Ecosystem Tools I: Quantitative Analysis & Research Method Courses				
Course Title	**Credits**	**Last Offered**	**Emphasis Area**	**Description**
AGRY 553 Intro to SAS for Statistical Analysis	1	F16	SAS programming	Introduction to SAS as a programming language, for students with no prior exposure to programming languages. Basics of programming languages, SAS concepts, data input and manipulation. Introduction to SAS for graphs, univariate statistics, simple statistics for classification data, analysis of variance, simple and multiple regression
EAPS 509 Data Analysis Techniques for Earth and Atmospheric Science	3	F18		Application of statistical techniques to analyze and interpret data containing substantial information about the dynamics of our planet Earth. Emphasis on fundamentals with elements of atmospheric/climate time series analysis and weather and climate extremes (necessary for understanding current research) interwoven with computer-intensive bootstrap methods (which work for complex data sets typical in geosciences).
EAPS 591 Climate Time Series Analysis	3	F17		
EDCI 615 Qualitative Research Methods in Education	3	S19	Qualitative research methods	This area provides a foundation for understanding the philosophical and theoretical underpinnings and procedures used in conducting qualitative research.

EDCI 616 Qualitative Data Collection and Analysis in Education Research	3	S19	Advanced Qualitative methods	Qualitative research methods at an advanced level beyond EDCI 615
FNR 580 Natural Resource Social Science Research Methods	3	F18	Methods	Research methods for natural resource social science.
FNR 647 Quantitative Methods for Ecologists	3	S18	Statistics	Training in the application of statistical techniques (principally multivariate) to analyze ecological data.
STAT 503 Statistical Methods for Biology	3	S19	Statistics	Descriptive statistics; elementary probability; sampling distributions; inference, testing hypotheses, and estimation; normal, binomial, Poisson, hypergeometric distributions; one-way analysis of variance; contingency tables; regression.
STAT 511 Statistical Methods	3	S19	Experimental design/analysis	Descriptive statistics; elementary probability; sampling distributions; inference, testing hypotheses, and estimation; normal, binomial, Poisson, hypergeometric distributions; one-way analysis of variance; contingency tables; regression.

STAT 512 Applied Regression Analysis	3	S19	Applied Analysis	Inference in simple and multiple linear regression, residual analysis, transformations, polynomial regression, model building with real data, nonlinear regression. One-way and two-way analysis of variance, multiple comparisons, fixed and random factors, analysis of covariance.
STAT 514 Design of Experiments	3	S19	Experimental Design	Fundamentals, completely randomized design; randomized complete blocks; latin square; multi-classification; factorial; nested factorial; incomplete block and fractional replications for 2n, 3n, 2m x 3n; confounding; lattice designs; general mixed factorials; split plot; analysis of variance in regression models; optimum design.
STAT 5200 Time Series and Applications	3	S19	Time series analysis	A first course in stationary time series with applications in engineering, economics, and physical sciences. Stationarity, autocovariance function and spectrum; integral representation of a stationary time series and interpretation; linear filtering, transfer functions; estimation of spectrum; multivariate time series. Use of computer programs for covariance and spectral estimation

Ecosystem Tools II				
Course Title	**Credits**	**Last Offered**	**Emphasis Area**	**Description**
A&AE 575 Introduction to Satellite Navigation and Positioning	3	F17	Spatial Analysis Tools	Introduction to radio-navigation techniques, using the Global Navigation Satellite System (GNSS); GNSS signal structures; satellite search and acquisition; satellite tracking; coordinate systems and time; observations; atmospheric effects; and position-velocity-time (PVT) solutions.
ABE 527 Computer Models in Environmental and Natural Resources Eng.	3	S18	Computer Models	Offers students in environmental and natural resources engineering programs an understanding of the hydrological processes and related design skills. Principles of soil erosion by water; drainage of agricultural lands; surface runoff; flood and reservoir routing; hydrodynamic and water quality in pipe network; nonpoint source pollution; and transport phenomenon are studied. Current computer models utilized in industry for decision support are applied using case studies to further enhance the understanding of the hydrological processes. Limitations and advantages of the models are discussed. Offered in alternate years.

