Master of Technology in Environmental Engineering

Prospectus – 2017

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Contents

Outline of the Program

Aim of the Program

The sustainable development of any country needs to recognize the intimate and intricate relationship between the human activities and the environment. With the rise in haphazard development processes, we risk irrecoverable damage to our environment through urgent and pervasive problems like pollution and impact of the built environment on our ecosystem. Hence, this program aims to equip the students with a sound knowledge-base of technical and engineering principles to assess and eliminate the environmental pollution in the environmental media, viz., air, water and soil. This task involves the techniques to increase the quality of life and sustainably protect the environment through integration of diverse domains of science and engineering, with focus on mass and energy principles, and the understanding of physical, chemical and biological processes in the natural and engineered environments.

The graduates have diverse job opportunities, such as government jobs, environmental impact assessments, pollution control in process industries, environmental consultancies, non-governmental organizations associated with environmental protection, wastewater treatment plants, water supply facilities, sewage treatment plants, air pollution control, solid waste management, sustainable energy development, urban planning, and so on.

The graduates of this program will be able to:

- Understand the processes governing the transport and transformation of the environmental pollutants from the source of emission to the receptor of the pollution.
- Understand the present and the future behavior of the environmental systems under the influence of anthropogenic activities and the ensuing engineering interventions.
- Propose the most appropriate control technologies to minimize the waste and pollution after quantitatively assessing the environmental impacts and the broader implications of anthropogenic and engineering activities such as infrastructure projects and engineering structures.
- Specialize in water treatment, air quality improvement and waste management.

Program Duration:	Two years
Course Type:	Engineering
Total Credit Hours:	60

Admission Requirements

1. The general admission requirements of Kathmandu University for the master's degree must be fulfilled.
2. The prior educational degree should be a four-year undergraduate degree in Engineering with minimum 50% aggregate or CGPA of 2.0 from any recognized university.
3. There will be entrance exam and screening interview.

Course Structure

Code	Name of the course	Cr.	Type of Course
	Year I Semester I		
ENVE 501	Environmental Chemistry and Microbiology	3	Core
ENVE 502	Computational Tools and Techniques for Environmental Engineers	3	Core
ENVE 503	Environmental Dynamics	3	Core
ENVE 504	Water Quality Engineering	3	Core
ENVE 505	Air Pollution Engineering	3	Core
	Total Credits	**15**	
	Year I Semester II		
ENVE 506	Solid Waste Engineering	3	Core
ENVE 507	Green Engineering	3	Core
ENVE 508	Environmental Process Modeling	3	Core
ENVE 53*	Elective I – Pool A	3	Elective
ENVE 53*	Elective II – Pool A	3	Elective
	Total Credits	**15**	
	Year II Semester I		
ENVE 601	Environmental Economics, Policies and Legislations	3	Core
ENVE 602	Environmental Impact and Risk Assessments	3	Core
ENVE 603	Colloquium in Environmental Engineering	1	Core
ENVE 604	Directed Study and Research Method for Thesis	2	Core
ENVE 53*	Elective III – Pool A	3	Elective
ENVE 63*	Elective IV – Pool B	3	Elective
	Total Credits	**15**	
	Year II Semester II		
ENVE 699	Thesis Research	15	Core
	Total Credits	**15**	

Code	Name	Cr.
	Electives – Pool A (Environmental Engineering and Science)	
ESEE 548	Aerosol Science and Technology	3
ESEE 532	Air Pollution Modeling	3
ESEE 534	Atmospheric Chemistry	3
ESEE 533	Atmospheric Science	3
ESEE 535	Climate Change: Mitigation Technologies and Policies	3
ESEE 536	Climate Dynamics and Modeling	3
ESEE 537	Design of Water Supply and Wastewater Systems	3
ESEE 531	Disaster Risk and Vulnerability Assessment	3
ESEE 547	Bioseparation and Bioremediation	3
ESEE 539	Energy System Design Engineering	3
ESEE 540	Engineering System Design for Sustainability	3
ENVE 533	Hazardous Waste Technology and Management	3
ESEE 542	Indoor Air Pollution and Energy Analysis	3
ESEE 543	Industrial Processes and Pollution Control	3
ESEE 544	Vehicular Emission Control Engineering	3
ESEE 545	Waste Reduction and Recycling	3
ESEE 546	Water Resources Engineering	3
	Electives – Pool B (Environmental Planning and Management)	
ESEE 631	Environmental Health and Safety in Industries	3
ESEE 632	Human Values and Personal Transformation	3
ESEE 633	Economic and Financial Analysis of Environmental Projects	3
ESEE 634	Principles of Cleaner Production	3
ESEE 635	Sustainability for the Environment	3
ESEE 636	Sustainable Industrial Systems	3
ESEE 637	Urban Energy and Environmental Planning	3
ESEE 638	Environmental Risk Analysis	3

