Module descriptions

Following modules will take place at the Humboldt-Universität zu Berlin:

<table>
<tr><td colspan="4">WP1 Mammalogy</td><td>Credit points: 9</td></tr>
<tr><td colspan="5">Learning objectives:
In this modul students gain knowledge about comparative anatomy of mammals and the evolution of Mammalia. Participants aquire skills in techniques of taxidermy, methods of fieldwork and working in museums.</td></tr>
<tr><td colspan="5">preconditions: none</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours Self-study according to § 5Par. 2</td><td>3 SP</td><td>Deepening of knowledge in the morphology of the mammal cranium and the postcranial skeleton, the systematics and evolution of mammals, tecniques of trapping and taxidermy of mammals, introduction in museological aspects.</td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours Self-study according to § 5Par. 2</td><td>1,5 SP, presentation (30 minutes)</td><td>Deepening of contents of the lecture and the practical training.
Presentations about the biology of small mammals/ or selected ecosystems related to occuring mammals.</td></tr>
<tr><td>Practical training</td><td>3</td><td><u>135 hours</u>
45 contact hours,
90 hours Self-study according to § 5Par. 2</td><td>4,5 SP</td><td>Knowledge of the determination of mammalspecies, documentation of attributes of the mammal cranium , techniques of taxidermy, excursion to Brandenburg (fieldwork, trapping)
Excursion: Introduction in mammalogical methods in the field and lab</td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Written exam (60-90 minutes) or oral exam (20 minutes)</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. Ulrich Zeller Ulrich.Zeller@mfn-berlin.de
Dipl.-Biol. Th. Göttert, Dipl.-Biol. S. Siniza, Dipl.-Biol. M. Wicke, Dr. K. Ferner</td></tr>
</table>

<table>
<tr><td colspan="4">WP 2 Vertebrate Adaption to Xeric Environments</td><td>Credit points: 9</td></tr>
<tr><td colspan="5">Learning objectives
Students gain knowledge with regard to ecological plasticity of vertebrates in adaption to the complexity of arid and semiarid areas. Students aquire skills in classifying adaptions (organs, physiology, behaviour, reproduction) of vertebrates in this ecosystems and have the expertise of methods to solve scientific questions independently.</td></tr>
<tr><td colspan="5">preconditions: none</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to §
5Par. 2</td><td>3 SP</td><td>-introduction and characteristics of arid environments
-Systematics of themajor vertebrate groups in arid ecosystems
- adaptions (anatomy, food, organs, physiology, behaviour, reproduction) of vertebrates in desert ecosystems
-examples of selected vertebrates and their adaptions
-Biodiversity of arid areas
-evolutionary aspects of vertebrate adaptions to arid ecosystems</td></tr>
<tr><td>Practical training</td><td>3</td><td><u>135 hours</u>
45 contact hours,
90 hours
Self-study
according to §
5Par. 2</td><td>4,5 SP
protocol</td><td>Approach of selected vertebrates of arid ecosystems with practical training and demonstrations: distribution, functional morphology, lifestyle… based on museum materials of the natural history museum Berlin
Excursion to the Zoo Berlin or Tierpark Berlin focused on the physiognomy and behaviour of vertebrates.</td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to §
5Par. 2</td><td>1,5 SP
presentation
30 minutes</td><td>Deepening of lecture contents by studiy of original literature: presentations and discussions of selected aspects with regard to vertebrate adaptions in arid areas</td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Written exam (90 minutes, 100%) or oral exam (20 minutes, 100%)</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. Ulrich Zeller Ulrich.Zeller@mfn-berlin.de
Dipl.-Biol. Th. Göttert</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☒ WS ☒ SS</td></tr>
</table>

WP3 Functional Biodiversity of arid and semiarid ecosystems	Credit Points: 9

Learning objectives:
In this module the participants gain in-depth knowledge with regard to desertification and management of natural resources with reference to the conservation of biodiversity.
The participants acquire the following knowledge and skills:

- understanding of the dynamics of natural resources for organisms in arid regions
- in-depth knowledge of eco-physiological conditions and processes
- special knowledge in ecology of arid ecosystems
- ability to explain natural processes effecting patterns of biodiversity
- background knowledge of the particularities for the management of natural resources by humans
- ability to discuss the possibilities for the sustainable development in arid regions

preconditions: *none*

Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	*2*	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	*3 SP, written examination*	- Introduction to Hot Arid Lands of the World and Namibia, geographic & climatological background, with emphasis on Namib - Ecophysiology in conditions of water limitation, food limitation, and heat: sources, limitations, time-space windows - Desert ecology and biodiversity in deserts - Management of natural resources in desert habitats - Desertification
SE	*2*	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par.2*	*3 SP, Homework with oral presentation*	Optional integration of a 2-days-seminar with emphasis on the specific problems of another arid region (e.g. Land Degradation and Desertification in the Sahel)
EX	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par.2*	*3 SP, Attendance, written report*	-Visit the Gobabeb Research Station
Module final examination			*Passing*	Written examination (180 Min) = 60 % Homework with oral presentation = 30 % Report excursion = 10% *Requirement: Attendance of all lectures and seminars as well as the excursion*
Duration of module	☒ 1 Semester	☐ 2 Semester		
Beginning of module	☐ WS	☒ SS		
lecturers	Dr. J. Henschel gobabeb@gobabeb.org			

<table>
<tr><td colspan="4">WP 4 Agriculture and Horticulture of Conurbations</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning objectives:
-gain knowledge about the specialiity of urban agriculture and horticulture.
-students can classify specific differences of urban agriculture and horticulture regarded to varying climatic areas and social conditions.
-gain knowledge of plant physiological reactions to urban stressors in respect to production- and quality management.</td></tr>
<tr><td colspan="5">preconditions: none, recommended: plant cultivation, physiology of plants</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to § 5Par. 2</td><td>3 SP</td><td>- description of coherence between production processes and the use of ressources in conurbations
- urban ecology parameters and their influence on process and quality management in urbane agriculture and horticulture
-production depending on climate zone specific characteristics and the social context (developing countries, industrialized countries)</td></tr>
<tr><td>EX</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td></td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Project report 10 pages (50%) and oral defence 15 minutes (50%)</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☒ WS ☐ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Ch. Ulrichs, christian.ulrichs@agrar.hu-berlin.de
PD Dr. H. Hoffmann,</td></tr>
</table>

WP 5 Evolutionary Morphology of Vertebrates				Credits points: 9
Learning objectives: -Students have knowledge in the fields of comparative anatomy, morphology, ecology, paleontology and evolution of vertebrates. Excursions and the working on recent and fossil biological material impart skills in comparative observation and analysis.				
preconditions: *none*				
Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	Systematic and evolution of vertebrates, Description of major vertebrate groups from an evolutionary point of view, Phylogeny, Anatomy, Ontogeny, functional morphology, lifestyle, fossil record,
SE	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP, Referat im Umfang von 30 Minuten	Deepening of lecture contents by study of original literature: presentations and discussions of selected aspects with regard to classical and modern problems in evolutionary biology of vertebrates
practical training	3	*<u>135 hours</u> 45 contact hours, 90 hours Self-study according to § 5Par. 2*	4,5 SP Anfertigung des Protokoll	Construction plan of Vertebrates, Approach of selected recent and fossil vertebrates with practical excercises and demonstrations, Chordates, paleozoic Gnathostomata, Anatomy and Evolution of Pisces, comparative Osteology of tetrapods, human anatomy from an evolutionary point of view, introduction to animal husbandry, Excursion to the Zoo Berlin or Tierpark Friedrichsfelde , functional morphology of terrestrial and aquatic vertebrates
Module final examination			passing	Written exam (90 minutes, 100%) or oral exam (20 minutes, 100%)
Duration of module		☒ 1 Semester	☐ 2 Semester	
Beginning of module		☒ WS	☐ SS	
lecturers		Prof. Dr. Ulrich Zeller ulrich.Zeller@mfn-berlin.de Dipl.-Biol. Th. Göttert, Dipl.-Biol. S. Siniza, Dr. K. Ferner		

<table>
<tr><td colspan="4">WP 6 Organic Farming</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning objectives:
Knowledge and skills in the development of production processes in organic enterprises</td></tr>
<tr><td colspan="5">preconditions: none</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>3,5</td><td><u>150 hours</u>
50 contact hours,
100 hours
Self-study
according to § 5Par. 2</td><td>5 SP</td><td>- characteristics of management systems including different model principles of organic farming
- legal and organisational framework of organic farming in Germany and europe
- nutrient management, soil tillage,
- rotation of crops, weed management and pest control in organic livestock farms and non livestock farms
- cultivation techniques of selected crop species
- inclusion of landscape-ecological aspects in production</td></tr>
<tr><td>EX</td><td>0,5</td><td>3<u>0 hours</u>
10 contact hours,
20 hours
Self-study
according to § 5Par. 2</td><td>1 SP</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Written exam 90 minutes or homework (10 pages, 50%) and presentation (15 minutes, 50%)</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">PD Dr. H. Hoffmann, heide.hoffmann@agrar.hu-berlin.de</td></tr>
</table>

WP 7 Special Aspects of Organic Farming				Credit points: 6
Learning objectives: Knowledge and skills in the development of production processes in organic enterprises				
preconditions: *none*, recommended: Module Crop and Plant Production, Site Ecology, plant nutrition, pest control, Agricultural Engineering				
Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	- Characteristics as well as legal and organisational framework of organic farming in an international context - nutrient management in organic farming - weed management and pest control
Practical training	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	
EX	-	-	-	Participation optional
Module final examination			passing	Oral exam 30 minutes or homework (10 pages, 50%) and presentation (15 minutes, 50%)
Duration of module		☒ 1 Semester ☐ 2 Semester		
Beginning of module		☒ WS ☐ SS		
lecturers		PD Dr. H. Hoffmann, heide.hoffmann@agrar.hu-berlin.de, PD Dr. St. Kühne(BBA Kleinmachnow), Prof. Ch. Engels		

<table>
<tr><td colspan="4">WP 8 Plants with Active Ingredients</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning objectives:
students
- are able to asses the development and the economic importance of the cultivation of medicinal and spice plants, aromatic plants, dyeing plants
- know secondary groups of ingredients
- have knowledge of the most important medicinal, spice plants and dyeing plants cultivated in Germany
- have knowledge about the quality evaluation of drugs
- know process design for quality assurance
- know about state-of-the-art research and developments</td></tr>
<tr><td colspan="5">preconditions: none, recommended: Module Crop and Plant Production, soil science, Fertilization</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>3</td><td><u>135 hours</u>
45 contact hours,
90 hours Self-study according to § 5Par. 2;</td><td>4,5 SP</td><td>- economic development and the impotance of medicinal and spice plants, aromatic plants, dyeing plants
- groups of ingredients / active agents, current development in research
- Occurence, distribution, botany, effects and fields of application
- specialtis of cultivation, harvest and preparatiion of medicinal and spice plants, dyeing plants
- quality features, quality assurance

literature:
- module in „MOODLE“ Crop and Plant Production
- module in „MOODLE“ Medicinal and Spice plant</td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours Self-study according to § 5Par. 2</td><td>1,5 SP, Seminar presentation</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Written exam 90 minutes (100%), advanced work: Seminar presentation</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">PD Dr. R. Schenk regina.schenk@agrar.hu-berlin.de</td></tr>
</table>

<table>
<tr><td colspan="4">WP 9 Hydroponical Systems in Horticulture</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:
- have a clear understanding of different hydroponical systems and are able to plan such systems for different crops
- are able to evaluate different substrates by use of modern physical and chemical methods
- are able to calculate the amount of water and the composition of nutrient solutions for hydroponics
- to know methods for regulating of processes in hydroponics and analysing growth factors in the rhicosphere and biomass production</td></tr>
<tr><td colspan="5">preconditions: none recommended: Horticultural crops</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>3</td><td><u>135 hours</u>
45 contact hours,
90 hours
Self-study
according to § 5Par. 2</td><td>4,5 SP</td><td>Contents:
- Definition and principle of von hydroponical (soil less)
systems for horticultural crops,
- Technical characteristics and technological systems in
hydroponics (substrate culture, water culture, aeroponics,
- Substrates, their characteristics, evaluation and
standardisation
- Calculation of water and nutrient supply for different
hydroponical systems
- Cultivation methods of selected horticultural crops in
hydroponics</td></tr>
<tr><td>Practical training</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP,
Protocols</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Oral exam 30 minutes (100%), protocols</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☒ WS ☐ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Doz. Dr. Dr. Böhme, Michael michael.boehme@rz.hu-berlin.de</td></tr>
</table>

<table>
<tr><td colspan="4">WP 10 Plant Nutrition in Different Natural Areas</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:
Building on the understanding of mechanisms for the acquirement and the utilization of minerals, students are able to recognize a limitation of plant growth caused of nutritions, water or other environmental factors under specific location conditions. Students can develop measures for avoiding growth disorders and thereby contribute to mitigation of climate changes.</td></tr>
<tr><td colspan="5">preconditions: none recommended: soil science, cultivation systems, Plant Nutrition and Fertilisation</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>3</td><td><u>135 hours</u>
45 contact hours,
90 hours
Self-study
according to § 5Par. 2</td><td>4,5 SP</td><td>- turn over of minerals in the soil/plant cycle under different location conditions(climate, soil, cultivation systems)
- Limitation of nutrients under different location conditions and adaption reactions of plants (uptake and utilization efficiency of minerals)
- Influence of changing enviromental conditions (airborne pollutants, temperature, rain) on growth and the nutrition of plants</td></tr>
<tr><td>Practical training</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Written exam 30 minutes or written homework 20 pages</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. E. George george@igzev.de, Prof. Ch. Engels, Dr. E. Neumann</td></tr>
</table>

WP 11 Pasture Management				Credit points: 6
Learning Objectives: Students - are able to asses pastures as a special grassland utilization (production and landscape conservation) - know the interactions between greenland and their animals - have special knowledge about herd management of different productive livestock species - can perform the organisation and technical realization of grazing processes with different animal species				
preconditions: *none* recommended: module grassland and forage crop management				
Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	-basics characterizations of grazing locations and their earnings potential -relationship between location, cultivation and pasture, interactions between grazing animal and pasture (influence of footsteps, browsing, animal behaviour, nutrient cycles) - Herd management depending on animal specie and cultivation intensity - pasture establishment and equipment - model calculation of grazed grassland supply Literature: - Grünlandlehre. (W. Opitz v. Boberfeld, Ulmer Verlag, 1994) - Zeitgemäße Grünlandbewirtschaftung. (K. Buchgraber, G. Grindl, L. Stocker Verlag, 2. Aufl. 2004)
Practical training	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
EX	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
Module final examination			passing	Oral exam (30 minutes)
Duration of module		☒ 1 Semester	☐ 2 Semester	
Beginning of module		☐ WS	☒ SS	
lecturers		Dr. H. Giebelhausen hermann.giebelhausen@agrar.hu-berlin.de Dr. M. Krocker manfred.krocker@agrar.hu-berlin.de		

