9.1 ABOUT THE DEPARTMENT

The Department of Mining, Metallurgical and Materials Engineering (DMMME) offers three undergraduate programs:

- B.S. Mining Engineering since 1936;
- B.S. Metallurgical Engineering since 1954; and,
- B.S. Materials Engineering since 1999.

It also offers the following graduate programs,

- M.S. in Metallurgical Engineering;
- M.S. in Materials Science and Engineering; and
- Ph.D. in Materials Science and Engineering.

The DMMME has several laboratory facilities for instruction and research. It has a pilot plant for minerals processing and metal extraction facilities. It has also acquired world-class mineral and materials characterization equipment such as scanning electron microscopes, thermal analysis equipment, surface morphology apparatus and hardness testers. There are also facilities for extractive metallurgy research and metals forming. There are many important pieces of equipment that can be used for pioneering local research on IC Device Fabrication such as LPCVD set-up, ion-shower doping apparatus, wet and dry etching facilities, spin coating, four-point probe apparatus, ellipsometer, etc. Lastly, computational studies such as modeling and simulation, mine reserve estimation and mine planning can also be done in the computational laboratory of the Department.

The DMMME also offers to private industry consultancy services, special in-house training in materials science and special topics in metallurgical engineering, assorted testing services involving materials characterization and analysis, pilot plant testing in mineral processing, failure analysis, and mining designs.

9.2 VISION

A leading academic and research institution on mining, metallurgical, and materials engineering that employs multidisciplinary holistic approach for national and global progress.

9.3 MISSION

- To provide top-quality EDUCATION in mining, metallurgical, and materials engineering using advanced facilities through high-caliber and internationally recognized faculty members;
- To foster INGENUITY and PRODUCTIVITY on sustainable and clean mineral and metal extraction technologies; synthesis, processing, and characterization of smart and functional materials and materials for energy from indigenous resources;
- To render socially-relevant and exceptional PROFESSIONAL SERVICES in mining, metallurgical, and materials engineering through dynamic and competent faculty members and staff.

9.4 UNDERGRADUATE PROGRAMS

The DMMME offers three undergraduate degree programs: B.S. Materials Engineering, B.S. Metallurgical Engineering and B.S. Mining Engineering.

9.4.1 Program Educational Objectives

The Program Educational Objectives of UP DMMME are to produce professional materials engineers, metallurgical engineers, and mining engineers who will be:

1. Leaders in their field of practice in the business and industries related to materials, metallurgical and mining engineering as demonstrated through their career advancement in their chosen line of work;
2. Active contributors to the materials, metallurgical and mining professional society and other institutions needing their services, thus being effective instruments in helping the nation achieve progress;
3. Engaged in continuous education opportunities through research and advanced studies in materials, metallurgical, mining engineering or allied fields to elevate their professional structure;
4. Able to demonstrate a set of good values and work ethics in the practice of their profession.

9.4.2 Program Outcomes

By the time of graduation, the students of the program shall be able to:

1. Apply knowledge of mathematics and science in the field of materials engineering, metallurgical engineering, and mining engineering;
2. Design and conduct experiments, as well as analyze and interpret data;
3. Design a materials, metallurgical, mining system, component, or process to meet desired needs within identified constraints;
4. Work effectively in multi-disciplinary and multi-cultural teams;

5. Recognize, formulate, and solve engineering problems in the fields of materials engineering, metallurgical engineering, and mining engineering;

6. Recognize professional, social and ethical responsibility;

7. Communicate effectively;

8. Understand the effects of engineering solutions in a comprehensive context;

9. Engage in life-long learning to keep abreast of current developments in the specific field of practice;

10. Know contemporary issues;

11. Use the techniques, skills, and modern engineering tools necessary for engineering practice; and

12. Know and understand engineering management principles as a member and leader in a team, to manage projects and in multidisciplinary environments.

9.5 GRADUATE PROGRAMS

9.5.1 Master of Science in Metallurgical Engineering

The complexity of ore bodies in the country has required an equally complex processing technology for extraction and purification such that specifications for nickel, copper, and gold among other metals for downstream industries are still satisfied. Furthermore, secondary metal resources such as electronic wastes are also getting much attention for the recovery of valuable metals like gold and copper. Metallurgical engineers pursuing graduate studies can pursue research and development so that special parameters for the above mentioned systems can become feasible and profitable.

The program leading to the degree of Master of Science in Metallurgical Engineering (M.S. MetE) aims to provide students with the advanced education that will prepare them for professional careers as leading metallurgical engineers in the industry, academia, or the public sector. The M.S. MetE can work for the mining and minerals industry so that sustainable and environmentally friendly practices will and always be adopted. Processing of the extracted valuable metals into useful, functional, and higher value-added metal products can also be headed engineers with this specialization.

9.5.2 Master of Science in Materials Science and Engineering and Doctor of Philosophy in Materials Science and Engineering

Materials are traditionally classified as metals, polymers, and ceramics. A fourth classification, composite materials, is a combination of two or more of the basic engineering materials. Metals are the oldest engineered materials used by man. These have good electrical and thermal conductivity, high ductility and malleability and high resistance to fracture. New challenges include alloys of higher strengths and improved corrosion resistance. Polymers are organic materials made of long molecules. Engineering applications include optic fibers, teflon and kevlar. Ceramics are inorganic compounds of metallic and non-metallic elements. Engineering ceramics are used in superconductors, integrated circuit packaging and high temperature turbines.

The field of Materials Science and Engineering is very broad and there are many niches in which the Philippines can excel, considering the vast material resources it is endowed with. It is imperative that a program in Materials Science and Engineering be offered in order that the country can secure its future and a chance of becoming a newly industrialized country.

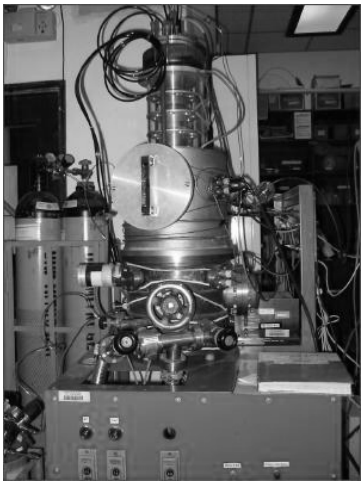
The program leading to the degree of Master of Science in Materials Science and Engineering, or M.S. MSE, aims to provide students with advanced education that will prepare them for professional careers as materials scientists and engineers in the industry, academia, or the public sector that can handle development and innovation required for the emerging needs for green or environmentally friendly materials, biomaterials, nanomaterials, and other smart and functional materials.

The program leading to the degree of Doctor of Philosophy in Materials Science and Engineering, or Ph.D. MSE, aims to provide students with advanced graduate education that will prepare them for professional careers as high-level materials scientists and engineers in the industry, academia, or the public sector. The Ph.D. MSE Program is specifically designed to enable students to (a) obtain a broad, integrated, interdisciplinary understanding of the four core elements of MSE - the structure and composition, properties, synthesis/processing, and performance of materials - and their interrelationships; (b) acquire a specialized, thorough knowledge of at least one class of materials (e.g., ceramics, polymers, composites, alloys, semiconductors, etc.); and (c) gain the competence to undertake original and independent research in materials science and engineering.

9.6 RESEARCH FACILITIES

Shono Semiconductor Devices Fabrication Laboratory

This semiconductor laboratory houses several equipment for thin films deposition and surface modification donated mostly by Dr. Katsufusa Shono from Sophia University in Japan and by the Department of Science & Technology. Some of its basic capabilities include film and substrate etching, and controlled oxidation of substrates used mostly for fabrication of semiconductor devices. Aside from being an instructional laboratory, some research groups have also upgraded existing equipment such as the Ion Shower Facility and Reactive Ion Etching Facility.



Ion-Impregnation Facility

Electron Microscopy Laboratory

The DMMME's Electron Microscopy Laboratory houses a Scanning Electron Microscope (SEM) with an Ion Sputter Coater for the sample preparation of non-conductive samples and a Transmission Electron Microscope (TEM) with a sample preparation set-up for the corresponding specimen-thickness requirement of the equipment. High magnification capabilities of these microscopes allow for study up to the nanometer level of both biological and material samples - from metals to polymers, ceramics to composites. Interaction of electrons with the atoms of the sample will give information such as surface topography, composition, crystal orientation and other properties of interest.

Scanning Electron Microscope

Metallography Laboratory

The DMMME's Metallography Laboratory consists of a Surface Morphology Apparatus and a polishing table where different grades of Silicon Carbide paper and polishing cloths can be interchangeably attached for sample preparation. Chemicals for the preparation of etching agents (etchants) are also available.

