FACULTY OF INDUSTRIAL TECHNOLOGY

Name of Programme	**MATERIALS AND METALLURGICAL ENGINEERING**
Programme Level	**POST GRADUATE (MAGISTER)**

Learning Outcome of Graduate Student		
Attitude	1.1	Believing in the oneness of God and able to demonstrate religious attitude;
	1.2	Upholding the value of humanity in undertaking the task based on religion, morality and ethics;
	1.3	Contributing in improving the quality of community life, nation and state and the advance of civilization based on Pancasila;
	1.4	Playing a role as a proud citizen who loves his/her homeland , having a nationalism and responsibility to the country and nation;
	1.5	Appreciating the diversity of cultures, point of view, religion and belief as well as opinion or the original findings of others;
	1.6	Working together, having social sensitivity and caring for community and environment;
	1.7	Law abiding and disciplined in community and state life;
	1.8	Internalizing values, norms and academic ethics;
	1.9	Demonstrating attitude of responsibility on work in his/her field of expertsei independently;

	1.10	Internalizing spirit of independence, struggle and entrepreneurship;
	1.11	Trying his/her best to achieve perfect results; and
	1.12	Working together to be able to make the most of his/her potential.
General Skills	1.1	Being able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;
	1.2	Being able to perform academic validation or studies in accordance with their areas of expertise in solving problems in relevant communities or industries through the development of knowledge and expertise;
	1.3	Being able to formulate ideas, result of thought, and scientific arguments in a responsible and academic manner, and communicate them through the media to the academic community and the wider community;
	1.4	Being able to identify the scientific field that becomes the object of his research and positions into a research map developed through interdisciplinary or multidisciplinary approach;
	1.5	Being able to take decisions in the context of solving problems of science and technology development that concerns and implements the humanities value based on analytical or experimental studies of information and data;
	1.6	capable of managing, developing and maintaining networking with colleagues, peers within the broader institutes and

		research community;
	1.7	Being able to improve the capacity of learning independently;
	1.8	capable of documenting, storing, securing, and rediscovering research data in order to ensure validity and prevent plagiarism;
	1.9	Being able to develop themselves and compete in national and international level;
	1.10	Being able to implement the principle of sustainability in developing knowledge; and
	1.11	Being able to implement information and communication technology in the context of execution of his work.
Knowledge	1.1	able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;
	1.2	able to develop the theoretical concepts of science-engineering and engineering principles required for the analysis and design of systems, processes, products or components;
	1.3	able to develop advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;
	1.4	able to develop advanced knowledge about communication techniques and negotiations both personally and publicly; and
	1.5	able to develop common concepts of project management in solving energy, marine, environmental, residential, information technology and materials processing problems with environmentally friendly technologies.

Extra Ordinary Skills	1.1	able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
	1.2	able to develop research that includes identification, formulation and analysis of engineering problems;
	1.3	able to formulate and develop alternative solutions to solve complex engineering problems with regard to economic, health, safety, public, cultural, social and environmental factors;
	1.4	able to develop systems, processes, and components with an analytical approach and consider technical standards, performance aspects, reliability, ease of application, sustainability, and attention to economic, health, safety, public, cultural, social and environmental factors;
	1.5	able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies; and
	1.6	able to develop reasoning based on contextual knowledge to solve social, health, safety, legal and cultural problems relevant to the field of materials engineering and metallurgy.

COURSE LIST

No.	Code	Name of Course	Credits
SEMESTER I			
1	TL185101	Structure and Mechanical Properties of Materials	3
2	TL185102	Advanced Materials Characterization	3
3	TL185103	Thermodynamics and Kinetics of Materials	3
4	TL185104	Design of Corrosion Control System	3
		Number of credits	12
SEMESTER II			
1	TL185205	Metallurgy of Casting and Welding	3
2	TL185206	Modelling of Materials Processing	3
3	TL185207	Heat Treatment and Surface Engineering	3
4	TL1854XX	Elective Course I	3
		Number of credits	12
SEMESTER III			
1	TL185308	Thesis - Proposals	3
2	TL1854XX	Elective Course II	3
		Number of credits	6
SEMESTER IV			
1	TL185413	Thesis – Seminar	6
		Number of credits	6

ELECTIVE COURSES

No.	Code	Name of Course	credits
1	TL185401	Advanced Polymer and Composite Materials	3
2	TL185402	High Temperature Corrosion	3
3	TL185403	Extractive Metallurgy	3
4	TL185404	Nano Materials Technology	3
5	TL185405	Mechanics of Composite Materials	3
6	TL185406	Advanced Ceramic Materials	3
7	TL185407	Energy Conversion and Storage Materials	3
8	TL185408	Electronic Materials	3
9	TL185409	Bio Materials	3
10	TL185410	Advanced Materials	3
11	TL185411	Special Topics	3

COURSE LIST OF MARTICULATION

No.	Code	Name of Course	Credits
1	TL185420	Metallurgy	3
2	TL185421	Polymer and Ceramic Materials	3

SYLLABUS

COURSE	**Name of Course**	**: Structure and Properties of Materials**
	Code	**: TL185101**
	Credit	**: 3 sks**
	Semester	**: 1**

COURSE DESCRIPTION

Properties and strength of materials, especially metal, can not be excluded from the crystal structure of the material. This course is a subjected to study the basics of material structure related to plastic deformation for single crystal, dislocation theory, microscopic reinforcement mechanism and its relation to mechanical strength associated with stress and strain for the elastic region followed by plasticity theory.

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies;

LEARNING OUTCOME OF THE COURSE

1. Students are able to explain and develop theories about material structure

2. Students are able to explain the mechanical properties of the material
3. Students are able to explain and develop the relationship of mechanical properties and the material micro structure

SUBJECT

1. Material structure:
• solid structure
• crystallography
• structural defects
• deformation on monocrystal and solid deformation
• dislocations
• slip plane and slip system
• Relation of dislocation movement with plastic deformation
2. Mechanical properties of material:
• elastic deformation and stress distribution
• stress-strain on uniaxial and biaxial loads
• material strength at low, medium and high temperature • material reinforcement mechanisms:
- strain-hardening and recovery
- deformation mechanisms at elevated temperatures
3. Relation of mechanical properties and microstructure:
• cold and hot working and recrystallization
• hardening precipitation
• heat treatment

PRECONDITION

No subject prerequisites

MAIN REFERENCES

1. George E Dieter, "Mechanical Metallurgy", Mc Graw Hill, Singapore, 1881
2. Sidney H Avner, "Introduction to Physical Metallurgy, Mc Graw Hill, Tokyo
3. Craig R. Barrett

ADDITIONAL REFERENCES

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COURSE	Name of The Course : Advanced Materials Characterization	
	Code	: TL185102
	Credit	: 3 credits
	Semester	: 1

COURSE DESCRIPTION

The science and technology of materials and metallurgical characterization has been undergone many developments. Characterization of material developed along with the development of the field of material science and metallurgy which are applied in various industries such as metals, polymers, ceramics, composites and superconductors. Material characterization is performed to determine the structure, properties and behavior of metallic materials, polymers, ceramics, composites and superconductors. These are to acquire properties and high material quality. The material has various properties such as mechanical, thermal, electrical, magnetic, optical and corrosion (degradation) properties. Advanced Materials Characterisation courses provide learning techniques for characterization of materials, characterization of material structure and material behavior. Mechanical characterization of materials are consist of spectroscopy, mechanical testing, infrared spectroscopy, X-ray diffraction, thermal testing, microscopy observations, and testing electrically. Learning activities carried out to provide materials characterization techniques of materials, providing material characterization project theme, doing practical material characterization, analysis of structure and material properties, write down the results of material characterization and presented an analysis of material characterization.

