

C o u r s e s o n t h e
ENVIRONMENT

*A Student Guide to University of Minnesota
Courses on Environmental Issues on the Twin Cities Campus*



1993 - 1994

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CURA RESOURCE COLLECTION

Center for Urban and Regional Affairs
University of Minnesota
330 Humphrey Center

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GENERAL INFORMATION

Courses on the Environment: A Student Guide to University of Minnesota Courses on Environmental Issues on the Twin Cities Campus, 1993-1994 is a supplemental guide to official bulletins issued by the colleges, schools, and institutes of the University of Minnesota. The guide is designed to help students locate courses which address topics relevant to various issues on the environment. There are 440 courses listed in the 1993-1994 guide, compared to 358 in 1992-1993. They are offered by fifty-one different departments.

The guide is assembled each year by the Center for Urban and Regional Affairs (CURA) at the University of Minnesota. CURA also compiles the *Environmental Events Calendar* which lists departmental seminars and other events such as lectures and discussion groups. It also announces internships, volunteer opportunities, and job postings. It is issued each month during the academic year. To request a copy of the course guide or to be added to the list to receive the environmental calendar, call CURA, 625-1551.

FEATURES OF THE 1993-1994 GUIDE

I. Academic Programs

Formal Interdisciplinary Programs: In Part I formal academic programs which focus on a broad range of environmental issues and use an interdisciplinary approach are listed. These programs are offered by several colleges, schools, and institutes at the University, and generally require a combination of courses from different fields of instruction. Degrees offered are at the bachelor, master, and doctoral levels, while some programs offer minors and concentrations. Information given for each program includes its name and where it is located, the name of a faculty contact person, the number of credits and other requirements, and a brief description.

Other degree programs and academic offerings which cover a broad range of environmental opportunities are also available.

Departmental Programs: Many departments listed in Part III of this guide offer degrees with an environmental studies emphasis within their own fields of instruction. To explore the full extent of degree programs and course offerings in a specific department, consult the appropriate college bulletin.

Student-Designed Majors: There are programs in the College of Liberal Arts and University College in which students can design their own environmental studies major. For information about CLA's special learning opportunities and individualized programs contact the Office for Special Learning Opportunities, 220 Johnston Hall, 624-7577. For information about UC's degree programs contact the Inter-College Program, 107 Armory, 624-2004, or the Program for Individualized Learning, 107 Armory, 624-4020.

U-SEARCH (University Student Environmental Audit Research): U-SEARCH connects students with interested faculty and staff to collaborate on environmental research projects for which academic credit can be earned. Projects can be independent studies, required research for University courses, or specifically designed audit seminars. The goal of the program is to improve environmental stewardship at the University by examining what changes might help to produce environmentally-sound practices for particular resources or particular waste streams. Contact U-SEARCH at the Center for Urban and Regional Affairs, 330 Humphrey Center, 625-6389, for further information or a list of project ideas.

II. Courses Listed by Subject Area

This section is a subject index where courses are arranged by broad subject areas. It is designed to help students find courses of interest in various colleges and departments. This subject area listing will be of special interest to students who wish to pursue an interdisciplinary area of environmental study. While some courses are obviously found in a certain department, it is difficult to be aware of all the courses which pertain to a particular topic because they are offered by so many different departments and are listed in so many different University bulletins.

New Subject Area: A new subject area has been added to the 1993-1994 guide. It is Technology, with thirty-one courses from sixteen departments. There are twenty-three subject areas in total. All 440 courses described in Part III are listed in one or more subject areas in Part II.

III. Courses Listed by Department

Part III lists courses by department and gives the name of a contact person who is prepared to advise students desiring more information. For each course, information is given on the number of credits, prerequisites, availability of registration as a day class or through the Department of Extension Classes, and course description. Part III can serve as a guide to students pursuing an environmental studies emphasis within a given departmental major or minor.

New Departments: Five departments are listed for the first time in this 1993-1994 guide. They are: Chemistry, Forest Products, Horticultural Science, International Relations, and Science in Agriculture.

New Courses and Deleted Courses: One hundred twenty-eight courses have been added to this year's guide. Thirty-one are from the five new departments, and the others are courses that are completely new or are from departments that have revised their course offerings and have changed numbers, titles, and contents of their courses. All these types of courses that are listed for the first time are marked "◆ new" at the beginning of the course description whether they are from a new department or are a new course. Forty-six courses have been dropped because they are no longer offered.

Registration through Day School and/or Extension Classes: Registration for courses at the University of Minnesota is possible through day school and/or Extension Classes, depending on the course. There are three types of courses, and the type for each course is noted at the end of the line giving credit and prerequisites information.

1. **Day class.** A course for which registration is possible only through day school.
- 2a. **Joint Day/Extension class.** A single course for which registration is possible through both day school and Extension Classes. The course usually meets at 3:30 p.m. or later and is listed in both the daytime *Class Schedule* and the *Extension Classes Bulletin*.
- 2b. **Joint Day/Extension class: refer to daytime *Class Schedule*.** A single course for which registration is possible through both day school and Extension Classes. The course usually is offered during the day and is listed in the daytime *Class Schedule* but not in the *Extension Classes Bulletin*.
3. **Extension class.** A course for which registration is possible only through Extension Classes. It usually meets in the evening.

Please note that some courses are offered through *both day school and Extension Classes*. These are two separate courses which meet at two different times. Such courses are noted as "Day class and Extension class."

There are certain requirements and restrictions for students registering for both day school and Extension classes, and it is suggested that students consult with their college offices and/or the Department of Extension Classes.

IV. Centers

Centers at the University of Minnesota that participate in environmentally-related activities are listed in this section. These activities often include research in which interested students and faculty members might become involved. In some cases students may obtain credit for work completed in such activities.

V. Libraries

The libraries section lists University of Minnesota libraries and collections that have material on environmental issues. Other Twin Cities libraries with material on the environment in their collections are also listed.

Course Symbols

- † All courses preceding this symbol must be completed before credit will be granted for any quarter of the sequence.
- § Credit will not be granted if credit has been received for equivalent course listed after this symbol.
- ¶ Concurrent registration is allowed, or required, in the course listed after this symbol.
- # Consent of instructor and a Registration Override Permit is required before registration.
- Δ Registration Override Permit, completed and signed by the department offering the course, is required for registration.
- H Honors course.

We welcome suggestions and comments about the course guide. If some academic programs, departments, courses, centers, or libraries have been missed, we ask that you bring them to our attention.

I. ACADEMIC PROGRAMS

Majors, Minors, and Concentrations for Bachelor's, Master's, and Doctoral Degrees

AGRICULTURE

B.S. with Minor in Sustainable Agriculture

Agronomy and Plant Genetics, College of Agriculture
Donald L. Wyse, 411 Borlaug Hall, 625-7064

Credits: 30 credits

Requirements: For the minor, the following three courses totaling 12 credits are required: Agro 5030—Weed Control, AnPI 5060—Insect Pest Management, Ent 5320—Ecology of Agriculture. The remaining 18 credits must be taken from at least three of the following four areas: 1) pest control; 2) crops, soils, and water; 3) agricultural economics; and 4) integration of agriculture and society.

Description: While all agriculturally-oriented majors of the College of Agriculture consider issues of sustainability of energy and resource-intensive agricultural systems, the sustainable agriculture minor provides a concentration of courses giving students an understanding of scientific, technological, and socioeconomic factors affecting the viability of agriculture. Students examine ecological features of agriculture and work through decision-making case studies involving integrated management of specific agricultural systems. The minor provides a degree of flexibility and individuality through several elective options.

CONSERVATION BIOLOGY

M.S. and Ph.D.

Fisheries and Wildlife, College of Natural Resources
Francie Cuthbert, 320 Hodson Hall, 624-1756

Credits: M.S., 44 credits; Ph.D., 68 credits

Requirements: All master's students must take the core courses and 15 credits of elective courses in the biological and social aspects of conservation biology.

Ph.D. candidates take the core courses and are expected to show competency in both the biological and social sciences. Students develop a program that emphasizes the ecological and social aspects of conservation biology.

Description: The conservation biology program has two complementary aims leading to a unique interdisciplinary program. The first is to provide students with sound graduate training in the biological sciences relevant to the conservation of plants, animals, and ecosystems globally. The second is to expose students to the social, political, and economic sciences that relate to both the recognition and solution of conservation problems. The overall objective of the program is to prepare students to develop solutions or approaches to these problems that are scientifically and environmentally sound and likely to be acted upon or implemented by existing social and political structures.

ECOLOGY, EVOLUTION, AND BEHAVIOR

B.S., M.S. and Ph.D.

College of Biological Sciences
Franklin Barnwell, 100 Ecology, 625-5700

Credits: 180 credits for the B.S. degree

Requirements: For the B.S. degree, in addition to general requirements for graduation from the College of Biological Sciences, there are required and recommended courses in the following groups: community ecology and paleoecology; population and evolutionary biology; organismal biology and physiological ecology; behavioral biology; limnology and ecosystem biology. Field experience in biology (at least 5 credits) at the Lake Itasca Forestry and Biological Station or other field stations is also required.

For the M.S. and Ph.D. degrees, an individual program which will meet the interests and needs of the student is designed.

Description: Ecologists study the evolutionary adaptations of plants and animals to the environment. The ecological perspective encompasses the growth and maintenance of populations and their interactions in communities, and the interrelationships among organisms and physical events in terrestrial and aquatic ecosystems. The behavioral biology perspective deals with adaptation to the environment, mechanisms of behavior, and the evolution of social systems.

ENVIRONMENTAL DESIGN

B.E.D.

Landscape Architecture
College of Architecture and Landscape Architecture
Roger Martin, 110 Architecture Building, 625-6860

Credits: 180 credits

Requirements: The Bachelor of Environmental Design program in the Department of Landscape Architecture requires a broad range of natural science courses such as biology and ecology, along with social science courses such as geography. The design segment requires skills in studio arts and aesthetics.

Description: This preprofessional degree enables students to explore a broad range of ecologically-oriented environmental and design courses, as well as to complete one year of preprofessional coursework in landscape architecture in preparation for graduate-level professional study. It can also offer preparation for careers in planning, design, development, real estate, or historic preservation without the extra time commitment needed to complete a professional degree.

ENVIRONMENTAL HEALTH

M.P.H.

Division of Environmental and Occupation Health
School of Public Health
Ian A. Greaves (Head), Donald Vesley (Major Chair),
Marilyn Zappia (Student Coordinator), Box 807 UMHC, 626-0900

Credits: 45 credits

Requirements: For the **Master of Public Health** degree, the course of instruction requires a minimum of eleven months of study which begins in the fall quarter and continues through the following summer sessions. Specialty areas require a two-year curriculum.

Description: This major is designed for general environmental health students and those wishing to focus in environmental toxicology, environmental chemistry, environmental and occupational epidemiology, environmental microbiology, industrial hygiene (including radiation protection), injury prevention, occupational medicine, and occupational health nursing. A new field of environmental health policy is being developed.

M.S. and Ph.D.

Graduate School
Ian A. Greaves (Head), Jack S. Mandel (Director of Graduate Studies),
Marilyn Zappia (Student Coordinator), Box 807 UMHC, 626-0900

Credits: 44 credits for M.S. degree

Requirements: For the **Master of Science** degree, the course of instruction requires a minimum of eleven months of study which begins in the fall quarter and continues through the following summer sessions. Specialty areas require a two-year curriculum. Candidacy for the Ph.D. program requires completion of the master's degree (or the equivalent) in environmental health.

Description: Emphases include environmental epidemiology, environmental health chemistry, environmental toxicology, general environmental health, hazardous waste management, industrial hygiene, injury prevention and control, institutional environmental health, occupational epidemiology, occupational health nursing, occupational injury prevention and safety, and occupational medicine. A new field of environmental health policy is being developed.

NATURAL RESOURCES AND ENVIRONMENTAL STUDIES

B.S.

College of Natural Resources and College of Agriculture
John V. Bell, 135 Natural Resources Administration Building (NRAB),
624-6768

Credits: 180 credits

Requirements: All students take the core curriculum of required courses plus at least 24 credits in an area of concentration: water resources, soil resources, environmental issues and planning, resources and environmental protection, resource assessment, and waste management.

Description: This program is for students interested in interdisciplinary study of the environment and the use and management of natural resources. The curriculum enables students to become knowledgeable and articulate about natural resource and environmental issues and to be sensitive to the many interrelationships between human and natural systems. Students will gain an appreciation of the important and evolving role of natural resource and environmental management in local, regional, national, and international communities.

Programs can be designed to: 1) gain an understanding of the interaction between natural resources and the functioning of modern society; 2) learn about the significant social and environmental roles that can be played by natural resources located throughout the nation and the world; 3) prepare for careers in public and private organizations that are responsible for planning the use and management of natural resources and protection of the environment; 4) learn about subjects that will prepare for positions in fields such as environmental assessment, resource inventory, natural resource planning, environmental protection, sustainable development, policy analysis, and waste management; 5) develop appropriate background for the pursuit of graduate study.

PUBLIC AFFAIRS

M.A. with Concentration in Technology, Energy, and Environmental Policy

Hubert H. Humphrey Institute of Public Affairs
D.E. Abrahamson, 230 Humphrey Center, 625-2338

Credits: 64 credits

Requirements: For the **Master of Arts** degree, students complete the core curriculum of six courses, at least 18 credits in a primary concentration, 12 credits in a secondary concentration, electives, the Plan B project, and an internship of at least three months.

Description: Courses explore the relation of science and technology to society and the policy process, the role of energy in contemporary societies, natural and physical environmental systems, and environmental aspects of technological innovation.

The M.A. degree offers broad-based education for careers and lives in the public interest. The curriculum recognizes that graduates will work in government, business, and the independent sector in leadership, management, analytical, and advocacy capacities.

M.P. with Concentration in Technology, Energy, and Environmental Policy

Hubert H. Humphrey Institute of Public Affairs
D.E. Abrahamson, 230 Humphrey Center, 625-2338

Credits: 64 credits

Requirements: For the **Master of Planning** degree, students complete the core curriculum of six courses, at least 18 credits in a single area of concentration, planning courses (in place of a secondary concentration), electives, the Plan B project, and an internship of at least three months.

Description: Courses explore the relation of science and technology to society and the policy process, the role of energy in contemporary societies, natural and physical environmental systems, and environmental aspects of technological innovation.

The M.P. program emphasizes training in the basic philosophy, theory, and methods of planning. Five important types of planning are covered: 1) policy planning, 2) resource allocation planning, 3) regulatory planning, 4) implementation or program planning, and 5) project management or operations planning.

WATER RESOURCES

Minor for M.S. or Ph.D.

Graduate School
Water Resources Minor, c/o Water Resources Research Center
Patrick L. Brezonik, Suite 302, 1518 Cleveland Ave., St. Paul Campus,
624-9282 or 625-0866

Credits: M.S., 13 credits; Ph.D., 21 credits

Requirements: An introductory seminar on water resources management (2 credits), two core courses (6-9 credits), and elective courses are required. At least 11 credits must be selected from one of these four categories for the master's and two for the doctoral degree: 1) biological sciences, 2) earth and climate sciences, 3) engineering, and 4) social sciences.

Description: This is an interdisciplinary structured program with faculty drawn from the colleges of Agriculture, Biological Sciences, Liberal Arts, Natural Resources, Humphrey Institute of Public Affairs, and the Institute of Technology.

WILDLIFE CONSERVATION

M.S., Ph.D., and Minor

Fisheries and Wildlife, College of Natural Resources
Francie Cuthbert, 320 Hodson Hall, 624-1756

Requirements: Plan A is recommended for the master's degree; Plan B is available under special circumstances. Students must become familiar with factors underlying wildlife population and habitat ecology, techniques in management, and the functioning of management agencies. Academic work includes courses in animal ecology, wildlife management, and statistics.

For the doctoral degree, programs include basic wildlife biology and development of analytical skills, and one or more areas of specialization.

A graduate minor is available for students majoring in other fields. Programs are designed according to individual student needs while insuring a comprehensive exposure to wildlife ecology and management.

Description: The wildlife conservation graduate program is an applied program emphasizing resource management and conservation problem-solving. For the M.S. degree, emphasis is on wildlife biology and related areas in ecology, animal behavior, and physiology as these relate to resource management and conservation problem-solving. For many students, the M.S. is a terminal degree leading to employment with government resource management agencies. For the Ph.D. program, emphasis is on basic biology and ecology with concentrated work in independent, original research generally relating basic science to management/conservation challenges.

II. COURSES LISTED BY SUBJECT AREA

AGRICULTURE

Agricultural and Applied Economic

- AgEc 5710. U.S. AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.
AgEc 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.

Agricultural Engineering

- AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.
AgEn 5560. MECHANICS OF FLOW IN THE UNSATURATED ZONE.

Agricultural Engineering Technology

- AgET 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Agronomy and Plant Genetics

- Agro 5030. WEED CONTROL.

Animal and Plant Systems

- AnPl 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.
AnPl 5060. INTEGRATED MANAGEMENT OF CROPPING SYSTEMS.

Entomology

- Ent 1005. ECONOMIC ENTOMOLOGY.
Ent 5210. INSECT PEST MANAGEMENT.
Ent 5280. LIVESTOCK ENTOMOLOGY.
Ent 5320. ECOLOGY OF AGRICULTURE.

Environmental and Occupational Health

- PubH 5214. AGRICULTURAL HEALTH AND SAFETY.

Horticultural Science

- Hort 5001. HARVEST TO MARKET OF HORTICULTURAL CROPS.
Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE.
Hort 8023. EVOLUTION OF CROP PLANTS.

Plant Pathology

- PIPa 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES.
PIPa 5201. BIOLOGY OF PLANT DISEASES.

Rhetoric

- Rhet 3375. HUMANITIES: AGRICULTURAL HERITAGE.

CLIMATOLOGY AND METEOROLOGY

Ecology, Evolution, and Behavior

- EEB 1019. OUR CHANGING PLANET.

Forest Resources

- FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.

General College

- GC 1111. SCIENCE IN CONTEXT: WEATHER AND CLIMATE.

Geography

- Geog 1425. INTRODUCTION TO METEOROLOGY.
Geog 3421. CLIMATOLOGY.
Geog 5424. APPLIED CLIMATOLOGY.
Geog 5441. QUATERNARY LANDSCAPE EVOLUTION.
Geog 8420. SEMINAR: CLIMATOLOGY.

Geology and Geophysics

- Geo 1019. OUR CHANGING PLANET.
Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE.

Physics

- Phys 5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE.

Plant Pathology

- PIPa 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Soil Science

- Soil 1262. INTRODUCTION TO METEOROLOGY.
- Soil 5240. MICROCLIMATOLOGY (SOILS).
- Soil 5424. APPLIED CLIMATOLOGY.

CULTURE, SOCIETY, AND ENVIRONMENTAL PROBLEMS

Anthropology

- Anth 5116. ECOLOGICAL ANTHROPOLOGY.
- Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.
- Anth 5176. ENVIRONMENTAL ARCHAEOLOGY.
- Anth 5960. SENIOR SEMINAR: HUMAN/ENVIRONMENT INTERACTIONS.

Architecture

- Arch 1401. THE DESIGNED ENVIRONMENT.
- Arch 3060. TECHNOS: FORCE, FORM AND ARCHITECTURE.
- Arch 3413. HISTORY OF LANDSCAPE ARCHITECTURE.
- Arch 5137. PLANNING: URBAN FUNCTION AND STRUCTURE.

Civil Engineering

- CE 5003. EARTH-SHELTERED BUILDING DESIGN.

Cultural Studies and Comparative Literature

- ÇsCl 3366. LANDSCAPE AND IDEOLOGY, 1600-1875.

Design

- Dsgn 3631. INTERIOR DESIGN RESOURCES AND MATERIALS.
- Dsgn 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES.

Design, Housing and Apparel

- DHA 1101. INTRODUCTION TO THE DESIGNED ENVIRONMENT.

General College

- GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

History of Science and Technology

- HSci 3331/5331. TECHNOLOGY IN AMERICAN CULTURE.

Housing

- Hsg 3463. ENVIRONMENT: HOUSING AND COMMUNITY.
- Hsg 5482. THE FAMILY AND ENERGY ISSUES.

Landscape Architecture

- LA 1401. THE DESIGNED ENVIRONMENT.
- LA 3413. HISTORY OF LANDSCAPE ARCHITECTURE.
- LA 5431. HISTORY OF LANDSCAPE ARCHITECTURE: INDIVIDUAL INFLUENCES.
- LA 8803. THE SUBLIME, THE BEAUTIFUL AND THE PICTURESQUE: THEORY AND PRACTICE.

Natural Resources and Environmental Studies

- NRES 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
- NRES 3800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION.

Plant Pathology

- PIPa 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICRO-ORGANISMS ON PLANTS AND HUMAN SOCIETY.
- PIPa 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Political Science

- Pol 5410. ADVANCED TOPICS IN GOVERNMENT AND POLITICS: POLITICS OF ENVIRONMENTAL MOVEMENTS.

Rhetoric

- Rhet 1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE.
- Rhet 3375. HUMANITIES: AGRICULTURAL HERITAGE.

Sociology

- Soc 3551. WORLD POPULATION PROBLEMS.
- Soc 3960. ENVIRONMENTAL SOCIOLOGY.

Strategic Management and Organization

- MBA 8055. BUSINESS, GOVERNMENT, AND MACROECONOMICS.
- MBA 8202. EXTERNAL AFFAIRS MANAGEMENT.

EARTH SCIENCES

Ecology, Evolution, and Behavior

EEB 1019. OUR CHANGING PLANET.

General College

GC 1171. PHYSICAL GEOLOGY.

GC 1173. GEOLOGY OF THE NATIONAL PARKS.

Geography

Geog 1401. PHYSICAL GEOGRAPHY.

Geog 5441. QUATERNARY LANDSCAPE EVOLUTION.

Geology and Geophysics

Geo 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY.

Geo 1012. PLANET EARTH.

Geo 1019. OUR CHANGING PLANET.

Geo 1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA.

Geo 1111. INTRODUCTORY PHYSICAL GEOLOGY.

Geo 1601. OCEANOGRAPHY.

Geo 3401. INTRODUCTORY MINERALOGY.

Geo 5004. MINERALOGY.

Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY.

Geo 5201. STRUCTURAL GEOLOGY.

Geo 5251. GEOMORPHOLOGY.

Geo 5261. GLACIAL GEOLOGY.

Geo 5311. GENERAL GEOCHEMISTRY.

Geo 5313. AQUEOUS GEOCHEMISTRY.

Geo 5641. GENERAL AND PHYSICAL HYDROGEOLOGY.

Geo 8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA.

ECOLOGY

Animal and Plant Systems

AnPI 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.

Anthropology

Anth 5116. ECOLOGICAL ANTHROPOLOGY.

Biochemistry

BioC 5301. ECOLOGICAL BIOCHEMISTRY.

Biology

Biol 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES.

Biol 5041. ECOLOGY.

Biol 5841. ECOLOGY.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: CONSERVATION BIOLOGY.

Conservation Biology

CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior

EEB 3001. INTRODUCTION TO ECOLOGY.

EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS.

EEB 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE.

EEB 5008. QUATERNARY ECOLOGY.

EEB 5014. ECOLOGY OF PLANT COMMUNITIES.

EEB 5016. ECOLOGICAL PLANT GEOGRAPHY.

EEB 5033. POPULATION AND QUANTITATIVE GENETICS.

EEB 5606. ECOLOGY OF FISHES.

EEB 5607. ECOLOGY OF ANIMAL PLANKTON.

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.

EEB 5814. PLANT COMMUNITY ECOLOGY.

EEB 5817. VERTEBRATE ECOLOGY.

Entomology

Ent 5040. INSECT ECOLOGY.

Ent 5250. FOREST ENTOMOLOGY.

Ent 5320. ECOLOGY OF AGRICULTURE.

Ent 8240. COLLOQUIUM IN INSECT ECOLOGY.

Fisheries and Wildlife

FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.

FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS.

ENERGY USE

- FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.
FW 8448. FISHERY SCIENCE.
FW 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.
FW 8459. STREAM AND RIVER ECOLOGY.
FW 8576. WILDLIFE MANAGEMENT: LARGE MAMMALS.
FW 8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH.

Forest Resources

- FR 3101. NORTHERN FOREST ECOSYSTEMS.
FR 3104. FOREST ECOLOGY.
FR 3107. FOREST ECOLOGY LABORATORY.
FR 5104. FOREST ECOLOGY.
FR 5142. TROPICAL FOREST ECOLOGY.
FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
FR 5215. FOREST FIRE MANAGEMENT.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
FR 8104. RESEARCH PROBLEMS: FOREST ECOLOGY.
FR 8105. ADVANCED FIELD SILVICULTURE.

General College

- GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

Geography

- Geog 5441. QUATERNARY LANDSCAPE EVOLUTION.

Geology

- Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY.

Horticultural Science

- Hort 1021. WOODY PLANT MATERIALS.
Hort 1022. HERBACEOUS PLANT MATERIALS.
Hort 5042. TURF GRASS SCIENCE.

International Relations

- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT.

Landscape Architecture

- LA 5212. ECOLOGICAL INFORMANTS OF DESIGN.
LA 5222. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION OF PLANTING DESIGNS.
LA 8223. REGIONAL LANDSCAPE DESIGN.
LA 8804. LANDSCAPE ECOLOGY AND DESIGN.

Microbiology

- MicB 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies

- NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.

Plant Biology

- PBio 3201. INTRODUCTORY PLANT SYSTEMATICS.

Plant Pathology

- PIPa 5102. ECOLOGY OF FUNGI.
PIPa 5206. BIOLOGY OF FUNGI.

Soil Science

- Soil 5605. MICROBIAL ECOLOGY.

ENERGY USE

Anthropology

- Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Architecture

- Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.
Arch 5535. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY.
Arch 5957. CLIMATE AND ARCHITECTURE.
Arch 5966. BUILDING ENERGY SYSTEMS.

Civil Engineering

- CE 5003. EARTH-SHELTERED BUILDING DESIGN.
CE 5004. UNDERGROUND CONSTRUCTION ENGINEERING.
CE 5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION.

Design

Dsgn 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES.

Geology and Geophysics

Geo 1005. GEOLOGIC PERSPECTIVES ON ENERGY.

Housing

Hsg 1401. RESIDENTIAL TECHNOLOGY.

Hsg 5482. THE FAMILY AND ENERGY ISSUES.

Mechanical Engineering

ME 5603. THERMAL ENVIRONMENTAL ENGINEERING.

ME 5604. HEATING AND COOLING LOADS IN BUILDINGS.

ME 5605. REFRIGERATION AND AIR CONDITIONING SYSTEMS.

ME 5630. THERMAL ENVIRONMENTAL ENGINEERING SENIOR LABORATORY.

ME 5712. SOLAR ENERGY UTILIZATION.

ME 8600. PSYCHROMETRICS AND AIR CONDITIONING.

Natural Resources and Environmental Studies

NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

Public Affairs

PA 5711. ENERGY POLICY I.

PA 5712. ENERGY POLICY II.

PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY.

PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Soil Science

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

Strategic Management and Organization

BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

ENVIRONMENTAL HEALTH AND POLLUTION CONTROL

Aerospace Engineering and Mechanics

AEM 5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE.

Architecture

Arch 5535. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY.

Biochemistry

BioC 5301. ECOLOGICAL BIOCHEMISTRY.

Civil Engineering

CE5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.

