DEPARTMENT OF ENVIRONMENTAL ENGINEERING

FACULTY OF CIVIL, ENVIRONMENTAL AND GEO ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

SYLLABUS

MASTER PROGRAM (S2)

CURRICULUM 2018 - 2023

Catalog 2018

Master Program (S-2)
Environmental Engineering

DEPARTMENT OF ENVIRONMENTAL ENGINEERING
FACULTY OF CIVIL, ENVIRONMENTAL AND GEO ENGINEERING
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

FOREWORD

Assalammualaikum Wr Wb.

Best Wishes,

Praise be to Allah SWT because of His gifts and blessings we have finished the preparation of Curriculum 2018-2023 and make it happen in the Curriculum Catalog 2018. This catalog contains the composition of the subject, the number of credits and other information contained in the new curriculum of the Department of Environmental Engineering FTSLK ITS. Preparation of the curriculum 2018 - 2023 has been through various stages, including analysis of competency needs required by stakeholders and users of graduates, so expected results in the form of a curriculum that meets the standards of competence, comprehensive and update.

The Catalog 2018 is expected to provide information and guidance to the academic community, students, parents of students and all parties about learning materials, types of knowledge and skills learned, including the standards and learning objectives, references used, and the type of assessment undertaken by Department of Environmental Engineering FTSLK ITS. In the end, it is expected that the learning system based on the curriculum 2018-2023 will produce graduates that meet the achievement of learning that has been set, update, achievement and competitive, so easily absorbed in the job market and even able to create field and employment opportunities.

In the end, we hope that all the information contained in this book will be of the greatest benefit. Thank you.

Wassalammualaikum Wr. Wb

Surabaya, January 2018
Head of Department

Adhi Yuniarto, ST., MT., PhD.

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PROFILE

The Department of Environmental Engineering is under the Faculty of Civil, Environment and Geo Engineering - Institute of Technology Sepuluh Nopember. The Department of Environmental Engineering was established in 1996 with the Environmental Engineering S-1 Program which is a change from the Program Study S-1 (Undergraduate) Sanitary Engineering. Currently the Department of Environmental Engineering has three programs, which are:

1. S-1 (Undergraduate) Environmental Engineering
2. S-2 (Master) Environmental Engineering
3. S-3 (Doctorate) Environmental Engineering

Vision:

References in the field of engineering and environmental management of international repute in the improvement of environmental quality.

Mission:

1. Conducting undergraduate and postgraduate education in internationally reputable engineering and environmental management.
2. Develop science and technology in the field of environmental engineering and management that prioritizes the quality of the environment, including coastal areas.
3. Disseminate and actively apply technological innovation work and methods to solve environmental quality problems.
4. Capture partnership networks with government agencies and private / industry at home and abroad in the field of environmental engineering and management.
5. Develop ethical values, morals, attitudes and softskills of the academic community.

Educational Objectives:

1. Producing graduates who devoted to God Almighty, noble personality, ethical, academic morality, has a strong attitude and values.
2. Producing graduates capable of designing engineering engineering in the field of environmental engineering, producing innovations in preventing and implementing pollution controls, and applying

innovative technology and designing environmental remediation solutions from pollutants, which are oriented towards updating and disseminating them through scientific publications at the national or international level.

3. Mastering the basic principles of theoretical concepts of natural science, application of engineering mathematics, engineering principles, basic control technologies and environmental pollution prevention processes, and the basic principles of the latest and latest technologies, as well as the process of restoring the polluted environment.
4. Able to manage jobs and make the right decisions based on problem identification, information and data analysis with the insight of sustainable development (sustainable development) covering environmental aspects and settlement, marine, energy, and information technology as well as promoting social awareness.

S-1 (Undergraduate) Environmental Engineering Program

The S-1 (Undergraduate) Environmental Engineering Program was opened in 1983 based on the Decree of the Director General of Higher Education, Ministry of Education and Culture of the Republic of Indonesia No. 116/DIKTI/Kep/1984 named the Sanitary Engineering Program under Department of Civil Engineering FTSP - ITS. In 1996, the Sanitary Engineering Program was turn into Environmental Engineering Program based on the Decree of the Director General of Higher Education Department of Education and Culture of the Republic of Indonesia No. 224/DIKTI/Kep/1996. This Study Program has been awarded by National Accreditation Board of Higher Education (BAN PT) with **Accreditation A** for the period of November 14, 2015 - November 14, 2020 based on the Decree of National Accreditation Board No. 1155/BAN-PT/Akred/S/XI/2015 14th November 2015.

S-2 (Master) Environmental Engineering Program

S-2 (Master) Environmental Engineering Program was opened in 1999 based on the Decree of the Director General of Higher Education, Ministry of Education and Culture of the Republic of Indonesia Number 15/DIKTI/Kep/1999. S-2 (Postgraduate) Environmental Engineering Study Program has two areas of expertise, namely Environmental Engineering and Environmental Sanitation Engineering.

In the field of Environmental Engineering, it is reviewed various environmental problems and solutions with emphasis on academic studies for scientific development. The Environmental Sanitation Engineering focuses on academic studies applicable to the field of keciptakaryaan. This field of expertise is the cooperation of FTSP with Education and Training Center Ministry of Public Works of Indonesia.

The S-2 (Master) Program has been awarded National Accreditation Board of Higher Education (BAN PT) with **Accreditation A** rating for period 9th January 2015 – 9th January 2020 based on Decree of National Accreditation Board No. 005/BAN-PT/M/I/2015, dated 9th January 2015.

S-3 (Doctorate) Environmental Engineering Program

The S-3 (Doctorate) Environmental Engineering Program was opened in 2009 based on the Decree of the Director General of Higher Education, Ministry of National Education of the Republic of Indonesia Number 1250/D/T/2009 dated 31st July 2009. The study program accepts students from graduates of S-2 (Master) Environmental Engineering or others related background.

Academic Facility

- Lecturing Room
- Examination and Seminars Room
- Laboratories
- Computer Room and Internet Network
- Library (Reading Room)
- Magazines/ Scientific Journals
- Lecturer Room
- Administration room

Management of Department of Environmental Engineering:

1. Head of Department:
   Adhi Yuniarto, ST., MT., PhD.
2. Secretary of Department:
   Arseto Yekti Bagastyo, ST., MT., MPhil., PhD.
3. Head of S-1 Study Program :
   Bieby Voijant Tangahu, ST., MT., PhD.
4. Secretary of S-1 Program:
   Welly Herumurti, ST., MSc.
5. Head of S-2 and S-3 Study Program:
   Dr.Ir. Ellina S. Pandebesie, MT.
6. Secretary of S-2 and S-3 Program:
   Ipung Fitri Purwanti, ST., MT., PhD.
7. Head of Laboratory:
   - Laboratory of Water Recovery Technology
     Prof. Ir. Wahyono Hadi, MSc., PhD.
   - Laboratory of Air Pollution and Climate Change
     Dr. Eng Ari Dipareza Syafe'i ST., MEPM
   - Laboratory of Solid Waste and B3
     Prof. Dr. Yulinah Trihadiningrum, MAppSc.
   - Laboratory of Environmental Remediation
     Prof. Dr. Ir. Sarwoko Mangkoedihardjo, MScES.
   - Laboratory of Environmental Quality Management
     Prof. Dr. Ir. Nieke Karnaningroem, Dipl.SE,. MSc.

The Department of Environmental Engineering currently has a staff of 29 permanent lecturers consisting of 23 doctorates (5 of whom are Professors), 6 masters, and some lecturers from other departments who foster basic subjects and public lectures.

Permanent Lecturers of Department of Environmental Engineering, ITS

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
1	Prof. Ir. Wahyono Hadi, M.Sc. PhD.	ITB	State Univ. of South Dakota, USA	Univ. Leuven, Belgium	Water Treatment
2	Dr.Ir. M. Razif, MM.	ITB	ITB	UB	Environmental Development and Management
3	Prof. Dr. Yulinah Trihadiningrum, MApp.Sc.	ITB	Univ. of New South Wales, Australia	Univ. of Antwerpen, Belgium	Solid and Hazardous Waste Treatment
4	Prof. Dr. Ir. Sarwoko Mangkoedihardjo, M.ScES.	ITB	Univ. of Gent, Belgia	Univ. Brawijaya	Environmental Sanitation and Phytoremediation
5	Prof. Dr. Ir. Nieke Karnaningroem, MSc.	ITB	IHE, Holland	Civil Eng, ITS	Environmental Management & Modeling

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
6	Dr. Ir. Agus Slamet, MSc.	ITS	IHE, Holland	ITS	Waste Water Treatment
7	Prof. Ir. Joni Hermana, MScES., PhD.	ITB	Univ. of Gent, Belgium	Univ. of Newcastl, England	Waste Water Treatment, Environmental Management System
8	Ir. Atiek Moesriati, MKes.	ITS	Univ. Of Airlangga, Surabaya		Environmental Health
9	Ir. Eddy Setiadi Soedjono, Dipl.SE, MSc., PhD.	ITS	IHE, Belanda	Univ. of Birmingham England	Water and Sanitation
10	Ir. Mas Agus Mardyanto, ME., PhD.	ITS	Univ. of Roorkee India	Univ. of Otawa	Ground Water Management

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
11	Ir. Bowo Djoko Marsomo, MEng.	ITB	Asian Institute of Technology		Water Treatment
12	Dr.Ir. Ellina S. Pandebesie, MT.	ITB	ITS	Chemical Eng. ITS	Solid Waste Manag. & Technology
13	Dr. Ir. R. Irwan Bagyo Santoso, MT.	ITS	ITB	ITS	Environmental Resource Management.
14	Dr. Ali Masduqi, ST., MT.	ITS	ITB	Civil Eng, ITS	Water Supply Manag. & Engineering
15	Susi Agustina Wilujeng, ST., MT.	ITS	ITB	Currently studying in ITB	Wastewater Treatment & Solid Waste Management.