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in

international journals;
b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;
SPECIAL SKILLS
a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies;

Learning Objectives

1. Students are able to recall the basic concepts of material structure
2. Students are able to recall the basic concepts of material characterization
3. Students are able to understand the further characterization of the chemical composition of the material
4. Students are able to understand the mechanical characterization of advanced materials
5. Students are able to explain further microscopic observations
6. Students are able to apply the advanced X-ray diffraction
7. Students are able to apply advanced infrared spectroscopy

SUBJECT DISCUSSION

1. Basic Concepts of Structural Materials
2. Basic Concepts of Materials Characterization
3. Characterization of Advanced Materials Chemical Composition
4. Mechanical Characterization of Advanced Materials
5. Advanced Microscopy Observations
6. Advanced X-ray Diffraction
7. Advanced Infrared Spectroscopy
8. Advanced Thermal Method
9. Characterization of Advanced Electrical Properties

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Larry Horath, 2001, Fundamentals of materials science for technologists: properties, testing and laboratory exercises, 2nd ed, Prentice Hall, New Jersey

SUPPORTING REFERENCES

1. Kehl, George L, The Principle of Metallographic Laboratory Practice, Mc Graw Hill Book Company, New York,1949
2. Cullity,B.D., Elements of X-Ray Diffraction, 2 edition, Addison Wesley Publishing Company Inc, Notre Dame, 1959
3. Dodd, W. James, dan Tonge, H.Kenneth, Analytical Chemistry by Open Learning,

Termal Methods, John Wiley & sons, Inggris, 1987
4. Walter Klopffer, Introduction to Polymer Spectroscopy, Springer-Verlag, Berlin, 1984

COURSE	Course Name	: Materials Thermodynamics and Kinetics
	Course Code	: TL185104
	Credit	: 3 credits
	Semester	: 1

COURSE DESCRIPTION

Materials Thermodynamics and Kinetics course deals with the changes of thermodynamics properties and chemical reaction kinetics for material and metallurgical process applications. In this course, the basic thermodynamic properties, thermodynamics of solution, thermodynamics of electrochemistry and thermodynamic of chemical reaction kinetics will be delivered.

LEARNING OUTCOMES

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;
b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;
b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;
b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering

for energy, marine, environmental, residential, information and communications technologies

COURSE LEARNING OUTCOMES

1. Students are able to calculate the changes of thermodynamics properties based on the First and Second Law of Thermodynamics, and determine the spontaneity criteria of chemical reaction based on Gibbs' free energy.
2. Students are able to calculate the changes of thermodynamics properties of solution.
3. Students are able to calculate the changes of thermodynamics properties of electrochemistry.
4. Students are able to calculate the changes of thermodynamics properties of chemical reaction kinetics.

POKOK BAHASAN

1. Review :
   - Reviews of basic thermodynamic properties: T, P, V, heat, work, energy, heat capacity, enthalpy, entropy and Gibbs' free energy.
   - Review of the First Law of Thermodynamics.
   - Review of the Second Law of Thermodynamics.
   - The Spontaneity Criteria of Chemical Reaction.
   - Ellingham Diagram.
2. Thermodynamics of Solution:
   - Partial Molar Quantity
   - Raoult's Law
   - Henry's Law
3. Thermodynamics of Electrochemistry
   - Elektrochemical Cells
   - Cell Potential
   - Nernst Equation
   - Pourbaix Diagram
   - The relations of E with G, H, S and T
   - Oxygen pressure calculation using electrochemical cell
4. Thermodynamics and Kinetics:
   - Reaction Order
   - Arrhenius equation

PRE-REQUISITE

No pre-requisite for this course

MAIN REFERENCES

1. David R. Gaskell "Introduction to Metallurgical Thermodynamics" International Student Ed., McGraw Hill, 1973.
2. David V. Ragone, "Thermodynamics of Materials" Vol. I and II, John Wiley and Sons, 1995.
3. G.S Upadhyaya and R.K Dube, "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon Press, Oxford, 1982
4. Swalin, R.A, "Thermodynamics of Solid",John Wiley & Sons, New York
5. T.D Eastop and A. Mc Conkey, "Applied Thermodynamics for Engineering Technologist" 5th ed., 1993

SUPPORTING REFERENCES

1. Yunus A. Cengel and Michael A. Boles " Thermodynamics An Engineering Approach" 2nd ed. Mc Graw Hill , 1994
2. J.M Smith, H.C Van Ness and M.M Abbot "Introduction to Chemical Engineering Thermodynamics" 5th ed., 1996

COURSE	Name of The Course : Design of Corrosion Control System
	Code : TL185104
	Credit : 3 credits
	Semester : 1

COURSE DESCRIPTION

Corrosion Control System Design is a course that studies the theory of corrosion such as corrosion mechanisms, themidinamics, kinetics, corrosion pourbaix diagram. In addition, corrosion control system include structure design and material selections, sacrificial anode cathodic protection (SACP), impressed current cathodic protection (ICCP), coating and inhibitors) are studied. From material aspect is studied corrosion resistance of metal (stainless steel, cast iron, carbon steel, low alloy steel, non-ferrous metal and its alloys) and also the material degradation of non metal (polimer, ceramic and composite)

LEARNING OUTCOME SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to explain and anlysis of the theory of corrosion
2. Students are able to explain and anlysis of the corrosion protection system
3. Students are able to explain and anlysis of the corrosion-resistant metal
4. Students are able to explain and anlysis of the degradation of non-metallic material

SUBJECT DISCUSSION

1. Theory of corrosion (basic theory of corrosion mechanism, corrosion thermodynamics, kinetics, polarization/tafel curve, pourbaix diagram (potential vs pH diagram)
2. Corrosion control system (structure design and material selection, sacrificial anode cathodic protection (SACP), impressed current cathodic protection (ICCP), coating, inhibitor)
3. Material corrosion resistance (stainless steels , cast steel, carbon steel, low alloy steel, non-ferrous metal and metal alloy)
4. Degradation material of non metal (polimer, ceramics and composite)

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. D.A. Jones, “Principles and Prevention of Corrosion”, Macmillan Publishing Co., 1992.
2. H. Morgan, “Cathodic Protection”, NACE, 1987
3. M.E. Parker, E.G. Pettie, “Pipeline Corrosion and Cathodic Protection”, Gulf Publishing Co.,1984
4. ___ASM Handbook 5: Surface Engineering, ASM International, 1994
5. Arthur A. Tracton, Coatings Materials And Surface Coatings, CRC Press, 2007
6. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Elsevier, 2006

