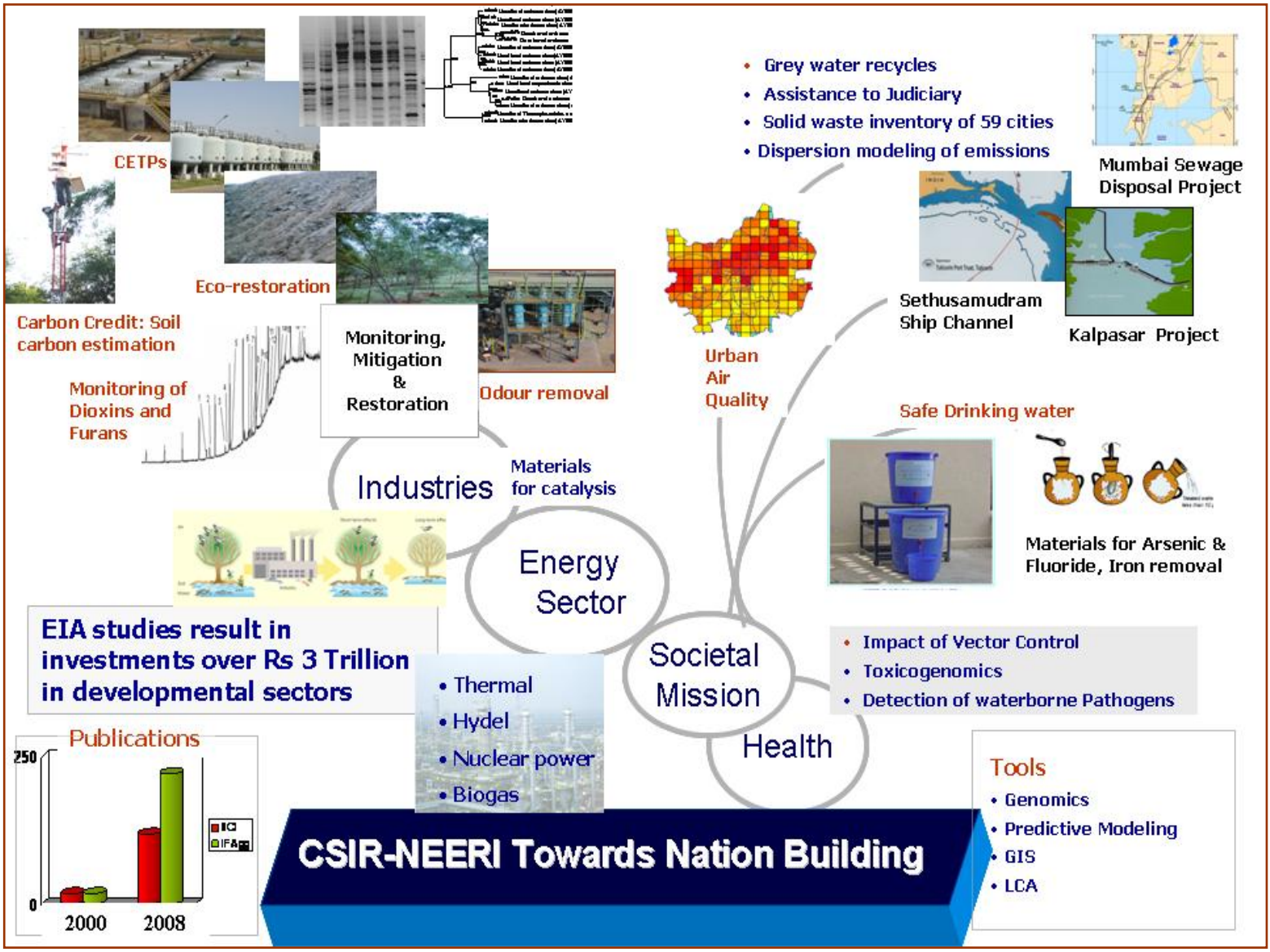
Post Graduate Research Programme in Engineering in Environmental System Modeling and Optimization

2010



National Environmental Engineering Research Institute
(Council of Scientific & Industrial Research)
Nagpur - 440020

Summary

The main goal of the course is to foster rational thinking in complex decision situations related to environmental problems by studying the physical laws underlying environmental phenomena. This course provides a background for engineering students to learn and achieve a scientific understanding of important environmental issues concerning pollution and mitigation. There is an urgent need to comprehend not only the physical and chemical principles underlying a process, but also to translate this understanding into a mathematical form, solve the resulting equations and interpret/apply the results towards process improvement with requisite engineering interventions. The field of mathematical modeling has seen significant progress, both in terms of techniques of modeling as well as the ability to handle complex models. Thus it is possible in many instances today to reduce actual experimentation to a minimum and obtain the required information through numerical experimentation on the mathematical model.

After completing the course, the student must be able to:

- Analyze the situation and decide the data collection strategy and methodology
- Collect and collate the relevant data required for modeling.
- Apply conceptual modeling
- Either apply existing available models or develop mathematical models for simulating environmental impact.
- Generate different scenarios ultimately to arrive at effective environment management plan with a view to support the decision makers.