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
16	Dr. Ir. Rachmat Boedisantoso, MT.	ITS	ITB	ITS	Air Quality Control and Management
17	Bieby Voijant Tangahu, ST. , MT.., PhD.	ITS	ITS	UK Malaysia	Waste Water Treatment
18	IDAA Warmadewanthi, ST., MT., Ph.D.	ITS	ITB	NTUST, Taiwan	Solid Waste Treatment
19	Adhi Yuniarto, ST., MT., PhD.	ITS	ITS	UT Malay. Malaysia	Environmental Management
20	Harmin Sulistiyaningtitah, ST., MT., PhD.	ITS	ITB	UKM, Malaysia	Solid and Hazard. Waste, and Phytoremediation

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
21	Ipung Fitri Purwanti, ST., MT., PhD.	ITS	ITS	UKM, Malaysia	Environmental Sanitation
22	Alia Damayanti, ST., MT.,PhD.	ITS	ITS	UTM, Malaysia	Environmental Sanitation
23	Dr. Abdu Fadli Assomadi, S.Si., MT.	Univ. Brawijaya	ITS	ITS	Env. Chemistry & Air Quality
24	Dr. Eng Ari Dipareza Syafe'i ST., MEPM.	ITS	NTU, Taiwan	Hiroshima Univ., Japan	Environmental Management & Air Quality
25	Arseto Yekti Bagastyo, ST., MT., MPhil. , PhD.	ITS	ITS dan The Univ. of Queensland	Univ. of Queensland	Hazardous Waste(water) Treatment
26	Welly Herumurti, ST.., MSc.	ITS	Univ. Petronas, Malaysia		Environmental Management
27	Alfan Purnomo, ST., MT.	ITS	ITS		Wastewater Treatment

NO	NAME	GRADUATE FROM			EXPERTISE
		S1 (Under-graduate)	S2 (Master)	S3 (PhD)	
28	Ervin Nurhayati, ST., MT., PhD.	ITS	ITS	National Chiao Tung University, Taiwan	Water Recovery
29	Iftitah Rahmatika, ST., M. ng.	UI	AIT Bangkok	Currently stidying in Tokyo	Water Treatment Technology

INFORMATION

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MASTER PROGRAM COURSES

No.	Course Code	Course Name	Credits
SEMESTER: I			
1	RE185101	Operation and Process of Physical Separation of Pollutants	3
2	RE185102	Environmental Resource Management	3
3	RE185103	Operation and Process of Biological and Chemical Water Treatment	3
		Total Credits	9

MASTER PROGRAM COURSES FOR THE AREA OF INTEREST OF ENVIRONMENTAL ENGINEERING

SEMESTER: II			
1	RE185201	Operation and Process of Environmental Remediation	3
2	RE185202	Solid Waste Treatment Technology	2
3	RE185203	Hazardous Waste Management Technology	2
4	RE185204	Gaseous Emission Control Technology	3
		Total Credits	10
SEMESTER: III			
1	RE185301	Health, Safety and Environment	3
2		Elective Course	3
3		Elective Course	3
		Total Credits	9
SEMESTER: IV			
1	RE185401	Thesis	8
		Total Credits	8

MASTER PROGRAM COURSES FOR THE AREA OF INTEREST OF ENVIRONMENTAL SANITATION ENGINEERING

No.	Course Code	Course Name	Credits
SEMESTER: II			
1	RE185205	Design and Evaluation of Solid Waste and Hazardous Waste Management System	3
2	RE185206	Design and Evaluation of Water Supply System	3
3	RE185207	Design and Evaluation of Wastewater Management System	3
		Total Credits	9
SEMESTER: III			
1	RE185314	Design and Evaluation of Urban Drainage Systems	3
2	RE185315	System Master Plan	3
3	RE185316	Socio-Economic Analysis	2
4	RE185317	Preparation of Settlements Infrastructure Development Plan (Studio)	2
		Total Credits	10
SEMESTER: IV			
1	RE185401	Thesis	8
		Total Credits	8

LIST OF ELECTIVE COURSES

No.	Subject Code	Subject Name	Credits
1	RE185302	Leachate Treatment Technology	3
2	RE185303	Sludge Treatment Technology	3
3	RE185304	Air Quality Modeling	3
4	RE185305	Air Pollution Control System	3
5	RE185306	Industrial Waste Treatment Technology	3
6	RE185307	Eco-hydrology	3
7	RE185308	Environmental Biotechnology	3
8	RE185309	System Analysis and Optimization	3
9	RE185310	Environmental Ecotoxicology	3
10	RE185311	Environmental Engineering Modeling	3
11	RE185312	Climate Change Adaptation and Mitigation	3
12	RE185313	Mine Land Remediation	3

COURSE	**Course Name**	: Operation and Process of Physical Separation of Pollutants
	Course Code	: RE185101
	Credits	: 3 credits
	Semester	: 1

COURSE DESCRIPTION

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Mastery of Knowledge:

- Mastery of knowledge of engineering science theories, design engineering, methods and techniques of pollutant removal required for the analysis and design of drinking water treatment and waste water

Specific skills:

- Able to solve problems through engineering pollutant reduction technologies and the development of water treatment processes and wastewater, as well as to contribute original and tested through research independently.

General skills:

- Able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs 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.

COURSE LEARNINNG OUTCOME

Able to analyze and develop the technology of separation of pollutants in water and wastewater using physical process.

SUBJECTS
PREREQUISITE
REFERENCES
1. Renolds, T.D. & Richard, P.A., "Unit Operations and Process in Environmental Engineering", Second Ed. PWS. New York, 1996 2. L. Huisman ,(1974) : "Slow Sand Filtration" World Health Organization (December 1, 1974) 3. Larry D, Benefield, Joseph F.Judkins, Jr, Barron L. Weand, "Process Chemistry for water and Wastewater Treatment", Prentice Hall Inc, New Jersey 07632, 1982, and Operation", Prentice-Hall. Upper Saddle River, 2000

COURSE		
	Course Name	: Environmental Resource Management
	Course Code	: RE185102
	Credit	: 3 credits
	Semester	: 1

SUBJECT DESCRIPTION

Water resources and environmental management is an effort to plan, implement, monitor, and evaluate the implementation of conservation, utilization and destructive potential control of water and environmental resources. Actions to manage water and environmental resources will be studied in this course by focusing on students' ability to solve water and environmental resource problems based on ecological-based development principles.
Task: case study of specific topics on environmental resource management.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude:

- Possessing a good attitude, mental and academic ethics, as well as maintaining values and norms, and personality as an Indonesian
- Demonstrating attitude of responsibility on work in his/her field of expertise independently

Mastery of Knowledge:

- Mastering the theories and methods of management, analysis of environmental issues and environmental management efforts by considering the risks that occur

Specific skills:

- Able to analyze and solve problems that occur in the environment well using management technology, establishing efforts that need to be done in solving the problems encountered, by considering the aspects of Engineering – socio – economic and environmental/health.
- Capable of deepening or expanding science in the field of designing, operating and maintaining engineering systems and environmental management to contribute original and tested

General skills:

- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerns and implements the value of humanities in

accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME

- Able to internalize values, norms, academic ethics, exhibiting responsible behavior towards the work independently by doing the task without doing plagiarism
- Able to apply the theory of engineering science, engineering design, methods and current techniques that are required for the analysis and design of environmental management in completing the task independently
- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics
- Able to solve engineering and technological problems and analyze the system, in the management of water and environmental resources e, which includes the management of natural resources, the usefulness and benefits of natural resources, the relationship between environmental economic theory with Natural Resources Management, modeling of surface water (rivers and lakes), ground water and Hydro-economy model on river management, IWRM, Groundwater and evaporation theory and Polder, Ground water related theory, natural resources theory related to polder/boezem utilization, and water budget.
- Able to deepen and expand the proficiency in designing, operating and maintaining engineering systems and environmental management to give original and verified contribution by preparing scientific paper review

SUBJECTS

- Fundamentals of water and environmental resource management according to ecological principles and ecosystem approach.
- Efforts to plan, implement, monitor, and evaluate the implementation of conservation, utilization and destructive potential control of water and environmental resources.
- The linkage between resources and environmental components with environmental economic concepts and theories
- Water and environmental resource inventory methodology.

- Planning for utilization of water resources and methods of conservation of resources such as rivers, forests, beaches, coastal areas and others according to their potential, functions and designated purpose.
- Principles of management and environmental resource management capability.

PREREQUISITE

REFERENCES

1. Schwab Glenn O, Fangmeier Delmar D, Elliot William J, Frevert Richard K, Soil and Water Conservation Engineering ", John Wiley & Sons, Inc., Canada, 1993
2. Dadhich, LK and AP Sharma (ed), 2002, "Biodiversity - strategies for conservation", APH Publishing, New Delhi.
3. Rimal, Naresh N. (Ed), "Water Resources Security and Sustainability", Seepwater, Kathmandu, 2006
4. Chaturvedi MC, "Water Resources System Planning & Management", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1992
5. Notodarmojo S, Soil and Soil Pollution, ITB Publisher, Bandung, 200
6. Sunaryo Trie M, Waluyo S Tjoek, Harnanto Aris, "Water Resources Management", Bayumedia Publishing, Malang, 2005

Course	**Course Name**	:	Operation and Process of Biological and Chemical Water Treatment
	Course Code	:	RE185103
	Credit	:	3 credits
	Semester	:	1

COURSE DESCRIPTION

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Mastery of Knowledge:

- Mastery of knowledge of engineering science theories, design engineering, pollution removal methods and techniques necessary for the analysis and design of drinking water treatment, waste water.

Specific skills:

- Able to solve the problem of pollutant reduction through technological engineering and development of drinking water and wastewater treatment process, operating unit design, and can give original and tested contribution through research independently

General skills:

- able to develop logical, critical, systematic, and creative thinking to go through scientific research, creation in the field of science and technology that cares and implements value humanities in accordance with their areas of expertise, constituting scientific conception and the results of the study based on rules, procedures, and scientific ethics in the form of a thesis or scientific journals that may be published in accredited or accepted scientific journals at international Journal.

COURSE LEARNING OUTCOME

Able to analyze and develop water pollutant conversion technique through Physical-biological, Physical-chemical process and apply in the process of designing water and wastewater treatment plant installation, as well as application in advanced processing.

SUBJECT
PREREQUISITE
REFERENCES
1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Resource Recovery", 5th Ed. McGraw-Hill. New York, 2014 2. Renolds, TD & Richard, PA, "Unit Operations and Process in Environmental Engineering", Second Ed. PWS. New York, 1996 3. Larry D, Benefield, Joseph F. Judkins, Jr., Barron L. Weand, "Process Chemistry for water and Wastewater Treatment", Prentice Hall Inc., New Jersey 07632, 1982. 4. Eckenfelder, WW Jr., "Industrial Water Pollution Control". 3rd Ed. MC. Graw-Hill, 2000 5. Qasim, SR Motley, EM and Guang, Z., "Water Works Engineering - Planning, Design, and Operation", Prentice-Hall. Upper Saddle River, 2000

COURSE		
	Course Name	: Operation and Process of Environmental Remediation
	Course Code	: RE185201
	Credit	: 3 credits
	Semester	: 2

COURSE DESCRIPTION
The contaminated environment requires special handling with remediation techniques. Various operations and remediation processes will be studied in this course, using physical-chemical methods, bioremediation techniques, and phytoremediation techniques. Besides, regulations and legislation related to environmental remediation will also be studied so that students will possess technical and non-technical insight of the subject. This subject is equipped with the task of: designing a remediation system using methods that match the characteristics of pollutants in the environment.
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude: • Demonstrating attitude of responsibility on work in his/her field of expertise independently Mastery of Knowledge: • Engineering science theories, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts; Specific Skills: • Able to perform academic validation or studies in accordance with their areas of expertise, especially in the field of environmental remediation in solving problems in relevant communities or industries through the development of knowledge and expertise; General Skills: • Able to solve engineering and technological problems, and design systems, processes and components on environmental management efforts including drinking water management, waste water, waste management, settlement drainage, wastewater control systems, solids and gases, air pollution control and occupational health and safety (K3) by utilizing other fields of science (if necessary, in this case the science of environmental remediation) and taking into account the economic, health and safety factors of the public, cultural, social and environmental

COURSE LEARNING COME

- Able to identify and analyze problems, sources and pollution processes in water, soil, and groundwater media.
- Able to solve engineering problems through operations and processes of environmental remediation
- Able to analyze and synthesize the application of polluted media remediation technology by considering both technical and non-technical aspects.
- Able to develop program for contaminated media remediation by considering legal, economic, financial and socio-cultural aspects.
- Able to design remediation of contaminated media by applying technology that has been studied carefully

SUBJECTS

- Types of environmental pollutants (water and soil), including organic and inorganic, sources and characteristics.
- Type of reactor, mass equilibrium, reaction rate, experimental set up.
- The remediation of the polluted environment by physical-chemical methods (air sparging, bioventing, flotation, soil washing, adsorption etc.)
- Environmental bioremediation technique.
- Environmental phytoremediation techniques.
- Regulations and legislation related to remediation.

