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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*



1994 - 1995

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Center for Urban and Regional Affairs

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July 1994

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

The 1994-1995 edition of the CURA publication *Courses on the Environment* is enclosed. It is designed to give information which will be helpful to students and faculty during the advising and course selection process. The General Information section at the front of the guide explains in detail the new features and organization of the guide.

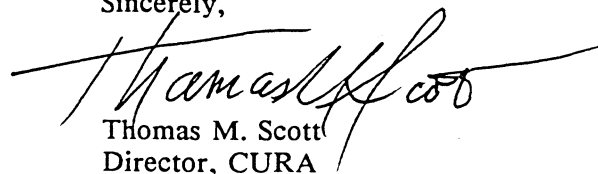
There are 477 courses from forty-nine departments listed this year. In Part I, courses fulfilling the environment theme requirement designated by the Council on Liberal Education are listed first, followed by a subject index where courses are arranged in twenty-three broad subject areas. Part II lists courses by department with the name of a contact person who is prepared to advise students. For each course, information is given on credits, prerequisites, availability of registration as a day class or through Extension Classes, and course description.

Other sections of the guide offer information on a variety of opportunities at the University with an environmental focus. Part III describes alternatives to regular courses which are optional ways to earn academic credit. Formal interdisciplinary programs offering degrees and minors are described in Part IV. Centers are listed in Part V, and libraries in Part VI.

Copies of the guide are being sent to all departments, academic programs, centers, faculty contacts, and libraries which are included in the listing, as well as college and department advising offices.

We hope you will find this course guide useful, and welcome your suggestions and comments. To obtain additional copies, call CURA at 625-1551.

Sincerely,



Thomas M. Scott
Director, CURA

C o u r s e s o n t h e
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Courses on Environmental Issues on the Twin Cities Campus*

1994 - 1995

CURA RESOURCE COLLECTION

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

A publication of the Center for Urban and Regional Affairs, 330 Humphrey Center, 301 19th Avenue S., Minneapolis, Minnesota 55455.

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This publication is available in alternative formats upon request. Please call Margaret R. Wolfe, Center for Urban and Regional Affairs, at 625-6324.

1994

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Compiled by Margaret R. Wolfe.

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GENERAL INFORMATION

PURPOSE AND SCOPE OF THE COURSE GUIDE

Courses on the Environment: A Student Guide to University of Minnesota Courses on Environmental Issues on the Twin Cities Campus, 1994-1995 is a supplemental guide to official University bulletins of the various colleges, schools, and institutes of the University of Minnesota. It is designed to help students locate courses which address topics relevant to various issues on the environment. There are 477 courses listed in the 1994-1995 guide, compared to 440 courses in 1993-1994 and 358 in 1992-1993. They are offered by forty-nine different departments.

The guide to courses is assembled each year by the Center for Urban and Regional Affairs (CURA) at the University of Minnesota. In addition to these courses, other opportunities to examine environmental issues include departmental seminars and lectures that are presented throughout the academic year. CURA compiles announcements of these events in the *Environmental Events Calendar* which also announces internships, volunteer opportunities, and job postings. It is issued each month during the academic year. To request a copy of this course guide or to be put on the list to receive the environmental calendar, call CURA at 625-1551.

NEW FEATURES OF THE 1994-1995 GUIDE

Environment Courses for the "Designated Theme of Liberal Education"

The environment is one of four "designated themes" that will be required starting in fall 1994 and are in addition to the four areas in the diversified core curriculum. These new requirements, developed by the Council on Liberal Education, apply to students enrolling with 38 or fewer credits and are uniform for all undergraduate students in every college on the Twin Cities campus.

A list of the courses that can be used to fulfill the requirement for at least one course on the environment appears as the first item in this guide. It is on page 3 at the beginning of Part I, Courses Listed by Subject Area. Additional courses that may be approved for the environment theme during the year will be listed in the winter and spring *Class Schedules*.

Alternative Ways to Earn Academic Credit

A new section, Part III, Alternative Ways to Earn Academic Credit, describes options for earning credit such as individually-designed study and research projects or study abroad opportunities. These alternatives to regular courses are

available through Continuing Education and Extension, the Global Campus, the Undergraduate Research Opportunities Program, and various special learning opportunities in many departments and colleges of the University.

New Courses, Academic Programs, and Centers

Sixty-four new courses have been added to this year's guide, while twenty-seven have been dropped. The Departments of Astronomy and the History of Medicine appear for the first time, and both offer environment theme classes. In Part IV where formal interdisciplinary academic programs are described, Microbial Ecology has been added. Centers added to Part V are the Center for Agricultural Impacts on Water Quality and the Minnesota Institute for Sustainable Agriculture.

ORGANIZATION OF THE GUIDE

Part I. Courses Listed by Subject Area

Following the listing of environment theme courses, this section is arranged alphabetically by twenty-three broad subject areas. This subject index is designed to help students find courses of interest in various colleges and departments. This 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.

Part II. Courses Listed by Department

Part II 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 or Extension class, and course description. Part II can serve as a guide to students pursuing an environmental studies emphasis within a given departmental major or minor.

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.

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 Extension Classes.

Part III. Alternative Ways to Earn Academic Credit

This section was described on page 1 of this Guide under “New Features.”

Part IV. Academic Programs

Types of Academic Programs: There are a variety of academic programs concerned with the environment. Many departments listed in Part II 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. 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 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.

Formal Interdisciplinary Programs: In Part IV 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.

Part V. 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.

Part VI. Libraries

The libraries section lists University of Minnesota libraries and collections that have material on environmental issues.

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
- ◆ new New course

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

I. COURSES LISTED BY SUBJECT AREA

ENVIRONMENT DESIGNATED THEME

Agricultural and Applied Economics (AgEc)

- 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS.
- 5650. ECONOMICS OF NATURAL RESOURCE AND ENVIRONMENTAL POLICY.

Animal and Plant Systems (AnPl)

- 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.

Anthropology (Anth)

- 1101 HUMAN ORIGINS.
- 1101H. HUMAN ORIGINS.
- 3116. ECOLOGICAL ANTHROPOLOGY.
- 5117. NATURAL RESOURCES ANTHROPOLOGY.

Astronomy (Ast)

- 1019. OUR CHANGING PLANET.
- 1031. EXPLORING THE UNIVERSE: A.
- 1032. EXPLORING THE UNIVERSE: L.

Biochemistry (BioC)

- 5301. ECOLOGICAL BIOCHEMISTRY.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.

Chemistry (Chem)

- 1051-1052. CHEMICAL PRINCIPLES I-II.
- 1051H-1052H. CHEMICAL PRINCIPLES I-II.

Ecology, Evolution, and Behavior (EEB)

- 1019. OUR CHANGING PLANET.

Entomology (Ent)

- 1005. ECONOMIC ENTOMOLOGY.
- 5320. ECOLOGY OF AGRICULTURE.

Fisheries and Wildlife (FW)

- 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.
- 3052. INTRODUCTION TO FISHERIES AND WILDLIFE.
- 5604. FISHERY AND WILDLIFE MANAGEMENT.

Forest Resources (FR)

- 1201. CONSERVATION OF NATURAL RESOURCES.
- 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES.
- 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.
- 3104. FOREST ECOLOGY.

- 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.

- 5104. FOREST ECOLOGY.

- 5114. FOREST HYDROLOGY.

- 5226. FOREST ECONOMICS AND PLANNING.

- 5231. RANGE MANAGEMENT.

- 5232. MANAGEMENT OF RECREATIONAL LANDS.

- 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.

General College (GC)

- 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

Geography (Geog)

- 1402. GEOGRAPHY AND ENVIRONMENTAL SYSTEMS.

Geology (Geo)

- 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY.
- 1005. GEOLOGIC PERSPECTIVES ON ENERGY.
- 1012. PLANET EARTH.
- 1019. OUR CHANGING PLANET.

History of Medicine (HMed)

- 3040. HUMAN DISEASE AND THE ENVIRONMENT IN HISTORY.

Microbiology (MicB)

- 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies (NRES)

- 1010. ISSUES IN THE ENVIRONMENT.
- 1040. NATURAL RESOURCES AS RAW MATERIALS.
- 3020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.
- 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
- 3070. FROM LOCAL TO GLOBAL ECOLOGY.
- 5020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.
- 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.

Plant Pathology (PIPa)

- 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Science in Agriculture (ScAg)

- 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS.

Soil Science (Soil)

- 1020. THE SOIL RESOURCE.
- 5605. MICROBIAL ECOLOGY.

AGRICULTURE

AGRICULTURE

Agricultural and Applied Economics (AgEc)

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

Agricultural Engineering (AgEn)

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

Agricultural Engineering Technology (AgET)

- 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Agronomy and Plant Genetics (Agro)

- 1007. BIOLOGY OF FOOD SYSTEMS AND THE ENVIRONMENT.
- 1010. PRINCIPLES OF AGRONOMY.
- 3020. GROWTH AND DEVELOPMENT OF FIELD CROPS.
- 3030. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS.
- 5010. FORAGE PRODUCTION AND UTILIZATION.
- 5020. INTRODUCTION TO PLANT BREEDING.
- 5030. WEED CONTROL.
- 5050. MANAGEMENT TECHNOLOGIES FOR CROP PRODUCTION IN MINNESOTA.
- 5120. GROWTH AND DEVELOPMENT OF FIELD CROPS.
- 5130. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS.
- 5200. WORLD FOOD PROBLEMS.
- 5310. ORIENTATION TO FIELD CROP BREEDING.
- 5320. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH.
- 8080. SUSTAINABLE AGRICULTURE COLLOQUIUM.

Animal and Plant Systems (AnPl)

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

Entomology (Ent)

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

Horticultural Science (Hort)

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

Natural Resources and Environmental Studies (NRES)

- 3020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.
- 5020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.

Plant Pathology (PIPa)

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

Rhetoric (Rhet)

- 3375. HUMANITIES: AGRICULTURAL HERITAGE.

CLIMATOLOGY AND METEOROLOGY

Astronomy (Ast)

- 1019. OUR CHANGING PLANET.
- 1031. EXPLORING THE UNIVERSE: A.
- 1032. EXPLORING THE UNIVERSE: L.

Chemistry (Chem)

- 1051-1052. CHEMICAL PRINCIPLES I-II.
- 1051H-1052H. CHEMICAL PRINCIPLES I-II.

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.
- 3421. CLIMATOLOGY.
- 5424. APPLIED CLIMATOLOGY.
- 5441. QUATERNARY LANDSCAPE EVOLUTION.
- 8420. SEMINAR: CLIMATOLOGY.

Geology and Geophysics (Geo)

- 1019. OUR CHANGING PLANET.
- 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)

- 1425. INTRODUCTION TO METEOROLOGY.
- 5240. MICROCLIMATOLOGY (SOILS).
- 5424. APPLIED CLIMATOLOGY.

CULTURE, SOCIETY, AND ENVIRONMENTAL PROBLEMS

Anthropology (Anth)

- 1101. HUMAN ORIGINS.
- 1101H. HUMAN ORIGINS.
- 3116. ECOLOGICAL ANTHROPOLOGY.
- 5117. NATURAL RESOURCES ANTHROPOLOGY.
- 5960. SENIOR SEMINAR: HUMAN/ENVIRONMENT INTERACTIONS.

Architecture (Arch)

- 1401. THE DESIGNED ENVIRONMENT.
- 3501. PEOPLE, ECOLOGY, AND DESIGN.
- 5458. ARCHITECTURE AND CULTURE.
- 5725. HOUSING AND VALUES.

Civil Engineering (CE)

- 5003. EARTH-SHELTERED BUILDING DESIGN.

Cultural Studies and Comparative Literature (CSCL)

- 3366. LANDSCAPE AND IDEOLOGY, 1600-1875.

Design, Housing and Apparel (DHA)

- 1101. INTRODUCTION TO THE DESIGNED ENVIRONMENT.
- 3463. ENVIRONMENT: HOUSING AND COMMUNITY.
- 3631. INTERIOR DESIGN RESOURCES AND MATERIALS.
- 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES.
- 5482. THE FAMILY AND ENERGY ISSUES.

General College (GC)

- 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

History of Medicine (HMed)

- 3040. HUMAN DISEASE AND THE ENVIRONMENT IN HISTORY.

History of Science and Technology (HSci)

- 3331/5331. TECHNOLOGY IN AMERICAN CULTURE.

Landscape Architecture (LA)

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

Natural Resources and Environmental Studies (NRES)

- 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
- 3070. FROM LOCAL TO GLOBAL ECOLOGY.
- 5800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION.

Plant Pathology (PIPa)

- 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICROORGANISMS ON PLANTS AND HUMAN SOCIETY.
- 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.
- 3375. HUMANITIES: AGRICULTURAL HERITAGE.
- 3395. IN SEARCH OF NATURE.

Sociology (Soc)

- 3551. WORLD POPULATION PROBLEMS.

Strategic Management and Organization (BGS, MBA, Mgmt)

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

EARTH SCIENCES

Astronomy (Ast)

- 1019. OUR CHANGING PLANET.
- 1031. EXPLORING THE UNIVERSE: A.
- 1032. EXPLORING THE UNIVERSE: L.

Ecology, Evolution, and Behavior (EEB)

- 1019. OUR CHANGING PLANET.

General College (GC)

- 1171. PHYSICAL GEOLOGY.
- 1173. GEOLOGY OF THE NATIONAL PARKS.

Geography (Geog)

- 1401. PHYSICAL GEOGRAPHY.
- 5441. QUATERNARY LANDSCAPE EVOLUTION.

Geology (Geo)

- 1001. THE DYNAMIC EARTH: AN INTRODUCTION TO GEOLOGY.
- 1012. PLANET EARTH.
- 1019. OUR CHANGING PLANET.
- 1021. INTRODUCTION TO GEOLOGY LAB: GEOLOGY OF MINNESOTA.
- 1601. OCEANOGRAPHY.
- 3402. INTRODUCTORY MINERALOGY.
- 5004. MINERALOGY.
- 5108. ADVANCED ENVIRONMENTAL GEOLOGY.
- 5201. STRUCTURAL GEOLOGY.
- 5251. GEOMORPHOLOGY.