CE 5506. ENVIRONMENTAL WATER CHEMISTRY.

CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.

CE 5515. WATER AND WASTEWATER MICROBIOLOGY.

CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.

CE 8507. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS.

CE 8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS.

CE 8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING.

Communication Disorders

CDis 5704. NOISE AND MAN.

Environmental and Occupational Health

PubH 5150-1. TOPICS IN ENVIRONMENTAL HEALTH: PRINCIPLES OF ENVIRONMENTAL HEALTH LAW.

PubH 5150-2. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: OCCUPATIONAL HEALTH LAW.

PubH 5150-3. TOPICS IN ENVIRONMENTAL HEALTH: POLLUTION CONTROL LAW.

PubH 5150-4. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: CONSUMER PRODUCTS LAW.

PubH 5151. ENVIRONMENTAL HEALTH.

PubH 5152. ENVIRONMENTAL HEALTH.

FISH AND WILDLIFE

- PubH 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH.
- PubH 5158. HEALTH RISK EVALUATION.
- PubH 5171. ENVIRONMENTAL MICROBIOLOGY.
- PubH 5181. AIR POLLUTION.
- PubH 5184. AIR ANALYSIS.
- PubH 5185. FIELD INSTRUMENTATION.
- PubH 5186. ENVIRONMENTAL CHEMISTRY.
- PubH 5201. RADIATION PROTECTION AND MEASUREMENT.
- PubH 5202. RADIATION LABORATORY.
- PubH 5210. INTRODUCTION TO INDUSTRIAL HYGIENE.
- PubH 5211. SURVEY OF INDUSTRIAL HYGIENE.
- PubH 5212. VENTILATION CONTROL OF ENVIRONMENTAL HAZARDS.
- PubH 5214. AGRICULTURAL HEALTH AND SAFETY.
- PubH 5215. APPLIED OCCUPATIONAL TOXICOLOGY.
- PubH 5216. PROPERTIES OF WORKPLACE AIRBORNE CONTAMINANTS.
- PubH 5220. VENTILATION CONTROL OF OCCUPATIONAL HAZARDS.
- PubH 5239. MICROBIOLOGY OF THE HUMAN ENVIRONMENT: SEMINAR.
- PubH 5253. INTRODUCTION: HAZARDOUS WASTE MANAGEMENT.
- PubH 5261. GENERAL ENVIRONMENTAL TOXICOLOGY.
- PubH 5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS.
- PubH 5266. INTRODUCTION TO HEALTH RISK ASSESSMENT.
- PubH 5267. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY.
- PubH 8185. ANALYSIS OF TOXICANTS.
- PubH 8261. MOLECULAR TOXICOLOGY.
- PubH 8264. HUMAN DISEASES CAUSED BY ENVIRONMENTAL AGENTS.
- PubH 8269. TOXICOLOGY SEMINAR.

Fisheries and Wildlife

- FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS.

Forest Resources

- FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.

Interdepartmental Study

- ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Law School

- Law 5885. ADVANCED ENVIRONMENTAL LAW.

Mechanical Engineering

- ME 5603. THERMAL ENVIRONMENTAL ENGINEERING.
- ME 5609. AIR POLLUTION.
- ME 5610. AIR POLLUTION CONTROL.
- ME 5616. AEROSOL MEASUREMENT.
- ME 5617. ADVANCED AEROSOL MEASUREMENT.
- ME 5620. CLEAN ROOM TECHNOLOGY AND PARTICLE MONITORING.
- ME 8600. PSYCHROMETRICS AND AIR CONDITIONING.
- ME 8613. FUNDAMENTALS OF AEROSOL BEHAVIOR.

Plant Pathology

- PIPa 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Sociology

- Soc 3960. ENVIRONMENTAL SOCIOLOGY.

Strategic Management and Organization

- BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

FISH AND WILDLIFE

Ecology, Evolution, and Behavior

- EEB 5136. ICHTHYOLOGY.
- EEB 5606. ECOLOGY OF FISHES.
- EEB 5817. VERTEBRATE ECOLOGY.
- EEB 5834. FIELD ORNITHOLOGY.

Fisheries and Wildlife

- FW 1001. ORIENTATION IN FISHERIES AND WILDLIFE.
- FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.
- FW 1101. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
- FW 3052. INTRODUCTION TO FISHERIES AND WILDLIFE.
- FW 5129. MAMMALOLOGY.
- FW 5455. AQUACULTURE.
- FW 5459. PHYSIOLOGY AND BEHAVIOR OF FISH.
- FW 5461. THE BEHAVIOR OF FISHES.

- FW 5570. AVIAN CONSERVATION AND MANAGEMENT.
- FW 5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS.
- FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS.
- FW 5604. FISHERY AND WILDLIFE MANAGEMENT.
- FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.
- FW 8448. FISHERY SCIENCE.
- FW 8460. FISH HABITATS AND RESTORATION.
- FW 8576. WILDLIFE MANAGEMENT: LARGE MAMMALS.
- FW 8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH.

Forest Resources

- FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
- FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.

General College

- GC 1133. NATURE STUDY.

FOREST RESOURCES

Entomology

- Ent 5250. FOREST ENTOMOLOGY.

Forest Resources

- FR 1001. FOREST RESOURCES ORIENTATION.
- FR 1100. DENDROLOGY.
- FR 1200. INTRODUCTION TO FOREST RESOURCES.
- FR 1202. FARM AND SMALL WOODLANDS FORESTRY.
- FR 3100. IMPORTANT FOREST PLANTS.
- FR 3101. NORTHERN FOREST ECOSYSTEMS.
- FR 3104. FOREST ECOLOGY.
- FR 3107. FOREST ECOLOGY LABORATORY.
- FR 3110. COLLOQUIUM IN NATURAL RESOURCES.
- FR 3201. FIELD FOREST MEASUREMENTS.
- FR 3225/5225. DIRECTED STUDY EXPERIENCE.
- FR 5100. SILVICULTURE.

- FR 5101. FIELD SILVICULTURE.
- FR 5102. FOREST WILDLIFE HABITAT MANAGEMENT.
- FR 5104. FOREST ECOLOGY.
- FR 5106. SENIOR SILVICULTURE SEMINAR.
- FR 5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS.
- FR 5114. FOREST HYDROLOGY.
- FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
- FR 5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS.
- FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
- FR 5142. TROPICAL FOREST ECOLOGY.
- FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
- FR 5152. FOREST GENETICS.
- FR 5153. ADVANCED FOREST HYDROLOGY.
- FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
- FR 5200. AERIAL PHOTO INTERPRETATION.
- FR 5202. REMOTE SENSING: FIELD APPLICATIONS.
- FR 5212. NATURAL RESOURCES INVENTORY.
- FR 5215. FOREST FIRE MANAGEMENT.
- FR 5222. FOREST RESOURCES INVENTORY.
- FR 5226. FOREST ECONOMICS AND PLANNING.
- FR 5236. FOREST RECREATION PLANNING.
- FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
- FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
- FR 5248. HARVESTING AND ENGINEERING.
- FR 5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT.
- FR 5401. SENIOR TOPICS.
- FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
- FR 5500. URBAN FOREST MANAGEMENT.
- FR 5703. COLLOQUIUM IN NATURAL RESOURCES.
- FR 8100. RESEARCH PROBLEMS: SILVICULTURE.
- FR 8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY.
- FR 8102. RESEARCH PROBLEMS: FOREST TREE GENETICS.
- FR 8103. RESEARCH PROBLEMS: FOREST HYDROLOGY.
- FR 8104. RESEARCH PROBLEMS: FOREST ECOLOGY.
- FR 8105. ADVANCED FIELD SILVICULTURE.
- FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS.

INTERNATIONAL ISSUES/WORLD RESOURCES

- FR 8108. FOUNDATIONS OF RENEWABLE RESOURCES RESEARCH.
- FR 8200. RESEARCH PROBLEMS: FOREST MANAGEMENT.
- FR 8201. RESEARCH PROBLEMS: FOREST ECONOMICS.
- FR 8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS.
- FR 8203. RESEARCH PROBLEMS: FOREST RECREATION.
- FR 8204. RESEARCH PROBLEMS: FOREST POLICY.
- FR 8205. RESEARCH PROBLEMS: REMOTE SENSING.
- FR 8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS.
- FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

Plant Pathology

- PIPa 5212. DISEASES OF FOREST AND SHADE TREES.

Soil Science

- Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

INTERNATIONAL ISSUES/WORLD RESOURCES

Agricultural and Applied Economics

- AgEc 5710. U.S. AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.
- AgEc 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.

Agricultural Engineering Technology

- AgET 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Animal and Plant Systems

- AnPI 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.

Anthropology

- Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Ecology, Evolution, and Behavior

- EEB 5016. ECOLOGICAL PLANT GEOGRAPHY.
- EEB 5129. MAMMALOLOGY.

Fisheries and Wildlife

- FW 5129. MAMMALOLOGY.
- FW 5455. AQUACULTURE.

Forest Resources

- FR 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
- FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
- FR 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
- FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
- FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

General College

- GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

Geography

- Geog 3421. CLIMATOLOGY.
- Geog 3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY.

Geology and Geophysics

- Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY.
- Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE.

Horticultural Science

- Hort 5032. TREE FRUIT PRODUCTION.
- Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE.

Interdepartmental Study

- ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

International Relations

- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: ENVIRONMENT AND DEVELOPMENT IN THE THIRD WORLD.
- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT.

Natural Resources and Environmental Studies

- NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.

Plant Biology

PBio 3201. INTRODUCTORY PLANT SYSTEMATICS.

Plant Pathology

PIPa 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Political Science

Pol 3872. INTERNATIONAL ORGANIZATIONS AND THE ENVIRONMENT.

Pol 5410. ADVANCED TOPICS IN GOVERNMENT AND POLITICS: POLITICS OF ENVIRONMENTAL MOVEMENTS.

Public Affairs

PA 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.

Sociology

Soc 3551. WORLD POPULATION PROBLEMS.

Soc 3960. ENVIRONMENTAL SOCIOLOGY.

Soil Science

Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

LAKE ITASCA FORESTRY AND BIOLOGICAL STATION**Biology**

Biol 5841. ECOLOGY.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: CONSERVATION BIOLOGY.

Ecology, Evolution, and Behavior

EEB 5814. PLANT COMMUNITY ECOLOGY.

EEB 5817. VERTEBRATE ECOLOGY.

EEB 5834. FIELD ORNITHOLOGY.

Entomology

Ent 5600. FIELD ENTOMOLOGY.

Ent 5610. AQUATIC ENTOMOLOGY.

Forest Resources

FR 3100. IMPORTANT FOREST PLANTS.

FR 3101. NORTHERN FOREST ECOSYSTEMS.

FR 3106. IMPORTANT PLANTS: FISHERIES & WILDLIFE HABITATS.

FR 3201. FIELD FOREST MEASUREMENTS.

FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.

LAKES AND WETLANDS**Civil Engineering**

CE 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS.

CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior

EEB 5601. LIMNOLOGY.

EEB 5607. ECOLOGY OF ANIMAL PLANKTON.

EEB 5621. LIMNOLOGY LABORATORY.

Geology and Geophysics

Geo 5601. LIMNOLOGY.

Geo 8602. ADVANCED LIMNOLOGY.

Plant Biology

PBio 5231. INTRODUCTION TO THE ALGAE.

Soil Science

Soil 5555. WETLAND SOILS.

LAND USE**Agricultural and Applied Economics**

AgEc 5600. LAND ECONOMICS.

AgEc 8360. LAND ECONOMICS AND POLICY.

Architecture

Arch 1401. THE DESIGNED ENVIRONMENT.

Arch 5137. PLANNING: URBAN FUNCTION AND STRUCTURE.

Biology

Biol 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.

LIFE SCIENCES

Forest Resources

- FR 5257. RECREATION LAND POLICY.
- FR 5262. REMOTE SENSING OF NATURAL RESOURCES.

Geography

- Geog 3361. LAND USE AND THE FEDERAL GOVERNMENT.
- Geog 3362. LAND USE AND STATE GOVERNMENT.
- Geog 5361. LAND IN AMERICA.
- Geog 5601. INTRODUCTION TO LAND USE PLANNING.
- Geog 8340. SEMINAR: LAND USE PLANNING.
- Geog 8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.
- Geog 8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.

Horticultural Science

- Hort 5026. LANDSCAPE MANAGEMENT.

Landscape Architecture

- LA 1401. THE DESIGNED ENVIRONMENT.
- LA 5211. MAKING LANDSCAPE SPACE.
- LA 5212. ECOLOGICAL INFORMANTS OF DESIGN.
- LA 5222. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION OF PLANTING DESIGNS.
- LA 5571. LANDSCAPE CONSTRUCTION: LANDFORM SYSTEMS.
- LA 5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE.
- LA 8222. THE LANDSCAPE ARCHITECTURAL DESIGN OF COMMUNITY PLACES.
- LA 8223. REGIONAL LANDSCAPE DESIGN.
- LA 8231. URBAN DESIGN LANDSCAPE.
- LA 8232. DESIGN OF RECREATIONAL LANDSCAPES.
- LA 8801. CONCEPTS OF LANDSCAPE EVALUATION.
- LA 8804. LANDSCAPE ECOLOGY AND DESIGN.

Public Affairs

- PA 5601. LAND USE.
- PA 5622. MANAGING URBAN GROWTH AND CHANGE.
- PA 5693. TOPICS IN ENVIRONMENTAL PLANNING.
- PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS.

Recreation, Park, and Leisure Studies

- Rec 5160. RECREATION LAND POLICY.

Rhetoric

- Rhet 1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE.

Soil Science

- Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.

LIFE SCIENCES

Biology

- Biol 5041. ECOLOGY.
- Biol 5841. ECOLOGY.
- Biol 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.
- Biol 5850. SPECIAL TOPICS IN BIOLOGY: CONSERVATION BIOLOGY.

Chemistry

- Chem 1003. PHYSICAL WORLD, CHEMISTRY.
- Chem 1008. PHYSICAL WORLD, CHEMISTRY.

Conservation Biology

- CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior

- EEB 3001. INTRODUCTION TO ECOLOGY.
- EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS.
- EEB 5033. POPULATION AND QUANTITATIVE GENETICS.
- EEB 5051. ANALYSIS OF POPULATIONS.
- EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.

Entomology

- Ent 5040. INSECT ECOLOGY.
- Ent 5320. ECOLOGY OF AGRICULTURE.

Fisheries and Wildlife

- FW 5129. MAMMALOGY.
- FW 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.
- FW 8576. WILDLIFE MANAGEMENT: LARGE MAMMALS.

Forest Resources

FR 5221. PLANT MOLECULAR EVOLUTION.

Microbiology

MicB 3103. GENERAL MICROBIOLOGY.

MicB 5352. APPLIED MICROBIOLOGY.

MicB 5611. MICROBIAL ECOLOGY.

Soil Science

Soil 5605. MICROBIAL ECOLOGY.

NATURALIST STUDIES

Biology

Biol 1103. GENERAL BOTANY.

Biol 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES.

Biol 3012. PLANT BIOLOGY.

Biol 5841. ECOLOGY.

Chemistry

Chem 1003. PHYSICAL WORLD, CHEMISTRY.

Chem 1008. PHYSICAL WORLD, CHEMISTRY.

Conservation Biology

CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior

EEB 5008. QUATERNARY ECOLOGY.

EEB 5014. ECOLOGY OF PLANT COMMUNITIES.

EEB 5016. ECOLOGICAL PLANT GEOGRAPHY.

EEB 5033. POPULATION AND QUANTITATIVE GENETICS.

EEB 5122. PLANT/ANIMAL INTERACTIONS.

EEB 5129. MAMMALOLOGY.

EEB 5134. INTRODUCTION TO ORNITHOLOGY.

EEB 5814. PLANT COMMUNITY ECOLOGY.

Entomology

Ent 3005. INTRODUCTORY ENTOMOLOGY.

Ent 5600. FIELD ENTOMOLOGY.

Fisheries and Wildlife

FW 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Forest Resources

FR 3100. IMPORTANT FOREST PLANTS.

FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.

FR 5102. FOREST WILDLIFE HABITAT MANAGEMENT.

FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.

FR 5152. FOREST GENETICS.

FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.

FR 5221. PLANT MOLECULAR EVOLUTION.

FR 5703. COLLOQUIUM IN NATURAL RESOURCES.

General College

GC 1133. NATURE STUDY.

Geography

Geog 3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY.

Geog 5441. QUATERNARY LANDSCAPE EVOLUTION.

Horticultural Science

Hort 1010. HOME HORTICULTURE.

Hort 1021. WOODY PLANT MATERIALS.

Hort 1022. HERBACEOUS PLANT MATERIALS.

Hort 1023. INDOOR PLANTS AND LANDSCAPES.

Hort 1036. PLANT PROPAGATION.

Hort 3001. GROWTH REGULATION OF HORTICULTURAL PLANTS.

Hort 3002. HORTICULTURAL CROPPING SYSTEMS.

Hort 3003. PLANT GENETICS AND IMPROVEMENT.

Hort 3004. APPLICATIONS OF PLANT BIOTECHNOLOGY.

Hort 3030. LANDSCAPE DESIGN OF RESIDENTIAL AND SMALL COMMERCIAL SITES.

Hort 3040. LANDSCAPE DESIGN AND IMPLEMENTATION.

Hort 3072. TURF MANAGEMENT.

Hort 5001. HARVEST TO MARKET OF HORTICULTURAL CROPS.

Hort 5026. LANDSCAPE MANAGEMENT.

Hort 5032. TREE FRUIT PRODUCTION.

Hort 5033. SMALL FRUIT PRODUCTION.

PEST AND DISEASE CONTROL

- Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE.
- Hort 5040. PLANT GROWTH REGULATION.
- Hort 5042. TURF GRASS SCIENCE.
- Hort 5046. NURSERY MANAGEMENT I.
- Hort 5047. NURSERY SCHEDULING AND ENTERPRISE DEVELOPMENT.
- Hort 5048. NURSERY MANAGEMENT II.
- Hort 5054. COMMERCIAL FLORICULTURE PRODUCTION PRACTICES.
- Hort 5055. COMMERCIAL FLORICULTURE PRODUCTION SYSTEMS.
- Hort 8023. EVOLUTION OF CROP PLANTS.

Plant Biology

- PBio 1009. MINNESOTA PLANT LIFE.
- PBio 3131. SURVEY OF PLANT PHYSIOLOGY.
- PBio 3201. INTRODUCTORY PLANT SYSTEMATICS.

Plant Pathology

- PIPa 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICRO-ORGANISMS ON PLANTS AND HUMAN SOCIETY.
- PIPa 1002. PLANT DISEASES AND YOUR GARDEN.
- PIPa 1003. DISEASES OF TREES AND TURFGRASS.
- PIPa 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES.
- PIPa 3002. MANAGEMENT OF HORTICULTURAL CROP DISEASES.
- PIPa 5102. ECOLOGY OF FUNGI.
- PIPa 5200. POISONOUS PLANTS.
- PIPa 5201. BIOLOGY OF PLANT DISEASES.
- PIPa 5206. BIOLOGY OF FUNGI.
- PIPa 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE.

Soil Science

- Soil 5610. SOIL BIOLOGY.

PEST AND DISEASE CONTROL

Agronomy and Plant Genetics

- Agro 5030. WEED CONTROL.

Entomology

- Ent 1005. ECONOMIC ENTOMOLOGY.
- Ent 5210. INSECT PEST MANAGEMENT.

- Ent 5250. FOREST ENTOMOLOGY.
- Ent 5280. LIVESTOCK ENTOMOLOGY.
- Ent 5610. AQUATIC ENTOMOLOGY.
- Ent 8240. COLLOQUIUM IN INSECT ECOLOGY.

Horticultural Science

- Hort 5032. TREE FRUIT PRODUCTION.
- Hort 5033. SMALL FRUIT PRODUCTION.
- Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE.
- Hort 5048. NURSERY MANAGEMENT II.

Plant Pathology

- PIPa 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICRO-ORGANISMS ON PLANTS AND HUMAN SOCIETY.
- PIPa 1002. PLANT DISEASES AND YOUR GARDEN.
- PIPa 1003. DISEASES OF TREES AND TURFGRASS.
- PIPa 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES.
- PIPa 3002. MANAGEMENT OF HORTICULTURAL CROP DISEASES.
- PIPa 5201. BIOLOGY OF PLANT DISEASES.
- PIPa 5212. DISEASES OF FOREST AND SHADE TREES.
- PIPa 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE.

PUBLIC POLICY

Agricultural and Applied Economics

- AgEc 5650. ECONOMICS FOR NATURAL RESOURCE POLICY.
- AgEc 5710. U.S. AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.
- AgEc 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.

Agricultural Engineering Technology

- AgET 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Biology

- Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH.
- Biol 5951. SOCIAL USES OF BIOLOGY.

Environmental and Occupational Health

- PubH 5150-1. TOPICS IN ENVIRONMENTAL HEALTH: PRINCIPLES OF ENVIRONMENTAL HEALTH LAW.
- PubH 5150-2. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: OCCUPATIONAL HEALTH LAW.
- PubH 5150-3. TOPICS IN ENVIRONMENTAL HEALTH: POLLUTION CONTROL LAW.
- PubH 5150-4. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: CONSUMER PRODUCTS LAW.
- PubH 5165. THE POLITICAL PROCESS IN PUBLIC HEALTH.
- PubH 5215. APPLIED OCCUPATIONAL TOXICOLOGY.
- PubH 5266. INTRODUCTION TO HEALTH RISK ASSESSMENT.

Forest Resources

- FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
- FR 5257. RECREATION LAND POLICY.

Geography

- Geog 5601. INTRODUCTION TO LAND USE PLANNING.

Horticultural Science

- Hort 5048. NURSERY MANAGEMENT II.

Interdepartmental Study

- ID 3970. DIRECTED STUDIES.
- ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

International Relations

- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: ENVIRONMENT AND DEVELOPMENT IN THE THIRD WORLD.
- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT.

Journalism and Mass Communication

- Jour 5133. INTERPRETIVE REPORTING ABOUT SCIENCE.

Landscape Architecture

- LA 5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE.
- LA 8223. REGIONAL LANDSCAPE DESIGN.

Law School

- Law 5215. ENVIRONMENTAL LAW.
- Law 5885. ADVANCED ENVIRONMENTAL LAW.

Natural Resources and Environmental Studies

- NRES 1010. ISSUES IN THE ENVIRONMENT.
- NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

Political Science

- Pol 3872. INTERNATIONAL ORGANIZATIONS AND THE ENVIRONMENT.
- Pol 5410. ADVANCED TOPICS IN GOVERNMENT AND POLITICS: POLITICS OF ENVIRONMENTAL MOVEMENTS.
- Pol 5523. THE POLITICS OF THE REGULATORY PROCESS.

Public Affairs

- PA 5693. TOPICS IN ENVIRONMENTAL PLANNING.
- PA 5701. TECHNOLOGY PLANNING I.
- PA 5711. ENERGY POLICY I.
- PA 5712. ENERGY POLICY II.
- PA 5721. ENVIRONMENTAL POLICY I.
- PA 5722. ENVIRONMENTAL POLICY II.
- PA 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.
- PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY.
- PA 5794. ECONOMICS OF NATURAL RESOURCE POLICY.
- PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS.
- PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Recreation, Park, and Leisure Studies

- Rec 5160. RECREATION LAND POLICY.

Science in Agriculture

- ScAg 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS.

Soil Science

- Soil 1020. THE SOIL RESOURCE.

Strategic Management and Organization

- BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.
- BGS 3019/H3019. TOPICS IN BUSINESS, GOVERNMENT AND SOCIETY: BUSINESS AND THE PHYSICAL ENVIRONMENT.
- BGS 8019. TOPICS IN BUSINESS AND SOCIETY: BUSINESS AND THE PHYSICAL ENVIRONMENT.
- MBA 8055. BUSINESS, GOVERNMENT AND MACROECONOMICS.
- Mgmt 8202. EXTERNAL AFFAIRS MANAGEMENT.

RECREATION AND OUTDOOR EDUCATION

Elementary Education

Elem 5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION.

Forest Resources

FR 5231. RANGE MANAGEMENT.
FR 5232. MANAGEMENT OF RECREATIONAL LANDS.
FR 5233. PRINCIPLES OF OUTDOOR RECREATION PLANNING.
FR 5236. FOREST RECREATION PLANNING.
FR 5257. RECREATION LAND POLICY.
FR 5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR.
FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
FR 8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS.

Horticultural Science

Hort 3072. TURF MANAGEMENT.
Hort 5026. LANDSCAPE MANAGEMENT.

Landscape Architecture

LA 8222. THE LANDSCAPE ARCHITECTURAL DESIGN OF COMMUNITY PLACES.
LA 8232. DESIGN OF RECREATIONAL LANDSCAPES.

Recreation, Park, and Leisure Studies

Rec 5160. RECREATION LAND POLICY.
Rec 5250. FINANCING LEISURE SERVICES.
Rec 5300. FOUNDATIONS OF OUTDOOR EDUCATION.
Rec 5310. PROGRAMMING IN OUTDOOR EDUCATION.
Rec 5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING.

RESOURCE MANAGEMENT

Agricultural and Applied Economics

AgEc 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS.
AgEc 5650. ECONOMICS OF NATURAL RESOURCE POLICY.
AgEc 8264. RESOURCE ECONOMICS.

AgEc 8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS.

Anthropology

Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT.

Economics

Econ 5611. RESOURCE AND ENVIRONMENTAL ECONOMICS.

Fisheries and Wildlife

FW 5455. AQUACULTURE.
FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.

Forest Resources

FR 1201. CONSERVATION OF NATURAL RESOURCES.
FR 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES.
FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.
FR 3110. COLLOQUIUM IN NATURAL RESOURCES.
FR 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
FR 3300. ELEMENTS OF SURVEYING.
FR 5102. FOREST WILDLIFE HABITAT MANAGEMENT.
FR 5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS.
FR 5200. AERIAL PHOTO INTERPRETATION.
FR 5202. REMOTE SENSING: FIELD APPLICATIONS.
FR 5212. NATURAL RESOURCES INVENTORY.
FR 5222. FOREST RESOURCES INVENTORY.
FR 5231. RANGE MANAGEMENT.
FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
FR 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
FR 5262. REMOTE SENSING OF NATURAL RESOURCES.
FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
FR 5412. ADVANCED REMOTE SENSING.

- FR 5703. COLLOQUIUM IN NATURAL RESOURCES.
 FR 8205. RESEARCH PROBLEMS: REMOTE SENSING.
 FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

Housing

- Hsg 1401. RESIDENTIAL TECHNOLOGY.
 Hsg 5482. THE FAMILY AND ENERGY ISSUES.

International Relations

- IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: ENVIRONMENT AND DEVELOPMENT IN THE THIRD WORLD.

Natural Resources and Environmental Studies

- NRES 1001. ORIENTATION TO NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
 NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.
 NRES 3001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
 NRES 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
 NRES 3050. EXPERIENCE AND TRAINING IN A FIELD SETTING.
 NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
 NRES 3225. NRES DIRECTED STUDY EXPERIENCE.
 NRES 3800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION.
 NRES 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
 NRES 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I.
 NRES 5220. SURVEY MEASUREMENT AND MODELLING METHODS FOR NATURAL RESOURCES II.
 NRES 5225. NRES DIRECTED STUDY EXPERIENCE.

Public Affairs

- PA 5794. ECONOMICS OF NATURAL RESOURCE POLICY.