PREREQUISITE

REFERENCES

1. USEPA-United States Environmental Protection Agency, "Phytoremediation Resource Guide :, EPA / 542 / B-99/003, 1999
2. USEPA-United States Environmental Protection Agency, "Ground Water Issue. Phytoremediation of Contaminated Soil and Ground Water at Hazardous Waste Sites "EPA / 540 / S-01/500, February 2001.
3. Singh, Ajay. & Ward, Owen P. (ed). "Applied Bioremediation and Phytoremediation", Springer, Berlin, 2004
4. Singh, Ajay. & Ward, Owen P. (ed). "Biodegradation and Bioremediation", Springer, Berlin, 2004

5. Cookson, John T., "Bioremediation Engineering - Design and Application". McGraw-Hill. New York, 1995
6. International journals of various publishers/International journals from various publishers.
7. Lehr, Jay. & Hyman, Marve & Gass, Tyler E. & Seevers, William J. 2002. Handbook of Complex Environmental Remediation Problems. McGraw-Hill. New York.
8. Chaudhry, G. Rasul (Ed). Biological Degradation and Bioremediation of Toxic Chemicals. Dioscorides Press. Portland, Oregon.
9. Margesin, Rosa & Schinner, Franz. 2005. Manual Of Soil Analysis - Monitoring and Assesing Soil Bioremediation. Springer. Berlin.
10. Schulte, A. & Ruhiyat. D (ed). 2002. Soils of Tropical Forest Ecosystems - Characteristics, Ecology and Management. Berlin. Springer
11. Alexander, Martin. 11990. Biodegradation and Bioremediation. Academic Press. San Diego.
12. Gadd, GM (ed). 2001. Fungi in Bioremediation. Cambridge University Press. Cambridge.
13. Sellers, Kathleen. 1998. Fundamentals of Hazardous Waste Site Remediation. Lewis. Boca Raton.
14. Rosenberg, E. (ed). 1993. Microorganisms to Combat Pollution. Kluwer Academic Publishers. Dordrecht.

COURSE	**Course Name**	: Solid Waste Treatment Technology
	Course Code	: RE185202
	Credit	: 2 credits
	Semester	: 2

COURSE DESCRIPTION

Solid waste is a material that requires special handling so as not to cause problems to the environment. Solid waste handling requires treatment technology which corresponds to the characteristics of the waste. In this course students study the technology and process of solid waste physical, chemical, and biological treatment. Moreover, recyclable solid waste treatment technology, biogas utilization, and RDF also will be studied.

To improve the capacity of the students, the course is equipped with assignment: Evaluation of solid waste treatment in Integrated Waste Treatment and final disposal sites/landfill (biogas); evaluation of waste recycling of domestic waste, domestic waste-like, and specific waste.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalize academic values, norms, and ethics;
- Demonstrate a responsible attitude towards the work in their own field of expertise; and
- Working together to be able to take full advantage of their potential.

Mastery of Knowledge

- Engineering science theories, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts;

Specific Skill

- Able to do deepening or extension of science in the field of designing, operating and maintaining engineering systems and environmental management to contribute original and tested through independent research;
- Able to adapt science or technology changes that occur to the implementation process and research substance faced in the field of environmental management.

General Skills

– Able to develop logical, critical, systematic, and creative thinking through scientific research, creation in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME

- Students understand technology and process of solid waste physical treatment (particle size reduction, separation, volume reduction)
- Students understand technology and process of solid waste chemical waste processing (incineration, pyrolysis and gasification)
- Students understand technology and process of solid waste biological waste processing (aerobic and anaerobic composting and digesting, vermicomposting)
- Students understand recyclable solid waste treatment technology (paper and plastic waste processing, iron and non-ferrous metal waste), biogas utilization, RDF.

- SUBJECTS

- Technology and process of solid waste physical treatment (particle size reduction, separation, volume reduction)
- Technology and process of solid waste chemical treatment (incineration, pyrolysis and gasification)
- Technology and process of solid waste biological treatment (aerobic and anaerobic composting and digesting, vermicomposting)
- Recyclable solid waste treatment technology (paper and plastic waste processing, ferrous and non-ferrous metal waste), biogas utilization, RDF.

PREREQUISITE

REFERENCES

1. LaGrega, MD, Buckingham, PL, and Evans, JC Hazardous Waste Management and Environmental Resources Management. McGraw-Hill International Edition, Boston. 2001.
2. Lens, P., Hamelers, B., Hoitink, H., and Bidlingmaier, W., "Resource Recovery and Reuse in Organic Solid Waste Management", IWA Publishing, London, 2004

3. Nindyapuspa, A. and Trihadiningrum, Y,. "Electronic Waste Management". ITS Press. Surabaya, 2013
4. Lehman, S. and Crocker, R., "Designing for Zero Waste - Consumption, Technologies and the Built Environment", Earthscan, London, 2012
5. Tang, WZ Physicochemical Treatment of Hazardous Wastes. Lewis Publishers. 2004
6. Tchobanoglous, G., Theisen, and Vigil, Integrated solid waste management, McGrawhill, 1993
7. John S., "Recycling of waste plastics - pyrolysis and related feedstock recycling technologies", John Wiley, 2005
8. Polprasert, C., "Organic Waste Recycling - Technology and Management" 3th ed. IWA Publishing, London, 2007
9. Hass, CN and Vamos, RC Hazardous and Industrial Waste Treatment. Prentice-Hall, Englewod Cliffs, New Jersey. 1995

COURSE	**Course Name**	:	Hazardous Waste Treatment Technology
	Course Code	:	RE185203
	Credit	:	2 credits
	Semester	:	2

COURSE DESCRIPTION

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalize academic values, norms, and ethics;
- Demonstrate a responsible attitude towards the work in their own field of expertise; and

Mastery of Knowledge

- Engineering science theories, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts;

Specific skill

- Able to solve engineering and technological problems and design systems, processes and components on environmental management efforts including waste management by considering economic, health and safety, public, cultural, social and environmental factors
- Capable of deepening or expanding science in the field of designing, operating and maintaining engineering systems and environmental management to give the original and tested contribution

General Skills

- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME
• Students understand hazardous waste minimization technology: operational control, reuse, recovery, recycle • Students understand technology and process of hazardous waste treatment including neutralization, precipitation, stabilization/solidification, ion exchange, incineration, biological treatment • Students understand the technology and process of hazardous waste treatment • Students are able to evaluate the hazardous waste treatment
SUBJECTS
PREREQUISITE
REFERENCES
1. LaGrega, MD, Buckingham, PL, and Evans, JC Hazardous Waste Management and Environmental Resources Management. McGraw-Hill International Edition, Boston. 2001. 2. Lens, P., Hamelers, B., Hoitink, H., and Bidlingmaier, W., "Resource Recovery and Reuse in Organic Solid Waste Management", IWA Publishing, London, 2004 3. Nindyapuspa, A. and Trihadiningrum, Y,. "Electronic Waste Management". ITS Press. Surabaya, 2013 4. Lehman, S. and Crocker, R., "Designing for Zero Waste - Consumption, Technologies and the Built Environment", Earthscan, London, 2012 5. Tang, WZ Physicochemical Treatment of Hazardous Wastes. Lewis Publishers. 2004 6. Tchobanoglous, G., Theisen, and Vigil, Integrated solid waste management, McGrawhill, 1993 7. John S., "Recycling of waste plastics - pyrolysis and related feedstock recycling technologies", John Wiley, 2005 8. Polprasert, C., "Organic Waste Recycling - Technology and Management" 3th ed. IWA Publishing, London, 2007

9. Hass, CN and Vamos, RC Hazardous and Industrial Waste Treatment. Prentice-Hall, Englewod Cliffs, New Jersey. 1995

COURSE			
	Subject Name	:	Gaseous Emission Control Technology
	Subject Code	:	RE185204
	Credit	:	3 credits
	Semester	:	2

COURSE DESCRIPTION
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude • Mastering contemporary and contextual interdisciplinary approaches related to the design of integrated environmental management systems. • Mastering contemporary and contextual interdisciplinary approaches related to the design of integrated environmental management systems. Mastery of knowledge • Mastery of knowledge of engineering science theories, design engineering, pollution removal methods and techniques necessary for the analysis and design of the app Specific skills • Able to solve the problem of pollutant reduction through technological engineering and development of appu operation unit General skills • Able to develop logical, critical, systematic, and creative thinking through scientific research, creation in science and technology that cares and implements humanities value in accordance with their fields of expertise, preparing scientific conceptions and study results based on scientific rules, procedures, and ethics in the form of theses or scientific journals which may be published in accredited scientific journals or accepted in international journals.

COURSE LEARNING OUTCOME
• Able to analyze and develop gaseous emission/pollutants control technology
SUBJECTS

PREREQUISITE
REFERENCES

1. Cooper, C. David & Alley, FC, "Air Pollution Control, A Design Approach". 4th.ed. Waveland Press. Long Grove, 2011.
2. Kalliat T. & Valsaray, "Elements of Environmental Engineering, Thermodynamics and Kinetics", CRC Press, New York, 2009.
3. Theodore, Louis, "Air Pollutin Control Equipment Calculations". John Wiley. New York, 2008
4. Rajaram, Vasudevan & Siddiqui, Faisal Zia & Khan, Mohd Emran, "From Landfill Gas To Energy technologies and Challenges" CRC Books, Boca Raton, 2012
5. Heinsohn, Robert Jennings & Cable, Robert Lynn, "Sources And Control of Air Pollution", Prentice-Hall, Englewood Cliffss, 1999
6. Degoobert, Paul, "Automobiles and Pollution", Edition TECHNIP, Paris, 1992
7. Fenger, Jes & Tjell, Jens Christian, "Air pOllution - From Local To A Global Perspective", Polyteknisk Forlag, 2009
8. Reis, Stefan, "Costs of Air Pollution Control - Analyzes of Emission Control Options for Ozone (O3) Abatement Strategies". Springer, Berlin, 2005
9. Nriagu, Jerome O. (ed.). Gaseous Pollutants – Characteristization and Cycling. John Wiley. New York.
10. Buonicore, Theodore (ed.), "Air Pollution Control Equipment - Selection, Design, Operation and Maintenance", Springer, Berlin, 1994
11. Greyson, Jermoe, "Carbon, Nitrogen, and Sulfur Pollutants, and Their Determination in Air and Water", Marcell Dekker, Basel, 1990

COURSE	**Course Name**	:	Evaluation of Solid Waste and Hazardous Waste Management System
	Course Code	:	RE185205
	Credit	:	3 credits
	Semester	:	3

COURSE DESCRIPTION

This course we discusses various methods in designing facilities and infrastructure of solid waste system technical management, including collection, sorting, reuse, recycling, processing, and final treatment of waste. After following this course, the students are expected to be able to evaluate the result of technical waste management system design

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalizing academic values, norms, and ethics
- Demonstrating attitude of responsibility on work in his/her field of expertise independently

General knowledge

- Engineering science theories, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts;

Specific skill

- Able to solve engineering and technological problems and design systems, processes and components on environmental management efforts including waste management by considering economic, health and safety, public, cultural, social and environmental factors
- Capable of deepening or expanding science in the field of designing, operating and maintaining engineering systems and environmental management to contribute original and tested

General Skills

- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME

- Able to internalize values, norms, academic ethics, exhibiting responsible behavior towards the work independently by doing the task without doing plagiarism
- Able to apply the theory of engineering science, engineering design, methods and current techniques that are required for the analysis and design of environmental management efforts in doing the task independently
- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics
- Able to solve engineering and technological problems and design systems, processes and components in environmental management including solid waste and hazardous waste treatment by considering economic, health and safety factors of public, cultural, social and environmental aspects.
- Able to deepen and expand their expertise in the field of designing, operating and maintaining engineering systems and environmental management to make original and verified contribution by preparing paper review

SUBJECTS

- Source, classification, characteristics, composition, and estimation of municipal waste generation.
- The paradigm of waste management as a resource
- Technical aspects of operations: service level, service area, collection system, transfer system, transportation system, final disposal system, design of equipment and other facilities
- Utilization of waste and 3R techniques at source and temporary waste collection site (TPS)
- Waste treatment: composting, incineration, landfills, leachate treatment.
- Evaluate the design drawings and technical specifications.
- Technical feasibility of solid waste sector development based on design criteria and local environmental conditions.