<table>
<tr><td colspan="4">WP 12 Quality Assurance of Plant Products</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:
students
- have knowledge about important parameters of quality and be able to evaluate the quality of plant products regarding their use
- have knowledge about methods of determining quality and quality evaluation of plant products
- have knowledge about important processing techniques and industrial processing methods of plant raw materials and their quality requirements
- are able to assess critically quality management systems in agriculture
- are able to assess critically cultivation techniques of agricultural crops with regard to quality parameters and quality requirements</td></tr>
<tr><td colspan="5">preconditions: none recommended: Module Prozessführung im Pflanzenbau</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours Self-study according to § 5Par. 2</td><td>1,5 SP</td><td rowspan="3">-special quality characteristics of important agricultural crops (grain, sugar beets, sweet corn, potatoes, selected specialty crops) for industrial processing methods
-Assessing of cultivation techniques of product quality generation for industrial processing
- Quality-relevant legal regulations on national and international level
- storage damage caused by diseases and pests and measures of prophylaxis and combats
- Toxicological aspects of plant disease</td></tr>
<tr><td>SE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours Self-study according to § 5Par. 2</td><td>3 SP</td></tr>
<tr><td>Practical training</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours Self-study according to § 5Par. 2</td><td>1,5 SP</td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>homework 20 pages (100%), advanced work: Protocol 10 pages</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">PD Dr. R. Schenk, regina.schenk@agrar.hu-berlin.de
Prof. F. Ellmer, Dr. M.Goßmann, Dr. K. Weiß</td></tr>
</table>

WP 13 Land use systems for horticultural crops				Credit points: 6
Learning objectives: -have a clear understanding of land use systems for horticultural crops - are able to plan crop rotation and land use programs annual and perennial horticultural crops - to know methods for appropriate configuration of technological processes to cultivate different crops - are able to analyse influences on the yield potential and to plan necessary activities				
preconditions: *none*				
Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	Contents: - Systems of land use and production of fruit and vegetable - Methods of integrated and ecological production of fruits and vegetables - Crop rotation and cultivation programs for annual and perennial horticultural crops - Configuration of technological outlets and processes - Measures for quality insurance (land preparation, fertilization, use of composts, cultivation technology, harvesting) - Regulation of growth factors during the cultivation of horticultural crops - Analyse of factors and regulation of growth systems to use the yield potential of horticultural crops
SE	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
Practical training	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
Module final examination			passing	seminar presentation 10 minutes (40 %) Oral exam 20 minutes (60 %)
Duration of module		☒ 1 Semester	☐ 2 Semester	
Beginning of module		☐ WS	☒ SS	
lecturers		Doz. Dr. Dr. Böhme, Michael michael.boehme@rz.hu-berlin.de		

WP 14 Cultivation of vegetables in tropics and subtropics				Credit points: 6
Learning Objectives: – To know the growing conditions for vegetables in tropics and sub tropics – Are able to develop production systems for different locations – To know the most important vegetables of the tropics and sub tropics – Are able to establish technological algorithm of production cycles and adequate quality measurements				
preconditions: Moodle Learnmanagementsystem				
Learning and teaching	Contact hours per week	Workload (hours)	Credit Points and requirements for assignation	Topics and contents
LE	2	*<u>90 hours</u> 30 contact hours, 60 hours Self-study according to § 5Par. 2*	3 SP	Contents: – Geographical and climatically description of the tropics and subtropics – Edaphic and climatic growing conditions for vegetables in different regions – Land use and production systems for vegetables in tropic and sub tropic regions – Dietary and economical value of the most important sub tropic and tropic vegetables – Evaluation of growth of tropical and subtropical vegetables – Basics of propagation and breeding of sub tropic and tropic vegetables including biotechnological methods
SE	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
Practical training	1	*<u>45 hours</u> 15 contact hours, 30 hours Self-study according to § 5Par. 2*	1,5 SP	
Module final examination			passing	Protocols 10 pages (20 %) Oral exam 20 minutes (80 %)
Duration of module		☒ 1 Semester ☐ 2 Semester		
Beginning of module		☐ WS ☒ SS		
lecturers		Doz. Dr. Dr. Böhme, Michael, Dr. I. Pinker michael.boehme@rz.hu-berlin.de		

<table>
<tr><td colspan="4">WP 15 Effects of plant nutrition and other environmental factors on composition and quality of vegetable and ornamental plants</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:
- Participants have a clear understanding of the plant physiological role of mineral elements
- Participants have a clear understanding of the effect of environmental factors on plant composition and quality
- Participants are able to design new horticultural systems with the potential to grow high-quality horticultural products</td></tr>
<tr><td colspan="5">preconditions: none</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to § 5Par. 2</td><td>3 SP</td><td>Contents:
- Functions of mineral elements in the primary and secondary metabolism of plants
- Effects of plant nutrition and other environmental factors on plant composition, taste, and quality</td></tr>
<tr><td>practical</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td>excursion</td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Oral exam 20 minutes or Seminar presentation 20 minutes</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. Eckhard George,
Prof. Dr. Christof Engels,
Dr. Bernhard Brückner (IGZ)
Dr. Angelika Krumbein (IGZ),
Dr. Uwe Drüge (IGZ),
Dr. Elke Neumann (IGZ)
george@igzev.de</td></tr>
</table>

WP 16 Plant nutrition and nutrient supply in environmentally-friendly horticultural systems	Credit points: 6
Learning Objectives: - Participants have a clear understanding of environmental effects of fertilization and horticultural production systems - Participants have a clear understanding of environmental effects of fertilization and horticultural production systems	

<table>
<tr><td colspan="5">in horticultural systems
- Participants are able to design new horticultural systems with low nutrient and energy requirements</td></tr>
<tr><td colspan="5">preconditions: none</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to § 5Par. 2</td><td>4,5 SP</td><td>Contents:
- Environmental benefits and costs of fertilization in horticultural systems
- Interactions of fertilization with plant CO_2 fixation
- Low-energy horticultural production and intelligent nutrient supply systems
- Plant nutrition in biological horticultural production systems</td></tr>
<tr><td>SE</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td></td></tr>
<tr><td>Practical training</td><td>1</td><td><u>45 hours</u>
15 contact hours,
30 hours
Self-study
according to § 5Par. 2</td><td>1,5 SP</td><td>excursion</td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Oral exam 20 minutes or Seminar presentation 20 minutes</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. Eckhard George,
Prof. Dr. Christof Engels,
Dr. Bernhard Brückner (IGZ)
Dr. Angelika Krumbein (IGZ),
Dr. Uwe Drüge (IGZ),
Dr. Elke Neumann (IGZ)
george@igzev.de</td></tr>
</table>

<table>
<tr><td colspan="4">WP 17 Tropical Fish Communities</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:

The students learn about
- ecology and zoogeography of tropical freshwater fish
- systematics of primary and secondary fishes
- characteristics of tropical fish communities
- periodicity of life cycles in the tropics
- overviews about aquaculture systems in the tropics and subtropics
- resources for tropical and subtropical aquaculture
- sustainability of tropical and subtropical aquaculture systems
- socioeconomy of tropical and subtropical aquaculture</td></tr>
<tr><td colspan="5">preconditions: none, recommended: modules Limnology, Biology, Ecology</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>LE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to § 5Par. 2</td><td>3 SP</td><td>- ecology and zoogeographic of tropical fish species
- systematic of primary and secondary tropical fish species
- characteristics of tropical fish communities
- periodicity of life cycles in the tropics
- overview about aquaculture systems in the tropics and subtropics
- resources for tropical and subtropical aquaculture
- sustainability of tropical and subtropical aquaculture systems
- - socioeconomy of tropical and subtropical aquaculture</td></tr>
<tr><td>SE</td><td>2</td><td><u>90 hours</u>
30 contact hours,
60 hours
Self-study
according to § 5Par. 2</td><td>3 SP</td><td></td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td>passing</td><td>Oral Exam 30 minutes (100%)</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☒ WS ☐ SS 4 semester rotation</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. F. Kirschbaum <u>frank.kirschbaum@staff.hu-berlin.de</u>
Dr. A. Müller-Belecke <u>andreas.mueller-belecke@ifb-potsdam.de</u></td></tr>
</table>

<table>
<tr><td colspan="4">WP 18 Gender and Globalization</td><td>Credit points: 6</td></tr>
<tr><td colspan="5">Learning Objectives:
- Knowledge on gender analysis
- Knowledge on concepts of political economy, state theory and global governance
- Ability to reflect these concepts from a gender perspective
- Ability to analyze the gendered effects of economic globalization
- Ability to identify the intersectionality between gender, class and ethnicity in globalization processes</td></tr>
<tr><td colspan="5">preconditions: Courses on the basics of gender analysis</td></tr>
<tr><td>Learning and teaching</td><td>Contact hours per week</td><td>Workload (hours)</td><td>Credit Points and requirements for assignation</td><td>Topics and contents</td></tr>
<tr><td>SE
and
presentations</td><td>4</td><td><u>180 hours</u>
60 contact hours,
120 hours Self-study according to § 5Par. 2</td><td>6 SP
Presentation and seminar paper writing</td><td>- Introduction to feminist theories of globalization and political economy
- Conceptual underpinnings of global economic restructuring
- Impacts of globalization on migration and natural resources
- Transformation of gender orders in the course of globalization
- The role of the state and of International Organizations in globalization processes
- Transnational feminist activism and women’s economic and social rights</td></tr>
<tr><td colspan="2">Module final examination</td><td></td><td></td><td>Oral presentation and discussion; seminar paper</td></tr>
<tr><td colspan="2">Duration of module</td><td colspan="3">☒ 1 Semester ☐ 2 Semester</td></tr>
<tr><td colspan="2">Beginning of module</td><td colspan="3">☐ WS ☒ SS</td></tr>
<tr><td colspan="2">lecturers</td><td colspan="3">Prof. Dr. Christine Bauhardt
christine.bauhardt@gender.hu-berlin.de
Dr. Gülay Caglar
guelay.caglar@gender.hu-berlin.de</td></tr>
</table>

Following elective modules will take place at the Texas Tech University:

Required Courses	**Theme**	**Instructor CV**
CE 5366 Water Resources Management	DW	Dr. Ken Rainwater
GEOG 5306 Seminar in Geography of Arid Lands	DE	Dr. Jeff Lee
NRM 5317 Watershed Management	DD	Dr. Ernest Fish
Elective Courses		
AAEC 5314 Environmental Economics and Policy Analysis	DD	Dr. Jeff Johnson
AGSC 5303 Ecology of Grazing Lands Systems	DE	Dr. Vivian Allen
ATMO 5302 Weather, Climate, and Applications	DE	Dr. Colleen Ann Leary
BIOL 5330 Advanced Landscape Ecology	DE	Dr. Nancy E. McIntyre
CE 5361 Surface Water Hydrology	DW	Dr. Ted Cleveland
CE 5363 Groundwater Hydrology	DW	Dr. Ken Rainwater
CE 5364 Groundwater Transport Phenomena	DW	Dr. Ken Rainwater
CE 5394 Natural Systems for Wastewater Treatment	DW	Dr. Clifford B. Fedler
ENTX 6361 Environmental and Wildlife Toxicology	DE	Dr. Phil Smith
ENTX 6371 Procedure & Techniques in Ecological Risk Assessment	DE	Dr. Phil Smith
GEOG 5300 Geographic Information Systems	DA	Dr. Kevin Mulligan
GEOG 5301 Remote Sensing of the Environment	DA	Dr. Tina Delahunty
GEOG 5302 Advanced Geographic Information Systems	DA	Dr. Kevin Mulligan
GEOG 5309 Seminar in Regional Analysis	DD	Dr. Perry Carter
GEOL 5341 Digital Imagery in Geosciences	DA	Dr. David Leverington
GEOL 5342 Spatial Data Analysis and Modeling in Geosciences	DA	Dr. Seiichi Nagihara
NRM 5310 Advanced Range Ecology	DE	Dr. Robert D. Cox
NRM 5322 Advance Nongame Ecology and Management	DE	Dr. Clint Boal
NRM 5404 Aerial Terrain Analysis	DA	Dr. Ernest Fish
NRM 6303 Imagery Interpretation for NRM	DD	Dr. Ernest Fish
NRM 6305 Geospatial Technologies in NRM	DA	Dr. Ernest Fish
PSS 5329 Precision Agriculture	DP	Dr. Stephen Maas
PSS 5333 Soil and Plant Relationships	DP	Dr. Robert Lascano
PSS 5334 Soils and Crops in Arid Lands	DP	Dr. Kevin Bronson

"Theme" Legend

DA = Natural Resource Data Analysis DP = Dryland Agriculture

DD = Dryland Economy and Development DW = Water Resource Management

DE = Ecology and Environmental Studies

MAJOR TOPIC: Water Resources and Environmental Technology

CE 5366 WATER RESOURCES MANAGEMENT (3 credit hours) **REQUIRED COURSE**

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text**: *Principles of Surface Water Quality Modeling and Control*, Thomann and Mueller, and other readings as assigned.

Course Description and Purpose:

Models and other technical elements of water resources systems in context of the political, social, and other environments in which they exist.

Course Outline:

Week	Text Source	Topics and **Events**
1	T&M 1	Introduction to Water Quality Modeling
2	2	Rivers and Streams
3		
4	6	Dissolved Oxygen
5		
6	3	Estuaries, Bays, and Harbors
7	4	Lakes, **First Review Due**
8		**Exam 1**
9	Readings	Engineering Economy
10		Spring Break
11	Readings	Decision Analysis
12		
13		Surface Water Reservoirs
14		Flood Mitigation, Water Supply
15		Water Resources Development and Policy
16		**Second Review Due**
17		Review

Expected Learning Outcomes:

The student will be trained in the modeling the processes and parameters that determine the fate of man-made discharges on surface water quality. The student will understand the major technical and non-technical considerations required in providing adequate planning and management of water resources projects. The course supports both the environmental and water resources specialty areas.

Criteria for Grading:

1. Homework – Several homeworks will be distributed through the semester, usually with one week to complete each assignment. After the graded homeworks are returned the solutions will be posted. Use of spreadsheets is encouraged for repetitive tabular calculations and graphs, but sample calculations are required for full credit. Each student must submit his/her own spreadsheet.
2. Article reviews – Two brief (3-5 pages, typed, double-spaced) reviews of articles from the professional literature will be required during the semester.
3. Exams – Two exams will be given. The final exam will only cover the material after Exam 1. No make-up exams will be given for simple absence. Both exams will be scheduled for 2.5 hr.
4. Class conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.