SOIL RESOURCES

Agricultural Engineering

- AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.
 AgEn 5540. WATERSHED ENGINEERING.
 AgEn 5550. WATER MANAGEMENT ENGINEERING.
 AgEn 5560. MECHANICS OF FLOW IN THE UNSATURATED ZONE.
 AgEn 8700. MOISTURE AND HEAT TRANSFER.

Agricultural Engineering Technology

- AgET 5400. DRAINAGE AND IRRIGATION.

Environmental and Occupational Health

- PubH 5186. ENVIRONMENTAL CHEMISTRY.

Forest Resources

- FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
 FR 8105. ADVANCED FIELD SILVICULTURE.
 FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS.

Soil Science

- Soil 1020. THE SOIL RESOURCE.
 Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY.
 Soil 3125. BASIC SOIL SCIENCE.
 Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
 Soil 5210. SOIL PHYSICAL PROPERTIES AND THE ENVIRONMENT.
 Soil 5510. FIELD STUDY OF SOILS FOR ENVIRONMENTAL ASSESSMENT.
 Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.
 Soil 5555. WETLAND SOILS.
 Soil 5610. SOIL BIOLOGY.

TECHNOLOGY

Agricultural Engineering Technology

- AgET 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Architecture

- Arch 3060. TECHNOS: FORCE, FORM AND ARCHITECTURE.
Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.
Arch 5137. PLANNING: URBAN FUNCTION AND STRUCTURE.

Biology

- Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH.
Biol 5951. SOCIAL USES OF BIOLOGY.

Civil Engineering

- CE 5003. EARTH-SHELTERED BUILDING DESIGN.
CE 5098. SOLID AND HAZARDOUS WASTE PROCESSING II.

Forest Products

- ForP 5305. PULP AND PAPER TECHNOLOGY.
ForP 5320. BIOLOGICAL AND ENVIRONMENTAL SCIENCE OF PULP AND PAPER.

History of Science

- HSci 3331/5331. TECHNOLOGY IN AMERICAN CULTURE.

Horticultural Science

- Hort 3001. GROWTH REGULATION OF HORTICULTURAL PLANTS.
Hort 3003. PLANT GENETICS AND IMPROVEMENT.
Hort 3004. APPLICATIONS OF PLANT BIOTECHNOLOGY.
Hort 5032. TREE FRUIT PRODUCTION.

Housing

- Hsg 1401. RESIDENTIAL TECHNOLOGY.

Interdepartmental Study

- ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Landscape Architecture

- LA 8574. LANDSCAPE CONSTRUCTION: MECHANICAL SYSTEMS.

Mechanical Engineering

- ME 5613. PRINCIPLES OF PARTICLE TECHNOLOGY.
ME 5614. PRINCIPLES OF PARTICLE TECHNOLOGY.
ME 5620. CLEAN ROOM TECHNOLOGY AND PARTICLE MONITORING.

Microbiology

- MicB 5352. APPLIED MICROBIOLOGY.
MicB 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies

- NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

Public Affairs

- PA 5701. TECHNOLOGY PLANNING I.
PA 5721. ENVIRONMENTAL POLICY I.
PA 5722. ENVIRONMENTAL POLICY II.
PA 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.
PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Science in Agriculture

- ScAg 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS.

Soil Science

- Soil 5605. MICROBIAL ECOLOGY.

Strategic Management and Organization

- BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

WASTE MANAGEMENT

Agricultural Engineering

- AgEn 5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING.

Architecture

- Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL.

Biology

- Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH.

Civil Engineering

- CE 5097. SOLID AND HAZARDOUS WASTE PROCESSING I.
 CE 5098. SOLID AND HAZARDOUS WASTE PROCESSING II.
 CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
 CE 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.
 CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.
 CE 5515. WATER AND WASTEWATER MICROBIOLOGY.
 CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
 CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT—PART II.
 CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.

Environmental and Occupational Health

- PubH 5233. BIOLOGICAL SAFETY.
 PubH 5253. INTRODUCTION: HAZARDOUS WASTE MANAGEMENT.
 PubH 5254. HAZARDOUS WASTE MANAGEMENT.

Forest Products

- ForP 5305. PULP AND PAPER TECHNOLOGY.
 ForP 5320. BIOLOGICAL AND ENVIRONMENTAL SCIENCE OF PULP AND PAPER.

Interdepartmental Study

- ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

Law School

- Law 5885. ADVANCED ENVIRONMENTAL LAW.

Natural Resources and Environmental Studies

- NRES 1010. ISSUES IN THE ENVIRONMENT.
 NRES 5600. PRINCIPLES OF WASTE MANAGEMENT.

Public Affairs

- PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

WATER RESOURCES**Agricultural Engineering**

- AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.
 AgEn 5540. WATERSHED ENGINEERING.
 AgEn 5550. WATER MANAGEMENT ENGINEERING.
 AgEn 8500. HYDROLOGIC MODELING—SMALL WATERSHEDS.

Agricultural Engineering Technology

- AgET 5410. HYDROLOGY AND WATER QUALITY.

Civil Engineering

- CE 5401. WATER RESOURCES ENGINEERING.
 CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN.
 CE 5425. GROUNDWATER MECHANICS.
 CE 5426. COMPUTER MODELING OF GROUNDWATER FLOW.
 CE 5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS.
 CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
 CE 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.
 CE 5505. WATER QUALITY ENGINEERING.
 CE 5506. ENVIRONMENTAL WATER CHEMISTRY.
 CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
 CE 8406. SEMINAR: ADVANCED HYDROLOGY.
 CE 8407. STOCHASTIC HYDROLOGY.
 CE 8413. MECHANICS OF SEDIMENT TRANSPORT.
 CE 8419. WATER RESOURCES SYSTEMS SIMULATION.
 CE 8425. ADVANCED GROUNDWATER MECHANICS.
 CE 8426. ADVANCED GROUNDWATER MECHANICS II.
 CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
 CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT—PART II.
 CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.
 CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.
 CE 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.

WATER RESOURCES

- CE 8507. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS.
CE 8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS.
CE 8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS.
CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior

- EEB 5608. ECOSYSTEMS: FORM AND FUNCTION.

Environmental and Occupational Health

- PubH 5186. ENVIRONMENTAL CHEMISTRY.
PubH 5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS.
PubH 5243. WATER AND HEALTH.

Fisheries and Wildlife

- FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS.
FW 8459. STREAM AND RIVER ECOLOGY.
FW 8460. FISH HABITATS AND RESTORATION.

Forest Resources

- FR 5114. FOREST HYDROLOGY.
FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
FR 5153. ADVANCED FOREST HYDROLOGY.
FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.

Geography

- Geog 5444. GEOGRAPHY OF WATER RESOURCES.

Geology and Geophysics

- Geo 5313. AQUEOUS GEOCHEMISTRY.
Geo 5641. GENERAL AND PHYSICAL HYDROGEOLOGY.
Geo 5642. QUANTITATIVE HYDROGEOLOGY.
Geo 5643. CHEMICAL HYDROGEOLOGY.
Geo 8612. ANALYTICAL GEOHYDROLOGY.

Natural Resources and Environmental Studies

- NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.

Soil Science

- Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY.
Soil 5210. SOIL PHYSICAL PROPERTIES AND THE ENVIRONMENT.

III. COURSES LISTED BY DEPARTMENT

AEROSPACE ENGINEERING AND MECHANICS (AEM)

Institute of Technology

107 Akerman, 625-8000

Theodore Wilson, 107 Akerman, 625-0856

AEM 5687. INTRODUCTION TO ACOUSTICS AND ENVIRONMENTAL NOISE. (4 cr; prereq Phys 1291 or Phys 1341 or equiv, Math 3321 or equiv; IT or grad IT stu; 3 lect and 1 lab hrs per wk; offered when feasible) Day class

Derivation of the wave equation, plane wave solution, transmission and reflection at boundaries, resonators and mufflers, three-dimensional wave propagation, properties of environmental noise sources, hearing and perception of sound, acoustical properties of rooms, laboratory experience in sound and noise measurements and noise control techniques.

AGRICULTURAL AND APPLIED ECONOMICS (AgEc)

College of Agriculture

231 Classroom Office Building, 625-1222

Reynold Dahl, 217 Classroom Office Building, 625-7287

AgEc 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS. (3 cr; prereq 1101, 1102 or Econ 1101, 1102 or #) Day class

Basic concepts of resource use including physical and economic classifications; physical and economic feasibility; benefits and costs; external effects; cost sharing; selected resource use problems. Economic areas and units for planning and development; generation of alternative program elements and development of consequences; problems in choosing elements for an optimum resource development program.

AgEc 5600. LAND ECONOMICS. (4 cr for undergrad, 3 cr for grad; prereq 3101, 3102, or Econ 3101, 3102 or #) Day class

Land as a factor of production; land use, classification, and value; sales and rental markets for land; domestic and foreign land policies.

AgEc 5650. ECONOMICS OF NATURAL RESOURCE POLICY.

(4 cr for undergrad, 3 cr for grad; prereq 3101 or econ 3101 or AgEc 3610 or #) Joint Day/Extension class: refer to daytime *Class Schedule* (Same as PA 5794) Application of economic analysis, including project evaluation, to current natural resource issues. Emphasis on conservation and resource scarcity, environmental quality, population growth, and resource use issues and their implications for public policy.

AgEc 5710. U.S. AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY. (3 cr; prereq 3003, 3006, 3007 or #) Day class

Development of U.S. agriculture and U.S. agricultural and trade policy; agricultural input and commodity markets; effects of U.S. environmental policies on agriculture; design and economics effects of U.S. agricultural policy; determinants of U.S. agricultural and trade policies.

AgEc 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY. (4 cr; prereq 3003 or Econ 3101 or #)

Day class

Characteristics of agriculture in Europe; determinants of development of European agriculture; goals and instruments of EC agricultural policy.

AgEc 8264. RESOURCE ECONOMICS. (3 cr; prereq Econ 5162 or ¶Econ 5162 or #) Day class

Economic analysis relevant to resource use and management; concepts of joint production and joint costs; external effects of resource decisions; applications of public finance, welfare economics, capital theory, and discount rates; cost-benefit analysis and other decision-making approaches; investment and management problems related to water resources, outdoor recreation, forestry, and fisheries; economic problems of air pollution and environmental quality.

AGRICULTURAL ENGINEERING

AgEc 8360. LAND ECONOMICS AND POLICY. (3 cr; offered when demand warrants) Day class

AgEc 8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS. (3 cr; offered when demand warrants) Day class

AGRICULTURAL ENGINEERING (AgEn)

Institute of Technology

213 Agricultural Engineering, 625-7733

J. L. Nieber, 203 Agricultural Engineering, 625-6724

C. J. Clanton, 230 Agricultural Engineering, 625-9218

AgEn 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS. (4 cr; prereq IT student, biology, AEM 3016 or ¶AEM 3016; 3 lect and 3 lab hrs per wk) Day class

Mechanical and hydraulic properties of soil; moisture relations; strength parameters for structural and mechanical design. Soil-machine action in tillage and traction. Energy and water balance in the soil-water-plant system. Plant structure and growth. Engineering and management requirements.

AgEn 5540. WATERSHED ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 3400; 3 lect and 3 lab hrs per wk) Day class

Application of engineering principles to the management of surface runoff and soil water in agricultural, range and urban lands. Design of facilities for control of surface runoff to mitigate problems of flooding and degradation of surface water quality.

AgEn 5550. WATER MANAGEMENT ENGINEERING. (4 cr; prereq IT upper division or grad IT major, 3052 or CE 3300, CE 3400; 3 lect and 3 lab hrs per wk) Day class

Application of engineering principles to the management of water for production and environmental protection in agricultural systems. Design of facilities to irrigate and drain croplands and to enhance water quality.

AgEn 5560. MECHANICS OF FLOW IN THE UNSATURATED ZONE. (4 cr; prereq Soil 5232, Math 3321, or #; upper division IT or grad IT or grad COA; 2 lect hrs per wk) Day class

- ◆ **new** Fluid retention and transmission properties of unsaturated porous media. Equations of mass conservation and Darcy's law for unsaturated porous media. Simultaneous flow of immiscible fluids. Analytical, finite difference and finite element solutions to the governing equations.

AgEn 5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING. (4 cr; prereq 3052, Chem 1005, CE 3400, upper div IT or grad IT major; 3 lect and 3 lab hrs per wk) Day class

Sources and characteristics of agricultural wastes including livestock, food processing, and domestic wastes. Physical, biological, chemical, rheological, and microbiological properties. Effects on the environment. Collection, storage, treatment (aerobic and anaerobic), and utilization/disposal. Land application of livestock and food processing wastes, municipal effluents, and sludges. On-site sewage treatment.

AgEn 8500. HYDROLOGIC MODELING—SMALL WATER-SHEDS. (4 cr; prereq CE 5405, grad IT major; 3 lect and 1 rec hrs per wk; offered alt yrs) Day class

Study and representation of hydrologic processes by mathematical models; infiltration, overland flow, return flow, evapotranspiration, channel flow, and storage. Time-flow relationships. Linear and nonlinear methods. Frequency relationships. Emphasis on parametric methods.

AgEn 8700. MOISTURE AND HEAT TRANSFER. (3 cr; prereq knowledge of differential equations and #, grad IT major; offered alt yrs) Day class

Mathematical study of transfer of moisture and heat in agricultural crops and soils.

AGRICULTURAL ENGINEERING TECHNOLOGY (AgET)

College of Agriculture

213 Agricultural Engineering, 625-7733
J. L. Nieber, 203 Agricultural Engineering, 625-6724
C. J. Clanton, 230 Agricultural Engineering, 625-9218

AgET 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT. (4 cr; prereq Math 1111, Chem 1001 or 1004, Phys 1041; 3 lect and 3 lab hrs per wk) Joint Day/Extension class

Definition, history, successes and failures of appropriate technology. Social and technical appropriateness. Water supply, treatment, storage, conveyance. Water pumps, sanitation. Power: pedal, wind, water, solar, rice-hull furnace, methane, Stirling-cycle engine. Building materials. Agricultural machinery and animal power. Transfer and adoption of technology. Lecture and laboratory.

AgET 5400. DRAINAGE AND IRRIGATION. (4 cr; prereq Soil 3210; 3 lect and 2 lab hrs per wk) Day class

Soil moisture excesses and deficiencies. Theory and design of tile drainage, surface drainage, and sprinkler irrigation systems. Development of irrigation water supplies. Selection of pumps and power units for drainage and irrigation. Economic feasibility. Legal problems and procedures.

AgET 5410. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phy 1041, Chem 1004, 1005; 3 lect, 3 lab, and 1 rec hrs per wk) Day class

The hydrologic cycle—precipitation, infiltration, evaporation, surface and sub-surface runoff, and groundwater recharge. Flow in streams, flow in aquifers, flow measurement. Soil erosion, sediment transport and deposition. Chemical pollution of surface water and ground water.

AGRONOMY AND PLANT GENETICS (Agro)

College of Agriculture

411 Borlaug Hall, 625-7773
D. L. Wyse, 411 Borlaug Hall, 625-7064

Agro 5030. WEED CONTROL. (5 cr; prereq 1010 or #; 3020 or PBio 3131 recommended) Joint Day/Extension class: refer to daytime *Class Schedule*

Survey of the magnitude of the weed problem. Regulatory aspects of weed control and herbicide usage. Principles and methods of weed control. Lecture and discussion.

ANIMAL AND PLANT SYSTEMS (AnPI)

College of Agriculture

411 Borlaug Hall, 625-7773
Lawrence H. Smith, 411 Borlaug Hall, 625-2778

AnPI 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION. (4 cr; prereq Biol 1008 or 1009) Day class

Sustainable food production via agriculture is crucial for humankind's survival. Agricultural systems are influenced by and impact the environment. This course examines ecological properties of world agricultural systems including issues of biodiversity, soil conservation, agricultural pollution, water quality, and waste management.

AnPI 5060. INTEGRATED MANAGEMENT OF CROPPING SYSTEMS. (4 cr; prereq Agro 3020 or Hort 1100, Soil 3125 or #) Day class

Case study/simulation and discussions considering integrated production management of selected agronomic and horticultural cropping systems in Minnesota. Emphasis on problem analysis, principle application, and decision making involving the integration of disciplines.

ANTHROPOLOGY (Anth)

College of Liberal Arts

215 Ford Hall, 625-3400

L. P. Gerlach, 219 Ford Hall, 625-5542

Anth 5116. ECOLOGICAL ANTHROPOLOGY. (4 cr; prereq 1102, 3201 or 5102) Extension class

Anthropological approaches to human-environment interactions. Discussion of Marxist, ecological, biological, humanistic, and ethnoscientific approaches to culture and resources. Key interactions in a wide range of settings, adaptations, and environments. Issues of energetics, production, consumption, values, and conservation.

Anth 5117. ANTHROPOLOGY OF RESOURCE MANAGEMENT. (4 cr; offered when feasible) Joint Day/Extension class

Employment of a cultural ecological and systems approach to examine ways in which social institutions and cultural concepts are applied across world societies to develop, use, and manage key environmental resources. Comparative studies from contemporary and historical United States, western Europe, Africa, Asia, and the Caribbean.

Anth 5176. ENVIRONMENTAL ARCHAEOLOGY. (4 cr; prereq 1101, 3111 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Archaeological and natural-scientific approaches to the study of past human society with emphasis on use of the environment and reconstructing past environmental conditions. Field and laboratory techniques in association with archaeological research problems.

Anth 5960. SENIOR SEMINAR: HUMAN/ENVIRONMENT INTERACTIONS. (4 cr; prereq sr maj) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Anthropological approaches to the study of interactions between humans and the environment.

ARCHITECTURE (Arch)

College of Architecture and Landscape Architecture

110 Architecture, 624-7866

Julia Robinson, 110 Architecture, 624-7866

Arch 1401. THE DESIGNED ENVIRONMENT. (4 cr; no prereq) Joint Day/Extension class

- ◆ **new** (Same as LA 1500) Principles and traditions within the design disciplines of architecture, landscape architecture, and urban design, along with references in the arts, sciences, and literature, will be explored in this review of the formal constructs of the designed environment.

Arch 3060. TECHNOS: FORCE, FORM AND ARCHITECTURE.

(4 cr; prereq Arch 1021, Arch major, and ¶Arch 3081) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to fundamental conceptual frameworks that relate science, technology, and building expression to architectural form. Present day to ancient periods. The impact of climate, gravity, and sunlight are examined in four case study houses.

Arch 3064-3065. ENVIRONMENTAL MANAGEMENT AND CONTROL. (4 cr per qtr; prereq Arch major or adult special, 3062, 3083 or #; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

Environmental-mechanical considerations including comfort technology, space habitability, climate, psychometrics, control and management systems; waste management including plumbing systems and waste disposal techniques. Electrical systems, energy, power distribution and machinery; lighting systems, physiology of seeing, light sources and control; spatial acoustics, noise barriers, absorption.

Arch 3413. HISTORY OF LANDSCAPE ARCHITECTURE. (4 cr; §LA 3413, §ArH 3412) Joint Day/Extension class

- ◆ **new** (Same as LA 3413) Lecture course introduction to history and theoretical issues of landscape architecture in topologically based survey format. Course covers landscape design from the ancient to the modern periods.

Arch 5137. PLANNING: URBAN FUNCTION AND STRUCTURE. (4 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Economic, technological, and social factors that underlie the location, distribution, and internal structure of urban settlements. Quantitative and qualitative analysis of social, economic, and physical problems or consequences of contemporary urbanization.

Arch 5535. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY. (4 cr; prereq 3062, 3064 or #) Extension class

- ◆ **new** Design and construction principles, problems, and solutions for housing and small commercial structures that improve comfort and energy efficiency. Building envelope assemblies—roofs, wall, and foundations—and their integration with basic building systems. Discussion and resolution of common problems associated with these construction methods, such as infiltration, degradation from moisture, and poor indoor air quality.

Arch 5957. CLIMATE AND ARCHITECTURE. (4 cr; prereq Arch major, 3082, 3064 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Climate as a context for architectural form and thought. Thermal comfort, synthesis and energy in architectural design in relation to temperature, humidity, wind, and solar radiation. Investigation of specific buildings/sites through graphic analysis, physical/computer simulation, and writings.

Arch 5966. BUILDING ENERGY SYSTEMS. (4 cr; prereq Arch major, 3064 or #; 4 lect hrs, 2 lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Conceptual understanding of the functions of building mechanical systems and their integration with other building components through case studies. Topics include residential and commercial HVAC systems, alternative energy sources, energy efficiency, spatial and structural implications of mechanical systems, indoor air quality, computer modeling, and environmental control strategies.

BIOCHEMISTRY (BioC)

College of Biological Sciences

140 Gortner Lab, 624-7755

Kathleen Peterson, 223 Snyder Hall, 624-9717

BioC 5301. ECOLOGICAL BIOCHEMISTRY. (3 cr; A-F or S-N; prereq Biol 5001 or grade B or better in BioC 3031 or #) Day class

The biochemistry of environmental processes will be covered. Topics include biochemistry of organismal interactions, biological responses to environmental stress, gene transfer in the environment, and effects and fate of environmental toxins.

BIOLOGY (Biol)

College of Biological Sciences

123 Snyder Hall, 624-2244

Kathleen Peterson, 223 Snyder Hall, 624-9717

Biol 1103. GENERAL BOTANY. (5 cr; §3012; prereq 1009; students who plan to major in biology in CLA or any bioscience major in CBS should take 3012) Day class and Extension class

- ◆ **new** Plant organization, function, growth and development and reproduction. Includes laboratory.

Biol 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES. (5 cr; §1008) Joint Day/Extension class; limited to 20 Extension students

- ◆ **new** Origins and foundations of modern evolutionary thought, putting evolutionary theory to work, evolution and ecology. Can be taken as a single course or as the first in the Biol 1201, 1202, 1203 sequence.

Biol 3012. PLANT BIOLOGY. (5 cr; §1103, §3812; prereq 1009, Chem 1052) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Plant diversity and evolution; structure and function of the plant cell and of the whole organism; growth and development of plants. Includes laboratory.

CHEMISTRY

Biol 3051. BIOLOGY AND THE FUTURE OF THE EARTH. (4 cr; bioscience students may not apply these credits to the major) Joint Day/Extension class limited to 25 Extension students

Nontechnical discussion of current environmental issues including air and water pollution, human population growth, toxic and hazardous wastes, urbanization, resource economics, biological diversity, energy, health, and environmental ethics.

Biol 5041. ECOLOGY. (4 cr; §5841, prereq Math 1142 or 1251, Biol 1103 or 1106 or 3011 or 3012) Joint Day/Extension class: refer to daytime *Class Schedule*

Growth, structure, and evolution of populations. Pairwise biotic interactions between species, effect on diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems.

Biol 5841. ECOLOGY. (5 cr; §5041; prereq 1103 or 1106 or 3011 or 3012, Math 1142 or 1251, Δ) Day class

Growth, structure, and evolution of populations. Pairwise biotic interactions between species and their effect on the diversity and structure of natural communities. Nutrient dynamics, function, productivity, and temporal stability of ecosystems. Field work at the Itasca station.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY. (5 cr; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This course considers some of the general principles of this emerging field, such as landscape structure and function, biotic diversity, landscape stability and change, with reference to the habitats in the Itasca area. Relationship of these principles to management problems will be considered. Research projects will be carried out as class exercises and GIS computer programs will be used to aid research when appropriate.

Biol 5850. SPECIAL TOPICS IN BIOLOGY: CONSERVATION BIOLOGY. (5 cr; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction to the influence of human activities on ecological systems. Field studies focusing on ecological changes caused by these activities in the Itasca area will be conducted by students. Written reports on the results of these studies will be required.

Biol 5951. SOCIAL USES OF BIOLOGY. (4 cr; S-N only; prereq 10 cr sciences) Day class and Extension class

Influence of biological science on the quality of human life: agriculture, medicine, occupational health, environmental science, and theories of human nature. Responsibilities and roles of biologists in policy formulation in the scientific and political world.

CHEMISTRY (Chem)

Institute of Technology

139 Smith Hall, 624-6000

Barbara Edgar, 113 Smith Hall, 624-0062

Chem 1003. PHYSICAL WORLD, CHEMISTRY. (5 cr, § any other college chemistry course; prereq 1 yr high school algebra; high school chemistry recommended; a terminal course—cannot be used as prereq for any other advanced chemistry course; 4 lect, 1 rec, one 2-hr lab per wk) Day class

- ◆ **new** Fundamental concepts of chemical bonding, structure of matter, and forces in the physical world. Scientific methods and principles that contribute to understanding the environment and problems faced in improving it. Labs to illustrate.

Chem 1008. PHYSICAL WORLD, CHEMISTRY. (4 cr, § any other college chemistry course; prereq 1 yr high school algebra; high school chemistry recommended; a terminal course—cannot be used as prereq for any other advanced chemistry course) Day class

- ◆ **new** Same as Chem 1003, but without lab.

CIVIL ENGINEERING (CE)

Institute of Technology

122 Civil and Mineral Engineering, 625-5522

M. Semmens, 150 Civil and Mineral Engineering, 625-9857

W. Maier, 148 Civil and Mineral Engineering, 625-3016

CE 5003. EARTH-SHELTERED BUILDING DESIGN. (2 cr) Day class

Use and design of underground/earth-sheltered facilities for residential and non-residential purposes. Energy use, planning, security, environment, building design, landscaping, building codes, financing, and psychological considerations.

CE 5004. UNDERGROUND CONSTRUCTION ENGINEERING. (4 cr; prereq IT upper division, 5003) Day class

Application of structural and geotechnical techniques to earth-sheltered buildings; construction techniques and problems. Topics include retaining systems, structural loads, drainage systems, waterproofing, site investigation, contracting practices, instrumentation, and heat transfer calculations. Housing, large scale buildings, and mines space.

CE 5097. SOLID AND HAZARDOUS WASTE PROCESSING I. (4 cr; prereq IT upper division, grad student, or #) Day class

Physical and chemical principles and their application to unit operations and processes for recovery and recycling of solid and hazardous wastes. Remediation techniques on solid and hazardous wastes originating from manufacturing industries, municipal waste treatment plants, electric power utilities, and the mining industry.

CE 5098. SOLID AND HAZARDOUS WASTE PROCESSING II. (4 cr; prereq CE 5097 or #) Day class

Continuation of CE 5097 with emphasis on pyro-processing and high temperature treatment approaches; chemistry of high temperature systems; thermal incineration principles; novel approaches for elimination of ash in incinerators and utility coal burners via slagging combustion and vitrification; developing technologies in high temperature treatment of hazardous wastes.

CE 5212. TRANSPORTATION PRODUCTIVITY AND ENERGY CONSERVATION. (4 cr; prereq #; offered when feasible) Day class

Measuring transportation productivity and energy consumption; application of control theory for improving transportation productivity; simulation of energy-conservation policies and effect of such policies on transportation ridership and economics through time; transportation use and energy consumption in relation to urban and rural structures; case studies.

CE 5401. WATER RESOURCES ENGINEERING. (4 cr; prereq 3400 or #, IT or grad student; 3 lect and 3 lab hrs per wk) Day class and Extension class

Introduction to water resources engineering including flow in conduits, pumps, open channels and culverts; introduction to flow measurements, hydraulic structures and systems approach to water resources engineering.