SUPPORTING REFERENCES

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SEMESTER II

COURSE	**Name of The Course : Metallurgy of Casting and Welding**	
	Code	**: TL185205**
	Credit	**: 3 credits**
	Semester	**: 2**

COURSE DESCRIPTION

Casting and welding are methods of shaping materials. Casting and welding are widely applied to obtain certain shape of engineering components from ferrous metal materials such as steel and cast iron and nonferrous metals such as copper, aluminum, magnesium and others. Casting is a technique of automotive cylinder block, pistons, valves, pumps, impellers, turbine and engine components manufacture. Welding is a technique for metal joining such as the manufacture of pipes, tanks, towers, railway, automotive, bridges and structures. Science and technology of welding and metallurgical casting is necessary to determine the characteristics and high quality of metal products. Metallurgy of casting and welding provide learning techniques for molding, casting systems, metal melting, freezing castings, castings inspection, welding engineering, welding thermal cycle, the heat affected area, weldability, evaluation of the welding process. Learning activities are carried out to provide materials an welding metallurgy cast, giving the project the theme of casting and welding, doing practical cast and welded, analyzing the structure and properties of castings and welds, write and present the results of analysis of metallurgical castings and welds.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a

college page, as well as papers published in scientific journals accredited or accepted in international journals;
b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to remember the basic concept of casting: Metal Liquid, Freezing Metals, Castings Micro Structure, Shape and Size of Castings Castings
2. Students are able to recall patterns advanced castings
3. Students are able to understand the advanced print system
4. Students are able to understand more sand molds
5. Students are able to explain metals smelting advanced
6. Students are able to explain advanced examination of castings
7. Students are able to apply the castings Disabilities
8. Students are able to apply the Settlement Castings
9. Students are able to apply special Coran advanced
10. Students are able to apply the basic concepts of welding
11. Students are able to analyze advanced Thermal Cycle
12. Students are able to analyze the Heat Affected Regions (Heat Affected Zone (HAZ))
13. Students are able to evaluate the ability of Welding advanced
14. Students are able to evaluate the welding process advanced

SUBJECT DISCUSSION

1. The basic concept of casting: Metal Liquid, Freezing Metals, Castings Micro Structure, Shape and Size of Castings Castings
2. Patterns castings up
3. The system advanced mold
4. Prints up sand
5. Consolidation of advanced metal
6. Examination of castings up
7. Defective castings
8. Completion Castings
9. Special Castings advanced
10. The concept of basic welding

11. Advanced Thermal Cycle 12. Areas Affected by Heat (Heat Affected Zone (HAZ)) 13. Ability Welding advanced 14. The process of welding up
PREREQUISITES
There is no prerequisite courses
MAIN REFERENCES
4. Tata Surdia, Kenji Chijiiwa, Teknik Pengecoran Logam, Pradnya Paramita, Jakarta, 2006
SUPPORTING REFERENCES
1. John Campbell, Casting, Butterworth-Heinemann, Oxford, 2003 2. R B Gupta, Foundry Engineering, Satya Prakashan, New Delhi, 1999 3. P N Rao, Manufacturing Technology Foundry, Forming, and Welding, Tata McGraw-Hill, New Delhi, 1999 4. Lanncaster J.F, Metallurgy of Welding, Brazing and Soldering, London: George Allen an Unwin 5. Harsono Wiryosumarto, Teknologi Pengeweldingan Logam, Pradnya Paramita, Jakarta

COURSE	Name of The Course : Modelling of Materials Processing	
	Code	: TL185206
	Credit	: 3 credits
	Semester	: 2

COURSE DESCRIPTION

Modeling of Materials Processing discusses the concept of mathematical modeling, physical simulation, numerical methods, finite element method, elements, coordinate, one-dimensional, two-dimensional, application software, and application to the formation of solid steel plate, casting, welding, construction of phase diagrams , alloy, material selection, crystallographic.

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical

engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to apply the modeling and simulation of the physical effects of material processing
2. Students are able to analyse the physical effect of materials processing

SUBJECT DISCUSSION

5. The concept of mathematical modeling
6. The physical simulation
7. The numerical method
8. The method of finite elements, elements, coordinate, one-dimensional, two-dimensional
9. The application software, and application to the formation of solid steel plate, casting, welding
10. The construction of the phase diagram, alloy, material selection, crystallographic

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Reddy J N, ”An Introduction to Finite Element Method”, McGraw Hill Internasional Student Edition, 1985
2. AMIE, ”Modeling of Casting, and Welding Process: Volume I & II”, The Metallurgical Society of AIME, 1981 & 1983

SUPPORTING REFERENCES

COURSE	Name of the Course : Heat Treatment and Surface Engineering	
	Code	**: TL185207**
	Credit	: 3 credits
	Semester	: 2

COURSE DESCRIPTION

Courses Heat Treatment and Surface Engineering is a subject that studies about the phase diagram of a material, the effect of phase and mechanical properties of hardness and residual stress, various technologies of heat treatment and surface engineering technology

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and

communications technologies

LEARNING OBJECIVES

1. Students are able to explain the phase transformation
2. Students are able to explain the phase and mechanical properties of materials
3. Students are able to explain the behavior of the heat
4. Students are able to explain some kinds of surface engineering technology

SUBJECT DISCUSSION

1. Transformation phase:
   - transformation during heating and cooling
   - transformation diagrams
2. Phase and mechanical properties:
   - hardenability
   - residual stress
   - the effect of alloying elements
3. The process of thermal behavior:
   - annealing
   - normalizing
   - hardening
   - precipitation hardening
4. The surface engineering technology:
   - Organic and inorganic coatings
   - cladding
   - thin films
   - electroplating
   - painting
   - galvanizing
   - Physical Vapor Deposition (PVD)
   - Chemical Vapor Deposition (CVD)

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Thelning K E, ”Steel and Its Heat Treatment”, Butterworths, London, 1984
2. Zakharov B, ”Heat Treatment of Metal, Foreign Languange, Moscow
3. ASM Metal Handbook Committee, Metal Handbook, Vol. 2, ASM, Metal Park, Ohio

SUPPORTING REFERENCES

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SEMESTER III

COURSE	**Name of The Course : Thesis Proposals**
	Code : TL185308
	Credit : 3 credits
	Semester : 3

COURSE DESCRIPTION

Pre-Thesis courses is a course that studies on the introduction of methods of scientific writing, induction deduction approach, qualitative and quantitative methods of scientific writing standards, quantitative methods qualitative, deduction-induction, the stage of the research stage and ordinances scientific writing.