Detailed Syllabus

ENVE 501 Environmental Chemistry and Microbiology [3]

Objectives: Understand the fundamentals of chemical and biological processes in air, water and soil; Learn analytical and instrumental techniques involved; Understand the role of microorganisms in removal of pollutants.

Learning Outcomes: Ability to use chemical and microbial systems in waste treatment; Expertise in handling the instruments in analyzing the environmental parameters.

Content

Atmosphere: Composition of atmosphere, Evolution of atmosphere, Photochemical and chemical reaction in the atmosphere, Chemistry of green house effect and ozone layer depletion, Chemistry of ground-level air pollution.

Lithosphere: Water and air in soil, Organic and inorganic components in soil, Effects of ecological factors on toxicity of soil.

Water: Basic water chemistry, Oxidation-reduction reactions and equations, Sources of water pollutants and their treatment.

Toxic organic compounds: Pesticides, dioxins, Furans, PCBs, PAHs.

Environmental microbiology: Biodegradation in the aquatic environment, Degradation in heterogeneous environments, Microbial activity in trace heavy metal cycling, Eutrophication, Microbiological indicators of pollution.

Instrumental methods of analysis: Optical methods, Electrical methods, Chromatographic methods.

Laboratory: Hands-on practice in instrumental analysis and solution preparations.

References

Clair Sawyer, Perry McCarty, and Gene Parkin. *Chemistry for Environmental Engineering and Science*. English. 5 edition. Boston: McGraw-Hill Education, Aug. 2002. ISBN: 978-0-07-248066-5

Colin Baird and Michael Cann. *Environmental chemistry*. Macmillan, 2005

Jason Birkett and John Lester. *Microbiology and Chemistry for Environmental Scientists and Engineers*. English. 2nd Revised ed. edition. New York: CRC Press, Nov. 1999. ISBN: 978-0-419-22680-2

ENVE 502 Computational Tools and Techniques for Environmental Engineers [3]

Objectives: Use of GIS and remote sensing tools and techniques to quantify and analyze the spatial environmental information; Programming for environmental data processing and visualization

Learning Outcomes: Ability to generate, process and analyze the spatial environmental data; Ability to automate the processing and visualization of environmental data.

Content

Geocomputation and Geographic Information System: Database integration, Open-source GIS, automated mapping, data conversion, mobile computing, Open GIS web

service and software suite, GRASS GIS applications and case studies in water resource, watershed management, and environmental management, Geomatic surveying techniques.

Satellite remote sensing: Data and information system, Remote sensing data formats and format conversions, MODIS calibration and characterization, MODIS reprojection tool, MODIS data processing for regional use, TRMM data access tools, Other satellite data processing.

Advanced programming with Python: Data processing and visualization, Mapping of environmental data, Time series analysis and plotting, Solution of ODE and PDE, Statistical and numerical data analysis.

Laboratory: Hands-on practice in GRASS GIS, QGIS and Python.

References

John J. Qu et al., eds. *Earth Science Satellite Remote Sensing: Vol.2: Data, Computational Processing, and Tools*. English. 2006 edition. Place of publication not identified: Springer, Nov. 2014. ISBN: 978-3-642-42155-6

Robert Scally. *GIS for Environmental Management*. English. Redlands, Calif: Esri Press, Sept. 2006. ISBN: 978-1-58948-142-8

Barnali Dixon and Venkatesh Uddameri. *GIS and Geocomputation for Water Resource Science and Engineering*. English. 1 edition. Chichester, West Sussex, UK: Wiley-Blackwell, Oct. 2015. ISBN: 978-1-118-35414-8

Hans Petter Langtangen. *A primer on scientific programming with Python*. Vol. 6. Springer, 2011

Wes McKinney. *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc.", 2012

ENVE 503 Environmental Dynamics [3]

Objectives: Understand the fluid mechanical processes that govern the transport of pollutants; Learn the mechanism and rates of chemical transport in the environment through different environmental media.