CE 5405. HYDROLOGY AND HYDROLOGIC DESIGN. (4 cr; prereq 5401 or #, IT or grad student; 3 lect and 3 lab hrs per wk) Day class and Extension class

Hydrologic cycle, precipitation, evaporation, infiltration, runoff analysis, flood routing, statistical procedures in hydrology, urban hydrology, introduction to mathematical models of medium and large watersheds, application of hydrology to design of outlet works and flow control structures.

CE 5425. GROUNDWATER MECHANICS. (4 cr; prereq 3400 or #, IT or grad student) Day class

Basic equations. Shallow confined and unconfined flows, two-dimensional flow in the vertical plane, and transient flow. Flow from rivers and lakes toward wells. Determination of streamlines and pathlines in two and three dimensions. Introduction to containment transport. Elementary computer modeling.

CE 5426. COMPUTER MODELING OF GROUNDWATER FLOW. (4 cr; prereq 3400 or #, IT or grad student) Day class

Principles of Analytic Element Method, Boundary Integral Equation Method, Finite Element Method, Finite Difference Method. Applications of these four methods to field problems using existing computer programs. Derivation and interpretation of basic equations for contaminant transport in groundwater. Implementation of transport mechanisms in the various computer models.

CE 5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS. (4 cr; prereq 3400 or #, IT or grad student) Joint Day/Extension class

Planning and engineering design considerations in developing water supply systems for urban centers. Supply quality, storage, treatment, distribution, and cost analysis.

CE 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS. (4 cr; prereq 3400 or #, IT or grad student) Day class

Planning and engineering design considerations in developing waste disposal systems for urban centers. Volumes and quality of waste streams, treatment and ultimate disposal of domestic and industrial wastewaters, and storm water runoff. Environmental effects, cost, and political aspects of ultimate disposal.

CE 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS. (4 cr; prereq 3400 or #; IT or grad student) Day class

- ◆ **new** Principles of reactor design for water and wastewater treatment and principles of pollutant transport in the environment.

CE 5505. WATER QUALITY ENGINEERING. (4 cr; prereq IT or grad student or #) Day class

Chemical and physical properties of natural waters, introduction to aquatic biology, and ecological considerations of element cycling of natural carbon, nitrogen, phosphorus, oxygen, and anthropogenic chemical species (pesticides, PCBs, heavy metals). Physical and chemical processes of water treatment.

CE 5506. ENVIRONMENTAL WATER CHEMISTRY. (4 cr; prereq Chem 1006 or #, IT or grad student; 3 lect and 1 rec hrs per wk) Extension class

Composition of natural waters and wastewater; chemical processes affecting distribution of pollutants and water quality parameters in natural waters; methods of evaluation to determine fate of organic pollutants.

CE 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT. (4 cr) Joint Day/Extension class

Characterization of solid and non-radioactive hazardous wastes and legislation affecting its disposal; processing methods: size reduction, physical separation, chemical separation, biological treatment, combustion and incineration; examples of material recovery and reuse. Emphasis on unit operations and processes associated with recycle and recovery of values.

CE 5515. WATER AND WASTEWATER MICROBIOLOGY. (4 cr; prereq Chem 1005, Math 1231) Joint Day/Extension class

Analysis of role of microbes in environmental degradation and pollution control. Organism growth and selection in wastewater treatment systems. Pathogenic organisms in water supply. System control using microbial based indicators.

CE 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY. (4 cr; prereq 5501, 5401 or #) Day class

Fate of chemicals in groundwater and soils will be analyzed and modeled. Transport, dispersion, chemical-biological transformations and accumulation will be considered. Models will be used to study in situ clean-up of groundwater and aquifers and simulate time-dependent changes in pollutant concentration.

CE 8406. SEMINAR: ADVANCED HYDROLOGY. (1 cr) Day class

Weekly seminar by staff, students, and guest speakers.

CE 8407. STOCHASTIC HYDROLOGY. (4 cr; prereq Stat 5021 or #) Day class

- ◆ **new** Analysis and synthesis of hydrologic series and systems; derived distributions; flood frequency analysis; hydrologic time series; correlation and spectral analysis; reservoir range analysis; linear analysis; linear estimation; geostatistics; sampling networks; and real-time hydrologic forecasting.

CE 8413. MECHANICS OF SEDIMENT TRANSPORT. (3 cr; prereq 5410 or #) Day class

- ◆ **new** Theories of sediment transport. Transport processes and types of movement. Interrelationship of sediment transport, channel geometry, and channel stability in alluvial streams. Applications to river regulation, artificial channels, local scour, deposition in reservoirs, beach processes, other areas.

CE 8419. COMPUTATIONAL HYDRODYNAMICS II. (4 cr; prereq 8418 or #) Day class

Computer simulation of 1-, 2-, and 3-dimensional flows of incompressible and weakly compressible fluids with and without free-surface. Basic principles of governing equations, finite difference, and other numerical schemes and their application to hydraulic and water resources engineering problems.

CE 8425. ADVANCED GROUNDWATER MECHANICS. (4 cr; prereq 5425 or #) Day class

Conforma mapping techniques for two-dimensional steady groundwater flow. The hodograph method. Problems involving a free boundary and horizontal drains. Boundary value problems. Application of boundary integral equation techniques.

CE 8426. ADVANCED GROUNDWATER MECHANICS II. (4 cr; prereq 5425 or #) Day class

- ◆ **new** Applying complex variable methods, including conformal mapping, in groundwater mechanics. Solving problems with free boundaries using hodograph method. Drains in aquifers with free boundary; superposition of solutions with drains. Singular Cauchy integrals. Boundary elements.

CE 8430. LAKE AND RESERVOIR HYDRODYNAMICS. (3 cr; prereq #) Day class

Overview of hydrodynamic phenomena, analysis of density stratification, energy and momentum transfer through a water surface, wind effects of stratification and circulation, standing of progressive waves, stratified flow, density currents, selective withdrawal, mixing.

CE 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT. (3 cr; prereq 5500, 5501, or #) Day class

Theoretical principles underlying physical and chemical processes for water and wastewater treatment including sedimentation, flotation, adsorption, precipitation, and disinfection.

CE 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT - PART II. (3 cr; prereq 5500, 5501, 5506 or #) Day class

Theoretical principles, design considerations, and performance of processes not covered in CE 8500. Coagulation flocculation, filtration, membrane processes, gas transfer, sludge dewatering, mixing, and other processes commonly used in water pollution control.

CE 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT. (3 cr; prereq 5501 or #) Day class

Theoretical principles underlying chemical and biological wastewater treatment processes including aerobic and anaerobic biological processes for carbon and nitrogen removal, aeration, and chemical processes for phosphorus and nitrogen removal.

CE 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq Chem 5506 or #) Day class

Application of principles of physical chemistry to quantification of chemical processes in aquatic systems. Natural waters as equilibrium and dynamic systems. Ionic equilibria; protolysis, complexation, solubility, and redox equilibria. Precipitation and mineral dissolution kinetics. Aqueous metal species in electrolyte solutions.

CE 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS. (4 cr; prereq 8505 or #) Day class

Natural interactions with rock and soil, precipitation and atmospheric fallout; industrial and domestic sources. Nature of aqueous metals in term of electrolyte solutions, hydrolysis reactions, complexation, chelation, redox, solubility, and precipitation. Interactions at solid-solution interfaces in terms of phenomenological and general models for adsorption. Hydrodynamic, biological, and chemical factors affecting distribution, transport and removal from aqueous phase. Computer techniques emphasized.

CE 8507. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS. (3 cr; prereq grad student, 5506 or #; offered 1993-94 and alt yrs) Day class

- ◆ **new** Occurrence, composition, and reactions of organic matter in surface- and groundwaters. Physical-chemical properties of organic contaminants; solubility; activity of organic chemicals in water. Processes controlling organic contaminant fate in natural waters. Environmental processing of organic chemicals in atmosphere, hydrosphere, sediments, and groundwaters case studies.

COMMUNICATION DISORDERS

CE 8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS. (4 cr) Day class

- ◆ **new** Principles of interfacial mass transfer in laminar and turbulent flows. Applications to aeration devices, toxic transport, and pollution cleanup through air-water volatilization and absorption. Techniques for measuring interfacial mass transfer. Inspectional analysis techniques for mass transfer similitude.

CE 8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS. (4 cr; prereq #) Day class

Introduction to hydrologic transport and water quality simulation in natural water systems. Mixed cell models, advection, turbulent diffusion and dispersion in one- and two-dimensional systems. Chemical and biological kinetics in water quality models. Applications to temperature, dissolved oxygen, primary productivity, and other water quality management problems in rivers, lakes, and reservoirs. Deterministic versus stochastic models. Water quality dynamics.

CE 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS. (1-5 cr; prereq 8550) Day class

Case studies of specific aquatic streams and lake systems.

CE 8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING. (1 cr; prereq #) Day class

Selected environmental engineering topics discussed by students, staff members, and guests.

COMMUNICATION DISORDERS (CDis)

College of Liberal Arts

110 Shevlin Hall, 624-3322

W.D. Ward, 121 Lions' Research Building, 2001 6th St. S.E., 626-9884

CDis 5704. NOISE AND MAN. (4 cr; prereq 5301 or #) Day class

Temporary and permanent effects of steady, intermittent, and impulse noise on hearing and health. Annoyance and community noise. Noise measurement, reduction, and control; ear defenders and their limitations. Hearing conservation programs; preemployment testing and monitoring audiometry.

CONSERVATION BIOLOGY (CB)

Graduate School

307 Johnston Hall, 625-3490

Francie Cuthbert, 320 Hodson Hall, 624-1756

CB 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq intro genetics course or #) Day class

Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

CULTURAL STUDIES AND COMPARATIVE LITERATURE (CSCL)

College of Liberal Arts

350 Folwell Hall, 624-8099

W. John Archer, 350 Ford Hall, 624-3830

CSCL 3366. LANDSCAPE AND IDEOLOGY, 1600-1875. (4 cr; §Hum 3366 or 3663) Day class

The cultural construction of "nature" as concept and as environment. From Puritan "garden in the wilderness" to 18th-century "natural" landscape garden and 19th-century transcendentalism. Attention to the role of agriculture, religion, philosophy, aesthetics, property relations, travel, and exploration.

DESIGN (Dsgn)

College of Human Ecology

240 McNeal Hall, 624-9700

Delores Ginthner, 491 McNeal Hall, 624-3293

Dsgn 3631. INTERIOR DESIGN RESOURCES AND MATERIALS. (3 cr, §3557; prereq 1555 or #; TexC 3621) Day class

Resources and materials used in interiors and their functional and aesthetic relationship to interior design. Includes life safety issues.

Dsgn 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES. (3 cr; prereq Phys 1001) Joint Day/Extension class: refer to daytime *Class Schedule*

Examination of types and uses of lighting, its relationship to color, and energy conservation. Evaluation of light quantity and quality for residential and non-residential spaces.

DESIGN, HOUSING, AND APPAREL (DHA)

College of Human Ecology

240 McNeal Hall, 624-9700

Ann M. Erickson, 240 McNeal Hall, 624-3205

DHA 1101. INTRODUCTION TO THE DESIGNED ENVIRONMENT. (3 cr) Day class

Analysis of the interaction between people and the designed environment, both at the micro and macro levels.

ECOLOGY, EVOLUTION, AND BEHAVIOR (EEB)

College of Biological Sciences

100 Ecology, 625-5700

Franklin H. Barnwell, 100b Ecology, 625-5700

Kathleen Peterson, 223 Snyder Hall, 624-9717

EEB 1019. OUR CHANGING PLANET. (4 cr; §AST 1019, §Geo 1019) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Study of interrelationships among earth's subsystems—solid earth, oceans, atmosphere and biosphere, and the solar and galactic super-systems. The way the earth works will be understood by studying the interactions of the natural cycles, their rates, feedbacks, etc., and human impacts.

EEB 3001. INTRODUCTION TO ECOLOGY. (4 cr; open to jrs and above but not to biology majors) Day class and Extension class

Basic concepts in ecology; the organization, development, and functioning of ecosystems; population growth and regulation. Human impact on ecosystems.

EEB 3101. ECOLOGY FOR ENGINEERS AND PHYSICAL SCIENTISTS. (4 cr; §3001; not open to biology majors; prereq Math 1261) Joint Day/Extension class: refer to daytime *Class Schedule*

Description and analysis of the spatial and temporal interactions between populations in ecosystems; processes affecting populations; transformations of energy and materials in the biosphere. Lectures and recitations.

EEB 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Events during the Quaternary Ice Age and earlier in Earth's history illustrate the interconnectedness of the biota, atmosphere, continents and oceans, resulting in a dynamic global ecosystem.

EEB 5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or 5841 or #; offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*

Impact of changes in the physical and biological environment during the Quaternary period on plants and animals. Changes in evolutionary rates, geographical distributions, community composition and fluctuations in population sizes. Impact of prehistoric human culture on the environment, including ecosystem-level changes recorded in sedimentary sequences. Recent climatic changes. General principles of analysis and methods of investigation and interpretation.

EEB 5014. ECOLOGY OF PLANT COMMUNITIES. (5 cr; prereq Biol 5041 or 5048 or 5841, 1 qtr statistics or #; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*

Methods of describing, sampling, and classifying plant communities; theory of their structure and development, and of the stability of the interactions among their constituent populations. Field trips to examine local vegetation types; analysis of quantitative data.

EEB 5016. ECOLOGICAL PLANT GEOGRAPHY. (5 cr; prereq Biol 5041 or 5841, PBio 3201 [formerly Bot 3201] or PBio 3201 or #; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*

Vegetation regions of the world and North America in detail; ecological principles of plant distribution; interpretation of regional and temporal patterns in distribution of vegetation and taxonomic groups. Field trips to floristic regions of Minnesota.

EEB 5033. POPULATION AND QUANTITATIVE GENETICS. (formerly GCB 5033; 4 cr; prereq GCB 3022 or Biol 5003, course in biometry or statistics or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction to genetic basis of microevolutionary change. Allelic frequency dynamics, with particular emphasis on natural selection and adaptive topography. Molecular evolution, additive genetic variance, consequences of artificial selection and current topics.

EEB 5051. ANALYSIS OF POPULATIONS. (4 cr; prereq Biol 5041 or 5841 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Factors involved in the regulation, growth, and general dynamics of populations. Data needed to describe populations, population growth, population models, and regulatory mechanisms.

EEB 5122. PLANT/ANIMAL INTERACTIONS. (4 cr; prereq Biol 1106 or 3011, 1103 or 3012 plus 10 credits in biological sciences or #; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*

Herbivory, pollination, seed dispersal. Implications of interaction for plants and animals at organismal, population, and community levels. Coevolution.

EEB 5129. MAMMALOLOGY. (5 cr; §FW 5129; prereq Biol 1106 or 3011 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Recent families and orders of mammals of the world and of genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

EEB 5134. INTRODUCTION TO ORNITHOLOGY. (5 cr; prereq Biol 1106 or 3011) Joint Day/Extension class: refer to daytime *Class Schedule*
Laboratory and field course in structure, classification, distribution, migration, habits, habitats, and identification of birds. Weekend trips scheduled.

EEB 5136. ICHTHYOLOGY. (4 cr; prereq 15 cr incl Biol 1106 or 3011) Joint Day/Extension class: refer to daytime *Class Schedule*

Biology of fishes including development, systematics, anatomy, physiology, and ecology.

EEB 5601. LIMNOLOGY. (4 cr; §Geo 5601; prereq Chem 1052 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Description and analysis of the events in lakes, reservoirs, and ponds, beginning with their origins and progressing through a study of their physics, chemistry, and biology. Interrelationships of these parameters and effects of civilization on lakes.

EEB 5606. ECOLOGY OF FISHES. (3 cr; prereq Biol 1106 or 3011, EEB 5136 plus 10 cr in the biological sciences; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*

Ecological requirements of fishes with emphasis on nongame species, habitat, food, interactions among species, and behavioral, anatomical, and physiological adaptations. Fishes in the aquatic ecosystem with emphasis on fresh waters.

EEB 5607. ECOLOGY OF ANIMAL PLANKTON. (4 cr; prereq Biol 5041 or 5841, EEB 5601 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Biology of animal plankton, including distribution of zooplankton in lakes, ecosystem functions such as grazing and remineralization, determination of production, physiological responses to contaminated environments, and important aspects of behavior.

EEB 5608. ECOSYSTEMS: FORM AND FUNCTION. (4 cr; prereq 5601 or Biol 5041 or 5841 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

Nature and development of terrestrial wetland and aquatic ecosystems. Analysis of energy flow and element cycling in relation to environmental controls, self-regulation, natural and human disturbances.

EEB 5621. LIMNOLOGY LABORATORY. (2 cr; §Geo 5621; pre-req EEB 5601 or Geo 5601 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Principal techniques for obtaining information about environmental conditions in lakes and streams. Procedures for measuring the abundance and population dynamics of aquatic organisms, with special emphasis on plankton; field instruments, sampling devices, chemical analyses, microscopy and analysis of data. One Saturday field trip.

COURSES OFFERED AT LAKE ITASCA FORESTRY AND BIOLOGICAL STATION

EEB 5814. PLANT COMMUNITY ECOLOGY. (5 cr; limited to 20 students; prereq course in ecology; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Communities represented in Itasca Park and vicinity, with emphasis on vegetation. Patterns of distribution of the communities, their interaction with the environment, and their dynamic relationships. Methods of community description and analysis.

EEB 5817. VERTEBRATE ECOLOGY. (5 cr; prereq course in ecology, Δ; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Field studies on populations and their relationships to local environments; habitat analysis and ecological research methods. All students will work as a team investigating factors influencing the distribution and abundance of selected vertebrates in various habitats. This is a research-oriented course supplemented with lectures and field trips.

EEB 5834. FIELD ORNITHOLOGY. (5 cr; prereq course in general biology including study of zoology; Δ; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Emphasis on the breeding season, biology, behavioral ecology of birds in the Itasca region. Field trips taken to a variety of habitats to learn bird identification and observe and practice techniques for conducting field studies. Laboratory sessions investigate family distinctions and species identification. Individual field projects. Designed primarily for students with fisheries and wildlife management interests. (Lab charge required)

ECONOMICS (Econ)

College of Liberal Arts

1035 Management and Economics, 625-6353
Director of Undergraduate Programs, 1035 Management and Economics, 625-6353

Econ 5611. RESOURCE AND ENVIRONMENTAL ECONOMICS. (4 cr; prereq 3101 or equiv, 1 qtr calculus) Day class

Exhaustible resources and the theory of optimal depletion. Renewable resources and the theory of optimal use. Will resource scarcity limit growth? Natural resources and natural environments. Environmental pollution and economic efficiency.

ELEMENTARY EDUCATION (Elem)

College of Education

125 Peik Hall, 625-6372
Audrey Borgstrom, 145 Peik Hall, 625-9809

Elem 5348. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; prereq elementary teaching experience, A-F only) Joint Day/Extension class

Classroom and fieldwork activities dealing with models, materials, and methods in the outdoor setting; consideration of broad topics such as ecological relationships, cyclic processes, and change as well as more specific topics such as rocks and minerals, plants and animals, and stargazing.

ENTOMOLOGY (Ent)

College of Agriculture

219 Hodson Hall, 624-3636

David W. Ragsdale, 416 Hodson Hall, 624-3636

Ent 1005. ECONOMIC ENTOMOLOGY. (4 cr; prereq Biol 1009 or #) Day class

Brief introduction to structure and classification of insects; management of insect populations; life histories, habits, and recognition of insect pests of livestock, orchards, field crops, vegetables, and ornamentals.

Ent 3005. INTRODUCTORY ENTOMOLOGY. (5 cr; prereq Biol 1009 or equiv) Day class

General morphology, life histories, habits, and classification of insects.

Ent 5040. INSECT ECOLOGY. (3 cr; prereq Biol 5041 or EBB 5122 or #) Day class

Synthetic analysis of the causes of insect diversity and of fluctuations in insect abundance. Focus on abiotic, biotic and evolutionary mechanisms influencing insect populations and communities.

Ent 5210. INSECT PEST MANAGEMENT. (4 cr; prereq 1005 or #) Day class

Management of insect, mite, and weed populations through integration of various methods and techniques.

Ent 5250. FOREST ENTOMOLOGY. (4 cr; prereq any two courses among the forestry, zoological, botanical, biological and/or agricultural sciences) Day class

Lectures and laboratory concerning ecology and population management of forest insects, with heavy emphasis on tree factors and biological control.

Ent 5280. LIVESTOCK ENTOMOLOGY. (3 cr) Day class

Biology and management of arthropods that affect livestock production systems.

Ent 5320. ECOLOGY OF AGRICULTURE. (4 cr; prereq two 3000 or above level courses in agronomy, horticulture or animal science, and two 3000 or above level courses in entomology, plant pathology or soil science or #) Day class

Ecological perspective on post-industrial agriculture. Discussions on the origins of agriculture and comparison of the function and ecology of contemporary and extinct agricultural systems.

Ent 5600. FIELD ENTOMOLOGY. (5 cr; prereq introductory biology; offered SSI at Itasca) Day class

Insect fauna in various natural habitats of the park and surrounding areas. Includes field trips and collection and identification of insects, as well as studies of general morphology, life histories, and habitats of local species.

Ent 5610. AQUATIC ENTOMOLOGY. (5 cr; prereq 3005 or 5600 or equiv or #; given at Itasca) Day class

Identification and biology of aquatic and littoral insects in all stages.

Ent 8240. COLLOQUIUM IN INSECT ECOLOGY. (3 cr; prereq 5040 or #) Day class

Dispersal, distribution, abundance, natural control and related problems.

ENVIRONMENTAL AND OCCUPATIONAL HEALTH (PubH)

School of Public Health

1155 Mayo Memorial Building, 626-0900

Kathryn Buxton, 1260 Mayo, 626-0900

PubH 5150-1. TOPICS IN ENVIRONMENTAL HEALTH: PRINCIPLES OF ENVIRONMENTAL HEALTH LAW. (1 cr)

Extension class: Winter Special Term, Sec 1

Among topics included are legal aspects of environmental decision making, legal processes, jurisdiction, and tort law.

PubH 5150-2. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: OCCUPATIONAL HEALTH LAW. (1 cr; prereq PubH 5150-1) Extension class: Winter Spec. Term, Sec 2

- ◆ **new** Among topics included are OSHA, right-to-know, workers' compensation, and discrimination.

PubH 5150-3. TOPICS IN ENVIRONMENTAL HEALTH: POLLUTION CONTROL LAW. (1 cr; prereq 5150-1) Extension class: Spring Special Term, Sec 3

Among topics included are Federal Clean Air Act, Clean Water Act, RCRA, TOSCA, and FIFRA.

PubH 5150-4. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: CONSUMER PRODUCTS LAW. (1 cr; prereq PubH 5150-1) Extension class: Spring Special Term, Sec 4

- ◆ **new** Among topics included are food and drug laws, Consumer Products Safety Commission, and housing legislation.

PubH 5151. ENVIRONMENTAL HEALTH. (3 cr; prereq #) Extension class

Methods for promoting human health and comfort by controlling environment.

PubH 5152. ENVIRONMENTAL HEALTH. (2 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

General principles of environmental health relating to macro and micro environments and products consumed or used by people.

PubH 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH. (2 cr; prereq PH or grad student, or #) Joint Day/Extension class: refer to daytime *Class Schedule*

The field, the current issues, and the principles and methods of environmental and occupational health protection. Independent field visits to observe, review and analyze environmental/occupational health programs is required.

PubH 5158. HEALTH RISK EVALUATION. (3 cr; prereq EH majors or #) Joint Day/Extension class: refer to daytime *Class Schedule*

General principles of health risk assessment and management; environmental pollutants; public domain and workplace, legislation and regulations.

PubH 5165. THE POLITICAL PROCESS IN PUBLIC HEALTH. (3 cr) Extension class

- ◆ **new** Preparation for assuming leadership in health policy arena. Emphasis on policy development; political, legislative, and regulatory processes; and political strategies in public health.

PubH 5171. ENVIRONMENTAL MICROBIOLOGY. (4 cr; prereq MicB 3103 or #; offered 1993-94 and alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

Survival, dissemination, monitoring, and significance of microorganisms in the environment; application of principles to environmental health problems.

PubH 5181. AIR POLLUTION. (4 cr; prereq 2 yrs chemistry, calculus, general physics or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Overview of current air pollution problems; sources of pollution, gas phase and aerosol phase chemistry, fate of pollutants, and human health and materials effects.

PubH 5184. AIR ANALYSIS. (3 cr; prereq 5211, #) Joint Day/Extension class: refer to daytime *Class Schedule*

Laboratory and field exercises involving air flow calibration, dynamic calibration of field equipment for analysis of air contaminants, respirable mass sampling, dust counting and sizing, and instrumentation for measuring physical environmental stresses.

PubH 5185. FIELD INSTRUMENTATION. (1 cr; prereq 5211) Extension class: Summer Special - Occupational Health and Safety Institute

- ◆ **new** Laboratory experience with the instruments used by industrial hygienists in the performance of field evaluations of occupational exposures to toxic agents. Sampling strategy.

PubH 5186. ENVIRONMENTAL CHEMISTRY. (3 cr; prereq general chemistry and organic chemistry or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Overview of air, water and soil chemistry with emphasis on pollution; transport and behavior of pollutants; current topics in environmental chemistry.

ENVIRONMENTAL AND OCCUPATIONAL HEALTH

PubH 5201. RADIATION PROTECTION AND MEASUREMENT.

(2 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Ionizing radiation sources, detection and measurement, protection principles, health implications.

PubH 5202. RADIATION LABORATORY.

(1 cr; prereq 5201 or concurrent with 5201) Joint Day/Extension class: refer to daytime *Class Schedule*

Radiation laboratory for 5201.

PubH 5210. INTRODUCTION TO INDUSTRIAL HYGIENE.

(3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction to theory and practice of industrial hygiene. Overview of historical development of occupational health, role of legislation and regulations, general principles of recognition, evaluation and control of hazards. Specific information on a variety of hazards and industrial processes.

PubH 5211. SURVEY OF INDUSTRIAL HYGIENE.

(3 cr) Extension class: Summer Special - Occupational Health and Safety Institute

- ◆ **new** Survey of industrial hygiene for non-practitioners. Recognizing, evaluating, and controlling health hazards in the workplace. Directed at safety and health professionals and others interested in basic understanding of industrial hygiene without detail required for practicing industrial hygienists.

PubH 5212. VENTILATION CONTROL OF ENVIRONMENTAL

HAZARDS. (3 cr; prereq 5210, or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Theory and application of exhaust ventilation in control of airborne environmental hazards: principles of air movement and mixing, design of appropriate ventilation controls, and techniques for measuring and evaluating controls. This course is designed for environmental health, engineering, and other students interested in industrial hygiene.

PubH 5214. AGRICULTURAL HEALTH AND SAFETY.

(3 cr) Extension class: Summer Special - Occupational Health and Safety Institute

- ◆ **new** Interdisciplinary focus on the major work-related problems facing the modern agricultural worker in the United States. These problems will be approached from a public health perspective with considerable emphasis on hazard control and disease prevention.

PubH 5215. APPLIED OCCUPATIONAL TOXICOLOGY.

(3 cr; prereq 5261 or #; offered 1993-94 and alt yrs) Joint Day/Extension

class: refer to daytime *Class Schedule*

- ◆ **new** Understanding and mitigating the toxic or harmful effects of chemicals on humans in the workplace. Provides insight into the mechanisms for determining chemical toxicity and communication of this information so others become aware of the hazards involved. Emphasizes the ethical, legal and regulatory responsibilities involved in manufacture and distribution of chemicals and products.