ECOLOGY

- 5261. GLACIAL GEOLOGY.
- 5311. GENERAL GEOCHEMISTRY.
- 5313. AQUEOUS GEOCHEMISTRY.
- 5641. GENERAL AND PHYSICAL HYDROGEOLOGY.
- 8617. TRANSPORT PHENOMENA IN NATURAL POROUS MEDIA.

ECOLOGY

Agronomy and Plant Genetics (Agro)

- 1007. BIOLOGY OF FOOD SYSTEMS AND THE ENVIRONMENT.

Animal and Plant Systems (AnPl)

- 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.

Anthropology (Anth)

- 3116. ECOLOGICAL ANTHROPOLOGY.

Architecture (Arch)

- 3501. PEOPLE, ECOLOGY, AND DESIGN.

Biochemistry (BioC)

- 5301. ECOLOGICAL BIOCHEMISTRY.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.
- 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES.
- 5041. ECOLOGY.
- 5841. ECOLOGY.
- 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.
- 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.
- 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE.
- 5008. QUATERNARY ECOLOGY.
- 5014. ECOLOGY OF PLANT COMMUNITIES.
- 5016. ECOLOGICAL PLANT GEOGRAPHY.
- 5033. POPULATION AND QUANTITATIVE GENETICS.
- 5606. ECOLOGY OF FISHES.
- 5607. ECOLOGY OF ANIMAL PLANKTON.
- 5608. ECOSYSTEMS: FORM AND FUNCTION.
- 5814. PLANT COMMUNITY ECOLOGY.
- 5817. VERTEBRATE ECOLOGY.

Entomology (Ent)

- 5040. INSECT ECOLOGY.
- 5250. FOREST ENTOMOLOGY.
- 5320. ECOLOGY OF AGRICULTURE.
- 8240. COLLOQUIUM IN INSECT ECOLOGY.

Fisheries and Wildlife (FW)

- 1002. WILDLIFE: ECOLOGY, VALUES AND HUMAN IMPACT.
- 5603. ECOLOGY AND MANAGEMENT OF FISH AND WILDLIFE HABITATS.
- 5620. GEOGRAPHICAL INFORMATION SYSTEMS (GIS) FOR FISHERIES, WILDLIFE, AND BIOLOGICAL CONSERVATION.
- 8448. FISHERY SCIENCE.
- 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.
- 8459. STREAM AND RIVER ECOLOGY.
- 8576. WILDLIFE MANAGEMENT: LARGE MAMMALS.
- 8579. ECOSYSTEM ANALYSIS AND SIMULATIONS: A NUMERICAL APPROACH.

Forest Resources (FR)

- 3101. NORTHERN FOREST ECOSYSTEMS.
- 3104. FOREST ECOLOGY.
- 3107. FOREST ECOLOGY LABORATORY.
- 5104. FOREST ECOLOGY.
- 5107. FOREST ECOLOGY LABORATORY.
- 5142. TROPICAL FOREST ECOLOGY.
- 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
- 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
- 5215. FOREST FIRE MANAGEMENT.
- 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
- 8104. RESEARCH PROBLEMS: FOREST ECOLOGY.
- 8112. RESEARCH PROBLEMS: PHYSIOLOGICAL ECOLOGY.

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.
- 1022. HERBACEOUS PLANT MATERIALS.
- 5015. RESTORATION AND RECLAMATION ECOLOGY.
- 5042. TURF GRASS SCIENCE.

International Relations (IntR)

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

Landscape Architecture (LA)

- 5202. LANDSCAPE ECOLOGY.
- 5212. ECOLOGICAL INFORMANTS OF DESIGN.
- 5222. PLANTING DESIGN.
- 8223. REGIONAL LANDSCAPE DESIGN.
- 8804. LANDSCAPE ECOLOGY AND DESIGN.

Microbiology (MicB)

- 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies (NRES)

- 3051. FROM TALL-GRASS PRAIRIES TO BOREAL FORESTS.
- 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
- 3070. FROM LOCAL TO GLOBAL ECOLOGY.
- 3100. CONSERVATION OF BIODIVERSITY.
- 5001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.

Plant Biology (PBio)

- 3201. INTRODUCTORY PLANT SYSTEMATICS.

Plant Pathology (PIPa)

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

Soil (Soil)

- 5605. MICROBIAL ECOLOGY.

ENERGY USE

Anthropology (Anth)

- 5117. NATURAL RESOURCES ANTHROPOLOGY.

Architecture (Arch)

- 5523. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY.
- 5531. LIGHTING AND ACOUSTIC DESIGN.
- 5539. DAYLIGHTING AND ARCHITECTURAL DESIGN.
- 5541. THERMAL DESIGN IN ARCHITECTURE.
- 5542. BUILDING ENERGY SYSTEMS.
- 5543. CLIMATE AND ARCHITECTURE.
- 5725. HOUSING AND VALUES.

Civil Engineering (CE)

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

Design, Housing, and Apparel (DHA)

- 1401. RESIDENTIAL TECHNOLOGY.

- 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES.
- 5482. THE FAMILY AND ENERGY ISSUES.
- 5634. INTERIOR DESIGN CODES AND ENVIRONMENTAL ISSUES.

Geology (Geo)

- 1005. GEOLOGIC PERSPECTIVES ON ENERGY.

Mechanical Engineering (ME)

- 5603. THERMAL ENVIRONMENTAL ENGINEERING.
- 5604. HEATING AND COOLING LOADS IN BUILDINGS.
- 5605. REFRIGERATION AND AIR CONDITIONING SYSTEMS.
- 5630. THERMAL ENVIRONMENTAL ENGINEERING SENIOR LABORATORY.
- 5712. SOLAR ENERGY UTILIZATION.
- 8600. PSYCHROMETRICS AND AIR CONDITIONING.

Natural Resources and Environmental Studies (NRES)

- 1040. NATURAL RESOURCES AS RAW MATERIALS.

Public Affairs (PA)

- 5711. ENERGY POLICY I.
- 5712. ENERGY POLICY II.
- 5792. ENERGY REGULATION ANALYSIS AND ADVOCACY.
- 8791-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN TECHNOLOGY, ENERGY, AND ENVIRONMENTAL POLICY.

Soil (Soil)

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

Strategic Management and Organization (BGS, MBA, Mgmt)

- 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)

- 5523. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY.

Biochemistry (BioC)

- 5301. ECOLOGICAL BIOCHEMISTRY.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.

Chemistry (Chem)

- 1051-1052. CHEMICAL PRINCIPLES I-II.
- 1051H-1052H. CHEMICAL PRINCIPLES I-II.

FISH AND WILDLIFE

Civil Engineering (CE)

- 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.
- 5506. ENVIRONMENTAL WATER CHEMISTRY.
- 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.
- 5515. WATER AND WASTEWATER MICROBIOLOGY.
- 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
- 8507. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS.
- 8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS.
- 8560. SEMINAR: SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING.

Design, Housing, and Apparel (DHA)

- 5634. INTERIOR DESIGN CODES AND ENVIRONMENTAL ISSUES.

Economics (Econ)

- 3611. ENVIRONMENTAL ECONOMICS.

Environmental and Occupational Health (PubH)

- 5150-1. TOPICS IN ENVIRONMENTAL HEALTH: PRINCIPLES OF ENVIRONMENTAL HEALTH LAW.
- 5150-2. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: OCCUPATIONAL HEALTH LAW.
- 5150-3. TOPICS IN ENVIRONMENTAL HEALTH: POLLUTION CONTROL LAW.
- 5150-4. TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: CONSUMER PRODUCTS LAW.
- 5151. ENVIRONMENTAL HEALTH.
- 5152. ENVIRONMENTAL HEALTH.
- 5155. ISSUES IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH.
- 5158. HEALTH RISK EVALUATION.
- 5171. ENVIRONMENTAL MICROBIOLOGY.
- 5181. AIR POLLUTION.
- 5184. MEASUREMENT OF AIRBORNE CONTAMINANTS IN WORKPLACES.
- 5186. ENVIRONMENTAL CHEMISTRY.
- 5201. RADIATION PROTECTION AND MEASUREMENT.
- 5202. RADIATION LABORATORY.
- 5210. INTRODUCTION TO INDUSTRIAL HYGIENE.
- 5211. SURVEY OF INDUSTRIAL HYGIENE.
- 5212. VENTILATION CONTROL OF ENVIRONMENTAL HAZARDS.
- 5215. APPLIED OCCUPATIONAL TOXICOLOGY.
- 5216. PROPERTIES OF WORKPLACE AIRBORNE CONTAMINANTS.
- 5220. VENTILATION CONTROL OF OCCUPATIONAL HAZARDS.
- 5239. MICROBIOLOGY OF THE HUMAN ENVIRONMENT: SEMINAR.
- 5253. INTRODUCTION: HAZARDOUS WASTE MANAGEMENT.
- 5261. GENERAL ENVIRONMENTAL TOXICOLOGY.
- 5262. METABOLISM AND DISTRIBUTION OF XENOBIOTICS.
- 5266. INTRODUCTION TO HEALTH RISK ASSESSMENT.

- 5267. INDUSTRIAL AND OCCUPATIONAL TOXICOLOGY.

- 8185. ANALYSIS OF TOXICANTS.

- 8264. HUMAN DISEASES CAUSED BY ENVIRONMENTAL AGENTS.

Fisheries and Wildlife (FW)

- 5460. POLLUTION IMPACTS ON AQUATIC SYSTEMS.

Forest Resources (FR)

- 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.

History of Medicine (HMed)

- 3040. HUMAN DISEASE AND THE ENVIRONMENT IN HISTORY.

Interdepartmental Study (ID)

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

Law School (Law)

- 5885. ADVANCED ENVIRONMENTAL LAW.

Mechanical Engineering (ME)

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

Plant Pathology (PiPa)

- 3004. AIR POLLUTION, PEOPLE AND PLANTS.

Strategic Management and Organization (BGS, MBA, Mgmt)

- BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

FISH AND WILDLIFE

Ecology, Evolution, and Behavior (EEB)

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

Fisheries and Wildlife (FW)

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

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

Forest Resources (FR)

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

General College (GC)

- 1133. NATURE STUDY.

Natural Resources and Environmental Studies (NRES)

- 5001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.

FOREST RESOURCES**Entomology (Ent)**

- 5250. FOREST ENTOMOLOGY.

Forest Resources (FR)

- 1001. FOREST RESOURCES ORIENTATION.
- 1100. DENDROLOGY.
- 1200. INTRODUCTION TO FOREST RESOURCES.
- 3100. IMPORTANT FOREST PLANTS.
- 3101. NORTHERN FOREST ECOSYSTEMS.
- 3104. FOREST ECOLOGY.
- 3107. FOREST ECOLOGY LABORATORY.
- 3201. FIELD FOREST MEASUREMENTS.
- 3225/5225. DIRECTED STUDY EXPERIENCE.
- 5100. SILVICULTURE.
- 5101. FIELD SILVICULTURE.
- 5102. FOREST WILDLIFE HABITAT MANAGEMENT.
- 5104. FOREST ECOLOGY.
- 5106. SENIOR SILVICULTURE SEMINAR.
- 5107. FOREST ECOLOGY LABORATORY.
- 5110. FORESTRY APPLICATIONS OF MICROCOMPUTERS.
- 5114. FOREST HYDROLOGY.
- 5115. FOREST HYDROLOGY, FIELD APPLICATIONS.
- 5120. INTRODUCTORY TREE PHYSIOLOGY AND GENETICS.

- 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
- 5142. TROPICAL FOREST ECOLOGY.
- 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
- 5152. FOREST GENETICS.
- 5153. ADVANCED FOREST HYDROLOGY.
- 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
- 5200. AERIAL PHOTO INTERPRETATION.
- 5202. REMOTE SENSING: FIELD APPLICATIONS.
- 5212. NATURAL RESOURCES INVENTORY.
- 5215. FOREST FIRE MANAGEMENT.
- 5222. FOREST RESOURCES INVENTORY.
- 5226. FOREST ECONOMICS AND PLANNING.
- 5236. FOREST RECREATION PLANNING.
- 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
- 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
- 5248. HARVESTING AND ENGINEERING.
- 5264. QUANTITATIVE TECHNIQUES IN FOREST MANAGEMENT.
- 5401. SENIOR TOPICS.
- 5460. WATER QUALITY: THE INTERNATIONAL DIMENSION.
- 5500. URBAN FOREST MANAGEMENT.
- 5703. COLLOQUIUM IN FOREST BIOLOGY.
- 5704. COLLOQUIUM IN NATURAL RESOURCES.
- 8100. RESEARCH PROBLEMS: SILVICULTURE.
- 8101. RESEARCH PROBLEMS: FOREST TREE PHYSIOLOGY.
- 8102. RESEARCH PROBLEMS: FOREST TREE GENETICS.
- 8103. RESEARCH PROBLEMS: FOREST HYDROLOGY.
- 8104. RESEARCH PROBLEMS: FOREST ECOLOGY.
- 8106. TOPICS IN SILVICULTURE—FOREST SOILS.
- 8107. SEMINAR: FOREST RESOURCES.
- 8108. FOUNDATIONS OF RENEWABLE RESOURCES RESEARCH.
- 8112. RESEARCH PROBLEMS: PHYSIOLOGICAL ECOLOGY.
- 8200. RESEARCH PROBLEMS: FOREST MANAGEMENT.
- 8201. RESEARCH PROBLEMS: FOREST ECONOMICS.
- 8202. RESEARCH PROBLEMS: FOREST MEASUREMENTS.
- 8203. RESEARCH PROBLEMS: FOREST RECREATION.
- 8204. RESEARCH PROBLEMS: FOREST POLICY.
- 8205. RESEARCH PROBLEMS: REMOTE SENSING.
- 8207. ECONOMIC ANALYSIS OF FORESTRY PROJECTS.
- 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.
- 8301. TEACHING PRACTICUM.