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical

engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECIVES

1. Students are able to understand and explain the scientific method in general, the standard of scientific writing
2. Students are able to understand, develop and analyze approaches in the study of deduction-induction, quantitative and qualitative
3. Students are able to understand, and resolve the issue of election research themes, research objectives and problem formulation
4. Students are able to understand, and resolve the problem formulation of hypotheses, identification of variables and data processing research, sampling techniques
5. Students are able to understand and resolve the issues of how scientific writing
6. Thesis Proposal Seminar

SUBJECT DISCUSSION

1. Introduction:
   • The introduction of the scientific method in general, scientific writing standards, examples are few scientific writing in the form of proposals, research reports, seminars and journal articles. General problem that often arises in engineering research and scientific writing. contract college
2. Deduction Induction Approach, qualitative and quantitative methods:
   • Method of Deduction, Induction Method, qualitative-quantitative methods
3. Phase 1 study:
   • Selection of Themes, Topic and Title Research, Objective Research Needs Identification, Identification, Selection and Formulation of Research Problems, Formulation of Objectives and Benefits Research,
4. Phase 2 study:
   • Formulating Hypotheses and Identifying Variables Data Research, Data Collection Tool Selection, Data Collection Methods, Techniques Research Sampling (Sampling), Designing Data Processing, Data Processing and Analysis, Conclusion Withdrawal, Reporting
5. Procedures for Scientific Writing:
   • Study Library / Study Theory, system adaptation and writing references, Study journal, proposal writing, writing memoir, writing scientific articles

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Creswell, J.W. 2003. Research Design : Qualitative, Quantitative and Mixed Methods Approaches. London : Sage Publication
2. Denzin, N.K. & Lincoln, Y.S. 2000. Handbook of Qualitative Research. London:

Sage Publication
3. Branen, Julia. (1999). Memadu Metode Penelitian Kualtatif & Kuantitaif. (Alih Bahasa H. Nuktah Arfawie Kurde. Yogyakarta: Pustaka Pelajar Offset.
4. Miles, Matthew B. and Huberman, A. Michael (1992).; Analisis Data Kualitatif. (Penerjemah Tjetjep Rohendi Rohidi dan Mulyarto).

SUPPORTING REFERENCES

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SEMESTER IV

COURSE	**Name of Course**	**: Thesis – Oral Defence**
	Code	**: TL185413**
	Credit	**: 6 Credits**
	Semester	**: 4**

COURSE DESCRIPTION

This thesis course is a course that studies the task independently, the implementation of research, data analysis, writing scientific research results and seminars

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

c. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

d. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

c. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

d. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OUTCOME OF THE COURSE

1. Students are able to develop research methodology
2. Students are able to develop the research implementation
3. Students are able to analyze data
4. Students are able to write scientific, thesis and seminar

SUBJECT LIST
1. Research methodology 2. Implementation of research 3. Data analysis 4. Scientific writing, thesis and seminar
PRASYARAT
No subject prerequisites
MAIN REFERENCES
1. William D. Callister, Materials Science and Engineering, An Introduction, 5th Edition, Jr., John Wiley & Sons, Inc., New York, 1999
ADDITIONAL REFERENCES
1. Mikell P. Grrover Fundamentals of Modern Manufacturing, Materials, Processing, and Systems, 2nd edition, , John Wiley & Sons, inc 2. Jurnal Internasional

ELECTIVE COURSE

COURSE	**Name of The Course : Advanced Polymer and Composite Materials**
	Code : TL185401
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

The science and technology of polymeric materials and composites have high development. Polymers and composites are widely used as a component in industrial engineering and household needs. Polymers and composites used as pipe materials, furniture, furnishings, office equipment, lenses, adhesives, paint coatings, bottles, bags, fiber, sports equipment, automobile equipment, marine equipment and electronic equipment. Polymers and composites have manufacture, processing and applications characteristics to acquire properties and high material quality. Advanced polymer and composites materials course provides lessons about the molecular structure of polymers, synthesis techniques polymerization, polymer characterization, testing of polymers, engineering processing of polymers, properties of plastic, the nature of the elastomer, the nature of thermosets, the characteristics of composites, processing composites, testing of composites, fiber technology, fiber continuous, short fibers, the nature of the interface (the interface), composite failure. Learning activities are carried out to provide information related to materials and composites engineering, synthesis and processing of polymers and composites project theme research, doing the practical aspects of polymers and composites, analyzing the structure and properties of polymeric materials and composites, wrote the analysis and present the performance of polymeric materials and composites.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific

research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;
b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS
a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to recall the basic concepts of polymer
2. Students are able to remember the synthesis of ionic polymers, organic polymers and coordination
3. Students are able to remember the solution properties and molecular weight measurement
4. Students are able to understand the structure of the polymer
5. Students are able to understand the testing and polymer properties
6. Students are able to understand the technology and polymer processing
7. Students are able to explain the stability and polymer recycling process
8. Students are able to explain the thermoplastic polymer and fiber
9. Students are able to explain and apply the thermoset polymers and elastomers
10. Students are able to apply the advanced polymer
11. Students are able to apply the basic concepts of composite
12. Students are able to apply the basic concepts of composite fabrication
13. Students are able to apply the composite interface
14. Students are able to apply the composite geometry
15. Students are able to analyze the composite micromechanical
16. Students are able to analyze the composite makromekanik
17. Students are able to evaluate the composite laminate
18. Students are able to evaluate the composite failure

SUBJECT DISCUSSION

1. The basic concept of polymer
2. Synthesis of ionic polymers, organic polymers and coordination
3. The nature of the solution and molecular weight measurement

4. The structure of the polymer
5. Testing and properties of polymers
6. Technology and processing of polymers
7. Stability and recycling of polymers
8. The thermoplastic polymers and fibers
9. thermoset polymers and elastomers
10. Polymers forward
11. The basic concept of composite
12. The basic concept of composite fabrication
13. Composite Interfaces
14. The geometry of the composite
15. Composite micromechanical
16. Composite makromekanik
17. Composite laminate
18. The failure of the composite

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Fred W Billmeyer, Jr, Textbook of Polimer Science, John Wiley and Sons, New York, 1971

SUPPORTING REFERENCES

1. John McMurry, Fundamentals of Organic Chemistry, Thomson Learning, California, 2003
2. Ger Challa, Polymer Chemistry An Introduction, Ellis Horwood, New York
3. Joel R Fried, Polymer Science and Technology, Prentice-Hall, New Jersey, 1995
4. Ralp J Fessenden, Joan S Fessenden, Aloysius Hadyana Pudjaatmaka, Kimia Organik, Erlangga, Jakarta, 1982
5. A Brent Strong, Plastics: Materials and Processing, Prentice Hall, New Jersey, 2000
6. Manas Chanda, Salil K Roy, Plastics Fundamentals, Properties, and Testing, Taylor & Francis, Boca Raton, 2009
7. Walter Klopffer, Introduction to Polymer Spectroscopy, Springer-Verlag, Berlin, 1984
8. Richard G Griskey, Polymer Process Engineering, Chapman & Hall, New York, 1995
9. Ulf W Gedde, Polymer Physics, Chapman & Hall, London, 1995
10. Michaeli, Greif, Kaufmann, Vosseburger, Training in Plastics Technology, Hanser, Munich, 1992
11. Krishan K. Chawla, Composite Materials Science and Engineering, Springer-Verlag, New York, 1987.
12. Derek Hull, An Introduction to Composite Materials, Cambridge University Press,

Cambridge, 1990
13. T J Pinnavaia, G W Beall, Polymer-Clay Nanocomposites, John Wiley & Sons, Chichester, 2000
14. L H Sperling, Polymeric Multicomponent Material An Introduction, John Wiley & Sons, New York, 1997