The microscope with an SLR camera attachment has magnification capabilities up to 2000X which is used primarily for microstructural analysis. A micrometer eyepiece attachment (with a micrometer slide for calibration) is also available for quick measurements of grains. As such, particle size analysis can also be done using the said equipment.

Plasma-Material Interactions Laboratory

The laboratory is engaged in fundamental research and novel engineering of gaseous discharges for different applications in technologically relevant fields. The primary objective of the facility is the study of gaseous discharges and its effect on different materials relevant to surface engineering, microelectronics manufacturing, value added processes for indigenous materials and biomedical applications.

Plasma-Material Interactions Laboratory

Composite Materials Laboratory

The Composite Materials Laboratory of the Department was established to develop products that utilizes locally available raw materials such as abaca fibers and nanoclay which are indigenous and abundant in our country. At present, facilities of this laboratory include different types of ultrasonicators, high shear mixers, vacuum bagging assembly, electrospinning set-up, universal testing machine, thermal conductivity meter, viscometer, and modeling software which are vital for the execution of activities for the different R&D projects being pursued in this laboratory.

Surface Science Laboratory

The laboratory is equipped with flotation apparatus that separates the valuable mineral from the waste by altering the surface properties of the mineral. Other

equipment such as analytical balance, optical microscope, air compressor and dissolved air flotation cell are also available.

Surface Science Laboratory

Advanced Ceramics Laboratory

The laboratory is engaged in studies in ceramic processing, synthesis and characterization. The objective is to produce ceramic materials from suitable precursors in solid, liquid and/or gaseous phase. The laboratory is equipped with planetary ball mill and sintering furnace.

Smart Materials Laboratory

The Smart Materials Laboratory, under the Sustainable Electronic Materials Research Group, is involved in the synthesis of various metallic and oxide nanomaterials for applications in the semiconductor and electronics industries. It houses equipment, such as potentiostat/galvanostat, electrochemical quartz crystal microbalance, spincoater, vacuum oven, thermal press, fume hood, optical microscopes, and four-point probe, which are vital in the preparation of various nanomaterials and in performing electrochemical and electrical measurements.

Smart Materials Laboratory

Metallurgical Pilot Plant

The Metallurgical Pilot Plant (MPP) houses most of the mineral processing equipment of the department. Comminution equipment such as Jaw crushers, a roll crusher and several laboratory scale ball mills are available for research and instructional use. The MPP also has several concentration equipment such as flotation cells, a laboratory scale Falcon Gravity Concentrator and a shaking table. The MPP is also home to the pilot scale mineral processing plant for gold and copper constructed by the UP-Department of Science & Technology Better Mine Project. The current research thrust of the teams working in the MPP is to develop technology that would make Mineral Processing operations more efficient and environment friendly.

Metallurgical Pilot Plant

Rubber Materials R&D and Consulting Facility

The facility specializes in rubber products innovation that aims to ensure sustainability and enhance competitiveness of rubber industry. It is composed of three laboratories namely, the Raw Materials and Rubber Processing Laboratory (RMRPL), the Raw Materials Characterization Laboratory (RMCL), and the Rubber Product Characterization Laboratory (RPCL).

RMRPL provides treatment processing for raw materials and additives including material recovery, purification, heat treatment, chemical treatment and particle size reduction, and R&D on rubber compounds formulation and processing. RMCL provides testing services including compositional analysis, physical, and chemical properties of raw materials. Lastly, RPCL provides mechanical testing services for natural rubbers and compounded rubber products. The Facility also provides quality research and testing services on various materials such as polymers, ceramics and metals.

Rubber Materials R&D and Consulting Facility

9.7 FACULTY AND STAFF

The current DMMME staff is composed of 29 full-time faculty. Eight are Ph.D. degree holders, ten M.S. degree holders, and the rest are pursuing their Master's degree. Two Adjunct Professors and seven Professorial and Senior Lecturers from related industries, are affiliated with the Department on a part-time basis. Support staff includes one university researcher, one administrative staff, and five laboratory technicians.

DMMME Faculty

Department Chair

Dr. Magdaleno R. Vasquez, Jr.

Professor Emeritus

Meliton U. Ordillas, Jr.
Ph.D. Metallurgical Engineering
Case Western Reserve University, 1970
Physical Metallurgy, Metals Forming and Heat Treatment

Professors

Alberto V. Amorsolo, Jr.
Ph.D. Materials Science & Engineering
University of Rochester, 1997
Thin Films and Electronic Materials, Materials Science and Engineering/Metallurgy

Manolo G. Mena
Ph.D. Metallurgical Engineering
University of Utah, 1983
Electrometallurgy, Thermodynamics and Kinetics in Extractive Metallurgy

Herman D. Mendoza
Dr. Eng. Material Processing and Mineral Engineering
Tohoku University, 1994
Surface Science, Material and Mineral Processing, Environmental Impact Assessment and Monitoring

Associate Professors

Mary Donnabelle L. Balela
Dr. Eng. Materials Science & Engineering
Kyoto University, 2011
Nanomaterials Synthesis, Electrochemistry

Arturo B. Cortes
Ph.D. Metallurgical Engineering
University of Utah, 1994
Numerical Algorithms, Mineral Processing, Tomography

Leslie Joy L. Diaz
Dr. Eng. Materials Science & Engineering
Tokyo Institute of Technology, 2006
Nanomaterials, Green Materials, Composite Materials, Materials Processing

Eduardo R. Magdaluyo, Jr.
M.S. Materials Science & Engineering
University of the Philippines Diliman, 2007
Materials for Environment, Biomedical and Energy Applications, Inorganic-Organic Mesoporous Materials, Failure Analyses and Materials Selections

Assistant Professors

Rinlee Butch M. Cervera
Ph.D. Materials Science & Engineering
University of Tokyo, 2008
Energy Storage and Conversion, Materials for Energy

Eligia D. Clemente
Ph.D. Environmental Engineering
University of the Philippines Diliman (in progress)
Mineral Processing, Leaching Kinetics, Materials Characterization and Analysis

Eden May B. Dela Peña
M.S. Metallurgical Engineering
University of the Philippines Diliman, 2011
Nanotechnology, Electrochemistry, Electrodeposition

Richard D. Espiritu
M.S. Materials Science & Engineering
University of the Philippines Diliman, 2010
Shape Memory Alloys

Astrid Ayla E. Liberato
M.S. Materials Science & Engineering
University of the Philippines Diliman, 2013
Ceramic and Metallic Biomaterials, Wastewater Treatment

Jill Z. Manapat
M.S. Materials Science & Engineering
University of the Philippines Diliman, 2015
Composite Materials, Service-Learning in Engineering

Aileen Grace M. Ongkiko
M.S. Materials Science & Engineering
University of the Philippines Diliman, 2013
Green Materials

Myra Ruth S. Poblete
M.S. Environmental Engineering
University of the Philippines Diliman, 2013
Green and Polymeric Materials

Djoan Kate T. Tungpalan
M.S. Environmental Engineering
University of the Philippines Diliman, 2011
Mineral Processing, Geometallurgy, Ore Body Characterization, Mineralogy, Texture-Based Modeling and Simulation

Magdaleno R. Vasquez, Jr.
Dr. Eng. Materials Science & Engineering
Doshisha University, 2011
Plasma Systems, Ion Beam Sources, Plasma-Material Interactions, Thin Film Deposition, Surface Modification

Noel R. Villavicencio
M.S. Metallurgical Engineering
University of the Philippines Diliman, 2013
Mineral Processing

Instructors

Karlo Leandro D. Baladad
B.S. Metallurgical Engineering
University of the Philippines Diliman, 2011

Jan Lowell P. Buquiz
B.S. Metallurgical Engineering
University of the Philippines Diliman, 2013

Juan Fidel B. Calaywan
B.S. Mining Engineering,
University of the Philippines Diliman, 2010

Audric Zuriel C. Cruz
B.S. Materials Engineering
University of the Philippines Diliman, 2013

John Kenneth A. Cruz
B.S. Materials Engineering
University of the Philippines Diliman, 2010

Stan Kristian G. Ejera
B.S. Metallurgical Engineering
University of the Philippines Diliman, 2012

Marie Angelynne C. Fabro
B.S. Metallurgical Engineering
University of the Philippines Diliman, 2011

Vincent Joseph Garcia
B.S. Materials Engineering
University of the Philippines Diliman, 2013

Jerilene L. Medrano
B.S. Materials Engineering
University of the Philippines Diliman, 2013

Russell Roy M. Palmejar
B.S. Mining Engineering
University of the Philippines Diliman, 2015

Gerwin John D. Rodriguez
B.S. Metallurgical Engineering
University of the Philippines Diliman, 2015

Adjunct Professors

Artemio F. Disini
Gabriel P. Pamintuan, Jr.