PubH 5216. PROPERTIES OF WORKPLACE AIRBORNE

CONTAMINANTS. (3 cr; prereq environmental health majors or grad

students with background in the physical sciences, engineering, or environmental sciences) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** A review of the properties of aerosols and gaseous contaminants like those found in workplace atmospheres, with special reference to their bearing on exposure and health effects, monitoring, and ventilation for hazard control.

PubH 5220. VENTILATION CONTROL OF OCCUPATIONAL

HAZARDS. (3 cr) Extension class: Summer Special - Occupational

Health and Safety Institute

- ◆ **new** Design, modification, testing and troubleshooting local exhaust systems. Uses and limitations of local exhaust systems for engineering control of occupational hazards. Characteristics and physics of air, properties of airborne contaminants, principles of air movement, ventilation, recirculation, thermal effects.

PubH 5233. BIOLOGICAL SAFETY.

(2 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Topics include: assessment of risk; primary barriers, laboratory design criteria, safety devices and equipment; personnel practices; sterilization and decontamination; laboratory animals; and shipping and disposal of biohazardous agents.

PubH 5239. MICROBIOLOGY OF THE HUMAN ENVIRON-

MENT: SEMINAR. (1 cr; prereq #) Joint Day/Extension class: refer

to daytime *Class Schedule*

Topics of current research interest on infectious disease and injury prevention through environmental intervention.

PubH 5242. ENVIRONMENTAL HEALTH ASPECTS OF GROUNDWATER SYSTEMS. (2 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Groundwater geology, quality, and treatment; well design, construction and maintenance; special references to public and environmental health problems.

PubH 5243. WATER AND HEALTH. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Occurrences, health effects, and treatment of physical, chemical and biological agents in transmission of waterborne diseases.

PubH 5253. INTRODUCTION: HAZARDOUS WASTE MANAGEMENT. (3 cr) Joint Day/Extension class

Review of roles of public and private sectors as generators, disposers and regulators of hazardous wastes. Includes definitions, sources, transportation, handling, treatment, recovery, disposal, and public health implications.

PubH 5254. HAZARDOUS WASTE MANAGEMENT. (1 cr) Extension class: Summer Special - Occupational Health and Safety Institute

Overview of problems and possible solutions. Technical, political, social, economic and regulatory factors are included.

PubH 5261. GENERAL ENVIRONMENTAL TOXICOLOGY. (3 cr) Joint Day/Extension class

Application of basic biochemical, anatomical, and physiological principles to environmental toxicology; assessment of potential health hazards; approaches to solution of toxic problems.

PubH 5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS. (3 cr; prereq 5261 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** In-depth examination of mechanisms and regulation of xenobiotic metabolism; kinetic models for distribution of toxicants and metabolites; receptor-mediated toxicity.

PubH 5266. INTRODUCTION TO HEALTH RISK ASSESSMENT. (1 cr) Extension class: Summer Special - Occupational Health and Safety Institute

- ◆ **new** Mechanics of the risk assessment process. Estimation of chemical exposure levels will use case studies from occupational health and general population scenarios. The social, political, and regulatory aspects of risk assessment will be explored.

PubH 5267. INDUSTRIAL AND OCCUPATIONAL TOXICOLOGY. (3 cr) Extension class: Summer Special - Occupational Health and Safety Institute

Basic principles of toxicology, including dose-response relation, metabolism and distribution, target specificity. Examples are drawn from exposures in the workplace and industrial toxicology.

PubH 8185. ANALYSIS OF TOXICANTS. (3 cr; prereq #; offered 1993-94 and alt years) Joint Day/Extension class: refer to daytime *Class Schedule*

Application of principles of analytical chemistry to analysis of toxic chemicals in environmental samples including air, soil, water and tissue; survey of instrumental methods (gas and liquid chromatography, mass spectrometry, and atomic and molecular spectroscopy); interpretation of results; analytical quality control. Includes lecture and lab.

PubH 8261. MOLECULAR TOXICOLOGY. (3 cr; prereq 5262; Biol 5001; #) Day class

- ◆ **new** Toxic actions and mechanisms of environmental chemicals at molecular level; emphasis on current research in selective toxicity.

PubH 8264. HUMAN DISEASES CAUSED BY ENVIRONMENTAL AGENTS. (3 cr; prereq 5261, 5262 and #) Day class

- ◆ **new** Clinical presentation of disease; investigation of exposed populations and affected individuals.

PubH 8269. TOXICOLOGY SEMINAR. (1 cr; prereq 5262, 8261, #) Day class

- ◆ **new** Evaluation of toxicological studies. Students present data from the literature or their own research.

FISHERIES AND WILDLIFE (FW)

College of Natural Resources

200 Hodson Hall, 624-3600

Ira Adelman, 204 Hodson Hall, 624-4228

FW 1001. ORIENTATION IN FISHERIES AND WILDLIFE.

(1 cr; S-N only) Joint Day/Extension class: refer to daytime *Class Schedule*

Survey of technical requirements and training of fishery and wildlife technicians and scientists; introduction to fields of work, problems and career outlets.

FW 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.

(3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Controversial issues involving specific wildlife management principles and techniques. Designed for students without natural science background who are interested in wildlife management issues.

FW 3052. INTRODUCTION TO FISHERIES AND WILDLIFE.

(3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to general ecological principles applied to management of fish and wildlife populations and their habitats; survey of legislation, agencies and policy affecting vertebrate populations; natural history of important Minnesota game and nongame vertebrates.

FW 5129. MAMMALOGY. (5 cr; §EBB 5129; prereq Biol 1106 or 3001 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Recent families and orders of mammals of the world and genera and species of mammals of North America, with emphasis on morphology, evolution, and zoogeographic history.

FW 5455. AQUACULTURE. (3 cr; prereq Biol 1009, 1103, 1106 or equiv, Chem 1001-2 or 1004-5 or equiv or #; offered 1993-94 and alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

Role of aquaculture in resource management and world food production; institutional and economic considerations; principles of husbandry of aquatic organisms; interactions between fish metabolism and water quality; nutrition and energetics; fish health and genetics.

FW 5459. PHYSIOLOGY AND BEHAVIOR OF FISH. (4 cr; prereq EEB 5136 or EEB 5156 or FW 5455 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Relationships between the physiology of fishes, their behavior and the aquatic environment. Includes examination of ionic and osmotic balance, gas exchange, locomotion, orientation and migration, reproduction, endocrinology, growth and stress.

FW 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS. (3 cr; prereq Bio 5041, EEB 5601 and Chem 1004, 1005, 3301, 3305 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Pollution assessment approaches, biological effects, fate and flow of contaminants in aquatic systems, and major types of pollutants will be described.

FW 5461. THE BEHAVIOR OF FISHES. (2 cr; prereq EEB 3111 or FW 5459 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Organismal and sub-organismal perspectives of behavior of fish. Topics include feeding behavior and optimal foraging theory; learning and intelligence in fish; genetic basis of behavior; neural and endocrine bases of behavior; communication, orientation and navigation; schooling and shoaling; reproduction; and the application of an understanding of fish behavior to the harvest, management and conservation of fishes.

FW 5570. AVIAN CONSERVATION AND MANAGEMENT. (4 cr; prereq grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Current problems in avian conservation and management, with emphasis on non-game, wetland, and game birds.

FW 5601. ASSESSMENT AND MANAGEMENT OF VERTEBRATE POPULATIONS. (5 cr; prereq Math 1142 or 1211 and PubH 5450 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

Conceptual models of populations, description of population characteristics and computer-assisted estimation of population parameters for the purpose of management. Competency in microcomputer word processing and spreadsheet data entry required.

FW 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS. (4 cr; prereq 5601 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Ecological analysis of environmental factors as they influence distribution, abundance, and productivity of terrestrial and aquatic vertebrates. Emphasis is placed on those factors which humans do or can influence. Three or four all-afternoon and/or Saturday morning field trips.

FW 5604. FISHERY AND WILDLIFE MANAGEMENT. (4 cr; prereq FW 5601 or #) Day/Extension class: refer to daytime *Class Schedule*

Basic understanding of fisheries and wildlife management with an emphasis on managed species of interest. Introduction to tactics and strategies of fisheries and wildlife management. Understanding of the role of strategic planning in directing and redirecting management actions and familiarity with the tools of fisheries and wildlife management and assessment of their efficacy.

FW 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION. (4 cr; prereq Biol 5041) Day class

Hands on experience with GIS as a tool for understanding analysis and management of ecological systems. Students will learn ARC-INFO and apply it to problems in fisheries, wildlife, and biological conservation.

FW 8448. FISHERY SCIENCE. (4 cr; prereq fisheries grad student or #; offered 1993-94 and alt yrs) Day class

- ◆ **new** Applications of ecological theory to the study and manipulation of fish populations; dynamics of growth, mortality, and yield of fish stocks; simulation applied to management problems.

FW 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES. (3 cr; prereq #) Day class

- ◆ **new** Seminar on current conservation biology issues; genetic, demographic, and environmental analysis and management of populations; ecosystem conservation; case studies of species conservation strategies.

FW 8459. STREAM AND RIVER ECOLOGY. (4 cr; prereq EEB 5601 or equiv or #; offered 1994-95 and alt yrs) Day class

- ◆ **new** Introduction to structure and dynamics of running waters from an ecosystem perspective. Historical perspective, basic hydrology and fluvial geomorphology, terrestrial-aquatic interactions, detrital dynamics, metabolism, drift, trophic relations, biotic and abiotic interactions, ecosystem experiments and natural alterations, stability and succession, and ecosystem dynamics in a watershed perspective. One field trip.

FW 8460. FISH HABITATS AND RESTORATION. (3 cr; Biol 5041 or equiv, grad, or #) Day class

- ◆ **new** Examination of mechanisms underlying physiology and behavior that shape fish community structure in specific north temperate habitats and current techniques and planning procedures for restoration of lakes and streams.

FW 8576. WILDLIFE MANAGEMENT: LARGE MAMMALS. (4 cr; prereq fisheries or wildlife conservation or ecol conservation biol grad student or #; offered 1993-94 and alt yrs) Day class

- ◆ **new** Comprehensive survey of ecology of ungulates and large carnivores, emphasizing North American species, with special reference to harvest, protection, and other management objectives.

FW 8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH. (5 cr; prereq 1 qtr calculus, 1 qtr statistics, some exposure to computers; offered 1994-95 and alt yrs) Day class

- ◆ **new** Systems analysis methods (e.g., state-space models, transfer functions) and numerical simulations in ecology and fisheries/wildlife management. Presentation of data in time and frequency domains; interpretation of results.

FOREST PRODUCTS (ForP)

College of Natural Resources

203 Kaufert Laboratory, 625-5200

Robert Rouda, 206 Kaufert Laboratory, 624-7229

ForP 5305. PULP AND PAPER TECHNOLOGY. (2 cr; prereq #)

Day class

- ◆ **new** Pulping processes, fiber refining and processing, manufacture of paper; fiber and paper properties; paper recycling; water requirements and effluent treatment.

ForP 5320. BIOLOGICAL AND ENVIRONMENTAL SCIENCE OF PULP AND PAPER. (3 cr; prereq sr or grad standing in ForP or #)

Day class

- ◆ **new** Biology and chemistry of the pulp and paper processes as related to their impacts on the environment; treatment of process effluents and discharges; government regulations and industry compliance; theory, design, and operation of equipment for the treatment or prevention of environmental effects; biochemistry of pulp and paper aquatic systems; advances in biological pulping and papermaking.

FOREST RESOURCES (FR)

College of Natural Resources

115 Green Hall, 624-3400

Alan Ek, 204 Green Hall, 624-3400

FR 1001. FOREST RESOURCES ORIENTATION. (1 cr) Joint

Day/Extension class: refer to daytime *Class Schedule*

Information about curricula offerings, areas of emphasis, CLE requirements, and summer job and internship programs.

FR 1100. DENDROLOGY. (4 cr; prereq Biol 1103) Joint Day/Exten-

sion class: refer to daytime *Class Schedule*

Identification, nomenclature, classification, and distribution of about 200 important forest trees. Preparation and use of keys, systems of natural classification, and field and lab methods of identification.

FR 1200. INTRODUCTION TO FOREST RESOURCES. (3 cr)

Joint Day/Extension class: refer to daytime *Class Schedule*

Multiple forest resources and their management. History, policy, and current issues in forest resources. Lectures and laboratory.

FR 1201. CONSERVATION OF NATURAL RESOURCES. (3 cr)

Joint Day/Extension class: refer to daytime *Class Schedule*

Development of thought on natural resource conservation in the United States. Renewable resources and their management problems; resource conservation and environmental management related to basic ecological principles.

FR 1202. FARM AND SMALL WOODLANDS FORESTRY. (3 cr for non-forestry majors, 2 cr for majors [3 cr with paper]; prereq for ma-

jors 1100 or ¶1100) Joint Day/Extension class: refer to daytime *Class Schedule*

Status and problems of the small woodland owner. Factors influencing tree growth. Cutting practices for and marketing products of small woodlands. Establishment and care of plantations, shelterbelts, and windbreaks. Field trips.

FR 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES. (3 cr; §1201; for non-forestry students) Joint Day/

Extension class: refer to daytime *Class Schedule*

Ecological, social, and economic implications of Minnesota's soil, water, forest, wildlife, and other resources are studied in field exercise and group discussions at nature centers and natural areas. Environmental teaching techniques for the elementary indoor classroom.

FR 3100. IMPORTANT FOREST PLANTS. (1 or 2 cr; prereq Biol

1103; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Identification of forest plants as related to forest types.

FR 3101. NORTHERN FOREST ECOSYSTEMS. (3 cr; prereq

Chem 1001 or Chem 1004; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Field examination of succession, soils, silvical characteristics, tree classification, stand structure, and the ecology of regeneration.

FR 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS. (2 cr; prereq Phys 1001, Phys 1005 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Fundamentals of meteorology and climatology as applied to wildland resource management.

FR 3104. FOREST ECOLOGY. (3 cr; prereq Itasca session) Joint Day/Extension class: refer to daytime *Class Schedule*

Ecological concepts and principles as a basis for silvicultural practice. The forest as an ecosystem.

FR 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS. (1 cr; prereq FW 3600 or ¶3600; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Field identification of important plants in fisheries and a wildlife habitat.

FR 3107. FOREST ECOLOGY LABORATORY. (1 cr; §3101, 3104) Day class

Field trips to introduce forest stands, communities, and ecosystems.

FR 3110. COLLOQUIUM IN NATURAL RESOURCES. (1-4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Selected topics in natural resources.

FR 3201. FIELD FOREST MEASUREMENTS. (1 cr; prereq Math 1008; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to land survey, tree and stand measurement, and basic forest sampling techniques.

FR 3225/5225. DIRECTED STUDY EXPERIENCE. (1-5 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the adviser for the project, a prospectus, and completes progress reports on his or her project.

FR 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr; also offered as FR 5200) Joint Day/Extension class: refer to daytime *Class Schedule*

International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies.

FR 3300. ELEMENTS OF SURVEYING. (2 cr; prereq Math 1008 or high school trigonometry; given at Cloquet Forestry Center 1 week prior to fall quarter) Joint Day/Extension class: refer to daytime *Class Schedule*

Basic concepts of elementary plane surveying for use in natural resource assessment. Introduction to public land and boundary surveys and geographic information systems. Lectures and labs.

FR 5100. SILVICULTURE. (4 cr; prereq Itasca session, 1100) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to silvics, forest regeneration and site preparation techniques, intermediate silvicultural practices, and silvicultural systems.

FR 5101. FIELD SILVICULTURE. (3 cr; prereq 5100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*

Regeneration surveys, plantation inspection, site preparation, and reforestation prescription. Practice in marking for thinning and determining effect on stands. Compartment examination and prescription. Written and oral reports.

FR 5102. FOREST WILDLIFE HABITAT MANAGEMENT. (1 cr; prereq FW 3052, FR 5100, concurrent registration in FR 5101; given at Cloquet) Day class

- ◆ **new** Forest vegetation management techniques for developing and maintaining wildlife habitat; consideration of vegetation dynamics, habitat requirements and silvicultural techniques.

FR 5104. FOREST ECOLOGY. (3 cr; prereq one course in biology or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Ecological concepts and principles as a basis for conservation and management of forest ecosystems.

FOREST RESOURCES

FR 5106. SENIOR SILVICULTURE SEMINAR. (2 cr [3 cr with research paper]; prereq senior, FR 5100, or #; A-N only) Joint Day/Extension class: refer to daytime *Class Schedule*

Students prepare, present, and critique seminars on silvicultural topic of interest. Guest speakers.

FR 5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS. (3 cr; prereq Stat 3011 and AgEt 3030 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

Use of microcomputer software to solve forestry problems, applications programming, working of hardware components. Hands-on access to microcomputers as well as lectures.

FR 5114. FOREST HYDROLOGY. (3 cr; prereq Itasca session, 3103, Geo 1001 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to the hydrologic cycle and hydrologic processes. Effects of forest management activities on water yield, storm flow, and water quality.

FR 5115. FOREST HYDROLOGY, FIELD APPLICATIONS. (2 cr; prereq 5114 or #; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*

Use of hydrologic instrumentation to measure precipitation, streamflow, infiltration capacity, soil moisture, air temperature, evaporation, and selected water quality constituents. Collection and interpretation of hydrologic information to evaluate forest-use impacts on water quantity and quality.

FR 5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS. (4 cr; prereq Chem 1001 or 1004, 10 cr Biol) Joint Day/Extension class: refer to daytime *Class Schedule*

Genetic variation in forest trees, underlying causes, use. Tree growth, nutrition, and water relation. Environmental and internal regulation of growth. Plant biochemistry and photo-chemistry. Physiology related to silviculturally and ecologically significant phenomena.

FR 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS. (2 cr; prereq 1122, 5100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*

Field examination of forest soils and their relationship to site productivity and forest management.

FR 5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS. (2 cr; prereq grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Provides an introduction to the application of Geographic Information Systems (GIS) to natural resource and regional planning studies. Theory and technical points covered, emphasis on applications. Hands-on experience on microcomputer. Case study is performed, including map digitizing, data processing, and generation of map products.

FR 5142. TROPICAL FOREST ECOLOGY. (3 or 4 cr; prereq one undergrad ecology course at the 3000 or above level) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Consideration of ecological principles related to form, function and development of wet and dry tropical forests, at organismal, community and ecosystem scales. Succession, productivity, biodiversity, sustainability, agroforestry and management alternatives will be discussed. Natural distribution of forest types, causes, consequences and extent of deforestation.

FR 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY. (3 or 4 cr; prereq one undergrad plant ecology or plant physiology course at the 3000 or above level) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Implications of global change elements upon wild and cultivated vegetation, including forests, grasslands, and agricultural ecosystems. Responses at ecosystem, community, organismal and physiological scales will be addressed. Potential climate change, elevated atmospheric concentrations of carbon dioxide, ozone and other trace gases, acid deposition, and other pollutants will be considered.

FR 5152. FOREST GENETICS. (3 cr; prereq sr or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Genetic variation of forest tree species and underlying principles; application of plant breeding principles to forestry.

FR 5153. ADVANCED FOREST HYDROLOGY. (4 cr; prereq 3220, 5114 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Current hydrologic problems in the management of forested watersheds. Analytical methods to evaluate effects of vegetation management on the quantity and quality of runoff. Lecture and laboratory.

FR 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS. (3 cr; prereq grad only; given at Itasca) Joint Day/Extension class: refer to daytime *Class Schedule*
Plant identification, plant dynamics, land survey, tree measurement.

FR 5200. AERIAL PHOTO INTERPRETATION. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Types, characteristics, procurement, preparation, viewing, and interpretation of color, black-and-white, and color infrared aerial photographs; basic aerial photography; introduction to mapping; applications to resource surveys.

FR 5202. REMOTE SENSING: FIELD APPLICATIONS. (2 cr; prereq 5200, 5212; given at Cloquet) Day class

- ◆ **new** Field applications of remote sensing for inventory, mapping and monitoring forest and natural resources.

FR 5212. NATURAL RESOURCES INVENTORY. (4 cr; prereq Itasca session, AgET 3030 or equiv computer programming course with FORTRAN or BASIC language, Math 1142 or Math 1211, Stat 3011 or Stat 5021) Joint Day/Extension class: refer to daytime *Class Schedule*
Measurement of stand variables, forest products, forest growth and yield. Elementary statistics. Sampling methods for estimating characteristics of natural resources and resources use for management decision making. Lecture and laboratory.

FR 5215. FOREST FIRE MANAGEMENT. (2 cr; prereq FR 1100, Itasca session, 3103, 5100, or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Concepts, principles, and techniques of fire control and use in wildland management.

FR 5221. PLANT MOLECULAR EVOLUTION. (3 cr; prereq Biol 5003 or GCB 3022 or GCB 5022; equiv to PBiol 5221) Joint Day/Extension class: refer to daytime *Class Schedule*

Experimental molecular techniques applicable to evolutionary studies. Molecular methods of quantifying genetic diversity. Statistical methods for phylogenetic reconstruction. Application of RFLPs to the study of morphological evolution. Evolution of organellar genomes. Evolution of multigene families. Role of transposable elements in plant evolution. DNA sequence evolution. Molecular aspects of development as related to plant evolution.

FR 5222. FOREST RESOURCES INVENTORY. (2 cr; prereq 5212; given at Cloquet) Day class

- ◆ **new** Field application of sampling methods for estimating natural resource characteristics for inventory, appraisal and monitoring purposes.

FR 5226. FOREST ECONOMICS AND PLANNING. (5 cr; prereq FR 5212, AgEc 1030 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Conduct and interpretation of economic analysis, forest planning concepts, principles and techniques of forest regulation.

FR 5231. RANGE MANAGEMENT. (3 cr; prereq Biol 1103 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Important range plants; range livestock; range management methods and improvements; public grazing land administration; relationship of livestock grazing to wildlife, forest, watershed, and recreation management on public and private range lands.

FR 5232. MANAGEMENT OF RECREATIONAL LANDS. (4 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Recreational use of the forest and associated land and water. Policy problems arising from recreational demands.

FOREST RESOURCES

FR 5233. PRINCIPLES OF OUTDOOR RECREATION PLANNING. (4 cr; prereq 5232 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

For advanced students associated with design, management, and planning of recreational facilities. Planning and design principles related to recreational land use and development; parks campsites, water areas, highways, summer and winter recreational facilities.

FR 5236. FOREST RECREATION PLANNING. (1 cr; prereq 5232; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*

Recreation area and site planning, examples and managerial concerns. Field work and presentation.

FR 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION. (3 cr; prereq sr in forestry or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Basic concepts of political and administrative processes in development of natural resource policies and programs. Policy processes, agenda setting, political decision rules, strategies for achieving agreement, participants in policy development, public means of implementing policies and case examples.

FR 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES. (3 cr; prereq FR 5240 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Advanced concepts of political and administrative processes important to the development of natural resource policies and programs. Issue creation and agenda setting theories, incremental decision-making styles, role of analysis and analytical information, actions of major policy participants (e.g., courts, legislatures, interest groups, media), program planning, budgeting and staffing, and evaluation of natural resource case studies.

FR 5248. HARVESTING AND ENGINEERING. (3 cr; prereq CE 3100; given at Cloquet) Joint Day/Extension class: refer to daytime *Class Schedule*

An introduction to harvesting systems, relationship to forest management, and preparation and administration of timber sales. Fundamentals of location, construction, and maintenance of forest roads.

FR 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES. (2 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

International perspective on important resource issues, including integration of natural resource, social, and economic considerations. Overviews of issues and case studies. Term paper, other requirements.

FR 5257. RECREATION LAND POLICY. (3 cr; prereq 5232 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
(Same as Rec 5160) Policy issues affecting the use and management of lands devoted entirely or in part to recreational objectives.

FR 5259. ANALYSIS OF OUTDOOR RECREATION BEHAVIOR. (3 cr; prereq 5232, RRM major or grad student or #; offered alt years beginning 1992) Joint Day/Extension class: refer to daytime *Class Schedule*

Development of environmental framework for understanding recreation behavior. Contributions of several disciplines, current cultural trends, management implications.

FR 5262. REMOTE SENSING OF NATURAL RESOURCES. (4 cr; offered alt yrs beginning 1993) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to remote sensing for natural resource inventories, land use analyses, and environmental monitoring activities; photographic, thermal, multispectral, and radar sensing procedures; airborne and satellite systems; visual and computer-assisted analysis techniques; oriented toward an interdisciplinary audience.

FR 5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT. (3 cr; prereq FR 5212, 5226 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Forestry applications of quantitative techniques in allocation and other decision-making problems. Mathematical programming, simulation, and other techniques.

FR 5401. SENIOR TOPICS. (ar cr; prereq sr in forestry or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Independent study in a field of interest to the student. Work must be planned with a forestry faculty member.

FR 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION. (3 cr) Extension class

Intended for elementary school teachers. Study of soil, water, forest, and wildlife resources of Minnesota and the biological principles and ecological implications of management.

FR 5412. ADVANCED REMOTE SENSING. (4 cr; prereq FR 5262 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Working knowledge of quantitative remote sensing. Both theoretical basis and practical aspects, including energy-matter interactions, radiation measurements and sensors, and digital analysis.

FR 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Water quality management practices and policies in rapidly changing societies; emphasis on developing countries.

FR 5500. URBAN FOREST MANAGEMENT. (3 cr; prereq 5100 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Discussion and development of basic concepts. Introduction to terminology and principles of urban tree inventory, propagation, and care; management case studies; equipment operation and costs.

FR 5703. COLLOQUIUM IN NATURAL RESOURCES. (1-2 cr; prereq varies with topic or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Colloquium on specialized topics in forest biology, silviculture, and related resource management.

FR 8100. RESEARCH PROBLEMS: SILVICULTURE. (ar cr) Day class

FR 8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY. (ar cr) Day class

FR 8102. RESEARCH PROBLEMS: FOREST TREE GENETICS. (ar cr) Day class

FR 8103. RESEARCH PROBLEMS: FOREST HYDROLOGY. (ar cr) Day class

FR 8104. RESEARCH PROBLEMS: FOREST ECOLOGY. (ar cr) Day class

FR 8105. ADVANCED FIELD SILVICULTURE. (3 cr; prereq FR 5101, #) Day class

Selected current problems and research in silviculture. Plant-soil relationships with particular reference to forest soils. Methods of forest soil investigations in the field and laboratory.

FR 8106. TOPICS IN SILVICULTURE—FOREST SOILS. (ar cr; prereq FR 5100 and 5 cr in soils or #) Day class

FR 8108. FOUNDATIONS OF RENEWABLE RESOURCES RESEARCH. (3 cr) Day class

FR 8200. RESEARCH PROBLEMS: FOREST MANAGEMENT. (ar cr) Day class

FR 8201. RESEARCH PROBLEMS: FOREST ECONOMICS. (ar cr) Day class

FR 8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS. (ar cr) Day class

FR 8203. RESEARCH PROBLEMS: FOREST RECREATION. (ar cr) Day class

FR 8204. RESEARCH PROBLEMS: FOREST POLICY. (ar cr) Day class

FR 8205. RESEARCH PROBLEMS: REMOTE SENSING. (ar cr) Day class

FR 8206. ADVANCED MANAGEMENT OF RECREATIONAL LANDS. (3 cr; prereq FR 5233, EBB 3004 or #) Day class

Relationship of people as recreationists to the natural environment. Principles of manipulation of plant and animal communities for outdoor recreation objectives. Lectures, readings, discussions, reports, field trips.