INTERNATIONAL ISSUES/WORLD RESOURCES

Natural Resources and Environmental Studies (NRES)

- 3020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.
- 3201. FIELD ASSESSMENT TECHNIQUES.
- 5020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.

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.
- 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.

Agricultural Engineering Technology (AgET)

- 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Agronomy and Plant Genetics (Agro)

- 5200. WORLD FOOD PROBLEMS.

Animal and Plant Systems (AnPl)

- 3010. ENVIRONMENT AND WORLD FOOD PRODUCTION.

Anthropology (Anth)

- 5117. NATURAL RESOURCES ANTHROPOLOGY.

Ecology, Evolution, and Behavior (EEB)

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

Fisheries and Wildlife (FW)

- 5129. MAMMALOLOGY.
- 5455. AQUACULTURE.

Forest Resources (FR)

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

General College (GC)

- 1112. ECOLOGICAL EVALUATION OF ENVIRONMENTAL PROBLEMS.

Geography (Geog)

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

Geology and Geophysics (Geo)

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

Horticultural Science (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.
- 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT.

Natural Resources and Environmental Studies (NRES)

- 1040. NATURAL RESOURCES AS RAW MATERIALS.
- 3020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.
- 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
- 3070. FROM LOCAL TO GLOBAL ECOLOGY.
- 5020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT.

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

Public Affairs (PA)

- 5731. TECHNOLOGY POLICY.
- 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.

Sociology (Soc)

- 3551. . WORLD POPULATION PROBLEMS.

Soil Science (Soil)

- 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
- 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.

Strategic Management and Organization (BGS, MBA, Mgmt)

- BGS 3019/H3019. TOPICS IN BUSINESS, GOVERNMENT AND SOCIETY: COMPARATIVE ENVIRONMENTAL POLICY.
- BGS 8019. TOPICS IN BUSINESS AND SOCIETY: COMPARATIVE ENVIRONMENTAL POLICY.

LAKE ITASCA FORESTRY AND BIOLOGICAL STATION**Biology (Biol)**

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

Ecology, Evolution, and Behavior (EEB)

- 5814. PLANT COMMUNITY ECOLOGY.
- 5817. VERTEBRATE ECOLOGY.
- 5834. FIELD ORNITHOLOGY.

Entomology (Ent)

- 5600. FIELD ENTOMOLOGY.
- 5610. AQUATIC ENTOMOLOGY.

Forest Resources (FR)

- 3100. IMPORTANT FOREST PLANTS.
- 3101. NORTHERN FOREST ECOSYSTEMS.
- 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
- 3201. FIELD FOREST MEASUREMENTS.
- 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.

Natural Resources and Environmental Studies (NRES)

- 3201. FIELD ASSESSMENT TECHNIQUES.

LAKES AND WETLANDS**Civil Engineering (CE)**

- 8430. LAKE AND RESERVOIR HYDRODYNAMICS.
- 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior (EEB)

- 5601. LIMNOLOGY.
- 5607. ECOLOGY OF ANIMAL PLANKTON.
- 5621. LIMNOLOGY LABORATORY.

Geology (Geo)

- 5601. LIMNOLOGY.
- 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 AND WATER ECONOMICS.
- 8360. LAND ECONOMICS AND POLICY.

Architecture (Arch)

- 1401. THE DESIGNED ENVIRONMENT.
- 5711. DESIGN PRINCIPLES OF THE URBAN LANDSCAPE.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.
- 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.

Forest Resources (FR)

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

Geography (Geog)

- 1402. GEOGRAPHY AND ENVIRONMENTAL SYSTEMS.
- 3361. LAND USE AND THE FEDERAL GOVERNMENT.
- 3362. LAND USE AND STATE GOVERNMENT.
- 5361. LAND IN AMERICA.
- 5601. INTRODUCTION TO LAND USE PLANNING.
- 8344. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.
- 8345. SEMINAR: PUBLIC LAND POLICY IN MINNESOTA.

Horticultural Science (Hort)

- 5026. LANDSCAPE MANAGEMENT.

Landscape Architecture (LA)

- 1401. THE DESIGNED ENVIRONMENT.
- 5202. LANDSCAPE ECOLOGY.
- 5211. MAKING LANDSCAPE SPACE.
- 5212. ECOLOGICAL INFORMANTS OF DESIGN.
- 5222. PLANTING DESIGN: ECOLOGICAL PRINCIPLES/LAND USE CONCEPTS AND IMPLEMENTATION OF PLANTING DESIGNS.
- 5571. LANDSCAPE CONSTRUCTION: LANDFORM SYSTEMS.
- 5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE.
- 8222. THE LANDSCAPE ARCHITECTURAL DESIGN OF COMMUNITY PLACES.
- 8223. REGIONAL LANDSCAPE DESIGN.
- 8231. URBAN DESIGN LANDSCAPE.
- 8232. DESIGN OF RECREATIONAL LANDSCAPES.
- 8801. CONCEPTS OF LANDSCAPE EVALUATION.
- 8804. LANDSCAPE ECOLOGY AND DESIGN.

Natural Resources and Environmental Studies (NRES)

- 3201. FIELD ASSESSMENT TECHNIQUES.

LIFE SCIENCES

Public Affairs (PA)

- 5601. LAND USE.
- 5622. MANAGING URBAN GROWTH AND CHANGE.
- 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)

- 5013. BIOLOGY OF MICROORGANISMS.
- 5041. ECOLOGY.
- 5841. ECOLOGY.
- 5850. SPECIAL TOPICS IN BIOLOGY: LANDSCAPE ECOLOGY.
- 5850. SPECIAL TOPICS IN BIOLOGY: CONSERVATION BIOLOGY.

Chemistry (Chem)

- 1003. PHYSICAL WORLD, CHEMISTRY.
- 1008. PHYSICAL WORLD, CHEMISTRY.
- 1051-1052. CHEMICAL PRINCIPLES I-II.
- 1051H-1052H. CHEMICAL PRINCIPLES I-II.

Conservation Biology (CB)

- 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior (EEB)

- 3001. INTRODUCTION TO ECOLOGY.
- 5033. POPULATION AND QUANTITATIVE GENETICS.
- 5051. ANALYSIS OF POPULATIONS.
- 5608. ECOSYSTEMS: FORM AND FUNCTION.

Entomology (Ent)

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

Fisheries and Wildlife (FW)

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

Forest Resources (FR)

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

General College (GC)

- 1133. NATURE STUDY.

Microbiology (MicB)

- 3103. GENERAL MICROBIOLOGY.
- 5105. BIOLOGY OF MICROORGANISMS.
- 5352. APPLIED MICROBIOLOGY.
- 5611. MICROBIAL ECOLOGY.

Natural Resources and Environmental Studies (NRES)

- 5001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.

Soil Science (Soil)

- 5605. MICROBIAL ECOLOGY.

NATURALIST STUDIES

Agronomy and Plant Genetics (Agro)

- 1007. BIOLOGY OF FOOD SYSTEMS AND THE ENVIRONMENT.
- 3020. GROWTH AND DEVELOPMENT OF FIELD CROPS.

Biology (Biol)

- 1103. GENERAL BOTANY.
- 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES.
- 1203. ADAPTIVE BIOLOGY.
- 3012. PLANT BIOLOGY.
- 5041. ECOLOGY.
- 5841. ECOLOGY.

Chemistry (Chem)

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

Conservation Biology (CB)

- 8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Ecology, Evolution, and Behavior (EEB)

- 5008. QUATERNARY ECOLOGY.
- 5014. ECOLOGY OF PLANT COMMUNITIES.
- 5016. ECOLOGICAL PLANT GEOGRAPHY.
- 5033. POPULATION AND QUANTITATIVE GENETICS.
- 5122. PLANT/ANIMAL INTERACTIONS.
- 5129. MAMMALOLOGY.
- 5134. INTRODUCTION TO ORNITHOLOGY.
- 5814. PLANT COMMUNITY ECOLOGY.

Entomology (Ent)

- 3005. INSECT BIOLOGY.
- 3200. SOCIAL INSECTS.
- 5600. FIELD ENTOMOLOGY.

Fisheries and Wildlife (FW)

8452. CONSERVATION BIOLOGY: GENETIC AND DEMOGRAPHIC ISSUES.

Forest Resources (FR)

3100. IMPORTANT FOREST PLANTS.
 3106. IMPORTANT PLANTS: FISHERIES AND WILDLIFE HABITATS.
 5102. FOREST WILDLIFE HABITAT MANAGEMENT.
 5146. DYNAMICS OF GLOBAL CHANGE: PLANT ECOLOGY.
 5152. FOREST GENETICS.
 5160. PRACTICUM IN FOREST BIOLOGY AND MEASUREMENTS.
 5704. COLLOQUIUM IN NATURAL RESOURCES.

General College (GC)

1133. NATURE STUDY.

Geography (Geog)

3431. INTRODUCTION TO PLANT AND ANIMAL GEOGRAPHY.
 5441. QUATERNARY LANDSCAPE EVOLUTION.

Horticultural Science (Hort)

1010. HOME HORTICULTURE.
 1021. WOODY PLANT MATERIALS.
 1022. HERBACEOUS PLANT MATERIALS.
 1023. INDOOR PLANTS AND LANDSCAPES.
 1036. PLANT PROPAGATION.
 3001. GROWTH REGULATION OF HORTICULTURAL PLANTS.
 3002. HORTICULTURAL CROPPING SYSTEMS.
 3003. PLANT GENETICS AND IMPROVEMENT.
 3004. APPLICATIONS OF PLANT BIOTECHNOLOGY.
 3030. LANDSCAPE DESIGN OF RESIDENTIAL AND SMALL COMMERCIAL SITES.
 3040. LANDSCAPE DESIGN AND IMPLEMENTATION.
 3072. TURF MANAGEMENT.
 5001. HARVEST TO MARKET OF HORTICULTURAL CROPS.
 5015. RESTORATION AND RECLAMATION ECOLOGY.
 5026. LANDSCAPE MANAGEMENT.
 5031. TEMPERATE FRUIT PRODUCTION.
 5034. COMMERCIAL VEGETABLE AGRICULTURE.
 5040. PLANT GROWTH REGULATION.
 5042. TURF GRASS SCIENCE.
 5046. NURSERY MANAGEMENT I.
 5047. NURSERY SCHEDULING AND ENTERPRISE DEVELOPMENT.
 5048. NURSERY MANAGEMENT II.
 5054. COMMERCIAL FLORICULTURE PRODUCTION PRACTICES.
 5055. COMMERCIAL FLORICULTURE PRODUCTION SYSTEMS.
 8023. EVOLUTION OF CROP PLANTS.

Plant Biology (PBio)

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

Plant Pathology (PIPa)

1001. THE GOOD, BAD AND UGLY EFFECTS OF MICROORGANISMS ON PLANTS AND HUMAN SOCIETY.
 1002. PLANT DISEASES AND YOUR GARDEN.
 1003. DISEASES OF TREE.
 1004. DISEASES OF TURFGRASS.
 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES.
 3002. MANAGEMENT OF HORTICULTURAL CROP DISEASES.
 5102. ECOLOGY OF FUNGI.
 5201. BIOLOGY OF PLANT DISEASES.
 5203. PHYSIOLOGICAL AND MOLECULAR PLANT-MICROBE INTERACTIONS.
 5204. FIELD PLANT PATHOLOGY.
 5206. BIOLOGY OF FUNGI.
 5213. PLANT NEMATOLOGY.
 5214. PLANT VIROLOGY.
 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE.

Soil Science (Soil)

5610. SOIL BIOLOGY.

PEST AND DISEASE CONTROL

Agronomy and Plant Genetics (Agro)

3030. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS.
 5030. WEED CONTROL.
 5130. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS.
 5320. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH.

Entomology (Ent)

1005. ECONOMIC ENTOMOLOGY.
 5210. INSECT PEST MANAGEMENT.
 5250. FOREST ENTOMOLOGY.
 5280. LIVESTOCK ENTOMOLOGY.
 5610. AQUATIC ENTOMOLOGY.
 8240. COLLOQUIUM IN INSECT ECOLOGY.

Horticultural Science (Hort)

5034. COMMERCIAL VEGETABLE AGRICULTURE.
 5048. NURSERY MANAGEMENT II.

PUBLIC POLICY

Plant Pathology (PIPa)

- 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICROORGANISMS ON PLANTS AND HUMAN SOCIETY.
- 1002. PLANT DISEASES AND YOUR GARDEN.
- 1003. DISEASES OF TREE.
- 1004. DISEASES OF TURFGRASS.
- 3001. MANAGEMENT AND CONTROL OF FIELD CROP DISEASES.
- 3002. MANAGEMENT OF HORTICULTURAL CROP DISEASES.
- 5201. BIOLOGY OF PLANT DISEASES.
- 5203. PHYSIOLOGICAL AND MOLECULAR PLANT-MICROBE INTERACTIONS.
- 5204. FIELD PLANT PATHOLOGY.
- 5212. DISEASES OF FOREST AND SHADE TREES.
- 5213. PLANT NEMATOLOGY.
- 5214. PLANT VIROLOGY.
- 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE.

PUBLIC POLICY

Agricultural and Applied Economics (AgEc)

- 5600. LAND AND WATER ECONOMICS.
- 5650. ECONOMICS OF NATURAL RESOURCE AND ENVIRONMENTAL POLICY.
- 5710. U.S. AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.
- 5730. EUROPEAN AGRICULTURE: FARM, FOOD AND ENVIRONMENTAL POLICY.