Professorial Lecturer

Adolfo Jesus R. Gopez
Diplôme de Docteur Ingénieur Science des Materiaux
Institut National Polytechnique de Lorraine, 1983
Testing of Solid Polymers, Physical Metallurgy, Plastic Deformation of Crystalline & Amorphous Materials, Failure Analysis

Lecturers

Nestor B. Encinas
Arlene Kris C. Go
Nesley F. Saysay
Michael Angelo O. Verdijo
Ace C. Acosta

Administrative Staff

Edrian D. Cuarez
Administrative Assistant II

Technical Staff

Aurelia C. Mechilina
University Researcher I

Edgar L. Argote
Precision Instrument Technician

Mark Andrew B. Alelojo
Laboratory Technician

Frederick L. Angala
Laboratory Technician

Prospero T. Gravidez Jr.
Laboratory Technician

Nestor G. Ore
Laboratory Technician

DMMME Staff and REPS

CONTACT INFORMATION

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9.8 UNDERGRADUATE PROGRAMS CURRICULA

BACHELOR OF SCIENCE IN MATERIALS ENGINEERING †

First Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (MST 1) Free Choice [3]	3	0	3	GE (SSP 2) Philo 1 (Philo Analysis)	3	0	3
GE (AH 1) Eng 10 (College English)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4
GE (SSP 1) Kas 1[1](Kasaysayan ng Pil)	3	0	3	Physics 71.1 (Elem Physics I Lab)	0	2	1
Chem 16 (General Chemistry)	3	6	5	Math 53 (Elementary Analysis I)	5	0	5
Math 17 (Algebra and Trigonometry)	5	0	5	Chem 17 (General Chemistry II)	3	6	5
PE [4] (Physical Education)			(2)	PE [4] (Physical Education)			(2)
	17	6	**19**		15	8	**18**

Second Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (AH 2) Comm 3 (Pract Speech Fund)	3	0	3	Math 55 (Elementary Analysis III)	3	0	3
Math 54 (Elementary Analysis II)	5	0	5	Physics 73 (Elementary Physics II)	4	0	4
Physics 72 (Elementary Physics II)	4	0	4	Physics 73.1 (Elementary Physics II Lab)	0	2	1
Physics 72.1 (Elementary Physics II Lab)	0	2	1	MatE 10 (Prop & Application of Eng Mat)	3	0	3
Chem 28 (Quantitative Inorganic Analysis)	3	0	3	ES 11 (Statics of Rigid Bodies)	2	3	3
Chem 28.1 (Quant Inorg Analysis Lab)	0	6	2	Chem 31 (Elementary Organic Chem)	3	0	3
PE [4] (Physical Education)			(2)	Chem 31.1 (Elem Org Chemistry Lab)	0	6	2
NSTP [5] (National Service Training Program)			(3)	PE [4] (Physical Education)			(2)
				NSTP [5] (National Service Training Program)			(3)
	15	8	**18**		15	11	**19**

Third Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
ES 1 (Engineering Drawing)	0	6	2	EEE 5 (Intro to Semicon Dev & Circ Theory)	3	3	4
ES 21 (Math Methods in Engineering)	3	0	3	ES 26 (Intro to Computer Programming)	0	6	3
ES 13 (Mech of Deformable Bodies I)	3	0	3	MatE 103 (Kinetics of Mat and Processes)	3	0	3
MatE 11 (Fundamentals of MatE)	3	0	3	MatE 104 (Thermo and Kinetics Lab)	0	6	2
MatE 14 (Design and Anal of Exper in MatE)	3	0	3	MatE 111 (Mechanical Deform of Mat)	3	0	3
MatE 101 (Thermodynamics of Materials)	3	0	3	MatE 100 (Metallic Materials)	3	0	3
MatE 180 (Economic Analysis)	2	0	2	MatE 100.1 (Metallic Materials Lab)	0	3	1
	17	6	**19**		12	18	**19**

Fourth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
MatE 105 (Analytical Techniques in MatE)	3	0	3	MatE 121 (Electronic Materials)	3	0	3
MatE 105.1 (Analytical Tech in MatE Lab)	0	3	1	MatE 121.1 (Electronic Materials Lab)	0	3	1
MatE 131 (Polymeric Materials)	3	3	3	MatE 123 (Thin Films Processing)	3	0	2
MatE 131.1 (Polymeric Materials Lab)	0	3	1	MatE 151 (Composite Materials)	3	0	3
MatE 141 (Ceramic Materials)	3	0	3	MatE 151.1 (Composite Materials Lab)	0	3	1
MatE 141.1 (Ceramic Materials Lab)	0	3	1	MatE 161(Fund of Nanotechnology)	3	0	3
GE (AH 3) Fil 40 [1] (Wika, Kultura at Lip)	3	0	3	GE (AH 4) Free Choice [2]	3	0	3
ES 12 (Dynamics of Rigid Bodies)	3	0	3	GE (SSP 3) Free Choice	3	0	3
	15	12	**18**		18	6	**19**

Fifth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (SSP 4) Free Choice	3	0	3	GE (AH 5) Free Choice [2]	3	0	3
GE (MST 2) STS (Science, Tech & Society)	3	0	3	GE (SSP 5) Free Choice	3	0	3
ES 15 (Fluid Mechanics)	3	0	3	GE (MST 3) Free Choice [3]	3	0	3
MatE 171 (Degradation of Metals)	3	0	3	PI 100 (The Life & Works of Jose Rizal)	3	0	3
MatE 173 (Forensic Engg in Materials)	3	0	3	MatE 196 / 199 (Product Design &	6	0	3
MatE 195 / 190 (Materials Selection / Seminar & Research Methods in MatE)	1	3	2	Prototyping/Undergraduate Research)			
				MatE Elective [6]	3	0	3
MatE Elective [6]	3	0	3				
	19	3	**20**		21	0	**18**

Total Number of Units = **187**

Notes:

† *Effective AY 2015-2016. Total Number of Units = 187*

[1] Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

[2] Nine (9) units of GE (AH) courses must be in Communication in English

[3] Except for Math 1, GE (MST) Physics, Chemistry or Mathematics cannot be credited as GE courses

[4] For physical education (PE), the student is required to complete any 4 physical education (PE) courses

[5] As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components: Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

[6] Any approved Specialization Course

DEPARTMENT OF MINING, METALLURGICAL AND MATERIALS ENGINEERING

BACHELOR OF SCIENCE IN METALLURGICAL ENGINEERING †

First Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (MST 1) Free Choice [3]	3	0	3	Chem 16 (General Chemistry)	3	6	5
GE (AH 1) Eng 10 (College English)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4
GE (SSP 1) Kas 1 [1] (Kasaysayan ng Pil)	3	0	3	Physics 71.1 (Elem Physics I Lab)	0	2	1
GE (SSP 2) Philo 1 (Philo Analysis)	3	0	3	Math 53 (Elementary Analysis I)	5	0	5
Math 17 (Algebra and Trigonometry)	5	0	5	GE (AH 2) Fil 40 [1] (Wika, Kultura at Lip)	3	0	3
PE [4] (Physical Education)			(2)	PE [4] (Physical Education)			(2)
	17	0	**17**		15	8	**18**

Second Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (AH 3) Comm 3 (Pract Speech Fund)	3	0	3	Chem 28 (Quant Inorganic Analysis)	3	0	3
Math 54 (Elementary Analysis II)	5	0	5	Chem 28.1 (Quant Inorganic Anal Lab)	0	6	2
Physics 72 (Elementary Physics II)	4	0	4	MetE 11 (Principles of Metallurgy)	3	0	3
Physics 72.1(Elementary Physics II Lab)	0	2	1	MetE 15 (Economic Analysis in Met)	2	0	2
Chem 17 (General Chemistry II)	3	6	5	Geol 11 (Principles of Geology)	3	0	3
PE [4] (Physical Education)			(2)	GE (SSP 3) Free Choice	3	0	3
NSTP [5] (National Service Training Program)			(3)	Math 55 (Elementary Analysis III)	3	0	3
				PE [4] (Physical Education)			(2)
				NSTP [5] (National Service Training Program)			(3)
	15	8	**18**		17	6	**19**

Third Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
ES 1 (Engineering Drawing)	0	6	2	ES 13 (Mech of Deformable Bodies)	3	0	3
ES 11 (Statics of Rigid Bodies)	2	3	3	Geol 40 (Elementary Mineralogy)	2	6	4
Geol 11.1 (Principles of Geology Lab)	0	3	1	MetE 17 (Metallurgical Thermo)	3	0	3
MatE 12 (Metallurgical Measurements)	0	3	1	MetE 143 (Elements of Materials Sci)	3	0	3
MetE 13 (Methods of Met Analysis)	0	6	2	GE (AH 4) Free Choice [2]	3	0	3
MetE 14 (Met Experimental Design)	3	0	3	GE (SSP 5) Free Choice	3	0	3
GE (MST 2) Free Choice [3]	3	0	3				
GE (SSP 4) Free Choice	3	0	3				
	11	21	**18**		17	6	**19**