FR 8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS.

(3 cr; prereq #) Day class

Public and private forestry projects; analysis of commercial profitability and application of benefit-cost analysis; preparation of feasibility studies; case studies.

FR 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

(3 cr) Day class

Identification and analysis of major international, national, and state issues of importance to natural resource management. Review of literature, case studies, and guest speakers.

GENERAL COLLEGE (GC)

340 Appleby Hall, 625-5529

Jay Hatch, 340 Appleby Hall, 625-9346

GC 1111. SCIENCE IN CONTEXT: WEATHER AND CLIMATE.

(5 cr; 5 lect, 1 lab hrs per wk) Day class and Extension class

Weather patterns; interactions among atmosphere, oceans, land surfaces, and earth motion. Storms, seasonal change, climatic change, fair weather, air pollution, and distribution of moisture and energy from theoretical and applied viewpoints. Scientific principles applied to analyzing and forecasting weather, interpreting climates and climatic change, and understanding individuals' interaction with atmospheric environment.

GC 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS. (5 cr) Day class and Extension class

Concepts of ecology (organization of ecosystems, material cycling, energy flow and production, population dynamics, and community interaction) needed to understand proximate and ultimate causes of environmental problems such as world hunger, endangered species, deforestation, solid and hazardous wastes, global climate change, acid rain, and cultural eutrophication. Frameworks and methodologies for critically evaluating impacts and proposing interventions.

GC 1133. NATURE STUDY. (4 cr; 4 hrs integrated lecture, laboratory and field work) Extension class

General natural history for students with little or no prior training in biology. Common Minnesota plants and animals examined in the field from the view-

point of the informed amateur naturalist. Natural habitat associations; field observation and identification techniques.

GC 1171. PHYSICAL GEOLOGY. (5 cr; 5 lect, 3 or more lab hrs per wk) Day class

Description and development of common land features—valleys, mountains, rivers, lakes. Processes responsible for their origin and change. Types of surface materials. Movements inside earth and their effects on its surface. Self-paced laboratory: mineral and rock analysis, topographic map reading, landform identification, landscape interpretation.

GC 1173. GEOLOGY OF THE NATIONAL PARKS. (5 cr; 7 hrs integrated lecture and laboratory) Day class

Processes that produced spectacular scenic and geologic features of North America's national parks and monuments, described using a regional approach. Basic geology introduced as needed. Cooperative learning format.

GEOGRAPHY (Geog)

College of Liberal Arts

414 Social Sciences, 625-6080

R. Skaggs, 568 Social Sciences, 625-6643

Geog 1401. PHYSICAL GEOGRAPHY. (5 cr; §NSci 1501) Joint Day/Extension class: refer to daytime *Class Schedule*

Distribution patterns of climate, relief, vegetation, and soils, regional differences in problems of physical development.

Geog 1425. INTRODUCTION TO METEOROLOGY. (4 cr; §Soil 1262) Joint Day/Extension class: refer to daytime *Class Schedule*

(Same as Soil 1262) The atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns, meteorological instruments and observation; plotting and analysis of maps; forecasting.

Geog 3361. LAND USE AND THE FEDERAL GOVERNMENT. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

The statutory and regulatory framework in which individuals choose to use land in the United States; the federal role in creating the framework.

Geog 3362. LAND USE AND STATE GOVERNMENT. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

The statutory and regulatory framework in which individuals choose to use land in the United States; the state's role in creating the framework.

Geog 3421. CLIMATOLOGY. (4 cr; prereq 1401 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

World distribution of climatic elements; methods of arranging climatic data; climatic classifications and world distributions of climatic types; general circulation; climatic change and climatic fluctuations.

Geog 3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY. (4 cr; not open to biology majors) Joint Day/Extension class: refer to daytime *Class Schedule*

World distribution of plants and animals; biological and ecological background; the geographical picture; the paleoecological record.

Geog 5361. LAND IN AMERICA. (4 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Land ownership in the United States.

Geog 5424. APPLIED CLIMATOLOGY. (3 cr; Soil §5424; prereq Geog 3421 or Soil 5420 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Application of climatic principles and data to selected problems in environmental management and agriculture.

Geog 5441. QUATERNARY LANDSCAPE EVOLUTION. (4 cr; prereq Geog 1401 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Examination of the roles of geomorphic history, climate change, soil development, and vegetation change in the evolution of landscape patterns during the Quaternary, with emphasis in North America.

Geog 5444. GEOGRAPHY OF WATER RESOURCES. (4 cr; prereq two courses in physical geography or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Distributional aspects of the magnitude, quality, and dynamics of water resources. Aesthetic, recreational, and material production uses of water; consequences of human actions in the hydrosphere, especially in fresh water.

Geog 5601. INTRODUCTION TO LAND USE PLANNING. (4 cr; §PA 5601) Joint Day/Extension class: refer to daytime *Class Schedule*

The context of planning within the changing geographic patterns of land use. The nature of land use plans; purpose and process of land use planning.

Geog 8340. SEMINAR: LAND USE PLANNING. (3 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (1 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA. (3 cr; prereq 8344) Joint Day/Extension class: refer to daytime *Class Schedule*

Geog 8420. SEMINAR: CLIMATOLOGY. (1-3 cr; prereq #) Joint Day/Extension class: refer to daytime *Class Schedule*

Detailed study of selected topics. Topics vary from year to year; examples include modeling, climatic variability, predictability, severe local storms, drought, and energy balance.

GEOLOGY AND GEOPHYSICS (Geo)

Newton Horace Winchell School of Earth Sciences

Institute of Technology

106 Pillsbury Hall, 624-1333

H.O. Pfannkuch, 2D Pillsbury Hall, 624-1620

Geo 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY. (4 cr; 4 lect hrs) Day class and Extension class

A nonmathematical introduction to earth, its internal structure; processes that shape its surface; theory of plate tectonics; action of streams, glaciers, waves, wind, and groundwater; limnology; fossil fuels and mineral deposits; environmental geology; planetary geology; and the geology of Minnesota.

Geo 1005. GEOLOGIC PERSPECTIVES ON ENERGY. (4 cr; 4 lect hrs per wk) Day class and Extension class

Introduction to the geologic aspects of energy resources, conventional and unconventional. History of energy use, distribution and amounts of known and potential reserves, environmental aspects and implications of U.S. consumption patterns.

Geo 1012. PLANET EARTH. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

A nonmathematical introduction to planet Earth. Emphasis will be on the relationships between the various earth systems; the solid earth, hydrosphere and the atmosphere; and on various natural cycles that control the way the planet works naturally and how human interactions are perturbing the natural cycles and their rates.

Geo 1019. OUR CHANGING PLANET. (4 cr; §Ast 1019, §EEB 1019) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Study of interrelationships among earth's subsystems—solid earth, oceans, atmosphere and biosphere, and the solar and galactic super-systems. The way the earth works will be understood by studying the interactions of the natural cycles, their rates, feedbacks, etc., and human impacts.

Geo 1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA. (1 cr; prereq 1001 or 1001 or #; one 2-hr lab) Day class and Extension class

Ten laboratory exercises based on the geology of Minnesota. These labs will introduce students to the bedrock, glacial history, topography, mineral resources, and environmental geology of the state through the use of appropriate minerals, rocks, topographic and geologic maps.

Geo 1111. INTRODUCTORY PHYSICAL GEOLOGY. (5 cr; prereq high school or college chemistry or #; 3 lect hrs, 1 rec hr, and two 2-hr labs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

For prospective majors and others desiring a more intensive course.

Geo 1601. OCEANOGRAPHY. (4 cr; 3 lect and 1 lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

How various processes in the ocean interact; analogies between the oceans and Lake Superior and smaller lakes in Minnesota. Topics include marine biology, waves, tides, chemical oceanography, marine geology and human interaction with the sea. Lab work includes study of live marine invertebrates and manipulation of oceanographic data.

Geo 3401. INTRODUCTORY MINERALOGY. (5 cr; §5004, §5404; prereq 1001 or 1111 or #, 1 term college chemistry, Math 1221; 3 lect and 6 lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

Crystallography, crystal chemistry, and crystal physics. Physical and chemical properties, crystal structures, and chemical equilibria of the major mineral groups. Laboratory includes crystallographic, polarizing microscope, X-ray powder diffraction exercises, and hand specimen mineral identification.

Geo 5004. MINERALOGY. (4 cr; §3401; not open to geology, geophysics, and geological or mineral engineering majors; prereq Math 1221, 1 term college chemistry, and #; 3 lect and 6 lab hrs per wk; offered when demand warrants) Joint Day/Extension class: refer to daytime *Class Schedule*

For description, see Geo 3401.

Geo 5108. ADVANCED ENVIRONMENTAL GEOLOGY. (4 cr; prereq geology core courses 1111 through 5201 or equiv or #) Joint Day/ Extension class

Human impact on the geological environment and the effect of geology; geologic processes on human life from the point of view of ecosystems and biogeochemical cycles. Geologic limits to resources and carrying capacity of the earth. Land use planning, environmental impact assessment, ecogeologic world models. Field project.

Geo 5201. STRUCTURAL GEOLOGY. (5 cr; prereq 3401; 3102; IT: upper division major in Geo, Geophys, GeoE, MinE; CLA: jr or sr GEO major; or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Primary and secondary structures of rocks, mechanics and modes of deformation, introduction to field methods in geology. Field trips.

Geo 5251. GEOMORPHOLOGY. (4 cr [5 cr with term project]; prereq 1001, Math 1111 or #; 3 lect, 2 lab hrs per wk; lab often used for field trips; offered when demand warrants) Joint Day/Extension class: refer to daytime *Class Schedule*

Study of the origin, development, and continuing evolution of landforms in various environments. Environmental implications are emphasized. Topics include weathering, slope and shore processes, fluvial erosion and deposition, wind action, tectonics, and impact phenomena.

Geo 5261. GLACIAL GEOLOGY. (4 cr [5 cr with term paper or map lab]; prereq 1002 or 3112; offered when demand warrants) Joint Day/Extension class: refer to daytime *Class Schedule*

Formation and characteristics of modern glaciers; erosional and depositional features of Pleistocene glaciers; history of Quaternary environmental changes in glaciated and nonglaciated areas. Field trips.

Geo 5311. GENERAL GEOCHEMISTRY. (4 cr; prereq 2 qtrs college chemistry or #) Joint Day/Extension class: refer to daytime *Class Schedule*

This course will develop principles pertaining to the distribution and control (structural, thermodynamic and kinetic) of chemical species in the earth and hydrosphere.

Geo 5313. AQUEOUS GEOCHEMISTRY. (4 cr; prereq 5311, Chem 5520 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Course emphasizes general principles of solution chemistry and with application to geology. These include solution-mineral equilibria, redox processes in natural waters, and the geochemistry of hydrothermal fluids.

Geo 5601. LIMNOLOGY. (4 cr; §EEB 5601; prereq Chem 1005 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

Description and analysis of events occurring in lakes, reservoirs, and ponds, beginning with their origins and progressing through study of their physics, chemistry, and biology. Emphasis on interrelationships of these parameters and on effects of civilization on lakes.

Geo 5641. GENERAL AND PHYSICAL HYDROGEOLOGY.

(4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105; Geo majors: core curriculum through 3402 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction to theory of groundwater geology, hydrologic cycle, watershed hydrology, Darcy's law, governing equations of groundwater motion, flow net analysis, analog models, and groundwater resource evaluation and development.

Geo 5642. QUANTITATIVE HYDROGEOLOGY. (4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105; Geo majors: core curriculum through 3402 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Applied analysis of steady and transient equations of groundwater motion and chemical transport using analytical and numerical methods. Topics include numerical flow net analysis, well hydraulics, salt-water intrusion problems, and unsaturated flow.

Geo 5643. CHEMICAL HYDROGEOLOGY. (4 cr; prereq 1001, Chem 1052, Math 1252, Phys 1105, Geo majors: core curriculum through 3402 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction to the chemistry of natural waters, acid-base and redox reactions, carbonate equilibria, contaminant hydrology, isotope hydrology, and chemical modelling.

HISTORY OF SCIENCE AND TECHNOLOGY

Geo 8262. QUATERNARY PALEOECOLOGY AND CLIMATE.

(4 cr; prereq 5261 or #; offered when demand warrants) Day class

Principles of stratigraphic pollen analysis. Pleistocene and Holocene vegetation and climatic history as interpreted from pollen diagrams from different parts of the world. Paleoclimatic interpretation of ocean-sediment cores.

Geo 8602. ADVANCED LIMNOLOGY. (3 cr; prereq 5601 or equiv, #) Day class

Detailed study of selected problems in limnology using current and classical literature. Term paper required.

Geo 8612. ANALYTICAL GEOHYDROLOGY. (3 cr; [4 cr with term paper]; prereq Math 3221, CE 3400 or #; offered when demand warrants) Day class

Microphysics of flow through porous media; geological factors in aquifer performance; equations for groundwater flow; analysis of pumping tests; potential theory in groundwater flow; computer and analog models of aquifers; groundwater basin analysis; contaminant fate and transport through aquifers.

Geo 8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA. (2 or 3 cr; prereq CE 3400 or Chem 5520 or equiv or #; 2 lect hrs per wk and term project ar; offered when demand warrants) Day class

Microscopic flow parameters, momentum, mass and energy transport through porous media, rate processes, coupled processes and nonequilibrium thermodynamics, geologic controls of natural flow systems in porous media and aquifers.

HISTORY OF SCIENCE AND TECHNOLOGY (HSci)

Babbage Institute for History of Information Processing

103 Walter Library, 624-5050

Arthur Norberg, 103 Walter Library, 624-5050

HSci 3331/5331. TECHNOLOGY IN AMERICAN CULTURE.

(4 cr) Day class

Technology in America with emphasis on its impact on society and culture.

Traces the growth of American technology in its cultural and intellectual context from colonial period to present.

HORTICULTURAL SCIENCE (Hort)

College of Agriculture

305 Alderman Hall, 624-5300

Evonne Kuyper, 305 Alderman Hall, 624-4242

Hort 1010. HOME HORTICULTURE. (4 cr) Extension class: Fall Qtr; Day class: Spring Qtr

- ◆ **new** For non-horticulture majors. Fundamental concepts of plant identification, growth, and culture with practical applications to home landscape, floral design, house plants, and fruit, flower, and vegetable gardening. Lecture and laboratory.

Hort 1021. WOODY PLANT MATERIALS. (5 cr) Day class: Fall Qtr; Extension class: Spring Qtr

- ◆ **new** Taxonomy, ecology, and landscape uses of trees, shrubs, and evergreens. Lecture, laboratory, field trips.

Hort 1022. HERBACEOUS PLANT MATERIALS. (5 cr) Day class and Extension class

- ◆ **new** Taxonomy, ecology, and landscape uses of perennial and annual flowers, tender and hardy bulbs, ground covers, wildflowers.

Hort 1023. INDOOR PLANTS AND LANDSCAPES. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Indoor plants and landscapes benefit people in many ways. Course focuses on the selection, identification, care, growth and use of plants in the home and other human environments. Field trips will demonstrate good examples of interior landscaping.

Hort 1036. PLANT PROPAGATION. (5 cr) Day class and Extension class

- ◆ **new** Principles and techniques of propagating plants by seeds, cuttings, grafts, buds, layers, division, and plant tissue culture. Lectures on principles; laboratories on practice of various propagating techniques.

Hort 3001. GROWTH REGULATION OF HORTICULTURAL PLANTS. (5 cr; prereq Biol 1103 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** The scientific basis for horticultural practices that manipulate growth, development, and yield will be examined. A comparative approach including laboratory exercises will encourage active learning.

Hort 3002. HORTICULTURAL CROPPING SYSTEMS. (5 cr; prereq Hort 1036, Biol 1103) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** The identification, manipulation and management of production systems generic to all horticulture commodities. Greenhouse production, field production and container production will be studied relative to providing basic optimum conditions for yield maximization with appropriate resources.

Hort 3003. PLANT GENETICS AND IMPROVEMENT. (4 cr; prereq Biol 1009) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of plant genetics, genetic and environmental variation, relationships of genetics to crop evolution and plant breeding, conservation and use of wild crop relatives in breeding. Laboratory experiments investigate hybridization, variation, and selection in horticultural crops and other plants.

Hort 3004. APPLICATIONS OF PLANT BIOTECHNOLOGY. (4 cr; prereq Hort 3003 or GCB 3022; Chem 1002 or 1005 or BioC 3001) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** The fundamentals of plant molecular biology and biotechnology and their practical applications to plant propagation, crop improvement, and research will be discussed. Laboratories will provide students with skills in biotechnology.

Hort 3030. LANDSCAPE DESIGN OF RESIDENTIAL AND SMALL COMMERCIAL SITES. (4 cr; prereq 1021, Ind 1600 or LA 1025) Day class

- ◆ **new** Theory and practice of design for home grounds and small commercial sites. Site analysis, needs assessment, space organization, selection of materials, and plan preparation. Lecture and graphics laboratory.

Hort 3040. LANDSCAPE DESIGN AND IMPLEMENTATION. (5 cr; prereq 3030) Day class

- ◆ **new** The course builds on design techniques learned in Hort 3030. Architectural and graphic techniques as well as design concepts in relation to horticultural plant performance and maintenance will be covered. Implementation of student's design will encompass grading, site manipulation, and plant installation.

Hort 3072. TURF MANAGEMENT. (4 cr; prereq Soil 3125, Hort 1100 or Agro 3020) Extension class: Winter special term; Day class: Spring Qtr

- ◆ **new** General landscape maintenance and turf culture. Work in areas of industrial grounds maintenance, park and recreation area maintenance, and general lawn care.

Hort 5001. HARVEST TO MARKET OF HORTICULTURAL CROPS. (3 cr; prereq PBio 3131) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Physiological processes of horticultural crops after harvest as related to maturity, time to harvest, quality, ripening, senescence, handling, storage, and marketing. Interdisciplinary approaches to problem solving and decision making in post harvest management.

Hort 5026. LANDSCAPE MANAGEMENT. (5 cr; prereq 1100 or 1036, 1021) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Applying basic biological principles to establishing and maintaining horticultural plantings, including commercial, private utility, recreational, highway, and park lands. Techniques and equipment for landscape plantings; adoptive management models for business and institutional organization.

Hort 5032. TREE FRUIT PRODUCTION. (4 cr; prereq 1100; PBio 3131 recommended; offered 1994-95 and alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of tree fruit production. Tree fruits of the world, with emphasis on temperate tree fruits. Site selection, cultural and management practices, taxonomic classification, physiological and environmental control of plant development, dwarfing, growth regulation compounds, pest control. Lecture, laboratory, field trips.

Hort 5033. SMALL FRUIT PRODUCTION. (3 cr; prereq 1100; PBio 3131 recommended; offered 1993-94 and alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of small fruit production. Major small fruit crops of the United States. Site selection, cultural and management practices, systematics, physiological and environmental control of plant development, pest control. Lecture, laboratory, field trips.

Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE. (5 cr; prereq 1100 or Agro 1010, Soil 3125; PBio 3131 recommended) Joint Day/Extension class

- ◆ **new** Crop cultural and product handling and use systems in various world regions. History and evolution of species and product development. Seed and stand establishment, propagation, pest management. Applied physiology and genetics of fruit, bulb, tuber initiation; sink development, maturation, and quality. Lecture, laboratory, field trips.

Hort 5040. PLANT GROWTH REGULATION. (4 cr; prereq 15 cr plant sci incl 3 cr plant bio) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of plant growth and development in relation to optimizing cropping efficiency and product quality. Emphasis on analysis of physiological and morphogenetic basis of horticultural practices to regulate growth and development. Exercises in using these principles to solve horticultural problems.

Hort 5042. TURF GRASS SCIENCE. (5 cr; prereq 3072, PIPa 1001, PBio 3131) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** For advanced students in turf with career objectives in professional turf management. All phases of the turf industry, with emphasis on the ecology, physiology, and theory of turf population dynamics and on specialized management situations such as golf course, commercial sod production, and fine turf athletic situations.

Hort 5046. NURSERY MANAGEMENT I. (4 cr; 5046-5047-5048 †; prereq 1021, 1100) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Introduction, history, organization, and scope of the nursery industry. General nursery business administration, production schedules, and cultural management for seed beds and field grown stock. Field trips required.

Hort 5047. NURSERY SCHEDULING AND ENTERPRISE DEVELOPMENT. (2 cr; 5046-5047-5048 †; prereq 5046) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Development of specific crop schedules using current technical and economic data for efficient production. Development of a total nursery enterprise designed for a workable and profitable business establishment.

Hort 5048. NURSERY MANAGEMENT II. (4 cr; 5046-5047-5048 †; prereq 5047) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Pest management and government regulations concerning the nursery industry. Container growing operations and marketing of all products. Specific topic research and nursery operation development by the student. Laboratory includes field trips and greenhouse and field training in nursery operations. Field trips required.

Hort 5054. COMMERCIAL FLORICULTURE PRODUCTION PRACTICES. (4 cr; prereq 1036, 3002, PBio 3131) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of commercial bedding plant production systems. Major bedding plant crops and their cultural practices will be emphasized. Lecture, laboratories and field trips will illustrate commercial production techniques and provide opportunities for application of these methods to bedding plant crops.

Hort 5055. COMMERCIAL FLORICULTURE PRODUCTION SYSTEMS. (5 cr; prereq 1036, 3002, PBio 3131 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Emphasis on problem-solving and management practices in floricultural crop production. Topics include cultural practices, diagnosis of problems, interpretation of soil/leaf analyses, scheduling crop production and mechanization and computerization of greenhouse operations. Lecture, laboratory, field trips.

Hort 8023. EVOLUTION OF CROP PLANTS. (4 cr; prereq 13 grad-level credits) Day class

- ◆ **new** Origin, distribution, and evolution of cultivated plants; implication of evolutionary processes on crop breeding for needs of people today.

HOUSING (Hsg)**College of Ecology**

240 McNeal Hall, 624-9700

Evelyn Franklin, 240 McNeal Hall, 624-2290

Hsg 1401. RESIDENTIAL TECHNOLOGY. (4 cr, §1801; prereq soph or #; Phys 1001 or 1041) Day class

Survey of equipment and technological systems in a residential environment. Emphasis on consumption and conservation of natural resources and energy sources and human considerations in kitchen planning and appliance design. Lecture, discussion, and laboratory.

Hsg 3463. ENVIRONMENT: HOUSING AND COMMUNITY.

(4 cr, §3863; prereq 1400 or 1851 or #) Day class

Housing process from development to occupancy, the many factors involved. Emphasis on design of physical environment and relationship of housing to neighborhood, community, city, and metropolitan area.

Hsg 5482. THE FAMILY AND ENERGY ISSUES. (3 cr, §5801; prereq 1400 or 1851, 1401 or 1801 or #; offered 1992-93 and alt yrs) Day class

Analysis of family behavior as it relates to energy use, impact of scarce resources on quality of family functioning, family/energy issues in future.

INTERDEPARTMENTAL STUDY (ID)**College of Liberal Arts**

220 Johnston Hall, 624-7577

Lisa Murphy, 220 Johnston Hall, 624-7577

ID 3970. DIRECTED STUDIES. (3-15 cr per qtr; prereq OSLO [Office for Special Learning Opportunities] approval, Δ) Day class

Individual readings and research on topics that cross departmental lines.

ID 5525-5526. GARBAGE, GOVERNMENT, AND THE GLOBE.

(4 cr winter, 4 cr spring) Extension class

Different topics covered each quarter. Students may register for one or two quarters. Call (612) 625-3898 for information as to when specific topics will

be offered, and for availability of graduate credit. A rigorous analysis of how garbage affects not only our economy, politics, environment, and health, but also the lives of untold future generations of humans and other species. The problem of garbage does not lend itself to narrow disciplinary approaches, but calls for cooperation among many fields. Reflecting this need for boundary crossing, this course offers an interdisciplinary approach to learning about messy, real-world problems. Faculty from the Institute of Technology, the Carlson School of Management, and the colleges of Agriculture, Biological Sciences, and Liberal Arts join students in examining topics such as the movement of toxic materials through the environment; the management of solid wastes, especially those generated by incinerators, power plants, municipal water treatment plants, etc.; the philosophic grounding of environmental exploitation in the ethics of humanism; the physical, chemical, and biological aspects of soils in environmental planning and conservation decisions; and the effect of environmental problems on economic competitiveness and domestic and international corporate operations. The courses will include lectures, exams, projects, films, and visiting speakers.

INTERNATIONAL RELATIONS (IntR)**College of Liberal Arts**

248 Social Sciences, 624-9353

Karlyn Eckman, 110 Green Hall, 624-3400

IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: ENVIRONMENT AND DEVELOPMENT IN THE THIRD WORLD.

(4 cr) Extension class: Fall Qtr, Sec 3

- ◆ **new** A broad, introductory overview of the issues related to environmental degradation and economic development in the Third World. A review of current international policy and programming efforts to promote sustainable development and natural resource management.

IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT. (4 cr) Extension class: Spring Qtr, Sec 5

- ◆ **new** Provides International Relations and other interested CLA students with a basic understanding of ecological processes and of contemporary global environmental problems and issues.

JOURNALISM AND MASS COMMUNICATION (Jour)

College of Liberal Arts

111 Murphy Hall, 625-9824

Julia Corbett, 111 Murphy Hall, 625-9824

Jour 5133. INTERPRETIVE REPORTING ABOUT SCIENCE.

(4 cr; prereq 3101 or #, Δ; offered 1992-93) Day class

Role of journalistic communication in science; scientist-journalist relationships; communicating results of scientific investigations to public, specialized audiences, industry.

LANDSCAPE ARCHITECTURE (LA)

College of Architecture and Landscape Architecture

125 Architecture, 625-6860

Joan Nassauer, 125 Architecture, 625-6568

LA 1401. THE DESIGNED ENVIRONMENT. (4 cr; no prereq)

Joint Day/Extension class

- ◆ **new** (Same as Arch 1500) Principles and traditions within the design disciplines of architecture, landscape architecture, and urban design, along with references in the arts, sciences, and literature, will be explored in this review of the formal constructs of the designed environment.

LA 3413. HISTORY OF LANDSCAPE ARCHITECTURE. (4 cr;

Arch 3413, ArtH 3412) Joint Day/Extension class

- ◆ **new** (Same as Arch 3413) Lecture course introduction to history and theoretical issues of landscape architecture in topologically based survey format. Course covers landscape design from the ancient to the modern periods.

LA 5211. MAKING LANDSCAPE SPACE. (6 cr; requires admit- tance to BED or BLA degree programs or Δ) Day class

- ◆ **new** A design exploration using three-dimensional models to make outdoor space for human habitation and use with landforms, structures and plants. Development of form vocabulary to provide spatial order. Use of metaphorical thinking to imbue designed landscape space with meaning.

LA 5212. ECOLOGICAL INFORMANTS OF DESIGN. (6 cr; pre- req 5211) Day class

- ◆ **new** This course draws from literature in landscape ecology, aesthetics, and the design arts to teach students to select and analyze ecological phenomena that influence the function and human experience of landscape, and to use the fundamental aesthetic principles to portray those phenomena in design.