PREREQUISITE
REFERENCES
1. Vesilind, PA Worrell, W. and Reinhardt, D. (2002), Solid Waste Engineering. Brooks / Cole Thomson Learning, Australia. 2. Diaz, LF Savage, GM Eggerth, LL and Golueke, CG (1993), Composting and Recycling Municipal Solid Waste. Lewis Publishers. London. 3. Lund, HF. (1993), Recycling Handbook. McGraw Hill. New York. 4. Tchobanoglous, G. Theisen, H. and Vigil, SA (1993), Integrated Solid Waste Management. Engineering Principles and Management issues. McGraw Hill. New York. 5. Landreth, RE, and Rebers, PA (1997), Municipal solid waste - problems and solutions, CRC Press,

COURSE	**Course Name**	:	Evaluation of Drinking Water Supply System
	Course Code	:	RE185206
	Credit	:	3 credits
	Semester	:	2

COURSE DESCRIPTION

This course discusses various methods in designing technical aspects of facilities and infrastructure of drinking water supply system, including raw water unit, production unit, distribution unit, and service unit. After following this course, the students are expected to be able to prepare a technical evaluation on the design of drinking water supply system.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalizing academic values, norms, and ethics
- Demonstrating attitude of responsibility on work in his/her field of expertise independently

General knowledge

- Theories of engineering science, engineering design, methods and current techniques necessary for the analysis and design of raw water treatment efforts into drinking water

Specific skill

- Able to solve engineering and technological problems and design systems, processes and components on drinking water treatment efforts including drinking water treatment by considering economic, health and safety, public, cultural, social and environmental factors
- Capable of deepening or expanding the sciences in the field of designing, operating, and maintaining systems engineering and drinking water treatment to contribute original and tested

General Skills

- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerns and implements the value of humanities in

accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME
• Able to internalize values, norms, academic ethics, exhibiting a responsible behavior towards the work independently by doing the task without doing plagiarism • Able to apply the theory of engineering science, engineering design, methods and current techniques necessary for the analysis and design of water treatment efforts in doing the task independently • Able to develop logical, critical, systematic, and creative thinking through scientific research, the creation of designs in the field of science and technology that observe and apply the value of the humanities according to their expertise, develop scientific conception and studies that conform scientific principles, procedures, and ethics • Able to solve the problems of engineering and technology and to design systems, processes and components in drinking water treatment with regard to economic factors, health and public safety, cultural, social and environmental aspects • Able to deepen or expand their knowledge in the field of design, operation, and maintenance of engineering systems and drinking water treatment plant to make an original and verified contribution by preparing a review paper
SUBJECTS
• Principles and concepts of drinking water supply (quality, quantity, continuity and affordability). • Standard quality of raw water and drinking water . • Water supply system components. • Piping system: raw water units, production units, distribution units, service units • Non-piping system • Water treatment processes: physical processes and physical-chemical processes. • The development plan of water supply system. • Evaluation of the design drawing and technical specifications. • The technical feasibility of drinking water supply plan based on the design criteria and local environmental conditions.

PREREQUISITE
REFERENCES
1. The Association of Boards of Certification (ABC). 2012. Water Treatment Need-to-Know Criteria. ABC Water Treatment Certification Examination. 2. The American Water Works Association (AWWA). 2012. The American Society of Civil Engineers (ASCE): Water Treatment Plant Design, Fifth Edition. DESIGN AND CONSTRUCTION, Chapter (McGraw-Hill Professional, 2012), Access Engineering

COURSE	**Course Name**	:	Evaluation of Wastewater Management System
	Course Code	:	RE1852 0 7
	Credit	:	3 credits
	Semester	:	2

COURSE DESCRIPTION

This courses discusses various methods in the technical design of facilities and infrastructure of wastewater management system, includes services unit, collection unit, treatment units, and sludge treatment technologies. After following this course, students are expected to be able to prepare a technical evaluation on the design of wastewater infrastructure.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalizing spirit of independence, struggle and entrepreneurship.
- Trying his/her best to achieve perfect results, and
- Working together to be able to make the most of his/her potential.

General knowledge

- Knowledge of engineering theory design, cutting-edge methods and techniques required for the analysis and design of environmental management efforts
- Knowledge of contextual and up-to-date interdisciplinary approach associated with designing an integrated environmental management system

Specific skill

- Able to solve problems of engineering and technology, as well as designing systems, processes and components of environmental management efforts
- Capable of deepening or expansion of knowledge in the field of design, operation, and maintenance of engineering systems and environmental management

General skills

- Able to take decisions in the context resolve the issue of science and technology

COURSE LEARNING OUTCOME
• Being able to design the collection system and wastewater treatment plant, complete with its supporting facilities Being able to evaluate and provide feedback on the results of a design of wastewater systems
SUBJECTS
• Domestic wastewater sources and characteristics . • On-site and off-site (centralized) system • Sewerage systems . • Wastewater treatment: physical, chemical, physical-chemical, and biological treatment. • The development plan of sanitation systems and domestic wastewater. • Evaluation of design drawing and technical specifications. • The technical feasibility of the wastewater infrastructure development based on the design criteria and local environmental conditions.
PREREQUISITE
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REFERENCES
1. Metcalf and Eddy. (2004), Wastewater Engineering (Treatment and Reuse). 4th Ed. McGraw-Hill. New York. 2. Droste, RL (1997), Theory and Practice of Water and Wastewater Treatment. John Wiley and Sons. NY. 3. Reynolds, TD (1996), Unit Operations and Processes in Environmental Engineering. Brooks / Cole. 4. Metcalf and Eddy, "Wastewater engineering: collection and pumping of wastewater" 5. ASCE & MPFC, 1969, "Design and construction of sanitary and storm sewer", ASCE, Washington DC

COURSE	**Course Name**	:	Health, Safety, and the Environment
	Course Code	:	RE185301
	Credit	:	3 credits
	Semester	:	3

COURSE DESCRIPTION
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude • Working together and have social sensitivity and concern for people and the environment, in particular during the preparation of SHE Management System document by discussion independently • Show an attitude responsible for the work in the field of independent expertise; especially in the completion of independent tasks of compiled and assess SHE Management System documents Knowledge Mastery • Being able to explain the principles, methodologies, and techniques of environmental management system design with an integrated system approach, particularly in the preparation and assessment of SHE Management System documents • Being able to explain the principles and current issues in the economic, social, ecological in general; particularly in the risk identification process in the preparation of SHE Management System documents • Being able to explain the basic principles of communication techniques and technological developments latest and up to date, particularly in the preparation of SHE Management System documents Specific skills • Being able to apply mathematics, statistics, physics, chemistry, biology, microbiology and engineering principles (engineering principles) to

solve complex engineering problems on at least one aspect, namely the protection of society from a dangerous environment, with the preparation of SHE Management System documents for activities that are currently operating

- Being able to identify the source of environmental pollution and apply engineering science in environmental engineering to protect the public, especially when the process of risk identification and occupational diseases
- Being able to identify the source of environmental pollution and apply engineering science in environmental engineering to protect and preserve the environment, especially when the process of risk identification and occupational diseases
- Being able to identify the source of environmental pollution and apply engineering science in environmental engineering to protect and preserve the environment, with ongoing SHE Management System programming
- Being able to propose and assess alternative solutions to complex engineering problems on at least one aspect, namely: protection of the public from a dangerous environment, taking into account economic factors, health and public safety, cultural, social and environmental, through the preparation of SHE Management System documents

General skills

- Able to apply logical thinking, critical, systematic and innovative in the context of the development or implementation of science and technology, especially in SHE Management System programming
- Able to perform an independent, qualified, and measurable; especially in completing tasks on preparation and assessment of SHE Management System document in accordance with the distribution of individual tasks that have been set
- Able to develop a scientific description of the study results in the form of scientific papers, particularly in the preparation and assessment SHE Management System documents
- Being able to take appropriate decisions in the context of the settlement of problems in the field of expertise, based on the analysis of information and data; particularly in the formulation of a checklist for SHE Management System
- Able to be responsible for the achievement of the group's work and the supervision and evaluation of the completion of the work assigned to workers who are under their responsibility, especially when preparing and assessing SHE Management System documents independently

COURSE LEARNING OUTCOME
• Students are able to independently compile SHE Management System document for organizations with employees over 100 people • Students are able to independently assess SHE Management System document for organizations with employees over 100 people
SUBJECT
PREREQUISITE
REFERENCES
1. Hammer, Willie, in 1981, 'Occupational safety management and engineering', Prentice Hall, Upper Saddle. 2. Holliday, George H., 1995, 'Environmental, Safety regulatory compliance for the oil and gas industry', Penwell. 3. Karvianian, HR 1990, "Occupational and environmental safety engineering and management", VanNostrand inhold, New York. 4. Roger L. Wabeke, 1998, the Air contaminants Ventilation and Industrial Hygiene, pss CRC LLC. 5. Government Regulation No. 50 of 2012 concerning the Application Management System Occupational Health and Safety, the State Gazette of the Republic of Indonesia, April 12, 2012.

COURSE	**Course Name**	:	Leachate Treatment Technology
	Course Code	:	RE185302
	Credit	:	3 credits
	Semester	:	Optional

COURSE DESCRIPTION

Leachate is the liquid waste produced from the decomposition of solid waste (garbage or WWTP Sludge). To reduce the negative effects on the environment, then the leachate must be treated before discharge. In this course, students will learn a variety of leachate treatment technology for the solution of environmental problems. Various methods of leachate treatment and the basics of process include: material balance, mass transfer, reaction kinetics, the type and model of the reactors, the ideal and non-ideal flow in isothermal reactor , bio-kinetics of suspended growth with and without recirculation, pollutants removal in leachate by chemical reaction.

Assignment: Design a leachate treatment system

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalize the values, norms, and academic ethics;
- Show an attitude responsible for the work in the field of independent expertise; and
- Working together as much as possible to take advantage of its potential.

Knowledge mastery

- The theory of engineering science, engineering design, cutting-edge methods and techniques required for the analysis and design of environmental management efforts;

Specific skill

- Capable of deepening or expansion of knowledge in the field of design, operation, and maintenance of engineering systems and environmental

management to contribute original and proven through independent research;
- Able to adapt to changes in science or technology happens to the process of implementation and research substances encountered in the field of environmental management.