Fourth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
EM 10 (Principles of Mining)	3	0	3	EEE 3/ EEE 5 (Elem EE / Intro to SD & CT)	3	0	3
MetE 19 (Kinetics and Reaction Rates)	3	0	3	MetE 127 (Mineral Processing II)	3	0	3
MetE 121 (Mineral Processing I)	3	3	3	MetE 128 (Mineral Processing Design)	0	6	2
MetE 146 (Physical Metallurgy I)	3	0	3	MetE 132 (Hydrometallurgy)	3	0	3
MetE 18 (Metallurgical Thermo Lab)	0	3	1	MetE 147 (Physical Metallurgy II)	3	0	3
ES 12 (Dynamics of Rigid Bodies)	3	0	3	ES 15 (Fluid Mechanics)	3	0	3
Elective	3	0	3	Elective	3	0	3
	18	6	**19**		18	6	**20**

Fifth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (MST 3) STS (Science,Tech & Society)	3	0	3	GE (AH 5) Free Choice [2]	3	0	3
PI 100 (The Life & Works of Jose Rizal)	3	0	3	ES 26 (Intro to Computer Programming)	0	6	3
ES 21 (Math Methods in Engineering)	3	0	3	MetE 135 (Extractive Metallurgy Lab)	0	6	2
MetE 134 (Pyrometallurgy)	3	0	3	MetE 136 (Production Metallurgy)	3	0	3
MetE 148 (Physical Metallurgy Lab)	0	6	2	MetE 150 (Adaptive Metallurgy Lab)	6	0	1
MetE 149 (Physical Metallurgy III)	3	0	3	MetE 199 (Research Laboratory)	2	0	2
MetE 198 (Special Problems)	3	0	3	MetE 156 (Metallurgical Plant Design)	0	6	2
	18	6	**20**		14	18	**16**

Total Number of Units = **184**

Notes:

† *Effective AY 2015-2016. Total Number of Units = 184*

[1] Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

[2] Nine (9) units of GE (AH) courses must be in Communication in English

[3] Except for Math 1, GE (MST) Physics, Chemistry or Mathematics cannot be credited as GE courses

[4] For physical education (PE), the student is required to complete any 4 physical education (PE) courses

[5] As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components: Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

DEPARTMENT OF MINING, METALLURGICAL AND MATERIALS ENGINEERING

BACHELOR OF SCIENCE IN MINING ENGINEERING †

First Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (AH 1) Eng 10 (College English)	3	0	3	GE (AH 2) Fil 40 [1] (Wika, Kultura at Lip)	3	0	3
GE (SSP 1) Kas 1 [1] (Kasaysayan ng Pil)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4
GE (SSP 2) Free Choice	3	0	3	Physics 71.1 (Elementary Physics I Lab)	0	2	1
Math 17 (Algebra and Trigonometry)	5	0	5	Math 53 (Elementary Analysis I)	5	0	5
Chem 16 (General Chemistry 1)	3	6	5	Chem 17 (General Chemistry II)	3	6	5
PE [4] (Physical Education)			(2)	PE [4] (Physical Education)			(2)
	17	6	**19**		15	8	**18**

Second Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (AH 3) Comm 3 (Pract Speech Fund)	3	0	3	Math 55 (Elementary Analysis III)	3	0	3
GE (MST 1) Free Choice [3]	3	0	3	Physics 73 (Elementary Physics III)	4	0	4
GE (SSP 3) Philo 1 (Philo Analysis)	3	0	3	Physics 73.1 (Elementary Physics III Lab)	0	2	1
Physics 72 (Elementary Physics II)	4	0	4	GE (SSP 4) Free Choice	3	0	3
Physics 72.1 (Elementary Physics II Lab)	0	2	1	ES 1 (Engineering Drawing)	0	6	2
Math 54 (Elementary Analysis II)	5	0	5	Geol 11 (Principles of Geology)	3	0	3
PE [4] (Physical Education)			(2)	Geol 11.1 (Principles of Geology Lab)	0	3	1
NSTP [5] (National Service Training Program)			(3)	PE [4] (Physical Education)			(2)
				NSTP [5] (National Service Training Program)			(3)
	18	2	**19**		13	11	**17**

Third Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (AH 4) Free Choice [2]	3	0	3	Geol 50 (Elementary Petrology)	2	6	4
Geol 40 (Elementary Mineralogy)	2	6	4	GE (AH 5) Free Choice [2]	3	0	3
ES 11 (Statics of Rigid Bodies)	2	3	3	ES 13 (Mech of Deformable Bodies)	3	0	3
GE 10 (General Surveying I)	3	3	3	GE 12 (General Surveying II)	2	6	4
MetE 11 (Principles of Metallurgy)	3	0	3	EM 36 (Underground Mining)	3	0	3
EM 10 (Principles of Mining)	3	0	3				
	16	12	**19**		13	12	**17**

Fourth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
Geol 112 (Structural Geology)	3	3	4	GE (SSP 5) Free Choice	3	0	3
PI 100 (The Life and Works of Jose Rizal)	3	0	3	Geol 194 (Metalliferous Ore Deposits)	3	6	5
Stat 101 (Elementary Statistics)	3	0	3	EEE 3 (Elementary Electrical Engg)	3	0	3
ES 12 (Dynamics of Rigid Bodies)	2	3	3	ES 15 (Fluid Dynamics)	3	0	3
ES 26 (Introd to Comp Programming)	2	3	3	MetE 13 (Methods of Met Analysis)	0	6	2
EM 45 (Surface Mining)	3	0	3	EM 146 (Rock Mechanics)	2	3	3
	16	9	**19**		14	15	**19**

Fifth Year

First Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units	Second Semester	Lect (hrs/wk)	Lab (hrs/wk)	Units
GE (MST 2) STS (Science, Tech & Society)	3	0	3	GE (MST 3) Free Choice [3]	3	0	3
MetE 120 (Ore Dressing)	3	0	3	EM 156 (Mine Plant Design)	3	0	3
EM 152 (Mine Management)	3	0	3	MetE 128 (Mineral Processing Design)	0	6	2
EM 154 (Mine Economics)	3	0	3	EM 157 (Mine Ventilation)	3	0	3
EM 198 (Special Problems)	3	0	3	EM 191 (Mining and Envi Laws)	3	0	3
Elective	3	0	3	Elective	3	0	3
	18	0	**18**		15	6	**17**

Total Number of Units = **182**

Notes:

† *Effective AY 2015-2016. Total Number of Units = 182*

[1] Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

[2] Nine (9) units of GE (AH) courses must be in Communication in English

[3] Except for Math 1, GE (MST) Physics, Chemistry or Mathematics cannot be credited as GE courses

[4] For physical education (PE), the student is required to complete any 4 physical education (PE) courses

[5] As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components: Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

9.9 GRADUATE PROGRAMS CURRICULA

Master of Science in Materials Science and Engineering (M.S. MSE)

Thesis Option

PROGRAM CHECKLIST

Total Minimum Units Required: 37 units

A.	Core Courses *	24 units
B.	Applied Mathematics	6
C.	Graduate Seminar	1
	Graduate Thesis	6
	Total	37

Course Number	Title	Units
	A. Core Courses *	**24**
MSE 201**	Fundamentals of Materials Science & Engineering	3
MSE 225	X-Ray Crystallography & Spectrography	3
MSE 231	Thermodynamics of Materials	3
MSE 233	Kinetics of Materials	3
MSE 241	Physics of Solids	3
MSE 251	Mechanical Properties of Solids	3
MSE 211 to	Combination of Courses in Laboratory Modules	
MSE 219	in MSE as listed below	6
MSE 211	Transmitted Light Microscopy	1
MSE 212	Mineragraphy	1
MSE 213	Crystallography	1
MSE 214	Vacuum Technologies & Thin Film Deposition	1
MSE 215	Electronic & Magnetic Measurements	1
MSE 216	Ceramics Processing & Characterization	2
MSE 217	Scanning Electron Microscopy	1
MSE 218	Metallography	1
MSE 219	Thermal Analysis	1
	B. Applied Mathematics	**6**
ES 201	Advanced Mathematical Methods in Engineering I	3
ES 204	Numerical Methods in Engineering	3
	C. Graduate Seminar	
MSE 296	Graduate Seminar	**1**
	Graduate Thesis	
MSE 300	Thesis	**6**
	Total	**37**

***** Students who have taken courses equivalent to the core courses will be required to complete 24 units by taking specialization courses.