LA 5222. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/ LAND USE CONCEPTS AND IMPLEMENTATION OF PLANT- ING DESIGNS. (4 cr; prereq two courses in plant materials: Hort 1021, 1022) Day class

- ◆ **new** Lectures, presentations, field trips, readings, and projects related to principles and practices of using plant materials in an ecologically sound and environmentally sensitive manner. Principles derived from prairie, northwoods, riverine, and wetland environments. Integration of naturalized materials in environments of various scales. Investigation of planting implementation skills.

LA 5431. HISTORY OF LANDSCAPE ARCHITECTURE: INDIVIDUAL INFLUENCES. (4 cr; prereq 3413) Day class

- ◆ **new** Lectures, presentations, field trips, readings, papers and/or projects. Assessment of the influences of individuals upon the formation of the profession of landscape architecture, from 1800 to present.

LA 5571. LANDSCAPE CONSTRUCTION: LANDFORM SYSTEMS. (4 cr; prereq 5211 or #) Day class

- ◆ **new** Theory and professional applications of landform systems for design. Topics include: landform topology, representation methods, manipulation techniques, use of survey data, and earthwork construction issues. Advanced issues include landscape integrity assurance and economic performance.

LA 5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORM- ANCE. (4 cr; prereq 5211 or #) Day class

- ◆ **new** Lectures and assignments in the theory and application of appropriate standards, proportions and dimensions for spatial performance in landscape architecture. Advanced topics include spatial accommodation of people and automobiles in landscape applications, and issues in land use and development controls.

LA 8222. THE LANDSCAPE ARCHITECTURAL DESIGN OF COMMUNITY PLACES. (6 cr; prereq 8221) Day class

- ◆ **new** Design studio. Examines public places as settings for the gathering of people. Historic precedent is used as an idea resource for the design of streets and outdoor public gathering spaces in the context of mixed use urban and suburban settings.

LA 8223. REGIONAL LANDSCAPE DESIGN. (6 cr; prereq LA/Geog/PA 5562 or FR 5130/LA 8222 or Δ) Day class

- ◆ **new** A design exploration of landscape ecology, landscape perception and public policy as informants of design decision-making in regional landscapes at or exceeding a township level scale. Geographic Information Systems are used as design tools.

LA 8231. URBAN DESIGN LANDSCAPE. (6 cr; no prereq) Day class

- ◆ **new** Advanced design studio that explores urban and landscape design principles through analysis of case studies and the development of strategies from landscape systems within the urban environment.

LA 8232. DESIGN OF RECREATIONAL LANDSCAPES. (6 cr; prereq 8223) Day class

- ◆ **new** Design studio. Analysis, development, and presentation of designs for diverse recreational landscapes.

LA 8574. LANDSCAPE CONSTRUCTION: MECHANICAL SYSTEMS. (4 cr; prereq 8221 or #) Day class

- ◆ **new** Lectures, projects and exercises in the landscape architectural applications of storm water management, urban utilities, irrigation, electrical and lighting systems and techniques. Advanced topics include systems planning and design, historical precedents, professional design communication, and landscape construction, integrity and performance issues.

LA 8801. CONCEPTS OF LANDSCAPE EVALUATION. (4 cr; no prereq) Day class

- ◆ **new** Studies on philosophical basis for wide-ranging approaches to evaluating qualitative aspects of landscape. Emphasis on aesthetic factors and integration of landscape evaluation into regional design decision-making.

LA 8803. THE SUBLIME, THE BEAUTIFUL AND THE PICTURESQUE: THEORY AND PRACTICE. (4 cr; prereq 3411 or 5431 or LA or Arch grad student) Day class

- ◆ **new** Readings, discussion, and research paper on 18th and early 19th century writings, theoretical bases for landscape design. Analysis of executed designs, theoretical relationships to current design issues.

LA 8804. LANDSCAPE ECOLOGY AND DESIGN. (4 cr; prereq LA grad student or #) Day class

- ◆ **new** Reading, discussion, and field investigations to establish a landscape ecological basis for designing ecosystems as a part of human settlement. Emphasis on 1) the design and planning implication of scientific conclusions and theory, and 2) meaningful techniques for creating high functioning ecosystems in inhabited landscapes.

LAW SCHOOL (Law)

285 Law Building, 625-1000
Daniel Farber, 350 Law, 625-1022

Law 5215. ENVIRONMENTAL LAW. (3 cr) Day class

Legal aspects of major environmental problems with emphasis upon pervasive issues that reappear in various regulatory contexts: e.g., the degree to which environmental quality should be protected; who should bear the cost enhancing environmental quality; the allocation of responsibilities among courts, legislatures, and administrative agencies; the role of citizens' groups and environmental litigation.

Law 5885. ADVANCED ENVIRONMENTAL LAW. (2 cr; Law 5215) Day class

This seminar will provide in-depth coverage of current issues in environmental law, with visiting lectures by environmental law specialists. Among the topics covered will be hazardous waste disposal, water pollution, and toxic torts. Student papers will analyze current controversial issues in environmental law. Satisfies senior writing requirement.

MECHANICAL ENGINEERING (ME)

Institute of Technology

125 Mechanical Engineering, 625-0705

B.Y. Liu, 130 Mechanical Engineering, 625-6574

ME 5603. THERMAL ENVIRONMENTAL ENGINEERING. (4 cr; prereq 3303, 5342 or equiv; 4 lect hrs per wk) Joint Day/Extension class
Thermodynamic properties of moist air; H-W diagram for moist air; solar radiation; heat and water vapor transmission in structures; effects of thermal environments upon people, processes, and materials; thermal loads, thermal environmental control systems.

ME 5604. HEATING AND COOLING LOADS IN BUILDINGS. (4 cr; prereq 5603; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Transient heat transfer through structures; lighting and other internal gains; ventilation; winter and summer design loads; seasonal energy estimation methods; computer simulation programs; codes and standards.

ME 5605. REFRIGERATION AND AIR CONDITIONING SYSTEMS. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Capor compression and absorption refrigeration systems; heat pumps; heat exchangers; piping and duct layout and sizing; operations and control of building air conditioning systems.

ME 5609. AIR POLLUTION. (4 cr; prereq 3303 or #, IT or grad student; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

Air pollution sources, atmospheric transport, transformations and fate. Air pollution meteorology, dispersion, and models. Basic chemistry of secondary pollutant formation, aerosol growth, air pollutant visibility relationships. Standards and regulations.

ME 5610. AIR POLLUTION CONTROL. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

Control devices and techniques for gases and particulate emissions from

stationary and mobile sources. Cyclones, electrostatic precipitators, bag houses, wet and dry scrubbers, combustion modification, and alternate fuels.

ME 5613. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 3303, IT or grad student; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Definition, theory, and measurement of particulate properties; particle statistics; fluid dynamics; optical, electrical, and thermal behavior of particles.

ME 5614. PRINCIPLES OF PARTICLE TECHNOLOGY. (4 cr; prereq 5613, IT or grad student; 4 lect hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Gas cleaning, particle transport, comminution, classification, surface properties, packed beds, powder behavior, and miscellaneous topics.

ME 5616. AEROSOL MEASUREMENT. (2 cr; prereq 5613, 5614 or #, IT or grad student; 3 lect-lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principals of aerosol measurement. Modern aerosol instrumentation. Optical techniques, inertial collectors, electrical mobility techniques, Beta attenuation and piezoelctric mass sensing techniques, condensation nuclei counters and diffusion batteries.

ME 5617. ADVANCED AEROSOL MEASUREMENT. (4 cr; §5616; prereq 5613 or #, IT or grad student) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles and techniques of airborne particle measurement. Modern aerosol instrumentation; inertial collectors, optical particle counters, differential mobility particle sizer. Aerosol generation and instrument calibration. Aerosol generation and instrument calibration. Aerosol measurement in clean room and source emission measurement. Data analysis and interpretation.

ME 5620. CLEAN ROOM TECHNOLOGY AND PARTICLE MONITORING. (4 cr; prereq IT or grad student, 3303 or #; 3 lect and 2 lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Fundamentals of clean room technology for microelectronics manufacturing; particle mechanics and filtration; filter performance and testing; airborne and liquid-borne particulate contaminants; optical particle counters,

condensation nucleus counter, wafer surface scanner, clean room design and operation; exhaust ventilation; high purity gas and water supply systems.

ME 5630. THERMAL ENVIRONMENTAL ENGINEERING SENIOR LABORATORY. (2 cr; prereq 3701, 3702, 5603 or ¶5603; ME upper division) Joint Day/Extension class: refer to daytime *Class Schedule*

Experiments in psychrometrics, refrigeration, air conditioning, solar energy, and other topics related to refrigeration and building heating and cooling.

ME 5712. SOLAR ENERGY UTILIZATION. (4 cr; prereq 3303, 5342 or equiv, IT or grad student; 4 lect hrs per wk) Extension class: Fall Qtr; Day class: Spring Qtr

History and potential of solar energy utilization; availability of solar radiation on clear and cloudy days; incident radiation on horizontal, vertical, and inclined surfaces; flat-plate and concentrating solar collectors; heating and cooling with solar energy; power generation; review of current research.

ME 8600. PSYCHROMETRICS AND AIR CONDITIONING. (3 cr; prereq 5603; 3 lect hrs per wk) Day class

- ◆ **new** Moist air properties, psychrometry and humidity measurement, processing of moist air; thermal loads for structures; air distribution; noise control; selected environmental and air conditioning topics.

ME 8613. FUNDAMENTALS OF AEROSOL BEHAVIOR. (4 cr; prereq 5613; 3 lect hrs per wk) Day class

- ◆ **new** Kinetic theory applications to aerosol systems, including free molecules and transition regime treatments of transport phenomena; analytical and numerical solutions to aerosol dynamics problems; homogeneous nucleation theory; light scattering and absorption.

MICROBIOLOGY (MicB)

College of Biological Sciences, College of Liberal Arts, and Medical School

1460 Mayo Memorial Building, 624-6190
Palmer Rogers, 925 Mayo Memorial Building, 624-7140

MicB 3103. GENERAL MICROBIOLOGY. (5 cr; §5105, §Biol 5013, §VPB 3103; prereq soph with C avg in courses prereq to major sequence, or jr with 10 cr chemistry and 5 cr biological sciences or #; offered 1992-93) Extension class

Morphology, physiology, taxonomy, and ecology of bacteria. Applications of fundamental principles. Lab.

MicB 5352. APPLIED MICROBIOLOGY. (4 cr; prereq 5321 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Microbial adaptation to various environments; role of microorganisms in the earth's biogeochemical cycles. Application of microbial systems to industrial processes; basic principles of fermentation technology; microbial bioconversions and product formation. Biodegradation of chemicals.

MicB 5611. MICROBIAL ECOLOGY. (3 cr; prereq 3103 or 5105 or Biol 5013 or Soil 5610 or #; §Soil 5605) Joint Day/Extension class: refer to daytime *Class Schedule*

Interrelationship of microorganisms with terrestrial, aquatic and organismal environments; survey of bacterial, fungal and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to the study of microbial ecology.

NATURAL RESOURCES AND ENVIRONMENTAL STUDIES (NRES)

College of Natural Resources and College of Agriculture

John V. Bell, 135 Natural Resources Administration Building, 624-6768;
Terence H. Cooper, 439 Borlaug Hall, 625-7747

NRES 1001. ORIENTATION TO NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (1 cr; S-N only) Day class

Information about NRES major. Discussions with faculty adviser. Employment information. Current topics in NRES. Information about facilities. Discussions with alumni.

NATURAL RESOURCES AND ENVIRONMENTAL STUDIES

NRES 1010. ISSUES IN THE ENVIRONMENT. (3 cr) Day class

Interdisciplinary offerings exploring five areas of environmental concern: aspects of environmental design providing maximum compatibility of human beings with their environment, sources of water pollution and their control, disposal and control of solid wastes from agriculture, minimization of pesticide pollution of the environment, and managed use of forest resources to maintain environmental quality. A televised course involving twenty taped lectures and ten discussion periods.

NRES 1040. NATURAL RESOURCES AS RAW MATERIALS.

(2 cr) Day class

Role of natural resources as raw materials for industry and economic development. Environmental and economic trade-offs associated with raw material gathering, processing, and use. Implications of processing technologies, energy consideration.

NRES 3001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (1 cr) Day class

Round table discussions of current topics in Natural Resources and Environmental Studies.

NRES 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT. (3 cr) Day class

- ◆ **new** Course is designed to help students formulate their philosophy toward natural resources based on concepts of ethical behavior. Ethical dilemmas inherent in management of natural resources are investigated through lectures, small group discussion, short writing assignments, and situation analysis.

NRES 3050. EXPERIENCE AND TRAINING IN A FIELD SETTING. (1-4 cr; prereq jr or sr standing) Day class

Students are required to obtain professional experience in a field setting by attending field sessions, completing a Professional Experience Program, or volunteering for various natural resource and/or environmental programs through local, state or federal agencies. Approval by an instructor required.

NRES 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT. (3 cr; §3060, §5060) Day class

Water quality issues and concerns in the broader context of natural resource management. Global and ecological perspectives toward understanding the management of surface and groundwater resources.

NRES 3225. NRES DIRECTED STUDY EXPERIENCE. (1-5 cr ar, prereq fresh or soph) Day class

Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the advisor for the project, a prospectus and completes progress reports and a final report on his or her project.

NRES 3800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION. (3 cr) Day class

- ◆ **new** Introduction to the broad field of natural resources interpretation and communication. Environmental education will be covered in the context of natural resource agencies.

NRES 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (5 cr; prereq sr standing) Day class

Development of a solution to a real-world natural resource and/or environmental problem. Discussions and assignments reflect diverse aspects of the problem. Oral and written presentations. Students participate as members of a team.

NRES 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I. (3 cr; prereq Math 1142, Stat 3011 and computer competency) Day class

Introduction to survey design, measurement concepts, and modelling methods useful in the study of natural resources and environmental issues. Emphasis on data collection and analysis.

NRES 5220. SURVEY MEASUREMENT AND MODELLING METHODS FOR NATURAL RESOURCES II. (4 cr; prereq 5212 or NRES 5210 or equiv and computer programming) Joint Day/Extension class: refer to daytime *Class Schedule*

Advanced survey design, measurement concepts, and modelling methods for study of natural resources and environmental problems.

NRES 5225. NRES DIRECTED STUDY EXPERIENCE. (1-5 cr ar; prereq jr, sr, or grad) Day class

Opportunity to pursue experiences not available under independent study or extra credit registration. The student develops, in consultation with the advisor for the project, a prospectus and completes progress reports and a final report on his or her project.

NRES 5600. PRINCIPLES OF WASTE MANAGEMENT. (4 cr; prereq Soil 1020 or 3125, and 1 course in chemistry and in biology) Day class

Understanding the issues, problems and solutions in remediating the waste stream generated by today's society. Topics include waste stream dynamics, MSW (municipal solid waste) and yard waste composting, WTE (waste to energy) incineration operation, ash disposal, recycling, landfill requirements, and requirements for direct land disposal, regulatory trends, and case studies.

PHYSICS (Phys)

Institute of Technology

148 Physics, 624-7375

K. Mauersberger, 42 Physics, 624-6305

Phys 5461. PHYSICS AND CHEMISTRY OF THE EARTH'S UPPER ATMOSPHERE. (4 cr; prereq general physics and calculus; offered when feasible) Day class

Survey of atmosphere above 15 km; physics and chemistry of the stratosphere, mesosphere, and thermosphere; temperature and density profiles; major and minor constituents and their distributions; aspects of pollutants; reactions and rates; global variation of constituents; the energy budget of the atmosphere.

PLANT BIOLOGY (PBio)

College of Biological Sciences

220 Biological Sciences Center, 625-1234

Kathleen Peterson, 223 Snyder Hall, 624-9417

PBio 1009. MINNESOTA PLANT LIFE. (4 cr; suitable for non-majors) Joint Day/Extension class: refer to daytime *Class Schedule*

Identification of the more characteristic and conspicuous Minnesota plants, including many lower forms, with discussion of their basic distinctions, life cycles, habitat requirements, distribution, vegetation types, and ecological relations. Lectures, demonstrations, six field trips.

PBio 3131. SURVEY OF PLANT PHYSIOLOGY. (4 cr; §5131, §PIPh 3131, §PIPh 5131; prereq Biol 1103 or 3012, BioC 3031 or BioC 3031 or Biol 5001) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Physiological principles underlying processes that occur in living plants, with emphasis on higher plants. Growth and development, mineral nutrition, transport, water relations and metabolism, especially emphasizing photosynthesis and nitrogen assimilation. For laboratory, see 5132.

PBio 3201. INTRODUCTORY PLANT SYSTEMATICS. (4 cr; prereq Biol 1103 or 3012) Day class

Systematics of the flowering plants of the world. The ecology, geography, origins, and evolution of the flowering plants; family characteristics; floral structure, function and evolution; pollination biology; methods of phylogenetic reconstruction; molecular evolution; taxonomic terms; methods of collection and identification. Two field trips.

PBio 5231. INTRODUCTION TO THE ALGAE. (5 cr; prereq 10 cr in plant biology or biology or #; offered when feasible) Day class
Structure, reproduction, and life histories of major algal divisions.

PLANT PATHOLOGY (PIPa)

College of Agriculture

495 Borlaug Hall, 625-8200

Philip Larsen, 495 Borlaug Hall, 625-8200

PIPa 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICRO-ORGANISMS ON PLANTS AND HUMAN SOCIETY. (2 cr) Day class and Extension class

- ◆ **new** This course is intended to familiarize undergraduate students with the positive or negative effect of microorganisms on plants and the ultimate effect on human history and society.

PLANT PATHOLOGY

PIPa 1002. PLANT DISEASES AND YOUR GARDEN. (2 cr) Joint Day/Extension class

- ◆ **new** Characteristics of the various causes of plant diseases that can affect the growth of flowers, small fruits, and vegetables in Upper Midwest gardens. Important diseases that may appear in your garden, why they can occur and how to avoid them.

PIPa 1003. DISEASES OF TREES AND TURFGRASS. (2 cr) Joint Day/Extension class

- ◆ **new** Important diseases of trees and turf in the United States will be studied with emphasis on diseases in the Upper Midwest. Lectures include basic concepts in plant pathology and commercial/homeowner disease management. Labs will emphasize disease diagnosis.

PIPa 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES. (4 cr; prereq Biol 1009 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This course will examine crop pathology in selected cropping rotations and procedures used to identify plant diseases and appropriate control measures. The course will have an emphasis on field level problem solving, utilizing the concepts of integrated pest management.

PIPa 3002. MANAGEMENT OF HORTICULTURAL CROP DISEASES. (4 cr; prereq Biol 1009 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Characteristics of pathogens and incitants that cause diseases of horticultural crops. Biological principles that affect disease incidence and severity are discovered through the study of the characteristics of a limited number of diseases and through problem solving.

PIPa 3004. AIR POLLUTION, PEOPLE AND PLANTS. (3 cr; prereq Chem 1052; Biol 1009 or equiv, or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** History of air pollution, its sources and types; global climate change; air pollution effects on human health, crops and forests; air pollution control and international perspective.

PIPa 5102. ECOLOGY OF FUNGI. (3 cr; prereq 6 cr botany or #; offered 1992-93 and alt yrs) Day class

Ecological studies and identification of fungi. Topics include fungal symbioses, morphology, coevolution and applicable ecological theory. Student teams determine species richness in an aquatic, grassland, and forest habitat.

PIPa 5200. POISONOUS PLANTS. (2 cr; prereq #) Extension class

- ◆ **new** Systemic study of important plants poisonous to animals. Lecture and field trips in field identification.

PIPa 5201. BIOLOGY OF PLANT DISEASES. (3 cr; prereq Biol 3012 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles and concepts of plant disease caused by selected bacteria, fungi, viruses and nematodes. In-depth presentation of pathogen biology, factors that cause disease and introduction and interaction of pathogens with plants. Epidemiology and control measures appropriate to plant diseases.

PIPa 5206. BIOLOGY OF FUNGI. (4 cr; prereq Biol 1009 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** A survey of the fungal kingdom, including recognition of all major groups of fungi, their important roles in ecosystems and in the affairs of humans, their environmental and nutritional needs, and their modes of dissemination and survival. Representative species of fungi will be observed and manipulated in the laboratory.

PIPa 5212. DISEASES OF FOREST AND SHADE TREES. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** An introductory course of forest and shade trees covering information on basic biological principles concerning tree diseases and ecological relationships among trees, microbes and the environment. Lecture, discussion and laboratory sessions develop an understanding of tree disease concepts.

PIPa 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE. (3 cr; prereq 5002 or 5050 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Concepts and methodology in the quantitative study of plant disease epidemics emphasizing the ecology of interacting host and microbial populations. Includes discussion of disease forecasting, disease in natural (non-agricultural) systems, and biological and chemical approaches to disease control.

POLITICAL SCIENCE (Pol)

College of Liberal Arts

1414 Social Sciences, 624-4144

Martin Sampson, 1414 Social Sciences, 624-4144

Pol 3872. INTERNATIONAL ORGANIZATIONS AND THE ENVIRONMENT. (4 cr; prereq pol sci or int rel maj or 12 cr in soc sci or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Provide opportunity for students to learn about international organization as an aspect of international relations; "learn" means awareness of basic characteristics of such groups and also awareness of disputes in the literature about the significance of international organizations.

Pol 5410. ADVANCED TOPICS IN GOVERNMENT AND POLITICS: POLITICS OF ENVIRONMENTAL MOVEMENTS.

(4 cr; prereq 3051 or non-political science grad student or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This course will raise some major issues in politics such as the greenhouse effect. It will show how political systems in different countries respond differently to political challenges raised by these problems.

Pol 5523. THE POLITICS OF THE REGULATORY PROCESS.

(4 cr; prereq 1001 or equiv or #; offered when feasible) Joint Day/Extension class: refer to daytime *Class Schedule*

Operations of regulatory agencies considered in context of political and legal environment. Principles of federal administrative law, informal procedures, interest group activity, philosophy of regulation, politics and processes of deregulation.

PUBLIC AFFAIRS (PA)

Hubert H. Humphrey Institute of Public Affairs

300 Humphrey Center, 625-9505

D.E. Abrahamson, 243 Humphrey Center, 625-2338

PA 5601. LAND USE. (4 cr; §Geog 5601; prereq grad or Δ) Joint Day/Extension class: refer to daytime *Class Schedule*

Physical, spatial basis for community and regional development. Private sector development processes. Public regulatory frameworks, guidance and interventional strategies. Integration of physical, social and economic factors in land use policy, planning and decision-making. Graduate status or written permission.

PA 5622. MANAGING URBAN GROWTH AND CHANGE. (3 cr)

Joint Day/Extension class: refer to daytime *Class Schedule*

Integrated systems of controls and incentives to manage land development at state, metropolitan, and local government levels. Traditional planning and land use devices, tax and fee techniques, environmental regulations and innovative controls.

PA 5693. TOPICS IN ENVIRONMENTAL PLANNING. (3 cr; pre-

req Geog 5562 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This course will explore the methods of environmental planning with particular reference to the environment and the urban development process. Topics include: analysis of land and natural resources, environmental planning in the land use planning process, air and water quality forecasting methods, methods of environmental impact analysis, the environment and land use regulation, conflict management in environmental planning.

PA 5701. TECHNOLOGY PLANNING I. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Relationship of science and technology to ideological bases of our society; identification of technology's significance to the policy process; analysis of our society's institutions for governing its technologies.

PA 5711. ENERGY POLICY I. (3 cr) Joint Day/Extension class:
refer to daytime *Class Schedule*

Possible energy supply systems and ways energy is consumed; relatively non-technical description of physical systems, environmental and social impacts, regulatory frameworks, resource base, and relationship to energy policy options.

PA 5712. ENERGY POLICY II. (3 cr; offered 1993-94) Joint Day/Extension class: refer to daytime *Class Schedule*

Energy policy options including political, economic, environmental, and other considerations.

PA 5721. ENVIRONMENTAL POLICY I. (3 cr; offered 1993-94)
Joint Day/Extension class: refer to daytime *Class Schedule*

Systems in the natural and physical environment. Environmental impacts of technological innovation. Associated social controversy. Legislative, judicial, regulatory responses.

PA 5722. ENVIRONMENTAL POLICY II. (3 cr; offered 1992-93)
Joint Day/Extension class: refer to daytime *Class Schedule*

Relationship of science and technology to ideological bases of our society; identification of technology's bases of our society, identification of technology's significance to the policy process analysis of our society's institutions for governing its technologies.

PA 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS. (3 cr) Joint Day/Extension class

Ways in which science and technology in the closing decades of the 20th century directly affect the global economic, political, and social environment. How the dynamics of technological development and specific advances in science and technology affect relations among nations in such matters as autonomy, national security, distribution of power, cultural identity and international cooperation. Various approaches to determining national policy and negotiating international agreements in areas affected by science and technology.

PA 5792. TOPICS IN ENVIRONMENT AND ENERGY POLICY.
(3 cr) Day class

Description not yet available. For information, contact Karen Schuster, 154 Humphrey Center, 625-3497.

PA 5794. ECONOMICS OF NATURAL RESOURCE POLICY.
(4 cr; prereq Econ 3101 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

(Same as AgEc 5650) Application of economic analysis, including project evaluation, to current natural resource issues. Emphasis on conservation and resource scarcity, environmental quality, population growth, and resource use issues and their implications for public policy.

PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Client-based workshops providing planning practice experience. Subject matter ranges broadly with the focus at regional and local levels of government.

PA 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.
(3 cr; offered 1992-93) Joint Day/Extension class: refer to daytime *Class Schedule*

Topics in technology, energy, and environment, such as hazardous waste, energy efficiency, nuclear technologies, or atmospheric carbon dioxide.

RECREATION, PARK, AND LEISURE STUDIES (Rec)

College of Education

203 Cooke Hall, 625-5300

Leo H. McAvoy, 203 Cooke Hall, 625-5887

Rec 5160. RECREATION LAND POLICY. (3 cr; prereq 1520 or 5100 or Δ) Day class

◆ **new** (Same as FR 5257) Environmental considerations in relation to recreation and leisure services.

Rec 5250. FINANCING LEISURE SERVICES. (3 cr; prereq 3550 or Δ) Day class

Methods and techniques of financing operations and capital improvements in public park and recreation agencies and nonpublic community leisure services; sources of revenue budgeting procedures.

Rec 5300. FOUNDATIONS OF OUTDOOR EDUCATION. (3 cr; prereq sr, 1520 or 5100 or #) Day class

Investigation of the philosophical, historical, and educational foundations of outdoor education.

Rec 5310. PROGRAMMING IN OUTDOOR EDUCATION. (4 cr; prereq 5300 or #) Joint Day/Extension class limited to 10 Extension students

Methods, materials and settings for outdoor education and environmental interpretation programs.

Rec 5350. WILDERNESS OUTDOOR RECREATION PROGRAMMING. (4 cr; prereq 3150 or #) Joint Day/Extension class limited to 10 Extension students

Exploration of leisure and educational resources of wilderness and management of wilderness-based outdoor recreation and outdoor education programs.

RHETORIC (Rhet)

College of Agriculture

202 Haecker Hall, 624-3445

Thomas Scanlan, 202 Haecker Hall, 624-1262

Rhet 1310. HUMANITIES: THE LAND IN AMERICAN EXPERIENCE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

American attitudes toward the land from colonial times to the present as expressed in social history, literature, and fine arts. Social thought and the relationship between farm and city, wilderness and countryside. The changing appearance of America.