COURSE	TL185402 : High Temperature Corrosion
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

High Temperature Corrosion of courses is a course that studies the mechanism of high-temperature corrosion, a method for controlling the oxidation process and choose the high-temperature corrosion-resistant material.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and

communications technologies

LEARNING OBJECIVES

1. Students are able to explain the mechanism of corrosion
2. Students are able to explain the corrosion reaction
3. Students are able to explain the impact of high-temperature reaction
4. Students are able to explain the oxidation kinetics
5. Students are able to use the Ellingham diagram to explain the thermodynamic stability of oxides and oxidation
6. Students are able to explain the high-temperature corrosion test method
7. Students are able to explain the corrosion-resistant materials
8. Students are able to explain the high-temperature corrosion of case studies in several application equipment

SUBJECT DISCUSSION

1. Classification of the corrosion mechanism:
   - Oxidation
   - sulfidation
   - Nitriding
   - Carburizing
2. Corrosion reactions:
   - The reaction of water vapor corrosion without esistensi
   - The effect of pressure and temperature
   - The effect of the composition of the hot environment
3. Impact of high-temperature reactions:
   - Metal dusting
   - Decarburizing
   - Exfoliation oxide
4. Oxidation Kinetics:
   - weight gain: linear oxidation law, cubic parabolic, logarithmic
   - weight loss
5. Ellingham diagram:
   - Stability oxide
   - thermodynamic oxidation
6. The method of high-temperature corrosion testing:
   - Method of discontinuous
   - Continuous Method
   - Methods thermogravimetrik
7. Material corrosion resistance:
   - Ni-base
   - Co-base
   - ceramic coating
8. Case study:

• blade gas turbine / steam • Nuclear Reactors 9. • Space trap gas engine
PREREQUISITES
There is no prerequisite courses
MAIN REFERENCES
1. N Birck, GH Meier, ”Introduction to High Temperatur and Oxidation of Metals”, Arnold Publishing, 1987 2. DA Jones, ”Principle and Prevention of Corrosion”, Macmillan Publishing, 1992 3. ASM Handbook Vol 13, “Corrosion”, ASM, 1987
SUPPORTING REFERENCES
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COURSE	TL185403 : Extractive Metallurgy
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Extraction courses are courses to learn about the basic principles of extraction methods and technological developments in processing non-ferrous metals and alloys that include primary metals (Cu, Pb, Zn, Ni), secondary metals, light metals (Mg, Al, Ti) and precious metals (Au).

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and

communications technologies

LEARNING OBJECTIVES

1. Students know the development of extraction processes in Indonesia and the World
2. Students understand and are able to explain the basic principles of metallurgical extraction
3. Students understand and are able to calculate the magnitude of the change concepts and thermodynamics; Ellingham Diagrams and Principles of electrochemistry
4. Students understand and are able to explain in detail the process of extraction of Cu
5. Students understand and are able to explain the process of extraction of Pb and Zn in detail
6. Students understand and are able to explain in detail the process of extraction of Ni
7. Students understand and are able to explain the process of extraction of Secondary Metals in general
8. Students understand and are able to explain in detail the process of extraction of Mg
9. Students understand and are able to explain in detail the process of extraction of Cu
10. Students understand and are able to explain in detail the process of extraction of Al
11. Students understand and are able to explain in detail the process of extraction of Au

SUBJECT DISCUSSION

1. Early developments in metal extraction (Introduction, discovery of metals and their importance, important landmarks, nonferrous metals in Indian history, uses of nonferrous metals)
2. Sources of nonferrous metals (Sources in land and sea, exploration methods, methods of beneficiation, nonferrous metals)
3. Principles of metals extraction, (Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry)
4. General methods of extraction, (Pyro-metallurgy – calcinations, roasting and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy –electrolysis and electro-refining)
5. General methods of refining, (Basic approaches, preparation of pure compounds, purification of crude metal produced in bulk)
6. Extraction of metals from oxide sources. Basic approaches and special features of

specific extraction processes, extraction of metals such as magnesium, aluminum, tin and ferro-alloying elements, production of ferro alloys.

7. Extraction of metals from sulphide ores, (Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc.)
8. Extraction of metals from halides, (Production of halides and refining methods, production of reactive and reactor metals. Methods of extraction of metals such as titanium, rare earths, uranium, thorium, plutonium, beryllium, zirconium etc.)
9. Production of precious metals (Methods applied for gold, silver and pt. group of metals)
10. Secondary metals and utilization of wastes, Energy and environmental issues in nonferrous metals extraction

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Habashi. Fathi, Handbook of Extractive Metallurgy, Canada, 1997
2. Extraction of nonferrous metals, H.S. Ray, R. Sridhar and K.P. Abraham Affiliated East West Press Pvt Ltd. , New Delhi (2007).
3. W.H. Dennis, Extractive Metallurgy, Philosophical Library,New York (1965)
4. F . Habashi, Principles of Extractive Metallurgy, Vol.1,Gordon and Breach, New York (1969).
5. T . Rosenqvist, Principles of Extractive Metallurgy, McGraw Hill, New York (1983)
6. J.L. Bray, Nonferrous production metallurgy, Wiley, New
7. York(1954)
8. R.D. Pehlke, Unit processed in extractive metallurgy, Elsevier, Amsterdam (1082)
9. H.S. Ray and A. Ghosh, Principles of extractive metallurgy, Wiley Eastern Ltd. , New Delhi (1991)
10. Introduction to melts - molten, salts and slags, Allied Pub. Pvt. Ltd. , New Delhi (2006)
11. H.S. Ray, B.P Singh and Sarama Bhattacharjee, Energy in minerals and metallurgical processes, Allied Publishers Ltd, New Delhi (2005)
12. Kvande.H, Introduction to Aluminium Electrolysis, Germany, 1993
13. J.J.Moore., Chemical metallurgy, Butterworth- Heineman, London, 1981
14. J.D.Gilchrist., Extractive Metallurgy, Pergamon. 2nd ed, Oxford, Pergamon Press, 1980
15. B.A.Wills., Mineral Processing Technology- An introduction to the practical aspects of ore treatment and mineral recovery, 5th ed - Pergaman Press, Oxford, 1992.