****** Student with Metallurgical or Materials Engineering background must take a 3-unit specialization course instead of MSE 201.

Master of Science in Materials Science and Engineering (M.S. MSE)

Non-Thesis Option

PROGRAM CHECKLIST

Total Minimum Units Required: 43 units

A.	Core Courses	24 units
B.	Applied Mathematics	6
C.	Graduate Seminar	1
D.	Specialization Courses (12 units Minimum)	12
	Comprehensive Examination	
	Total	43

Course Number	Title	Units
	D. Specialization Courses	
MSE 243	Epitaxial Growth	3
MSE 243.1	Epitaxial Growth Laboratory	2
MSE 245	Semiconductor Characterization	3
MSE 245.1	Semiconductor Characterization Laboratory	2
MSE 253	Heat Treatment of Ferrous & Special Alloys	3
MSE 255	Metal Casting	3
MSE 265	Ceramic Materials	3
MSE 266	Polymer Materials	3
MSE 267	Surface Science	3
MSE 268	Degradation of Materials	3
MSE 271	Physics of Liquid Crystals	3
MSE 271.1	Liquid Crystals Laboratory I	2
MSE 271.2	Liquid Crystals Laboratory II	2
MSE 275	Advanced Physics of Solids I	3
MSE 276	Advanced Physics of Solids II	3
MSE 281	Dislocation Theory	3
MSE 282	Composite Materials	3
MSE 283	Semiconductor Materials & Processes	3
MSE 283.1	Semiconductor Device Fabrication Laboratory	3
MSE 285	Electron Microscopy	3
MSE 286	Powder Technology	3
MSE 287	Crystal Growth	3
MSE 287.1	Crystal Growth Laboratory	2
MSE 298	Special Problems	3

Doctor of Philosophy in Materials Science and Engineering (Ph.D. MSE)

For Students Without a Master's Degree in MSE

PROGRAM CHECKLIST

Students admitted without a Master's Degree in MSE shall be required to complete at least forty-five (45) units of formal graduate courses in MSE.

Course Number	Title	Units
	A. Core Courses *	**24**
MSE 201**	Fundamentals of Materials Science & Engineering	3
MSE 225	X-Ray Crystallography & Spectrography	3
MSE 231	Thermodynamics of Materials	3
MSE 233	Kinetics of Materials	3
MSE 241	Physics of Solids	3
MSE 251	Mechanical Properties of Solids	3
MSE 211 to	Combination of Courses under Experimental	
MSE 219	Methods in MSE as listed below	6
MSE 211	Transmitted Light Microscopy	1
MSE 212	Mineragraphy	1
MSE 213	Crystallography	1
MSE 214	Vacuum Technologies & Thin Film Deposition	1
MSE 215	Electronic & Magnetic Measurements	1
MSE 216	Ceramics Processing & Characterization	2
MSE 217	Scanning Electron Microscopy	1
MSE 218	Metallography	1
MSE 219	Thermal Analysis	1

***** Students who have taken courses equivalent to the core courses will be required to complete the minimum twenty-four (24) units by taking specialization courses.

****** Students with Metallurgical or Materials Engineering background must take a 3-unit specialization course instead of MSE 201.

Students with geology or engineering background are required to take at least an additional three (3) units of Advanced Mathematics (ES 201, ES 202, ES 204 or equivalent).

Advanced Mathematics

Course Number	Title	Units
ES 201	Advanced Mathematical Methods in Engineering I	3
ES 202	Advanced Mathematical Methods in Engineering II	3
ES 204	Numerical Methods in Engineering	3

Course Number	Title	Units
	B. Specialization Courses (21 units in the student's chosen area of specialization)	**21**
MSE 243	Epitaxial Growth	3
MSE 243.1	Epitaxial Growth Laboratory	2
MSE 245	Semiconductor Characterization	3
MSE 245.1	Semiconductor Characterization Laboratory	2
MSE 253	Heat Treatment of Ferrous & Special Alloys	3
MSE 255	Metal Casting	3
MSE 265	Ceramic Materials	3
MSE 266	Polymer Materials	3
MSE 267	Surface Science	3
MSE 268	Degradation of Materials	3
MSE 271	Physics of Liquid Crystals	3
MSE 271.1	Liquid Crystals Laboratory I	2
MSE 271.2	Liquid Crystals Laboratory II	2
MSE 275	Advanced Physics of Solids I	3
MSE 276	Advanced Physics of Solids II	3
MSE 281	Dislocation Theory	3
MSE 282	Composite Materials	3
MSE 283	Semiconductor Materials & Processes	3
MSE 283.1	Semiconductor Device Fabrication Laboratory	2
MSE 285	Electron Microscopy	3
MSE 286	Powder Technology	3
MSE 287	Crystal Growth	3
MSE 287.1	Crystal Growth Laboratory	2
MSE 298	Special Problems	3
	Graduate Seminar	
MSE 296	Graduate Seminar	**1**
	Ph.D. Dissertation	
MSE 400	Dissertation	**12**
	Total	**58**

Doctor of Philosophy in Materials Science and Engineering (Ph.D. MSE)

For Students Who Have a Master's Degree in MSE

Specialization Courses in MSE		**24** units
Ph.D. Dissertation		**12** units
	Total	**36** units

Master of Science in Metallurgical Engineering (M.S. MetE)

(Extractive Metallurgy – Thesis Option)

PROGRAM CHECKLIST

Course Number	Title	Units
	A. Core Courses	**15**
MetE 210	Advanced Metallurgical Thermodynamics	3
MetE 213	Rate Processes	3
MetE 221	Advanced Mineral Processing I	3
MetE 231	Advanced Extractive Metallurgy I	3
MetE 232	Advanced Extractive Metallurgy II	3
MetE 235	Physical Chemistry of Steelmaking	3
	B. Advanced Mathematics	**6**
ES 201	Advanced Mathematical Methods in Engineering I	3
ES 202	Advanced Mathematical Methods in Engineering II	3
ES 204	Numerical Methods in Engineering	3
	C. Electives *	**3**
MetE 217	Minerals Industry Analyses	3
MetE 218	Process Synthesis	3
MetE 241	Advanced Physical Metallurgy	3
MetE 243	Heat Treatment of Ferrous & Special Alloys	3
MetE 251	Metal Casting	3
MetE 257	Deformation Processing	3
MetE 298	Special Problems	3
	D. Graduate Thesis	
MetE 300	Thesis	**6**
	Total Minimum Units Required	**30**

***** One elective from other fields may be given with the approval of the adviser

Master of Science in Metallurgical Engineering (M.S. MetE)

(Physical Metallurgy – Thesis Option)

PROGRAM CHECKLIST

Number	Title	Units
	A. Core Courses	**12**
MetE 210	Advanced Metallurgical Thermodynamics	3
MetE 213	Rate Processes	3
MetE 241	Advanced Physical Metallurgy	3
MetE 243	Heat Treatment of Ferrous and Special Alloys	3
MetE 251	Metal Casting	3
MetE 257	Deformation Processing	3
MetE 298*****	Special Problems	
	****** *Any of the following MSE courses can be substituted for MetE 298 to be credited as part of the core course requirement.*	
MSE 225	X-Ray Crystallography & Spectrography	3
MSE 267	Surface Science	3
MSE 268	Degradation of Materials	3
MSE 281	Dislocation Theory	3
MSE 282	Composite Materials	3
MSE 285	Electron Microscopy	3
MSE 286	Powder Technology	3
	B. Electives	**6**
	Any of the core courses listed above can be also be credited under electives if not being applied for credit as a core course. Other MetE graduate courses can be credited under electives. Any of the MSE courses except MSE 201 can be credited under electives as long as they are not considered equivalent of MetE core courses already applied for credit as a core course	
	C. Advanced Mathematics	**6**
ES 201	Advanced Mathematical Methods in Engineering I	3
ES 202	Advanced Mathematical Methods in Engineering II	3
ES 204	Numerical Methods in Engineering	3
	D. Graduate Thesis	
MetE 300	Thesis	**6**
	Total Minimum Units Required	**30**

9.10 UNDERGRADUATE PROGRAM RETENTION RULES

1. Any student who obtains a final grade of 5.00 twice in any one of the required Math, Physics and Chem (Math 17, Math 53, Math 54, Math 55, Physics 71, Physics 71.1, Physics 72, Physics 72.1, Physics 73, Physics 73.1, Chem 16, Chem 17) courses as specified in the curriculum shall be dismissed from his/her program.

