NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING
ENVIRONMENTAL ENGINEERING PROGRAM

GA158 – SIMULATION AND ENVIRONMENTAL MODELING

I. GENERAL INFORMATION

CODE	**:**	GA142 – Simulation and Environmental Modeling
SEMESTER	**:**	10
CREDITS	**:**	04
HOURS PER WEEK	**:**	04 (Theory – Practice – Laboratory)
PREREQUISITES	**:**	Environmental and territorial planning
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

Environmental simulation provides tools for detailed planning of research projects, as well as for decision-making in other areas such as environmental management. In the introductory part of the course, the appropriate concepts are studied to defer to the course of simulation and environmental modeling, and the tools for the processing and systematization of information are provided. The course begins with the simulation of dispersion of polluting emissions into the atmosphere, the second part develops the simulation of pollutant discharges in aquatic environments (rivers, lakes, sea, etc.) that involve physical-chemical and biological phenomena, in the third part The simulation of electromagnetic propagation in the atmosphere will be studied, the last part develops the methods for the evaluation of the models used. At the same time, the sequence is developed to perform a good environmental simulation and modeling using software.

III. COURSE OUTCOMES

By the end this course the student will:

- Perform simulations based on physical, chemical and biological knowledge.
- Use scientific programming language for the execution of simulations.
- Use modeling software in aquatic environments backed by international environmental agencies.
- Select, process and systematize data suitable for entering the models.
- Use post-processing tools to perform an adequate analysis and interpretation of modeling results.
- Understand the procedure of sensitivity, validation, calibration and general quality control of a modeling.

IV. LEARNING UNITS

1. INTRODUCTION TO SIMULATION AND ENVIRONMENTAL MODELING / 4 HOURS

Introduction to modeling and simulation; application of environmental modeling; steps for environmental modeling; the relationship of mass and concentration; mass balances; the processes of mass transport; spill models; the estimation of the relative importance of the transport processes; compartmental (box) models.

2. **SIMULATION AND ATMOSPHERIC MODELING / 16 HOURS**
   Principles of atmospheric modeling, Information for modeling atmospheric pollutants, Models of spatial and temporal distribution of emissions.
   Modeling of pollution at the local and urban scale, modeling of point sources (chimneys), modeling of other sources. Modeling of air pollutants at a regional and global scale or at a large scale.

3. **SIMULATION AND MODELING IN AQUATIC MEDIA / 12 HOURS**
   Principles of modeling in liquid medium, Information for modeling water pollutants, Models of spatial and temporal distribution of pollutants in water.

4. **SIMULATION AND MODELING IN POROUS MEDIA / 12 HOURS**
   Principles of modeling in porous media, Information for modeling groundwater contaminants, Models of spatial and temporal distribution of groundwater contaminants.
   Configuration of an underground water model (spatial discretization of an aquifer), simulation of groundwater under transient conditions, simulation of boundary or border conditions, volumetric water balance because water volumes and flow rates are involved.

5. **SIMULATION AND MODELING OF ENVIRONMENTAL SYSTEMS / 8 HOURS**
   Basin Modeling, Basin Inputs and Outputs, Precipitation, Evapotranspiration Runoff and Basin Discharges, Airborne Propagation Model, Prediction Schemes, Noise Prediction due to Industries, Constructions and Industrial Activities.

6. **EVALUATION OF ENVIRONMENTAL MODELS / 4 HOURS**
   Sensitivity studies, calibration and validation of models, use of software for model evaluation.

V. LABORATORIES AND PRACTICAL EXPERIENCES

The corresponding syllabus for computer lab practices are the following:

- Application of atmospheric modeling for pollutants and data sources with a mesoscale atmospheric model.
- Application of the Airmod Model to estimate the quality of the air and using as a source the outputs of atmospheric models.
- Application of the HSPF or WAPS Model to estimate water quality and using various available data as a source.
- Application of the PRMS Basin Model or similar for hydrological cycle and balance in an ecosystem.
- Application of MODFlow groundwater model and similar for dispersion of pollutants.
- Application of the CORMIX Model and / or Visual plumes for effluent emitters. Application of noise propagation models.

The topics that correspond to the monographs are the following:

- Application of the Airmod Model to estimate the quality of the air and using as a source the outputs of atmospheric models for an industrial source.

- Application of the HSPF or WASP Model to estimate water quality and using as a source various data available for a watershed of interest.

- Application of the MODFlow groundwater model for a type case of filtration or pollutant drainage.

- Application of a model to the group's choice.

- Final work - free theme

VI. METHODOLOGY

- The course is developed in sessions of theory, practice and computer lab. In the theory sessions, the teacher presents the concepts, theorems and applications. In the practical sessions, various problems are solved and their solution is analyzed.

- In laboratory sessions, different packages or models are used to solve problems and analyze their solution product from which the group must submit an application report. At the end of the course the student must present and present an integrating project or work. In all the sessions, the active participation of the student is promoted.

- The practical part will be evaluated by exposure in practice class as well as the final work (the exhibition must be of all the members of the group).

VII. EVALUATION FORMULA

The learning will be evaluated through the "G" system.

- Partial Exam: Weight 1
- Final Exam: Weight 1
- Average of Practices/Monographic Work: Weight 1.

VIII. BIBLIOGRAPHY

- De Nevers N. 1998. Ingeniería de control de la contaminación del aire. Mcgraw Hill. México DF.

- López, M. (2009). Aplicación del modelo de dispersión CALPUFF para la estimación de concentraciones del PM2.5. México DF.

- Andrew Ford, Modeling the Environment: An Introduction to System Dynamics Modeling of Environmental Systems. 1st ed. Island Press. 1999.

- William C. Skamarock et all. 2008. A Description of the Advanced Research WRF Version 3. NCAR

- Barlas Y. 2002. System Dynamics: Systemic Feedback Modeling For Policy Analysis, Encyclopedia of Life Support Systems (EOLSS), UNESCO Publishing, Paris-Oxford.

- Jerald L. Schnoor, (1996), “Environmental Modeling – Fate and Transport of Pollutants in Water, Air and Soil”, John Wiley & Sons Inc., New York.

- Jorgensen S.E. y G. Bendoricchio, Fundamentals of Ecological Modeling, Elsevier, 2001. (Reference text for several modeling methodologies).

- Michael L. Deaton and James J. Winebrake, Dynamic Modeling of Environmental Systems, 2000. (Reference text for simple environmental systems)

- Seinfeld, J. H., Pandis, S. N. (2006). Atmospheric Chemistry and Physics - From Air Pollution to Climate Change (2nd Ed.). John Wiley and Sons.XX

- Chunmiao Zheng, Gordon D. Bennett 1995. Applied Contaminant Transport Modeling. Wiley

- Política Nacional del Ambiente. Decreto Supremo Nº 012-2009-MINAM. Publicado en el diario oficial El Peruano el 23 de Mayo del 2009.

- Plan Nacional de Acción Ambiental PLANAA 2011-2021. Decreto Supremo N° 014-2011-MINAM. Publicado en el diario oficial El Peruano el 9 de julio del 2011 y en Separata Especial el texto completo el 14 de julio del 2011.

- Programa de las Naciones Unidas sobre el Medio Ambiente. Conferencia de las Naciones Unidas sobre el Medio Ambiente y el Desarrollo, Programa 21. PNUMA, Nairobi, Kenia.1992. Rio+10 Sudáfrica. Río +20 Brasil.

- Selected readings delivered each week for theory and practice.