Learning Outcomes: Ability to assess the transport of chemical pollutants in the environment; Ability to use tools and techniques to quantify the distribution of chemicals in the multimedia environment.

Content

Fluid flow: Bulk conservation equations, Equations of motion, Effect of viscosity, Porous media flow, Boundary layer flow, Turbulent flow, Open channel flow, Uniform flow, Environmental hydraulics, Mixing in Environmental flows, Kinematics of dispersion.

Transport processes: Mass transfer, Diffusive transport, Diffusion equation, Diffusive transport in reactive systems, Convective transport, Chemical exchange between air and water, Chemical exchange between water and sediment, Chemical exchange between air and soil, Intraphase chemical transport and fate in water and air.

Laboratory: Study of environmental transport processes at lab.

References

Jorg Imberger. *Environmental Fluid Dynamics: Flow Processes, Scaling, Equations of Motion, and Solutions to Environmental Flows*. English. 1 edition. Amsterdam ; Boston: Academic Press, Sept. 2012. ISBN: 978-0-12-088571-8

Louis J Thibodeaux. *Environmental chemodynamics: Movement of chemicals in air, water, and soil*. Vol. 110. John Wiley & Sons, 1996

Harindra Joseph Fernando, ed. *Handbook of Environmental Fluid Dynamics, Two-Volume Set*. English. CRC Press, Dec. 2012. ISBN: 978-1-4665-5603-4

A. Eduardo Sáez and James C. Baygents. *Environmental Transport Phenomena*. English. 1 edition. Boca Raton: CRC Press, Dec. 2014. ISBN: 978-1-4665-7623-0

ENVE 504 Water Quality Engineering [3]

Objectives: Learn the physical and chemical treatment processes in environmental engineering; Understand the design principles of treatment devices; Learn the separation techniques for solids and soluble matters.

Learning Outcomes: Ability to design and operate the water and wastewater treatment plants.

Content

Reactors and reactions: Mass balances, Continuous flow reactors, Reaction kinetics.

Removal of particles from water: Particle treatment processes, Flocculation, Gravity separations, Granular media filtration, Filtration dynamics.

Membrane-based water and wastewater treatment: Membrane processes, Membrane system operation, Pressure-driven membrane systems, Electrodialysis.

Laboratory: Hands-on practice at water and wastewater treatment facilities.

References

Mark M. Benjamin and Desmond F. Lawler. *Water Quality Engineering: Physical / Chemical Treatment Processes*. English. 1 edition. Hoboken, N.J: Wiley, July 2013. ISBN: 978-1-118-16965-0

Warren Viessman et al. *Water supply and pollution control*. Pearson Prentice Hall New Jersey (NJ), 2009

Inc Metcalf & Eddy et al. *Wastewater Engineering: Treatment and Resource Recovery*. English. 5 edition. New York, NY: McGraw-Hill Education, Sept. 2013. ISBN: 978-0-07-340118-8

ENVE 505 Air Pollution Engineering [3]

Objectives: Understand the chemical kinetics and combustion process in air pollution; Learn the control technologies for mobile emissions, particulate emission and gaseous emissions; Learn design principles of air pollution control devices.

Learning Outcomes: Ability to design and operate air pollution control devices; Expertise in air quality testing and abatement.

Content

Introduction: Air pollutants, Chemical kinetics, Mass and heat transfer, Turbulent mixing, Air pollution control strategies.

Combustion: Thermodynamics, Kinetics, Flame propagation and structure, Combustion of liquid and solid fuels.

Pollutant formation and control in combustion: Nitrogen oxides, Carbon monoxide, Hydrocarbons, Sulfur oxides.

Internal combustion engines: Spark ignition engines, Diesel engine.

Aerosols: Non-continuum effects, Motion of particles, Diffusion, Size distribution, General dynamic equation, Particle formation in combustion, Removal of particles from gas streams.

Removal of gaseous pollutants: Interfacial mass transfer, Absorption, Adsorption, Removal of sulfur oxides and nitrogen oxides.