Grading Policy

Homework 30% Article reviews 20% Exams 50% Total: 100%

Class Attendance: Required

MAJOR TOPIC: Earth Sciences

GEOG 5306 SEMINAR IN GEOGRAPHY OF ARID LANDS (3 credit hours) REQUIRED COURSE

Faculty Information:

Name: Dr. Jeff Lee Office: Holden Hall 209A Email: jeff.lee@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text:** There is no required textbook. Readings will be assigned during the semester and students will choose a book to read.

Course Description and Purpose:

This course deals with the arid and semi-arid regions of the world. We will explore these lands through a combination of relevant topics and regional studies. While the main focus will be on the scientific aspects of the environments, humanistic approaches to the study of arid lands will be part of the course as well. The graduate and undergraduate courses will be taught together and will be organized partly as a lecture course and partly as a seminar.

Course Outline:

Introduction; Defining Arid Lands
Climate
Landscapes
Plants and Animals
agriculture and water resources.
Exam 1;
North America
South America
North Africa
Southern Africa
Middle East
Central Asia
Australia
Project Presentations
Project Presentations; Conclusions
Exam 2: (Final)

Expected Learning Outcomes:

After completing this course, the student is expected to 1) Be able to locate the arid and semiarid regions on Earth and in each case explain the climatic reasons for the aridity. 2) Understand the adaptations plants and animals have made to live in arid regions. 3) Explain why the hydrology, soils and geomorphology of arid and semiarid lands are different than in wetter environments. 4) Knowledgably discuss human adaptation to drylands. 5) Knowledgably discuss land degradation in arid and semiarid lands.

Criteria for Grading:

Exam 1 (50 points).
Exam 2 (50 points).
Term Paper (50 points). Topic must be approved. 10 to 15 pages, double spaced.
Book Report (25 points). Book must be approved.
Class Project (25 points).

Class Attendance:

Attendance is encouraged, but does not directly affect a student's grade.

MAJOR TOPIC: Agricultural Science and Natural Resources

NRM 5317 WATERSHED MANAGEMENT (3 credit hours) **REQUIRED COURSE**

Faculty Information:

Name: Dr. Ernest B. Fish Office: 102 Goddard Building Email: ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text:** Brooks, K. N., P. F. Ffolliott, H. M. Gregersen and L. F. DeBano. 2003. Hydrology and the Management of Watersheds. 3rd Edition. Iowa State University Press. Ames, Iowa. 574 pp

Course Description and Purpose:

To provide the student with an understanding of the watershed as a unit of resource oriented planning and development. To provide information on the principles and objectives of watershed planning; physical description of watersheds; relationships between land use conditions and the water delivery character of watersheds.

Course Outline:

I. Introduction
- A. Overview of water resources and watershed planning
- B. Historical development of watershed planning
- C. Specialized terminology

II. Water Resource Problems
- A. Absolute supply problems
- B. Regimen or timing problems
- C. Quality problems

III. Watershed Planning and Application
- A. Objectives
- B. Contents
- C. Procedures
- D. Summary

IV. Hydrologic Processes on Watersheds
- A. The hydrologic cycle
- B. Energy balance concept
- C. Active surface concept
- D. Precipitation
- E. Water losses
  - 1. Interception 2. Evaporation 3. Transpiration
- F. Water movement into and through the soil profile
  - 1. Infiltration 2. Percolation
- G. Runoff

V. Erosional Processes
- A. Water
- B. Wind

VI. Watershed Protection
- A. Introduction
- B. Prevention of damages associated with various resource uses
  - 1. Road aspects 2. Forestry aspects 3. Range and wildlife aspects
  - 4. Recreational use aspects 5. General considerations

VII. Watershed Restoration
- A. Introduction
- B. General considerations
- C. Structural measures
- D. Vegetative measures

VIII. Water Yield Manipulation
- A. Alpine life zone
- B. Montane life zone
- C. Phreatophytic manipulation
- D. Review of specific studies and results

Expected Learning Outcomes:

1. To provide the student with a knowledge of techniques and sources for watershed planning and application.

2. To provide the student with a background knowledge of water resource problems and the historical development of watershed planning.
3. To provide the student with a knowledge of the hydrologic cycle components and understanding of their functional relationships.
4. To provide the student with a basic knowledge of erosional processes.
5. To provide the student with a knowledge of watershed protection principles and techniques involving various types of natural resource management.
6. To provide the student with a basic knowledge of watershed restoration practices.
7. To provide the student with a basic knowledge of the results of water yield control efforts resulting primarily from vegetative manipulation on the watershed.
8. To provide the student with a sufficient background to enable him or her to make sound land planning recommendations, based on the objectives of watershed planning and other resources.

Criteria for Grading:

Graded material will consist of two hourly exams and a final exam, all of which carry equal weight and are comprehensive in nature. Additionally, unannounced quizzes, various problem sets and projects may be assigned throughout the semester. Total point accumulation for the entire course is normally 450-550.

Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester.

A	**90-100**
B	**80 - 90**
C	**70 - 80**
D	**60 - 70**
F	**<60**

Student must pass the final exam to receive a passing grade for the course.

Class Attendance:

100 points is allocated to class participation. Five points are deducted for each unexcused absence.

AAEC 5314 Environmental Economics and Policy Analysis

Faculty Information:
Dr. Jeff Johnson Agricultural Sciences jeff.johnson@ttu.edu

Course Description:

In this course we will distinguish between natural resource issues and environmental issues. Natural resource management deals with resources such as water, oil and gas, forests, wildlife, and agriculture. The issues faced by natural resource managers are generally supply and distribution of those resources in a sustainable manner. Environmental issues include pollution of resources such as water, air, or land and focus on policies and economic tools that will reduce, mitigate, or prevent pollution.

Learning Outcomes:

This course has one general learning outcome. Upon completion of this course, you will be able to understand and use basic economic concepts to evaluate natural resource and environmental issues. Additionally, each section has lesson objectives that support those of the overall course.

Course Outline:

a. Section 1. Economic Concepts

Learning Outcomes: Upon completion of this section of the course, the student will be able to understand the following economic concepts in preparation for using the concepts to analyze policies:

Understand how economics is used to value the environment.
Understand concepts of net benefits, net present value, and static and dynamic efficiencies
Understand risk assessment, valuation methods, and discount rate issues
Understand property rights and externalities
Understand intertemporal fairness and economic sustainability

b. Section 2. Natural Resource Economics

Learning Outcomes: Upon completion of this section of the course, the student will be able to:

Understand the concepts of efficient intertemporal and market allocations.
Identify and discuss major issues pertaining to management of energy, water, agriculture, forest, and commercially valuable species.
Analyze selected policies of one of the above natural resources using the economic methods discussed.

c. Section 3. Environmental Economics

Learning Outcomes: Upon completion of this section of the course, the student will be able to:

Understand efficient and market allocation of pollution and efficient and cost-effective policy responses to pollution.
Identify and discuss major environmental issues of local air pollution, regional and global pollutants, transportation, water pollution, solid waste, and toxic waste.
Analyze selected policies of one of the above environmental issues the economic methods discussed.

Methodology:

You will meet the course learning objectives through individual study of the required readings, review and analysis of pertinent issues, research and review of additional readings, and the completion of course written requirements. You may discuss the subject matter with others who might contribute to your learning.

a. The lesson order takes you from understanding of economic concepts, to natural resource management issues, environmental issues such as pollution mitigation and prevention, and finally to issues of sustainability.

b. In each section, you will develop the concepts and issues through a series of readings from the textbook and from articles from other sources. In sections 2 and 3, we will analyze the economics of various issues through specified readings, then you will provide an economic analysis of one issue of your choosing and approved by the instructor.

c. A writing requirement will be designated for each section. The requirement for sections 2 and 3 will pertain to your selected issue.

d. The final exam will be a paper dealing with a sustainability issue that will require you to use concepts developed throughout the course.

e. Your comprehension and knowledge of the material in each lesson is evaluated. In general you should be able to answer the requirement satisfactorily from the material within the lesson. In all of the requirements, I am interested in how you use the concepts to develop the solution to the proposed problems. I am interested in your thoughts and how you express them; however, you should have some basis for your thoughts. Your solution to the writing requirement should answer the questions in a manner that shows your comprehension of the course material.

Course Materials:

The resources listed below will be used throughout the course and contain assigned readings and references required to achieve the learning objectives and complete the course requirements.

Tietenberg, T. Environmental Economics and Policy. Fifth Edition. Pearson Addison Wesley Publishing. 2006. ISBN-13: 9780321348906

Ellsworth, B. and J.A. Higgins. English Simplified. Tenth Edition. Longman Publishers. 2004.

TTU Guidelines for Dissertations and Theses. Chapter 2. http://www.depts.ttu.edu/gradschool/current/THDGuidelines.php

Written Requirements:

All grades for this course will be earned through written assignments. Ellsworth and Higgins publication is a quick refresher and good reference for grammar and punctuation usage. Use the TTU guidelines for proper format of the assignments.

AGSC 5303 ECOLOGY OF GRAZING LANDS SYSTEMS (3 credit hours)

Faculty Information:

Dr. Vivien G. Allen Dept. of Plant and Soil Science, Texas Tech Felician@ttu.edu
Dr. John Fike Dept. Crop and Soil Env. Sci., Virginia Tech Blacksburg jfike@vt.edu
Dr. Rob Kallenbach Div. Plant Sciences, U. Missouri Columbia KallenbachR@missouri.edu
Dr. Paul Olenbusch Pasture and Range Mgmt., Kansas State U. (Retired)
ole7734@suddenlink.net
Dr. John Waller Dept. Animal Science, U. Tennessee jwaller@utk.edu

Course Information:

- **Prerequisites:** Verification of qualification by the student's major professor and permission of the instructor is required. Because students will come from a number of different institutions with differences in curricula, prerequisites must be in subject matter and not in specific courses. It is recommended that students should have completed at least one course at the junior or higher level in each of five of the following subject matter groups prior to taking this class,
  Group One: Forage Crop Ecology, Forage Management, Range Management, Range Improvement
  Group Two: R u m i n a n t, Nutrition, Feeds and Feeding, Equine Nutrition, Beef Cattle Nutrition, Dairy Cattle Nutrition, Beef Cattle Management, Sheep Management Dairy, Cattle Management, Ruminology
  Group Three: Soil Fertility and Fertilizers
  Soil Chemistry Soil
  Management Soil Physics
  Soil Genesis and Morphology
  Group Four: Biochemistry, Physiology (Plant or Animal), Toxicology
  Group Five: Statistics, Biometry
  Group Six - A course in group six can be substituted for meeting a requirement in groups 1 through 5 Ecology Economics Farm Management Plant Taxonomy Agrostology Wildlife Management
- **Required Text:** No required text
- Other required supplies or financial obligations: A $600 (US) field-trip fee is charged for each student. This fee covers transportation costs during the field trip, lodging, and meals. Students are responsible for transportation to the departure point for the trip and for their return from the ending point of the trip.

Course Description and Purpose:

A field oriented course that takes participants into diverse grazing lands ecosystems across several states and may include other countries. Students learn about (a) the components and functions of grazing lands and how these vary in different ecoregions, (b) research needs, objectives and techniques in soil-plant-animal research, (c) forage-livestock ecology and systems in grazing lands (cropland, pastureland, rangeland and forestland), (d) the role of forages in conservation practices, wildlife habitat, and sustainable agriculture, and (e) industries involved with forages and livestock.

This is a graduate level course that includes a two-week field trip and is open to students who meet the qualifications. Graduate credit is received through your home institution and is credited to your program of study. Enrollment is limited to about 24 students and is taught during the first summer semester (quarter). Routes for the field trip will be different each time the course is offered, and students will travel through widely divergent ecosystems. International trips offered in some years.

Forages play a key role in addressing the issues of sustainability of agriculture and the environment. Forages are grown on more than half of the land in the United States. Private grazing lands occupy more than one-third of the land area in the lower 48 states. Forages and grazing lands are central to soil conservation, clean water, wildlife habitat, recreation, and open space, and they provide the major portion of the diets of domesticated ruminants and equines. As we seek solutions to the complex issues of maintaining agricultural production while preserving and protecting the environment and our future productive potential, we find that forages are central to these issues. It is critical that we provide learning opportunities for students that allow them to comprehend broad principles that extend across ecoregions. Students must take an integrated, systems approach to solving problems of agriculture and the environment. This can best be taught by bringing together an array of expertise and providing exposure to a broad range of sites.

While multidisciplinary courses such as this are needed, few universities have the required number of graduate students and the attendant resources to offer them. The multiuniversity nature of this course allows students and faculty from any cooperating university to participate. Benefits of this process include the interaction and sharing of knowledge among students and professors from a

number of institutions and areas of expertise. Because faculty and students are from various universities, students become more knowledgeable about programs in other areas.

Course Outline:

No textbook is required. A core set of reading assignments provides the necessary background information. Selected reading assignments from publications and technical papers will familiarize students with the sites to be visited as well as with the professionals they will meet. Prior to departing on this trip, four modules are to be completed by students. This will be conducted using an online 'Knowledge Hunt' where students are directed to locate and synthesize specific information relevant to understanding information during the trip and better equipping them to ask relevant questions. This is to be completed between March 1 and May 1.

During the class, a Daily Journal must be kept by each student. At the end of the trip, the student should be able to articulate: (a) What this experience has meant to them. (b) How they can apply information gained to their future careers (teaching, research, production, etc).(c) How this experience relates to their graduate program. (d) How this course has changed their ideas of what they might do in the future.

(e) How it changed their perspective of grasslands and their function within ecosystems and ecotomes across ecoregions. (f) What impact the course has had on them.

Expected Learning Outcomes:

1). To gain first-hand experiences in grazing land ecology through various ecoregions and to learn about techniques to address education and researchable needs. Students will become familiar with research needs and objectives in several geographical and climatic areas, techniques used in soil-plant-animal research, forage-livestock ecology, systems that include native and/or introduced forage species, and intensive and extensive management. Students will be able to qualify and quantify differences in ecosystems and the resultant effects on forage-livestock systems and agriculture in general. By familiarizing students with different ecosystems, they will be better able to integrate grazing management, watershed management, wildlife issues, and conservation of natural resources.

2). To gain interactions with professionals active in the multidisciplinary areas of forage livestock research, teaching, extension, industry, and production. As a result, students will gain a greater appreciation and knowledge of the interdisciplinary nature of forage-livestock research. The importance of forage-livestock systems as an integral component of agriculture and how they contribute to productive, economically viable, socially acceptable, and sustainable agricultural systems will become evident to students.

Criteria for Grading:

Grading is based on completion of pre-trip modules and upon participation in class activities during the two-week trip. An oral exam is given at the conclusion of the trip in a group setting.

Class Attendance:

Policy: Mandatory. Non-attendance constitutes withdrawal from this class.

ATMO 5302 WEATHER, CLIMATE AND APPLICATIONS (3 credit hours)

Faculty Information:

Colleen A. Leary Office - BA 1207 colleen.leary@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Meteorology, Understanding the Atmosphere, by Ackerman and Knox (1st Edition). Please bring your textbook to class.