General skills
- Able to develop logical thinking, critical, systematic, and creatively through scientific research, the creation in the field of science and technology that observe and apply the value of the humanities according to their expertise, develop scientific conception and the results of the study by the rules, ordinances, and scientific ethics.

COURSE LEARNING OUTCOME
• Students understand the characteristics of the leachate • Students are able calculate leachate production • Students understand the concept of biological leachate treatment processes: aerobic and anaerobic • Students are able to engineer biological leachate treatment technology • Students understand the concept of chemical leachate treatment process • Students are able to engineer chemical leachate treatment technology • Students are able to engineer biological and chemical leacahate treatment
SUBJECTS
• Material balance • Mass transfer (convective, advective, dispersion and diffusion) • The kinetics of the reaction, the type and model of the reactor, the reactor isothermal with ideal and non-ideal flow • Bio-kinetics of suspended growth with and without recirculation. • Removal of pollutants in the leachate by chemical reaction.
PREREQUISITE
REFERENCES

1. Yung-Tse Hung, Lawrence K Wang, Nazih K Shammas (Editors). 2012. Handbook of Environment and Waste Management: Air and Water Pollution Control, Chapter: 19 Publisher: World Scientific Publishing Co., Singapore. pp.819-888 .
2. Aziz, Abdul Hamidi. Amr, Abu Salem. 2015. Control and Treatment of Landfill Leachate for Sanitary Waste Disposal. Idea Group, Harrisburg, PA, United States.
3. Mulamoottil, George & McBean, Edward A. & Rovers, Frank. (Ed.), 1998. Constructed Wetlands for the Treatment of Landfill Leachate. Lewis Publishers. Boca Raton.
4. Metcalf and Eddy. 2004. Wastewater Engineering (Treatment and Reuse). 4th Ed. McGraw-Hill. New York.
5. Christensen, TH, Cossu, R & Stegmann, R. (ed.). 1992. Landilling of Waste: Leachate. Elsevier Applied Science. London.
6. Williams, Paul T. 2005. Waste Treatment and Disposal. 2nd Ed. John Wiley. New York.
7. Bagcchi, Amalendu. 1994. Design, Construction, and Monitoring of Landfills. 2nd ed. John Wiley. New York.

COURSE	**Course Name**	: Sludge Treatment Technology
	Course Code	: RE185303
	Credit	: 3 credits
	Semester	: Optional

COURSE DESCRIPTION
This course contains the study of treatment technology for sludge generated from the treatment of drinking water, domestic and industrial waste water. Sludge treatment studies include the analysis of processing and alternative Sludge treatment technologies, and calculate the dimensions of the unit operations and unit processes required. To complete this subject, students will be given the task in the form of: Planning and evaluation of Sludge treatment building.
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude • Internalize the values, norms, and academic ethics; • Show an attitude responsible for the work in the field of independent expertise; and Knowledge mastery • The theory of engineering science, engineering design, cutting-edge methods and techniques required for the analysis and design of environmental management efforts; Specific skill • Able to solve the problems of engineering and technology and design systems, processes and components of the environmental management includes waste management by considering economic factors, health and public safety, cultural, social and environmental • Capable of deepening or expansion of knowledge in the field of design, operation, and maintenance of engineering systems and

environmental management to contribute original and proven through independent research;

General skills

- Able to develop logical thinking, critical, systematic, and creatively through scientific research, the creation in the field of science and technology that observe and apply the value of the humanities according to their expertise, develop scientific conception and the results of the study by the rules, ordinances, and scientific ethics

COURSE LEARNING OUTCOME

- Being able to internalize the values, norms, ethics, academic, show a responsible attitude on its own work with a task without doing plagiarism
- Mastering the engineering theory, engineering design, methods and the latest techniques in the processing of Sludge
- Being able to apply theoretical engineering science, engineering design, methods and the latest techniques in the processing of Sludge
- Able to solve the problems of science and technology of processing Sludge through inter- or multidisciplinary approach with attention to economic factors, health and public safety, cultural, social and environmental
- Able to develop logical thinking, critical, systematic, and creatively through scientific research, Sludge processing technology design creation also able to compile scientific conception and the results of the study by the rules, ordinances, and scientific ethics
- Capable of deepening or expansion of knowledge in the field of processing Sludge to contribute original and tested to make the task of a review paper

SUBJECTS

1. Characteristics and sources of sludge produced in the process of drinking water and wastewater treatment
2. Technology and process of sludge treatment:
    - Water content reduction:
        - Concentration (Thickening)
        - Natural sludge drying by sludge drying bed;
        - Filter press and belt press

- Sludge stabilization
  - Biological processes: Anaerobic and aerobic sludge digester, composting of organic sludge
3. Chemical process: the addition of coagulant aid and pH stabilization.
4. Disposal and utilization of stabilized sludge.

PRERQUISITE

REFERENCES

1. Turovskiy, IS & Mathai, PK Wastewater Sludge Processing. (John Wiley & Sons, Inc., 2006). doi: 10.1002 / 047179161X
2. Kurita Handbook of Water Treatment. (Kurita Water Industries Ltd., 1999)
3. Metcalf & Eddy (2003) Wastewater Engineering; Tatment, Disposal, use, McGraw Hill Book Co. NY

COURSE	**Course Name**	: Air Quality Modeling
	Course Code	: RE185304
	Credits	: 3 credits
	Semester	: Optional

COURSE DESCRIPTION

Material behavior in the air can be studied from its physical, chemical, and dynamical characteristics. Through the model, material behavior can be predicted for various purposes. This course will explain the modeling of air pollutants from mobile and stationary sources and model applications for air quality mapping. Deepening of course understanding by assignment: Creating the mapping for urban air quality by studying the Air quality modeling from mobile and stationary sources and dispersion modeling.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude:

- Internalize academic values, norms, and ethics;
- Demonstrate responsible attitudes towards the work in their own field of expertise;
- Internalize the spirit of independence, stability, and entrepreneurship

Knowledge Mastery:

- The latest theories of engineering science, engineering design, methods and techniques required for the analysis and design of environmental management efforts, able to explain the concept of natural science and the principles of application of mathematical engineering to the analysis of environmental management system issues;
- System and application of the latest mathematical optimization theory

Specific Skills:

- Able to deepen or extend knowledge in the field of designing,

operating and maintaining engineering systems and environmental management to provide original and tested contributions through independent research;

- Able to formulate new ideas (new research question) from the results of research conducted for the development of technology and environmental management systems
- Able to adapt the changes of science or technology that occur to the implementation process and the substance of research faced in the field of environmental management.

General Skills:

- Able to document, store, secure, and rediscover data to ensure validity and prevent plagiarism

COURSE LEARNING OUTCOME

- Able to synthesize air quality and air pollution modeling
- Able to solve the problem of air pollutant through air quality and air pollution modeling
- Able to develop a planning on air pollution and a modeling to solve sophisticated issues related to the environment
- Able to develop modeling related to air pollution in the field of environmental engineering
- Able to produce models in the field of air pollution in overcoming municipal and industry environmental problem

SUBJECTS

- Type of dispersion model
- Parameters that influence dispersion
- Application and implementation of dispersion model

PREREQUISITE
REFERENCES

1. De Visscher A. (2014) Air Dispersion Modeling. John Wiley & Sons, Inc, New Jersey
2. Vallero D. (2008) Fundamental of Air Pollutions. 4th Edition, Elsevier, New York
3. Boedisantoso, Rachmat, 2002,“Teknologi Pengendalian Pencemar Udara”, DUE-Like ITS, Jurusan Teknik Lingkungan FTSP-ITS, Surabaya.
4. C. David Cooper, Alley, F. C., 1994, "Air Pollution Control A Design Approach", Waveland Press Inc., Illinois, USA.
5. Davis, Wayne T., 2000, "Air Pollution Control Engineering Manual", Air and Waste Management Association, John Willey & Sons.
6. Kenneth E. Noll,1999, "Design of Air Pollution Control Devices", American Academy of Environmental Engineering, USA.
7. Ogawa, Akira, 1987, " Separation of Particles from Air and Gases", CRC Press Florida.
8. Seinfeld JH., Pandis SN., 2006, “Atmospheric Chemistry and Physics, from air Pollution to Climate Change” John Wiley & Sons, Inc.

COURSE	**Course Name**	: Air Pollution Control System
	Course Code	: RE185305
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPTION

Air pollution in the form of gas and particulate must be well managed so as not to cause negative impact to the environment. Technology used in the processing of gases emission and particulates will be studied in this course, including gas treatment technology from mobile sources, gas treatment at stationary sources, as well as particulate treatment. To deepen students' understanding, there will be an assignment: designing air pollution control technology from mobile sources and/or stationary sources. After studying this course, students will be able to produce innovative technology in designing air pollution control devices.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude:

- Mastering contemporary and contextual interdisciplinary approaches related to the design of integrated environmental management systems.
- Mastering contemporary and contextual interdisciplinary approaches related to the design of integrated environmental management systems.

Knowledge Mastery:

- Mastering the latest design engineering, engineering, and engineering science theories necessary for the analysis and synthesis of environmental management

Specific Skills:

- Able to solve engineering, technological and design problems, systems, and components in environmental management efforts including: drinking water, wastewater, waste, drainage of settlements and air by deepening the scientific field of environmental engineering to provide original and tested contributions through research independently.

General Skills:

- Able to produce innovative environmental technology works in the control and prevention system of pollution of solid and gaseous liquid waste, pollution control, and K3 by utilizing other fields of science if necessary with attention to economic, health and safety factors of public, cultural, social, and environment.
- Able to formulate new ideas from the results of research conducted and adapting science changes that occur for the development of environmental media recovery technology made from pollutants

COURSE LEARNING OUTCOME

- Able to solve air pollutant problem through onsite control program - Able to develop air pollution-related planning and up-to-date research results to solve environmental problems
- Able to develop planning and management concepts related to air pollution
- Able to produce air pollution related programs in overcoming municipal and industrial environmental problems

SUBJECTS

- Study of types and sources of air pollutants
- Basic theory of fluid dynamics and its application to air pollution control
- Operation and processing of gas treatment from mobile source (catalytic converter)
- Operation and processing of gas treatment from stationary source (adsorption, absorption, condensation and combustion)
- Operation and processing of particulate matter treatment (settling chamber, cyclone, fabric filtration, electrostatic precipitator and wet collector)

PREREQUISITE
REFFERENCES
MAIN SOURCE : 1. Cooper, C. David & Alley, F.C., “Air Pollution Control, A Design Approach”. 4th.ed. Waveland Press. Long Grove, 2011. 2. Kalliat T. & Valsaray,” Elements of Environmental Engineering, Thermodynamics and Kinetics”, CRC Press, New York, 2009. 3. Fenger, Jes & Tjell, Jens Christian. “Air pollution – From Local To A Global Perspective”. Polyteknisk Forlag, 2009 4. Reis, Stefan. “Costs of Air Pollution Control – Analyses of Emission Control Options for Ozone Abatement Strategies”. Springer. Berlin. 2005 5. Janick F. Artiola, Ian L. Pepper, Mark Brussean, “Environmental Monitoring and Characterization”, Elsivier Academic Press, USA, 2004.