Eligibility

4 years Bachelor's Degree in Environmental, Civil, Chemical, Electrical and Mechanical engineering shall be considered as the basic pre-requisite qualification for admission to the programme. Only Indian nationals who have passed in the last year (2009) or are going to pass in the current year (2010) are eligible to apply. Other conditions and eligibility criteria shall be as per CSIR guidelines.

Number of Seats in the Programme

The total number of seats available is 8 for 2010-2012 batch.

Fellowship

The selected candidates shall be provided fellowship of Rs. 25,000/- per month. The candidates have to pay semester fees @ Rs. 24,000/- per semester in addition to hostel rent and other fees as mentioned at http://csir.res.in/csirpgrp/pgrpe.htm.

Application & Selection Process
The application and selection process shall be as per CSIR guidelines. The details are available http://csir.res.in/csirpgrp/pgrpe.htm.

Programme Description

The programme consists of two semesters of course work, and two semesters of project work and thesis work.

Course Content

First Semester		
Sr. No	**Name**	**Credit**
1	Numerical Methods	3:0
2	Data Analysis and Parameter Estimation	3:0
3	Introduction to GIS	2:2
4	Optimization Techniques	3:0
5	Environmental Monitoring and Assessment	2:1
Second Semester		
Sr. No	**Name**	**Credit**
1	Air Pollution Modeling	3:1
2	Noise Pollution Modelling	2:0
3	Water pollution Modelling	3:2
4	Ecological and Climate Change modeling	2:0
5	Risk Analysis	2:1
Third and Fourth Semester		
1	Project and Thesis Work	0:32

Semester-wise Course Scheme
A. The first Semester

Numerical Methods: (3:0)
Solutions of linear algebraic equations, existence and uniqueness of solutions, Gauss elimination, LU decomposition, Cholesky factorization and iterative methods; eigenvalues-eigenvectors, symmetric and non-symmetric matrices, similarity transformations, Jordan forms, SVD, applications to linear ODE's; computing eigenvalues, power, inverse power, Householder, QL and QR algorithms; non-linear equations; Picard iteration, Newton-Raphson, contraction mapping theorem; Sturm-Liouville problems, separation of variables in rectangular and cylindrical coordinates; numerical solution of initial value problems; time-integration methods, Runge-Kutta, predictor-corrector methods, stability; Finite differences for PDE's.

Data Analysis and Parameter Estimation: (3:0)

- Scales of measurement, data description. Probability and probability distributions,
- Sampling techniques and sampling distributions, confidence interval for population mean, Hypothesis testing, p-value, Analysis of Variance, t-distribution, f- distribution
- Discrete Fourier Transform, Estimation of spectra, Filtering, correlation and deconvolution of time sequences, ARIMA models, time series prediction
- Contingency table and Chi-square test of independence ,Linear regression models, least squares method, correlation, Spearman's rank order correlation, inferences about the parameters in the linear regression model
- Multivariate Data Analysis, Factor Analysis, Principal component analysis, Discriminant Analysis.
- Linear regression models, least squares method, inferences about the parameters in the linear regression model, generalized matrix inverse, Bayesian estimation, nonlinear parameter estimation

Introduction to GIS: (2:2)

- Gain a basic, practical understanding of GIS concepts, techniques and real world applications.
- Understand the basic concepts of geography necessary to efficiently and accurately use GIS technology.
- GIS data concepts and analysis
- Practical applications of GIS.
- Understand the technical language of GIS.
- Gain practical experience using basic GIS tools.
- GIS as it relates to software development.

Optimization Techniques: (3:0)

- **Introduction:** Historical Development, Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems.
- **Linear Programming:** Graphical method, Simplex method, Revised simplex method, Duality in linear programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transportation, assignment and other applications.
- **Non Linear Programming:** Unconstrained optimization techniques, Direct search methods, Descent methods, Constrained optimization, Direct and indirect methods, Optimization with calculus, Khun-Tucker conditions.

- **Dynamic Programming:** Introduction, Sequential optimization, computational procedure, curse of dimensionality,
- **Advanced Techniques of Optimization:** Introduction, Genetic algorithms for optimization and search.

Environmental Monitoring and Assessment: (2:1)

This course covers quantitative methods for estimation of pollution loads and environmental analysis. Planning for data collection its handling and statistical analysis, with a focus on environmental monitoring, based on field data. The data include remote sensing, meteorological, river flow data and topographic studies.

B. The Second Semester

This semester will cover systems analysis, modeling and scenario generation including conceptual modeling. This module encompasses several scenarios encompassing:

Air Pollution Modeling: (3:1)
Meteorological aspects related to air pollution involving wind circulation, lapse rate, stability conditions, turbulence, Richardson number, boundary layer structure, mixing height, plume behaviour, heat island effect, wind rose. etc. Model classification considers box model, Gaussian dispersion model, dispersion parameters, plume rise, removal mechanisms, point, line and area sources, long term and short term dispersion models.