Course Description and Purpose:

Teaches basic principles of atmospheric science, with particular emphasis on applications, including severe weather, air pollution, and global climate change.The Atmospheric Science Group in the Department of Geosciences offers this graduate course to contribute to the Multi-Disciplinary Science M.S. degree program for elementary through secondary science teachers. The course's intrinsic value lies in its use of basic physical principles to explain interesting and important phenomena in our atmospheric environment. Understanding phenomena like clouds, precipitation, and winds add interest and meaning to watching the sky. Understanding phenomena like hurricanes, flash floods, lightning, severe thunderstorms, and tornadoes increases appreciation of the strength and intensity of natural forces. Learning the facts about prolonged exposure to ultraviolet radiation, air pollution, extreme heat and cold, extreme wind and cold, and extremes in pressure makes it less likely that we and those in our care will suffer their ill effects. Our ability to contribute to discussions and decisions about public policy will increase along with our knowledge of air pollution, climate, global warming, ozone holes, and El Niño.

Course Outline:

Class Date Subjects and Textbook Chapter and Page References

1. 29 Aug. Weather elements; composition of the atmosphere; air pollution; ozone; ozone holes; radiation; energy balance; greenhouse effect; temperature; stability
   Chapter 1: Pages 1-18
   Chapter 2: Pages 27-31, 32-33, 36-44, 47-52
   Chapter 3: Pages 57-59, 65, 68-70, 74-76 Box 3.1
   Chapter 4: Pages 110-112
   Chapter 10: Pages 301-304
   Chapter 15: Pages 433-438, 440-441
2. 12 Sept. Seasons and temperature; winds and advection; climate typing with respect to temperature; growing, heating, and cooling degree days, wind chill, heat index; humidity
   Chapter 2: Pages 44-47, 50-53
   Chapter 3: Pages 59-65, 70-81
   Chapter 4: Pages 86-94
   Chapter 14: Pages 401-403
3. 19 Sept. Fog and clouds; how clouds produce rain; climate typing with respect to precipitation; dew and frost; weather modification; frozen precipitation; icing; visibility
   Chapter 4: Pages 92-123
   Chapter 2: Pages 32-36, 50-53
   Chapter 12: Pages 355-356
   Chapter 14: Pages 401-403
4. 26 Sept. Remote sensing; radar, satellites
   Chapter 5: Pages 132-148
5. 3 Oct. Catch up or move ahead day. Class ends at 7:30 p.m. on this night only
6. 10 Oct. Measuring pressure; winds and forces; thermal circulations; sea breeze, mountain winds, and monsoons; general circulation of the atmosphere and oceans
   Chapter 1: Page 20
   Chapter 5: Pages 130-132
   Chapter 6: Pages 159-186
   Chapter 7: Pages 190-206
   Chapter 12: Pages 351-352; 353-354
7. 17 Oct. El Niño
   Chapter 8: Pages 209-222
   Chapter 2: Pages 66-69
8. 24 Oct. Hurricanes
   Chapter 8: Pages 223-245
9. 31 Oct. Air masses, fronts, and extra-tropical cyclones
   Chapter 1: Pages 18-24
   Chapter 2: Pages 31-32

Chapter 5: Pages 128-132
Chapter 9: Pages 249-268
Chapter 10: Pages 271-304
Chapter 12: Pages 342-343; 350-351; 352-353 Box 12.4

10. 7 Nov. Weather forecasting; stability and convection; air parcels
    Chapter 13: Pages 363-397
    Chapter 1: Pages 21-24
    Chapter 2: Pages 32-36
    Chapter 3: Pages 74-79
    Chapter 12: Pages 339-342, 354-355
11. 14 Nov. Thunderstorms and tornadoes; lightning; the dry line; microbursts
    Chapter 11: Pages. 307-335
    Chapter 12: Pages. 344-350
12. 21 Nov. Climate types
    Chapter 14: Pages. 401-411
13. 28 Dec. Climate change
    Chapter 14: Pages 411-428
14. 5 Dec. Global warming
    Chapter 15: Pages 431-454

Expected Learning Outcomes:

After completing this course you will be able to:

- Calculate heating, cooling and growing degree-days, utilize wind chill and heat index charts, and explain the health effects of extremely high and low temperatures, air pollution, and exposure to ultraviolet radiation.
- Interpret the appearance of the sky by identifying the major cloud groups and their locations within large and small weather systems.
- Explain the possibility of global warming and the roles land-surface changes, air pollution, greenhouse gases, clouds, and the oceans in climate change.
- Analyze force-balance concepts and relate them to horizontal wind patterns that explain vertical air motions and weather in high and low pressure systems.
- Differentiate between hurricanes (tropical cyclones) and extra-tropical cyclones in terms of their origins, life cycles, temperature distributions, precipitation patterns, and wind patterns.
- Combine basic information about the atmosphere and the ocean to construct a conceptual model of the El-Niño-Southern Oscillation.
- Characterize the different stages of the life cycles of thunderstorms and tornadoes and point out likely areas for the occurrence of various types of severe thunderstorm weather.
- Critique weather forecasting methods, including numerical weather forecasts.
- Group different geographical areas by type of climate and explain the factors that determine climate type.

Criteria for Grading:

The expected learning outcomes for this course will be assessed by:

- In-class graded quizzes, In-class application activities, Polling the class, Class discussions, Active learning activities

Class Attendance:

Attendance at every class is an important part of this course.

BIOL 5330 ADAVANCED LANDSCAPE ECOLOGY (3 credit hours)

Faculty Information:

Name: Dr. Nancy E. McIntyre Office: Room 420 Biology Building nancy.mcintyre@ttu.edu

Course Information:

- **Prerequisites**: Instructor consent
- **Required Text**: Gergel, S.E., and M.G. Turner, eds. 2002. *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*. Springer, New York.
- Other required supplies or financial obligations: 1GB (minimum size) flash drive

Course Description and Purpose:

Landscape ecology is the study of the effect of spatial patterns on ecological processes and how those processes in turn create environmental patterns. This field represents a new awareness among ecologists that spatial patterning can no longer be ignored nor environments assumed to be homogeneous for logistical convenience; rather, spatial patterning is now recognized to be a dynamic force in ecology and not just a statistical nuisance. Fundamental principles of landscape ecology serve as foundations for decision-making and problem-solving in conservation biology, natural resource management, and urban planning and development.

Course Outline: Weekly course outline found at

http://www.biol.ttu.edu/faculty/nmcintyre/Landscape%20Ecology/topics.htm

Expected Learning Outcomes:

Upon successful completion of course requirements, students will be able to quantify spatial heterogeneity and its effects on biological processes affecting individuals, populations, and communities (including dispersal, risk of extinction, and diversity), and to discuss why such skills are necessary to conservation and natural resource management (e.g. in terms of reserve design and placement). There will be a weekly computer lab session, where students will conduct hands-on exercises; after successfully completing this class, students will be able to perform the most common methods of data analysis used in landscape ecology, including Markov and neutral landscape modeling and spatial statistics such as semivariance and autocorrelation analyses, using software packages that are standards in the field, including Fragstats and Rule.

Methods for Assessing Learning Outcomes:

(1) student performance on lecture exams
(2) student performance on weekly lab exercises
(3) student performance on cumulative lab exam
(4) change in performance on a pre/post diagnostic test
(5) student performance on cumulative lecture final exam
(6) participation in discussion section held outside normal course hours

Criteria for Grading:

10% on exam I
10% on exam II
10% on exam III
30% on cumulative final lecture exam
40% on lab

Requirements for Graduate Students:

Grad students will be expected to exhibit a more thorough and synthetic mastery of the subject; consequently, they will have different tests from undergrads. Grad students will also be involved in a regular discussion section, during which papers from the recent and classic landscape ecology primary literature will be examined and critiqued.

Absences and Missed Assignments:

Because there is a causal relationship between attendance and performance, I do take note of attendance. Make-up assignments will be given only in the event of a satisfactory, written excuse (e.g. doctor's note or TTU-sanctioned absence). Students with unexcused absences should not even *think* of enquiring about how to improve their grade, extra credit, or the like.

CE 5361 SURFACE WATER HYDROLOGY (3 credit hours).

Faculty Information:

Dr. Ted Cleveland Dept. of Civil Engineering

Course Description and Purpose:

Advanced study of hydrologic cycle: hydrologic abstractions, surface-runoff mechanics, hydrographs, baseflow separation, data analysis, reservoir and channel routing, and an introduction to rainfall-runoff modeling.

Expected Learning Outcomes:

The purpose of this class is to study hydrologic processes in the context of analysis and design and to apply selected hydrologic models to the analysis of real watersheds.

The student will be able to

1. Delineate watersheds by their topographic and anthropegenic features1, and estimate various physical metrics of a watershed (length, slopes, etc.).
2. Analyze, synthesize, and apply runoff hydrographs for engineering design.
3. Analyze, synthesize, and apply abstractions (storage and losses) for engineering design.
4. Route hydrographs using a variety of hydrologic technologies.
5. Read, synthesize, and communicate ideas presented in current and historical technical literature.

ABET Program Outcomes Addressed in CE 53612:

3[a]. Ability to apply knowledge of mathematics, science, and engineering.
3[b]. Ability to design and conduct experiments, as well as to analyze and interpret data.
3[e]. Ability to identify, formulate, and solve engineering problems.
3[i]. Recognition of need for life-long learning.
3[k]. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
8[d]. Proficiency in water resources engineering.

Course Schedule: by week

1 Hydrologic cycle. Mass, momentum, and energy. Conduit, open, and porous flow.
2 Atmospheric, and sub-surface water.
4 Surface water, measurements and data sources.
6 Unit Hydrographs. Convolution/deconvolution and synthesis.
8 Hydrologic and hydraulic routing
9 Mid-term Exam: All covered
10 Probability estimation, and frequency analysis.
12 Design storms and event modeling.
14 Continuous-simulation modeling
Final Exam: All covered

Prerequisites:

Mastery of material from CE 3354 or an equivalent physical hydrology course is required.

Attendance:

If you come to class every day, you won't miss anything. Please let the instructor know if you must miss a class for a legitimate reason.

Grading:

Final grades are determined based on performance during the semester. Letter grades will be assigned using University standards. The approximate weighting of graded material in determining the final grade is as follows:

Article Reviews 10%
Homework 40%
Examinations 50%

CE 5363 GROUNDWATER HYDROLOGY (3 credit hours)

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisite:** CE 3354 or consent of instructor.
- **Textbook:** Fetter, C.W., 2001, Applied Hydrogeology, 4th ed., Prentice Hall, Englewood Cliffs, New Jersey.

Other Required Materials:

McDonald, M.G. and Harbaugh, A.W., 1988, A Modular Three-Dimensional Finite-Difference Groundwater Flow Model, Chapter A1, Book 5, Techniques of Water-Resources Investigations of the United States Geological Survey, USGS, Reston, Virginia. Also other MODFLOW support files.

Course Purpose:

The purpose of this course is to introduce the student to the hydrogeologic, hydrologic, and engineering principles that are applied to problems of groundwater investigation, development, production, and quality.

Course Objectives:

Upon successful completion of this course, the student will be able to do the following.

1. Determine hydrogeologic parameters from geologic materials, field tests, and estimates.
2. Describe subsurface conditions with proper hydrogeologic terminology.
3. Apply analytical and numerical modeling techniques to simulate groundwater flow in ideal and nonideal aquifer systems.
4. Recognize the importance of groundwater quality in consideration of regional flow descriptions and water resource development.

Topics:

1. Connections between geological and geotechnical information to hydrogeologic and hydraulic parameters.
2. Description, measurement, and/or estimation of aquifer hydraulic parameters.
3. Construction of hydraulic head contours for homogeneous, isotropic conditions.
4. Application of Darcy's Law for horizontal and vertical flow.
5. Application of appropriate analytical relationships for radial flow to wells.
6. Performance and analyses of pump tests for aquifer parameters.
7. Performance and analyses of slug tests for aquifer parameters.
8. Application of superposition to represent aquifer boundaries and well interference.
9. Application of MODFLOW for numerical simulation of non-ideal aquifer systems.
10. Well drilling, development, construction, and rehabilitation procedures.
11. Regional groundwater flow patterns, recharge and discharge areas.
12. Unsaturated zone conditions.
13. Equilibrium water chemistry, especially carbonate equilibrium.
14. Groundwater contamination concerns.
15. Development and management of well fields.
16. Groundwater rights.

Class Schedule:

Class meets fifteen weeks, three times per week for 50 minutes per class session.

Evaluation Process:

1. Homework – There will be six to eight homework assignments scattered through the course, usually with two class days (or one week) between assignment and due date allowed for completion. There is no late policy. Solutions should include brief problem statements and outline the solution approach leading to a well-labeled answer. Work on one side of the paper only. Illegible homework will be returned ungraded. Computer applications will be used on some assignments. Students are expected to be computer literate. When spreadsheets are used, sample calculations are required, and each student must turn in his/her own result.

2. Project – There will be one individual modeling project during the middle of the semester. The groundwater model will be available for PC use.

3. Exams – Two exams, one at midterm and one during the final period, will be given. No make-up exams will be given for simple absence. If a student has an emergency conflict with any assignment, prior notice must be given to the instructor.

4. Class Conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.

5. Grading Policy

	CE 5363
Homework	20%

Two Exams	40%	
Project		20%
Two Reviews		20%
	100%	

Contribution of Course to Professional Component of the Curriculum:

This course is one of the two groundwater courses in the MENVE curriculum. This course builds on the water resources background begun in CE 3354 Engineering Hydrology by emphasizing hydraulics of groundwater flow in simple to complex situations. This course prepares students to deal with investigation and development of groundwater resources, an important part of the nation's water supply. The following graduate course, CE 5364 Groundwater Transport Phenomena, emphasizes the movement of dissolved and liquid phase contaminants in the subsurface. These two courses complete the preparation of the students for most practical problems in groundwater quantity and quality. Individual projects are used in both courses to simulate the working environment in engineering practice.

Relationship to Program Objectives:

This course provides the conceptual framework, mathematical tools, and modern software techniques to insure the students' proficiency in engineering problems associated with use of groundwater resources. As water supply and quality issues are integral for civil and environmental engineers, this material addresses the objectives of both the civil engineering and environmental engineering degree programs.

ABET Program Outcomes:

3(a) an ability to apply knowledge of mathematics, science, and engineering
3(c) an ability to design a system, component, or process to meet desired needs
3(e) an ability to identify, formulate, and solve engineering problems
3(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
8(e) proficiency in water resources engineering
8(g) design a system, component, or process in more than one civil engineering context

CE 5364 GROUNDWATER TRANSPORT PHENOMENA (3 credit hours)

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text**: *Ground Water Contamination*, 2nd ed., Bedient, Rifai, and Newell. Some computer manuals will be required at different times during the semester.

