organic chemistry (bonding atom and molecule, polar molecules, free radicals, the nomenclature of organic compounds, isomer, conjugation and resonance). Reaction types of organic compounds, addition reactions, nucleophilic and electrophilic substitution, elimination, rearrangement, and radical reaction mechanism. Basic Properties of Polymer Chemistry
Prerequisite: -

ENMT 612006 - TRANSPORT PHENOMENON – (3 Credit Points)
Mass transfer, Fluid flow concept, Laminar flow, momentum conservation, Turbulent flow, Enthalpy & heat transfer, Solid & liquid diffusion mass transport
Prerequisite: Thermodynamics of Materials

ENMT 613007 - CHEMICAL CHARACTERIZATION OF MATERIAL LABORATORY – (1 Credit Point)
Quantitative analysis of organic and anorganic matter using titrimetry method
Prerequisite: Chemical Characterization of Material

ENMT 613008 - ELECTRO-CHEMISTRY – (3 Credit Points)
Basic concepts and applications of electrochemistry, and conductivity solution, Faraday's law, and their application. Elektrode electrochemical cell (definition, potential, equation Nerst, electrical double layer, the polarization, the measurement of potential, free energy and electrode potential, equilibrium potential), the reference electrode,Construction Pourbaix diagram and its application. Electrochemical kinetics, electrode reaction speed, mixed potential theory, Evans-diagram, the mixed-potential diagram

Prerequisite: -

ENMT 613009 - HEAT TREATMENT & SURFACE ENGINEERING – (3 Credit Points)
Definition of heat treatment, phase transformation and microstructure, TTT and CCT diagram, the influence of heating and cooling rate, stable and metastable microstructure, hardenability, the influence of alloying element, hardening, softening, temper brittleness, distortion and its prevention, carburization, nitro-carburizing, nitriding, boronizing, non-ferrous heat treatment, various heat-treating furnace and its atmosphere, deviation in heat treatment process, special heat treatment, case study of heat treatment and surface engineering
Prerequisite: Physical Metallurgy 1

ENMT 613010 - PHYSICAL METALLURGY 1 – (4 Credit Points)
(1) Definition of crystal; (2) Crystal lattice(3) Unit cell; (4) Bravais lattice; (5) Miller index for planes and direction; (6) Stereographic projection; (7) Crystal symmetry; (8) Formation of crystal; (9) Identification of crystal; (10) Crystal defects: point defects, line defects (dislocations), edge dislocations, screw dislocations, burgers vector, movement of dislocations, energy of dislocation, dislocations in FCC, BCC and HCP structures, planar defects; (11) Fatigue and Fracture of Materials; (12) Creep of Materials; (13) Strengthening Mechanism: strain (work) hardening, grain boundary strengthening, solid solution strengthening, precipitation (two-phase) strengthening, steel alloys strengthening, composite strengthening, study case in materials strengthening.
Prerequisite: -

ENMT 613011 - POLYMER TECHNOLOGY – (3 Credit Points)
Relationship of structure and behaviour of polymer molecule, polimer material characteristics (thermal, chemical, mechanic, optic and electrical), fabrication process stages (formulation, continuous & discontinuous manufacturing, product finalization) on thermoplastic, thermosetting and rubber product, polimer raw material formulation, case study of polymer product in packaging, automotive, electronic and construction application
Prerequisite: Polymer Chemistry

ENMT 613012 - STATIC & MECHANIC OF MATERIALS – (3 Credit Points)
General principle of mechanics, Vector and forces, Equilibrium points, Resultant of forces, Structure analysis, Center of gravity and centroid, Moment inertia, Internal forces, Friction. The concept of stress strain, Relation of stress and strain in axial loading, Twisting, Buckling, Transversals loading, Stress analysis, Design of shaft and beam, Beam deflection, Structural joints, Column and thick cylinder, Energy method.
Prerequisite: -

ENMT 614013 - CORROSION & PROTECTION OF METALS – (3 Credit Points)
Principles of corrosion, kinetics of corrosion, polarization, passivation, measurement of corrosion rate, metallurgical aspects, corrosion tests, forms of corrosion, high temperature corrosion, cathodic protection, anodic protection, coating, inhibition, materials selection and design, monitoring and inspection, analysis of corrosion driven-damage, standards related to corrosion
Prerequisite: Electro-Chemistry