SUPPORTING REFERENCES

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COURSE	**TL185404 : Nano Materials Technology**
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Subjects Nano Materials Technology is a course that studies how the synthesis, fabrication, properties and applications of nanostructures and nanomaterials. Synthesis of nano technology being studied includes the chemical and physical processes to the structure of 0-D, 1-D and 2-D. As for nanomaterials including carbon nanotubes and mesoporous order.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to explain the historical development of nanotechnology and its applications.
2. Students are able to calculate, develop and analyze the physical-chemical analysis of solid surfaces.
3. Students are able to compute and solve problems of zero-dimensional nanostructures of nanoparticles
4. Students are able to compute and solve problems one-dimensional nanostructures of nanoparticles
5. Students are able to compute and solve problems 2-dimensional nanostructures of nanoparticles
6. Students are able to compute and solve problems 2-dimensional nanostructures of nanoparticles
7. Students are able to compute and solve problems nanomaterial types and properties
8. Students are able to compute and solve problems karaktrisasi nanomaterial properties

SUBJECT DISCUSSION

1. Introduction:
   - Introduction to nanotechnology, development and industrial applications.
   - Approach in nanotechnologies
2. Analysis of chemical-physics of solid surfaces:
   - The surface energy, steric stabilization and Electrostatic
3. 0-D nanostructures: nanoparticles:
   - The process of homogeneous nucleation
   - metal nanoparticles
   - semiconductor nanoparticles,
   - The process of heterogeneous nucleation, the core shell, spray pyrolysis
4. 1-D nanostructures: nanorod and nanotube:
   - The process of spontaneous growth
   - template-based Synthesis
   - elektrospinning
   - lithography
5. 2-D nanostructures: thin film
   - Basic film growth
   - Physical Vapor Deposition (PVD)
   - Chemical Vapor Deposition (CVD)

- Atomic Layer Deposition (ALD)
- Superlattice
- Self Assembly

6. nanomaterial:
   - Carbon Fullerenes and Nanotubes
   - Micro and mesoporous
   - Core shell
   - Organic-Inorganic Hybrid
   - intercalation
7. Synthesis of nanostructures in Physical:
   - lithography
   - Nanomanipulasi
   - nanoassembly
8. Characterization of nanomaterial properties: SEM, XRD, HRTEM, AFM

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Guozhong Cao ,"Nanostructures and Nanomaterials , synthesis , properties and applications" , Imperial College, Press ,2004.
2. T. Pradeep , "NANO The Essential , understanding Nanoscience and Nanotechnology". Tata McGraw-Hill, Publishing Company Limited , 2007.
3. Ajayan, Schadler and Braun, "Nanocomposite Science & Technology"
4. Bharat Bhusha, "Springer Handbook of Nanotechnology"

SUPPORTING REFERENCES

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COURSE	TL185405 : Mechanics of Composite Materials
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Mechanics of Composite Materials The course is a course that studies the application of polymers for composite materials, materials for the matrix and reinforced, composite character anisotropy, micro mechanics lamina, lamina strength, the strength of the macro lamina, laminate mechanics and methods for making composites for mechanical applications

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical

engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECIVES

1. Students are able to explain the mechanics of polymers
2. Students are able to explain the composition of the composite material and its mechanical behavior
3. Students are able to explain the mechanics of micro lamina
4. Students are able to explain the strength of the lamina
5. Students are able to explain the strength of the macro lamina
6. Students are able to explain the mechanics of laminate

SUBJECT DISCUSSION

1. Polymer Mechanics:
   - polymerization
   - solid state polymer
   - the effect of structural modifications: molecular weight, composition, cross-linking, branching chain
2. The introduction of composite materials:
   - composite classification
   - matrix and reinforced
   - the mechanical behavior of composites
   - applications
3. Mechanics of micro lamina:
   - lamina unidireksional
   - mechanical analysis of fiber direction and the direction orthogonal
4. Strength of Lamina:
   - Constant techniques
   - orthotropic lamina
   - failure criterion
5. Macro Lamina Strength:
   - The relationship of stress and strain
   - lamina plain strain and plain stress
   - voltage-way immersion
   - influence higrothermal
6. Mechanics laminate:
   - The relationship of stress and strain laminate
   - Style and moments in the laminate
7. • influence higrothermal

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Jones RM, "Mechanics of Composite Materials" McGraw Hill Inc., 1975 ISBN: 0-07.032790-4 2. Sulistijono, "Mekanika Material Komposit" ITS Press, 2012 ISBN: 9-786029-494129
SUPPORTING REFERENCES
-

COURSE	Name of the Course : Advanced Ceramics Materials
	Code : TL185406
	Credit : 3 sks
	Semester : 2 atau 3

COURSE DESCRIPTION

Mata kuliah Material Keramik Lanjut ini merupakan mata kuliah yang membahas secara komprehensif material keramik yang ditiitikberatkan pada proses pembuatan dan karakterisasinya untuk aplikasi material keramik modern/maju.

LEARNING OUTCOME SUBJECTED TO THE CURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies;

LEARNING OUTCOME OF THE COURSE

After following the learning process of Advanced Materials Ceramics course, students are expected to be able to:

1. Understand the basic concepts of advanced ceramic materials (definition, scope and history of advanced ceramic material developments)

2. Describe and distinguish (nature and characteristics, synthesis and manufacturing process and its application) traditional ceramic material vs. advanced ceramic material

3. Describe and explain the process of making ceramic material further in accordance with the application

4. Characterize and manganalisis advanced ceramic materials by using related instruments in accordance with the application.

SUBJECT LIST

1. Introduction to ceramics materials (definition, history and application of ceramics materials, description of common ceramic materials including stuctures and properties)
2. Traditional vs. Advanced Ceramics Materials (brief description of properties, processing and applications of both ceramics materials)
3. Applications and Processing of Advanced Ceramics Materials:
4. Reliable ceramics coatings
5. Ceramics for extreme temperature applications
6. Ceramics for Energy and supercapacitor
7. Superconductor Ceramics
   Biomedical Ceramics
8. Magnetic and Radar Absorbing Ceramics.
9. Characterization of Advanced Ceramics Materials

PRECONDITION

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MAIN REFERENCES

1. Ashutosh Tiwari, “Advanced Ceramic Materials”, 2016
2. Richerson, D.W., “Modern Ceramic Engineering, 3rd. Edition”, 2006
3. William Callister, 7th Edition, Materials Science and Engineering, 2007

ADDITIONAL REFERENCES

1. Micherl W Barsoum, “Fundamentals of Ceramics”, 2003
2. Yet-Ming Chiang, dunbar Birnie III, W. D. Kingery, “Physical Ceramics”, 2002

COURSE	Name of the Course : Materials of Energy
	Code : TL185407
	Credit : 3 sks
	Semester : 2 or 3

COURSE DESCRIPTION

This course provides an understanding of the background, fundamental science and analysis of energy materials based on electrochemical processes as materials for energy conversion and energy storage

LEARNING OUTCOME SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies.