Course Description and Purpose:

Study of sources and fates of contamination in groundwater. Mathematical modeling of reactive and nonreactive pollutant movement. Aquifer restoration strategies.

Course Outline:

Week	Topics and **Events**
1	Introduction (Ch 1), Contamination Sources (Ch 4)
2	Anisotropy, Transport Mechanisms (Ch 6)
3	Fate Processes (Ch 7), Modeling Attenuation (Ch 8)
4	Risk Assessment
5	Risk Assessment
6	Numerical Models (Ch 10), Attenuation and RBCA (Ch 12)
7	MODFLOW/MODPATH/MOC3D Model, **First Review Due**
8	**Exam 1**
9	Site Investigations (Ch 5)
10	Spring Break
11	Flow and Transport in Unsaturated Zone (Ch 9)
12	CHEMFLO Model
13	NAPLs (Ch 11)
14	Remediation Alternatives (Ch 13)
15	Legal Protection (Ch 14), **Second Review Due**
16	
17	Review

Expected Learning Outcomes:

The student will be trained in the fundamental descriptions of the physical and chemical processes that control the movement of contaminants in the subsurface. Analytical solutions and existing computer models will be presented to typify the available tools with corresponding limitations.

Criteria for Grading:

1. Homework and projects – Several homework and project assignments will be distributed through the semester, weighted according to their relative scopes. After the graded homeworks are returned, the solutions will be posted. Use of spreadsheets is encouraged for repetitive tabular calculations and graphs, but sample calculations are required for full credit. Each student must submit his/her own spreadsheet.
2. Article reviews – Two brief (3-5 pages, typed, double-spaced) reviews of articles from the professional literature will be required during the semester.
3. Exams – Two exams will be given. The final exam will only cover the material after Exam one. No make-up exams will be given for simple absence.
4. Class conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.

Grading Policy

Homework and projects: 40% Article reviews: 20% Exams: 40% Total: 100%

Class Attendance:

Required

CE 5394 NATURAL SYSTEMS FOR WASTEWATER TREATMENT (3 credit hrs.)

Faculty Information:

Dr. C. B. Fedler, Rm. 202 Civil Engineering Building

Required Texts:

-Natural Systems for Waste Management and Treatment, by S.C. Reed, R.W. Crites and E.J. Middlebrooks. Second Edition, ISBN 0-07-060982-9.

-EPA, 1981, Process Design Manual: Land Application of Municipal Wastewater (EPA-625/1-81-013)

Course Objective:

The objective of this class is for a student to learn how to design various types of natural wastewater treatment systems for treating various types of wastewater streams.

Course Outline:

Introduction

Examination of municipal wastewater
General concepts of land application of wastewater
Fate of wastewater constitutents

Slow Rate Systems

Design considerations
Crop selection, buffer area, drainage, retention ponds, crop harvesting, storm water, irrigation systems
Preapplication treatment
Water application efficiency - sprinklers
Land limiting constituents
Nitrogen removal and nitrogen balance
Land requirements
Determination of storage requirements
Fixed irrigation schedule, variable leaching (TWC method)
Fixed leaching, variable irrigation
Operation and maintenance
Monitoring/Management

Rapid Infiltration Systems

Basic concepts of the system
Nutrient removal processes
Design considerations
hydraulic loading rate, infiltration rate, mound dissipation
Operation and maintenance
Monitoring/Management

Overland Flow Systems

Basic concepts of the system
Nutrient removal processes
Design considerations
Crop selection, hydraulic loading, slope, infiltration rate
Start-up problems, temperature effects
Operation and maintenance
Monitoring/Management

Pond Systems

Aerobic
Anaerobic
Others

Wetland/Aquacultural Systems

Components
plants, soil, organisms, etc.
Pond design
Performance
Design considerations
Operation and maintenance

Land Application of Hazardous Wastes (if time permits)

Basic concepts of the system
Review of hazardous waste regulations
Review of reported treatment systems
Process required to obtain a permit
Design philosophy

Learning Outcomes:

After completing this course, students will be able to:

1) Calculate the mean crop consumptive use for various plants and free surface water bodies
2) Analyze the land limiting constituents for a surface application system for wastewater
3) Complete a water balance, nutrient balance, and a salt balance for a surface application system
4) Determine the storage requirements for a natural wastewater treatment system
5) Design a slow rate land application system
6) Design a overland flow land application system
7) Design a rapid infiltration land application system
8) Design the various types of pond systems for treating wastewater
9) Design a surface flow wetland
10) Design a subsurface flow wetland

Outcome Assessment:

GRADING SCALE - PERCENTAGE OF GRADE

Problem Sets - 25%
Semester Project - 25%
Midterm Exam - 25%
Final exam - 25%

NOTE: All assignments, computer programs and the design project must be turned in to obtain a passing grade in the course. Late work will be deducted by half the graded score unless prior arrangements have been made.

ENTX 6361 ENVIRONMENTAL AND WILDLIFE TOXICOLOGY (3 credit hours).

Faculty Information:

Dr. Phil Smith Institute of Environmental and Human Health

Course Information:

- **Prerequisite:** Organic chemistry, ecology, or consent of instructor.

Course Description and Purpose:

This course will address impacts of toxic substances on the fitness, survival, and reproduction of wildlife species. The procedures used to investigate these impacts will be presented. Environmental contaminants that will be discussed include pesticides, metals, petroleum products, persistant organic pollutants, and endocrine disrupting chemicals. The course will be taught from the perspective of an ecological risk assessor. This course will be valuable to future wildlife and environmental science professionals.

Course Outline:

January Historical perspective of wildlife and environmental toxicology
Laws and regulations pertaining to wildlife and environmental toxicology
Principles of toxicology

February Uptake, biotransformation, and elimination of toxic substances
Ecological aspects of toxicology
Integrating toxicology and ecology
Exposure to contaminants among wildlife
Biochemical and physiological measures of toxicity
Quiz 1
Terrestrial Ecotoxicology

March Aquatic toxicology
Pesticides and wildlife
Pesticides and wildlife
Spring Break
Spring Break
Metals and wildlife
Metals and wildlife

April Persistant organic pollutants and wildlife
Persistant organic pollutants and wildlife
Petroleum products and wildlife
Quiz 2
Endocrine disrupting compounds and wildlife
Endocrine disrupting compounds and wildlife
Emerging contaminant threats to wildlife
Indirect and sublethal effects of contaminants in wildlife
Ecological risk assessment

May Final Exam

Grading Policy: Grades will be based on point totals accumulated on 2 quizzes, and a comprehensive final exam.

Quizzes = 100 x 2 = 200 points
Final exam = 150 points
Final letter grades will be assigned based on the following scale:

A = 315 – 350 points
B = 280 – 314 points
C = 245 – 279 points
D = 210 – 244 points
F = 0 – 209 points

The instructor reserves the right to curve grades upwards. Extra credit is possible, but will only be granted following additional effort by the student requesting the credit. Extra credit (up to 25 points) assignments may include, but are not limited to writing reviews of wildlife toxicology topics, or wildlife-based risk assessments.

Expected Learning Outcomes and Assessment:

Upon completion of this course the student should have a generalized knowledge of wildlife toxicology principles, a wide variety of environmental contaminants affecting wildlife populations, methods used to evaluate the exposure and effects of toxicants in wildlife, and the EPA risk assessment process. They should be capable of evaluating exposure and effects information as it relates to wildlife, and understand how these concepts are considered together to determine risk. In addition to the testing schedule detailed above, student learning of these concepts described above will be monitored by in-class discussions that will include frequent queries from the instructor.

Attendance: Expected, and highly recommended.

ENTX 6371 PROCEDURES AND TECHNIQUES IN ECOLOGICAL RISK (3 credit hours)

Faculty Information:

Dr. Philip N. Smith Institute of Environmental and Human Health phil.smith@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** 1. US EPA Risk Assessment Guidelines
  2. Ecological Risk Assessment for Contaminated Sites. Suter et al., eds., Lewis Publishers, Boca Raton, FL

Course Description and Purpose:

To provide students with a solid foundation in risk assessment methods. Specifically, students will learn how the ecological risk assessment framework developed by the U.S. Environmental Protection Agency is used to assess the potential hazards of chemicals in the environment with specific focus placed on hazardous waste sites (Superfund). □

Course Outline:

August	Syllabus
September	Course Outline, Goals, Strategies for Success
	What is risk, Risk Perceptions, Policy of Risk Assessment
	Risk Assessment Frameworks
	Problem Formulation, Assessment Endpoints
	Conceptual Models and Analysis Plans
	Quiz 1
	Analysis of Exposure
	Analysis of Exposure
	Analysis of Effects
October	Analysis of Effects
	Risk Characterization
	NO CLASS
	NO CLASS
	Risk Characterization
	Quiz 2
	Uncertainty Analysis
	Probabalistic Methods
	Risk Communication and Management
November	EPA FIFRA Risk Assessment Process AQUATIC
	EPA FIFRA Risk Assessment Process TERRESTRIAL
	Emphasizing Ecology in Ecological Risk Assessment
	Quiz 3
	Case Studies
	NO CLASS SETAC National Meeting
	Case Studies
	NO CLASS Thanksgiving
December	Case Studies
	Review
	COMPREHENSIVE FINAL EXAM

Expected Learning Outcomes:

Upon completion of this course the student should have a generalized knowledge of the EPA risk assessment framework, and how it is applied to risk assessments on hazardous waste sites. They should be capable of evaluating risk in terms of exposure and effects, and understand how these concepts are considered together to determine risk. Students should have a basic understanding of methods of integrating exposure and effects risks via several methods including the quotient method and probabilistic risk assessments. Students will learn how ERA relates to natural resource damage assessments. Students will also have a basic understanding of how ecological risk assessments are applied to situations other than hazardous waste site evaluations (e.g. pesticide registration). In addition to the testing schedule detailed above, student learning of these concepts described above will be monitored by in-class discussions that will include frequent queries from the instructor.

Criteria for Grading:

Grades will be based on point totals accumulated on 3 quizzes, and a comprehensive final exam.

Quizzes = 100 x 3 = 300 points

Final exam = 150 points

Final letter grades will be assigned based on the following scale:

A = 405 – 450 points

B = 360 – 404 points

C = 315 – 359 points

D = 270 – 314 points

F = 0 – 269 points

The instructor reserves the right to curve grades upwards. Extra credit is possible, but will only be granted based on extreme circumstances and after considerable extra effort by the student requesting the credit. Extra credit (up to 25 points) assignments may include, but are not limited to writing reviews of, or performing risk assessments.

Class Attendance:

Expected, and highly recommended.

GEOG 5300 GEOGRAPHIC INFORMATION SYSTEMS (3 credit hours)

Faculty Information:

Dr. Kevin R. Mulligan Office - 208 Holden Hall kevin.mulligan@ttu.edu

Course Information:

- **Prerequisites:** Working knowledge of the Microsoft Windows environment.
- **Required Text:** Ormsby *et al.*, 2004, *Getting to Know ArcGIS Desktop, Second Edition*, Environmental Systems Research Institute, Redlands, California. This is a software course book that we will use as the basis for lab instruction. The book includes two CDs - a data CD and a 180-day timed version of ArcGIS 9. If you want to work at home, you will need both CDs and a computer running either Windows 2000 or Windows XP.
- **Other required supplies and financial obligations:** USB Flash Drive. To save your lab work, you need to purchase a USB flash drive early in the semester. Since GIS data can take up a lot of space, a 256 MB flash (or larger) is recommended.
  Required Lab: GEOG 5300 section 501 or 502.

Course Description and Purpose:

Geographic information systems are computer systems designed to manage and analyze spatial data, where spatial data can be any data that are tied to places or geographic coordinates. In this course we will develop a basic understanding of geographic information systems using ArcGIS, a very powerful and widely-used GIS.

Course Outline:

Introduction – What is a Geographic Information System?
Feature types and data structures (raster vs vector)
Types of maps (map scale and function)
Thematic mapping (choropleth, isoline, dot density, proportional symbol)
Data classification (natural breaks, quantile, defined interval, standard deviation)
The geographic grid (datums, ellipsoids, spatial reference, latitude and longitude)
Map projections (getting the Earth onto a flat map – cylindrical, conic and planer projections)
Projected coordinate systems (UTM coordinate system, state plane coordinate system)
Land division systems (public land surveys)
Topographic maps (map interpretation, marginalia and symbolization)
Effective map design (knowing the purpose of your map)
Data collection (land surveys, remote sensing, the Global Position System)
GIS analysis (basic measures, spatial relationships, spatial modeling and map algebra)
Designing a GIS (database design and implementation)
Metadata and accuracy (knowing the origins of data)
Data sources (data in the public domain - working with DEMs, DRGs and DOQs)
The Spatial Analyst extension to ArcGIS (working with raster data)
The 3D Analyst extension to ArcGIS (creating animations & 3D fly-throughs)

Expected Learning Outcomes:

1) Explain what a GIS is, how it works, and what it can do.
2) Analyze spatial data and create publication quality maps using ArcGIS.
3) Understand and apply basic cartographic principles (e.g. map projections, symbology and cartographic design).
4) Obtain GIS data from Internet sources and evaluate these data in the context of a given project.

Criteria for Grading:

There are two exams in this course (a midterm and a final), two lab quizzes, one basemap project and one final project. Each exam is worth 100 points and each lab quiz is worth 50 points. The basemap project is worth 50 points and the final project is worth 100 points. Your final course grade is therefore based upon a possible total of 450 points. To ensure a grade in this course you must meet the following minimum requirements: A - 90%, B - 80%, C - 70%, D - 60%.

Students are also expected to complete each of the lab assignments **during the lab class time**. Five (5) points will be deducted for each unexcused absence **and** five points will be deducted for each missed or incomplete exercise. Missed or incomplete lab assignments may be turned in late for credit with approval.

Exams and Quizzes: The exams and quizzes will consist of a combination of true/false, multiple choice, and short answer questions. The lecture exams will be based upon the lectures and reading assignments. The lab quizzes will be open-book and open-computer based upon the information covered in the labs.

Class Attendance:

You are expected to attend all of the lectures and labs and complete all of the lab exercises in lab. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let us know.

Make-Up Exams: You are required to take the exams and quizzes at the scheduled times. Exceptions will be made in the case of a documented serious illness, medical emergency, or other university approved excuse. If you have prior knowledge that an exam or quiz will be missed, you must inform one of us before the time of the exam or quiz. If you need to make up an exam or quiz, it is your responsibility to make arrangements as soon as possible.

Missed Information: If you miss a lab, it is your responsibility to complete the exercise on your own (or with the help of your classmates).

GEOG 5301 REMOTE SENSING OF THE ENVIRONMENT (3 credit hours)

Faculty Information:

Dr. Tina Delahunty Dept. of Economics and Geography tina.delahunty@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:**
- Other required supplies or financial obligations-- You are required to enroll in a lab section as part of this class.