Laboratory: Hands-on practice in air pollution measurement and control devices.

References

Richard C Flagan and John H Seinfeld. *Fundamentals of air pollution engineering*. Courier Corporation, 2013

Noel De Nevers. *Air pollution control engineering*. Waveland Press, 2010

Lawrence K Wang et al. *Air pollution control engineering*. Vol. 1. Springer, 2004

Lawrence K Wang et al. *Advanced air and noise pollution control*. Springer, 2005

ENVE 506 Solid Waste Engineering [3]

Objectives: Learn waste sampling, generation rate, characterization and composition of solid waste; Learn storage, collection, transportation of solid waste; Learn resource recovery and disposal.

Learning Outcomes: Ability to manage solid waste problems with storage and handling technologies; Expertise in waste to energy technology.

Content

Municipal solid waste characteristics and quantities: Generation, composition, properties.

Collection and mechanical processes: Refuse collection system, Design of collection systems, Conveying, compacting, shredding, pulping, granulating, roll crushing.

Separation processes: Screens, Float/sink separators, Magnets and electromechanical separators.

Biological processes: Anaerobic digestion, Composting

Thermal processes: Heat value of refuse, Materials and thermal balances, Design of waste-to-energy combustor, Pyrolysis, Gasification, Waste heat, Air pollutants.

Landfills:Processes, Design, Operations.

Special topics: Management of used oil, Medical and infectious waste, Construction and demolition debris, Electronic waste

Laboratory: Survey and design of waste-to-energy technologies and landfills.

References

William A. Worrell. *SI- Solid Waste Engineering*. English. 2nd Revised edition edition. Stamford, Conn.: Engineering, Mar. 2011. ISBN: 978-1-4390-6217-3

Lisa Branchini. *Waste-to-Energy: Advanced Cycles and New Design Concepts for Efficient Power Plants*. English. 2015 edition. Springer, June 2015. ISBN: 978-3-319-13607-3

George Tchobanoglous, Hilary Theisen, Samuel Vigil, et al. *Integrated solid waste management: engineering principles and management issues.* McGraw-Hill, Inc., 1993

ENVE 507 Green Engineering [3]

Objectives: Understand the concept of sustainable or green engineering based on global issues. Practices and methods to assess environmental quality, performance of engineered products or/and systems Study laws, regulations, occupational health concerns and ethics in environmental engineering

Learning Outcomes: To educate students the concept of sustainable and green engineering to maintain the environmental quality

Content

Environmental issues and regulations: Risk assessment, Environmental laws and regulations, Roles of engineers in environmental protection, Process safety, Engineering ethics.

Improvement of environmental performance in engineering processes: Green chemistry, Unit operations and pollution prevention, flowsheet analysis for pollution prevention.

Green Engineering for products: Life-cycle assessment, industrial ecology, the economics of green engineering, Product stewardship.

Innovations in Green Chemistry and Green Engineering: Renewable materials, Green nanoscience.

Laboratory: Use of life-cycle assessment tools.

References

David T. Allen and David R. Shonnard. *Green Engineering: Environmentally Conscious Design of Chemical Processes*. English. 2 edition. Upper Saddle River, N.J.; London: Prentice Hall, 2013. ISBN: 978-0-13-265707-5

Anne E Marteel-Parrish and Martin A Abraham. *Green chemistry and engineering: A pathway to sustainability*. John Wiley & Sons, 2013

Paul T. Anastas and Julie B. Zimmerman, eds. *Innovations in Green Chemistry and Green Engineering: Selected Entries from the Encyclopedia of Sustainability Science and Technology*. English. 2013 edition. New York: Springer, Dec. 2012. ISBN: 978-1-4614-5816-6

ENVE 508 Environmental Process Modeling [3]

Objectives: Understand the development and deployment of environmental models in all the environmental media; Learn the process-based modeling techniques and practices in water quality and air quality; Understand the modeling of dynamical systems in the environment; Learn the system modeling approach to solve environmental problems.

Learning Outcomes: Ability to develop and use air quality and water quality models; Expertise in modeling the dynamical processes; Ability to integrate state-of-the-art modeling tools.

Content

Modeling methods: Types, Development, Application, Parameter estimation, Validation and sensitivity analysis.