LEARNING OUTCOME OF THE COURSE

1. Students are able to explain the basic principles of energy conversion process through photosynthesis process and how its application in solar cell

2. Students are able to explain the various types of solar cells and the mechanism of how they work, describe the materials used and the morphological changes
3. Students are able to perform measurements and calculate the efficiency of different types of solar cells
4. Students are able to explain the electrochemical process as the basis for material for batteries, capacitor and fuel cell applications
5. Students are able to provide solutions and report on problems related to the process of energy conversion and energy storage for solar cell materials, batteries, supercapacitors and fuel cells

SUBJECT LIST

1. The basic principles of the process of converting solar energy into electrical energy,
2. The basic principle of calculating the efficiency of solar cells,
3. Differences in various solar cell technologies, dye sensitized solar cells, solar cells made from organic,
4. Separation and transport,
5. Electrochemical processes in various types of batteries, capacitors, and fuel cells
6. Materials for batteries, supercapacitors, and fuel cells, characterization and chemical reactions in batteries, capacitors and fuel cells
7. Safety and reliability of battery system, capacitor and fuel cell

PRECONDITION

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MAIN REFERENCES

1. David S. Ginley, David Cahen,"Fundamentals of Materials for Energy and Environmental Sustainability"
2. Allen J. Bard, Larry R. Faulkner, "Electrochemical Methods: Fundamentals and Applications"
3. Augustin McEvoy, L. Casyaner, Tom Markvart,"Solar Cells, Second Edition: Materials, Manufacture and Operation"
4. Linden's Handbook of Batteries, 4th Edition,
5. James Larminie, Andrew Dicks, "Fuel Cell Systems Explained (Second Edition)"

ADDITIONAL REFERENCES

1. Materials for Electrochemical Energy Storage and Conversion II-Batteries, Capacitors and Fuel Cells: Volume 496 (MRS Proceedings)

COURSE	TL185408	: Electronic Materials
	Credit	: 3 credits
	Semester	: 2 or 3

COURSE DESCRIPTION

Electronic Materials is a course that studies electronic materials and its advanced technology.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

ACHIEVEMENTS OF LEARNING COURSE
1. Students are able to explain the advanced electronic materials applications. 2. Students are able to develop and analyse charge carrier behaviours and andvanced energy levels. 3. Students are able to explain and develop advanced semiconductor. 4. Students are able to develop advanced electronic-magnetic behaviours. 5. Students are able to analyse principal work and synthesize of advanced electronic materials.
SUBJECT DISCUSSION
1. Basic concept of electronic materials 2. Charge carrier behaviours and advanced energy levels 3. Advanced semiconductor 4. Advanced electronic-magnetic behaviours 5. Basic principal and synthesize of advanced electronic materials
PREREQUISITES
There is no prerequisite courses
MAIN REFERENCES
1. Rolf E. Hummel, "Electronic Properties of Materials", Hench, L.L dan West, J.K., Principle of Electronic Ceramics, John Wiley & sons, 1990
SUPPORTING REFERENCES
1. William D. Callister, Materials Science and Engineering, An Introduction, 5th Edition, Jr., John Wiley & Sons, Inc., New York, 1999 2. Kittel, C., Introduction to Solid State Physics, 6thedition, John Wiley & sons, 1986 3. Moulson, A.J & Herbert, J., Electroceramics : Materials, Properties, Application, 2ndedition, John Wiley & sons, 2003 4. Kingery, dkk., Introduction to Ceramics 2nd, Singapura: John Wiley & sons, 1975 5. Mikell P. Grrover Fundamentals of Modern Manufacturing, Materials, Processing, and Systems, 2nd edition, , John Wiley & Sons, inc

COURSE	TL185409 : Bio Materials
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

The course Bio material discusses the basic concepts of Bio materials and material systems of the human body, the types of bio-materials, and the way synthesize biocompatibility properties of bio material during time interacting with human tissue.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES
1. Students are able to explain the basic concepts of bio materials and systems of the human body 2. Students are able to explain the types of materials synthesis and processing bio and bio material karakteriasasi 3. Students are able to apply and analyze bio materials applied to living issues.
SUBJECT DISCUSSION
1. The basic concept of bio materials, soft tissue, hard tissue, transplantation 2. Material bio-based polymers, ceramics and metals, the synthesis of hydroxyapatite (HA), bio-static material katakterisasi 3. The nature of the structure of biological systems, the characterization of the nature of the biocompatibility
PREREQUISITES
There is no prerequisite courses
MAIN REFERENCES
1. Donald L. Wise, Biomaterials and Bioengineering Handbook, CRC Press, 2000 2. Joon Park dan Roderic Lakes, Biomaterials, Springer, 2007 3. Kay C Dee, David A. Puleo, Rena Bizios., An Introduction to Tissue-Biomaterial Interactions, John Wiley & Sons, Inc., 2002
SUPPORTING REFERENCES
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COURSE	TL185410 : Advanced Materials
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Subjects Advanced Materials is a course that studies on the classification of Advanced Materials include solid materials, metals, ceramics, composites and glass, magnetic, steel, copper alloys, aluminum and magnesium alloys, super hard materials, plastics and polymers, materials Manufacturing Engineering advanced, which includes methods of engineering alloys-Thermal, mechanical and chemical, metallurgy, mechanism of reinforcement materials, elements of dislocation theory, hardening, control size, single crystal growth, Reinforcing fibers to the polymer, Super alloy materials, super composites, Smart materials and Nano materials.

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;
b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to understand and explain the definition of advanced materials and various applications.
2. Students are able to explain the advanced materials, emphasizing the relations of production / structure / property / function and application of a number of advanced materials in a variety of engineering applications, ultra lightweight materials, biomaterials, composites, heat-resistant materials and coatings for high temperature applications, shape memory alloys
3. Students are able to understand, develop and analyze high temperature thermal barrier material
4. Students are able to understand and explain the advanced materials based on metals, polymers, and ceramics.

SUBJECT DISCUSSION

1. Introduction:
   • The definition of advanced materials, scope of advanced materials, advanced materials applications, linkage-material-application process
2. Metal-based Advanced Materials, Properties and Characteristics, Synthesis and applications:
   • Material high temperature thermal barrier, Shape Memory Alloy,
3. Polymer-based Advanced Materials, Properties and Characteristics, Synthesis and applications:
   • ferrofluid, Polymers heat barrier and application structure
4. Ceramic-based Advanced Materials, Properties and Characteristics, Synthesis and applications:
5. • Superconductors, lightweight brick, CNT

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. P. Flinn and P.K. Trojan, “Engineering Materials and Applications” MIR Publications
2. A.K Bhargava, “Engineering Materials: Polymers, Ceramics and Composites “, Prentice Hall of India
3. Serope Kalpakjian, ”Manufacturing processes for Engineering Materials”, Wesley Publishing Co.

4. S.H. Avner, “An introduction to Physical Metallurgy” McGraw Hill 5. P. Rama Rao, “Advances in Materials and Their Applications Wiley
SUPPORTING REFERENCES
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COURSE	TL185411 : SPECIAL TOPIC : Fracture and Deformation Analysis
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Courses Fracture and Deformation Analysis is a course that studies the concept of fracture mechanics, the formation of cracks, fracture mechanics principles formulation to describe the risk of failure, crack propagation and stress distribution, stress concentration, the estimated remaining service life, the stress intensity factor and J-integral methods and solution / failure analysis

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical

engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES

1. Students are able to explain the formation of cracks
2. Students are able to explain the crack propagation and stress distribution
3. Students are able to estimate the remaining lifetime of the material
4. Students are able to explain the concept of the J-integral and stress intensity factor

SUBJECT DISCUSSION

1. The formation of cracks:
   - the concept of stress-strain
   - stress concentration
   - crack initiation mechanism
2. The crack propagation and stress distribution:
   - crack propagation mechanism
   - fracture mode
   - stress distribution around the crack (crack tip)
3. Estimation of remaining lifetime:
   - concept of energy dissipation
   - decrease in stiffness by cracks
4. The concept of the J-integral and stress intensity factor:
   - stress intensity factor and fracture toughness
   - the concept of non-linear fracture mechanics

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

1. Richard W, Hertberg, “Deformation and Fracture Mechanics of Engineering Materials”, John Wiley & Sons, New York, 1976
2. Ralph Stephen, ”Metal Fatigue Engineering”, John Wiley and Sons, New York, 1976
3. fred Nilsson,"Fracture Mechanics from Theory to Application", KTH, 2001
4. Geiger, G.H. and Poirier, D.R., “Transport Phenomena Metallurgy”, Addism Wesley Publishing Company, Reading, Massachussetts.