Course Description and Purpose:

Remote sensing refers to the acquisition and analysis of imagery (spatial data) obtained using a remote platform, most often an aircraft or satellite. The imagery might be in the form of aerial photographs or the imagery might be digital in the case of airborne or satellite multi-spectral scanners. The purpose of this course is to develop a basic understanding of remote sensing and digital image processing techniques. In the first part of this course we will work with conventional black & white, color, and infrared aerial photographs. In the second part of the course we will work with digital satellite imagery. In particular, this course will focus on the use of remote sensing to solve spatial problems by integrating image processing and GIS analysis. To learn about image processing and geographic information systems, we will use a hands-on approach. In this course we will use the Image Analysis extension to ArcGIS and ERDAS Imagine.

Methods for Assessment:

Learning Outcomes will be assessed by the following methods:
Objective testing (Multiple choice, true-false, and fill in the blank questionnaires), Classroom assessment (Completion of, and perfomance on, laboratory assignments), and Individual reflection (Creation and presentation of PowerPoints and in-class discussion and debate regarding assignments). Each module of objective testing, classroom assessment and individual reflection is worth 10 points. At the end of the semester all points are totaled and averaged. Be aware that some 10 point assignments are easy and some are difficult. There will be no make-up assignments. If you do not attend a class you will receive a zero for the assignment(s) done or due on that day. 100% attendance is expected. Attendance is taken at the beginning of each class period. One 10-pointer is dropped for each student at the end of the semester. Grade distribution is based on standard 90% and above A, 80% and above B, etc. Performance on the assignments act as evidence that you are making progress in the course and that you are achieving the expected learning outcomes.

Expected Learning Outcomes:

1) Understand the sub-discipline's relationship to major geographic principles
2) Describe and discuss common uses of raster imagery and be aware of the breadth of disciplines that use remote sensing as a tool to monitor phenomena on the Earth
3) Understand the basics of the acquisition of moderate and high resolution raster data
4) Understand what the raw pixel data of an image represents on the Earth's surface and the concepts behind viewing imagery in different band combinations
5) Locate, download, and manipulate free moderate and high resolution imagery from the Global Land Cover Facility, EROS, TNRIS, Seamless USGS, and various online county and state organizations
6) Perform basic image manipulation in two free remote sensing software packages (Multispec and GRASS)
7) Perform advanced image manipulation in ERDAS: a) Interpret raw data in terms of ERDAS pixel data, histograms, and raster attribute options, b) Enhance imagery via contrast stretching and atmospheric correction, c) Perform unsupervised and supervised classification, d) Mask unwanted features from imagery, e) Clip imagery to political or other polygon boundaries, f) Quantify landscape change using image classification and recode techniques, and g) Perform accuracy assessment of classified imagery
8) Successfully rectify imagery in ArcGIS and define and reproject raster imagery in ERDAS and ArcGIS
9) Successfully import/export various raster image file types
10) Create map documents in ERDAS and ArcGIS
11) Communicate in remote sensing terminology
12) Be painfully aware of software and data compatibility issues

Criteria for Grading:

There are three exams in this course (two midterms and a final) and one final project. Each exam and the final project are worth 50 points. Your final grade is therefore based upon a total of 200 points. You are also expected to successfully complete all of the lab assignments and 10 points

will be deducted for each missed or incomplete exercise. There is no extra credit work in this course. To ensure a grade in this course you must meet the following minimum requirements: A - 90%, B - 80%, C - 70%, D - 60%.

Exams: All of the exams will consist of a combination of multiple choice, short answer and short essay questions. The exams will be based upon the lectures, reading assignments and lab exercises. For each exam I will provide a general study guide outlining what the exam will cover.

Class Attendance:

You are expected to attend all of the lectures and labs and complete all of the exercises. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let me know.

GEOG 5302 ADVANCED GEOGRAPHIC INFORMATION SYSTEMS

Faculty Information:

Dr. Kevin R. Mulligan Office – 208 Holden Hall kevin.mulligan@ttu.edu

Course Information:

- **Prerequisites:** Working knowledge of the Microsoft Windows environment and ArcGIS. These requirements can be fulfilled with GEOG 5300 or an equivalent course.
- **Required Text:** none
- **Other required supplies and financial obligations:** USB Flash Drive. To save your work, you will need to purchase a USB flash drive. Given that GIS data can take up a lot of space, a 512 MB flash (or larger) is recommended.
  Required Lab: You are required to enroll in GEOG 5302 - section 501

Course Description and Purpose:

This course is a second course in GIS designed as a continuation of GEOG 5300. The intent of the course is to cover the principle extensions to ArcGIS (Spatial Analyst, 3D Analyst, and Geostatistical Analyst) and related topics dealing with the creation of GIS data, data sources, advanced cartographic techniques and Internet mapping.

Course Outline:

Introduction (course logistics and overview of the ESRI Virtual Campus)
Working with Rasters in ArcGIS 9 - Raster Basics
Working with Rasters in ArcGIS 9- Displaying Rasters in ArcMap
Spatial Analyst - Getting Started with ArcGIS Spatial Analyst
Spatial Analyst - Analyzing Surfaces
Spatial Analyst - Working with Map Algebra
Spatial Analyst - Interpolating Raster Surfaces
Spatial Analyst - Mapping Distance and Density
Spatial Analyst - Using Cell, Neighborhood, and Zonal Statistics
3D Analyst – Introduction to ArcGIS 3D Analyst
3D Analyst – Displaying 3D Data
3D Analyst – Symbolizing and Analyzing Data
3D Analyst – Creating and Converting 3D Data
3D Analyst – Calculating Raster Surfaces
3D Analyst – Interpolating Raster Surfaces
Geostatistical Analyst – Geostatistical Analysis of Rasters
Working with Internet map services – An introduction to ArcIMS and ArcGIS Server

Expected Learning Outcomes:

1) Explain the difference between the vector, raster and TIN data models
2) Perform advanced geospatial and geostatistical analyses of raster surfaces
3) Apply advanced cartographic techniques in the creation publication quality maps
4) Obtain GIS data from Internet sources and evaluate the quality of the data

Criteria for Grading:

Your grade in this course will be based on several factors: 1) successful completion of the ESRI Virtual Campus courses, 2) a midterm exam, 3) completion of assigned exercises, and 4) a final project. To ensure a grade in this course you must meet the following minimum requirements:
A - 90%, B - 80%, C - 70%, D - 60%.

Exams: The midterm exam will consist of a combination of multiple choice, short answer and short essay questions. The exam will be based upon the materials covered in the ESRI Virtual Campus courses.

Class Attendance:

You are expected to attend all of the scheduled classes and complete all of the Virtual Campus modules on time. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let me know.

Make-Up Exams: You are required to take the midterm exam at the scheduled time. Exceptions will be made in the case of a documented serious illness, medical emergency, or other university approved excuse

Missed Information: If you miss a lab, it is your responsibility to complete the exercise on your own (or with the help of your classmates).

GEOG 5309 SEMINAR IN REGIONAL ANALYSIS (3 credit hours)

Faculty Information:

Dr. Perry Carter Office - Holden 210 perry.carter@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Reluctant Metropolis: The Politics of Urban Growth in Los Angeles by William B. Fulton Ecology of Fear: Los Angeles and the Imagination of Disaster by Michael Davis
  Cultural Economy of Cities: Essays on the Geography of Image-Producing Industries by Allen Scott
  Whitewashed Adobe: The Rise of Los Angeles and the Remaking of Its Mexican Past by William Deverell
  L.A. City Limits: African American Los Angeles from the Great Depression to the Present by Josh Sides

Course Description and Purpose:

This course is designed as a survey of issues in urban geography. Because urban geography's focus is the city (*a place*) rather than a particular *topic* the course covers a range of topics relevant to cities – politics, economics, culture, gender, ethnicity, urban migration, residential spaces, retail location, urban form, …. Because all these issues co-exist and interact in one place—the city—the main aim of this course will be to understand the linkages among the many topics we study. Simply, we want to understand the city *as a whole* rather than understand specific parts of the city in isolation (its economy, its politics, its culture, etc.).

Urban geography takes a *spatial* approach to understanding cities, and urban geographers want to know where things are, why they are *there*, and why their location is important. Moreover, they are interested in *spatial patterns* in the city—they attempt to describe and explain the city's spatial layout. This *spatial* approach to cities—an approach that strives to understand how people and culture and power and relationships are embedded within the *spaces* of the city— is the defining feature of urban geography. The primary objective of this course is to teach you this spatial approach and to teach you how to critically examine cities.

The aims of this course will be explored using two specific urban examples – Los Angeles and Lubbock. By reading about Los Angeles and going out and studying Lubbock, students will get a better understanding of how to critically (to carefully analyze and interpret) urban landscapes. A secondary goal of this course is to develop students' writing and presentations skills. To further this goal, students will write a 10 page paper and will give a 15 minute power point presentation based on their paper topic.

Course Outline:

Date	Readings (chapters)	Quizzes	Summaries	Emailed questions
1-15				
1-22	Wolch: intro, Deverell: intro-1, Flamming: intro	1	1	1
1-29	Wolch: 1, Deverell: 2, Flamming: 1	2	2	2
2-5	Wolch: 2, Deverell: 3, Flamming: 2	3	3	3
2-12	Wolch: 6, Deverell: 4, Flamming: 3	4	4	4
2-19	Wolch: 5, Deverell: 5, Flamming: 4	5	5	5
2-26	Wolch: 8 , Flamming: 5, Gumprecht: intro-1	6	6	6
3-4	Fulton: 1, Flamming: 6, Gumprecht: 2	7	7	7
3-11	Fulton: 2, Flamming: 7-8, Gumprecht: 3	8	8	8
3-18	**Spring Break**			
3-25	Fulton: 3, Gumprecht: 4	9	9	9
4-1	Fulton: 4, Gumprecht: 5	10	10	10
4-8	Fulton: 5, Gumprecht: 6	11		11
4-15	**No Class**			
4-22	Fulton: 10 & 11	12		12
4-29	**➔ [Exam]**			
5-5	**Final Paper Due in my Office by 5:00**			

Expected Learning Outcomes:

This **Course has four goals:**

1. The development of a spatial view of urban landscapes – the ability to see places as the products of certain economic, social, and cultural decisions and histories as well as locations which derive their meanings via their relationships with other places.
2. The cultivation of a practice of critical thinking – an agnostic and persistently questioning method of thought.

3. Provide students the opportunity to learning by researching.
4. Provide students the opportunity to think through writing – placing a stream of coherent thoughts on a page.

Student Learning Outcomes	Assessment Activities
By the completion of this course student will:	
1) Demonstrate an understanding of the spatial view	1) Final paper
2) Show an ability to learn by researching	2) Final paper
3) Manifest developing critical thinking and evaluative abilities.	3) Emailed questions and class discussion of readings
4) Exhibit a grasp of a variety of urban issues and class discussions	4) Weekly quizzes and summaries,

Criteria for Grading:

Starting the second week of class students must go to the Los Angeles Times (www.latimes.com) and find an article dealing with LA (it can be anything that relates to the city) and type a half page summary of the article. There will be ten of these summaries each worth one point for a total of **10** points towards your final grade.

1. Summaries will be due at the beginning of class.
2. Starting the second week of class students must type a one page, single spaced, summary of that weeks readings. This summary should focus on the main themes of the readings and should include your thoughts on the readings. There will be thirteen weeks of readings and each summary will be worth one point for a total of **13** points towards your final grade
3. Starting the second week of class quizzes over the assigned reading will be given. There are thirteen weeks of readings and thus there will be thirteen quizzes each worth three points for a total of **39** towards your final grade.
4. One exam will be given which will cover everything read or presented in class up until that point. It is worth **14** points towards your final grade.
5. Students are to write a ten (10) page paper which **Must** be in the following format: 1) a cover page with the title of the paper and your name on it (not part of the 10 pages), 2) a bibliography containing all the sources cited in the text of your paper (not part of the 10 pages). You should cite at least 5 sources. 3) the text of you paper must be written in Times New Roman font 12 point (the font and point size used in this syllabus); the margins of the text must be 1 inch on all four sides; and the line spacing must be 1 ½. No matter how good your paper might be if you do not follow this format you will receive a zero on it and forfeit **16** points towards you final grade. Detail about the paper will be given in class.
6. The last two weeks of class each student will give a 15 minute PowerPoint presentation based on their papers. This presentation is worth **8** points towards your final grade. Detail about the presentation will be given in class.

Class Attendance:

Attendance is mandatory.

GEOG 5341 DIGITAL IMAGERY IN THE GEOSCIENCES (3 credit hours)

Faculty Information:

Dr. David Leverington Office – SC 316 david.leverington@ttu.edu

Course Information:

- **Prerequisites:** none
- **Required Text:** *Remote Sensing and Image Interpretation*, Lillesand, Kiefer, and Chipman (John Wiley and Sons, Fifth Edition)

Course Description and Purpose:

Remote sensing is the gathering of information without actual physical contact with what is being observed. In the earth sciences, this usually involves the use of photography, electronic spectroscopy, or radar to detect and differentiate surface materials.

Digital Imagery in the Geosciences is an introductory course in remote sensing. Emphasis is on general remote-sensing principles, including aspects of the nature of electromagnetic radiation, the spectral-response curves of earth materials, and a review of remote-sensing sensors and orbiting platforms. Numerous basic image-processing techniques are covered in this course, including image enhancement, image georeferencing, and image classification. Topics such as planetary remote sensing and the use of remotely-sensed topography in the study of terrestrial surface processes will also be covered.

No previous experience in remote sensing is assumed, although students are expected to have basic skills in computer usage and to have completed introductory mathematics courses at the first-year level. The main software package used in this course is *PCI Geomatica*.

Expected Learning Outcomes:

1) Students will have a basic understanding of fundamental remote sensing concepts such as the electromagnetic spectrum, blackbody radiation, atmospheric windows, and spectral response curves.
2) Students will have a general appreciation for the history of development of photographic and digital remote sensing technology.
3) Students will have an understanding of the different types of digital remote-sensing sensors, including the major optical, thermal, and microwave remote sensing systems that are presently operational.
4) Students will understand how to apply basic principles of digital image processing toward the extraction of information from remote-sensing databases; these principles include those of image enhancement, query, filtering, georeferencing, classification, and arithmetic.
5) Students will be exposed to basic methods of processing of remotely-sensed topographic databases.
6) Students will appreciate the practical value of remote sensing in the study of the Earth as well as in the exploration of other solar system bodies.

Criteria for Grading:

Assessments of learning will be based on three exams and eight (8) lab exercises. Additionally, there will be an optional comprehensive makeup exam that can replace one of the regular exams (e.g., for those who missed an exam earlier in the term, or for those who wish to try to improve their final grade by replacing their poorest exam result with a better result); the makeup exam will cover *all* material covered in the semester. Exams will be based on materials presented in the lectures, labs, and assigned readings. There is no final exam.