ENMT 614014 - IRON & STEEL MAKING PROCESS – (2 Credit Points)
Classification and the development of steel (iron ores, reductor, etc.) and their preparatory process, thermodynamics and kinetics of iron and steel making process, blast furnace reduction of iron ores, direct reduction (hylsa, midrex, rotary kiln SL-RN, rotary hearth), smelting reduction, desulfurization, deoxidation, dephosphorisation, degassing, steel making in EAF (Electric Arc Furnace) and BOF (Basic Oxygen Furnace), secondary metallurgy process, continuous casting, hot and cold rolling, special steel making
Prerequisite: Mineral Processing

ENMT 614015 - MINERAL PROCESSING – (4 Credit Points)
Understanding mineralogy, classification of minerals, mineral properties, mineral that has economic value. Terminology

and basic concepts of processing mineral / ore, potential sources of mineral / ore that can be processed in a technically and economically, the processes of size reduction (comminution): The process of crushing, screening process, grinding process, the classification process, process of separation/concentration: Gravity concentration: Concentration Heavy Jigging Flowing Film, Media Separation, Flotation process, Magnetic Separation, High Tension Separation, Dewatering and Thickening process
Prerequisite: Physical Metallurgy 1

ENMT 614016 - NUMERICAL COMPUTATION – (2 Credit Points)
Introduction to models, types of models, basics of Matlab, array in Matlab, if and switch selection, loop in Matlab, function and m-file in Matlab, linear equation, Taylor expansion method, Euler, differential equation, basic of solid works, solid modeling, basics of simulink, first and second order simulink
Prerequisite: -

ENMT 614017 - PHYSICAL METALLURGY 2 – (3 Credit Points)
(1) Concept of Equilibrium: single component system, binary component system, the phase rule, binary phase diagrams; (2) Fe-Fe3C Phase Diagram; (3) Ternary Equilibrium: ternary system representation, ternary system containing 2 phase, ternary system containing 3 phase; (4) Diffusion in Materials: atomic mechanism of diffusion, interstitial diffusion, substitutional diffusion; (5) Crystal Interfaces and Microstructure: interfacial free energy, grain boundary, interphase interfaces in solids, interface migration; (6) Solidification: nucleation in pure metals, growth of a pure solid, solidification of alloy, solidification of ingots and castings, solidification of fusion welds, rapid solidification; (7) Diffusional Transformation in Solids: homogeneous and heterogeneous nucleation in solids, precipitate growth, transformation kinetics, eutectoid transformation, ordering transformation; (8) Diffusionless Transformation in Solids: theories of martensite nucleation, martensite growth, tempering of ferrous martensite, martensite transformation in nonferrous metals, case study in diffusionless transformation
Prerequisite: Thermodynamics of Materials

ENMT 614018 - TECH. OF MICROSTRUCTURAL ANALYSIS – (2 Credit Points)
Techniques of microstructure analysis, Phase formation and general characteristic of material structures, Microstructure of steel; stable and metastable phases and the formation and mechanism, Microstructure of non-ferrous alloys; aluminum, copper, titanium, Macrostructure, Sampling techniques, Samples preparation, Observation techniques with optical and electron microscopes, Special measurements; micro-hardness, coating thickness, roughness, Quantitative metallography; grain size, volume fraction of phases and precipitates.
Prerequisite: Physical Metallurgy 1

ENMT 614019 - TESTING OF MATERIALS – (2 Credit Points)
Introduction to material testing, Review of mechanical behavior of materials, Data analysis and presentation of test results, Testing procedures, Testing machine and instruments, Standardization of materials testing, Destructive testing (tensile, compression, shear, fatigue, stress relaxation, and wear), Non-destructive (visual, penetrant, ultrasonic, radiography, eddy current and magnetic particle)
Prerequisite: Physical Metallurgy 1

ENMT 614020 - CHEMICAL CHARACTERIZATION OF MATERIAL LABORATORY – (1 Credit Point)
Quantitative analysis of organic and anorganic matter using titrimetry method
Prerequisite: Chemical Characterization of Material