Agricultural Engineering Technology (AgET)

- 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Agronomy and Plant Genetics (Agro)

- 8080. SUSTAINABLE AGRICULTURE COLLOQUIUM.

Architecture (Arch)

- 5711. DESIGN PRINCIPLES OF THE URBAN LANDSCAPE.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.
- 5951. SOCIAL USES OF BIOLOGY.

Civil Engineering (CE)

- 5580. INTRODUCTION TO ENVIRONMENTAL LAW FOR ENGINEERS.

Economics (Econ)

- 3611. ENVIRONMENTAL ECONOMICS.

Environmental and Occupational Health (PubH)

- 5150-1 TOPICS IN ENVIRONMENTAL HEALTH: PRINCIPLES OF ENVIRONMENTAL HEALTH LAW.
- 5150-2 TOPICS IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH: OCCUPATIONAL HEALTH LAW.
- 5150-3 TOPICS IN ENVIRONMENTAL HEALTH: POLLUTION CONTROL LAW.

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

5165. THE POLITICAL PROCESS IN PUBLIC HEALTH.

5215. APPLIED OCCUPATIONAL TOXICOLOGY.

5266. INTRODUCTION TO HEALTH RISK ASSESSMENT.

Forest Resources (FR)

5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.

5257. RECREATION LAND POLICY.

Geography (Geog)

5601. INTRODUCTION TO LAND USE PLANNING.

Horticultural Science (Hort)

5015. RESTORATION AND RECLAMATION ECOLOGY.

5048. NURSERY MANAGEMENT II.

Interdepartmental Study (ID)

3970. DIRECTED STUDIES.

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

International Relations (IntR)

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

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

Landscape Architecture (LA)

5572. LANDSCAPE CONSTRUCTION: SPATIAL PERFORMANCE.

8223. REGIONAL LANDSCAPE DESIGN.

Law School (Law)

5215. ENVIRONMENTAL LAW.

5885. ADVANCED ENVIRONMENTAL LAW.

Natural Resources and Environmental Studies (NRES)

1010. ISSUES IN THE ENVIRONMENT.

1040. NATURAL RESOURCES AS RAW MATERIALS.

3100. CONSERVATION OF BIODIVERSITY.

Political Science (Pol)

3872. INTERNATIONAL ORGANIZATIONS AND THE ENVIRONMENT.

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

5523. THE POLITICS OF THE REGULATORY PROCESS.

Public Affairs (PA)

5701. SCIENCE AND STATE I.

5711. ENERGY POLICY I.

5712. ENERGY POLICY II.

5721. ENVIRONMENTAL POLICY I.

- 5722. ENVIRONMENTAL POLICY II.
- 5731. TECHNOLOGY POLICY.
- 5741. ECONOMICS OF ENVIRONMENTAL AND RESOURCE POLICY.
- 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.
- 5792. ENERGY REGULATION ANALYSIS AND ADVOCACY.
- 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS.
- 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, MBA, Mgmt)

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

RECREATION AND OUTDOOR EDUCATION

Curriculum and Instruction (CI)

- 5502. WORKSHOP: OUTDOOR SCIENCE EDUCATION.

Forest Resources (FR)

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

Horticultural Science (Hort)

- 3072. TURF MANAGEMENT.
- 5026. LANDSCAPE MANAGEMENT.

Landscape Architecture (LA)

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

Recreation, Park, and Leisure Studies (Rec)

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

RESOURCE MANAGEMENT

Agricultural and Applied Economics (AgEc)

- 3610. RESOURCE DEVELOPMENT AND ENVIRONMENTAL ECONOMICS.
- 5650. ECONOMICS OF NATURAL RESOURCE AND ENVIRONMENTAL POLICY.
- 8264. RESOURCE ECONOMICS.
- 8364. SEMINAR: RESOURCE AND ENVIRONMENTAL ECONOMICS.

Anthropology (Anth)

- 5117. NATURAL RESOURCES ANTHROPOLOGY.

Design, Housing and Apparel (DHA)

- 1401. RESIDENTIAL TECHNOLOGY.
- 5482. THE FAMILY AND ENERGY ISSUES.
- 5634. INTERIOR DESIGN CODES AND ENVIRONMENTAL ISSUES.

Economics (Econ)

- 3611. ENVIRONMENTAL ECONOMICS.
- 5611. RESOURCE AND ENVIRONMENTAL ECONOMICS.

Fisheries and Wildlife (FW)

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

Forest Resources (FR)

- 1201. CONSERVATION OF NATURAL RESOURCES.
- 1203. INTRODUCTION TO MINNESOTA'S NATURAL RESOURCES.
- 3103. METEOROLOGY AND CLIMATOLOGY FOR RESOURCE MANAGERS.
- 3250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
- 3300. ELEMENTS OF SURVEYING.
- 5102. FOREST WILDLIFE HABITAT MANAGEMENT.
- 5130. GEOGRAPHIC INFORMATION SYSTEMS IN NATURAL RESOURCE ANALYSIS.
- 5131. GEOGRAPHIC INFORMATION SYSTEMS LAB.
- 5200. AERIAL PHOTO INTERPRETATION.
- 5202. REMOTE SENSING: FIELD APPLICATIONS.
- 5212. NATURAL RESOURCES INVENTORY.
- 5222. FOREST RESOURCES INVENTORY.
- 5231. RANGE MANAGEMENT.

SOIL RESOURCES

- 5240. NATURAL RESOURCE POLICY AND ADMINISTRATION.
- 5241. NATURAL RESOURCE MANAGEMENT: POLITICAL AND ADMINISTRATIVE PROCESSES.
- 5250. ROLE OF RENEWABLE NATURAL RESOURCES IN DEVELOPING COUNTRIES.
- 5262. REMOTE SENSING OF NATURAL RESOURCES.
- 5403. FUNDAMENTALS OF NATURAL RESOURCE EDUCATION.
- 5412. ADVANCED REMOTE SENSING.
- 5704. COLLOQUIUM IN NATURAL RESOURCES.
- 8205. RESEARCH PROBLEMS: REMOTE SENSING.
- 8211. SEMINAR: NATURAL RESOURCE POLICY ISSUES.

Geography (Geog)

- 1402. GEOGRAPHY AND ENVIRONMENTAL SYSTEMS.

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.
- 1040. NATURAL RESOURCES AS RAW MATERIALS.
- 3001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
- 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT.
- 3050. EXPERIENCE AND TRAINING IN A FIELD SETTING.
- 3051. FROM TALL-GRASS PRAIRIES TO BOREAL FORESTS.
- 3060/5060. WATER QUALITY IN NATURAL RESOURCE MANAGEMENT.
- 3201. FIELD ASSESSMENT TECHNIQUES.
- 3225. NRES DIRECTED STUDY EXPERIENCE.
- 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES.
- 5101. INTEGRATED NATURAL RESOURCE MANAGEMENT.
- 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I.
- 5220. SURVEY MEASUREMENT AND MODELLING METHODS FOR NATURAL RESOURCES II.
- 5225. NRES DIRECTED STUDY EXPERIENCE.
- 5800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION.

Public Affairs (PA)

- 5741. ECONOMICS OF ENVIRONMENTAL AND RESOURCE POLICY.

SOIL RESOURCES

Agricultural Engineering (AgEn)

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

Agronomy and Plant Genetics (Agro)

- 5320. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH.

Environmental and Occupational Health (PubH)

- 5186. ENVIRONMENTAL CHEMISTRY.

Forest Resources (FR)

- 5126. SILVICULTURE: SOIL-SITE RELATIONSHIPS.
- 8106. TOPICS IN SILVICULTURE—FOREST SOILS.

Soil Science (Soil)

- 1020. THE SOIL RESOURCE.
- 3125. BASIC SOIL SCIENCE.
- 3220. SOIL CONSERVATION AND LAND USE MANAGEMENT.
- 3416. PLANT NUTRIENTS IN THE ENVIRONMENT.
- 5210. ENVIRONMENTAL BIOPHYSICS.
- 5510. FIELD STUDY OF SOILS FOR ENVIRONMENTAL ASSESSMENT.
- 5550. PEATLANDS: FORMATION, CLASSIFICATION, AND UTILIZATION.
- 5555. WETLAND SOILS.
- 5610. SOIL BIOLOGY.

TECHNOLOGY

Agricultural Engineering Technology (AgET)

- 5027. APPROPRIATE TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT.

Biology (Biol)

- 5951. SOCIAL USES OF BIOLOGY.

Civil Engineering (CE)

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

Design, Housing and Apparel (DHA)

- 1401. RESIDENTIAL TECHNOLOGY.

Forest Products (ForP)

- 5305. PULP AND PAPER TECHNOLOGY.
- 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.
- 3003. PLANT GENETICS AND IMPROVEMENT.
- 3004. APPLICATIONS OF PLANT BIOTECHNOLOGY.

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

Microbiology (MicB)

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

Natural Resources and Environmental Studies (NRES)

- 1040. NATURAL RESOURCES AS RAW MATERIALS.

Public Affairs (PA)

- 5701. SCIENCE AND STATE I.
- 5721. ENVIRONMENTAL POLICY I.
- 5722. ENVIRONMENTAL POLICY II.
- 5791. SCIENCE, TECHNOLOGY AND INTERNATIONAL AFFAIRS.
- 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, MBA, Mgmt)

- BGS 3003. BUSINESS AND THE NATURAL ENVIRONMENT.

WASTE MANAGEMENT**Agricultural Engineering (AgEn)**

- 5910. AGRICULTURAL WASTE MANAGEMENT ENGINEERING.

Biology (Biol)

- 1051/3051. ENVIRONMENTAL STUDIES.

Civil Engineering (CE)

- 5097. SOLID AND HAZARDOUS WASTE PROCESSING I.
- 5098. SOLID AND HAZARDOUS WASTE PROCESSING II.
- 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.

- 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.

- 5510. SOLID AND HAZARDOUS WASTE MANAGEMENT.

- 5515. WATER AND WASTEWATER MICROBIOLOGY.

- 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.

- 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT - PART II.

- 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.

Environmental and Occupational Health (PubH)

- 5233. BIOLOGICAL SAFETY.

- 5253. INTRODUCTION: HAZARDOUS WASTE MANAGEMENT.

- 5254. HAZARDOUS WASTE MANAGEMENT.

Forest Products (ForP)

- 5305. PULP AND PAPER TECHNOLOGY.

- 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.

- 5600. PRINCIPLES OF WASTE MANAGEMENT.

Public Affairs (PA)

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

WATER RESOURCES**Agricultural and Applied Economics (AgEc)**

- 5600. LAND AND WATER ECONOMICS.

Agricultural Engineering (AgEn)

- 3052. ENGINEERING PRINCIPLES OF SOIL-WATER-PLANT SYSTEMS.

- 5540. WATERSHED ENGINEERING.

- 5550. WATER MANAGEMENT ENGINEERING.

- 8500. HYDROLOGIC MODELING - SMALL WATERSHEDS.

Agricultural Engineering Technology (AgET)

- 5410. HYDROLOGY AND WATER QUALITY.

Civil Engineering (CE)

- 5401. WATER RESOURCES ENGINEERING.

- 5405. HYDROLOGY AND HYDROLOGIC DESIGN.

- 5425. GROUNDWATER MECHANICS.

- 5426. COMPUTER MODELING OF GROUNDWATER FLOW.

WATER RESOURCES

- 5500. ANALYSIS AND DESIGN OF WATER SUPPLY SYSTEMS.
- 5501. ANALYSIS AND DESIGN OF WASTEWATER SYSTEMS.
- 5504. MASS TRANSPORT WITH ENVIRONMENTAL APPLICATIONS.
- 5505. WATER QUALITY ENGINEERING.
- 5506. ENVIRONMENTAL WATER CHEMISTRY.
- 5507. ENVIRONMENTAL ENGINEERING LABORATORY.
- 5540. ANALYSIS OF GROUNDWATER-SOIL POLLUTION ABATEMENT TECHNOLOGY.
- 8406. SEMINAR: ADVANCED HYDROLOGY.
- 8407. STOCHASTIC HYDROLOGY.
- 8413. MECHANICS OF SEDIMENT TRANSPORT.
- 8419. COMPUTATIONAL HYDRODYNAMICS II.
- 8425. ADVANCED GROUNDWATER MECHANICS.
- 8426. ADVANCED GROUNDWATER MECHANICS II.
- 8500. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT.
- 8501. PHYSICAL AND CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT - PART II.
- 8502. BIOLOGICAL AND CHEMICAL PROCESSES FOR WASTEWATER TREATMENT.
- 8505. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.
- 8506. AQUATIC CHEMISTRY FOR ENVIRONMENTAL ENGINEERS.
- 8507. ENVIRONMENTAL PROCESSING OF ORGANIC CHEMICALS.
- 8540. INTERFACIAL MASS TRANSFER WITH ENVIRONMENTAL APPLICATIONS.
- 8550. ANALYSIS AND MODELING OF AQUATIC ENVIRONMENTS.
- 8551. SEMINAR: MODELS OF AQUATIC ENVIRONMENTS.

Ecology, Evolution, and Behavior (EEB)

- 5608. ECOSYSTEMS: FORM AND FUNCTION.

Environmental and Occupational Health (PubH)

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

Fisheries and Wildlife (FW)

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

Forest Resources (FR)

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

Geography (Geog)

- 5444. GEOGRAPHY OF WATER RESOURCES

Geology (Geo)

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

Natural Resources and Environmental Studies (NRES)

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

Soil Science (Soil)

- 5210. ENVIRONMENTAL BIOPHYSICS.

II. 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
Frances Homans, 217F Classroom Office Building, 625-6220

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 AND WATER ECONOMICS. (4 cr for undergrad, 3 cr for grad; prereq 3101, 3102, or Econ 3101, 3102 or #) Day class
Land and water as public resources and as factors of production; economic analysis of policies that influence asset use; sale and rental markets; valuation of rights to land and water; taxation and regulation as instruments for influencing private management decisions; comparative land and water legal market settings.