Exams will consist of multiple choice questions, fill-in-the-blank questions, and short-answer questions. Multiple-choice sections of exams will be computer scantron graded.

In addition to exams and discussion of exam results, assessments of learning will be made throughout the semester on the basis of periodic non-graded quizzes, and through discussion in labs and lectures.

The final course grade will be based on A) the best 3 exam results, with each exam worth 20% of the final grade (total = 60% of final grade); and B) the 8 lab exercises, with each lab worth 5% (total = 40% of final grade); unless otherwise noted these exercises will be due one week after the relevant lab, and will be penalized 20% per late day.

The grading scale is as follows: *A* (90-100%); *B* (75-89.99%); *C* (60-74.99%);*D* (50-59.99%); *F* (0-50%).

GEOL 5342 SPATIAL DATA ANALYSIS AND MODELING IN GEOSCIENCES (3 credit hours)

Faculty Information:

Dr. Seiichi Nagihara Dept. of Geosciences seiichi.nagihara@ttu.edu

Course Information:

- **Prerequisites:** GEOL 3428/5428 or GEOG 3300/5300, and Statistical Methods (MATH 2300) or equivalent
- **Required Text**: *An Introduction to Applied Geostatistics,* E.H. Isaaks and R.M. Srivastava, Oxford University Press (**required**)
  Data in Three Dimensions: A Guide to ArcGIS 3D Analyst, H. Kennedy, OnWord Press (**required**)

Course Description and Purpose:

In this course, students will learn advanced techniques in GIS-based data interpretation, statistical analyses, and geospatial modeling. It is designed for researchers and practitioners who deal with a large volume of geologic, atmospheric, and other environmental data sets. The fundamental theories behind the analytical and modeling techniques are covered in detail. The theoretical knowledge will be enforced by a series of computer exercises, using real geological and environmental data. *ArcGIS* (Environmental Systems Research Institute, Inc.) and its extensions (*Geostatistical Analyst, Spatial Analyst,* and *3-D Analyst*) will be the primary GIS software tool for the exercises. We will also use *Microsoft Excel* for exercises in statistics.

Course Outline:

Expected Learning Outcomes:

1. To determine basic geospatial relationship (direction, distance, area size, elevation/altitude, volume etc.) of objects displayed in 3-D perspectives on computers.

2. To produce maps in 3-D perspectives on computers, if given necessary geospatial datasets.

3. To perform univariate and bivariate statistical analyses applied to geographically referenced data.

4. To understand the fundamental theories of spatial interpolation.

5. To perform surface interpolation of geographically reference data.

6. To perform model simulations on hydrologic processes.

Criteria for Grading:

Students will be graded on their performances in four sets of homework assignments. Each assignment must be turned in by the prescribed deadline. Each assignment consists of technical questions related to the course material covered and computer exercises.

	Time Allowed	Percentage contribution to the Final Grade
HW1	2.5 weeks	25%
HW2	2.5 weeks	25%
HW3	2.5 weeks	25%
HW4	2.5 weeks	25%

Grade Breakdown A (≥85%), B (≥70%), C (≥ 55%), D (≥40%), F (<40%)

Class Attendance:

Attendance is required although not part of the final grade.

NRM 5310 ADVANCED RANGE ECOLOGY (3 credit hours)

Instructor: Robert D. Cox
Office 09C, Goddard Building

742-2841 (Office)

Office Hours: 9:30-12:30 Monday, Wednesday, Thursday

or by appointment

Course Purpose:

An in-depth exploration of plant ecology theories and their application to the species and community levels. Individual environmental parameters and the plant's and community's response to these parameters will also be discussed, particularly as relating to arid and semi-arid environments and rangelands.

Expected Learning Outcomes:

At the end of the course, students should:

A. Understand how the history of plant ecological theory informs our current understanding:

Trace the development of ecological thought through time, and how discuss how one's background and experiences may influence their ecological thought.

Recognize major ecologists working today, as well as some of the ecologists who have influenced modern ecological thought.

B. Understand major plant communities of the world, with special focus on the United States:

Be able to recognize the major plant communities of North America and their geographical location.

Be able to describe the dominant plants, soils, and climate regime of each major plant community.

C. Understand the basics of prevailing world climates and climate change.

Describe the distribution of world climates and the causes of major climatic patterns.

Be able to associate specific plant formations with specific climatic regimes.

Understand the importance of climate and weather in influencing plant communities.

D. Be familiar with the environmental complex and selection of ecotypes best suited to particular environments:

Describe how the complexity of the environment, including climates and soils, influences plant communities and species.

Describe the adaptability of ecotypes to specific environmental regimes.

E. Understand resource allocation in plants as a response to varying environmental factors and management implications:

Be able to describe resource (i.e., energy) allocation in plants.

Define how plants are capable of responding to environmental cues and changing regimes.

Understand r- and k- selected life history patterns and their ecological relationships.

F. Understand how plants interact with each other:

Be able to describe different types of plant-plant interactions and how each interacting

member in affected.
Describe how plant interactions influence community development.
G. Gain a thorough understanding of plant succession:
Differentiate between primary and secondary succession.
Understand seral and climax stages.
Understand different models of community succession and change.
H. Understand energy budgets, energy relations, and water use by native plants:

Understand energy budgets and the inter-relationships of energy budget components

Understand plant responses to high and low temperatures.
Understand light influences on the vegetation, and how the vegetation influences the light within the community.
Understand C3, C4, and CAM photosynthetic pathways and their ecological relationships.
Understand water potentials and transpiration in natural environments.

NRM 5322 ADVANCED NONGAME ECOLOGY AND MANAGEMENT (3 credit hours)

Faculty Information:

Dr. Clint Boal Office - 218 Agriculture Sciences clint.boal@ttu.edu

Course Information:

- **Prerequisites:** NRM 2301 or consent of instructor
- **Required Text:** Assigned readings only. Copies of assigned readings will be placed on reserve.

Course Description and Purpose:

Wildlife Management in North America was originally based on game management. Evolving social viewpoints, improved understandings of biotic community health and ecosystem stability, the value of biodiversity, and shifting social attention on non-consumptive uses of wildlife resulted in nongame conservation and management. This course introduces graduate students to the issues relating to nongame species and their conservation. We will briefly review basic principles of wildlife management for a common frame of reference. We will then survey selected species and species groups, their environments, the conservation issues facing them, and management approaches taken. The semester will draw heavily on assigned readings followed by discussions. Quizzes will follow assigned readings.

Course Outline:

Month	Day	Topic	Assigned Readings	
Jan	12	Nongame Intro		
Jan	17	Who manages wildlife		
Jan	19	**No class**		
Jan	24	Legislation		
Jan	26	Endangered Species Act	Morrow et al. 2004,	**Quiz**
Jan	31	Wolves of Yellowstone	Handout	
Feb	2	Populations	Caughley and Sinclair Chp 4	**Quiz**
Feb	7	Conservation Genetics		
Feb	9	Monitoring Overview	Handout	
Feb	14	**EXAM I**		
Feb	**16**	**TWS Meeting**	**no class**	
Feb	21	Bird Migration		
Feb	23	Passerine Bird Declines		
Feb	28	Fragmentation studies	Franklin et al. 2002, Faaborg 2002	**Quiz**
Mar	2	NA birds	Askins Chp 2&3	**Quiz**
Mar	7	NA birds	Askins Chp 5&6	**Quiz**
Mar	9	NA birds	Askins Chp 8&9	**Quiz**
Mar	**14**	**Spring break**	**no class**	
Mar	**16**	**Spring break**	**no class**	
Mar	21	Raptors	TBA	**Quiz**
Mar	23	**EXAM II**		
Mar	28	Amphibian&Reptiles	Semlitsch 2000	**Quiz**
Mar	30	Amphibian&Reptiles	TBA	
Apr	4	Focus: *Atrox*	Beaupre and Duvall 1998, Fitzgerals and Painter 2000	**Quiz**
Apr	6	Mammals	Mattson 2004, Nie 2004	**Quiz**
Apr	11	Focus: *Chiroptera*	Grad Presentation	
Apr	13	Focus: *Urocyon & Vulpes*	Grad Presentation	
Apr	18	Focus: *Dipodomys*	Grad Presentation	
Apr	20	Urban Wildlife	Bolen and Robinson Ch 17	**Quiz**
Apr	25	Urban Wildlife	Gehrt 2004, Mannan and Boal 2004	**Quiz**
Apr	27	Wildlife Rehabilitation	TBA	
May	**2**	**Last Day**		

Although this is not a writing intensive course, **it is reading and discussion intensive**.

Expected Learning Outcomes:

1. Demonstrate an understanding of basic wildlife management history and principles and how they relate to nongame species conservation. This will include:
    - The history of wildlife management and legislation in the United States
    - Population growth and limitations
    - Influences of habitat and habitat change
    - Community structure and dynamics
2. Demonstrate an understanding of basic monitoring and inventory methods, and the inherit biases, used for nongame birds, mammals, reptiles and amphibians.
3. Demonstrate an understanding of causes of declines of selected North American nongame bird species in different environments, and the conservation approaches taken.
4. Demonstrate an understanding of migration ecology, and the conservation issues concerning bats and neotropical migrant birds.
5. Demonstrate an understanding of conservation issues concerning North American reptiles and amphibians.
6. Demonstrate an understanding of conservation issues, causes, and management approaches concerning declining species of selected North American nongame mammals

Criteria for Grading:

Exams will be from lecture notes, presentations, videos, and reading assignments. All exams will be comprehensive. Point values are as listed below.

Assignments and Exams	Points	% of grade	Points	Letter Grade
Exam I	100	22	405	= A
Exam II	100	22	360	= B
Final Exam	150	33	315	= C
Class Project (Individual Component)	50	11	270	= D

Class Project (Total Project)	25	6	< 270	= lets not go there
Assigned Lecture	25	6		
Total Points Available	450	100		

Meeting: Each student will schedule a 10 minute meeting with the instructor prior to the first exam.
Quizzes: Quizzes will be given following 12 reading assignments. The lowest 2 scores will be dropped.

Class Attendance:

Class attendance is expected. Excessive absences (>3/month) without discussion with the instructor is grounds for dropping you from the class. In the event of excessive absences, the student must visit the instructor to discuss his or her status in the course. If the drop occurs before the 45th class day of the long semester or the 15th class day of the summer term, the instructor will assign a grade of W (see sections on dropping a course and on withdrawal). If the drop occurs after that time period, the student will receive a grade of F. This drop can be initiated by the instructor but must be formally executed by the academic dean. In extreme cases the academic dean may suspend the student from the university.

Make-up exams: Make-up exams will usually not be given. Arrangements must be made with the instructor in advance. If you do not do so, you will receive 0 points for that exam.

NRM 5404 AERIAL TERRAIN ANALYSIS (4 credit hours)

Faculty Information:

Dr. Ernest B. Fish Office - Room 102B Goddard Building ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Campbell, J. B. 2002. Introduction to Remote Sensing. Third Edition. Guilford Press. New York, New York. 620 pp.
  Wanless, H. R. 1973. Aerial Stereo Photographs. Hubbard Press. Northbrook, Illinois. 92p.

Course Description and Purpose:

To provide the student an introductory knowledge of the principles of photogrammetry, geographic information systems, global positioning systems, and fundamentals of aerial photograph reading, interpretation, and evaluation with emphasis on and application to the management of renewable natural resources.

Course Outline:

I. Introduction
    A. Historical Background
    B. Terminology
II. Factors Influencing the Aerial Photograph
    A. The Aerial Camera
    B. The Camera Mounting
    C. Filters
    D. The Film
        1. General Film Construction
        2. Film Processing and Printing
    E. Atmospheric Conditions
    F. Surficial Characteristics
        1. Optical Properties
        2. Physical Properties
III. Characteristics of Aerial Photographs
    A. Vertical Photographs
        1. Scale
        2. Effective area
        3. Marginal Information
        4. Radial Displacement
        5. Flight Planning
    B. Oblique Photographs
        1. Types
        2. Scale
        3. Uses
IV. Stereoscopy - Stereoscopic Study of Aerial Photographs
    A. Properties of Human Vision
    B. The Stereoscopic Image
    C. Parallax
    D. Types of Stereoscopes
    E. Pseudoscopic Images
    F. Preparation for Stereoscopic Viewing
V. Basic Photogrammetric Techniques
    A. Radial Line Triangulation
        1. Theory
        2. General Methodology
        3. Types of Templates
        4. Radial Planimetric Plotter
        5. Sketchmaster Devices
    B. Topographic Mapping
        1. Techniques
        2. The Kelsh Plotter
VI. Characteristics of Digital Imagery
    A. Sensor Systems
        1. Landsat
        2. SPOT
    B. Digital Image Analysis
        1. Manual
        2. Computer Assisted
VII. Geographic Information Systems (GIS)
    A. Theory
    B. Applications and Examples
VIII. Global Positioning Systems (GPS)
    A. Theory
    B. Applications and Examples
IX. General Principles of Photo-Interpretation
    A. Introduction
    B. Diagnostic Characteristics of Images
    C. Photo-Interpretation Aids
X. Integrated Photographic Interpretation Applications
    A. Introduction
    B. Geographic Considerations

C. Geologic Considerations
D. Geomorphic Considerations
    1. Landform Analysis
    2. Drainage Pattern Analysis
    3. Soil Considerations
F. Vegetative Considerations
G. Hydrologic Considerations
H. Land Use Considerations

Expected Learning Outcomes:

1. To provide the student with a perspective of the historical development and current status of the fields of photogrammetry and photo interpretation.
2. To provide the student with a basic knowledge of the factors influencing the quality characteristics of aerial photography.
3. To provide the student with a basic understanding of photogrammetric principles and operations
4. To provide the student with a basic understanding of photo image interpretation principles and their specific applications in various areas of study
5. To provide the student with a basic understanding of digital image analysis.
6. To provide students with a basic understanding of Geographic Information Systems (GIS) and current GIS technology.
7. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Criteria for Grading:

Graded material will consist of 2 mid-term exams and a final exam all of which carry an equal weight and are comprehensive in nature (100 points each). Additionally, laboratory exercises will be graded and there will be laboratory quizzes which are unannounced. These exercises and quizzes usually constitute approximately 200 points. Total point accumulation for the entire course is normally 550-650.

Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester.

Student must pass the final exam to receive a passing grade for the course.

A	**90-100**
B	**80 - 90**
C	**70 - 80**
D	**60 - 70**
F	**<60**

NRM 6303 IMAGERY INTERPRETATION FOR NATURAL RESOURCE (3 credit hours)

Faculty Information:

Dr. Ernest B. Fish Office - Room 9 Goddard Building ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** RWFM 4403 or RWFM 5404 or equivalent course
- **Required Text:** Campbell, J. B. 1996. Introduction to Remote Sensing. Second Edition. Guilford Press. New York, New York. 622 pp.
  Wanless, H. R. 1973. Aerial Stereo Photographs. Hubbard Press. Northbrook, Illinois. 92p.