SUPPORTING REFERENCES

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COURSE	TL185411 : SPECIAL TOPIC : Atomistic Models of Materials
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

The course material atomistic modeling is a subject that studies computer simulation modeling for material

LEARNING OUTCOMES GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modelling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and communications technologies

LEARNING OBJECTIVES
1. Students are able to apply the basics of atomistic computer simulation modeling to the real nature of the material and energy models. 2. Students are able to apply the density functional theory, the qualitative prediction accuracy and atomistic modeling of materials. 3. Students are able to apply thermodynamics deviation, coarse-grain approach and meso-scale models in atomistic modeling of materials.
SUBJECT DISCUSSION
1. The basics of atomistic computer simulation modeling to the real nature of the material and energy model 2. The density functional theory, the qualitative prediction accuracy and atomistic modeling of materials Students are able to apply thermodynamics deviation, coarse-grain approach and meso-scale models in atomistic modeling of materials
PREREQUISITES
There is no prerequisite courses
MAIN REFERENCES
5. Allen M P, DJ Tildesley, “Computer Simulation of Liquids”, New York, Oxford University Press, 1989 6. Frenkel D, B Smit, “Understanding Molecular Simulation”, San Diego, Academic Press, 2001 7. Jensen F,”Introduction to Computational Chemistry”, New York, John Wiley and Sonds, 1998”
SUPPORTING REFERENCES
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COURSE	TL185411 : SPECIAL TOPIC : Advanced Powder Metallurgy
	Credit : 3 credits
	Semester : 2 or 3

COURSE DESCRIPTION

Powder Metallurgy courses this is a subject that studies the further development of the metallurgical process for producing P / M with good performance.

SUPPORTED LEARNING ACHIEVEMENTS

LEARNING OBJECTIVES

1. Students are able to explain the stages of powder metallurgy, advantages and disadvantages of the P / M, the application process P / M.
2. Students are able to calculate, develop and analyze a method to achieve product P / M with full density.
3. Students are able to compute and solve problems further sintering, the sintering mechanism and process variables.
4. Students are able to calculate and resolve manufacturing issues and application components P / M

SUBJECT DISCUSSION

1. Introduction:
   Stages of powder metallurgy process, the advantages and disadvantages of the P / M, the application process P / M
2. The method to achieve full density:
   Hot Isotatic pressing (HIP) and cold pressing Isotatic
3. Sintering further:
   Sintering Mechanism, Mechanism of diffusion, recrystallization, liquid phase sintering. Effect of pressure-temperature compaction and sintering time on the product P / M. Type sintering furnace. sintering atmosphere
4. The process of manufacturing and application components P / M is important:
   Porous bearings, electrical contacts, metal filters, cemented carbide, magnetic, friction materials and composites

PREREQUISITES

There is no prerequisite courses

MAIN REFERENCES

8. Randal M. German, Powder Metallurgy Science, Frizt V. Lenel, Powder Metallurgy Principles and Application, Metal Powder Industries Federation Princenton, 1980
9. Joel S. Hirschron, Indroction to powder Metallurgi, America Powder Mellurgy Institute, Princenton, 1976

SUPPORTING REFERENCES

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COURSE	Course name : Metallurgy
	Course code : TL185420
	Credit : 3
	Semester : Each semester

COURSE DESCRIPTION

Students learn physical sctructure of materials and many aspecst related to mechanical properties of materials. This course also provides information about cast iron and steel including the influence of alloy on mechanical properties of cast iron and steel. Several nonferrous alloys will also be studied in this course.

LEARNING OUTCOME GRADUATE SUBJECTED TO THE COURSE

ATTITUDE

a. uphold the value of humanity in carrying out duties based on religion, morals and ethics;

b. demonstrate a responsible attitude towards the work in the field of expertise independently;

KNOWLEDGE

a. able to develop advanced concepts on the structure, properties, processes and performance of metallic and nonmetallic materials;

b. capable of developing advanced concepts of manufacturing metallurgy, corrosion and failure analysis of materials, polymers, composites, ceramics, electronic materials, bio materials, extraction and processing of minerals and material modeling;

GENERAL SKILLS

a. able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs or works of art in the field of science and technology which concerns and applies the humanities value in accordance with their field of expertise, prepares scientific conception and result of study based on rules, procedures and scientific ethics in the form of a thesis or other equivalent form, and uploaded on a college page, as well as papers published in scientific journals accredited or accepted in international journals;

b. able to identify the scientific field that became the object of his research and position it into a research map developed through interdisciplinary or multidisciplinary approaches;

SPECIAL SKILLS

a. able to develop the advanced principles of mathematics and natural science as well as engineering principles to solve complex engineering problems;

b. able to develop solutions for problems related to material and metallurgical engineering for energy, marine, environmental, residential, information and

communications technologies

COURSE LEARNING OUTCOME

1. Students understand and can explain mechanism of crystal structure, plastic deformation, recrystallization
2. Mahasiswa mampu menjelaskan konsep mengenai cacat material dan pengaruhnya terhadap sifat material
3. Mahasiswa mampu menerapkan berbagai mekanisme penguatan pada logam
4. Mahasiswa mampu memahami berbagai jenis sifat mekanik material
5. Mahasiswa mampu menjelaskan dan menerapkan berbagai pengujian sifat mekanik material seperti uji tarik, uji kekerasan, uji impact, uji kelelahan
6. Mahasiswa mampu mengenal macam-macam besi tuang dan baja, sifat dan penggunaannnya, memahami hubungan antara komposisi, struktur mikro dan sifat baja
7. Mahasiswa mampu menganalisis logam non ferrous dan paduannya

POKOK BAHASAN

1. Atomic bonding, crystal structure, crystal, atomic bonding, defects
2. Strengthen mechanism of materials and important mechanical properties of materials
3. Materials testing: Tensile test, hardness test, impact test, fatique test
4. Metallurgy of cast iron and steel, properties and its application, alloy and its influence, international standardization code, characteristics of several steel products
5. Cast iron: Types, microstructure, mechanica properties and application
6. Stainless and tool steel: Classification, mechanical properties, application
7. Nonferrous alloys: Aluminium and copper

PREREQUISITE

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MAIN REFFERENCE

1. William D. Callister, David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, Wiley, 2015
2. James F. Shackelford, Introduction to Materials Science for Engineers, 8th ed., Pearson, 2014

SUPPORTING REFFERENCE

1. Derek Hull, D. J. Bacon, Introduction to Dislocations, Elsevier, 2011
2. William D Callister, Jr.; David G Rethwisch, Materials science and engineering : an introduction, 9th ed., Willey, 2014