AgEc 5650. ECONOMICS OF NATURAL RESOURCE AND ENVIRONMENTAL POLICY. (4 cr for undergrad, 3 cr for grad; §PA 5741, §PA 5794; prereq 3101 or Econ 3101 or AgEc 3610 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

The application of economic analysis, including project evaluation, to current natural resource and environmental issues. Emphasis on conservation and resource scarcity, environmental quality, 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.

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

AgEc 8364. SEMINAR: ENVIRONMENTAL ECONOMICS AND POLICY. (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;
nieber@gaia.ageng.umn.edu
C. J. Clanton, 230 Agricultural Engineering, 625-9218;
clant001@maroon.tc.umn.edu

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 3261, or #; upper division IT or grad IT or grad COA; 2 lect hrs per wk) Day class
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 1052, 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 WATERSHEDS. (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;
nieber@gaia.ageng.umn.edu
C. J. Clanton, 230 Agricultural Engineering, 625-9218;
clant001@maroon.tc.umn.edu

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 5410. HYDROLOGY AND WATER QUALITY. (5 cr; prereq Math 1111, Phy 1041, Chem 1052; 3 lect, 3 lab, and 1 rec hrs per wk) Day class
The hydrologic cycle—precipitation, infiltration, evaporation, surface and subsurface 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
Lawrence H. Smith, 301 Hayes Hall, 625-2778

Agro 1007. BIOLOGY OF FOOD SYSTEMS AND THE ENVIRONMENT. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Biological principles and processes are learned in the context of food production systems and the environment. We introduce basic elements of biology, progress into whole plant and animal systems, and ultimately discuss plants and animals in ecosystems. Lecture and lab.

Agro 1010. PRINCIPLES OF AGRONOMY. (5 cr; §3010, §3020, §3030) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles and practices of plant and related sciences as they apply to increasing efficiency, productivity, and genetic improvement of field crops. Topics include crop selection, improvement of crops through plant breeding, seeds and seeding, growth and development, minimizing production hazards, harvesting and storage. Lecture and lab.

Agro 3020. GROWTH AND DEVELOPMENT OF FIELD CROPS. (4 cr; prereq 1007 or Biol 1009, Chem 1002 or 1051 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles and mechanisms of growth and development of field crops which affect crop productivity. Emphasis on physiological and morphological basis of growth and development, and effects of physical and biological environmental factors on crop growth and development. Lecture and lab.

Agro 3030. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS. (4 cr; prereq 1007 or Biol 1009, Chem 1002, 1051 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Crop quality traits associated with utilization as they influence crop harvest, processing and storage. Principles and technology utilized in crop storage to minimize damage from fungi and insects and maximize crop quality. Lecture and lab.

Agro 5010. FORAGE PRODUCTION AND UTILIZATION. (3 cr; prereq 1010 or #; offered Win95 only, will be replaced by 5050) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Interrelationships between plants and animals as they are involved in the selection, production, and use of forage crops. Crop management practices including establishment, maintenance, and harvesting of forages such as pasture, hay, or silage. Physiological basis of forage management of various species. Forage quality and use for livestock feeding with emphasis on ruminant nutrition. Lecture.

Agro 5020. INTRODUCTION TO PLANT BREEDING. (4 cr; prereq GCB 3022, Hort 3003 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Applying genetic principles to improve crop plants. Includes self-pollinated, cross-pollinated, and asexually propagated crops. Lecture. Discussion for graduate students only.

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.

Agro 5050. MANAGEMENT TECHNOLOGIES FOR CROP PRODUCTION IN MINNESOTA. (4 cr; prereq a course in Agro; offered 1995-96) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Course focuses on appropriate solutions to crop production problems. Quality, productivity, and profitability will be emphasized. Discussion, lectures and readings will emphasize the principles needed for decisions. Corn/soybean, small grains, and forage crops will be emphasized. Lecture and discussion.

Agro 5120. GROWTH AND DEVELOPMENT OF FIELD CROPS. (4 cr; §3030; prereq 1007 or Biol 1009; Chem 1002, 1051 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles and mechanisms of growth and development of field crops which affect crop productivity. Emphasis on physiological and morphological basis of growth and development, and effects of physical and biological environmental factors on crop growth and development. Lecture and lab.

Agro 5130. HARVEST, STORAGE AND UTILIZATION OF FIELD CROPS. (4 cr; §3030; prereq 1007 or Biol 1009, Chem 1002, 1051 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Crop quality traits associated with utilization as they influence crop harvest, processing and storage. Principles and technology utilized in crop storage to minimize damage from fungi and insects and maximize crop quality. Lecture and lab.

Agro 5200. WORLD FOOD PROBLEMS. (3 cr; §AgEc 5790, §CAPS 5280, §FScN 5643; prereq sr or grad with #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Multidisciplinary approach to the social, economic, and technical problems of feeding the world's growing population. Principles sought from the social and economic sciences and plant, animal, and food sciences for their application to world food problems.

Agro 5310. ORIENTATION TO FIELD CROP BREEDING. (1 cr; prereq 5020 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Field study of plant breeding programs and techniques.

ANIMAL AND PLANT SYSTEMS

Agro 5320. ORIENTATION TO AGRONOMY AND SOILS FIELD RESEARCH. (1 cr; prereq 5050 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Field survey and discussion of research techniques in crop physiology, crop and soil management, and weed science programs in agronomy and soils.

Agro 8080. SUSTAINABLE AGRICULTURE COLLOQUIUM. (2 cr; pre-req grad) Day class

- ◆ **new** Discussion of features of a sustainable agriculture system. Analysis of the interdisciplinary and interorganizational interaction required for an effective sustainable agriculture; the impact of public policy on sustainable agriculture; and how individuals in production agriculture respond to the concept of sustainable agriculture.

ANIMAL AND PLANT SYSTEMS (AnPI)

College of Agriculture

411 Borlaug Hall, 625-7773

Lawrence H. Smith, 301 Hayes 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 1101. HUMAN ORIGINS. (5 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** World prehistory as investigated by anthropologists. Methods and concepts used by anthropologists to study prehistoric human biological and cultural development.

Anth 1101H. HUMAN ORIGINS. (5 cr; prereq B avg or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** For description, see 1101.

Anth 3116. ECOLOGICAL ANTHROPOLOGY. (4 cr; prereq 1102, 3201 or 5102) Joint Day/Extension class: refer to daytime *Class Schedule*

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. NATURAL RESOURCES ANTHROPOLOGY. (4 cr) Joint Day/Extension class; refer to daytime *Class Schedule*

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

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; §LA 1401) Joint Day/Extension class

(Same as LA 1500) Principles and traditions in architecture, landscape architecture, and urban design, with references in the arts, sciences, and literature, explored in a review of the formal constructs of the designed environment.

Arch 3501. PEOPLE, ECOLOGY, AND DESIGN. (4 cr; prereq Arch major, 3311, 3412 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Issues, design procedures, and short- and long-term impacts of development decisions made by architects and landscape architects on local and global ecological systems.

Arch 5458. ARCHITECTURE AND CULTURE. (3 cr, §5951; prereq Arch major, 3412 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Architecture as a cultural medium; relation among architecture, people, and culture; physiological and symbolic messages; relation between research findings and design; relation between vernacular and high style architecture; reception theory in architecture; cultural critique and cultural change; implications for architectural practice.

Arch 5523. LIGHT FRAME BUILDINGS: DESIGN FOR ENERGY EFFICIENCY, HEALTH, AND DURABILITY. (4 cr; prereq Arch grad, 5521, 5541 or #) Extension class

Design principles and construction methods for resolving problems of comfort, energy efficiency, and durability. Problems integrating building systems and envelope assemblies with design solution for moisture, infiltration, indoor air quality, and material degradations.

Arch 5531. LIGHTING AND ACOUSTIC DESIGN. (4 cr, §3065; prereq Arch major or Arch grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of daylighting, electric lighting, and acoustic design in architecture. Relationship between luminous and acoustic environments, human comfort and architectural experience. Analytic methods, design process, and modeling of daylighting.

Arch 5539. DAYLIGHTING AND ARCHITECTURAL DESIGN. (4 cr, §5959; prereq Arch grad, 5531 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Role of daylighting in architectural design: principles, strategies, energy and environmental issues, psychology of light, color, integration of electric lighting. Design projects investigate qualitative and quantitative issues through drawing, physical models, and photometric analysis.

Arch 5541. THERMAL DESIGN IN ARCHITECTURE. (4 cr, §3064; prereq Arch major or Arch grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Thermal and climatic issues in designing small and midsize buildings. Built and mechanical means to modify the climate. Evaluation of design techniques in terms of potential impacts on energy use, the environment, and architectural meaning.

Arch 5542. BUILDING ENERGY SYSTEMS. (4 cr; §5966; prereq Arch grad, 5541 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Understanding 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, and structural implications of mechanical systems, indoor air quality, and environmental control strategies.

Arch 5543. CLIMATE AND ARCHITECTURE. (4 cr; §5957; prereq Arch grad, 5541 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
Role of climate in architectural design and theory. Lectures and discussions focus on environmental and energy implications at the site, building, and component scales. Design projects explore graphic analysis, physical modeling, and quantitative assessment.

Arch 5711. DESIGN PRINCIPLES OF THE URBAN LANDSCAPE. (4 cr, §5137; prereq 1601, Arch grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Art and design of making city, neighborhood, and development plans. Public policies, planning tools and process, and physical models for design professionals and private and civic institutions to shape the physical environment.

Arch 5725. HOUSING AND VALUES. (4 cr, §5953; prereq upper div or grad) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Meanings and values attached to housing in different cultures at various stages in the life cycle and in different climatic situations. Impact of housing heritage on housing choice, potential impact of emerging constraints (e.g., energy ability) on current and future housing decisions.

ASTRONOMY (Ast)

Institute of Technology
355 Physics, 624-8009
Thomas Jones, 358 Physics, 624-8546

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

- ◆ **new** Interrelationships among Earth's subsystems—solid earth, oceans, atmosphere, and biosphere—and solar and galactic super-systems. Interactions of the natural cycles, their rates and feedbacks, and human impacts.

Ast 1031. EXPLORING THE UNIVERSE: A. (4 cr; 3 lect hrs per wk and 1 active learning session hr per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** The human place in the universe. Study of the Earth as a planet, other planets, the sun, stars, and galaxies. Background and fragility of life of Earth. Scale, origin, and history of the universe and our relationship to it.

Ast 1032. EXPLORING THE UNIVERSE: L. (4 cr; 3 lect hrs per wk and 2 lab hrs per wk) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** The human place in the universe. Study of the Earth as a planet, other planets, the sun, stars, and galaxies. Background and fragility of life of Earth. Scale, origin, and history of the universe and our relationship to it.

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 3021 or 5331 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 1051/3051. ENVIRONMENTAL STUDIES. (4 cr; §1051; bioscience students may not apply these credits to the major) Joint Day/Extension class limited to 25 Extension students
Principles of ecology and current environmental issues including air and water pollution, human population growth, toxic and hazardous wastes, urbanization, land use, biological diversity, energy, environmental health, conservation history, attitudes towards nature, environmental politics, and ethics. Meets environmental theme for liberal education curriculum.

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
Plant organization, function, growth and development and reproduction. Includes lab.

Biol 1201. EVOLUTIONARY AND ECOLOGICAL PERSPECTIVES. (5 cr; §1008; intended for non-biology majors to meet the biology liberal education requirement. Also intended for pre-biology majors in preparation for 1202-1203. No chemistry background required) Joint Day/Extension class limited to 20 Extension students
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 1203. ADAPTIVE BIOLOGY. (5 cr; §1103 and §1106 and §1806; prereq 1202, Chem 1052 or equivalent or Δ) Joint Day/Extension class: refer to daytime *Class Schedule*
• **new** Explores how plants, animals and microbes have adapted to similar environmental challenges, studies the commonalities in these adaptations, and studies the evolutionary diversity of organisms. Lab includes dissections.

Biol 3012. PLANT BIOLOGY. (5 cr; §1103, §3812; prereq 1009 or 1202, Chem 1052) Joint Day/Extension class: refer to daytime *Class Schedule*
Plant diversity and evolution; structure and function of the plant cell and of the whole organism; growth and development of plants. Includes laboratory.

Biol 5013. BIOLOGY OF MICROORGANISMS. (5 cr; §MicB 5105, §MicB 3103, §VPB 3103; prereq 5 cr biological sciences, 5001 or BioC 3021 or BioC 5331 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
• **new** Taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Molecular structure in relation to bacterial function. Lab.

Biol 5041. ECOLOGY. (4 cr; §5841, prereq 1103 or 1106 or 1806 or 3011 or 3012 or 3812, Math 1142 or 1251) Joint Day/Extension class: refer to daytime *Class Schedule*
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. Includes lab.

Biol 5841. ECOLOGY. (5 cr; §5041; prereq 1103 or 1106 or 1206 or 3011 or 3012 or 3812, Math 1142 or 1251, Δ) Day class
(Equivalent to 5041 but additional field experience at the Itasca station for this number (5841) makes it 5 credits.) 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*
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*
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
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.
Same as Chem 1003, but without lab.

Chem 1051-1052. CHEMICAL PRINCIPLES I-II. (4 cr per qtr; primarily for students majoring in science of engineering; prereq 1001 or passing placement exam; 1051 is a prereq for 1052) Day class

- ◆ **new** Structure of atoms and molecules, chemical periodicity, chemical reactions and stoichiometry, the energetics of chemical reactions, equilibrium, and the properties of gases, solutions and ionic compounds. Examples of the relationships of chemical concepts to environmentally-relevant topics are interwoven with lecture material, assigned readings and problems, and lab exercises. Topics include the kinetics of ozone depletion in the upper atmosphere; the relationship between energy and chemistry; atmospheric gases; the effect of burning fossil fuels on climate, air and water quality; pollution and the second law of thermodynamics.