Course Description and Purpose:

To provide the student knowledge of geographic information systems, remote sensing imagery systems and fundamentals of imagery reading, interpretation, and evaluation with emphasis on and application to the management of renewable natural resources.

Course Outline:

I. Introduction
- A. General
- B. Review of Photogrammetric Principles
  1. Scale determinations and horizontal measurements
  2. Height determinations
     a. Single vertical photographs
     b. Vertical stereo pairs
  3. Area determinations
  4. Stereoscopy
     a. Airbase
     b. Stereoscope focal length
     c. Flying height
     d. Camera lens focal length
     e. Preparation for stereo viewing

II. Principles and Theories of Image Interpretation
- A. Levels of examination
  1. Image reading 2. Image analysis 3. Image interpretation
- B. Diagnostic characteristics of images
  1. Shape or configuration 2. Shadow 3. Tone, shade, color contrast 4. Pattern 5. Texture
  6. Surroundings or association 7. Size
- C. Levels of detail
  1. Reconnaissance 2. Semi-detailed 3. Detailed
- D. Interpretation Sequence
  1. Data collection 2. Synoptic overview 3. Preliminary interpretation 4. Detailed interpretation
  5. Formation of conclusions
- E. Miscellaneous considerations
  1. Backgrounds 2. Training 3. Experience

III. Imagery Producing Systems
- A. Photographic
  1. Black and white
     a. General photographic theory
     b. Photographic properties
        (1) Sensitometric
        (2) Image structure
            Color
            Color theory
            Photographic properties
  3. Color infrared
     a. Infrared theory
     b. Photographic properties
  4. Black and white infrared
- B. Thermal Imagery
  1. Thermal theory 2. System functions 3. Image characteristics
- C. Radar (S.L.A.R.) Imagery
  1. Radar theory 2. System functions 3. Image characteristics
- D. Multispectral Scanners
  1. Multispectral theory
  2. System functions

3. Data characteristics
   a. Imagery
   b. Electromagnetic

IV. Digital Image Analysis
  A. Manual
  B. Computer assisted
    1. Statistics extraction 2. Display alternatives 3. Image enhancement 4. Thematic extraction

V. Geographic Information Systems
  A. Characteristics
  B. Applications

VI. Global Positioning Systems (GPS)
  A. Theory and Characteristics
  B. Applications and Examples

VII. Integrated Interpretation and Applications
  A. General
  B. Agricultural Applications
    1. Soils mapping
    2. Land use classification
    3. Land capability classification
    4. Erosion surveys
    5. Salinity surveys
    6. Irrigation surveys
    7. Crop yield surveys
    8. Crop stress detection
  C. Forestry, Botany, Ecology Applications
    1. Temperate zone forestry 2. Tropical zone forestry 3. Botany - Ecology
  D. Urban and Regional Studies Applications
    1. Urban planning 2. Urban operations 3. Regional planning 4. Regional operations

VIII. Summary

Expected Learning Outcomes:

8. To provide the student with a perspective of the historical development and current status of the field of remote sensed imagery.
9. To provide the student with a basic knowledge of the factors influencing the quality characteristics of remote sensed imagery.
10. To provide the student with a basic understanding of image interpretation principles and their specific applications in various areas of study.
11. To provide the student with a basic understanding of digital image analysis.
12. To provide the student with a basic understanding of Geographic Information System technology.
13. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Criteria for Grading:

Graded material will consist of 2 mid-term exams and a final exam all of which carry an equal weight and are comprehensive in nature (100 points each).

NRM 6305 GEOSPATIAL TECHNIQUES IN NATURAL RESOURCE (3 credit hours)

Faculty Information:

Dr. Ernest B. Fish Dept. of Natural Resources Management

Course Information:

- Prerequisites: None
- Required Texts: -Chrisman, Nicholas. 1997. Exploring Geographic Information Systems. John Wiley and Sons, Inc. New York. 298p.
  -Ormsby, T., E. Napoleon, R. Burke, C. Groessl and L. Feaster. 2004. Getting to know ArcGIS desktop: basics of ArcView, ArcEditor, and ArcInfo. 2nd ed., updated for ArcGIS 9. ESRI Press. Redlands, California.
- Course Purpose: To provide the student an introductory knowledge of the principles of Geographic Information Systems and Global Positioning Systems. Applications for natural resource inventory, planning, and management will be emphasized.

Course Objectives:

1. To provide the student with a perspective of the historical development and current status of Geographic Information Systems and Global Positioning Systems technologies.

Expected Learning Outcomes:

   a. Be able to define and understand the specific technical terminology involved in the fields of Geographic Information Systems and Global Positioning Systems.
   b. Be able to identify suitable applications for Geographic Information Systems and/or Global Positioning Systems for the solution of renewable natural resource management problems.

2. To provide students with a basic understanding of Geographic Information Systems (GIS) and current GIS technology.

Expected Learning Outcomes:

   a. Be able to define and discuss the characteristics of a Geographic Information System.
   b. Be able to demonstrate an application of a Geographic Information System in the practical solution of a natural resource planning or management situation.

3. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Expected Learning Outcomes:

   a. Be able to identify and discuss the functional components of a Global Positioning System.
   b. Be able to use Global Positioning Systems equipment in a practical solution of a natural resource planning or management situation.

Criteria for grade determination:

Graded material will consist of an hourly midterm examination and a final exam each worth 100 points. Additionally, laboratory exercises and quizzes will constitute approximately 200 points. 200 points are allocated to class attendance and class participation. Total point accumulation for the entire course is normally 600 points.

Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester.

A	90 - 100
B	80 - 90
C	70 - 80
D	60 - 70
F	<60

PSS 5329 PRECISION AGRICULTURE (3 credit hours).

Faculty Information:

Dr. Stephen Maas Dept. of Plant and Soil Sciences
stephen.maas@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** None

Course Description and Purpose:

Introduction to site-specific management of agricultural crops emphasizing collection and use of geospatial information in performing variable-rate farming practices.

Expected Learning Outcomes:

At the completion of this course, the student should be able to:

1. Understand how to operate a GPS,
2. Understand how yield monitors work,
3. Understand how to sample a field for soil characteristics,
4. Understand how remote sensing can be used in site-specific farming,
5. Understand how to use a GIS for on-farm applications,
6. Understand how to use integrated pest management on a site-specific basis,
7. Understand how to use variable-rate equipment and autosteer.

Methods for Assessing Expected Learning Outcomes:

The expected learning outcomes for the course will be assessed with periodic class assignments and a final exam.

Course Assignments and Grading Procedures:

A. There will be several class assignments and a comprehensive final exam. The final exam may contain a variety of question types, including definitions, essay, and computational problems. The final exam is scheduled at the time specified by the University for this class.
B. Class assignments will consist of problems or exercises to be completed by the student.

Grades

Class Assignments (100 pts.) + Final Exam (100 pts.) = TOTAL (200 pts.)

Point Distribution

A =	200 – 180	(90-100%)
B =	179 – 160	(80-89%)
C =	159 – 140	(70-79%)
D =	139 – 120	(60-69%)
F =	0 - 119	(0-59%)

General Information:

A. No make-up exams will be given, except for University-approved absence.
B. Extra credit may be offered at the discretion of the Instructor.
C. “The University is committed to the principle that in no aspect of its programs shall there be differences in the treatment of persons because of race, creed, national origin, age, sex, or disability, and that equal opportunity and access to facilities shall be available to all. If you require special accommodations in order to participate, please contact the instructor. Students should present appropriate verification from “AccessTECH” located in the Counseling Center. No requirement exists that accommodations be made prior to completion of this approved University process.” The URL for AccessTECH is http://www.accesstech.dsa.ttu.edu/default.asp
D. Integrity and professionalism are expected at this level of education. Collaboration on assignments other than as specified, as well as dishonesty on exams, will not be tolerated. The guidelines set forth by the University will be followed with any infraction.
E. Regular class attendance is encouraged.

PSS 5333 SOIL AND PLANT RELATIONSHIPS (3 credit hours)

Faculty Information:

Dr. Robert J. Lascano USDA-ARS, 3810 4th Street, Lubbock, TX r-lascano@tamu.edu

Course Information:

- **Prerequisites:** Must be approved by instructor.
- **Required Text:** Given the interdisciplinary nature of this course no specific text is assigned to this class. Pertinent reference material is photocopied and distributed to students. Students are encouraged to purchase the student version of MathCad to solve homework assignments.

Course Description and Purpose:

This class teaches students in agronomy and associated disciplines about the physical principles and concepts as they relate to transport of *water* and *energy* in a soil-plan atmosphere system. Emphasis is given to measurement techniques and instrumentation of environmental parameters. The following is a general guideline used for each lecture.

- Outline of each lecture will be given to students.
- A suggested reading will be given for each lecture.
- Assigned readings will be given for each lecture with a required summary
- Assignment of problems (homework).

This course is to familiarize students with the basic concepts related to productivity and water management of agricultural systems. In addition, students are given pertinent literature related to the subject matter and are asked to provide synthesis of several journal articles. These are assigned based on the student's interests and background. Parts of the subject matter are specific to the interest and needs of the students.

Course Outline:

This is outline is subject to change and is modified to the specific needs and interests of the students that take this class.

1. Introduction of Materials and Basic Concepts
   - Introduction of course, instructor and students
   - Explanation to students of examinations, term paper, assignments, grades, etc.
2. Basic Physical Concepts
   I. Explanation of basic physical concepts, definitions and units
   a. Work, Pressure, Power, Mechanics, Water Potential
   b. *S.I.* Units
   c. The concept of a *flux*
3. Scientific Principles and Measurement Techniques
   a. Accuracy vs. precision
   b. Error in measurement
   c. Spatial variability
   d. Significant digits
4. Soil Water and Related Terms and Different Measurement Techniques
   - Gravimetric and volumetric methods
   - Direct vs. indirect methods
   - Soil hydraulic properties, i.e., water potential and hydraulic conductivity
5. Measurement of Environmental Parameters (irradiance, air temperature and humidity,& wind speed).
   - Instrumentation
   - Concept and calculation of potential evapotranspiration
   - Weather networks and the use of PET to calculate daily values of evapotranspiration

6 — 7. Water and Energy Balance, and Calculation of Fluxes

- Temperature, sensible heat
- Humidity, latent heat
- Radiation, radiant energy
- Gaseous diffusion
- Energy balance of a leaf

8 — 9. Soil-Water Balance of a Bare Soil (Concepts and Applications)

- Law of conservation of matter
- Inputs and outputs
- Integral form of the water balance equation
- Models of the soil water balance:
- General flow equation-Richard's equation

- Water Infiltration and evaporation from a bare soil

10. Energy and Water balance of a Soil-Plant System (Concepts and Examples)
    - Radiative energy transfer
    - Energy balance of the plant canopy
    - Energy balance of the soil surface
    - Root water uptake

11 — 12. Water Requirements of Crops and Irrigation
    - Precision farming (systems)
    - Variable rate technologies

13 — 14. Student Presentations
    - Oral presentations of term papers.

Expected Learning Outcomes:

Upon completion of this course, the students will be able to:

A. Have a general understanding of the factors that affect the energy and water balance of bare soil and cropped surfaces.

B. Have analytical skills to take weather information and calculate the potential evapotranspiration in reference to water requirement of crops.

C. Quantitative understanding of soil water in relation to crop water requirements.

D. Be able to apply theoretical concepts to practical applications of factors that affect crop production.

Criteria for Grading:

A. **Weekly homework assignments**. In these assignments students must answer open-ended questions and solve problems related to the subject of the weekly lectures. Students are encouraged to correct mistakes and return assignment for further verification. Students are encouraged to work as a team as a means to understand and comprehend difficult concepts. These homework assignments represent 20% of the final grade. All homework assignments with no exception are due a week after (7 days) given out in class.

B. **Mid-term exam**. An open book take home exam is given on the material covered in the first half of the class. Several questions are open-ended to allow students to search for information not necessarily given in class. This exam represents 15% of the final grade.

C. Weekly reading assignments. Every week students are given 2-3 journal articles and they are requested to provide a critical synthesis or summary of the paper. This also allows student's to practice technical writing. These assignments are 15% of the final grade. All reading assignments with no exception are due a week after (7 days) given out in class**.**

D. Term paper and Presentation. Students are requested to write a short term paper on a subject matter of their choice that is related to the content of the course. Also, students give a 12-15 minute oral presentation to the class on their term paper. This term paper and oral presentation represent 20% of the final grade.

E. Final Exam. A comprehensive open book exam is given at the end of the class. This exam follows the same format as that of the mid-term exam and represents 15% of the final grade.

F. Attendance and Student in-class participation. Class attendance and in-class discussion is encouraged and expected of all students. This component represents 15% of the final grade.

Grades:

Class attendance and participation 15%
Homework assignments 20%
Reading assignments 15%
Mid-term (open book) 15%
Class presentation (written and oral report) 20%
Take-Home open book final exam 15%

PSS 5334 SOILS AND CROPS IN ARID LANDS (3 credit hours)

Faculty Information:

Dr. Kevin Bronson Office : Room 7,Texas A&M Res & Extn Cntr kevin.bronson@ttu.edu

Course Information:

- **Prerequisites:** Introductory Soils
- **Required Text:** No one specific, chapters from multiple books provided as pdfs

Course Description and Purpose:

Overview of the soils, climate, geography, and cropping systems of arid and semiarid regions of the world. Soil and crop management topics specific to dry regions and case studies from six arid/semarid countries are addressed..

Course Outline:

Introduction to arid/semiarid regions

Saline/sodic soil management
Water management
Nutrient management
Conservation tillage
Erosion and CRP
Soil carbon management
Precision agriculture
Animal waste management
Wastewater and biosolids
West Texas case study
Eastern Colorado case study
Western Australia case study
Israel Negev case study
Pakistan case study
Uzbekistan case study
Afghanistan case study

Expected Learning Outcomes:

Students should understand and be able to discuss the following topics:

Definition of arid and semiarid regions
Saline/sodic soils and management
Water management in arid/semiarid regions
Nutrient management in arid/semiarid regions
Conservation tillage in arid/semiarid regions
Erosion and CRP
Soil carbon management
Precision agriculture in arid/semiarid regions
Animal waste management in arid/semiarid regions
Wastewater and biosolids in arid/semiarid regions
West Texas soils and crops
Eastern Colorado soils and crops
West/Central Asia soils and crops
Western Australia soils and crops
Israel Negev soils and crops

Criteria for Grading:

25 % mid-term, 25 % final, 25 % term paper and presentation, 25 % class participation

Class Attendance:

Required, no more than two absences, read assigned readings before class