ABE 529 Nonpoint Source Pollution Engineering	3	S19	Environmental Engineering Modeling	Variable Title Course Number: Special Topics Engineering principles involved in assessment and management of nonpoint source (NPS) pollution. Effect of NPS pollution on ecosystem integrity. Use of GIS/mathematical models to quantify extent of pollution. Design/implementation of best management practices to improve water quality. Discussion of Total Maximum Daily Load (TMDL) principles and processes
ABE 560/BME 521 Biosensors: Fundamentals and Applications	3	F18	Field/Lab Techniques	An introduction to the field of biosensors and an in-depth and quantitative view of device design and performance analysis. An overview of the current state of the art to enable continuation into advanced biosensor work and design. Topics emphasize biomedical, bioprocessing, environmental, food safety, and biosecurity applications.
ABE 651 Environmental Informatics	3	S19	Data Use and Analysis	This course will educate students in the use, manipulation and analysis of environmental data by introducing them to scripting languages (e.g. c-shell, python), data types (e.g. ASCII, binary, NetCDF), databases (e.g. XML, DBF) and data visualization software (e.g. GMT, ArcMap) as well as techniques for checking data quality, handling time series and spatial data, and filling in missing data.

AGRY 545 Remote Sensing Of Land Resources	3	F18	Spatial Analysis Tools	Application of remote sensing and spatial databases for observing and managing land resources within the Earth System; analysis and interpretation of remotely sensed data in combination with field observations and other data sources; conceptualization and design of a global earth resources information system.
AGRY 565 Soils and Landscapes	3	F18	Spatial Analysis Tools	This course has required class trips. Students will pay individual lodging or meal expenses where necessary. The soil as a natural body; its characteristics and processes of formation; the principal soils of Indiana; their adaptations, limitations, productivity, and use; soil survey methods and airphoto interpretation of soil patterns.
AGRY 649 Molecular Microbial Ecology	3	F18	Field/Lab Techniques	Focuses on the application of various molecular genetic techniques for studying micro-organisms from and in the environment. The method, theoretical basis of each method, and interpretation of results are covered. The major areas discussed are the application of molecular genetic techniques to study: (1) total microbial communities; (2) diversity of micro-organisms in a community; and (3) biotechnological uses of micro-organisms. Prerequisite: AGRY 32000 or 58000 or BCHM 56200 or BIOL 24100 or 43800 or 54900.

ASM 540 Geographic Information Systems Application	3	F18	GIS Tools and Application	Fundamentals of GIS analysis applied to environmental, agricultural, and engineering-related problems. Topics include data sources, spatial analysis; projections; creating data and metadata, and conceptualizing and solving spatial problems using GIS.
*CE 457 Air pollution control & design	3	S19	Atmospheric Models	Fundamental concepts and design procedures for the removal of particulates, gases, and toxic air pollutants from waste gas streams. Problem assessment; characterization of exhaust gas streams; fan characteristics.
CE 559 Water quality modeling	3	F17	Chemcial/Biological Modeling	Mathematical modeling of chemical and biological processes occurring in natural aquatic systems. Classical oxygen demand and nutrient processes are modeled, as well as chemical specific transport and fate processes. Emphasis is placed on deterministic models, mass balance approaches, and chemical specific coefficients or parameters.

CE 597 Introduction to Modeling Social-Ecological, Socio-Technical, and Socio-Hyrdological Systems	3	S19		We will explore models on how human and natural systems interact (or social-ecological systems), e.g., resource-harvest models. These will introduce the important concepts of stability, resilience, regime shift (an important phenomenon related to sustainability, in which apparently slow changes can lead to large, rapid consequences), and early warning signals of such regime shifts. Dynamical systems theory will be introduced to gain a mathematical understanding of these concepts. We will also cover game theory—an analysis of human conflicts—at the basic level. Building on this foundation, we will also cover a few simple models of other types of 'coupled' systems, e.g., socio-technical systems and socio-hydrological systems, in which the role of engineered or technical components is more clearly present.
EAPS 523 Radar Meteorology	3	S18	Spatial Analysis Tools	Origin and evolution of radar. Modern weather radar systems and their component parts. Propagation of microwave energy in the atmosphere. Rayleigh and Mie scattering theory, with application to scattering by precipitation. Utilization of radar systems in forecasting quantitative analyses and cloud physics research. Recent refinement and future potential. Prior course work in synoptic meteorology labs and atmospheric physics is required.