Chem 1051H-1052H. HONORS: CHEMICAL PRINCIPLES I-II. (4 cr per qtr; primarily for students majoring in science of engineering; prereq selection for IT honors curriculum or consent of IT Honors Office and 1001 or passing placement exam; 1051 is a prereq for 1052) Day class

- ◆ **new** For description, see 1051-1052.

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
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 5507. ENVIRONMENTAL ENGINEERING LABORATORY. (4 cr; prereq 5500 or 5501 or #, IT upper div; 3 lect and 3 lab hrs per wk) Day class
♦ **new** Methods for sampling of natural waters and wastewaters; techniques for chemical, biological and physical characterization of samples, including nutrients, indicator organisms, BOD, major and minor ions, natural and synthetic organic matter.

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 5580. INTRODUCTION TO ENVIRONMENTAL LAW FOR ENGINEERS. (4 cr) Extension class
♦ **new** The intent of this course is to introduce students to the legal terminology and regulatory concepts found in the environmental field using specific references to federal statutes and rules. The material will be presented primarily through lecture with some discussion.

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

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

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

Conformal 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

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 terms 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
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.

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

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.

CONSERVATION BIOLOGY

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.

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, 103 Folwell 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.

CURRICULUM AND INSTRUCTION (CI)

College of Education (formerly Elementary Education)

125 Peik Hall, 625-6372

Audrey Borgstrom, 145 Peik Hall, 625-9809

CI 5502. WORKSHOP: OUTDOOR SCIENCE EDUCATION. (3 cr; § Elem 5348; 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.

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

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

DHA 1401. RESIDENTIAL TECHNOLOGY. (4 cr, §1801; prereq soph or #; Phys 1001 or 1041) Joint Day/Extension class: refer to daytime *Class Schedule*
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.

DHA 3463. ENVIRONMENT: HOUSING AND COMMUNITY.

(4 cr, §3863; prereq 1400 or 1851 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

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.

DHA 3631. INTERIOR DESIGN RESOURCES AND MATERIALS. (3 cr; prereq pass IntDsgn portfolio review, TexC 3216 or #) Joint Day/Extension class:

refer to daytime *Class Schedule*

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

DHA 3633. LIGHTING DESIGN FOR ENVIRONMENTAL SPACES.

(3 cr; prereq IntDsgn portfolio review or #) 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.

DHA 5482. THE FAMILY AND ENERGY ISSUES. (3 cr, §5801; prereq 1400 or 1851, 1401 or 1801 or #; offered 1994-95 and alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

Analysis of family behavior as it relates to energy use, impact of scarce resources on quality of family functioning, family/energy issues in future.

DHA 5634. INTERIOR DESIGN CODES AND ENVIRONMENTAL ISSUES. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Explores the impact of environmental issues, legislation, and social awareness on designing for life safety, health, diverse populations, and our earth's resources.

ECOLOGY, EVOLUTION, AND BEHAVIOR (EEB)

College of Biological Sciences
100 Ecology, 625-5700

Patrice Morrow, 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*

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 5004. DYNAMICS OF GLOBAL CHANGE: QUATERNARY HISTORY OF ECOSYSTEM RESPONSE. (4 cr; §Geo 5631; prereq Geo 3202, 3301 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Interdisciplinary study of global change forcing mechanisms, feedbacks and dynamics on various time scales, using paleorecord to illustrate processes.

EEB 5008. QUATERNARY ECOLOGY. (4 cr; prereq Biol 5041 or 5841 or #) 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*

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 1806 or 3011, 1103 or 3012 or 3812 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 1806 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 1806 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 1806 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 1806 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 and advanced courses in writing such as Comp 3015, 3027, 3033, 3085 or Rhet 3562) 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; prereq 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
Simran Sahi, 1035 Management and Economics, 625-6353

Econ 3611. ENVIRONMENTAL ECONOMICS. (4 cr; prereq 1101, 1102, college algebra) Day class
◆ **new** Efficient use of renewable and non-renewable resources like food, fisheries, water, timber, minerals, and petroleum. Pollution control, taxation versus permits. Environmental concerns versus trade and development. Measuring environmental impact through cost-benefit analysis. Externalities and property rights.

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.

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

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. INSECT BIOLOGY. (3 cr; prereq Biol 1009 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

Biodiversity and natural history of insects; functional roles in natural and managed environments; effects of insects on human history and approaches to managing problems caused by insects.

Ent 3200. SOCIAL INSECTS. (4 cr; prereq college level course in general biology) Day class

- ◆ **new** Lectures and discussion groups will examine the termites, ants, social wasps and social bees. Topics include natural history, caste determination and regulation, group effects and control of nestmates, communication and pheromones, the superorganism concept, and the evolution of sociality.

Ent 5040. INSECT ECOLOGY. (3 cr; prereq Biol 5041 or EBB 5122 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

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

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

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

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

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

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

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
Kathleen Soupir, 807 Mayo, 625-0622

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 Special Term, Sec 2

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

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;

offered when feasible) Joint Day/Extension class: refer to daytime *Class*

Schedule

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. MEASUREMENT OF AIRBORNE CONTAMINANTS IN WORKPLACES. (4 cr; prereq 5210, 5216, or #) 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 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.

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*

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

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 5215. APPLIED OCCUPATIONAL TOXICOLOGY. (3 cr; prereq 5261 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
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 the 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*
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
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 ENVIRONMENT: 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 GROUND-WATER 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; offered when feasible) 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*
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
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 8264. HUMAN DISEASES CAUSED BY ENVIRONMENTAL AGENTS. (3 cr; prereq 5261, 5262 and #) Day class
Clinical presentation of disease; investigation of exposed populations and affected individuals.

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) 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. FISH PHYSIOLOGY. (4 cr; prereq AnSci 3301 or EEB 5136 or EEB 5156 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 1051-1052, 3301, 3305 or #; offered alt yrs) 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 EEB 5134 or grad or #; offered alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*
Current problems in avian conservation and management, with equal 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
Application 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
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
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 #; offered 1993-94 and alt yrs) Day class
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
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
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
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
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/Extension 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.

FOREST RESOURCES

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 habitat and 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 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
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.

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 5107. FOREST ECOLOGY LABORATORY. (1 cr; § 5160; prereq ¶5104) Joint Day/Extension class: refer to daytime *Class Schedule*
◆ new Forest stands, communities, and ecosystems. Field trips.

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 sr or grad or #) Joint Day/Extension class: refer to daytime *Class Schedule*

Introduction to the application of geographic information systems (GIS) to natural resource and regional planning studies. Theory and technical points; emphasis on applications. Hands-on experience with microcomputer. Case study, including map digitizing, data processing, and generation of map products.

FR 5131. GEOGRAPHIC INFORMATION SYSTEMS LAB. (1 cr; prereq ¶5130) Joint Day/Extension class: refer to daytime *Class Schedule*

◆ new Lab for 5130.

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*

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*

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

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

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 FOREST BIOLOGY. (1-4 cr; prereq varies with topic; #) Joint Day/Extension class: refer to daytime *Class Schedule*

◆ **new** Colloquium on specialized topics in forest biology and silviculture.

FR 5704. COLLOQUIUM IN NATURAL RESOURCES. (1-4 cr; prereq varies with topic, #) Joint Day/Extension class: refer to daytime *Class Schedule*
Colloquium on specialized topics in forest biology and silviculture.

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

FR 8107. SEMINAR: FOREST RESOURCES. (1 cr) Day class
◆ **new**

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

FR 8112. RESEARCH PROBLEMS: PHYSIOLOGICAL ECOLOGY. (ar cr) Day class
◆ **new**

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.

FR 8301. TEACHING PRACTICUM. (1-4 cr) Day class

◆ new

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 viewpoint 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 1402. GEOGRAPHY AND ENVIRONMENTAL SYSTEMS. (5 cr; §1401) Joint Day/Extension class: refer to daytime *Class Schedule*

◆ new Examination of geographic patterns, dynamics, and interactions of atmospheric, hydrospheric, geomorphic, pedologic, and biologic systems as the context for human population, development, and resource use patterns.

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 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*
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 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 3402. INTRODUCTORY MINERALOGY. (5 cr; §5004, §5404; prereq 1001 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; §EBB 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*

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*

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

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 MEDICINE (HMed)

Medical School
510 Diehl Hall, 624-4416
Leonard G. Wilson, Box 506 Mayo, 624-4416

HMed 3040. HUMAN DISEASE AND THE ENVIRONMENT IN HISTORY. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*
◆ **new** An introduction to the changing relationship of human health and the environment. The course will examine the ways in which human-induced environmental changes have altered our experiences with disease and our prospects of health.

HISTORY OF SCIENCE AND TECHNOLOGY (HSci)

Institute of Technology
Arthur Norberg, 4-213 Electrical Engineering/Computer Science, 625-1067

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
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
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
Taxonomy, ecology, and landscape uses of perennial and annual flowers, ferns, weeds, tender and hardy bulbs, grasses, herbs and native plants. Lecture, laboratory, field trips, and garden experience.

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

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*

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*

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*

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, 1022, LA 1025 or #) Day class

Fundamentals of landscape design theory including organization of space, complementary shapes and forms, site analysis, and the relationship of structure, texture, and seasonal interest in the landscape; includes further study of plants and environmental requirements as they influence design.

Hort 3040. LANDSCAPE DESIGN AND IMPLEMENTATION. (5 cr; prereq 3030) Day class

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

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*
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 5015. RESTORATION AND RECLAMATION ECOLOGY. (4 cr; prereq 1 course in plant biology or botany, and ecology) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Ecological and physiological concepts as a basis for the revegetation of grasslands, wetlands, forests, and other landscapes. Methods for plant materials selection, stand establishment, evaluating revegetation success. Overview of state and federal programs that administer restoration and reclamation programs. Weekend and evening trips to examine reclamation and restoration sites in several areas of Minnesota.

Hort 5026. LANDSCAPE MANAGEMENT. (4 cr; prereq completion of all or majority of coursework in the Landscape, Nursery and Turf sequence, plus Business Enrichment requirements) Joint Day/Extension class: refer to daytime *Class Schedule*

Integrates the environmental horticulture industry disciplines and commodities while superimposing appropriate business management principles. Utilization of scientific methods and technical applications will be incorporated through problem solving and case studies.

Hort 5031. TEMPERATE FRUIT PRODUCTION. (4 cr; prereq 3001, PBio 3131 recommended; offered odd yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Principles of fruit production emphasizing temperate fruit crops. Integrated management of fruit cropping systems, including site selection, cultural and management practices, taxonomic classification, physiological and environmental control of plant development. Integration of writing into understanding various cropping systems.

Hort 5034. COMMERCIAL VEGETABLE AGRICULTURE. (5 cr; prereq 1100 or Agro 1010, Soil 3125; PBio 3131 recommended) Joint Day/Extension class
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; offered even yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

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*
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*
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*
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*
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*
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*
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
Origin, distribution, and evolution of cultivated plants; implication of evolutionary processes on crop breeding for needs of people today.

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

LANDSCAPE ARCHITECTURE

IntR 3900. TOPICS IN INTERNATIONAL RELATIONS: THE ECOLOGY OF DEVELOPMENT. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

Provides International Relations and other interested CLA students with a basic understanding of ecological processes and of contemporary global environmental problems and issues.

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

(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

(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 5202. LANDSCAPE ECOLOGY. (3 cr; prereq one course in ecology or #) Day class

- ◆ new Relationships among spatial patterns, temporal patterns and ecological processes in the landscape are explored. Topics including factors affecting landscape pattern, measurement of landscape pattern, material transport through landscapes, effects of landscape pattern on population dynamics, and landscape planning are covered.

LA 5211. MAKING LANDSCAPE SPACE. (6 cr; requires admittance to B.E.D or M.L.A. degree programs or Δ) Day class

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; requires admittance to B.E.D or M.L.A. degree programs or Δ); prereq 5211) Day class

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 PLANTING DESIGNS.

(4 cr; prereq two courses in plant materials or Δ) Day class

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

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

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 PERFORMANCE.

(4 cr; prereq 5211 or #) Day class

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; requires admittance to M.L.A. degree program or Δ)

Day class

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; requires admittance to M.L.A. degree program or Δ); prereq LA/Geog/PA 5562 or FR 5130/LA 8222 or Δ) Day class

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; requires admittance to M.L.A. degree program or Δ) Day class

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; requires admittance to M.L.A. degree program or Δ ; prereq 8223) Day class
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
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
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
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
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*
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*
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.

MICROBIOLOGY

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*
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*
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*
Principals of aerosol measurement. Modern aerosol instrumentation. Optical techniques, inertial collectors, electrical mobility techniques, Beta attenuation and piezoelectric 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*
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 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*
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 tentatively scheduled for fall 1995; Day Class
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
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
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 #) Extension class
Morphology, physiology, taxonomy, and ecology of bacteria. Applications of fundamental principles. Lab.

MicB 5105. BIOLOGY OF MICROORGANISMS. (5 cr; §Biol 5013, §MicB 3103, §VPB 3103; prereq 5 cr biological sciences, Biol 5001 or BioC 3021 or BioC 5331 or #) Joint Day/Extension class: refer to daytime *Class Schedule*
• **new** Taxonomy, anatomy, physiology, biochemistry, and ecology of microbes. Molecular structure in relation to bacterial function. 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 day-time *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.

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

Roundtable discussions of current topics in Natural Resources and Environmental Studies.

NRES 3010. ETHICS AND VALUES IN RESOURCE MANAGEMENT. (3 cr) Day class

Course is designed to help students formulate their philosophy toward natural resources based on concepts of ethical behavior. Ethical dilemma inherent in management of

natural resources are investigated through lectures, small group discussion, short writing assignments, and situation analysis.