Transport processes: Transport equation, Boundary and initial conditions, Transport with decay and degradation, Transport and sorption, kinetics, and equilibrium reactions.

Dynamical systems: River and lake quality models, flow modeling in porous media, Groundwater modeling, Aquifer baseflow and meshing, Potential and flow visualization.

Water budget models: Flow modeling in a homogeneous system, Flow modeling in heterogeneous systems, Fully coupled watershed-scale water balance model, GIS and model integration.

2D and 3D Transport solutions: Gaussian puffs and plumes with constant line and instantaneous line sources.

System models: Simple reactor and bioreactor models, Population balance models, Artificial Neural Network models.

Laboratory: Modeling the environmental processes and flow systems using open-source programming.

References

Ekkehard Holzbecher. *Environmental modeling: using MATLAB*. Springer Science & Business Media, 2012

Andrew Ford. *Modeling the Environment: An Introduction To System Dynamics Modeling Of Environmental Systems*. English. 1 edition. Washington, D.C: Island Press, Mar. 1999. ISBN: 978-1-55963-601-8

Ashok Kumar Verma. *Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering*. English. CRC Press, Oct. 2014

Steven C. Chapra. *Surface Water-Quality Modeling*. English. Waveland Pr Inc, Dec. 2008. ISBN: 978-1-57766-605-9

ENVE 601 Environmental Economics, Policy and Legislations [3]

Objectives: Learn the international and national laws and regulations related to environmental domains; Understand the development of environmental legislations and

policies.

Learning Outcomes: Awareness about the current laws, regulations and policies related to different environmental sectors.

Content

Air quality: Laws, Acts and regulations, International treaties, National air quality standards, Non-governmental actions.

Solid waste facilities: Financing calculations, Contracting for solid waste services, Public or private ownership and operation, SWM Legislation.

Regulatory development: Legislations, Laws, Regulations, Policy, Guidance, Environmental justice.

Environmental policies and legislations of Nepal.

ENVE 602 Environmental Impact and Risk Assessments [3]

Objectives: Learn the methods of assessing the impacts of anthropogenic activities on the different environmental sectors; Understand the applications of risk assessment tools and environmental management systems.

Learning Outcomes: Ability to evaluate and predict the environmental impacts using quantitative tools; Expertise in environmental impact assessment and risk assessment.

Content

Processes for IEE, EIA, and TOR (components of EIA reports)

Methods for impact identification, Description of environmental setting.

Prediction and assessment of impacts on air, noise, water, soil, land use, terrestrial and aquatic ecology, Environmental indices and indicators.

Cumulative impact assessment, Greenhouse emission assessment, Risk assessments and accident analyses, Social impact assessment and environmental justice, International environmental impact assessment process, Environmental management systems.

References

Larry Canter. *Environmental Impact Assessment*. English. 2 edition. New York: McGraw-Hill Science/Engineering/Math, Sept. 1995. ISBN: 978-0-07-009767-4

Charles H. Eccleston. *Environmental Impact Assessment: A Guide to Best Professional Practices*. English. 1 edition. Boca Raton: CRC Press, Mar. 2011. ISBN: 978-1-4398-2873-1

ENVE 603 Colloquium in Environmental Engineering [1]

Objectives: Provide exposure to the views and opinions of the experts and professionals on the scope as well as challenges for the environmental engineering graduates.

Learning Outcomes: Strong interaction and linkage between the academic and professional expertise.

Content

Lectures on current research topic in environmental engineering and its related fields, which will be presented by faculty members and invited speakers.

ENVE 604 Directed Study and Research Method for Thesis [2]

Objectives: Intensive preparation for the masters thesis work; Learn the methods and tools for the thesis research.

Learning Outcomes: Development of research method and review of the literature.

Content

Research and preparation for the thesis of the last semester. It will cover the development of the research theme, methodology and review of the literature.

ENVE 699 Thesis Research [15]

Introduction

Research work and thesis submission will be carried out by the students with supervision by the assigned faculty members. It will cover the actual research work, thesis-writing, oral defense of the thesis, and publication. The students may collaborate with relevant institutions with the permission of the department.

Learning Outcomes

Masters thesis on environmental engineering with strong academic merit.