Noise Pollution Modelling: (2:0): Sources and effects of noise pollution, noise standards, basics of sound propagation, noise scales and rating methods, Noise modeling and its application

Water pollution Modelling:(3:2): Sources and effects of water pollutants, introduction to principles of water quality modeling, distribution of water quality in rivers, estuaries and lakes. Contaminant transport in groundwater, river, and ocean. Water quality modeling applications and discussion of case studies.

Ecological and Climate Change modeling: (2:0): Introduction to ecological processes and modeling tools and techniques.

- Ecology & Its Interdisciplinarity
- Introduction to Various Kinds of Models (Linear, Non-Linear, Statistical, Structural etc.)
- Models Applied in Ecology
- Ecosystems, their Structure & Functioning
- Flow of Energy in Ecosystems
- Food-Chains, Food-webs, Trophic Levels and Energy Flow
- Nutrient Cycles and Bio-geo-physico-chemical Cycling

Risk Analysis: (2:1): Concept of risk, objective and scope of risk assessment, probabilistic risk, risk perception and acceptability. Quantitative aspects of risk. Three levels of risk quantification, PRA management, preliminary hazard analysis, HAZOP and HAZAN, FMEA and FMECA analysis, Fault tree Analysis. Digraph and other approaches. Computation of Hazard probability, unavailability and other parameters using fault tree methodology. Monte Carlo Simulation technique, Event tree analysis, identification of initiating events, sequence and scenario development, system analysis, external events and dependent failure analysis and quantification, Accident-consequence Analysis, uncertainty analysis, sensitivity analysis and importance measures. Bayesian approaches. Human reliability Analysis.

C. Third (& Fourth) Semester(0:32)

Project Work: covers application of different models and collected data to real life situations. Application of GIS in solving environmental problems and hands on experience will be a part of this module.

Faculty for Course on

First Semester

Numerical Methods: (3:0)

Sr. No.	Name	Qualifications
1.	Dr. Aabha Sargaonkar	M.Sc., Ph.D.
2.	Dr. Asha Lalwani	M.Sc., B.Ed., Ph.D., Advance Diploma in Computer Software
3.	Dr. Rajiv Sohony	M.Tech., Ph.D.

Data Analysis and Parameter Estimation: (3:0)

Sr. No.	Name	Qualifications
1.	Dr. Asha Lalwani	M.Sc., B.Ed., Ph.D., Advance Diploma in Computer Software
2.	Dr. Indrani Gupta	Ph.D.

Introduction to GIS: (2:2)

Sr. No.	Name	Qualifications
1.	Dr. Aabha Sargaonkar	M.Sc., Ph.D.
2.	Mr. Ritesh Vijay	M.Tech.

Optimization Techniques: (3:0)

Sr. No.	Name	Qualifications
1.	Dr. Indrani Gupta	Ph.D.
2.	Dr. Rajesh Biniwale	D.Sc.

Environmental Monitoring and Assessment: (2:1)

Sr. No.	Name	Qualifications
1.	Dr. S. K. Goyal	M.E., Ph.D
2.	Dr. D. D. Majumdar	M.Sc., Ph.D.

Sr. No.	Name	Qualifications
1.	Dr. N.N. Rao	M.Sc., Ph.D
2.	Dr. P. R. Pujari	Ph.D.
3.	Dr. G.R. Pophali	M.E., Ph.D.

1.	Dr. T.V.B.P.S. Ramakrishna	M.Sc., Ph.D
2.	Dr. Aabha Sargaonkar	M.Sc., Ph.D.
3.	Dr. Tapan Chakravarti	M.Sc., Ph.D.

Second Semester

Air Pollution Modeling: (3:1)

1.	Dr. S. K. Goyal	M.E., Ph.D
2.	Dr. C. V. Chalapathi Rao	M.E., Ph.D.
3.	Dr. T.V.B.P.S. Ramakrishna	M.Sc., Ph.D

Noise Pollution Modelling:

1.	Dr. Rajiv Sohony	M.Tech., Ph.D.

Water pollution Modelling:(3:2):

1.	Dr. Apurva Gupta	M.Sc., M.Tech.,Ph.D
2.	Dr. Indrani Gupta	Ph.D.
3.	Dr. Aabha Sargaonkar	M.Sc., Ph.D.
4.	Dr. Anjali Shrivastava	M.Sc., Ph.D.

Ecological modeling:

1.	Dr. J.S. Pande	M.Sc., Ph.D.

Risk Analysis:

1.	Mr. Santosh Ghuge	M.Tech.

C. Third (& Fourth) Semester(0:32)

Project Work:

1.	Dr. Rajiv Sohony	M.Tech., Ph.D.
2.	Dr. Aabha Sargaonkar	M.Sc., Ph.D.
3.	Mr. Ritesh Vijay	M.Tech.

Research Activities and Facilities at NEERI

Research activities and facilities at NEERI can be found at http://www.neeri.res.in .