2. Any student who obtains a final grade of 5.00 twice in either ES 11 or ES 13 shall be dismissed from his/her program.

3. Any student who obtains a final grade of 5.00 twice in any one of the required MatE, MetE or EM major courses as specified in the curriculum shall be dismissed from his/her program.

9.11 UNDERGRADUATE PROGRAMS COURSE DESCRIPTIONS

Materials Engineering (MatE)

MatE 10 Engineering Materials. A survey of the different engineering materials; relationship of structure properties to their applications. Prereq: Physics 72. 3 u.

MatE 11 Fundamentals of Materials Engineering. Structure and composition of materials (metals, polymers, ceramics and composite materials); properties and behavior in service environments. Prereq: Chem 16, Physics 72. 3 u.

MatE 14 Design and Analysis of Experiments in Materials Engineering. Basic statistical concepts; design and analysis of experiments; optimization techniques; data presentation and report writing. Prereq: Math 54. 3 u.

MatE 100 Metallic Materials. Mechanisms of development and control of microstructure of metals; phase transformations and heat treatment; strengthening mechanisms; heat treatment practices and metal forming; metallography. Prereq: MatE 11. 3 u.

MatE 100.1 Metallic Materials Laboratory. Tensile and compressive strength measurements; heat treatment of steel and other metals/alloys; precipitation hardening; determination of the hardenability of steel and other metals/alloys. Prereq: MatE 11; Coreq: MatE 100. 1 u.

MatE 101 Thermodynamics of Materials. Basic thermodynamic quantities and laws; phase transformations and chemical reactions; partial molal and excess quantities; phase of variable compositions; free energy of binary systems, surfaces and interfaces. Prereq: Chem 17, MatE 11. 3 u.

MatE 103 Kinetics of Materials and Processes. Reaction rates, mechanisms, and transport phenomena in materials application to nucleation, crystal growth, recrystallization, precipitation, sintering, solid state reactions, the role of kinetics in the development of microstructures. Prereq: MatE 101, Math 54. 3 u.

MatE 104 Thermodynamics and Kinetics Laboratory. Demonstrative applications of thermodynamic and kinetic principles relevant to materials engineering; determination of kinetic parameters; investigation of surface thermodynamic properties; thermal analysis of bulk materials. Coreq: MatE 103. 6 h (lab) 2 u.

MatE 105 Analytical Techniques in Materials Engineering. Concepts, operation principles of x-ray diffractometry, compositional analysis, spectroscopy, surface analysis, microscopy, non-destructive tests, and other emerging analytical techniques. Prereq: MatE 11, Chem 28. 3 u.

MatE 105.1 Analytical Techniques in Materials Engineering Laboratory. Laboratory exercises in available analytical methods for materials characterization including data acquisition and calculations involved in techniques for thermal analysis, x-ray diffraction, imaging, spectroscopy, etc.; sample preparation, equipment conditioning, and detection limits, etc. Prereq: Chem 28.1; Coreq: MatE 105. 3 h (lab)1 u.

MatE 111 Mechanical Deformation of Materials. Mechanisms of deformation and fracture mechanics; failure of materials (fatigue, creep, stress corrosion) and strengthening mechanisms; plastic deformation processing, tools and equipment (forging, rolling, extrusion, drawing, forming and machining). Prereq: MatE 11, ES 13, ES 21. 3 u.

MatE 121 Electronic Materials. Electrical and magnetic materials and their properties; band theory of solids and lattice vibrations; periodic structures; lattice waves; electron states; static properties of solids; electron-electron interactions; dynamics of electrons in solids. Prereq: MatE 11, Physics 73. 3 u.

MatE 121.1 Electronic Materials Laboratory. Laboratory exercises in the characterization of the electrical, magnetic, and optical properties of materials. Coreq: MatE 121. 3 h (lab)1 u.

MatE 123 Thin Films Processing Laboratory. Laboratory exercises in vacuum technologies and thin film deposition techniques as applied to semiconductor device fabrication; characterization of thin films. Prereq: MatE 104. 2 u.

MatE 131 Polymeric Materials. Structure, properties and synthesis of polymers; processing, fabrication techniques, and conversion to plastics; applications and degradation of polymers. Prereq: MatE 11, Chem 31. 3 u.

MatE 131.1 Polymeric Materials Laboratory. Synthesis of polymers; processing, fabrication techniques, and conversion to plastics; characterization. Prereq: MatE 105.1, MatE 103; Coreq: MatE 131. 3 h (lab)1 u.

MatE 141 Ceramic Materials. Structure, properties, and synthesis of ceramics; processing, fabrication techniques; applications, performance, and degradation of ceramics.Prereq: MatE 103. 3 u.

MatE 141.1 Ceramic Materials Laboratory. Synthesis of ceramics; processing, fabrication techniques; characterization. Prereq: MatE 105.1, MatE 103; Coreq: MatE 141. 1 u.

MatE 151 Composite Materials. Structure and property of fibers; matrices and final composites; fabrication techniques and processing of composites; degradation and failure analysis of composites. Prereq: MatE 111, MatE 131, MatE 141. 3 u.

MatE 151.1 Composite Materials Laboratory. Laboratory exercises in the fabrication and characterization of composite materials. Prereq: MatE 151. 3 h (lab) 1 u.

MatE 161 Fundamentals of Nanotechnology. Principles of nanoscience and nanotechnology; experimental tools of nanotechnology; diversity of nanostructures, nanomaterials, and nanosystems; current and future nanotechnology applications. Coreq: MatE 151. 3 h (lec) 3 u.

MatE 171 Degradation of Materials. Degradation of metals by corrosion, oxidation, mechanical wear, fatigue, erosion; thermodynamics and kinetics of corrosion; forms of corrosion, its detection and prevention; effects of the environment on metal performance. Prereq: MatE 111. 3 u.

MatE 173 Forensic Engineering in Materials. Failure analysis of materials; destructive and non-destructive testing methods related to failure analysis and reliability testing; industrial standards for materials. Prereq: MatE 105, MatE 151. 3 u.

MatE 180 Economic Analysis in Materials Engineering. Introduction to economic analysis applied to materials engineering; cost estimation; overview of feasibility study preparation. Prereq: 3rd yr. standing. 2 u.

MatE 181 Biomaterials. Qualification for biomedical applications; molecular and cellular interactions of biomaterials; classifications based on composition, function, clinical application; basic biomedical device design, fabrication and testing considerations. Coreq: MatE 151 or COI for non-MatE students. 3 h (lec) 3 u.

MatE 182 Green Materials. Materials life cycle; materials selection for environmental impact considertation; environmental applications and hazards of nanomaterials. Coreq: MatE 151 or COI for non-MatE students. 3 h (lec) 3 u.

MatE 183 Construction Materials. Manufacture and use of high performance construction materials including but not limited to concrete, steel, polymeric materials, geosynthetics, masonry materials and coatings, and fiber reinforced cement and polymer composites. Coreq: MatE 151 or COI for non-MatE students. 3 h (lec) 3 u.

MatE 184 Materials for Energy. Energy problem; materials for harvesting energy; fuel cells, batteries and energy storage; materials issues in efficiency and degradation; safety risks in energy storage; emerging technologies. Coreq: MatE 151 or COI for non-MatE students. 3 h (lec) 3 u.

MatE 185 Materials for Electronic Devices. Materials important in solid state electronics; dielectrics, semiconductors and superconductors; semiconductor device fabrication; electronic device assembly; microelectronic materials manufacturing; quality and reliability aspects. Coreq: MatE 151 or COI for non-MatE students. 3 h (lec) 3 u.

MatE 190 Seminar and Research Methods in Materials Engineering. Preparation of undergraduate research proposal, data gathering, and preliminary experimentation. Prereq: MatE 151. 2 u.

MatE 195 Materials Selection. Introduction to engineering design and materials selection; material processing; systematic product design conceptualization. Prereq: MatE 151. 1 h (lec), 3h (lab) 2 u.

MatE 196 Product Design and Prototyping. Product development; design with materials; computational and structural design; cost, life cycle, and risk analysis; design strategy, implementation, and evaluation; prototype development. Prereq: MatE 195. 6 h (lab) 3 u.

MatE 197 Special Topics. Special topics related to materials engineeringMay be repeated for a minimum of six units. Prereq: 5th year standing. 3 u.

MatE 199 Undergraduate Research Project. Undergraduate Research Paper and Defense. Prereq: MatE 190. 3 u.

Summer Plant Practice. 8 weeks of on the job training in a related plant. Prereq: 4th yr. standing. Must have passed MetE12. No credit.

Metallurgical Engineering (MetE)

MetE 11 Principles of Metallurgy. An introduction to mineral dressing; to pyro-, hydro-, and electro-metallurgy, and to adaptive metallurgy. Terminology, principles and processes. Coreq: Chem 17. 3 u.