Guidelines for Master Thesis

- Students need to develop the concept paper.
- On the base of the accepted concept paper the research proposal need to be developed .
- Supervisor will be assigned and all the modality of the proposal defense, thesis writing, thesis defense depends upon the location of the student's registration for research.
- Regular individual progress meetings with the supervisors will be held to monitor the progress on the research and thesis writing, and records of the progress will be kept.

The Basis for Evaluating the Master Research

- Problem statement and research topic and its rationale for research.
- In-depth literature review, including assessment of the usability of literature and previous research.
- Collection of relevant on-line and archived data.
- If appropriate, preparation and execution of fieldwork to collect primary data required for the research.
- Data processing and analysis and, if deemed necessary, adjustment of the research plan in consultation with the supervisors (based on sound arguments).

- Active participation in seminars and conferences related to the research theme.
- Mid-term presentation;
- Preparation of the final manuscript of the master thesis (hard-copy thesis and CD-ROM with thesis, appendices and full dataset including the original data and results);
- A critical review of the quality, use and usefulness of the data and results, as well as the learning process;
- Oral presentation and defense of the master thesis before the Thesis Assessment Board.

Evaluation Scheme

Courses

The academic performance of the students will be judged through:

- Continuous assessment, and
- Final assessment

The continuous assessment of the student will be made by the concerned faculty member in any or a combination of the following:

- Written tests
- Assignments and reports
- Seminars
- Term papers
- Any other deemed suitable by the concerned faculty member.

The final assessment will normally be conducted according to the examination schedule notified by the concerned office for a distributed course and at the end of course for an intensive type course. The mode of evaluation in a given course is decided by the concerned faculty member who may assign varying weights to one or more of the evaluation modes. The faculty member shall normally announce such weights in the beginning of the course.

Masters Thesis

A thesis in topic related with the student's discipline is a necessary requirement for the successful completion of M.Tech. in Environmental Engineering. The candidate must have achieved result of significance in the thesis work and must indicate an ability to express in satisfactory style, both in written and oral.
Normally the thesis shall be submitted at the end of the final semester. However, upon the recommendation of the supervisor, and subject to the approval of the School, only one term extension of six months can be granted to a student if he/she requires so. The student will receive a satisfactory or unsatisfactory grade and must have a satisfactory grade to qualify.

Grading Modes

In each course, student will be evaluated on a 4 point scale as follows:

Grade	A	A–	B+	B	B–	C+	C	F
Grade Point	4	3.7	3.3	3	2.7	2.3	2	0

The grades indicate the quality of students' performance as follows:

A = Outstanding
A– = Excellent
B+ = Very good
B = Good
B– = Fair
C+ = Poor
C = Very Poor
F = Failure

Apart from the letter grades mentioned above, the following letter grade can also be awarded:

W = Withdrawn
NC = Non Credit Course
INC = Incomplete
S = Satisfactory
U = Unsatisfactory
AU = Audit

W Indicates that a student has officially withdrawn from a course without grade or penalty. During the regular semester, a student seeking to withdraw from a course must do so before the final examination with the permission of the concerned faculty member. 'W' may not be processed after the final examination.

NC Indicates that student has officially attended a course till the end and completed it successfully but for which no credit will be given. A student can take a non

INC Indicates that a student has not completed all the assignments required in the particular course. 'INC' becomes 'F' if the student does not complete the required work before the deadline agreed upon with the concerned faculty. A maximum of 6 months will be allowed for 'INC' removal.

S Indicates completion of dissertation at satisfactory level.

U Indicates dissertation was not completed at a satisfactory level.

AU Indicates completion of credit course on top of the required credited courses.

Graduation Requirement

To graduate a student must achieve the following:

1. Completion of the minimum number of required course credit hours with not less than C grade in each course.

2. A minimum grade point average (GPA) of 2.5 in every semester and a cumulative grade point average (CGPA) of at least 3.0.

3. Completion of oral defense of thesis with satisfactory grade.

4. The maximum time allowed to complete the degree is five years from the date of admission into the program.

Failures and Dismissal

A student must maintain a semester grade point average (GPA) of 2.5 or above at the end of each semester failing which the student will be subject to dismissal from the program.
There will be no re-examination for any student who is absent during the final assessment. Absence will render the status of the student's course as incomplete.