NRES 3020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT. (4 cr; prereq ¶5020, Biol 1009 or Biol 1201, Biol 1202, soph standing) Day class

- ◆ **new** Same as NRES 5020. World vegetation management practices, extent. Emphasis on forest management; agriculture and agro-forestry; historical, current, and prospective practices and environmental and societal implications.

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 3051. FROM TALL-GRASS PRAIRIES TO BOREAL FORESTS. (4 cr) Day class

- ◆ **new** Two-week field course on ecology of the Upper Midwest and teaching methods of ecological research using experts in ornithology, ichthyology, herpetology, community ecology, ecosystems, ecology, mammalogy, paleoecology, archeology, and limnology. Designing and implementing field experiments.

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 3070. FROM LOCAL TO GLOBAL ECOLOGY. (3 cr; prereq any biology course) Day class

- ◆ **new** A study of ecosystem processes, worldwide, the plants and animals that they support and human impacts; discussion of the cultural and economic determinants of environmental problems related to these ecosystems and what could be done to solve them.

NRES 3100. CONSERVATION OF BIODIVERSITY. (4 cr) Day class

- ◆ **new** Biological and social principles underlying biodiversity conservation. Management and policy alternatives for maintaining biodiversity.

NRES 3201. FIELD ASSESSMENT TECHNIQUES. (1 cr; at Itasca) Day class

- ◆ **new** Land survey and mapping; measurement and sampling methods for forest vegetation, wildlife, and other resources.

PHYSICS

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 5001. COLLOQUIUM IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (1 cr) Day class

- ◆ **new** Key concepts and techniques in restoration; common factors in restoration projects; threats to health of aquatic ecosystems.

NRES 5020. PLANT RESOURCE MANAGEMENT AND THE ENVIRONMENT. (4 cr; prereq ¶3020) Day class

- ◆ **new** Same as NRES 3020. Discussion period; term paper.

NRES 5100. PROBLEM SOLVING IN NATURAL RESOURCES AND ENVIRONMENTAL STUDIES. (5 cr; prereq sr) 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 5101. INTEGRATED NATURAL RESOURCE MANAGEMENT.

(5 cr; prereq FR 5240, FR 5226, NRES 5210 or FR 5212 and one course in recreation management, ecology and hydrology) Day class

- ◆ **new** Provide students an opportunity to apply skills from individual course subjects in addressing natural resource management questions. Information and models useful for assessing the impacts of natural resource management and trade-offs between alternative management approaches will be explored.

NRES 5210. SURVEY, MEASUREMENT, AND MODELLING METHODS FOR NATURAL RESOURCES I. (3 cr; prereq Math 1142, Stat 3011, AgEt 3030 or GC 1571 or equiv computer competency) Day class

Introduction to survey design, measurement concepts, and modeling 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 5210 or FR 5212 or equiv; offered alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*

Advanced survey design, measurement concepts, and modelling methods for studying 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 Biol 1009 or Biol 1201, Biol 1202 or Chem 1051, Stat 3011 or #) Day class

Understanding the issues, problems and solutions in remediating the waste stream generated by today's society. Topics include waste stream dynamics, municipal solid waste and yard waste composting, waste-to-energy incineration operation, ash disposal, recycling, landfill requirements, and requirements for direct land disposal, regulatory trends, and case studies.

NRES 5800. NATURAL RESOURCES INTERPRETATION AND COMMUNICATION. (3 cr) Day class

Environmental education in the context of natural resource agencies.

PHYSICS (Phys)

Institute of Technology

148 Physics, 624-7375

Clayton Giese, 148 Physics, 624-5586

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; prereq Biol 1103 or 3012 or 3812, BioC 3021 or BioC 5331 or Biol 5001) Joint Day/Extension class: refer to daytime *Class Schedule*
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 or 3812) 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
Delores Huebner, 495 Borlaug Hall, 625-8200;
delores@puccini.crl.umn.edu

PIPa 1001. THE GOOD, BAD AND UGLY EFFECTS OF MICROORGANISMS ON PLANTS AND HUMAN SOCIETY. (2 cr) Day class and Extension class
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.

PIPa 1002. PLANT DISEASES AND YOUR GARDEN. (2 cr) Joint Day/Extension class
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 TREE. (2 cr; offered alt yrs) Joint Day/Extension class
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 1004. DISEASES OF TURFGRASS. (2 cr; offered 1995-96 and alt yrs)
Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** U.S. turf diseases with emphasis on diseases in the Upper Midwest. Plant pathology and commercial/homeowner disease management. Labs 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*

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*

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*

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 alt yrs) Joint Day/Extension class: refer to daytime *Class Schedule*
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 5201. BIOLOGY OF PLANT DISEASES. (3 cr; prereq Biol 3012 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*
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 5203. PHYSIOLOGICAL AND MOLECULAR PLANT-MICROBE INTERACTIONS. (3 cr; prereq an introductory course in biochem or plant physiology or #) Joint Day/Extension class: refer to daytime *Class Schedule*
◆ **new** A course for upper division undergraduates or graduate students covering the genetics, physiology, and molecular biology of plant-microbe interactions. Major topics include: communication between plants and microbes, signal transduction, control of gene expression, symbiosis and parasitism, plant host response mechanisms and plant disease physiology.

POLITICAL SCIENCE

PIPa 5204. FIELD PLANT PATHOLOGY. (2 cr; prereq 3001 or 3002 or 5201) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Characteristics and management of plant diseases in field, forest, golf course, greenhouse, and urban environments.

PIPa 5206. BIOLOGY OF FUNGI. (4 cr; prereq Biol 1009 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

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*

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 5213. PLANT NEMATOTOLOGY. (4 cr; prereq PIPa 3002 or 5200, 5201 or 3001) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Modified case study approach to evaluation of significance of plant parasitic nematodes in Upper Midwest field, garden, turfgrass, and greenhouse situations.

PIPa 5214. PLANT VIROLOGY. (4 cr; prereq PBio 3012 or equiv) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Importance, symptomatology, transmission and identification of viroid, virus and virus-like diseases of plants. Epidemiology and principles of control. Biological and biochemical properties of virus, viroid and virus-like pathogens. Laboratory exercises will include current techniques for plant virus identification and characterization, utilizing transmission, immunodiagnosis, electron microscopy and other experimental manipulation of these pathogens.

PIPa 5500. EPIDEMIOLOGY AND ECOLOGY OF PLANT DISEASE.

(3 cr; prereq 5002 or 5050 or #) Joint Day/Extension class: refer to daytime *Class Schedule*

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 (PoI)

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*

Examines international organizations and environmental issues. Provides historical background; considers various theoretic and conceptual ideas; and looks at selected case studies, such as protection of the ozone layer and efforts to reduce pollution of the seas. Emphasis is on intergovernmental organizations. Cases vary.

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*

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

Sandra O. Archibald, 255 Humphrey Center, 625-3533

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 5701. SCIENCE AND STATE 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) 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) 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) 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 5731. TECHNOLOGY POLICY. (3 cr; offered 1995-96) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This course develops methodologies to explore and assess the role of policy in development, diffusion and adoption of technologies, both nationally and internationally; means to evaluate the impacts of technology policy on sustainable economic growth and development including social costs and benefits. Technological lock-in and increasing returns.

PA 5741. ECONOMICS OF ENVIRONMENTAL AND RESOURCE POLICY. (4 cr; §PA 5794, §AgEc 5650) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** Develop appropriate economic concepts, methodologies and policy mechanisms and apply them to environmental and natural resource problems. These include social-benefit cost analysis, cost effective policy mechanisms for pollution control, policies for renewable and non-renewable resource use.

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. ENERGY REGULATION ANALYSIS AND ADVOCACY. (3 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** This class attempts to prepare students to understand and participate in a changing regulatory climate as analysts, activists, and advocates. Regulatory agencies are assuming new duties and dealing with new issues such as resource planning, competitive acquisition of power plants, and the growing inability to enforce exclusive franchises. In turn, environmental organizations, consumer advocates, business interests, and utilities themselves are all becoming more active in existing and new regulatory proceedings. There is a need among all of these organizations for analysts and managers prepared to deal with the evolving issues the industries are facing. Individuals with both technical skills and a broad public affairs background will be prepared to fill these roles in modern utility regulation.

PA 8691-99. WORKSHOP/SEMINAR: ADVANCED TOPICS IN LAND USE AND HUMAN SETTLEMENTS. (3 cr; offered 1995-96) 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) 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
(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.

Rhet 3395. IN SEARCH OF NATURE. (4 cr) Joint Day/Extension class: refer to daytime *Class Schedule*

- ◆ **new** An interdisciplinary humanities course which examines the reasons Americans want a "nature experience" and how this has helped shaped our social and political life.

SCIENCE IN AGRICULTURE (ScAg)

College of Agriculture
439 Borlaug Hall, 625-1244
Michael J. Sadowsky, 439 Borland Hall, 624-2706

ScAg 1500. BIOTECHNOLOGY: BASIC CONCEPTS AND APPLICATIONS. (3 cr) Day class
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.

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 1425. 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 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 3416. PLANT NUTRIENTS IN THE ENVIRONMENT. (4 cr; prereq 3125) Day class
• **new** Fundamental concepts in nutrient evaluation. Emphasis on dynamics of mineral elements in soil and evaluation and interpretation of plant and soil relationships. Lecture and recitation.

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
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)

Carlson 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; pre-req 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: COMPARATIVE ENVIRONMENTAL POLICY. (3 cr) Day class and Extension class

This course examines comparative institutional contexts for the development of environmental policies and alternative policy instruments for carrying out such policies. The course deals with the managerial response to environmental policies in different national and international settings. Given uncertain and incomplete information, the student will learn how to: 1) analyze environmental challenges facing multinationals in diverse international contexts, and 2) develop alternative policy responses to these challenges. The challenges include: environmentalists' demands raised in connection with a global summit; an international business association's need to develop a position about the environment and economic growth; a company's desire to learn from the pollution prevention experiences of other companies; and an industry's desire to learn from industrial accidents. The student will develop the capacity to: assess how firms in established industries (chemicals, automotive, and energy) respond to demands that they introduce alternative products (CFC substitutes, electric vehicles, photovoltaics); and analyze market opportunities created by environmental issues.

BGS 8019. TOPICS IN BUSINESS AND SOCIETY: COMPARATIVE ENVIRONMENTAL POLICY. (3 cr) Day class

This course examines comparative institutional contexts for the development of environmental policies and alternative policy instruments for carrying out such policies. The course deals with the managerial response to environmental policies in different national and international settings. Given uncertain and incomplete information, the student will learn how to: 1) analyze environmental challenges facing multinationals in diverse international contexts, and 2) develop alternative policy responses to these challenges. The challenges include: environmentalists' demands raised in connection with a global summit; an international business association's need to develop a position about the environment and economic growth; a company's desire to learn from the pollution prevention experiences of other companies; and an industry's desire to learn from

industrial accidents. The student will develop the capacity to: assess how firms in established industries (chemicals, automotive, and energy) respond to demands that they introduce alternative products (CFC substitutes, electric vehicles, photovoltaics); and analyze market opportunities created by environmental issues.

MBA 8055. BUSINESS, GOVERNMENT AND MACROECONOMICS. (4 cr; prereq MBA 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, Inter-College Program, 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.

PART III. ALTERNATIVE WAYS TO EARN ACADEMIC CREDIT

EXTENSION CLASSES

Continuing Education and Extension

Directed Studies and Directed Research

314 Nolte Center for Continuing Education, 625-2500

A wide range of opportunities is available for earning credit for individually designed Directed Studies or Directed Research projects. These projects may be designed around job activities, involvement in the community or around the special interests of students. Contact a faculty member in the particular area of interest, and consult CEE Counseling, 314 Nolte Center, 625-2500 for further assistance and to obtain the special permission form.

Research Explorations (REX)

202 Wesbrook Hall, 626-0214 or 624-5092

Academic credit is available for participating in most of these projects which offer the opportunity for public participation in field and laboratory research projects of University of Minnesota faculty by assisting with tasks such as data collection, observation, photography, sampling, interviewing, and coding. Many of these projects deal with environmental topics. Examples of projects for the 1994-95 academic year are: REX 0108 Effects of Sediment on Streams; REX 0121 Impact of Agricultural Chemicals on Surface and Groundwater; REX 0139 Paper Recycling Technology; REX 0152 Fish and Mussels: Research Toward Conservation. Tentative projects for summer 1995 include research on home lawn fertilization, forest biodiversity and succession, reducing the need for pesticides by the development of insect- and disease-resistant vegetables, and a decision case study for environmental education. For complete information and an application form, call 624-5092.

Science CentrUM

202 Wesbrook Hall, 624-5092

This new center develops teacher enhancement opportunities for K-12 teachers in science and related fields and draws on faculty and resources throughout the University. For a description, see Part IV, Centers in this course guide.

INDEPENDENT STUDY

Continuing Education and Extension

Brian Duren, 45 Wesbrook Hall, 624-5805, duren001@maroon.tc.umn.edu

Courses taken through Independent Study may be started at any time and must be completed within one year from the date of registration. There are six 4-credit undergraduate courses dealing with environmental topics: Biol 3051 Environmental Studies; EEB 3001 Introduction to Ecology; FR 1201 Conservation of Natural Resources; Geog 3355 Environmental Problems; Geo 1001 The Dynamic Earth: An Introduction to Geology; and Hort 1010 Home Horticulture: Landscape Gardening and Design. Call 624-0000 for further information and a copy of the Independent Study bulletin.

THE GLOBAL CAMPUS

Institute of International Studies and Programs

104 Nicholson Hall, 625-3379

Marine Environmental Studies

Denmark's International Study Program (DiS) offers a semester or a full-year program which addresses issues of the natural environment and the impact of human activity upon it in the two seas bordering Denmark. Courses include: Marine Biology of European Coastal Waters; Ecology and Human Impact in the North and Baltic Seas; Fisheries Biology of Northern European Seas; Marine Biological Science Project; Environmental Problems and Policy: A European Perspective; and Environmental Business Strategy. Students normally take five courses per semester, and receive University of Minnesota residence credit.