MetE 12 Metallurgical Measurements. Measurement and data acquisition in metallurgy.Coreq: Physics 72.
3 h (lab) 1 u.

MetE 13 Methods of Metallurgical Analysis. Classical and modern methods of metallurgical analysis.
Prereq: MetE 11. 6 h (lab) 2 u.

MetE 14 Metallurgical Experimental Design. Statistical concepts. Design and analysis of metallurgical experiment. Optimization techniques. Quality control methods. Data presentation and report writing. Prereq: Chem 17. 3 u.

MetE 15 Economic Analysis in Metallurgy. Introduction to economic analysis applied to metallurgy; cost estimation; overview of feasibility study preparation. Prereq: 3rd yr. standing. 2 u.

MetE 17 Metallurgical Thermodynamics. Principles of thermodynamics. Application of thermodynamics to metallurgical systems. Prereq: MetE 11. 3 u.

MetE 18 Metallurgical Thermodynamics Laboratory. Demonstrative application of thermodynamic principles. Determination of some thermodynamic quantities.Prereq: MetE 17. 3 h (lab) 1 u.

MetE 19 Kinetics and Reaction Rates. Reaction rates, mechanisms and transport phenomena, applications to microstructure development, nucleation, crystal growth, grain growth, re-crystallization, precipitation, sintering and solid state reactions. Prereq: MetE 17, 4th yr. standing. 3 h (lec) 3 u.

MetE 121 Mineral Processing I. Size reduction and separation; gravity, magnetic and electrical concentration; de-watering; materials handling. Prereq: MetE 11. 3 u.

MetE 127 Mineral Processing II. Flotation. Production of industrial minerals. Tailings disposal.
Prereq: MetE 121/COI. 3 u.

MetE 128 Mineral Processing Laboratory. Coreq: MetE 120/127. 6 h (lab) 2 u.

MetE 132 Introduction to Hydrometallurgy. Physical chemistry of hydrometallurgical processes. Dissolution, solution purification, metal winning from solutions. Electrochemical phenomena and corrosion. Prereq: MetE 17. 3 u.

MetE 134 Pyrometallurgy. Unit process of high temperature metallurgy. Production and utilization of heat. Slags and refractories. Prereq: MetE 17. 3 u.

MetE 135 Extractive Metallurgy Laboratory. Experiments in hydrometallurgy and pyrometallurgy.
Prereq: MetE 132, MetE 134. 6 h (lab) 2 u.

MetE 136 Production Metallurgy. Production of refined metals from ores. Integration and application of principles of minerals engineering and extractive metallurgy. Coreq: MetE 134. 3 u.

MetE 143 Elements of Materials Science. Structure and composition of materials. Properties and behavior in service environments. Metals, ceramics, organic and composite materials. Prereq: Chem 16, Physics 72. 3 u.

MetE 146 Physical Metallurgy I. Origin, mechanisms of development and control of internal structure of metals. Phase transformation and heat treatment. Deformation and fracture. Strengthening mechanisms. Prereq: MetE 143; Coreq: MetE 17. 3 u.

MetE 147 Physical Metallurgy II. Continuation of MetE 146 placing emphasis on the detailed study of the alloy series. Heat treatment practice. Metal forming. Prereq: ES 13, MetE 146. 3 u.

MetE 148 Physical Metallurgy Laboratory. Coreq: MetE 147. 6 h (lab) 2 u.

MetE 149 Failure and Degradation of Materials. General introduction to the failure behavior of metals, ductile and brittle behavior; failure analysis techniques; NDT; fractography; failure modes such as fatigue, wear, creep, corrosion, hydrogen degradation, degradation of metals in industrial applications. Prereq: MetE 147, 5th year standing. 3 u.

MetE 150 Adaptive Metallurgy Laboratory. Application of adaptive metallurgy principles, casting of metals, mechanical forming processes, consolidation and joining. Characterization of fabricated metals.
Prereq: MetE 148, MetE 149. 3 h (lab) 1 u.

MetE 156 Metallurgical Plant Design. Elements of plant design including choice of process, equipment and materials, site and plant layout. Prereq: Senior standing. 6 h (lab) 2 u.

MetE 197 Special Topics. 3 u., may be taken twice.

MetE 198 Special Problems. Independent work in a construction, design or research project.
Prereq: MetE 12, MetE 13, MetE 128; Coreq: MetE 148. 3 u.

MetE 199 Research Laboratory. Application of research techniques to designated topics. Prereq: MetE 198.
6 h (lab) 3 u.

Metallurgical Plant Practice. 8 weeks. One summer of field work in an operating metallurgical plant as arranged by Dept. faculty. May include ore dressing mills, cyanide plants, metal processing plants, or the University Metallurgical Pilot Plant.

Mining Engineering (EM)

EM 10 Principles of Mining. Socio-economic importance and characteristics of the mineral industry. Principles of mineral exploration, mine development, exploitation and rehabilitation. Introduction to surface and underground mining methods. Prereq/Coreq: Geol 11. 3 u.

EM 36 Underground Mining. Criteria for the selection of underground mining method including coal mining. Techniques, unit operations and mine systems involved in the different underground mining methods. Development planning, engineering layout and extraction. Underground haulage systems, draw and grade control. Prereq: EM 10. 3 u.

EM 45 Surface Mining. Engineering and economic factors in the planning and design of open pit and other surface mining methods, including coal mining. Selection and use of various equipment and systems involved in surface mining. Concepts of stripping ratios, grade control and mine planning. Prereq: EM 10. 3 u.

EM 146 Rock Mechanics. Introduction to rock mechanics. Physical and engineering properties of rocks, rock failures and fundamentals of rocks mass and rock response to applied loads. Principles and design of underground openings and pit slopes, ground support, tunneling, monitoring and other practical applications. Prereq: EM 36, EM 45, ES 13. 5 h (2 lec, 3 lab) 3 u.

EM 152 Mine Management. Introduction to mine administration, corporate planning, organization, maintenance management, mine labor cost analysis, industrial relations and human resource development. Corporate social responsibility and quantitative management analysis. Prereq: Senior standing. 3 u.

EM 154 Mine Economics. Feasibility studies, methods of sampling, ore reserve estimations and statistical analysis for evaluating mineral deposits. Engineering economic principles with emphasis on the economic evaluation of mineral development and mining projects. Prereq: Econ 11/100.2, Stat 101, Senior standing. 3 u.

EM 156 Mine Plant Design. Analysis and design of: materials handling systems including hauling and hoisting, mine de-watering, compressed air, and power systems. Some operations research applications in mining. Prereq: EEE 3, ES 13, ES 15, Senior standing. 3 u.

EM 157 Mine Ventilation. Fundamentals of mine ventilation, including gas, dust, temperature, and humidity control. Economics of airflow, natural and mechanical ventilation. Analysis and design of ventilation systems. Prereq: ES 15, Senior standing. 3 u.

EM 191 Mining and Environmental Laws. The mining and environmental laws, policies, implementing rules and regulations. Legal and ethical issues affecting the practice of Mining Engineering. Mine safety and accident prevention. Prereq: Senior standing. 3 u.

EM 197 Special Topics. 3 u., may be taken twice.

EM 198 Special Problems in Mining Engineering. Undergraduate individual study project and written report on various subjects or problems on mining engineering. Presentation and discussion of the written reports submitted by students before the class. Subjects to be assigned by the faculty-in-charge. Prereq: Senior standing. 3 u.

Mine and Mill Practice. 8 weeks. Actual work in mine and mill. May not be waived/replaced by class work.

9.12 GRADUATE PROGRAMS COURSE DESCRIPTIONS

Materials Science and Engineering (MSE)

MSE 201 Fundamentals of Materials Science and Engineering. Materials classification, properties and applications; principles of processing; raw materials for the Philippine industry. Prereq: COI. 3 u.

MSE 211 Laboratory Module in Transmitted Light Microscopy. Prereq: COI. 3 h (lab) 1 u.

MSE 212 Laboratory Module in Mineragraphy. Prereq: COI. 3 h (lab) 1 u.

MSE 213 Laboratory Module in Crystallography. Prereq: COI. 3 h (lab) 1 u.

MSE 214 Laboratory Module in Vacuum Technologies and Thin Film Deposition. Prereq: COI. 3 h (lab) 1 u.

MSE 215 Laboratory Module in Electronic and Magnetic Measurements. Prereq: COI. 3 h (lab) 1 u.

MSE 216 Laboratory Module in Ceramics Processing and Characterization. Prereq: COI. 6 h (lab) 2 u.

MSE 217 Laboratory Module in Scanning Electron Microscopy. Prereq: COI. 3 h (lab) 1 u.