COURSE	**Course Name**	: Industrial Waste Treatment Technology
	Course Code	: RE185306
	Credits	: 3 credits
	Semester	: Optional

COURSE DESCRIPTION
Students will study the various treatment of industrial waste (liquid and solid) by physico-chemical and biological process with emphasis on advanced theory mastery, as a continuation of basic theory at the undergraduate level. The tasks that must be made by the students are: Planning of industrial waste treatment, evaluation of industrial waste treatment.
GRADUATE LEARNING OUTCOME MANDATAED TO THE COURSE
Attitude • Internalize academic values, norms, and ethics; • Demonstrating the responsible attitude of the work in the field of expertise independently; • Internalizing the spirit of independence, striving, and entrepreneurship; • Trying maximally to achieve perfect results; and • Working together to be able to take full advantage of the potential possessed. General Knowledge: • Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology • Able to examine the implications of the development or implementation of science and technology that concerns and implements the value of humanities in accordance with their expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs. • Able to make appropriate decisions in the context of problem solving in their areas of expertise, based on the results of information and data analysis;

- Able to take responsibility for the achievement of group work and to supervise and evaluate the completion of work assigned to workers who are under the responsibility

Specific Skills

- Able to design necessary systems and processes for environmental management efforts with an analytical approach and taking into applicable technical standard, applicable safety and health, performance aspects, reliability, ease of implementation, sustainability, and attention to economic, public health and safety, social, and environment; and
- Capable of selecting resources and utilizing design tools and analysis of environmental engineering based on appropriate information and computing technology to carry out engineering activities in handling environmental management issues.

General Skills

- Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology; and
- Able to demonstrate independent, quality, and measurable performance

COURSE LEARNING OUTCOME
• Able to describe various industries that produce waste; sources, types, and characteristics of the waste, including industrial hazardous waste; • Able to determine the concept of end of pipe; Various types of major pollutant components in liquid, solid and gaseous wastes; • Able to evaluate various technologies for physico-chemical, biological treatment of waste in liquid, solid and gaseous wastes; • Able to determine the type and principles of the latest technologies in industrial waste treatment; and • Able to explain the concept and design the implementation of Clean Technology in industrial activities.
SUBJECTS
• Type of industrial waste and its characteristics. • Advanced theory of biological processes in the treatment of liquid waste and solid waste (Type of biological processes based on oxygen demand and microbial growth patterns in wastewater treatment system both suspended and attached)

- Advanced theory of chemical processes in the treatment of liquid and solid waste (coagulation-flocculation, water softening, redox reactions for decreasing the metal content in water, ion exchange, activated carbon adsorbent and gas transfer)
- Technology of treatment and utilization of industrial solid waste

PREREQUISITE

REFFERENCES

1. Reynolds, T. Richard, A.P. 1996. Unit Operations and Processes in Environmental Engineering. 2nd Ed. PWS Publishing Company.
2. Tchobanoglous, G. 2002. Wastewater Engineering: Treatment and Reuse. 3rd Ed. McGraw-Hill Science/Engineering/Math.
3. Numerow, N.L. 2006. Industrial Waste Treatment. Elsevier Science & Technology Books
4. Eckenfelder, W. W. 1999. Industrial Waste Pollution Control. McGraw-Hill Science/Engineering/Math.
5. Misra, K. 1996. Clean Production: Environmental and Economic Perspectives. Springer.

COURSE	**Course Name**	: Eco-hydrology
	Course Code	: RE185307
	Credits	: 3 credits
	Semester	: Optional

COURSE DESCRIPTION

Eco-hydrology is the study of the interaction of hydrological processes with biological dynamics in various spatial (space) and temporal (time) conditions. This science is a new concept in environmental problem solving based on ecological and hydrological integration within the watershed (DAS). A variety of Eco-hydrological materials will be studied in this course, which includes water resource management or integrated watershed management. Tasks: Special topics related to actual water resources issues.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Knowledge Mastery:

- Mastering a contextual and cutting-edge interdisciplinary approach related to the design of integrated environmental management systems.

Specific Skill:

- Able to solve engineering and technological problems, also designing systems, processes and components on environmental management efforts including drinking water management, waste water, waste management, settlement drainage, liquid waste, solid and gas control systems, air pollution control and occupational health and safety (K3) by utilizing other fields of science (if necessary) and taking into account the economic, health and safety factors of the public, cultural, social and environmental factors.

General Skills:

- Able to identify the field of science that becomes the object of his research and positioned into a research map developed through interdisciplinary or multidisciplinary approach.
- Able to make 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.

COURSE LEARNING OUTCOME

- Able to provide non-technical considerations to the technical design results of the drinking water sector, waste water, waste management, and settlement drainage.
- Able to develop strategic plans in the field of environmental infrastructure (drinking water sector, waste water, waste management, and settlement drainage).
- Able to plan medium-term investment development in the field of environmental infrastructure.

SUBJECTS

1. ECOHYDROLOGY: Basic Concepts & Definitions
2. SURVEYS & ASSESSMENT: How to Assess & Quantify Specific Issues in Watersheds
    a. LANDSCAPES: Defining Critical Areas in Watersheds
    b. LAND-WATER INTERACTIONS: How to Assess their Effectiveness
    c. STREAMS & RIVERS: Defining their Quality & Absorbing Capacity
    d. LAKES & RESERVOIRS: Defining their Ecosystem Status
    e. ESTUARINE & COASTAL AREAS: How & What to Measure
3. MANAGEMENT: How to Prevent Degradation & Restore Watersheds
    a. LANDSCAPE MANAGEMENT: Regulating Pollution Exports & Hydrological Cycles
    b. LAND-WATER INTERACTIONS: Reduction of Contamination Transport
    c. MANAGEMENT OF STREAMS & RIVERS: How to Enhance Absorbing Capacity against Human Impacts
    d. RESERVOIR & LAKE MANAGEMENT: Improvement of Water Quality
    e. ESTUARINE & COASTAL AREAS: How to prevent degradation and restore
4. Tropical Deforestation and the Land-Water Interface
5. Water Quality Modeling
6. Actuality:
    a. Water Crisis and Scarcity
    b. Indicator of Watershed Quality

c. Climate Change and Ecohydrology
PRREQUISITE
REFERENCES
1. UNEP-United Nation Environmental Program, “Integrated Watershed Management Ecohydrology & Phytotechnology – Manual”, 2004 2. Paolo D'Odorico, Amilcare Porporato, “Dryland Ecohydrology”, 2006 3. Eric Wolanski, “Estuarine Ecohydrology”, 2007 4. Malin Falkenmark, Johan Rockström, “Balancing Water for Humans and Nature: The New Approach in Ecohydrology”, 2013 5. David M. Harper, Maciej Zalewski, “Ecohydrology: processes, models and case studies: an approach to the sustainable management of water resources”, 2008 6. Derek Eamus, Tom Hatton, Peter Cook, Christine Colvin, “Ecohydrology: vegetation function, water and resource management”, 2006 7. Ignacio Rodríguez-Iturbe, “Amilcare Ecohydrology of Water-Controlled Ecosystems: Soil Moisture and Plant Dynamics”, 2004

COURSE	**Course Name**	: Environmental Biotechnology
	Course Code	: RE185308
	Credits	: 3 credits
	Semester	: Optional

COURSE DESCRIPTION

Environmental biotechnology is a science related to the use of genetic engineering applied to the field of environmental engineering. Various aspects of this science will be studied in this course. After joining this course, students will be able to produce innovative technology in the field of environmental biotechnology for overcoming environmental problems. This course is completed with the task: Processing gaseous waste using biofiltration.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Law abiding and disciplined in community and state life.
- Internalizing values, norms and academic ethics.
- Demonstrating attitude of responsibility on work in his/her field of expertise independently.
- Internalizing spirit of independence, struggle and entrepreneurship.
- Trying his/her best to achieve perfect results, and
- Working together to be able to make the most of his/her potential.

General Skills

- Able to perform academic validation or studies in accordance with the area of expertise in solving problems in relevant communities or industries through the development of knowledge and expertise
- Able to formulate ideas, thought, and scientific arguments in a responsible and academic Attitude, and communicate them through the media to the academic community and the wider community
- Able to identify the field of science that becomes the object of research and positioned into a research map developed through interdisciplinary or multidisciplinary approach

- Able to document, store, secure, and rediscover research data in order to ensure validity and prevent plagiarism

Knowledge Mastery

- Mastery of engineering science theories knowledge, design engineering, advanced methods and techniques necessary for the analysis and the development of environmental technology
- • Mastery of a contextual and cutting-edge interdisciplinary approach knowledge related to the development of integrated environmental technology

Specific Skills

- Able to solve engineering and technological problems, also able to design systems, processes and components in the effort in controlling liquid, solid and gas waste, controlling air pollution by utilizing other fields of science and pay attention to economic, health and safety factors of public, cultural, social and environmental to provide original and tested contributions through research independently
- Able to perform deepening or extension of science in the field of design, operation, and maintenance of engineering systems to contribute original and tested through research independently
- Able to design the systems, and processes necessary for environmental management efforts with an analytical approach and considering the applicable technical, safety and health standards, performance aspects, reliability, ease of application, sustainability, and economic, health and safety, social, and environment;
- Able to explain principles, methodology, and to design technique of environmental management system using integrated system approach
- Able to develop logical, critical, systematic, and creative thinking through scientific research, creation in the field of science and technology that concerns and implements the value of humanities in accordance with the field of expertise, preparing scientific conception and result of study based on scientific rules, procedures, and ethics in the form thesis or other equivalent forms, and may be published in accredited scientific journals or accepted in international journals

COURSE LEARNING OUTCOME

Able to explain the principles of cell metabolism that support the process in biological waste treatment technology, describes the steps of waste treatment technology and the remediation of environmental quality, describes creatively the alternative process and technologies of microorganisms utilization in handling pollution problems in water, soil and air, implementing reactor design in waste treatment techniques with biological transformation, as well as integrating the knowledge by analyzing biotechnology applications in real life problem and creatively proposing better alternative planning.

SUBJECTS

- Introduction to Biotechnology as a basic science of environmental engineering
- Principles of utilization of microbiology in the field of biotechnology
- Sterilization process, fermentor design theory, concentration separation, and industrial scale manufacturing
- Biofiltration technology for gaseous waste treatment
- Biotechnology applications to provide solutions to environmental pollution problems.

PREREQUISITE

REFERENCES

1. Wisemann, A., 1988. Principles of Biotechnology. Second Ed. Surrey University Press, Chapman and Hall, NY.
2. Jackson, A.T., 1990. Principles of Biotechnological Engineering. Open University Press, Milton Keynes, UK
3. Evans, G. M and J. C. Furlong, 2003. Environmental Biotechnology: Theory and Application. Lohn Willey & Sons, England
4. Shuler, M. L. and F. Kargi, 2002. Bioprocess Engineering: Basic Concepts. Second Edition. Prentice Hall, NJ
5. Jördening, H.J. and J. Winter, 2003. Environmental Biotechnology: Concepts and Applications. Willey VCH, Weinheim, FRG.