The Global Environment: Issues, Perspective, Experience

Minnesota Studies in International Development (MSID) offers internships with organizations working on environmental issues and development in Ecuador, India, Jamaica, Kenya, Morocco and Senegal. Participants work in community-level projects in direct contact with the people of the host society. MSID interns earn University of Minnesota credit for preparation course work on the University campus during fall quarter and internships and research in development projects overseas during winter and spring quarters. During the overseas period, interns live with local host families. The program is open to junior,

senior, and graduate students as well as recent graduates or professionals. Credits can be earned through the internship, individual directed study, and research projects. Recent internships include: evaluating an agro-forestry project; studying local pesticide use; developing a plastics recycling and education program; working with a women's cooperative on a tree nursery project, and teaching composting techniques to local farmers.

Monteverde Institute Costa Rica

Ecology of the Rainforest: Tropical Biology and Conservation

The program takes place in the Tilarán range in northwestern Costa Rica. Students stay at a new biological station which abuts a large rainforest reserve which is contiguous with the Monteverde Cloud Forest Reserve. There is opportunity for educational interactions with resident biologists and graduate students pursuing independent research. The program was developed to: 1) introduce students to all aspects of tropical biology, such as ecology, forestry, entomology, and environmental sciences while giving participants an opportunity to study the language and culture of Costa Rica. This summer-session program features these courses: Tropical Biology, Independent Study, and Spanish Conversation/Agroecology. There is also an eight-day field trip to various locations and a one-week home stay with a rural family. Students may earn up to 15 University of Minnesota residence credits.

SPECIAL LEARNING OPPORTUNITIES

Special learning opportunities exist in many departments and colleges of the University. For example, in the College of Liberal Arts, the Office for Specialized Learning Opportunities (OSLO) can arrange individualized study projects such as community service, field experience, internships, and domestic exchange programs. Contact OSLO, 220 Johnston Hall, 624-7577 for further information. Interdepartmental Study, also in the College of Liberal Arts, will arrange from 3-15 credits for individual readings and research on topics that cross interdepartmental lines. See the listing for ID 3970 under Interdepartmental Study in Part II of this guide for further information.

University College, through its Program for Individualized Learning, offers an opportunity for undergraduate students to earn from 3-15 credits regardless of college affiliation. Projects beyond the scope of a single department or college may be pursued. See the listing for ID 3075 under University College in Part II for further information.

Special study and learning opportunities are also available in the College of Agriculture, the College of Biological Sciences, the College of Natural Re-

sources, and General College. Some of the centers listed in Part V may also have opportunities for research where it may be possible to earn credit.

Examples of departments with special learning opportunities are: Forest Resources which offers both a directed study experience where 1-5 credits can be arranged (FR3225/5225 in Part II) and a senior topics independent study with arranged credits (FR 5401); and Natural Resources and Environmental Studies which offers juniors and seniors a directed study experience for 1-5 credits (NRES 3225). Check with other individual departments for similar offerings.

UNDERGRADUATE RESEARCH OPPORTUNITIES PROGRAM (UROP)

Office of Vice President for Arts, Sciences, and Engineering
Vicki Munro, 12 Morrill Hall, 625-3853

UROP offers academic credit or financial awards to undergraduates for research, scholarly, or creative projects undertaken in partnership with a faculty member. Students collaborate with faculty members on the design and implementation of a project outside of their regular courses. Faculty have the opportunity to work closely with students and receive valuable assistance with their own research or professional activity. Applications are judged on the quality of the proposed project and the educational benefit to the student. Students have a choice of receiving either 4 credits or a stipend up to \$800 for each project, and in addition receive \$250 for supplies and expenses. There are UROP coordinators in each college and institute at the University. Call the UROP office for a brochure which includes a list of coordinators.

UNIVERSITY STUDENT ENVIRONMENTAL AUDIT RESEARCH (U-SEARCH)

Center for Urban and Regional Affairs
330 Humphrey Center, 625-1551

U-SEARCH connects students with interested faculty and staff to collaborate on environmental research projects for which academic credit can be earned. The goal of the program is for students to help improve the University's environmental stewardship by examining the changes needed to produce environmentally-sound practices on the campus. Students may design their own projects or choose from a list of environmental topics identified as research needs by University administrators.

IV. 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
Lawrence H. Smith, 301 Hayes Hall, 625-2778

Credits: 30 credits

Requirements: For the minor, the following three courses totaling 12 credits are required: Agro 5030—Weed Control, AnPl 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
Kendall Corbin, 100 Ecology, 624-6750

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
Patrice Morrow, 100 Ecology, 625-5709

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 that 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, 624-6860

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.

M.L.A.

Graduate School
Joan Nassauer, Head; Roger Martin, Director of Graduate Studies;
125 Architecture, 625-6860

Credits: 80 credits for students completing B.E.D.; 131 credits for other bachelor candidates

Requirements: The Master of Landscape Architecture is a professional degree focused on developing the skills for practice of landscape architecture. Courses in history, theory, graphics, technology and design are interwoven to develop competence in solving problems of fitting human needs to the land.

Description: The program, accredited by the National Landscape Architectural Accreditation Board, is designed for students who wish to become registered landscape architects. Twelve credits of preparatory work plus 119 credits are required including design (61 credits), technology and ecology (30 credits), graphic and written communication (8 credits), landscape history (8 credits), landscape design theory (19 credits), and research methods (5 credits).

ENVIRONMENTAL HEALTH

M.P.H.

Division of Environmental and Occupation Health, School of Public Health
Ian A. Greaves, Head; Donald Vesley, Major Chair; Kathleen Soupir
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, Directory of Graduate Studies;
Kathleen Soupir, 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 and occupational epidemiology, environmental chemistry, environmental toxicology, environmental microbiology, hazardous waste management, industrial hygiene, injury prevention, occupational health nursing, and occupational medicine. A new field of environmental health policy is being developed.

MICROBIAL ECOLOGY**Minor for M.S. and Ph.D.**

Graduate School

Microbial Ecology Minor Program

Michael Sadowsky, 439 Borlaug Hall, 624-2706

Credits: M.S., 21 credits; Ph.D., 24 credits

Requirements: For master's students, two required courses (MicB 5105 and Biol 5041) plus 12 credits from outside the student's major department—which must include at least one laboratory course in microbiology and one ecology (EEB) course. The remaining courses are chosen from a list of approved elective courses in civil engineering, plant biology, plant pathology, and soil science. For doctoral students, 17 of the 24 credits must come from five required microbiology and EEB core courses.

Description: Microbial ecology is an area of interdisciplinary research concerned with the relationships of microorganisms to their natural environment. The microbial ecology program offers course work in microbiology, microbial physiology, microbial genetics, microbial ecology, and theoretical ecology as well as additional courses in other departments and opportunities to interact with others interested in microbial ecology. The microbial ecology seminar series allows students and faculty to hear and interact with microbial ecologists from other universities. The curriculum encourages interdisciplinary interaction, communication, and synthesis.

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

Sandra O. Archibald, 255 Humphrey Center, 625-3533

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.

PUBLIC AFFAIRS

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

Hubert H. Humphrey Institute of Public Affairs
Sandra O. Archibald, 255 Humphrey Center, 625-3533

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. and Ph.D. *

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

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

Requirements: A seminar on current issues in water resources (2 credits), a course on water policy, law and management (4 credits), and a core course and elective course(s) from one of the following three categories for the M.S. degree (or two categories for the Ph.D.): 1) aquatic biology, 2) hydrologic science, 3) water engineering and technology.

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, Institute of Technology, School of Public Health, and Science and Engineering (Duluth).

*A proposal to expand this program into a systemwide graduate major (M.S. and Ph.D.) starting in the fall of 1995 is undergoing administrative review and approval as this guide goes to press.

WILDLIFE CONSERVATION

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

Fisheries and Wildlife, College of Natural Resources
James Kitts, 200 Hodson Hall, 624-3600

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.

V. CENTERS

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, along with the annual presentation of *JASON* and *Bell Museum LIVE*.

CENTER FOR AGRICULTURAL IMPACTS ON WATER QUALITY

College of Agriculture and Agricultural Experiment Station
James Anderson, S501 Soil Science, Phone: 625-8209; Fax: 625-2208

The Center for Agricultural Impacts on Water Quality conducts research on the relationship between surface and groundwater quality and agricultural management practices, with a focus on the basic behavior of chemicals and nutrients in the environment, practices for responsible management of chemicals, and modeling of chemical behavior in the environment. Research objectives include: minimizing water contamination by agricultural chemicals; developing and improving management procedures that reduce agricultural chemical use; increasing our understanding of the longevity and behavior of such chemicals in soil and water; and assessing the social and economic impacts of management practices.

The Center promotes interdisciplinary research and education by involving faculty from several College of Agriculture departments, as well as eight agricultural branch stations. Research sites have been established in sensitive soil and hydrogeologic areas around the state. Information from the Center's research is published in technical journals and extension documents. The Center conducts workshops to address the impacts of agricultural practices on surface and ground water quality and has developed computer software to facilitate site-specific management decisions.

CENTER FOR POPULATION ANALYSIS AND POLICY

Humphrey Institute of Public Affairs
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 several 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

Robert Johns, Acting 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 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 on Lake Minnetonka 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; Phone: 624-7005; Fax: 625-3819;
 lrc@maroon.tc.umn.edu

This center conducts research on lakes from five 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, and e) lakes as ecosystems. Studies of lake history are made through analyses of microfossils, sediment components, stable isotopic, 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, and a Graduate Research Training Grant for geofluids.

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
 David L. Southwick, Interim Director, 2642 University Avenue,
 St. Paul, MN 55114; Phone: 627-4780; south002@maroon.tc.umn.edu

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 627-4782.

MINNESOTA INSTITUTE FOR SUSTAINABLE AGRICULTURE (MISA)

College of Agriculture
 Donald L. Wyse, Executive Director; Helene Murray, Coordinator,
 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108;
 Phone: 625-8235; Fax: 625-1268; misamail@gold.tc.umn.edu

The Minnesota Institute for Sustainable Agriculture (MISA) promotes dynamic agricultural systems which integrate the ecological, economic, and social aspects of life. The purpose of MISA is to bring together the interests of the agricultural community in a cooperative effort to develop and promote sustainable agriculture. MISA is a joint venture between the University of Minnesota's College of Agriculture and the Sustainer's Coalition (a group of individuals and nonprofit organizations).

MISA funds interdisciplinary research and education teams on a competitive basis. Each team addresses important issues affecting community agricultural sustainability. A brochure is available from MISA which describes its ongoing activities and the topics addressed by the MISA-funded teams—which include the "Biological, Financial and Social Farming Systems Monitoring Team" and the "Sustainable Dairy Farming Team." The brochure also includes a list of the members of the Sustainers' Coalition and the MISA Board of Directors.

MINNESOTA LANDSCAPE ARBORETUM

Department of Horticultural Science, College of Agriculture
Anne M. Hanchek, Director of Arboretum Educational Programs,
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; credit and non-credit University classes. For a full listing of classes and events, call 443-2460.

MINNESOTA PUBLIC INTEREST RESEARCH GROUP (MPIRG)

Heather Cusick, Executive Director, 2512 Delaware Street S.E.,
Minneapolis, MN 55414 (campus office, 235 Coffman Union);
Phone: 627-4035; Fax: 627-4050

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 the courts.

ST. ANTHONY FALLS HYDRAULIC LABORATORY

Civil and Mineral Engineering, Institute of Technology
Heinz Stefan, Associate Director, Mississippi River at 3rd Avenue S.E.,
Minneapolis, MN 55414; 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 on the results of these research studies is available as reports and films. These are listed in *SAFHL Circular No. 3*.

The laboratory provides academic and financial assistance to graduate and undergraduate students interested in water resources engineering and related programs.

SCIENCE CENTRUM

Continuing Education and Extension
Susan Henderson, Director, 202 Wesbrook Hall, 77 Pleasant St. S.E.,
Minneapolis, MN 55455; 624-5092

The Science CentrUM promotes and develops teacher enhancement opportunities at the University of Minnesota for K-12 teachers in science and related fields. The Science CentrUM draws on faculty and resources throughout the University. Established in 1993, the CentrUM co-sponsors lectures and workshops on excellent science education; offers credit and noncredit classes; and develops innovative opportunities for professional development for K-12 teachers. A course in urban environmental science for elementary teachers which will employ an innovative, hands-on approach is currently being developed by the CentrUM.

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 concerning 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).

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 or 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 re-authorized 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.

VI. LIBRARIES

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, 624-6383

Contains material on architecture, design, landscape architecture, and urban planning.

Bio-Medical Library

Diehl Hall, 626-5653; Reference: 626-3260

Contains environmentally-related materials in the fields of health sciences, including microbiology, pharmacology, environmental health, and genetics.

Walter Library

624-9500

Education/Psychology Collection, Reference: 624-4185. Contains environmentally-related materials in the fields of education, sports, outdoor recreation, and psychology.

Science and Engineering Collection, Reference: 624-0224. Contains environmentally-related materials in the fields of chemistry, engineering, geology, mines and metallurgy, physics, and transportation.

MINNEAPOLIS CAMPUS—WEST BANK

Wilson Library

624-0303; Reference: 626-2277

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, 625-9800; Reference: 625-4309

Contains environmental law materials.

ST. PAUL CAMPUS

St. Paul Central Library

624-2233; Reference: 624-1212

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., 624-1292

Entomology, Fisheries and Wildlife Library, 375 Hodson Hall, 624-9288

Forestry Library, B50 Natural Resources Adm., 624-3222

Plant Pathology Library, 395 Borlaug Hall, 625-9777

Veterinary Medical Library, 450 Veterinary Science, 624-4281



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UNIVERSITY OF MINNESOTA