Rhet 3375. HUMANITIES: AGRICULTURAL HERITAGE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Examination and analysis of significant events or periods affecting rural agriculture peoples as expressed in historical, cultural, and literary documents. Understanding of major values, attitudes, and philosophies related to agricultural change and development.

SCIENCE IN AGRICULTURE (ScAg)

College of Agriculture

439 Borlaug Hall, 625-1244

Michael J. Sadowsky, 439 Borlaug Hall, 624-2706

ScAg 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS. (3 cr) Day class

- ◆ **new** Introduction to biotechnology as part of a liberal education or as preparation for careers in science. Genetic engineering, applications of biotechnology to microbes, plants and animals, and legal and ethical issues.

SOCIOLOGY (Soc)

College of Liberal Arts

909 Social Sciences, 624-4300

Robert Kennedy, 1125 Social Sciences, 624-1615

Soc 3551. WORLD POPULATION PROBLEMS. (4 cr) Day class

Population growth and natural resources, population dynamics, fertility and mortality in less developed and industrialized nations, population forecasts, policies to reduce fertility.

Soc 3960. ENVIRONMENTAL SOCIOLOGY. (4 cr) Day class

Societal causes of environmental pollution and degradation. Includes investigation of religion, economics, politics, social movements, social stratification by wealth, race and gender, world development and global response to the problem.

SOIL SCIENCE (Soil)

College of Agriculture

439 Borlaug Hall, 625-1244

Terence H. Cooper, 439 Borlaug Hall, 625-7747

Soil 1020. THE SOIL RESOURCE. (5 cr; §3125) Extension class:
Fall Qtr; Day class: Winter Qtr

Introduction to the physical, chemical, and biological aspects of soils. Use of the soil classification system to understand the use of soil survey information for land-use planning. Concepts of soil fertility for understanding plant growth requirements. Introduction to urban soils and their management. Understanding soil's role in environmental planning and conservation decisions.

Soil 1262. INTRODUCTION TO METEOROLOGY. (4 cr) Day class
(Same as Geog 1425) Pre-calculus introductions to nature of atmosphere and its behavior. Atmospheric composition, structure, stability, and motion; precipitation processes, air masses, fronts, cyclones and anticyclones; general weather patterns; meteorological instruments and observations; plotting and analysis of maps; forecasting.

Soil 3118. SEMINAR: SOIL AND WATER POLLUTION AND PUBLIC POLICY. (1 cr; [may be repeated for max 3 cr]; S-N only)
Extension class

Speakers from the University, the public, and state and federal agencies address a current rural soil and water environmental issue, with emphasis on policies and pertinent technical concerns. A new topic is examined each time offered.

Soil 3125. BASIC SOIL SCIENCE. (5 cr; prereq Chem 1001 or 1004) Day class

Basic physical, chemical, and microbiological properties of soil. Soil genesis, classification, and principles of soil fertility. Lectures and laboratory.

Soil 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT. (4 cr; prereq Soil 1020/3125 or #) Day class

Soil erosion and land degradation processes on rural and urban landscapes. Technical, historical, economic, social, and international considerations of soil conservation. Land-use management practices for soil conservation and methods of natural resource assessment. Lectures, field trips, and computer lab.

Soil 5210. ENVIRONMENTAL BIOPHYSICS. (4 cr; prereq 1020 or 3125 or #) Day class

Physical characteristics of soil related to movement of water, solutes, and heat. Relationship of soil physical properties to water quality, plant water use, and growth. Lecture and laboratory.

Soil 5240. MICROCLIMATOLOGY (SOILS). (5 cr; prereq Math 1111, 10 cr physics or #) Day class

Meteorology and climatology in relation to the soil-atmosphere interface, with emphasis on the microclimate, physical processes taking place within the microclimate, modification of the microclimate, description of meteorological instruments, and use of weather data.

Soil 5424. APPLIED CLIMATOLOGY. (3 cr; prereq 5140 or Geog 3421 or #) Day class

Intended for advanced undergraduates and beginning graduate students who have a background in the principles of climatology or microclimatology. Sources of climatic data, methods of analysis, and selected set of specific applications that focus on agricultural and environmental management problems.

Soil 5510. FIELD STUDY OF SOILS FOR ENVIRONMENTAL ASSESSMENT. (4 cr; prereq 1020 or 3125 or #) Day class

Field observation and identification of the morphological characteristics of soils. Interpretation of soil profiles for environmental assessment. Identification of soil landscapes and the influence of soil-forming factors on soil morphology. Lecture and field laboratory.

Soil 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION. (3 cr; prereq 1122 or #) Day class

Formation, properties, and management of peatlands important to crop, forestry, and energy production in this state and worldwide. Lecture.

Soil 5555. WETLAND SOILS. (3 cr; prereq 3520 or #) Joint Day/
Extension class

- ◆ new Morphology, chemistry, hydrology and formation of mineral and organic soils in wet environments. Soil indicators of wet conditions and techniques for identifying hydric soils for wetland delineations. Field trips and delineation exercise; emphasis on peatlands; wetland benefits, preservation, regulation, and mitigation.

Soil 5605. MICROBIAL ECOLOGY. (3 cr; prereq MicB 5105 or Biol 5013 or Soil 5610 or #; §MicB 5611) Day class

Interrelationship of microorganisms with terrestrial, aquatic and organismal environments; survey of bacterial, fungal and algal components of ecosystems; evolution and structure of microbial communities; population interactions within ecosystems; quantitative and habitat ecology; biogeochemical cycling; and biotechnological approaches to the study of microbial ecology.

Soil 5610. SOIL BIOLOGY. (4 cr; prereq 1020/3125 and PIPa 1001 or #) Day class

The soil environment and its biological population. Role of living organisms in the soil-plant environment and cyclic transformations of agronomic interest (carbon, nitrogen, and mineral substances). Effect of soil microflora on soil fertility and plant nutrition. Lectures and laboratory.

STRATEGIC MANAGEMENT AND ORGANIZATION (BGS, MBA, Mgmt)

School of Management

835 Management and Economics, 624-5232

A. Marcus, 871 Management and Economics, 624-2812

BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

(4 cr; prereq jr or sr and at least 90 credits completed or in progress; may not be taken S-N) Extension class

Management strategies to comply with environmental laws are surveyed. Course examines management systems to reduce environmental impacts caused by resource use, hazardous waste disposal, and manufacturing. Methods for siting industrial plants and controlling pollution are explored. In-class mediation and team debates are used to discuss environmental issues.

BGS 3019/H3019. TOPICS IN BUSINESS, GOVERNMENT AND SOCIETY. (3 cr) Day class and Extension class

Topic varies from quarter to quarter depending on the instructor. Check with the department.

BGS 8019. TOPICS IN BUSINESS AND SOCIETY. (3 cr) Day class

Topic varies from quarter to quarter depending on the instructor. Check with the department.

MBA 8055. BUSINESS, GOVERNMENT AND MACRO-ECONOMICS. (4 cr; prereq MBA grad student) Day class

Roles of government and business in society; alternative systems of economic and political values; social, political, economic, and cultural conflicts affecting the business sector.

Mgmt 8202. EXTERNAL AFFAIRS MANAGEMENT. (4 cr; prereq PhD student or Grad Sch Mgmt approval) Day class

How organizations adapt to external pressures and manage their external affairs. Topics include environmental uncertainties, government regulation, collective action, and public opinion. Proactive and reactive organizational strategies, major ethical issues.

UNIVERSITY COLLEGE (UC)

107 Armory, 624-2022

Susan Stonefield, 107 Armory, 624-2004

UC 3075. INDEPENDENT STUDY. (3-15 cr; prereq Δ) Day class and Extension class

UC 3075 is an undergraduate-directed study registration available to students who wish to pursue learning projects that go beyond the scope of any single department or college of the University. Students must have a University of Minnesota faculty sponsor. Projects are either interdisciplinary in nature or are monitored by faculty from departments that do not have an appropriate undergraduate directed study registration. Students design their own learning projects, working closely with appropriate faculty who also supervise and evaluate the project. May be taken for 1 to 15 degree credits.

IV. CENTERS

JAMES FORD BELL MUSEUM OF NATURAL HISTORY

College of Biological Sciences
Kendall W. Corbin, Interim Director, 10 Church Street S.E., University of Minnesota, Minneapolis, MN 55455; 624-4112

The museum features exhibits of Minnesota wildlife, the Touch and See Room, and the Jacques Gallery of natural history art. It also curates extensive research collections of birds, mammals, reptiles, amphibians, and fish. Public education programs on natural history are offered throughout the year.

CENTER FOR POPULATION ANALYSIS AND POLICY (CPOP)

Sanders Korenman, Director, 267 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, MN 55455; 624-0260

The Center for Population Analysis and Policy (CPOP) is an interdisciplinary population research center founded in 1987. In addition to two Humphrey Institute faculty members, CPOP affiliates come from a broad range of disciplines at the University of Minnesota, and have research interests in United States and developing country topics. CPOP offers a weekly research seminar.

CENTER FOR TRANSPORTATION STUDIES

Richard P. Braun, Director, 110 Civil and Mineral Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN 55455; 626-1077

The Center for Transportation Studies was established in 1987 by the University's Institute of Technology. It serves as a focal point for strengthening knowledge in transportation through multidisciplinary approaches that address transportation problems. The Center identifies critical issues in transportation and develops research, education, and outreach programs that: 1) create an interactive environment for faculty, students, and practitioners from multiple disciplines to collaborate in transportation research and education efforts; and 2) provide leadership and outreach efforts to government officials, private sector representatives, and the public in the application of new knowledge

and the implementation of policies, programs, and technology that improve transportation.

The Center's research program is categorized into four main emphases: transportation and the economy, transportation safety and traffic flow, the transportation infrastructure, and transportation and the environment. The last emphasis includes research in disciplines ranging from mechanical engineering to plant biology and urban planning. Topics include alternative fuels; vehicle emission measuring systems; alternative modes of transportation such as light-rail transit and bicycling; urban design concepts for improving the efficiency of transportation systems; tolerance of native Minnesota grasses to road salt; and electric vehicles.

In education, the Center works to improve existing transportation education programs as well as to strengthen and broaden continuing education opportunities for professionals. Through several federal programs administered by CTS, four new transportation courses have been conducted at the University, and fellowships and scholarships are funded each year. The Center also supports the development of new faculty positions and promotes transportation careers to University students through seminars and other means.

Finally, in the outreach area the Center conducts a comprehensive program that includes an annual research conference, seminars, publications, and other means of communication. These efforts are designed to encourage interaction and technology transfer among faculty, students, and practitioners in support of the public service mission of the University.

CENTER FOR URBAN AND REGIONAL AFFAIRS (CURA)

Thomas M. Scott, Director, 330 Humphrey Center, 301 19th Ave. S., University of Minnesota, Minneapolis, MN 55455; 625-1551

The regents established the Center for Urban and Regional Affairs to help make the University more responsive to the needs of the larger community and to increase the constructive interaction between faculty and students, on the one hand, and between the University and those dealing directly with major public problems, on the other hand.

Specific projects of the center are selected from several broad problem areas reflecting major concerns in this region: economic development and employment, environment, housing, human services, land use management, planning and public affairs, and the diffusion of information about these topics. These problems cut across a wide and changing array of disciplines.

CURA's role is to help coordinate and stimulate projects in these problem areas. It works with the faculty and students of all academic units of the University. All CURA programs are pilot, experimental, or short term projects. The goal is to probe and evaluate, complete short-term projects, discard unsuccessful ones, and help build successful ones into the appropriate part of the academic structure. It confines itself to projects for which there is currently no other practical administrative home.

The center also publishes a newsletter, the *CURA Reporter*. Information about both the newsletter and the center may be obtained from the CURA office.

DEPARTMENT OF PROFESSIONAL DEVELOPMENT AND CONFERENCE SERVICES

Nolte Center for Continuing Education
David Grossman, Acting Director and Associate Dean, 215 Nolte
Center for Continuing Education, 315 Pillsbury Drive S.E., University
of Minnesota, Minneapolis, MN 55455; 626-2255

The Department of Professional Development and Conference Services, with support from the University of Minnesota academic faculty, assists groups in developing and presenting noncredit continuing education programs.

The department has a professional staff to assist interested parties in planning, publicizing, administration, and evaluation of continuing education programs. PDCS occasionally sponsors programs for the general public in the fields of environment, urban problems, and planning. For further information contact the director.

GRAY FRESHWATER BIOLOGICAL INSTITUTE

College of Biological Sciences
Steven J. Eisenreich, Director, P.O. Box 100, County Roads 15 and 19,
Navarre, MN 55392; 471-8476

The Gray Freshwater Biological Institute is a research facility where faculty and staff members, postdoctoral fellows, and students from several disciplines

(microbiology, biochemistry, limnology, biogeochemistry, environmental chemistry) conduct basic and applied research dealing with problems of aquatic systems.

LAKE ITASCA FORESTRY AND BIOLOGICAL STATION

College of Biological Sciences
Administrative Office: Donald B. Siniff, Director, 303 Ecology,
1987 Upper Buford Circle, St. Paul, MN 55108; 624-6743

Located at the headwaters of the Mississippi River in northern Minnesota, the field station is an ecological area where three plant regions of the United States meet. Fifty square miles of protected forest provide unique opportunities for study of varied ecosystems and of the fauna and flora with southern, northern, and western origins. Diverse lakes and wetlands provide unusual field advantages for aquatic studies. For a list of courses held at the Station, see the entry for Lake Itasca in Part I, "Courses Listed by Subject Area."

LIMNOLOGICAL RESEARCH CENTER

Newton Horace Winchell School of Earth Sciences,
Institute of Technology
Kerry Kelts, Director, 220 Pillsbury Hall, 310 Pillsbury Drive S.E.,
University of Minnesota, Minneapolis, MN 55455; 624-7005

This center conducts research on lakes from four perspectives: a) lakes as archives of changing environment and climate, b) lakes as models of biological, ecological, physical and biogeochemical processes, c) lakes as geological features in Earth history, d) lakes as natural resources. Studies of lake history are made through analyses of microfossils, sediment components, and geochemical signatures. Research activities are global in scope.

Evening seminars for current problems are held in Fall for limnology, and Spring for paleoenvironment. Courses and degree programs are coordinated through the Department of Geology and the Department of Ecology, Evolution, and Behavior, and a Quaternary Paleoecology minor. The center participates in a Research Training Group for paleorecords of global change.

MINNESOTA BUILDING RESEARCH CENTER

College of Architecture and Landscape Architecture
Institute of Technology
Institute of Agriculture, Forestry, and Human Ecology
David T. Grimsrud, Director, 1425 University Ave. SE, Room 220,
Minneapolis, MN 55455; 626-7419

The Minnesota Building Research Center (MnBRC) is a network of researchers from a range of disciplines (architecture, landscape architecture, civil and mineral engineering, mechanical engineering, forest products, design, housing, and apparel, agricultural engineering, and extension service) who are concerned with solving problems associated with the design, construction and operation of energy efficient, cost effective buildings in cold climates. MnBRC provides both a focus for the development of interdisciplinary research concerning these issues and a common source of information germane to cold climate buildings and their environments.

MINNESOTA GEOLOGICAL SURVEY

Newton Horace Winchell School of Earth Sciences
Institute of Technology
Priscilla Grew, Director, 2642 University Avenue, St. Paul, MN 55114;
627-4780

The Minnesota Geological Survey is engaged in a number of activities related to the environment and planning. These include developing a database of waterwell logs and groundwater data for the state of Minnesota and preparing county atlases containing geological, hydrogeological, and resource information useful for environmental planning and management.

Undergraduate and graduate students are employed by the survey as aides and research assistants. Whenever possible their work forms part of the research for a master's thesis or Ph.D. dissertation. The Minnesota Geological Survey is a potential source of employment and research support in geologically related aspects of the environment and planning.

The Minnesota Geological Survey maintains an inventory of topographic and geologic maps of the state, as well as publications on the state's geology and resources. For further information, call 627-4780.

MINNESOTA LANDSCAPE ARBORETUM

Department of Horticultural Science
College of Agriculture
Peter Olin, Director, P.O. Box 39, Chanhassen, MN 55317; 443-2460

Established in 1958, the Arboretum covers 905 acres of rolling hills with native woods, marshes, a prairie, formal display gardens, home demonstration gardens, walking/ski paths, and a variety of plant collections. Its programs include the Andersen Horticultural Library with over 9,000 non-circulating volumes, publications including "The Source List" which lists sources for over 40,000 commercially grown plants; research programs which develop cold-hardy fruit varieties (including most of the apples grown in Minnesota today); educational classes for adults and children on horticulture, landscape design, and related areas.

MINNESOTA PUBLIC INTEREST RESEARCH GROUP (MPIRG)

Heather Cusick, Executive Director, 2512 Delaware Street S.E.,
Minneapolis, MN 55414 (campus office, 235 Coffman Union);
627-4035

MPIRG is a nonprofit, nonpartisan organization representing Minnesota college students and working for constructive social change to benefit all Minnesotans. MPIRG activities related to environmental issues include work on energy policy, recycling and waste reduction, forest protection, and alternative modes of transportation.

MPIRG is funded by nearly 30,000 students on nine Minnesota college and university campuses who pay a special fee for its support. It is directed by a board of elected student representatives from the participating institutions. The board holds open meetings at least once a month. All matters of organizational business—from hiring staff, to allocating \$400,000 annual budget, to selecting projects for the organization—are handled by the board. Any enrolled, fee-paying student may seek election to the board. Annual elections are held in the spring.

MPIRG employs a full-time staff of fifteen people including attorneys, researchers, organizers and support staff. MPIRG publishes Statewatch two times a year. MPIRG sponsors coursework on advocacy—on campus, in communities, and with the legislature. It also provides numerous internships involving research, organizing, and legislative work. Students work with MPIRG staff in coordinated programs that involve publication of research findings and

recommendations for public action, active representation before government agencies, law reform through legislative action, and, where necessary, legal action through courts.

MINNESOTA SEA GRANT

Steven B. Laursen, Interim Director, Room 302, 1518 Cleveland Ave N, St. Paul, MN 55108; 625-1253

Minnesota Sea Grant is a statewide program that supports research, extension, and education programs related to Lake Superior and Minnesota's water resources. Programs relate to economic development, pollution, exotic species, fisheries management, and aquaculture. It works to sustain and enhance the aquatic environment for increased productivity through basic research on aquatic systems and ways to control the major threats to those systems.

It publishes a free newsletter, *Seiche*. The newsletter and selected free publications, journal reprints, and publication lists are available from the office by mail or phone.

ST. ANTHONY FALLS HYDRAULIC LABORATORY

Civil and Mineral Engineering
Institute of Technology

Roger Arndt, Director, Mississippi River at 3rd Avenue S.E., Minneapolis, MN 55414; 627-4012 or 627-4010

The St. Anthony Falls Hydraulic Laboratory's focus is on fluid mechanics and water resources engineering and its relationship to the fields of water resources development, including water quality dynamics and hydropower. The Laboratory conducts research on the flow of water in streams, rivers, estuaries, lakes, and man-made pipes, channels, and reservoirs. Transport of sediment, heat, and dissolved substances, as well as natural and artificial water storage, drainage, runoff, and other hydrological processes are part of the research program. The related fields of low speed aerodynamics and wind engineering are also studied.

In its fifty-five year history the laboratory staff, comprised of Civil and Mineral Engineering Department faculty, civil service employees, and graduate and undergraduate students, has conducted hundreds of studies on water-related projects locally, nationally, and internationally. Extensive documentation is available through reports and films of the research studies in the Lorenz G. Straub Memorial Library.

The laboratory provides academic and financial assistance to graduate and undergraduate students interested in water resources engineering and related programs.

UNDERGROUND SPACE CENTER

Civil and Mineral Engineering
Institute of Technology

Raymond L. Sterling, Director, 790 Civil and Mineral Engineering Building, 500 Pillsbury Drive S.E., University of Minnesota, Minneapolis, MN 55455; 624-0066

Established in 1977, the Underground Space Center is a research and information center concerned with various aspects of underground development and construction. It is housed within the Department of Civil and Mineral Engineering, and is also a participant in the Minnesota Building Research Center (MnBRC).

Underground space offers potential solutions to a wide range of problems related to land use, buildings, and the environment. Placing functions underground can contribute to more efficient land use, preservation of the natural environment, and the creation of more open space. Underground space provides opportunities for energy conservation, and can be exploited for uses such as transportation and utility systems.

The goals of the Center are to: serve as a focal point for planning and coordination of underground space use; carry out research in areas affecting underground space use; provide an information and referral service for all aspects of underground space utilization, and serve as a focal point for international cooperation on research and information transfer.

Research at the Underground Space Center is conducted on a wide range of topics, including: planning of underground space; legal and regulatory issues; habitability of underground space; life safety; subsurface heat transfer; building foundation construction and energy use; geomechanics; frost heave action in soils; energy conservation retrofits; and underground infrastructure construction and maintenance.

A course on "Underground Construction Engineering" (CE 5004) is offered through the Department of Civil and Mineral Engineering. Publications are available, including two books—*Building Foundation Design Handbook* (1988) and *Underground Space Design* (1992)—written by Center researchers.

WATER RESOURCES RESEARCH CENTER

College of Natural Resources

Patrick Brezonik, Director, Room 303, 1518 Cleveland Ave. N., St.

Paul, MN 55108; 624-9282

The center has responsibility for promoting water resources research at the University of Minnesota and at state and private colleges with funds provided by the Federal Water Resources Research Act of 1964 (most recently reauthorized in 1990). The WRRC also promotes coordination and cooperation among the water research programs of University departments and centers and state and federal agencies throughout the state. The WRRC supports water research activities of faculty primarily through an open competitive grant proposal mechanism. Both fundamental and applied research is supported on physical, biological, economic, social, and political aspects of water resources. Projects generally are related to pressing water issues in the state, such as groundwater contamination, effects of atmospheric contaminants on surface waters, nonpoint source pollution, and impacts of climate change on Minnesota's water resources. Training of scientists for work in water resources fields is an important function of the WRRC. The majority of funds on most projects awarded by the Center are used directly for graduate research assistantships and/or for undergraduate support. In addition, some opportunities exist for student employment on projects conducted directly by the Center.

The center assists in recruiting students and in guiding them into appropriate programs of study. The center has been helpful in developing new courses in various areas of water resources and a new graduate minor program in water resources.

The WRRC publishes and distributes a newsletter called *Minnegram* as well as other informative publications to people throughout the state. The results of research projects are published in technical reports and theses, which the center distributes to scientists and water managers throughout the state and nation. To provide an opportunity for professional people and students working in water resources fields to meet and exchange information, the WRRC organizes and sponsors symposia and conferences on specific water issues. In addition, in cooperation with the Minnesota Environmental Quality Board and other state agencies, the Center sponsors a biennial conference on water resources issues and problems in the state.

V. LIBRARIES

UNIVERSITY LIBRARIES—TWIN CITIES

Research collections that support the courses and programs in the environment are found throughout the libraries which comprise the University Libraries.

In addition to strong collections, the University Libraries offer a full range of reference services and research tools. Databases on CD-ROMs provide free, do-it-yourself computer searching to locate relevant information found in journal articles, newspapers, government documents, statistical data, maps, and other sources. CD-ROMs are housed in libraries by subject focus of collections.

Minneapolis Campus—East Bank

Architecture Library—160 Architecture

Contains material on architecture, design, landscape architecture, and urban planning.

Bio-Medical Library—Diehl Hall

Contains environmentally-related materials in the fields of health sciences, including microbiology, pharmacology, environmental health, and genetics.

Walter Library

Education/Psychology Collections: Contain environmentally-related materials in the fields of education, sports, outdoor recreation, and psychology.

Physical Sciences and Engineering Collections: Contain environmentally-related materials in the fields of chemistry, engineering, geology, mines and metallurgy, physics, and transportation.

Minneapolis Campus—West Bank

Wilson Library

Humanities and Social Sciences Collections: Contain environmentally-related materials in a broad range of social sciences and humanities, including anthropology, economics, environmental policy, geography, international relations, political science, public administration, and sociology.

Also located in Wilson Library are: John R. Borchert Map Library (S-76), Business Reference Service (201), and Government Publications Library (409). The Government Publications Library receives depository publications of the U.S. government, the state of Minnesota, the United Nations, the European Community, intergovernmental agencies, the Metropolitan Council of the Twin Cities, and many publications from foreign governments.

Law Library—Law Building

Contains environmental law materials.

St. Paul Campus

St. Paul Central Library

Contains material on agriculture, biological science, botany, design, ecology, environmental policy, home economics, horticulture, human ecology, and plant science.

Other St. Paul Libraries:

Biochemistry Library	406 Biological Science Ctr.
Entomology, Fisheries and Wildlife Library	375 Hodson Hall
Forestry Library	350 Natural Resources Adm.
Plant Pathology Library	395 Borlaug Hall
Veterinary Medical Library	450 Veterinary Science

NON-UNIVERSITY LIBRARIES

Environmental Conservation Library (ECOL)

Bill Johnston, Librarian, Minneapolis Public Library, 300 Nicollet Mall, Minneapolis, MN 55401; 372-6570

ECOL, a special collection within the Minneapolis Public Library, brings together materials from various subject fields that relate to the physical, environmental, and human impact on planet Earth. ECOL has books, periodicals, newsletters, pamphlets, bibliographies, posters, and government documents relating to such topics as air and water pollution, solid waste, wildlife, conservation of natural resources, land use planning, environmental law, energy resources, and environmental education. ECOL was designated by the Minnesota Legislature as a state center for environmental information and receives publications of many state agencies, including environmental impact statements. ECOL serves as the local public document room for U.S. Nuclear Regulatory Commission materials relating to nuclear power plants in Minnesota. A newsletter, *ECOL News*, is published twice a year and is free to the public.

A large collection of full documents and articles on microfiche are available for use and loan. Entitled *Envirofiche*, they are keyed to the abstract journal *Environment Abstracts*.

Minnesota Department of Health Library

Diane Jordan, Librarian, 717 Delaware Street S.E., Minneapolis, MN 55440; 623-5090

This collection has been developed with the needs of public health professionals in mind, but the public is welcome. It is a specialized library with technical, as opposed to popular, literature. It is a reference collection only and extends no loan privileges except through interlibrary loan. Citizens may make photocopies at their own expense. The library subscribes to some 200 periodicals. Hours are 8:00 a.m. to 4:30 p.m. Monday through Friday. Please note that it is now a security building.

Minnesota Department of Public Service Library (formerly Minnesota Energy and Economic Development Library)

Galina Mogilyansky, Librarian, 500 Metro Square Building, 121 7th Place E., St. Paul, MN 55101; 296-7952

This research library has a noncirculating collection, although some items may be borrowed through the MINITEX system. The collection contains United States and Minnesota statistics of energy use, Department of Energy reports, and approximately 130 periodicals. There is strong emphasis on energy conservation reports. The library has environmental information on electric power, nuclear power, solar energy, and coal development.

The library also has a collection on economic development issues including trade, high technology, and location of industry, with materials discussing Minnesota and U.S. business conditions.

Minnesota Pollution Control Agency Library

Kathy Malec and Helena Peskova, Librarians, 520 Lafayette Road, St. Paul, MN 55155; 296-7719 or 296-6623

This collection has been developed with the needs of professional pollution control scientists and engineers in mind. It is essentially a technical library with few subprofessional materials. The library extends reference services.

Center for Urban and Regional Affairs
330 Hubert H. Humphrey Center
301 19th Avenue South
Minneapolis, MN 55455
612/625-1551



UNIVERSITY OF MINNESOTA