COURSE	**Course Name**	: System Analysis and Optimization
	Course Code	: RE185309
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPTION
In this course, students will learn about system analysis approach and optimization in solving environmental problems. Optimization to determine the best scenario in decision-making for policies related to environmental management, various mathematical approaches that can support optimization and overall decision-making to choose the best alternative in solving environmental problems.
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude • Demonstrate a responsible attitude towards the work in his/her own field of expertise independently Knowledge • Mastering optimized math knowledge, systems theory, and application Specific Skills • Able to solve engineering and technological problems and design systems, processes and optimization of all components in environmental management efforts • Able to deepen and extend the science in the field of designing, operating, and maintaining engineering systems and environmental management to contribute original and tested result General Skills • Able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific rules, procedures, and ethics

COURSE LEARNING OUTCOME
• Able to internalize values, norms, academic ethics, exhibiting a responsible behavior towards the work independently by doing the task without doing plagiarism • able to apply the theory of engineering science, engineering design, methods and techniques that are needed for the analysis and design of environmental management efforts in doing the task independently • able to develop logical, critical, systematic, and creative thinking through scientific research, creation of design in the field of science and technology that concerning and implementing the value of humanities in accordance with their field of expertise, preparing scientific conception and result of study based on scientific rules, procedures, and ethics • able to solve engineering and technological problems and design systems, processes and components on environmental management efforts including waste management by taking into account the economic, health and safety factors of the public, cultural, social and environmental • able to perform deepening or extension of science in the field of designing, operating and maintaining systems engineering and environmental management to contribute original and tested by making paper review task
SUBJECTS
Principles of system, system analysis methodology, problem formulation, principles of optimization, system optimization model, system approach in planning process and decision making, design and analysis of complex environmental system, and optimization with liner and dynamic programming modeling
PREREQUISITE
REFERENCES

1. Eriyatno. 1998. Ilmu Sistem. IPB Press. Bogor.
2. Miser, J.H. 1995. Handbook of System Analysis. John Wiley and Sons. Chichester.
3. Simatupang,T. 1994. Teori Sistem. Andi Offset. Jogya.
4. Raq, Ss.1994. Optimation Theory and Application. Wiley Eastern Limited. New Delhi.
5. Saaty.T.L. 1994. Fundamental of Decicion Making in Priority Theory. RWS Publications

COURSE	**Course Name**	: Environmental Ecotoxicology
	Course Code	: RE185310
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPION

Environmental ecotoxicology is a study of the characteristics of substance in terms of its toxic properties to organisms. This science can be applied in various fields such as industry, drinking water treatment and wastewater treatment. This course will equip students with the analysis of the exposure of substances in the environment based on the nature of the substance and its environment, and various methods to determine the level of toxicity of a substance in the environment. After studying this course, students will be able to design ecotoxicology research for the application in the field of environmental engineering. The tasks that students should make are: reviewing journals related to toxicology research results and designing toxicology research.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Demonstrating attitude of responsibility on work in his/her field of expertise independently.

General Skill

- Able to perform academic validation or studies in accordance with their areas of expertise, especially in environmental toxicology in solving problems in relevant communities or industries through the development of knowledge and expertise;

Kowledge Mastery

- Engineering science theories, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts;

Specific Skill

- Able to solve engineering and technological problems, also design systems, processes and components on environmental management

efforts including drinking water management, waste water, waste management, settlement drainage, wastewater control systems, solids and gases, air pollution control and occupational health and safety (OHS) by utilizing other fields of science (if required, in this case environmental toxicology) and taking into account economic, health and safety, public, cultural, social and environmental factors;

COURSE LEARNING OUTCOME

- Able to identify environmental problems through ecotoxicology which include: drinking water, wastewater, solid waste, drainage system by deepening proficiency on environmental engineering.
- Able to design ecotoxicological research in various fields such as industry, drinking water treatment and wastewater treatment, etc.
- Able to analyze and synthesize environmental engineering applications in the field of ecotoxicology in preventing environmental pollution.
- Able to prepare the concept and program of prevention of environmental pollution and remediation of polluted environment in the field of ecotoxicology by considering the aspect of legislation, economy, finance, and socio-culture.

SUBJECTS

- Analysis of exposure to substances in the environment based on the nature of the substance and its environment.
- Analysis of the effects of substances on living things including lethal concentration (LC) and lethal dose (LD), acute effects, chronic effects and living response criteria.
- Toxicity test technique and interpretation of effect test result.
- Application of negative effects test of life-based substances: micro toxicology (effects of substance on microbes), biotoxicology (effects of substances on animals), phytotoxicology (effects of substances on plants).
- Application of negative effects test on ecosystem-based substances: microcosms, mesocosms and macrocosms.

PREREQUISITE
REFERENCES
1. Ariens. E.J., E. Mutschler, A.M. Simonis, Toksikologi Umum Pengantar, Gadjah Mada University Press, Yogyakarta, 1993. 2. Casarret, Curtis. D. Klaassen, Toxicology: The basic Science of Poisons, Fifth Edition, McGraw Hill, New York, 1996. 3. Connel, Dw, dan G.J. Miller, Kimia dan Toksikologi lingkungan Pencemaran, Terjemahan oleh Yanti Koestoer, UI Press, Jakarta 4. Jorgensen, Sven E., Handbook of estimation methods in ecotoxicology and environmental chemistry, Lewis, New York, 1998. 5. Peakall, David, Animal biomarkers as pollution indikators - with a contribution on immunology, Chapman and Hall, London, 1992. 6. Mangkoedihardjo, S., Toksikologi lingkungan, Jurusan Teknik Lingkungan, ITS, Surabaya, 1999. 7. Moriarty, F., Ecotoxicology - The studi of pollutants in ecosystems, second edition, Academic Press, San Diego, 1993. 8. Soemirat, Juli, Toksikologi Lingkungan, Gadjah Mada University Press, Yogyakarta, 2003.

COURSE	**Course Name**	: Modeling of Environmental Engineering
	Course Code	: RE185311
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPTION
This environmental modeling course will teach the students to be able to apply the concept of model in solving environmental problems. The content of the course covers the type and characteristics of the model, the application of various models for environmental engineering problem solutions, and special topics to introduce various environmental modeling programs/software. Task: designing and applying models in the field of environmental engineering.
COURSE LEARNING OUTCOME MANDATAED TO THE COURSE
Attitude: • have a good attitude, mental and academic ethics, maintain values and norms, and personality as a nation of Indonesia • demonstrating attitude of responsibility on work in his/her field of expertise independently Knowledge Mastery: • Mastering the theories and methods of management, analysis of environmental issues and environmental management efforts by considering the possible risks Specific Skills: • Able to analyze and solve problems that occur in the environment well by using management technology, establishing efforts that need to be done in solving the problems encountered, considering the aspects of engineering - economic and environmental/health.. • Capable of deepening or expanding the proficiency in the field of designing, operating and maintaining engineering systems and environmental management to make original and tested contribution General Skill

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

COURSE LEARNING OUTCOME

- Able to internalize values, norms, academic ethics, demonstrating attitude of responsibility on work in his/her field of expertise independently by avoiding plagiarism in doing the task
- Able to apply the theory of engineering science, engineering design, methods and techniques necessary for the analysis and design of environmental management efforts in doing the task independently
- 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
- Able to solve engineering and technological problems and analyze the system on water and environmental resource management, which includes the management of natural resources, the usefulness and benefits of natural resources, the relationship between environmental economic theory with *PSDAL*, surface water modeling (rivers and lakes), ground water and hydroeconomic model on river management, IWRM, Groundwater and evaporation theory and Polder, Ground water theory, *SDAL* theory related to polder/ boezem utilization, and water budget.
- Able to deepen and expand the proficiency in the field of designing, operating and maintaining systems engineering and environmental management to make original and tested contribution by making paper review task

SUBJECTS

1. Basic modeling in the field of environmental engineering.
2. Linear and non-linear equations, simultaneous linear equations, quadrature (numerical integration), ordinary and partial diffraction equations, finite difference method.

3. Introduction and compilation of mathematical models, systems approach, mathematical modeling solution, model presentation, type and development of environmental models.
4. Special topics:
   a. Water Quality Modeling
   b. Model Distribusi Polutan Udara
   c. Structural Equation Modeling
   d. Decision Making Modeling

PREREQUISITE

REFERENCES

1. Kernevez, J-P. 1997. The Sentinel Methods and Its Application to Environmental Pollution Problems. CRC. Boca Raton.
2. Griffiths, D.V. and Smith, I.M. 1991. Numerical Methods for Engineers. Blackwell Scientific. Oxford UK.

COURSE	**Course Name**	: Climate Change Adaptation and Mitigation
	Course Code	: RE185312
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPION
In this course, students will learn: Adaptation and mitigation of climate change, climate change adaptation and mitigation objectives, adaptation and mitigation legislation, potential climate change disasters; regional vulnerability to climate change and its disaster; mitigation and adaptation planning; the adaptation actors, adaptation to coastal climate change, water resources, agriculture, human health and infrastructure; mitigation actors, climate change mitigation programs (carbon emission reduction and sequestration); mitigation steps.
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Knowledge Mastery: • Mastering the latest theoretical engineering science, design, and engineering theories necessary for the analysis and synthesis of environmental management Specific Skill : • Able to solve engineering and technological problems, as well as designing systems, processes and components on environmental management efforts including: drinking water, wastewater, solid waste, drainage system and air by deepening the proficiency of environmental engineering to make original and tested contribution through independent research. General Skills: • Able to produce innovative environmental technology work in the field of control and prevention system of liquid, solid, and gaseous waste pollution. Producing pollution control, as well as OHS by utilizing other fields of science if necessary by considering the economic, health and safety, public, cultural, social and environmental factors. • Able to formulate new ideas from the results of research conducted and

adapt science changes that have taken place for the environmental remediation technology

COURSE LEARNING OUTCOME

- Understand the definition and the objectives of climate change adaptation and mitigation
- Able to understand the laws and regulations related to climate change adaptation and mitigation
- Understand potential of disaster, disaster map and level of regional vulnerability to climate change and disaster
- Able to plan climate change adaptation and mitigation programs
- Able to determine adaptation and mitigation steps
- Able to collect and analyze data and information correctly

SUBJECTS

- Definition of adaptation and mitigation of climate change
- The objectives of climate change adaptation and mitigation
- Regional vulnerability linked to climate change adaptation and mitigation
- Impact of climate changes
- Adaptation and mitigation of climate change planning

PREREQUISITE

REFERENCES

MAIN REFERENCES :

1. Peraturan Presiden RI No. 61 tahun 2011, tentang Rencana Aksi Nasional Penurunan Gas Rumah Kaca, 2011
2. Endah Murniningtyas dkk., "Developing Indonesian Climate Mitigation Policy 2020 - 2030 Through RAN-GRK Review", Bappenas, Jakarta, 2015
3. Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J.,

Fukuda, M. and Troxler T.G. , “Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands”, (eds). Published: IPCC, Switzerland, 2014.
4. Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K., “ IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme”, (eds). Published: IGES, Japan, 2006.
5. Janick F. Artiola, Ian L. Pepper, Mark Brussean, “Environmental Monitoring and Characterization”, Elsivier Academic Press, USA, 2004.

SUPPORTING REFERENCES :

1. Bappenas, “Pedoman Kaji Ulang Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca (Rad-Grk) I Pedoman Penyusunan Kaji Ulang Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca Pedoman Penyusunan Kaji Ulang Rencana Aksi Daerah Penurunan Emisi, Bappenas, 2016
2. Bappenas, “Pedoman Umum dan Petunjuk Teknis Pemantauan, Evaluasi dan Pelaporan Pelaksanaan RAN-GRK dan RAD-GRK”, Bappenas, 2015.
3. Kementerian Lingkungan Hidup, “Pedoman Penyelenggaraan Inventarisasi Gas Rumah Kaca Nasional’, KLH, 2012.
4. Edvin Aldrian, Mimin Karmini, Budiman, “Adaptasi dan Mitigasi Perubahan Iklim di Indonesia”, Pusat Perubahan Iklim dan Kualitas Udara Kedeputian Bidang Klimatologi, BMKG, 2011.
5. BMKG, “Modul Perubahan Iklim” BMKG, 2013.
6. Bappenas, “Pedoman Penyusunan RAD-GRK”, Bappenas, 2011.