ENMT 614021 - CORROSION & PROTECTION OF METALS LABORATORY – (1 Credit Point)
Corrosion cells, corrosion potential measurement of selected metals, polarization of stainless steel, cathodic protection, surface treatment.
Prerequisite: -

ENMT 615022 - INDUSTRIAL MANAGEMENT – (2 Credit Points)
Introduction to industrial management, organization and management functions, theories and techniques of decision-

making, management of production / operations, the strategic decisions of products and processes, location and layout, management and control of stocks (inventory), R & D, project management, QC and productivity, management production practices, marketing and industrial management, HR management, IT and manufacturing industry, manufacturing industry in Indonesia
Prerequisite: -

ENMT 615023- METAL MANUFACTURING PROCESS – (4 Credit Points)
The forming of metals as a part of design process and manufacture; fundamentals of metal casting (mould, molten metal, solidification), mould (sand, ceramic, metal), pouring system (pattern, riser, pressure and unpressure, chill) and its simulation, solidification of cast iron and aluminum, liquid treatment for ferrous metals (inoculation, Mg treatment) and non-ferrous (modifier, grain refiner), various methods of casting, casting defect; common principle of solid forming of a metal, techniques of metal forming through: pressing, forging, rolling, extrusion, wire drawing, sheet metal forming; thermo-mechanical processing (TMP). General principle of powder metallurgy, powder fabrication and mechanism of powder forming, powder characteristics and characterization, mechanical alloying, pre-compaction process, compaction, precursor characteristic, sintering and powder consolidation, full density processing, sintering equipment and related aspects, application of powder metallurgy products
Prerequisite: Physical Metallurgy 1

ENMT 615024 - NON-FERROUS EXTRACTIVE METALLURGY – (3 Credit Points)
Basic principles of extractive metallurgy (pyrometallurgy, hydrometallurgy and electrometallurgy). Process/treatment process of ore to be extracted. Leaching method of oxide and sulfide ores, Bayer process, Al, Au leaching by cyanidation (Leaching; precipitation techniques; ion exchange; solvent extraction; reverse osmosis). Electrometallurgy (Electro winning and electro refining). Molten salt electro winning. Hall process. Electro winning of Mg, Ti. Secondary metals. Obtaining metals from scrap and secondary sources by using pyro, hydro, and electrometallurgy. Pyrometallurgy, mineral separation, slag, blast furnace, raw materials, reactions, material balance, iron ore, roasting, smelting, refining of Sn, Ni, Cu, Zn, Pb.
Prerequisite: Electro-chemistry, Mineral Processing

ENMT 615025 - TECH. OF MICROSTRUCTURAL ANALYSIS LABORATORY – (1 Credit Point)
Metallographic sample preparation (techniques of cutting, grinding, polishing and etching), micro-structural analysis techniques of metal (ferrous and non-ferrous) with an optical microscope
Prerequisite: Tech. of Microstructural Analysis

ENMT 615026 - TESTING OF MATERIALS LABORATORY – (1 Credit Points)
Tensile test, Compressive test, Micro and Macro Hardness test, Impact Test, Wear Test
Prerequisite: Testing of Materials

ENMT 616027 - CERAMIC TECHNOLOGY – (3 Credit Points)
Introduction to ceramics (general), crystal structure, glass structure, phase diagrams, phase transformations. Properties of ceramics: thermal, optical, mechanical, electrical and magnetic fields, as well as the nature dielektris. Manufacture of ceramic technology and applications: conventional ceramic (aluminum-silicate; clay, glaze); cement and concrete; glass and advanced ceramics (advanced ceramics). The processes for modern ceramics, ceramic thin film, ceramic for field application of mechanical, electronic, optical and magnetic. -Based ceramic matrix composites. Refractory ceramics. Refractory raw materials, types of refractories: refractory system Alumininum - silica, silica refractories, refractory magnesite, chromite refractories, refractory carbon, special refractories. Manufacture of refractories, the use of refractory metals in the industry and others, as well as the failure mechanism of refractory.
Prerequisite: Physical Metallurgy 2

ENMT 616028 - COMPOSITE TECHNOLOGY – (3 Credit Points)
The concept, definition and clarification of the composite, matrix and reinforcement type for composites, metal matrix composite, polymer matrix composite, ceramic matrix composite, fiber composite nature. Reinforced fibers and Whiskers, the rule of mixtures, the interface in composite materials, interfacial area, Interfacial Wettability, interfacial bonding
Prerequisite: Polymer Technology