EAPS 535 Atmospheric Observations and Measurements	3	F17	Spatial Analysis Tools	A course that introduces students to direct and remotely sensed observations of the atmosphere. Directly measured quantities discussed include temperature, pressure, moisture, wind, solar radiation, chemical properties of the atmosphere, etc. Remote sensing of cloud, precipitation, and air motion by weather radars, satellites, profilers, lidars, and other emerging technologies is reviewed. Students will gain experience in observation techniques and data interpretation, and will learn uncertainty and error assessment.
*ECE 438 Digital Signal Processing with Applications	4	S19	Spatial Analysis Tools	The course is presented in five units. Foundations: the review of continuous-time and discrete-time signals and spectral analysis; design of finite impulse response and infinite impulse response digital filters; processing of random signals. Speech processing; vocal tract models and characteristics of the speech waveform; short-time spectral analysis and synthesis; linear predictive coding. Image processing: two-dimensional signals, systems and spectral analysis; image enhancement; image coding; and image reconstruction. The laboratory experiments are closely coordinated with each unit. Throughout the course, the integration of digital signal processing concepts in a design environment is emphasized.

ECE 538 Digital Signal Processing I	3	F18	Spatial Analysis Tools	Theory and algorithms for processing of deterministic and stochastic signals. Topics include discrete signals, systems, and transforms, linear filtering, fast Fourier transform, nonlinear filtering, spectrum estimation, linear prediction, adaptive filtering, and array signal processing.
ECE 577 Engineering Aspects of Remote Sensing	3	S19	Spatial Analysis Tools	Introduction to the concepts of multispectral image data generation and analysis. Basic principles of optical radiation, reflection, and measurement in natural scenes. Fundamentals of multispectral sensor design and data analysis for complex scenes. Application of signal processing and signal design principles and of statistical pattern recognition to these problems. Spatial image processing methods and algorithms as appropriate to land scene data. Practice with analysis of actual aircraft and spacecraft data in a cross-disciplinary environment.
ECE 641 Digital Signal Processing II	3	F18	Spatial Analysis Tools	An advanced treatment of selected topics in digital image processing. Image models, color, digital video, synthetic aperture radar, magnetic resonance imaging, stack filters, morphological filters, in-verse problems in computational vision, multiscale techniques. Offered every third semester. Prerequisite: ECE 60000, 63700.

*EEE 300 Environmental and Ecological Systems Modeling	3	S19	Computer models	Introduction to computational methods for describign physical, chemical and microbiological processes that occur in natural and engineering aqueous systems, including rivers and lakes, water and wastewater treatment systems.
*FNR 357 Fundamental Remote Sensing	3	F18	Spatial Analysis Tools	Introduction to the principles of remote sensing, aerial photo interpretation, photogrammetry, geographic information systems, and global positioning systems. Primary applications of geospatial science and technology in forestry and natural resources.
FNR 558 Remote Sensing Analysis and Applications	3	S19	Spatial Analysis Tools	Advanced course in the use of digital remote sensing techniques and geographic information systems (GIS) for renewable natural resources management. Emphasizes the physical principles behind the digital remote sensing of vegetative features, present-day instrument technology, spatial data processing and analysis algorithms, error analysis and accuracy assessment procedures, and multi-source data integration. Provides hands-on experience with forest canopy modeling, atmospheric modeling, image processing, and GIS software on microcomputer and workstation platforms.
FNR 650 Individual-Based Modeling and Ecology	3	S17	Computational ecosystems modeling	Individual-based computational modeling and analysis of ecosytesms

FNR 535 Forest Regeneration	3	F18	Applied Analysis	Tools for analysing the regenerating forested ecological systems
HSCI 552: Introduction to Aerosol Science	3	S19	Aerosl Analysis & Sampling Tools (Lab & Field)	This course covers the principles of aerosol behavior and sampling with particular emphasis on applications in the health sciences. Topics include aerosol aerodynamics, particle size distributions, methods of particulate air sampling, operating principles of aerosol instrumentation, pulmonary deposition of aerosols, aerosol lung dosimetry, and environmental aerosol measurements.
ME 597: Innovation and Problem Solving	3	S19		Understanding the objective function, developing problem representation and system modeling based on the objective, developing your own solution approaches or adapting methods from a variety of disciplines integrated in a functional framework on http://opensourcetriz.com/ to reduce problem complexity, solving simplified optimization problems with standard methods, designing experiments, implementation, market and IP strategy.

*Students can have up to 6 credits of 300-400 level courses applied to their plan of study.