MSE 218 Laboratory Module in Metallography. Prereq: COI. 3 h (lab) 1 u.

MSE 219 Laboratory Module in Thermal Analysis. Prereq: COI. 3 h (lab) 1 u.

MSE 225 X-Ray Crystallography and Spectrography. X-ray methods for the characterization of crystal structure and determination of chemical composition. Prereq: COI. 3 u.

MSE 231 Thermodynamics of Materials. Theory of thermodynamics; applications to phase equilibria. Prereq: COI. 3 u.

MSE 233 Kinetics of Materials. Reaction rates, mechanism and transport phenomena in materials. Prereq: COI. 3 u.

MSE 241 Physics of Solids. Band theory of solids and lattice vibrations; electrical magnetic and optical properties. Prereq: COI. 3 u.

MSE 243 Epitaxial Growth. Processing and preparation of semiconducting materials and related compounds, microstructures and devices with emphasis on the principles of epitaxial growth; in-situ analytical methods for the evaluation of growth fronts. Prereq: MSE 241. 3 u.

MSE 243.1 Epitaxial Growth Laboratory. Prereq: MSE 243. 6 h (lab) 2 u.

MSE 245 Semiconductor Characterization. Advance methods of evaluating semiconductor materials, microstructures and devices including electronic analysis, spectroscopy, x-ray diffraction and surface analysis. Prereq: MSE 241. 3 u.

MSE 245.1 Semiconductor Characterization Laboratory. Prereq: MSE 245. 6 h (lab) 2 u.

MSE 251 Mechanical Properties of Solids. Mechanism of deformation and fracture mechanisms, failure of materials and strengthening mechanisms, plastic deformation processing, tools and equipment. Prereq: COI. 3 u.

MSE 253 Heat Treatment of Ferrous and Special Alloys. Types of ferrous alloys, interrelationships among compositions, microstructure, service requirements and mechanical properties of ferrous alloys, industrial heat treatment practice, special alloys. Prereq: COI. 3 u.

MSE 255 Metal Casting. Metallurgy of cast metals, unit foundry operations, sand testing and control, melting and casting practices; manufacture of special cast metals and alloys. Prereq: COI. 3 u.

MSE 265 Ceramic Materials. Structure and properties, synthesis and processing of ceramics, high technology and engineering applications. Prereq: MSE 241. 3 u.

MSE 266 Polymer Materials. Structure, properties and synthesis of polymers, processing and conversion to plastics, applications and performance of polymers. Prereq: COI. 3 u.

MSE 267 Surface Science. Surface and interface, thermodynamics and electrical aspects of surface and interface, absorptions, chemisorptions, catalysis, colloidal systems, applications to processing and manufacturing. Prereq: MSE 231. 3 u.

MSE 268 Degradation of Materials. Degradation of, and effects of the environment on metals, polymers ceramics and composites. Prereq: MSE 231. 3 u.

MSE 271 Physics of Liquid Crystals. Study of anisotropic fluids, main type and properties, long and short order in nematics, principles of the main field (Maier-Sanpe) and the continuum theories, statics and dynamic properties of nematics, cholesterics and smectics, applications of liquid crystals. Prereq: COI. 3 u.

MSE 271.1 Liquid Crystals Laboratory I. Characterization of LCs; optical microscopy, refractometry; uv-vis-ir spectrophotometry; FTRI; differential scanning calorimetry. Prereq: MSE 271. 6 h (lab) 2 u.

MSE 271.2 Liquid Crystals Laboratory II. Synthesis of LCs; fabrication of polymer dispersed liquid crystals (PDLC) fabrication; characterization and applications in simple LC devices. Prereq: MSE 271.1. 6 h (lab) 2 u.

MSE 275 Advance Physics of Solids I. Fundamental principles of the physics of solids, periodic structure, lattice wave, electron states; static properties of solids; electron-electron interaction; dynamics of electrons in solids. Prereq: MSE 241. 3 u.

MSE 276 Advance Physics of Solids II. Transport and optical properties of solids. Fermi surface, magnetism superconductivity, amorphous and disordered systems. Prereq: MSE 275. 3 u.

MSE 281 Dislocation Theory. Foundations of dislocation theory, dislocation movements, forces, interactions role of dislocations in strengthening mechanisms in solids. Prereq: MSE 241. 3 u.

MSE 282 Composites Materials. Basic mechanics and materials science of important modern composite materials structure and properties of fibers, matrices and final composites. Prereq: COI.3 u.

MSE 283 Semiconductor Materials and Processes. Substrate materials preparation, physics of semiconductors device fabrication technologies, packaging and encapsulation. Prereq: MSE 241. 3 u.

MSE 283.1 Semiconductor Device Fabrication Laboratory. Prereq: MSE 283. 6 h (lab) 2 u.

MSE 285 Electron Microscopy. Techniques for transmission and scanning electron microscopy, secondary and back-scattered electron imaging, microchemical and microstructural analysis. Prereq: MSE 217. 5 h (2 lec, 3 lab) 3 u.

MSE 286 Powder Technology. Problems associated with forming powders into shapes, powder characterizations processes of sintering and vitrification, operations of grinding, finishing and coating. Prereq: MSE 241. 3 u.

MSE 287 Crystal Growth. Application of thermodynamics and phase diagrams to crystal growth, segregation nucleation; techniques and choice of method for a specific material. Prereq: MSE 231. 3 u.

MSE 287.1 Crystal Growth Laboratory. Prereq: MSE 287. 6 h (lab) 2 u.

MSE 296 Graduate Seminar. Prereq: COI. 1 u.

MSE 298 Special Problems. Prereq: COI. 3 u.

MSE 300 MS Thesis. Prereq: Consent of Thesis Adviser. 6 u.

MSE 400 PhD Dissertation. Prereq: Passing of the Candidacy Examination. 12 u.

Metallurgical Engineering (MetE)

MetE 210 Advanced Metallurgical Thermodynamics. Application of thermodynamics principles in prediction of stable phases. Prereq: MetE 17. 3 u.

MetE 213 Rate Processes. Heat and mass transfer, kinetics and mechanisms of reactions in metallurgical systems. Prereq: MetE 132. 3 u.

MetE 217 Mineral Industry Analyses. Microeconomic and macroeconomic analyses of the minerals industry, market conditions, structure and price formation of major mineral commodities, government regulations and global trends affecting the mineral sector. Prereq: Econ 11. 3 u.

MetE 218 Process Synthesis. Metallurgical process synthesis, flowsheet development and associated economic analysis. Prereq: MetE 136/COI. 3 u.

MetE 221 Advanced Mineral Processing I. Technology of mineral beneficiation, current plant procedures, operating controls, plant research, metallurgical accounting, materials inventory and economic recoveries. Prereq: MetE 127. 3 u.

MetE 222 Advance Mineral Processing II. Special topics in flotation and comminution theory, mineral physics, thermal decripitation, use of radioactive tracers and ion exchange resins. Prereq: MetE 127. 3 u.

MetE 231 Advance Extractive Metallurgy I. Theory, operation and economics of modern industrial hydrometallurgical processes, including electroplating, electrowinning and electrolytic refining. Prereq: MetE 132. 3 u.

MetE 232 Advance Extractive Metallurgy II. Problems in roasting, smelting and refining. Pyro- and electro-metallurgical processes. Prereq: MetE 134/COI. 3 u.

MetE 235 Physical Chemistry of Steelmaking. Analysis of iron extraction and steelmaking processes, with emphasis on blast surface, basic oxygen furnace and electric furnace; application of deoxidizers, vacuum and inert gas processes for product purification. Prereq: MetE 134/COI. 3 u.

MetE 241 Advanced Physical Metallurgy. Electron theory of metals, theory of crystal binding, solid solutions and compound formation, phase stability, solid state phase transformations, microstructures and mechanical properties. Prereq: MetE 147. 3 u.

MetE 243 Heat Treatment of Ferrous and Special Alloys. Types of ferrous alloys, interrelationships among composition, microstructure, service requirements and mechanical properties of ferrous alloys, industrial heat treatment practices, special alloys. Prereq: MetE 146. 3 u.

MetE 251 Metal Casting. Metallurgy of cast metals. Unit foundry operations. Sand testing and control. Melting and casting practices. Manufacture of special cast metals and alloys. Prereq: MetE 147. 3 u.

MetE 257 Deformation Processing. Fundamentals of plastic deformation processing, forging, rolling, extrusion and drawing, tools and equipment. Prereq: MetE 147/COI. 3 u.

MetE 296 Seminar. 1 unit/sem; maximum of 3 u.

MetE 298 Special Problems. 3 u.; may be taken twice; topics to be indicated for record purposes.

MetE 300 MS Thesis. 6 u.