ENMT 616029 - MATERIALS JOINING – (3 Credit Points)

Principles of various material joining and its classification, adhesive bonding, mechanical joining, methods of welding: fusion welding (electric arc), electrical resistance welding, pressure welding (solid state welding), other welding process (EBW, laser welding, thermit welding, underwater welding), soldering and brazing, design of joint and welding symbol, welding metallurgy: carbon steel, low alloy steel, stainless steel, concrete steel, non ferrous, WPS and welding standards and code, weld defect and its prevention, control of joint and its testing
Prerequisite: Physical Metallurgy 1, Testing of Materials

ENMT 616030 - EXTRACTIVE METALLURGY LABORATORY – (1 Credit Point)
Metals extraction test and electrometallurgy (e.g. Electroplating, froth flotation)
Prerequisite: Non Ferrous Extractive Metallurgy

ENMT 616031 - METAL MANUFACTURING PROCESS LABORATORY – (2 Credit Points)
(1) Sand particle size distribution, water content calculation, additive substance (bentonite) content in mould, sand flowablity, relation of water and additive content in sand with permeability, shear and compressive strength of sand, (2) utilization of simulation software in calculation and design of casting, (3) Design of inlet and riser, mould making from patterns, making of the core of the mould, melting and pouring of molten metal to the mould, analysis of casting defect, analysis of casting product related to the alloying element and casting process. (4) Solid silinder forging, (5) Sheet metal rolling, (6) Sheet metal forming which includes non-simulative testing (tensile testing for n and r value), and simulative testing (strecthing and deep-drawing, LDH and LDR)
Prerequisite: Metal Manufacturing Process Metal

ENMT 616032 - CAPITA SELECTA – (2 Credit Points)
Specific topics that have not been included in Subjects and supplied by external resource persons which is experienced in industry
Prerequisite: Metal Manufacturing Process, Corrosion & Protection of Metals

ENMT 616033 - ENGINEERING DESIGN OF PRODUCT – (3 Credit Points)
Introduction to Engineering Design, total design activity, group dynamics and design management, problem identification and design specification, creativity and the conception of design, modeling, optimallisation, materials and process selection, design communication and presentation.
Prerequisite: Polymer Technology, Composite Technology, Ceramic Technology, Iron & Steel Making Process

ENMT 616034 - FRACTURE MECHANICS & FAILURE ANALYSIS – (4 Credit Points)
Aspects of failure engineering and its analysis, sources/factors contributing the material's failure, explanation of failure factors, types of fractures, stress system and residual stress, theories of fracture mechanics and introduction to the risk-based inspection, failure due to: fatigue, creep, wear, brittleness, heat behavior, residual stress, corrosion and environment, case study.
Prerequisite: Physical Metallurgy 1, Testing of Materials, Tech. of Microstructural Analysis, Corroson & Protection of Metals

ENMT 616035 - INTERNSHIP – (2 Credit Points)
Specify the job objectives in the proposal; Implement an internship at a site that has been approved and in accordance with its specifiity; Study and describe the process of technical work, quality control, project management, project specifications, engineering drawings and other aspects; Identify the problem related to the technical work, quality control, project management, project specifiations, engineering drawings and other aspects; Conduct problems that occur at each stage of the project; Determine ways or solutions to overcome the problems associated with the project learned; Prepare a final report includes project description, existing problems and problem solving
Prerequisite: Student has obtained minimum of 100 credits

ENMT 616036 - SEMINAR OF FINAL PROJECT PROPOSAL – (1 Credit Points)
Final assignment writing guide including initial research, abstract writing guide, research methodology, type of references, discussion, also conclusion. To make scientific paper from existing final report which then be presented according to certain journal term or final assignment proposal presentation.
Prerequisite: Student has obtained minimum of 105 credits

ENMT 616037 - FINAL PROJECT – (4 Credit Points)

Implementation/application of various lectures taken by students on integration in a research to solve a problem in metallurgy and material engineering field. The research result is presented in a form of scientific report and presented in front of the judging lecturers.
Prerequisite: Student has obtained minimum of 125 credits