COURSE	**Course Name**	: Mine Land Remediation
	Course Code	: RE185313
	Credits	: 3 Credits
	Semester	: Optional

COURSE DESCRIPION
This course examines: types and characteristics of mining waste, activities causing damage to the land , petroleum components, petroleum products, petroleum processing, remediation technology of ex-mining and oil and gas, and the determination of appropriate remediation technology Task: case study of mining pollution also oil and gas
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitude • Demonstrating attitude of responsibility on work in his/her field of expertise independently; • Trying his/her best to achieve perfect results; • Working together to be able to make the most of his/her potential; Mastery of Knowledge • Theory of engineering science, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts; Specific Skills • Capable of deepening and expanding proficiency in the field of designing, operating and maintaining engineering systems and environmental management to provide original and tested contributions through independent research; • Able to formulate new ideas (new research question) from the research conducted for the development of technology and environmental management system; General Skills

- 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; and
- Capable of managing, developing and maintaining networking with colleagues, peers within the broader institutes and research community.

COURSE LEARNING OUTCOME

- Able to explain the definition and characteristics of the mining area
- Able to explain the stages in the mining process that potentially produce waste or causing land damage
- Able to identify waste generated from the mining process and land damage caused by mining activities
- Able to determine the remediation technology of ex-mining land

SUBJECTS

- Definition and characteristics of mining as well as oil and gas
- Petroleum components, products of processed petroleum
- Petroleum processing
- Remediation technology for ex-mining fields also oil and gas
- Determination of appropriate land remediation technology according to the level of damage

PREREQUISITE

REFERENCES

1. Sellers K. 1998, Fundamentals of Hazardous Waste Site Remediation, Lewis Publishers, pp 326
2. Jurnal-jurnal internasional berbagai penerbit
3. Peraturan Menteri Energi dan Sumber Daya Mineral Republik Indonesia No 7 Tahun 2014 tentang pelaksanaan reklamasi dan pascatambang pada usaha pertambangan mineral dan batubara
4. Lottermoser, B.G. 2007. Mine Wastes Characterization, Treatment, Environmental Impacts 2nd ed. Springer.
5. H., Meuser. 2013. Soil Remediation and Rehabilitation. Springer Netherlands

COURSE	Course Name	: Evaluation of Urban Drainage System
	Course Code	: RE185314
	Credits	: 3 Credits
	Semester	: 3

COURSE DESCRIPION

This course discusses various methods in designing facilities and infrastructure of rainwater drainage system technically, covering hydrological aspects, hydraulics aspects (rain water distribution system), and environmental based rainwater management. After following this course, the students are expected to be able to perform technical evaluation on the design of drainage facilities.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude

- Internalize academic values, norms, and ethics
- Demonstrating attitude of responsibility on work in his/her field of expertise independently

Mastery of Knowledge

- Engineering science theory, design engineering, advanced methods and techniques necessary for the analysis and design of environmental management efforts;

Specific Skills

- Able to solve engineering and technological problems, also able to design systems, processes and components on environmental management efforts by considering to economic, health and safety factors of public, cultural, social and environmental
- Capable of deepening or expanding proficiency in the field of designing, operating and maintaining engineering systems and environmental management to contribute original and tested result

General Skill

- 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

COURSE LEARNING OUTCOME
• Able to internalize values, norms, academic ethics, show a responsible attitude towards the work independently by avoiding plagiarism in doing the task • Able to apply the latest theories of engineering science, design engineering, methods and techniques necessary for the analysis and design of environmental management efforts in finishing the tasks independently • Able to develop logical, critical, systematic, and creative thinking through scientific research, design creation in the field of science and technology that concerns and implements the value of humanities in accordance with their field of expertise, prepares scientific conception and result of study based on scientific principles, procedures, and ethics • Able to solve engineering and technological problems and able to design systems, processes and components on environmental management efforts by taking into account economic, health and safety factors of public, cultural, social and environmental • Able to deepening or expanding the proficiency of designing, operating and maintaining engineering systems and environmental management to provide original and tested contribution by making paper review tasks
SUBJECTS
• Hydrological analysis: determination of catchment area, run-off coefficient, rain intensity, rainfall discharge calculation. • Concept of rainwater channeling and open-channel hydraulics. • Drainage canal layout and network. • Canal dimensions evaluation. • Drainage system supporting structures. • Evaluation of plan drawing and technical specifications. • Technical feasibility based on analysis of hydrology, hydraulics, and local environmental conditions.
PREREQUISITE
REFERENCES

1. The Association of Boards of Certification (ABC). 2012. Water Treatment Need-to-Know Criteria. ABC Water Treatment Certification Examination.
2. The American Water Works Association (AWWA). 2012. The American Society of Civil Engineers (ASCE): Water Treatment Plant Design, Fifth Edition. DESIGN AND CONSTRUCTION, Chapter (McGraw-Hill Professional, 2012), AccessEngineering

COURSE	**Course Name**	: System Master Plan
	Course Code	: RE185315
	Credits	: 3 Credits
	Semester	: 3

COURSE DESCRIPION

This course discusses the process of preparing the master plan in the field of environmental infrastructure, including the master plan of drinking water, the master plan of wastewater, the master plan of solid waste, and the master plan of drainage system. By studying this course, students are expected to be able to develop long-term plans for the development of a well-planned and sustainable environmental sanitation system

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GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitudes:

- Mastering the contextual and cutting-edge interdisciplinary approach related to the design of integrated environmental management systems.

Knowledge Mastery:

- Mastering the contextual and cutting-edge interdisciplinary approach related to the design of integrated environmental management systems.

Specific Skills:

- Able to solve engineering and technological problems, and able to design systems, processes and components on environmental management efforts including management of drinking water, wastewater, solid waste, drainage system, pollution control systems of liquid, solids and gaseous waste, air pollution control and occupational health and safety (OHS) by utilizing other fields of science (if necessary) and considering the economic, health and safety factors of the public, cultural, social and environmental concerns.

General Skill:

- 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.
- Able to make 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.

COURSE LEARNING OUTCOME

- Able to plan long-term development of environmental sanitation system
- Able to analyze the long-term plan of environmental sanitation system development

SUBJECTS

- Definition, purpose, and scope of master plan
- Long term development plan of environmental sanitation system
- The linkage of master plan with feasibility study and technical planning
- Integration of sanitation system master plan with other environmental infrastructure
- Preparation of master plan: data requirement, data analysis, and evaluation (covering drinking water sector, wastewater, solid waste, and drainage)
- Aspects of regulation and institutions

PREREQUISITE

REFERENCES

1. Peraturan Menteri Pekerjaan Umum Nomor: 18/PRT/M/2007 Tentang Penyelenggaraan Pengembangan Sistem Penyediaan Air Minum
2. Dep. PU (2008), Persiapan & Perencanaan Teknis (Penyusunan Proposal Kegiatan), Suplemen Teknis Pelaksanaan Kegiatan Prasarana dan Sarana Lingkungan , Direktur Jendral Cipta Karya Departemen Pekerjaan Umum.

COURSE	**Course Name**	: Socio-Economic Analysis
	Course Code	: RE185316
	Credits	: 2 Credits
	Semester	: 3

COURSE DESCRIPION

This course discusses non-technical aspects covering environmental, economic-financial, socio-cultural, institutional, and regulatory aspects associated with environmental facilities and infrastructure of the settlement. After attending this course, students will be able to perform non-technical evaluation on the results of the design of the facilities and infrastructure of drinking water, wastewater, solid waste and drainage system.

GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE

Attitude:

- Mastering the contextual and cutting-edge interdisciplinary approach related to the design of integrated environmental management systems.

Knowledge Mastery:

- Mastering the contextual and cutting-edge interdisciplinary approach related to the design of integrated environmental management systems.

Specific Skill:

- Able to solve engineering and technological problems, and able to design systems, processes and components on environmental management efforts including drinking water management, waste water, solid waste management, and drainage system, pollution control systems of liquid, solids and gaseous waste, air pollution control and occupational health and safety (OHS) by utilizing other fields of science (if necessary) and considering the economic, health and safety factors of the public, cultural, social and environmental factors.

General Skills:

- 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

- Able to make 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

COURSE LEARNING OUTCOME

- Able to develop a strategic plan in the field of environmental infrastructure.
- Able to plan medium-term investment development in the field of environmental infrastructure

SUBJECTS

- Able to provide non-technical considerations to the technical design results of the drinking water , wastewater, solid waste management, and drainage sectors.
- Able to develop strategic plans in the field of environmental infrastructure (drinking water , wastewater, solid waste management, and drainage sectors).
- Able to plan medium-term investment development in the field of environmental infrastructure.

PREREQUISITE

REFERENCES

1. Freddy Rangkuti, ANALISIS SWOT: Teknik Membedah Kasus Bisnis, Penerbit PT Gramedia Pustaka Utama, Jakarta, 2006
2. Ahmad Subagyo, Studi Kelayakan, Teori dan Aplikasi, Elex Media Komputindo, Jakarta, 2008
3. Andreas Budihardjo, Organisasi, Menuju Pencapaian Kinerja Optimum, Prasetya Mulya Publishing, Jakarta, 2011
4. Mochammad Natsir, Pengelolaan Sumberdaya Investasi Bagi Penyelenggaraan Infrastruktur, Pusat Pembinaan Sumber Daya Investasi, Badan Pembinaan Konstruksi, Kementerian Pekerjaan Umum
5. Abdul Halim, Analisis Kelayakan Investasi Bisnis : Kajian dari Aspek Keuangan, Graha Ilmu, 2008
6. Pedoman Penyusunan Rencana Pembangunan Investasi Jangka

Menengah Bidang Cipta Karya, 2012

COURSE	**Course Name**	: Preparation of Settlement Infrastructure Development Plan (Studio)
	Course Code	: RE185316
	Credits	: 2 Credits
	Semester	: 3

COURSE DESCRIPTION
In this course, students are assigned to conduct a group case study on a city that focused on the sectors of environmental infrastructure development. The expected case study result is the preparation of medium term investment development plan for one of the sectors studied.
GRADUATE LEARNING OUTCOME MANDATED TO THE COURSE
Attitudes • Internalizing spirit of independence, struggle and entrepreneurship. • Trying his/her best to achieve perfect results, and • Working together to be able to make the most of his/her potential. Knowledge Mastery • Knowledge of current engineering design theories, methods and techniques required for the analysis and design of environmental management efforts; • Knowledge of contemporary and contextual interdisciplinary approaches related to the design of integrated environmental management systems Specific Skills • Able to solve engineering and technology problems, and able to design systems, processes and components on environmental management efforts; • Capable of deepening and expanding proficiency in the field of designing, operating and maintaining engineering systems and environmental management General Skill • Able to make decisions in the context of solving problems of science and technology development;

COURSE LEARNING OUTCOME
• Able to evaluate the development and management plan of settlement infrastructure which includes drinking water, wastewater, solid waste and drainage
SUBJECTS
• Development and management plan of drinking water infrastructure • Development and management plan of wastewater infrastructure • Development and management plan of solid waste infrastructure • Development and management plan of drainage infrastructure.
PREREQUISITE
REFERENCES
Various references related to the previous subjects according to the division of tasks